Missouri River Basin (Upper Big Sioux, Lower Big Sioux, Little Sioux, and Rock River Watersheds) Monitoring and Assessment Report

Minnesota Pollution Control Agency

September 2014

Authors

MPCA Missouri River Basin Watersheds Report Team:
Aaron Onsrud, Dereck Richter, Joel Chirhart, Mike Koschak, Dave Christopherson, David Duffey, Bruce Monson, Shawn Nelson, Kris Parson, Kelli Nerem

Contributors / acknowledgements

Citizen Stream Monitoring Program Volunteers
Minnesota Department of Natural Resources
Minnesota Department of Health
Minnesota Department of Agriculture
Rock County SWCD
Nobles County SWCD
Pipestone County SWCD
Jackson County SWCD

Project dollars provided by the Clean Water Fund (from the Clean Water, Land and Legacy Amendment).

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 | www.pca.state.mn.us | 651-296-6300
Toll free 800-657-3864 | TTY 651-282-5332

This report is available in alternative formats upon request, and online at www.pca.state.mn.us

Document number: wq-ws3-10170204b

List of acronyms

AUID Assessment Unit Identification Determination

CCSI Channel Condition and Stability Index

CD County Ditch

CI Confidence Interval

CLMP Citizen Lake Monitoring Program

CR County Road

CSAH County State Aid Highway

CSMP Citizen Stream Monitoring Program

CWA Clean Water Act

CWLA Clean Water Legacy Act

DOP Dissolved Orthophosphate

E Eutrophic

EQuIS Environmental Quality Information System

EX Exceeds Criteria (Bacteria)

EXP Exceeds Criteria, Potential Impairment

EXS Exceeds Criteria, Potential Severe Impairment

FIBI Fish Index of Biotic Integrity

FS Full Support

FWMC Flow Weighted Mean Concentration

H Hypereutrophic

HUC Hydrologic Unit Code

IBI Index of Biotic Integrity

IF Insufficient Information

K Potassium

LRVW Limited Resource Value Water

M Mesotrophic

MCES Metropolitan Council Environmental Services

MDA Minnesota Department of Agriculture

MDH Minnesota Department of Health

MDNR Minnesota Department of Natural Resources

MIBI Macroinvertebrate Index of Biotic Integrity

MINLEAP Minnesota Lake Eutrophication Analysis Procedure

MPCA Minnesota Pollution Control Agency

MSHA Minnesota Stream Habitat Assessment

MTS Meets the Standard?

N Nitrogen

Nitrate-N Nitrate Plus Nitrite Nitrogen

NA Not Assessed

NHD National Hydrologic Dataset

NH3 Ammonia

NS Not Supporting

NT No Trend

OP Orthophosphate

P Phosphorous

PCB Poly Chlorinated Biphenyls

PWI Protected Waters Inventory

RNR River Nutrient Region

SWAG Surface Water Assessment Grant

SWCD Soil and Water Conservation District

SWUD State Water Use Database

TALU Tiered Aquatic Life Uses

TKN Total Kjeldahl Nitrogen

TMDL Total Maximum Daily Load

TP Total Phosphorous

TSS Total Suspended Solids

USGS United States Geological Survey

WPLMN Watershed Pollutant Load Monitoring Network

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Executive summary

The Missouri River Basin in Minnesota is made up of four major watersheds - the Upper Big Sioux River, Lower Big Sioux River, Rock River, and Little Sioux River. The Missouri River Basin drains roughly 1783 mi^2 of southwestern Lincoln, southwestern Murray, Rock, most of Nobles, and southwest Jackson counties. The four watersheds stretch from the South Dakota border near Lake Benton southeast to the Iowa border just west of Jackson. These four watersheds are all headwaters to the Big Sioux River and Little Sioux River which eventually flow into the Missouri River outside of the state. This area of Minnesota has very fertile soils and has an important agricultural economy rich in crop production and livestock operations. Wind power is another important part of the economy in southwest Minnesota. The high ground which separates the Missouri River Basin from the Minnesota River Basin is called Buffalo Ridge and is a prime place for wind turbines. This ridge also plays a role on how streams are configured in the watersheds.

These watersheds are home to the Topeka shiner. The Topeka shiner is a federally endangered fish species. They were found with some frequency thoughout our sampling in the Missouri River Basin. Topeka shiner were found in the Upper Big Sioux River Watershed (1 site, 24 individuals), Lower Big Sioux River Watershed (5 sites, 23 individuals), and the Rock River Watershed (14 sites, 133 individuals).

When early pioneers came to this area, tallgrass prairie was the predominant land cover. The soil was so fertile that it was quickly transformed into a booming agricultural area. Poor agricultural practices have created water quality impairments that are widespread across the watersheds. With the monitoring data in this study, 93 of 181 stream units (AUIDs) were assessed for aquatic life and/or aquatic recreation. Of the assessed streams, only three AUIDs were considered fully supporting of aquatic life and one stream was fully supporting of aquatic recreation. Fifty-three AUIDs are non-supporting of aquatic life and 31 non-supporting of aquatic recreation.

Drinking water, aquatic recreation and aquatic life uses are compromised by high nitrate, bacteria, and turbidity levels. These stressors are also likely impacting biological communities, a pattern observed across southern Minnesota. Unlike surrounding flatter watersheds, the Upper Big Sioux River, Lower Big Sioux River, and Rock River Watersheds have less channelized streams. This is mainly due to the presence of open pasture along the stream corridors instead of channelizing the streams for maximum row crop usage. The Little Sioux River Watershed is an exception with over 80% of the watershed channelized for agricultural purposes. Sediment turbidity impairments likely stems from stream bank erosion as streams cut into banks because of little or no vegetation due to grazing, trampling from livestock, increased flow rates from drain tile, and straightening of stream channels.

More work is needed to bring surface waters into compliance with water quality standards. Future turbidity reduction efforts should include measures to stabilize stream banks and reduce erosion. Attainment of water quality standards for bacteria and nitrates should focus on nonpoint sources of pollution including fertilizer and livestock waste management, and failing septic systems. Best management practices (BMPs) should be implemented in a targeted approach toward sensitive features on the landscape that are known to impact surface water quality to ensure restoration resource dollars are spent in areas where they will do the most good. Local cooperation will be crucial to making surface water quality improvements, as using regulatory authority to reduce nonpoint source pollution is limited.

Introduction

Water is one of Minnesota's most abundant and precious resources. The Minnesota Pollution Control Agency (MPCA) is charged under both federal and state law with the responsibility of protecting the water quality of Minnesota's water resources. MPCA's water management efforts are tied to the 1972 Federal Clean Water Act (CWA) which requires states to adopt water quality standards to protect their water resources and the designated uses of those waters, such as for drinking water, recreation, fish consumption and aquatic life. States are required to provide a summary of the status of their surface waters and develop a list of water bodies that do not meet established standards. Such waters are referred to as "impaired waters" and the state must make appropriate plans to restore these waters, including the development of Total Maximum Daily Loads (TMDLs). A TMDL is a comprehensive study determining the assimilative capacity of a waterbody, identifying all pollution sources causing or contributing to impairment, and an estimation of the reductions needed to restore a water body so that it can once again support its designated use.

The MPCA currently conducts a variety of surface water monitoring activities that support our overall mission of helping Minnesotans protect the environment. To successfully prevent and address problems, decision makers need good information regarding the status of the resources, potential and actual threats, options for addressing the threats and data on the effectiveness of management actions. The MPCA's monitoring efforts are focused on providing that critical information. Overall, the MPCA is striving to provide information to assess, and ultimately, to restore or protect the integrity of Minnesota's waters.

The passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 provided a policy framework and the initial resources for state and local governments to accelerate efforts to monitor, assess, restore, and protect surface waters. This work is implemented on an on-going basis with funding from the Clean Water Fund created by the passage of the Clean Water Land, and Legacy Amendment to the state constitution. To facilitate the best use of agency and local resources, the MPCA has developed a watershed monitoring strategy which uses an effective and efficient integration of agency and local water monitoring programs to assess the condition of Minnesota's surface waters, and to allow for coordinated development and implementation of water quality restoration and improvement projects.

The strategy behind the watershed monitoring approach is to intensively monitor streams and lakes within a major watershed to determine the overall health of water resources, identify impaired waters, and to identify waters in need of additional protection. The benefit of the approach is the opportunity to begin to address most, if not all, impairments through a coordinated TMDL process at the watershed scale, rather than the reach-by-reach and parameter-by-parameter approach often historically employed. The watershed approach will more effectively address multiple impairments resulting from the cumulative effects of point and nonpoint sources of pollution and further the CWA goal of protecting and restoring the quality of Minnesota's water resources.

This watershed-wide monitoring approach was implemented in the Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux Watersheds beginning in the summer of 2011. This report provides a summary of all water quality assessment results in the Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux Watersheds and incorporates all data available for the assessment process including watershed monitoring, volunteer monitoring and monitoring conducted by local government units.

I. The watershed monitoring approach

The watershed approach is a 10-year rotation for monitoring and assessing waters of the state on the level of Minnesota's 81 major watersheds (Figure 1). The major benefit of this approach is the integration of monitoring resources to provide a more complete and systematic assessment of water quality at a geographic scale useful for the development and implementation of effective TMDLs, project planning, effectiveness monitoring and protection strategies. The following paragraphs provide details on each of the four principal monitoring components of the watershed approach. For additional information see: Watershed Approach to Condition Monitoring and Assessment (MPCA 2008) (http://www.pca.state.mn.us/publications/wq-s1-27.pdf).

Pollutant Load Monitoring Network

The Watershed Pollutant Load Monitoring Network (WPLMN) is a long-term monitoring approach designed to measure levels of key pollutants in the state's watersheds and compare regional differences and long-term trends in water quality among Minnesota's major rivers, including the Red, Rainy, St. Croix, Mississippi, and Minnesota. Since the network's inception in 2007, the WPLMN has adopted a multi-agency monitoring design that combines site specific stream flow data from United States Geological Survey (USGS) and Minnesota Department of Natural Resources (MDNR) flow gaging stations, with water quality data collected by the Metropolitan Council Environmental Services (MCES), local monitoring organizations and the MPCA. WPLMN staff compute annual pollutant loads at 79 river monitoring sites across Minnesota. Intensive water quality sampling occurs year round at all WPLMN sites. Data will also be used to assist with TMDL studies and implementation plans, watershed modeling efforts and watershed research projects.

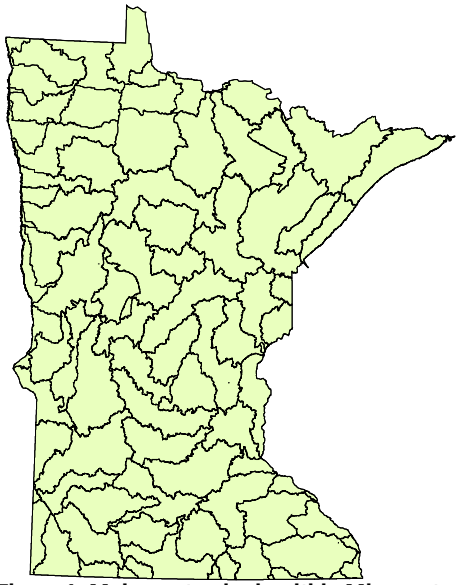

Figure 1. Major watersheds within Minnesota (8-Digit HUC).

Intensive watershed monitoring

The intensive watershed monitoring (IWM) strategy utilizes a nested watershed design allowing the sampling of streams within watersheds from a coarse scale to a fine scale (Figure 2). Each watershed scale is defined by a hydrologic unit code (HUC). These HUCs define watershed boundaries for water bodies within a similar geographic and hydrologic extent. The foundation of this approach is the 81 major watersheds (8-HUC) within Minnesota. Using this approach many of the smaller headwaters and tributaries to the main stem river are sampled in a systematic way so that a more holistic assessment of the watershed can be conducted and problem areas identified without monitoring every stream reach. Each major watershed is the focus of attention for at least one year within the 10-year cycle.

River/stream sites are selected near the outlet of each of three watershed scales, 8-HUC, 12-HUC and 14-HUC (Figure 2). Within each scale, different water uses are assessed based on the opportunity for that use (i.e., fishing, swimming, supporting aquatic life such as fish and insects). The major river watershed is represented by the 8-HUC scale. The outlet of the major 8-HUC watershed (purple dot in Figure 3) is sampled for biology (fish and macroinvertebrates), water chemistry and fish contaminants to allow for the assessment of aquatic life, aquatic recreation and aquatic consumption use support. The 12-HUC is the next smaller subwatershed scale which generally consists of major tributary streams with drainage areas ranging from 75 to 150 mi^2. Each 12-HUC outlet (green dots in Figure 3) is sampled for biology and water chemistry for the assessment of aquatic life and aquatic recreation use support.

Within each 12-HUC, smaller subwatersheds (14 HUCs, typically 10-20 mi^2), are sampled at each outlet that flows into the major 12-HUC tributaries. Each of these minor subwatershed outlets is sampled for biology to assess aquatic life use support (red dots in Figure 3).

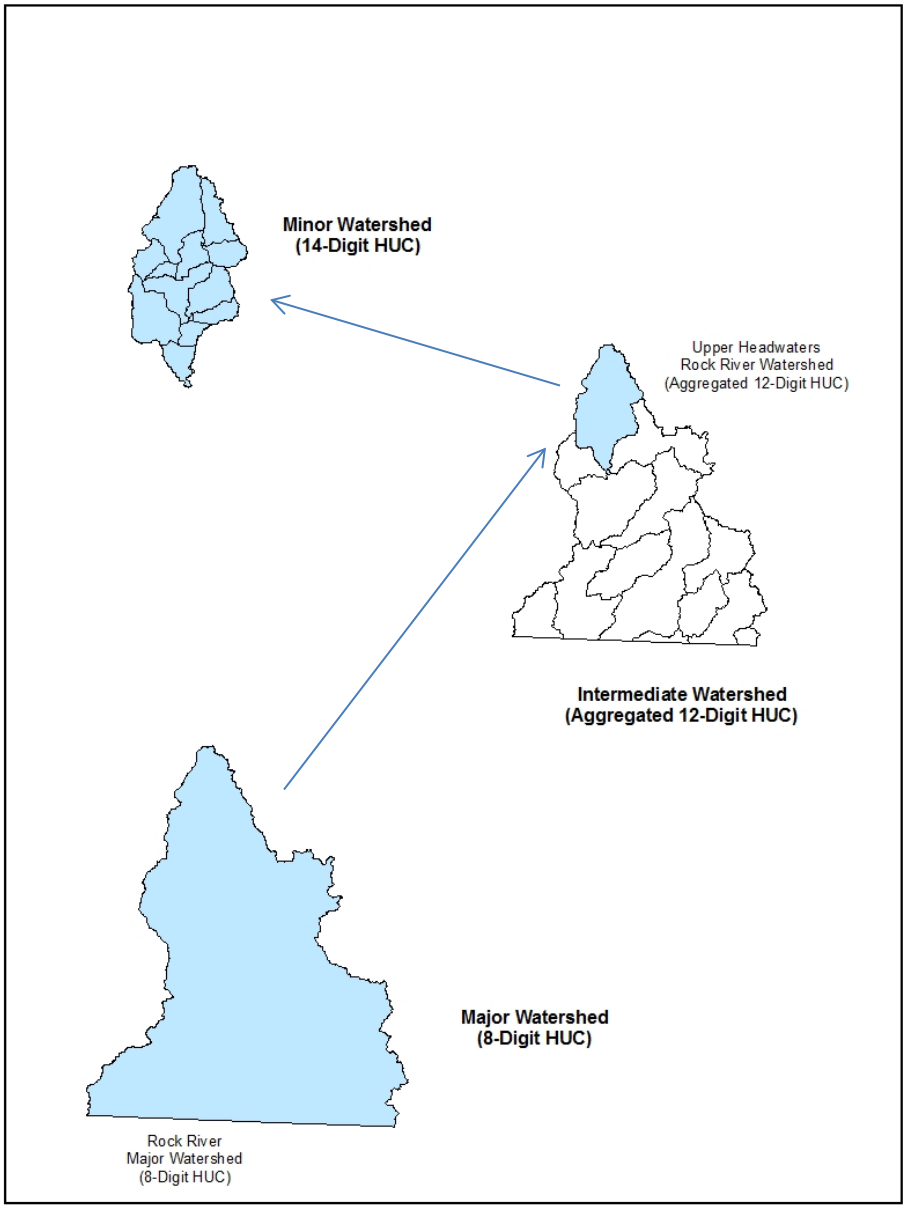

Figure 1. The intensive watershed monitoring design.

Within the IWM strategy, lakes are selected to represent the range of conditions and lake type (size and depth) found within the watershed. Lakes most heavily used for recreation (all those greater than 500 acres and at least 25% of lakes 100-499 acres) are monitored for water chemistry to determine if recreational uses, such as swimming and wading, are being supported. Lakes are sampled monthly from May-September for a two-year period. There is currently no tool that allows us to determine if lakes are supporting aquatic life; however, a method that includes monitoring fish and aquatic plant communities is in development.

Specific locations for sites sampled as part of the intensive monitoring effort in the Upper Big Sioux (pages 40-45), Lower Big Sioux (pages 46-83), Rock (pages 84-151), and Little Sioux (pages 152-177)

Watersheds are shown in Figure 3 and are listed in Appendix 2, Appendix 4.2, Appendix 4.3, Appendix 5.2 and Appendix 5.3.

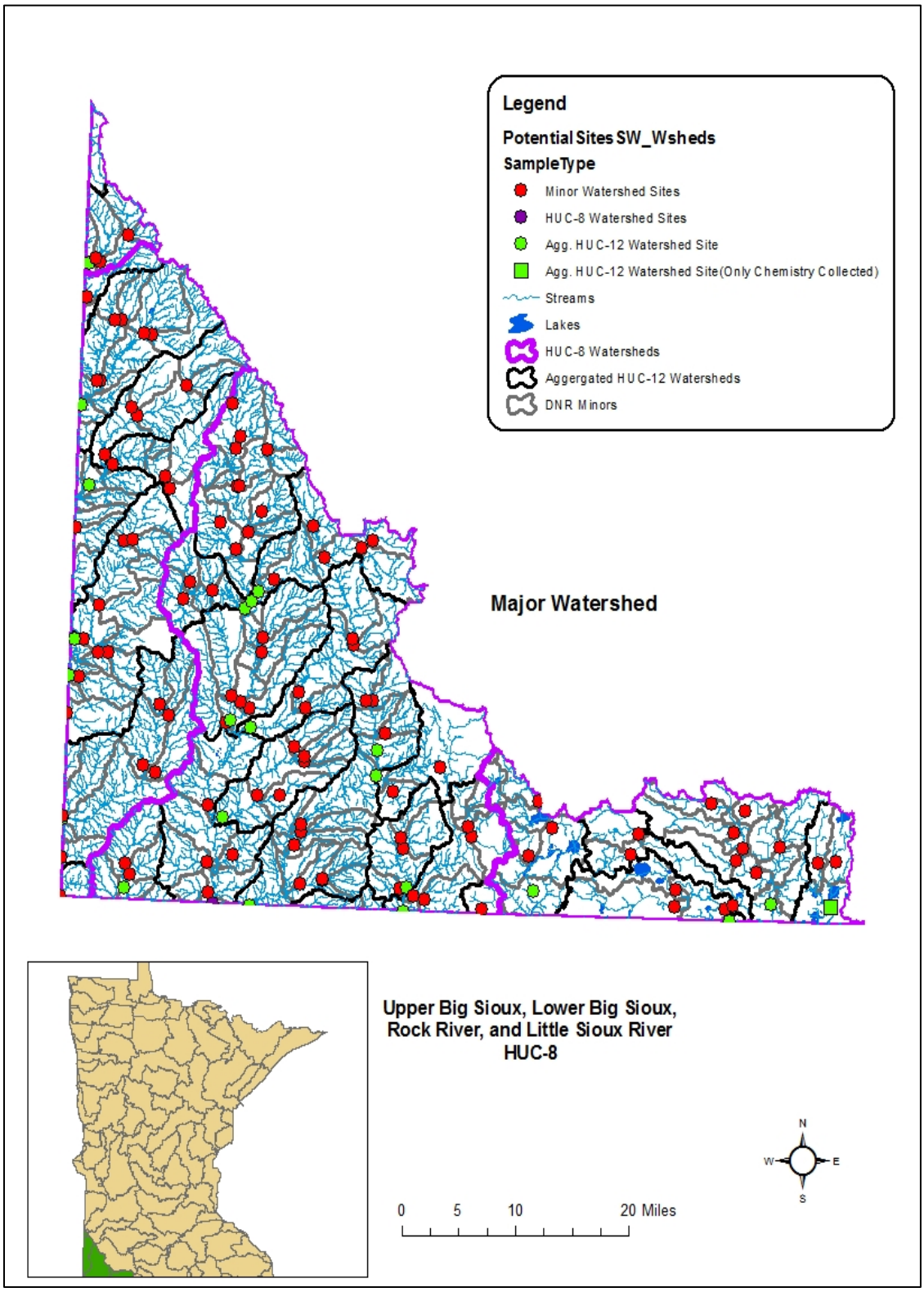

Figure 2. Intensive watershed monitoring sites for streams in the Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux Watersheds.

Citizen and local monitoring

Citizen and local monitoring is an important component of the watershed approach. The MPCA and its local partners jointly select the stream sites and lakes to be included in the IWM process. Funding passes from MPCA through Surface Water Assessment Grants (SWAGs) to local groups such as counties, soil and water conservation districts (SWCDs), watershed districts, nonprofits and educational institutions to support lake and stream water chemistry monitoring. Local partners use the same monitoring protocols as the MPCA, and all monitoring data from SWAG projects are combined with the MPCA's to assess the condition of Minnesota lakes and streams. Preplanning and coordination of sampling with local citizens and governments helps focus monitoring where it will be most effective for assessment and observing long-term trends. This allows citizens/governments the ability to see how their efforts are used to inform water quality decisions and track how management efforts affect change. Many SWAG grantees invite citizen participation in their monitoring projects and their combined participation greatly expand our overall capacity to conduct sampling.

The MPCA also coordinates two programs aimed at encouraging long term citizen surface water monitoring: the Citizen Lake Monitoring Program (CLMP) and the Citizen Stream Monitoring Program (CSMP). Like the permanent load monitoring network, having citizen volunteers monitor a given lake or stream site monthly and from year to year can provide the long-term picture needed to help evaluate current status and trends. Citizen monitoring is especially effective at helping to track water quality changes that occur in the years between intensive monitoring years. Figure 4, Figure 5, Figure 6, and Figure 7 provides an illustration of the locations where citizen monitoring data were used for assessment in the Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux Watersheds.

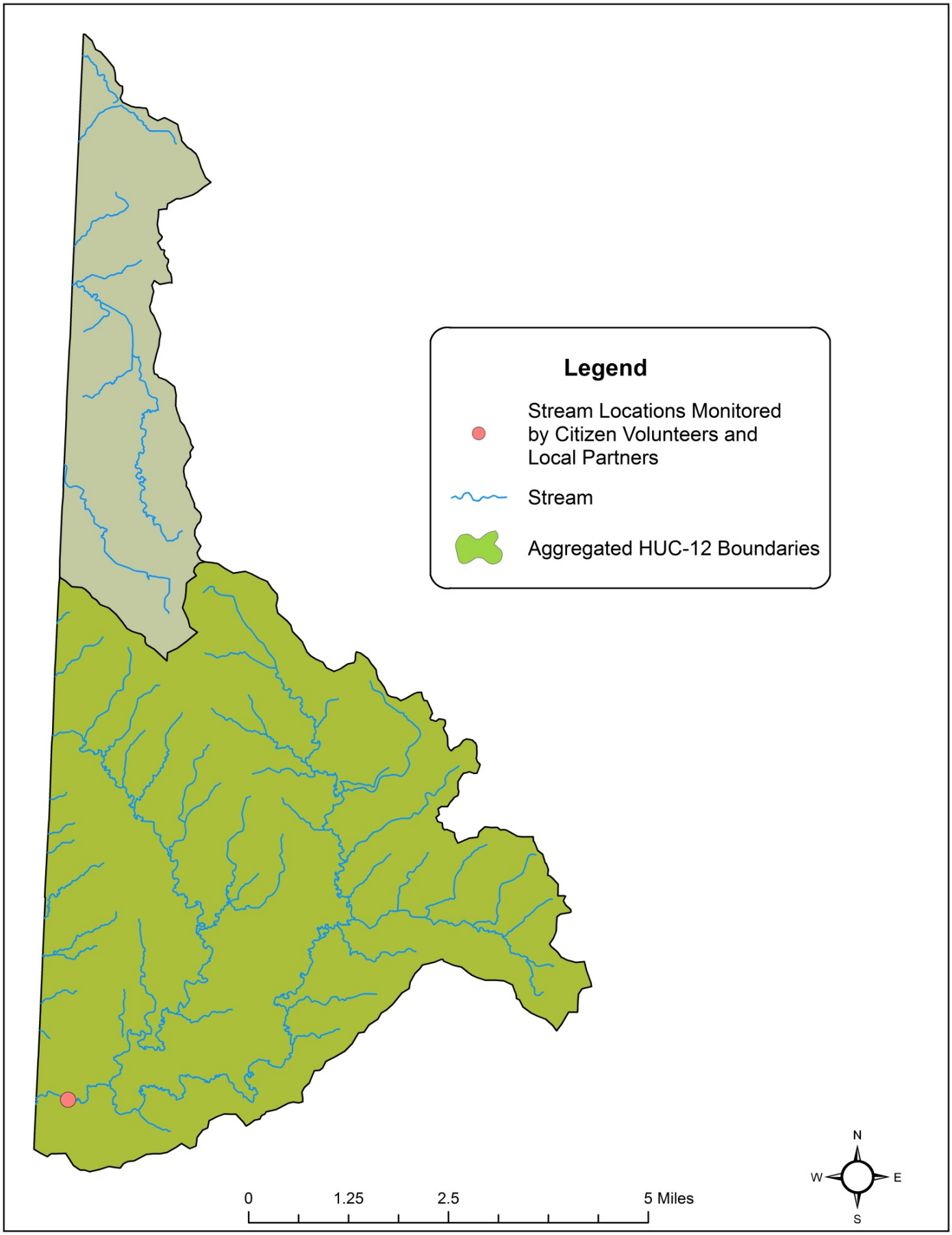

Figure 3. Monitoring locations of local groups that monitored a stream in the Upper Big Sioux River Watershed.

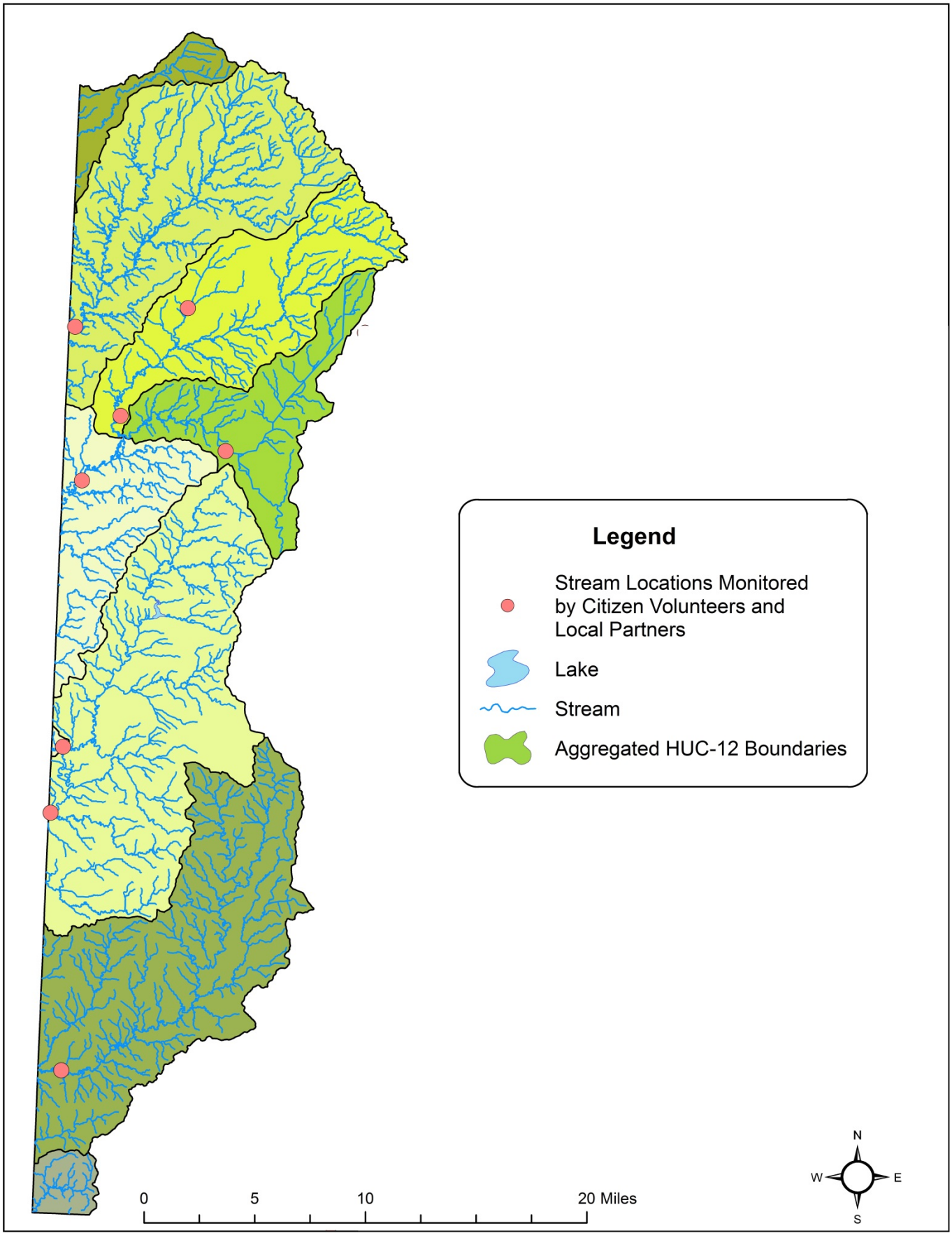

Figure 5. Monitoring locations of local groups and citizens monitoring the Lower Big Sioux River Watershed.

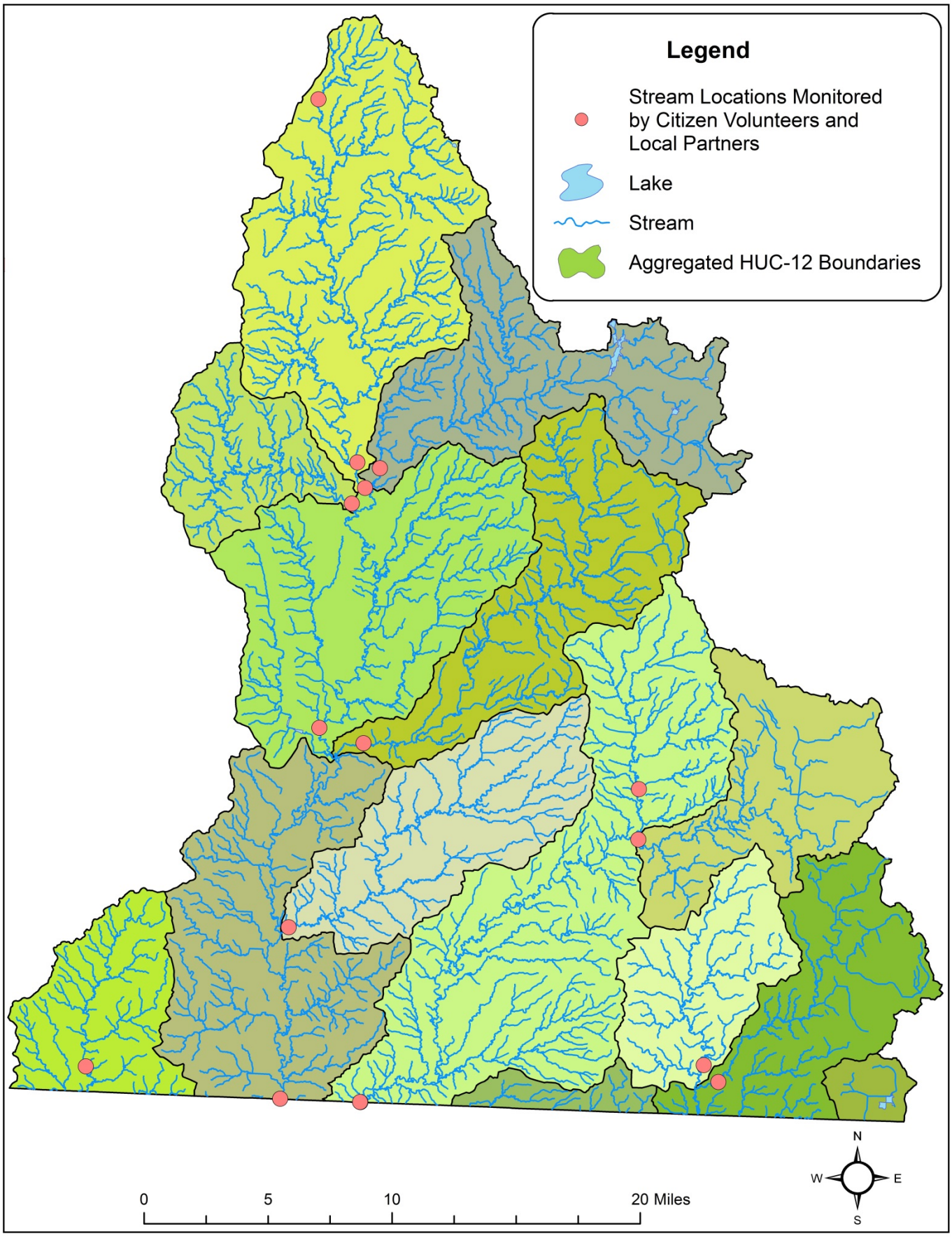

Figure 6. Monitoring locations of local groups and citizens monitoring the Rock River Watershed.

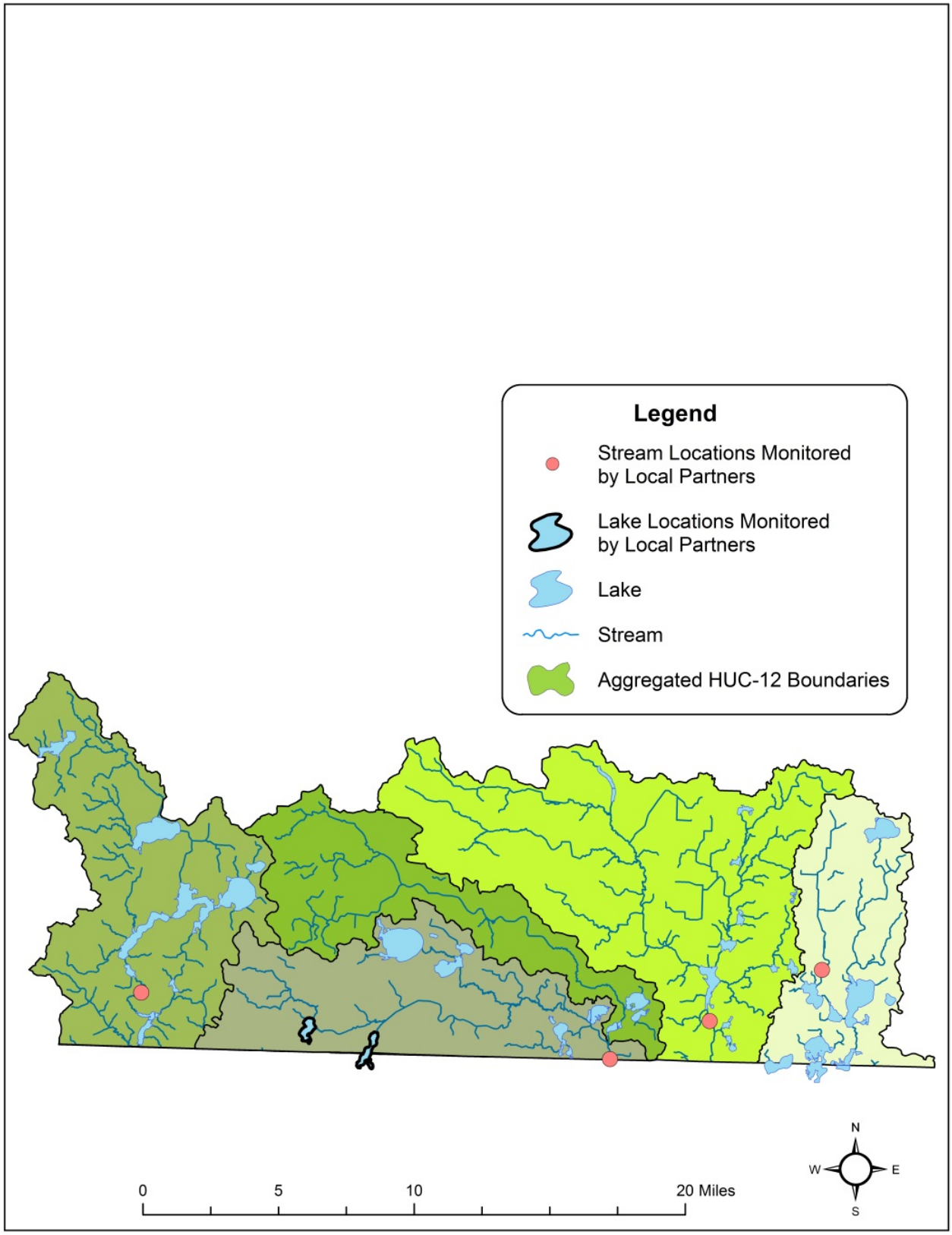

Figure 4. Monitoring locations of local groups, citizens and the MPCA lake monitoring staff in the Little Sioux River Watershed.

II. Assessment methodology

The CWA requires states to report on the condition of the waters of the state every two years. This biennial report to Congress contains an updated list of surface waters that are determined to be supporting or non-supporting of their designated uses as evaluated by the comparison of monitoring data to criteria specified by Minnesota Water Quality Standards (Minn. R. ch. 7050 2008; https://www.revisor.leg.state.mn.us/rules/?id=7050). The assessment and listing process involves dozens of MPCA staff, other state agencies, and local partners. The goal of this effort is to use the best data and best science available to assess the condition of Minnesota's water resources. For a thorough review of the assessment methodologies see: Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2012). http://www.pca.state.mn.us/index.php/view-document.html?gid=16988.

Water quality standards

Water quality standards are the fundamental benchmarks by which the quality of surface waters are measured and used to determine impairment. These standards can be numeric or narrative in nature and define the concentrations or conditions of surface waters that allow them to meet their designated beneficial uses, such as for fishing (aquatic life), swimming (aquatic recreation) or human consumption (aquatic consumption). All surface waters in Minnesota, including lakes, rivers, streams, and wetlands are protected for aquatic life and recreation where these uses are attainable. Numeric water quality standards represent concentrations of specific pollutants in water that protect a specific designated use. Narrative standards are statements of conditions in and on the water, such as biological condition, that protect their designated uses.

Protection of aquatic life means the maintenance of a healthy aquatic community, including fish, invertebrates, and plants. The sampling of aquatic organisms for assessment is called biological monitoring. Biological monitoring is a direct means to assess aquatic life use support, as the aquatic community tends to integrate the effects of all pollutants and stressors over time. Interpretations of narrative criteria for aquatic life in streams are based on multi-metric biological indices including the Fish Index of Biological Integrity (Fish IBI), which evaluates the health of the fish community, and the Macroinvertebrate Index of Biological Integrity (macroinvertebrate IBI), which evaluates the health of the aquatic invertebrate community. Additionally, chemical parameters are measured and assessed against numeric standards developed to be protective of aquatic life, including pH, dissolved oxygen, un-ionized ammonia nitrogen, chloride and turbidity.

Protection of aquatic recreation means the maintenance of conditions safe and suitable for swimming and other forms of water recreation. In streams, aquatic recreation is assessed by measuring the concentration of E. coli bacteria in the water. To determine if a lake supports aquatic recreational activities its trophic status is evaluated, using total phosphorus, secchi depth, and chlorophyll-a as indicators. Lakes that are enriched with nutrients and have abundant algal growth are eutrophic and do not support aquatic recreation.

Protection of consumption means protecting citizens who eat fish from Minnesota waters or receive their drinking water from waterbodies protected for this beneficial use. The concentrations of mercury and polychlorinated biphenyls (PCBs) in fish tissue are used to evaluate whether or not fish are safe to eat in a lake or stream and to issue recommendations regarding the frequency that fish from a particular waterbody can be safely consumed. For lakes, rivers, and streams that are protected as a source of drinking water, the MPCA primarily measures the concentration of nitrate in the water column to assess this designated use.

A small percentage of stream miles in the state (~1% of 92,000 miles) have been individually evaluated and re-classified as a Class 7 Limited Resource Value Water (LRVW). These streams have previously

demonstrated that the existing and potential aquatic community is severely limited and cannot achieve aquatic life standards either by: a) natural conditions as exhibited by poor water quality characteristics, lack of habitat or lack of water; b) the quality of the resource has been significantly altered by human activity and the effect is essentially irreversible; or c) there are limited recreational opportunities (such as fishing, swimming, wading or boating) in and on the water resource. While not being protective of aquatic life, LRVWs are still protected for industrial, agricultural, navigation and other uses. Class 7 waters are also protected for aesthetic qualities (e.g., odor), secondary body contact, and groundwater for use as a potable water supply. To protect these uses, Class 7 waters have standards for bacteria, pH, dissolved oxygen and toxic pollutants.

Assessment units

Assessments of use support in Minnesota are made for individual waterbodies. The waterbody unit used for river systems, lakes, and wetlands is called the "assessment unit". A stream or river assessment unit usually extends from one significant tributary stream to another or from the headwaters to the first tributary. A stream "reach" may be further divided into two or more assessment reaches when there is a change in use classification (as defined in Minn. R. ch. 7050) or when there is a significant morphological feature, such as a dam or lake, within the reach. Therefore, a stream or river is often segmented into multiple assessment units that are variable in length. The MPCA is using the 1:24,000 scale high resolution National Hydrologic Dataset (NHD) to define and index stream, lake and wetland assessment units. Each river or stream reach is identified by a unique waterbody identifier (known as its AUID), comprised of the USGS eight digit hydrologic unit code (8-HUC) plus a three character code that is unique within each HUC. Lake and wetland identifiers are assigned by the MDNR) The Protected Waters Inventory (PWI) provides the identification numbers for lake, reservoirs and wetlands. These identification numbers serve as the AUID and are composed of an eight digit number indicating county, lake and bay for each basin.

It is for these specific stream reaches or lakes that the data are evaluated for potential use impairment. Therefore, any assessment of use support would be limited to the individual assessment unit. The major exception to this is the listing of rivers for contaminants in fish tissue (aquatic consumption). Over the course of time it takes fish, particularly game fish, to grow to "catchable" size and accumulate unacceptable levels of pollutants, there is a good chance they have traveled a considerable distance. The impaired reach is defined by the location of significant barriers to fish movement such as dams upstream and downstream of the sampled reach and thus often includes several assessment units.

Determining use attainment

For beneficial uses related to human health, such as drinking water or aquatic recreation, the relationship is well understood and thus the assessment process is a relatively simple comparison of monitoring data to numeric standards. In contrast, assessing whether a waterbody supports a healthy aquatic community is not as straightforward and often requires multiple lines of evidence to make use attainment decisions with a high degree of certainty. Incorporating a multiple lines of evidence approach into MPCA's assessment process has been evolving over the past few years. The current process used to assess the aquatic life use of rivers and streams is outlined below and in Figure 8.

The first step in the aquatic life assessment process is a comparison of the monitoring data to water quality standards. This is largely an automated process performed by logic programmed into a database application and the results are referred to as 'Pre-Assessments'. Pre-assessments are then reviewed by either a biologist or water quality professional, depending on whether the parameter is biological or chemical in nature. These reviews are conducted at the workstation of each reviewer (i.e., desktop) using computer applications to analyze the data for potential temporal or spatial trends as well as gain a better understanding of any attenuating circumstances that should be considered (e.g., flow, time/date of data collection, or habitat).

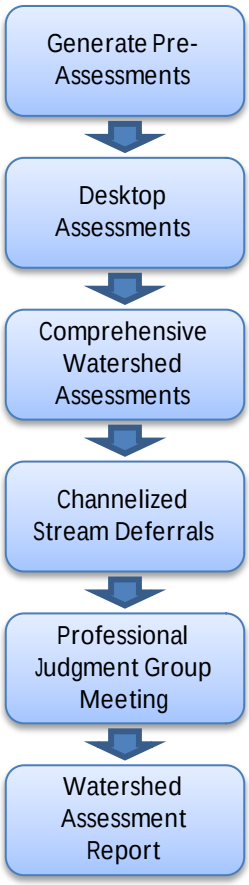

Figure 5. Flowchart of aquatic life use assessment process.

The next step in the process is a Comprehensive Watershed Assessment meeting where reviewers convene to discuss the results of their desktop assessments for each individual waterbody. Implementing a comprehensive approach to water quality assessment requires a means of organizing and evaluating information to formulate a conclusion utilizing multiple lines of evidence. Occasionally, the evidence stemming from individual parameters are not in agreement and would result in discrepant assessments if the parameters were evaluated independently. However, the overall assessment considers each piece of evidence to make a use attainment determination based on the preponderance of information available. See the Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List (MPCA 2012) http://www.pca.state.mn.us/index.php/view-document.html?gid=16988 for guidelines and factors considered when making such determinations.

Any new impairment (i.e., waterbody not attaining its beneficial use) is first reviewed using GIS to determine if greater than 50% of the assessment unit is channelized. Currently, the MPCA is deferring any new impairments on channelized reaches until new aquatic life use standards have been developed as part of the Tiered Aquatic Life Use (TALU) framework. For additional information, see: http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-rulemaking/tiered-aquatic-life-use-talu-framework.html. However, in this report, channelized reaches with biological data are evaluated on a "good-fair-poor"

The last step in the assessment process is the Professional Judgment Group meeting. At this meeting results are shared and discussed with entities outside of the MPCA that may have been involved in data collection or that might be responsible for local watershed reports and project planning. Information obtained during this meeting may be used to revise previous use attainment decisions (e.g., sampling events that may have been uncharacteristic due to annual climate or flow variation, local factors such as

impoundments that do not represent the majority of conditions on the AUID). Waterbodies that do not meet standards and therefore do not attain one or more of their designated uses are considered impaired waters and are placed on the draft 303(d) Impaired Waters List. Assessment results are also included in watershed monitoring and assessment reports.

Data management

It is MPCA policy to use all credible and relevant monitoring data to assess surface waters. The MPCA relies on data it collects along with data from other sources, such as sister agencies, local governments and volunteers. The data must meet rigorous quality assurance protocols before being used. All monitoring data required or paid for by MPCA are entered into EQuIS (Environmental Quality Information System), MPCA's data system and are also uploaded to the US Environmental Protection Agency's data warehouse. Data for monitoring projects with federal or state funding are required to be stored in EQuIS (e.g., Clean Water Partnership, CWLA Surface Water Assessment Grants and TMDL program). Many local projects not funded by MPCA also choose to submit their data to the MPCA in an EQuIS-ready format so that the monitoring data may be utilized in the assessment process. Prior to each assessment cycle, the MPCA sends out a request for monitoring data to local entities and partner organizations.

Period of record

The MPCA uses data collected over the most recent 10 year period for all water quality assessments. This time-frame provides a reasonable assurance that data will have been collected over a range of weather and flow conditions and that all seasons will be adequately represented; however, data for the entire period is not required to make an assessment. The goal is to use data that best represents current water quality conditions. Therefore, recent data for pollutant categories such as toxics, lake eutrophication and fish contaminants may be given more weight during assessment.

III. Watershed overview

The Missouri River Basin in Minnesota consists of four major watersheds: Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux. These are not true complete watersheds in the sense that only a small percentage of the overall area of each of these watersheds falls within the border of Minnesota. The Missouri River Basin drains approximately 1,783 mi2 of southwest Minnesota. Its northern boundary is just west of Lake Benton and the Redwood Watershed and borders South Dakota to the west all the way south to the Iowa border. The eastern most edge of the basin is just west of Jackson and the Lower Des Moines Watershed, and follows the Iowa border west to the South Dakota border. Most of the eastern border of the watershed borders the Des Moines Watershed. The Upper Big Sioux, Lower Big Sioux, and the Rock River drain into the Big Sioux River, which eventually empties into the Missouri River in Sioux City, Iowa. The Little Sioux River is a direct tributary that flows south and enters the Missouri River in Little Sioux, Iowa. With the exception of the Rock River Watershed, many of the headwater streams do not connect with the mainstem river of their watershed in Minnesota. These watersheds are home to the Topeka shiner which is the only federally endangered fish species in Minnesota.

The Upper Big Sioux Watershed is the smallest of the four watersheds, drains 41 mi2 of southwest Lincoln County, and is housed entirely in the Northern Glaciated Plains ecoregion (Figure 9) (Omernik and Gallant, 1988). The Lower Big Sioux Watershed drains 511 mi2 of southwest Lincoln, western Pipestone, and western Rock Counties. The northern third of the watershed falls in the Northern Glaciated Plains ecoregion and the southern two-thirds falls in the Western Corn Belt Plains ecoregion (Figure 10) (Omernik and Gallant, 1988). The Rock River Watershed is the largest of the four watersheds and drains 910 mi2 of southeast Pipestone, southwest Murray, eastern Rock, and western Nobles Counties. The northern tip of the watershed falls in the Northern Glaciated Plains ecoregion and the rest is in the Western Corn Belt Plains ecoregion (Figure 11) (Omernik and Gallant, 1988). The Little Sioux River Watershed drains 321 mi2 of southeast Nobles and southwest Jackson Counties. The watershed falls completely in the Western Corn Belt Plains ecoregion (Figure 12) (Omernik and Gallant, 1988).

There are two types of landscape ecosystems in the Missouri River Basin. The coteau is typified by highly dissected, loess-covered till plains that are Illinoian, pre-Illinoian, and late Wisconsinan in age (Lehr and Gilbertson 1988). These were originally covered with tallgrass and midgrass (mixed grass) prairie. The outer edges of the coteau are non-dissected, non-loess-covered late Wisconsinan (Des Moines lobe) end and ground moraines. This is the loess-mantled terrain beyond the outer margin of Wisconsin Glaciation. The drainage system is better developed than in more recently glaciated portions of the coteau, and there are relatively few wetlands. A massive outcrop of red quartzite bedrock is a prominent landmark. This ridge is called Buffalo Ridge and is 60 miles long through Lincoln, Pipestone, Murray, Nobles and Rock Counties, and divides the Missouri and Mississippi River Basins. Because of its high altitude compared to surrounding land and high average wind speed, Buffalo Ridge has been transformed into a place for creating alternative energy. Currently, hundreds of wind turbines stand along Buffalo Ridge.

Uninterrupted prairie originally covered the basin. The Missouri River Basin in Minnesota, like most areas across the Midwest, has a watershed that has been converted from mostly a range of tallgrass prairie and a small amount of wet prairies to a matrix of intensive agricultural uses. This conversion has resulted in large alterations to watersheds in the portions of the Missouri River Basin in Minnesota. Primarily, the alteration has been an increase in overland flow of energy and material resources resulting from a decrease in groundwater infiltration/subsurface recharge. An increase in surface runoff has been associated with increases in the nonpoint source transport of sediment, nutrients, agricultural and residential chemicals, and feedlot runoff.

Land use summary

The Upper Big Sioux River Watershed land use can be characterized as forest/shrub (0.33%), rangeland (34.14%), cropland (60.20%), developed (4.6%), wetland (0.69%), open water (0.04%) and barren land (0.01%) (Figure 13). The Lower Big Sioux River Watershed land use can be characterized as forest/shrub (0.61%), rangeland (15.21%), cropland (77.35%), developed (5.86%), wetland (0.73%), open water (0.14%) and barren land (0.02%) (Figure 14). The Rock River Watershed land use can be characterized as forest/shrub (0.84%), rangeland (10.86%), cropland (80.59%), developed (6.24%), wetland (1.19%), open water (0.21%) and barren land (0.07%) (Figure 15). The Little Sioux River Watershed land use can be characterized as forest/shrub (1.32%), rangeland (3.42%), cropland (82.71%), developed (6.14%), wetland (2.72%), open water (3.64%) and barren land (0.03%) (Figure 14). The entire region of the Missouri River Basin is dominated by row crop agriculture with scattered livestock operations. Cropland is predominately planted in corn, forage for livestock, and soybeans (MNDA 2009 and MNDA 2010). Rangeland typically follows stream corridors, which is a large reason for less channelization of the streams than in similar regions of Minnesota. The Little Sioux River Watershed has less rangeland and more channelization due to more intensive crop farming.

The watershed is predominately rural, with populations clustered in its largest city Worthington (12,764), Luverne (4,745), and Pipestone (4,317) (U.S. Census Bureau, 2010).

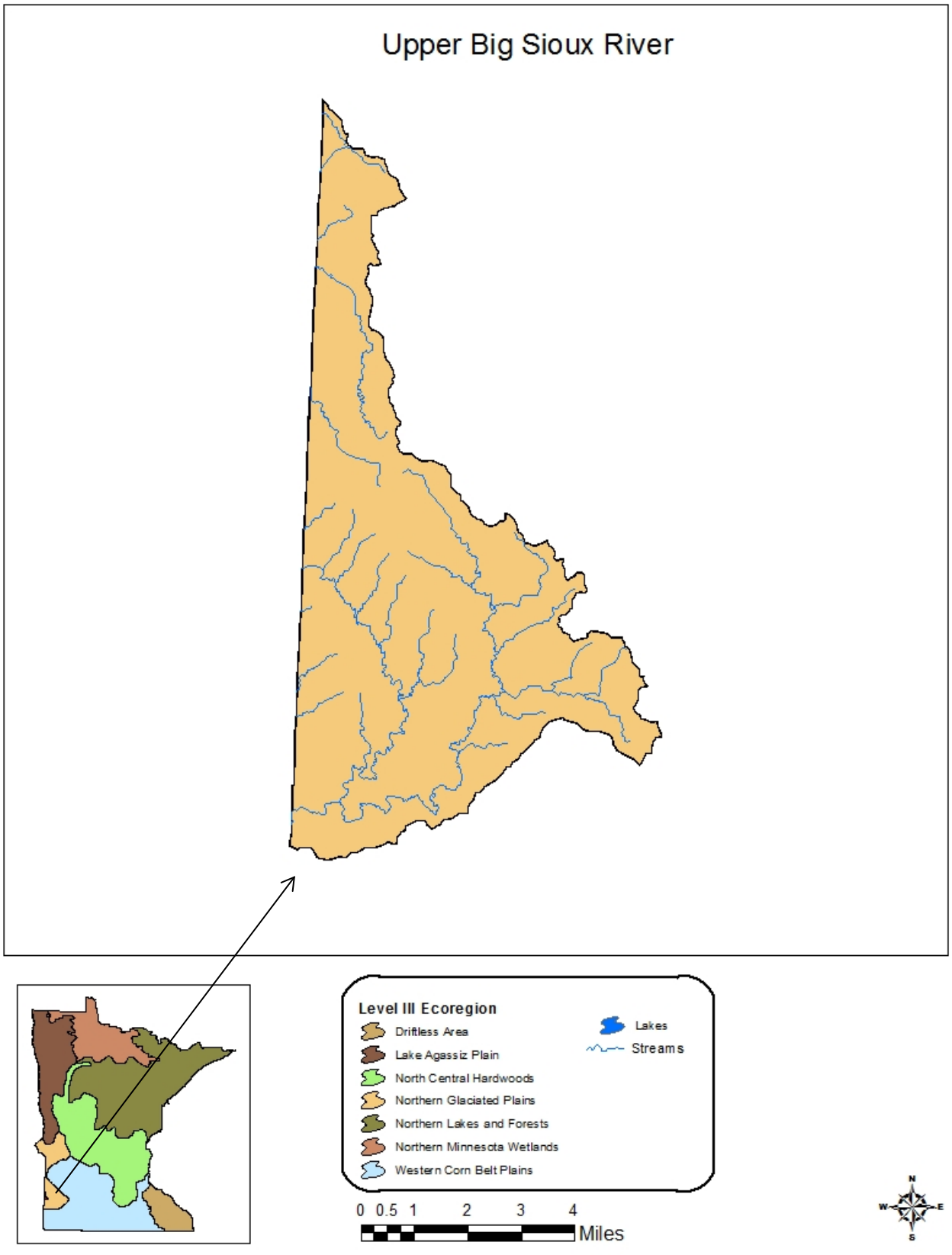

Figure 6. The Upper Big Sioux River Watershed within the Northern Glaciated Plains ecoregion of southwestern Minnesota.

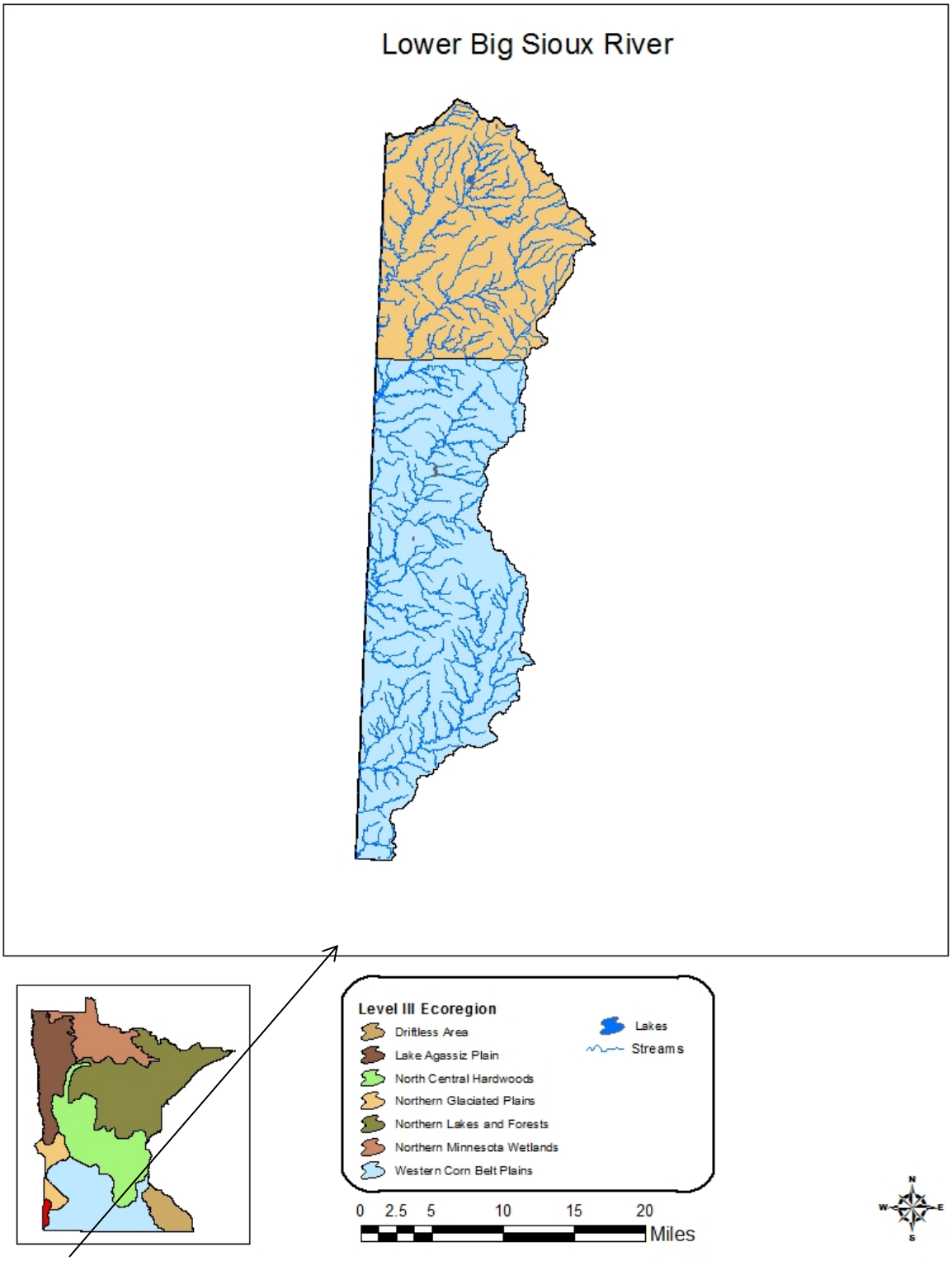

Figure 7. The Lower Big Sioux River Watershed within the Northern Glaciated Plains and Western Corn Belt Plains ecoregions of southwestern Minnesota.

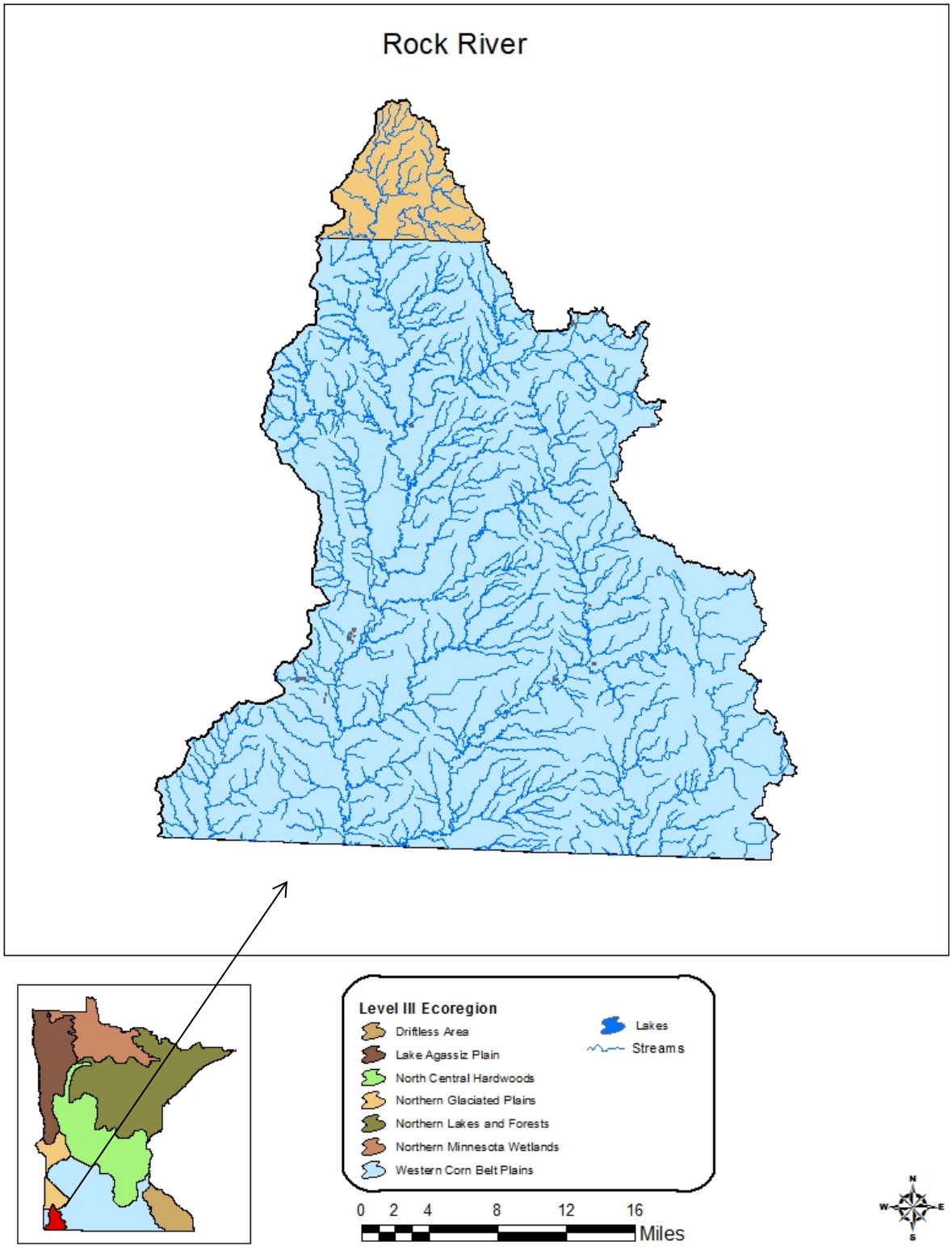

Figure 8. The Rock River Watershed within the Northern Glaciated Plains and Western Corn Belt Plains ecoregions of southwestern Minnesota.

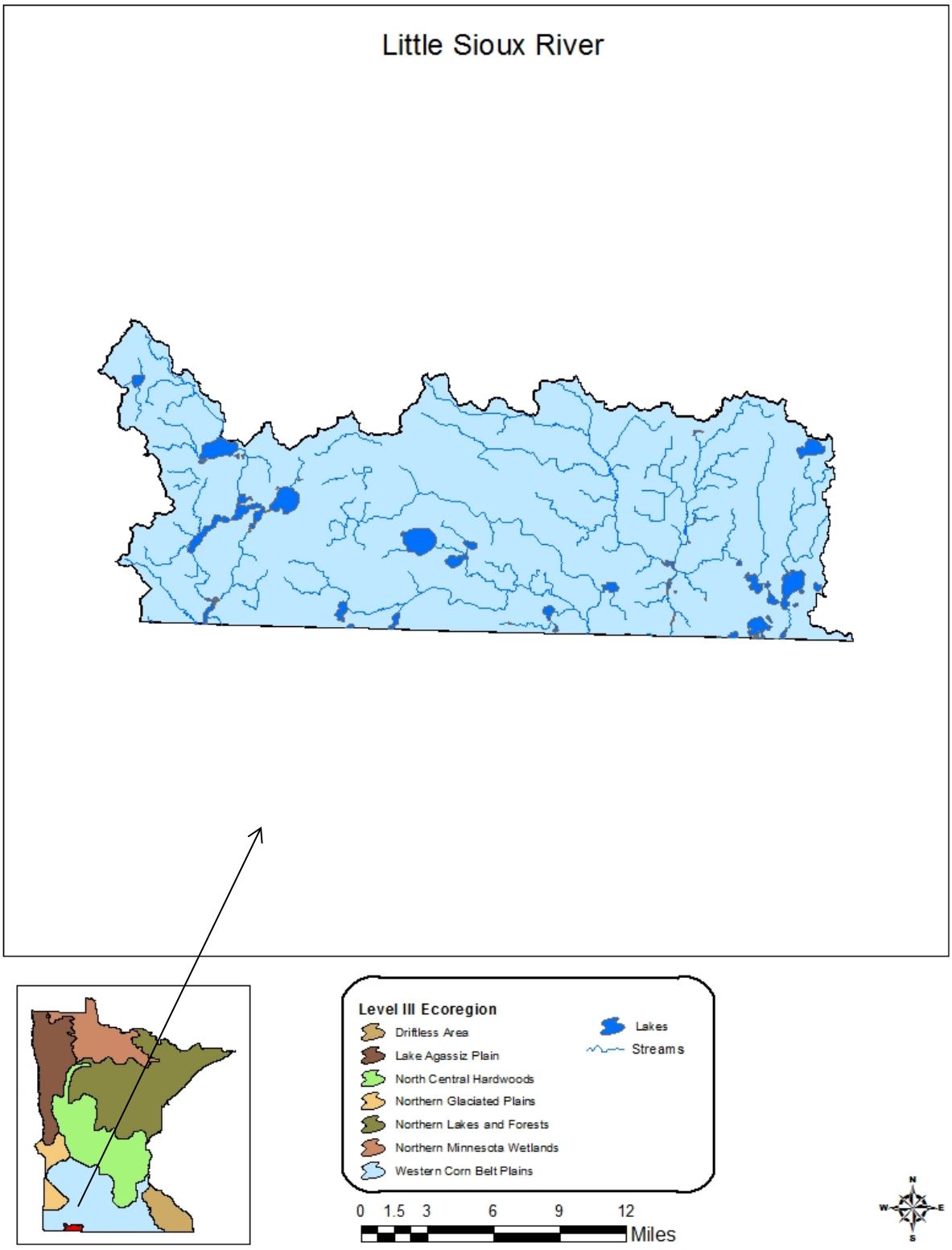

Figure 9. The Little Sioux River Watershed within the Western Corn Belt Plains ecoregion of southwestern Minnesota.

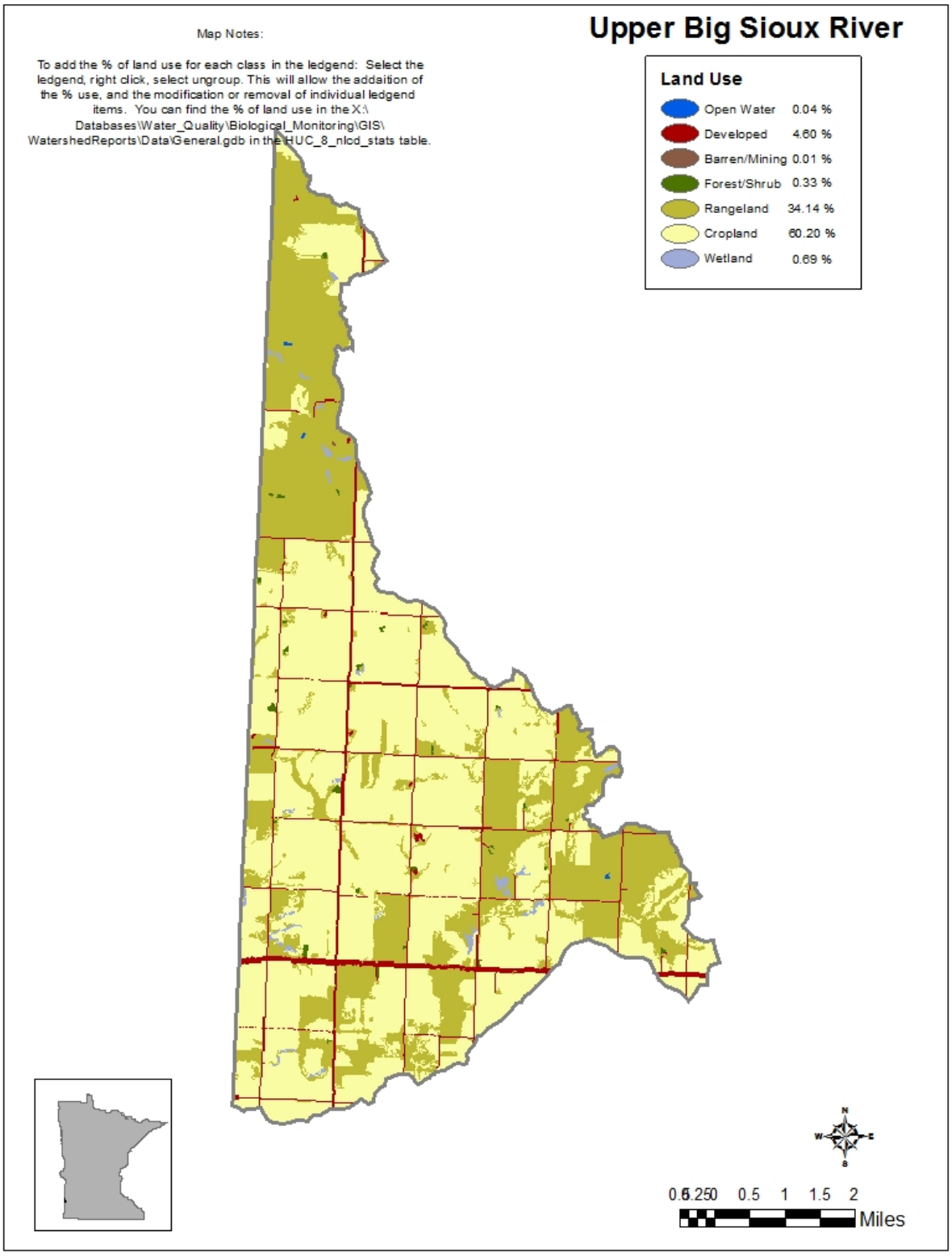

Figure 10. Land use in the Upper Big Sioux River Watershed.

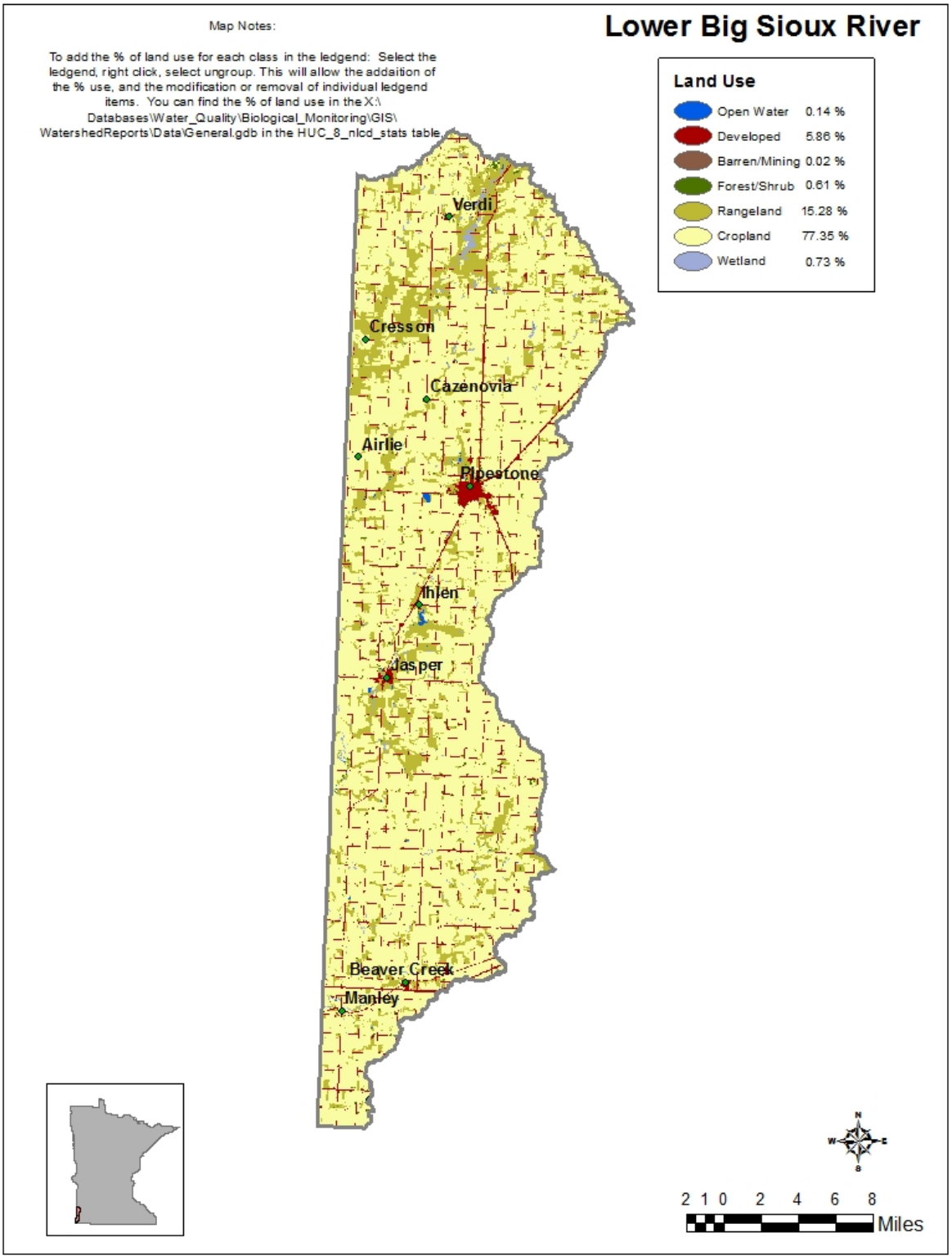

Figure 11. Land use in the Lower Big Sioux River Watershed.

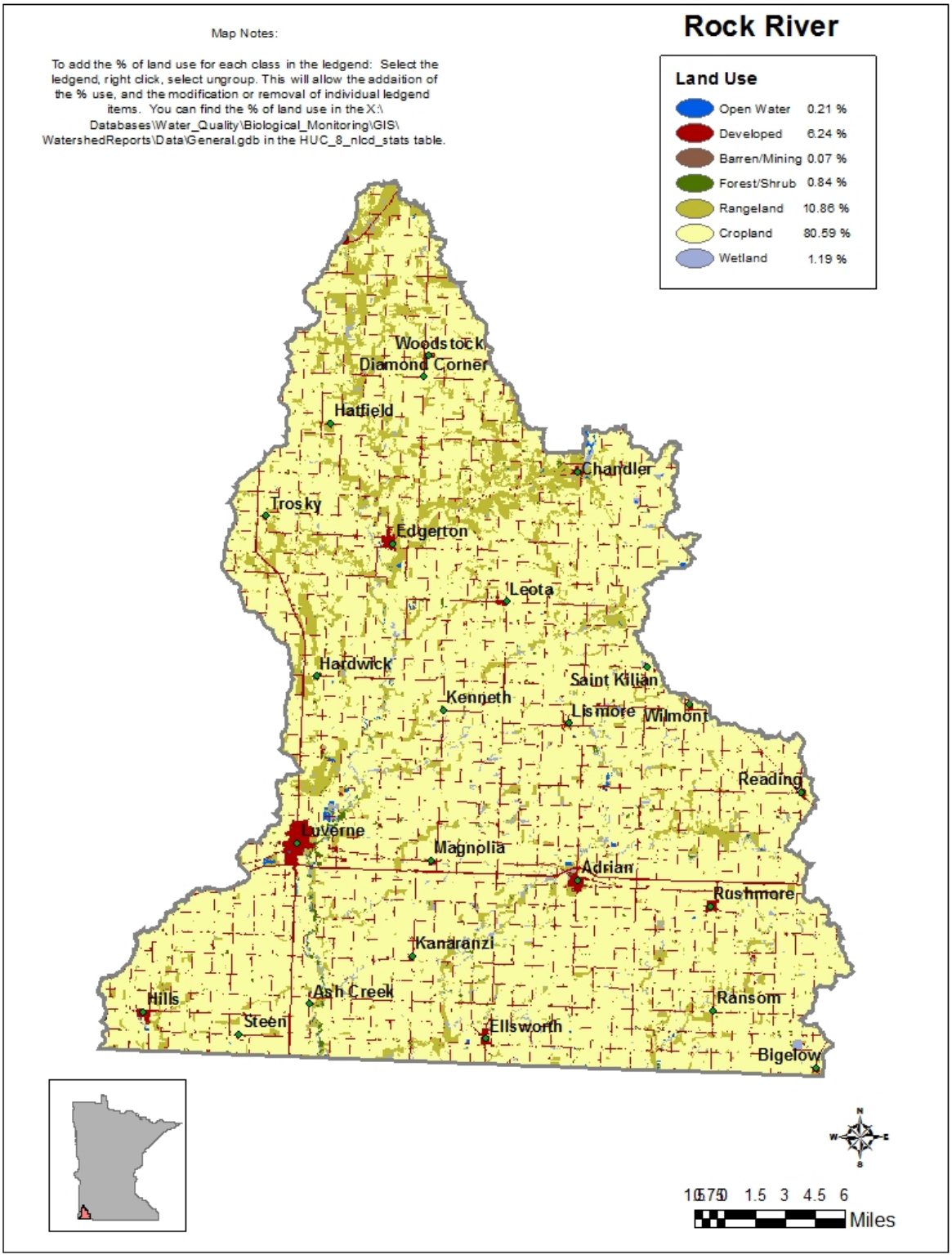

Figure 12. Land use in the Rock River Watershed.

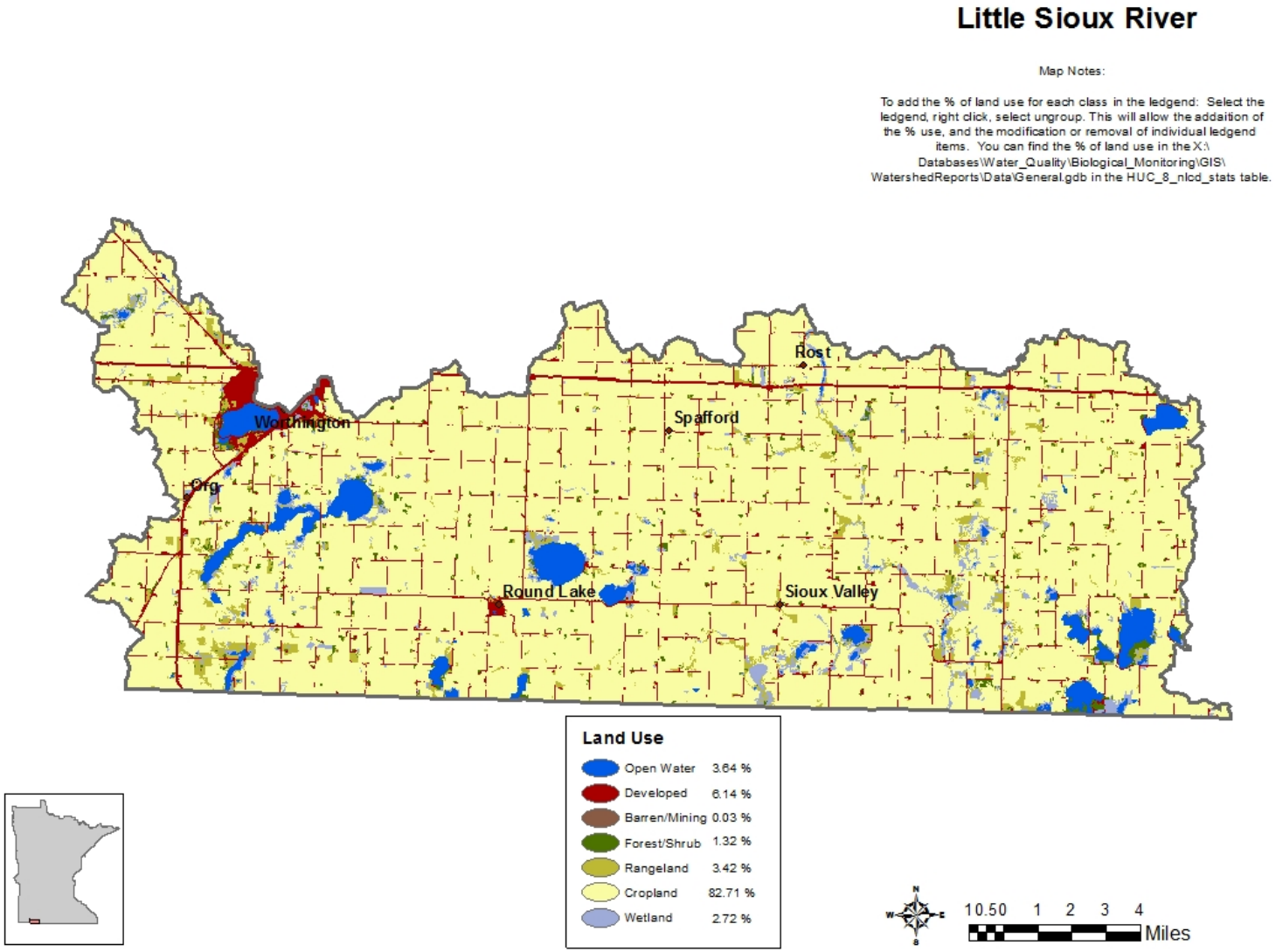

Figure 13. Land use in the Little Sioux River Watershed.

Surface water hydrology

The Missouri River Basin watersheds in Minnesota are a headwaters section of the greater Missouri River Basin, covering the southwest corner of Minnesota. Many small spring-fed tributaries and runoff create all of the streams in these watersheds. Comprised of four watersheds (8 HUC), the Missouri River Basin only has a few large streams and only the Little Sioux River is a direct tributary to the Missouri River. Most of the streams, with the exception of the Rock and its tributaries, flow directly west into South Dakota or south to Iowa. The largest river in the Missouri River Basin in Minnesota is the Rock River, which flows south into the Big Sioux River in Iowa before entering the Missouri River. Lakes are not a prominent feature of the Missouri River Basin and all but one (which is a reservoir) are in the Little Sioux River Watershed. Nine lakes had enough information to be assessed and all nine are impaired for aquatic recreation use.

Climate and precipitation

These watersheds have a "continental climate", marked by warm summers and cold winters. The mean annual temperature for Minnesota is 4.5˚C; the mean summer temperature for the Little Sioux River Watershed is 20.0˚C; and the mean winter temperature is -8.9˚ C (Minnesota State Climatologists Office, 2003).

Figure 17 shows recent precipitation trends in Minnesota for calendar year 2011 and 2012. On the left is total precipitation, showing the typical pattern of increasing precipitation moving from the west toward the southeast portion of the state. To its right is a depiction of how that precipitation total deviated from normal.

Overall, the four watersheds in the southwest corner of Minnesota were slightly drier than normal in both 2011 and in 2012. In 2011, the watersheds received as little as 20 inches of precipitation in the Upper Big Sioux Watershed to as much as 32 inches in the Little Sioux Watershed, which was approximately two to four inches below normal. In 2012, total precipitation was even less, ranging only from 20-28 inches for the year and deviating as much as 16 inches below normal in the western portion of the Lower Big Sioux Watershed.

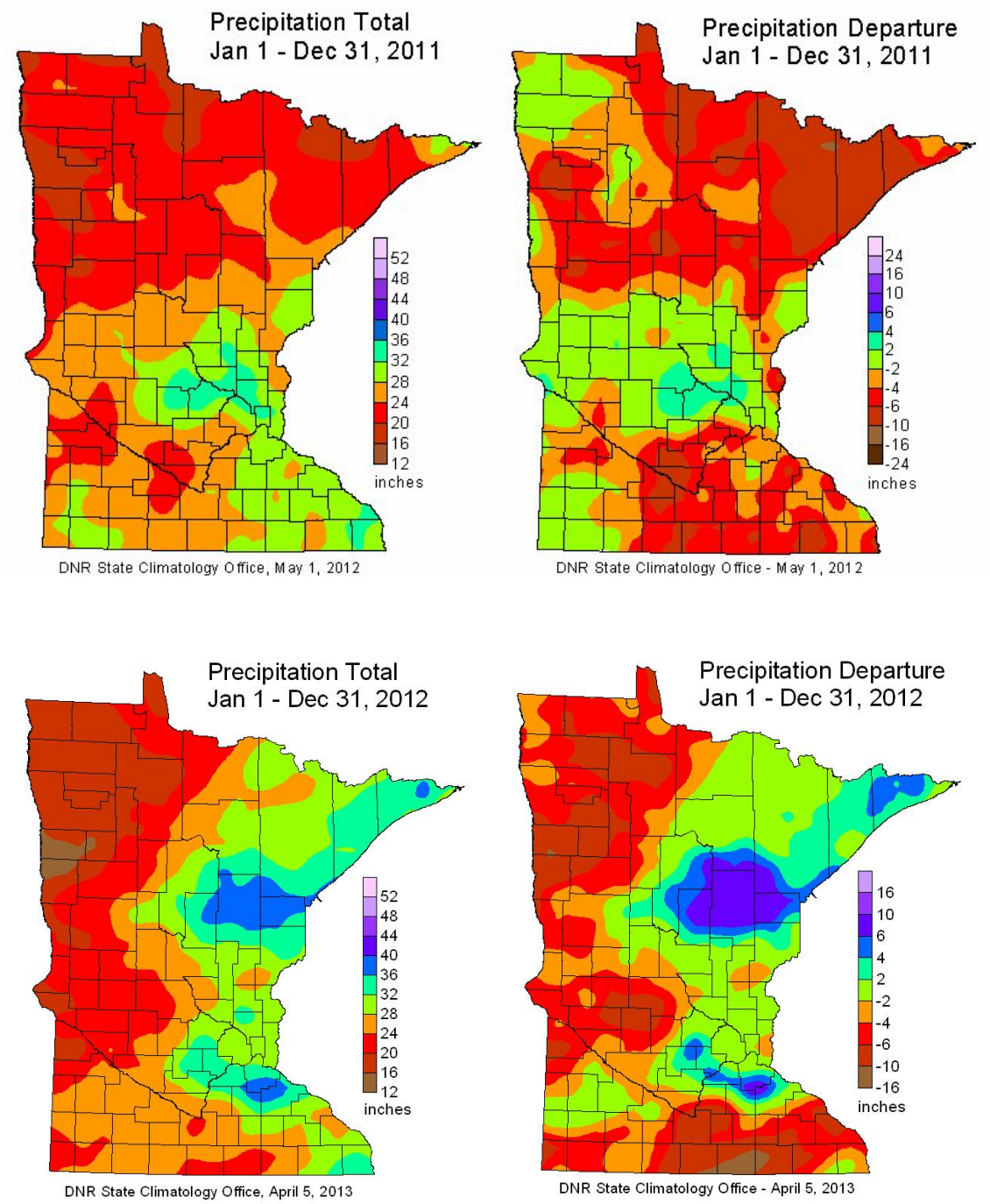

Figure 14. State-wide precipitation levels 2011 (above) and 2012 (below).

Figure 18 displays the areal average representation of precipitation in southwest Minnesota. An areal average is a spatial average of all the precipitation data collected within a certain area presented as a single dataset. This data is taken from the Western Regional Climate Center, available as a link from the University of Minnesota Climate website: http://www.wrcc.dri.edu/spi/divplot1map.html. Though rainfall can vary in intensity and time of year, rainfall totals in the southwest region display no significant trend over the last 20 years.

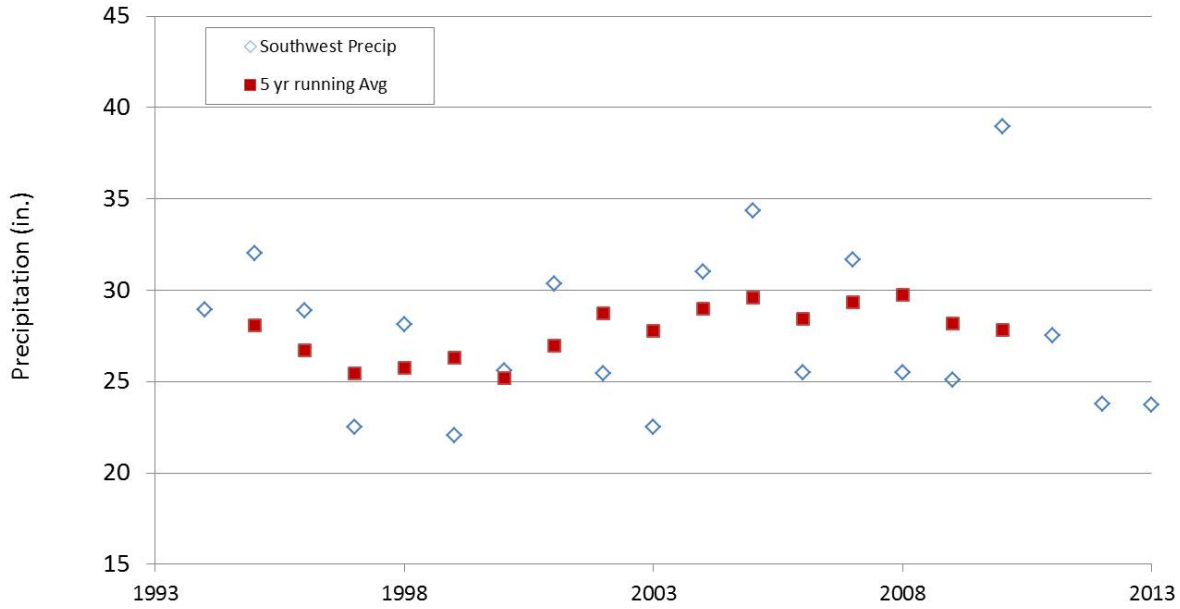

Figure 15. Precipitation trends in Southwest Minnesota (1993-2013) with five-year running average.

However, precipitation in southwest Minnesota exhibits a statistically significant rising trend over the past 100 years (p=0.001). This is a strong trend and matches similar trends throughout Minnesota.

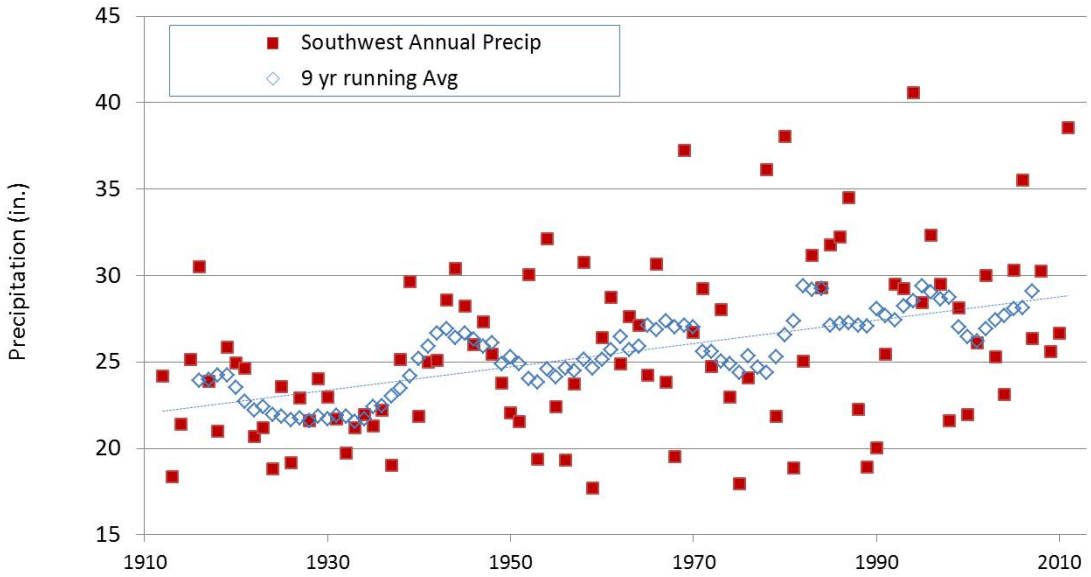

Figure 16. Precipitation trends in Southwest Minnesota (1913-2013) with ten-year running average.

Hydrogeology

The four watersheds making up the Missouri River Basin in Minnesota fall within Minnesota's Western Groundwater Province as defined by the MDNR. This hydrogeologic region is characterized by "clayey glacial drift overlying Cretaceous and Precambrian bedrock." The glacial drift and Cretaceous bedrock contain sand and sandstone aquifers that are used locally as water sources but are of limited extent. (MDNR, 2001)

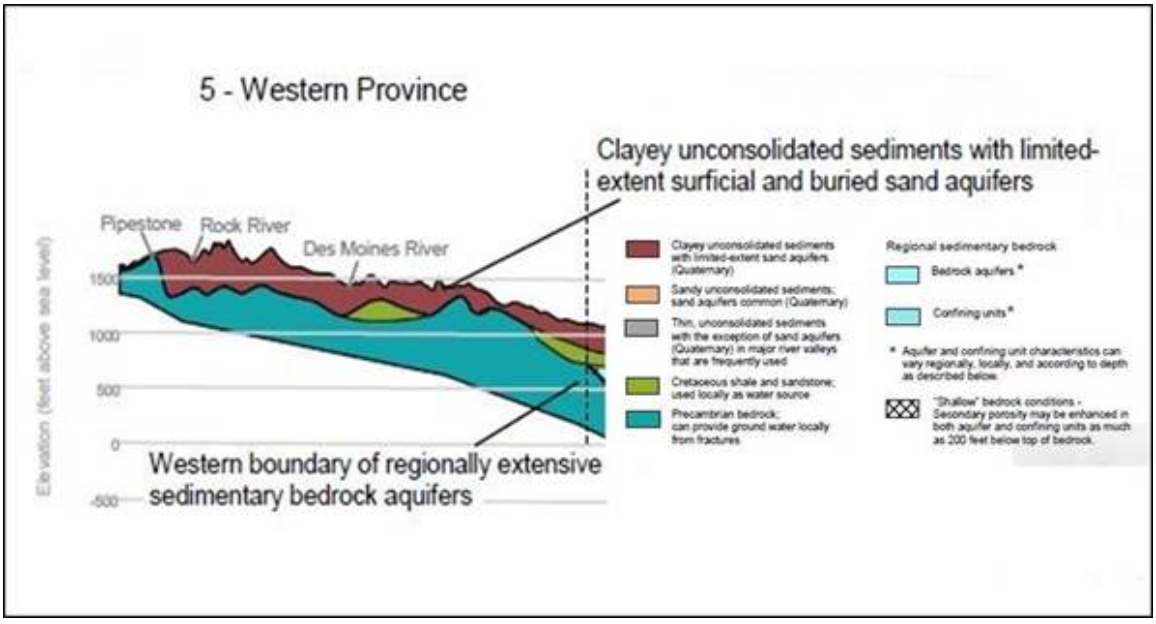

Figure 20. Western Province Generalized Cross Section (Source: MDNR, 2001)

As a region, southwest Minnesota has four types of aquifers present: the buried sand and gravel, surficial sand and gravel, Precambrian, and Cretaceous aquifers. The majority of wells in this region of Minnesota draw from the buried sand and gravel aquifers, which include the Quaternary Buried Artesian Aquifer (QBAA), the Quaternary Buried Unconfined Aquifer (QBUA), and the Quaternary Buried Undifferentiated Aquifer (QBUU). (MPCA, 1998) The surficial sand and gravel aquifers - the Quaternary Water Table Aquifer (QWTA) and the Quaternary Undifferentiated Unconfined Aquifer (QUUU) - are important groundwater sources in the region. These are comprised of well-sorted outwash deposits left behind from the Des Moines glacial lobe. The Cretaceous aquifers underlie the majority of southwest Minnesota and are only absent where Precambrian bedrock surfaces. Cretaceous deposits include interbedded shale, siltstone and sandstone that can range from 300 to 500 feet. The Precambrian bedrock underlies the entire southwest region, making it the oldest, lowermost bedrock type in southwest Minnesota. The Precambrian aquifers include the Sioux Quartzite and Crystalline aquifers, which are nearly impermeable and as a result, very few wells draw from this layer.

Recharge of these aquifers is important and limited to areas located at topographic highs, those areas with surficial sand and gravel deposits, and those along the bedrock/surficial deposit interface. Typically, recharge rates in unconfined aquifers are estimated at 20 to 25% of precipitation received, but can be less than 10% of precipitation where glacial clays or till are present (USGS, 2007). In southwest Minnesota, the average annual recharge rate to surficial materials ranges from near zero up to six inches per year (Figure 21).

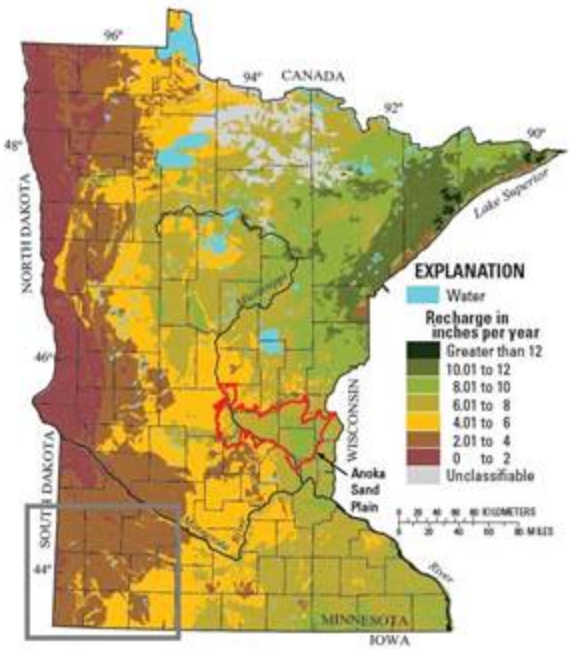

Figure 21. Average Annual Recharge Rate to Surficial Materials in Minnesota (1971-2000) (Source: USGS, 2007)

Wetlands

Portions of four major watersheds (HUC8) in southwest Minnesota comprise Minnesota's Missouri River (HUC2 – 10) drainage area. This region of the state is dominated by rolling topography that is incised by a dendritic network of streams. In an early 20thcentury history account of Rock County, Rose (1918) described the Rock County landscape as, "…the topography is gently undulating. There are no lakes and sloughs and no flat expanses of territory such as characterize some portions of southwestern Minnesota; consequently there is no waste land from this source." The Missouri River drainage surface geology varies by HUC8 watershed; however the Coteau des Prairies is the prominent landscape feature dividing the Missouri River drainage from the Minnesota River drainage to northeast. Wetlands developed in various geologic settings in this southwest corner of Minnesota, and wetlands originally provided many vital watershed functions, including slowing and retaining water thereby providing flood reduction and pollutant treatment, and protection of downstream water quality as well as providing vital wildlife habitat (Mitsch and Gosselink 2007).

Excluding open water portions of lakes, ponds, and rivers, the four major watersheds comprising the Minnesota portion of the Missouri River drainage currently support approximately 22,631 acres of wetlands, which is roughly 1% of this watershed area. Figure MG1 illustrates the distribution and class of current wetlands in the Missouri River drainage. Emergent wetlands are by far the most common wetland type across the HUC8 watersheds, making up nearly 82% of the total existing wetland in the region. Emergent wetlands are typically dominated by narrow-leaved perennial emergent herbaceous plants such as grasses, sedges, bulrushes or cattails. Likely, many of these emergent wetlands are spongy wet meadows, though some probably have shallow surface water for at least part of the growing season (i.e. marshes). Roughly 17% of the current wetlands in Minnesota's Missouri River drainage have shallow open water (i.e. deep marshes). This wetland class is usually dominated by floating leaved and submerged leaf species such as water lilies (Nymphaea sp. and Nuphar sp.), duckweeds (Lemna sp.), coontail (Ceratophyllum sp.) and various pondweeds (Potamogeton sp.). Less than 1% of the wetland area in the Missouri drainage is forested or scrub-shrub wetlands that usually occur in close association with stream habitats. These wetland estimates represent a snapshot of the location, type, and extent of wetlands occurring in the Missouri River watersheds in 1980-1984 which is the period that aerial imagery was acquired in this part of Minnesota to develop the National Wetlands Inventory (NWI).

Changes to wetlands have likely occurred in these watersheds since the early 1980s, though the NWI remains the best data available to estimate current wetland extent. Minnesota natural resource agencies are cooperating to update the state NWI over a 10-year schedule which is slated for completion in 2019, with the southern half of the state NWI update expected to be completed by the summer of 2015.

Digital soils data can be used to estimate the extent of wetlands prior to European homesteading and settlement prior to significant conversion of significant amounts of wetlands in much of Minnesota. Analysis of Natural Resources Conservation Service (NRCS) digital soil survey map (SSURGO) units classed as "Poorly Drained" and "Very Poorly Drained" was used here to estimate the extent of historic wetlands. Based on soil survey drainage class an estimated 326,300 acres of wetland or 17% of the Missouri River drainage occurred prior to settlement. Comparing the area of hydric SSURGO map units with contemporary national wetland inventory data for these watersheds suggests that approximately 7% of the historic wetland area remains as wetland in Minnesota's portion of the Missouri River drainage. In other words, 93% of the historic wetland in Minnesota's Missouri drainage has been lost to improve agricultural cropping practices and other development enterprises, including transportation and municipal development.

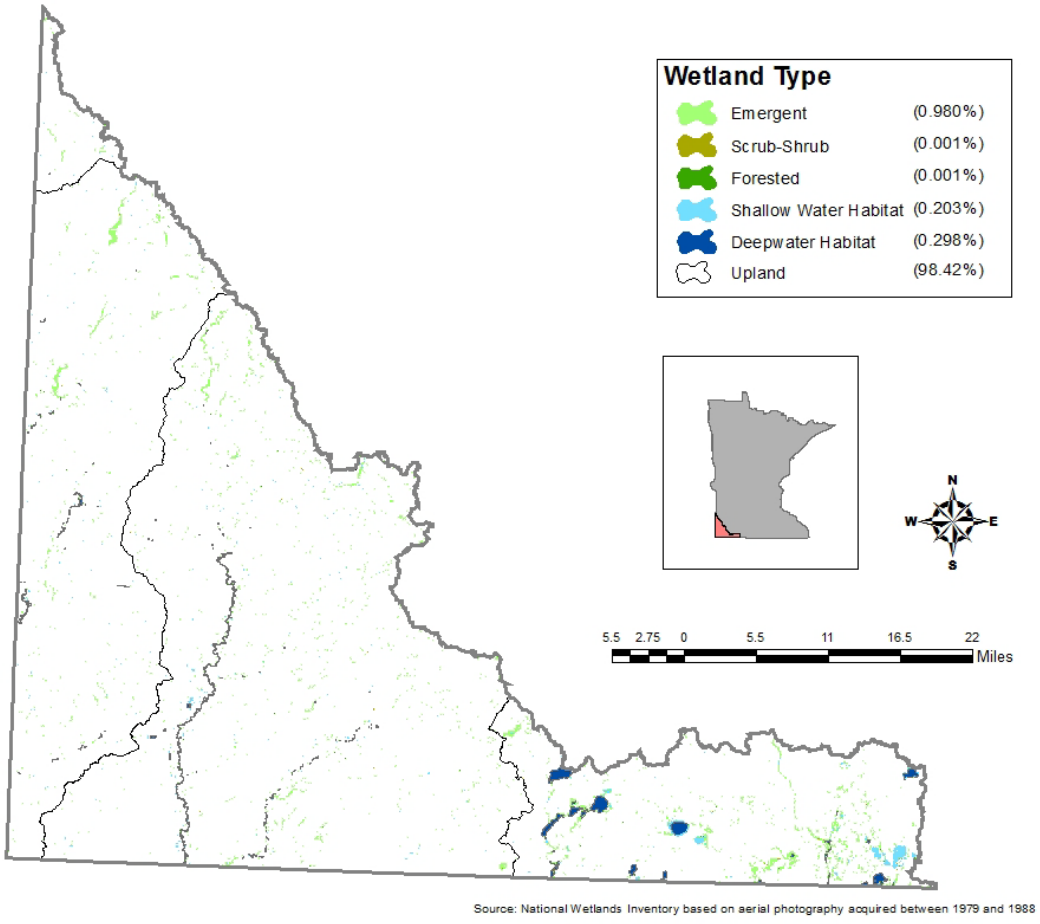

Figure 22. Contemporary distribution of wetlands by National Wetland Inventory wetland type within the Missouri River Basin.

Historic wetland extent

Rate of historic wetland loss was not consistent across the four major watersheds comprising the Minnesota portion of the Missouri River drainage. This section presents estimated loss rates by subwatershed in each major watershed.

The surface geology in the Middle Big Sioux Watershed (101700202) in the northwest part of Minnesota's Missouri River drainage is almost entirely composed of coarse sorted till as part of an end moraine. Coarse moraine till is particularly well suited to producing seepage meadow type wetlands on slopes, toes of slopes or along streams in the valleys. Soil drainage class map units suggest extensive historic wetlands were closely associated with streams and slopes. Grass and sedge dominated meadow type wetlands were likely the most common wetland type. Table 1 presents estimates of historic, current and percent wetland area converted to non-wetland in the two 12-digit subwatersheds of the Middle Big Sioux drainage. The Deer Creek subwatershed has the distinction of having the lowest percentage loss of historic wetland (62%) extent among all 29 12-digit subwatersheds located in Minnesota's portion of the Missouri River drainage.

Table 1. Big Sioux River (10170202) historic wetland extent based on hydric soil data for each subwatershed

Subwatershed Name	Area (acres) SSURGO 'hydric' map units	Watershed area (acres)	Wetland area (NWI – acres)	Percent wetland loss
Deer Creek	794.8	42798.5	298.3	62
Medary Creek	3345	85852.3	458.3	86

Surface geology in the Lower Big Sioux Watershed (10170203) is dominated by much older gray drift that was left from earlier glacial periods. This more weathered area resulted in significant wetland resources occurring in topographic depressions and flats, as well as along upper reaches of the stream drainage network. Table 2 presents wetland area and loss percent estimates for each aggregated 12-digit subwatershed on the Minnesota side of the Lower Big Sioux Watershed. Extent of historic wetland loss was roughly 10% lower in the four northern most 12-digit subwatersheds compared with the four southern subwatersheds which are estimated to have lost 94-98% of their historic wetlands. On the east side of Rose Dell Township, about five miles southwest of Jasper in the western lobe of the Upper Split Rock Creek subwatershed, is a large round flat area with hydric soils which is a very prominent feature on the SSURGO drainage class data. Like many wetlands in the area, this large wetland appears to have been effectively drained in the early part of the 20th century. A July 1936 aerial photo shows well developed row crop agriculture growing in the bed of this historic wetland. Personal communication with the MDNR area hydrologist confirmed that Rock County spent $800,000 in 2013 to improve the ditch system to more effectively drain soils in this historic wetland area.

Table 2. Big Sioux River (Pipestone 10170203) historic wetland extent based on hydric soil data for each subwatershed

Subwatershed Name	Area (acres) SSURGO 'hydric' map units	Watershed area (acres)	Wetland area (NWI – acres)	Percent wetland loss
Spring Creek	980.8	41177.5	161.3	84
Flandreau Creek	11524.7	74591.6	1357.1	88
Lower Pipestone Creek	6000.0	71755.0	768.9	87
North Branch Pipestone Creek	9464.2	40985.1	1173.3	88
Upper Pipestone Creek	9818.4	28740.5	166.5	98
Beaver Creek	13288.3	102413.7	742.7	94
Upper Split Rock Creek	18929.6	104663.5	757.6	96
Blood Run-Big Sioux River	1296.7	92650.8	49.7	96

In the Rock River Watershed, the surface geology is comparatively complex including moraine till along the eastern third, gray drift with the historic Rock River outwash plain dividing the western third, and shale bearing loess in the center third. This geology mosaic developed a rich array of wetlands, both hydrologically isolated wetlands in flatter areas as well as wetlands more closely associated with the stream network. Many of the historic Rock River Watershed wetlands were associated with slopes. Table 3 presents estimated current wetland areas and percent drained historic wetland extent in the fourteen subwatersheds of the Minnesota's portion of the Rock River Watershed. The Rock River subwatersheds have sustained some of the greatest extent of wetland conversion and loss compared with the other major watersheds in the Missouri River drainage. The upper reaches of Chanarambie Creek, Champepadan Creek, Kanaranzi Creek, East Branch of Kanaranzi Creek, and Upper Little Rock Creek which start up on the Coteau des Prairies were historically particularly rich in wetlands. Based on existing wetland class extent these same subwatersheds retain some of the highest acreages of current wetlands.

Table 3. Rock River (10170204) historic wetland extent based on hydric soil data for each subwatershed

Subwatershed Name	Area (acres) SSURGO 'hydric' map units	Watershed Area (acres)	Wetland area (NWI – acres)	Percent wetland loss
Lower Headwaters-Rock River	14512.4	64753.2	637	96
Poplar Creek	5480.3	22364.3	119.5	98
Upper Headwaters-Rock River	16375.9	72718.6	1823.3	89
Chanarambie Creek	13736.8	47914.6	1157.7	92
Kaaranzi Creek	27148.2	94567	1470.5	95
East Branch Kanaranzi Creek	13800	3644.3	434.2	97
Upper Rock River	12208.3	68301.9	684.4	94
Elk Creek	12282.4	41219.8	388.6	97
Champepadan Creek	16118.5	48553.1	628.5	96
Mud Creek	6948.8	88735.1	111.9	98
Upper Otter Creek	2646.3	82688.8	159.0	94
Upper Little Rock River	13181.7	66636.4	378.5	97
Little Rock Creek	8001.5	26934.4	97.8	99
Tom Creek	1908	39332.8	40.7	98

In comparison with historic estimates of emergent and shallow open water wetlands, these wetland types provide many important water quality and habitat benefits.

In the Minnesota portion of the Little Sioux Watershed the terrain flattens out and the surface geology is dominated by three distinct types of moraine (end, ground, and stagnation moraine complexes), each of which provided ideal conditions to support development of large wetland complexes and shallow lakes. This watershed represents the southernmost reach of the important Prairie Pothole region in Minnesota. Table 4 presents wetland extent and loss for the Little Sioux Minnesota Watershed by 12-digit subwatersheds.

Table 4. Little Sioux River () historic wetland 10230003extent based on hydric soil data for each aggregated subwatershed

Subwatershed Name	Area (acres) SSURGO 'hydric' map units	Watershed Area (acres)	Wetland area (NWI – acres)	Percent wetland loss
West Fork Little Sioux River	15228.3	82172.2	1908.3	87
Judicial Ditch 13 (Skunk Creek)	12688.9	28961.9	908.1	93
Milford Creek	10423.5	92340.0	2197.1	79
Upper Headwaters Little Sioux River	30544.1	81422.3	2893.0	91
Upper Ocheyedan River	17622.8	113607.0	2009.7	89

Wetland condition

The MPCA began biological monitoring of wetlands in the early 1990s, focusing on wetlands with emergent vegetation in a depressional geomorphic setting (i.e., marshes). This work resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, & crustaceans) indices of biological integrity (IBIs) to evaluate biological condition or "health" of depressional wetlands. Recently the MPCA wetland monitoring program has begun transitioning toward greater use of Floristic Quality Assessment (FQA) to assess wetland condition based on the plant community. Future watershed wetland assessment reports will begin to use FQA wetland assessment approaches. One advantage to the FQA approach is the methods have been developed to apply to all Minnesota wetland types.

Both the invertebrate and plant IBIs are scored on a 0 to 100 scale with higher scores indicating better condition. These indicators have been used in surveys of wetland condition where results can be summarized statewide and for Minnesota's three Level II Ecoregions (Genet 2012). Minnesota's portion of the Missouri River drainage occurs entirely within the Temperate Prairie Ecoregion that is characteristic of the upper Midwest.

Statewide estimates have found depressional wetlands in the Temperate Prairies Ecoregion to typically be in poor condition when compared to regional reference sites. The wetland plant community integrity results suggest 17% of the depressional wetlands in this ecoregion are estimated to be in good condition, 28% are in fair condition and 54% are in poor condition. Invasive plants, particularly narrow-leaved (*Typha angustifolia*) and hybrid cattail (*Typha* X *glauca*) as well as reed canary grass (*Phalaris arundinacea*) are important wetland stressors and can respond strongly to disturbed watershed conditions including nutrient enrichment, hydrologic alterations and toxic pollutants such as chloride loading (Galatowitsch 2012). Unfortunately, cattails and reed canary grass are very common, often dominating marshes within this region of the state and are detrimental to plant community health (Genet 2012). Survey condition estimates of depressional wetland condition in the Temperate Prairies Ecoregion based on the macroinvertebrate IBI reported 33% of the wetlands in this region are in good condition, 20% in fair condition and 47% are recognized as being in poor condition.

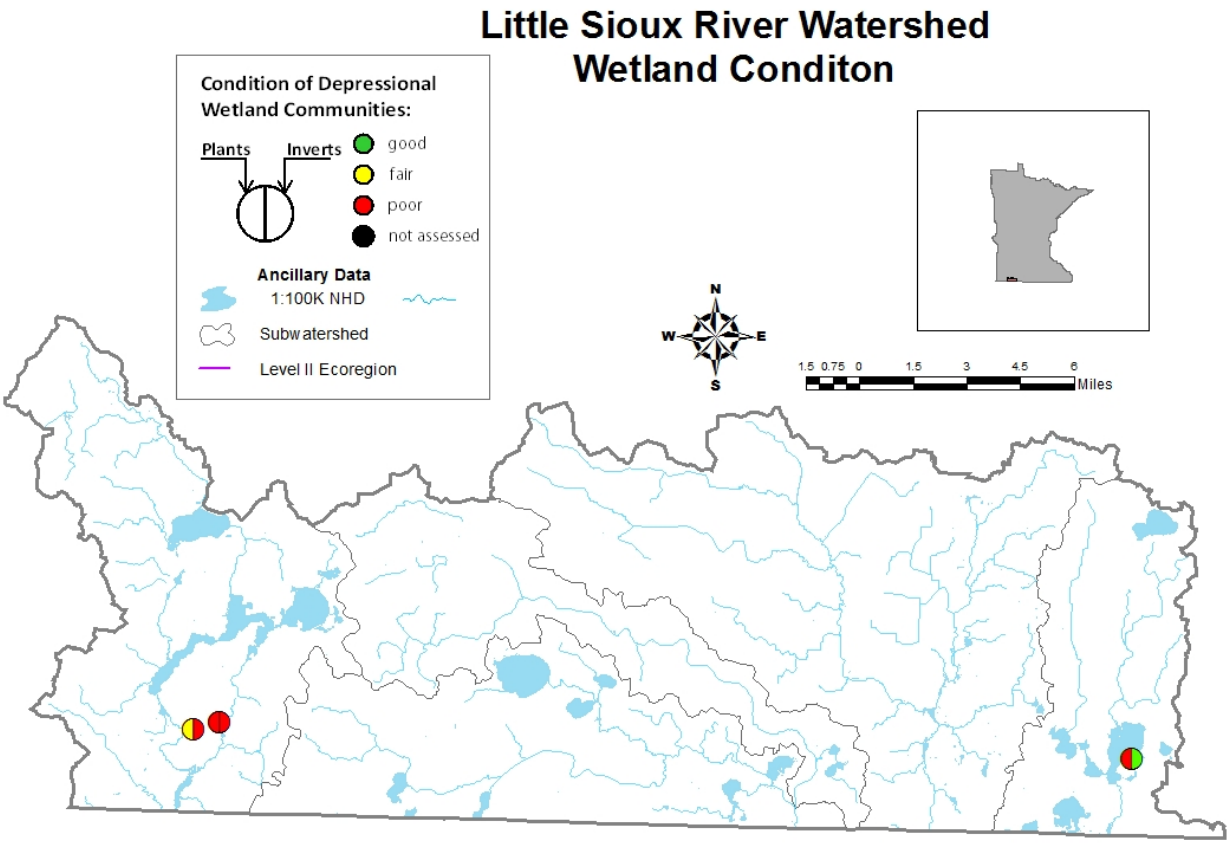

Figure 23. Depressional wetland IBI results (invertebrate and plant community indices) for the MPCA wetland biological study sites located in the Little Sioux Watershed as part of the Missouri drainage.

In the last 10 years MPCA ambient wetland biological condition data has been collected at only three natural depressional wetlands in the Missouri River watersheds. All three of these sites were in the Little Sioux Watershed. Invertebrate and plant biological condition results for these sites are presented in Figure 23. These sites were sampled as part of a probabilistic survey of the Temperate Prairie Ecoregion. Invertebrate community IBI scores at these three sites ranged from 45 to 72 (0 to 100 scale with 100 being high integrity). Based on the macroinvertebrate IBI, two of these sites were found to be in 'Poor' condition and one was in 'Good' condition. The difference between Good and Fair is set at the 25th percentile of IBI scores within a set of Ecoregion least disturbed reference sites (Genet 2012). The plant communities at these same three wetlands were similarly sampled for biological assessment endpoints. Two of the wetlands scored as 'Poor' condition and one of them were rated as 'Fair' condition. The two wetlands in poor condition each were dominated by invasive plants including cattails and reed canary grass.

Three wetlands sampled in only one part of the Missouri drainage is a very small data set and was not intended to represent the Missouri drainage. Considering both indicators, this small dataset however demonstrates that there is a range of wetland condition in this region of Minnesota, though additional assertions cannot be made.

IV. Watershed-wide data collection methodology

Load monitoring

Intensive water quality sampling occurs throughout the year at all WPLMN sites. Approximately 35 samples are collected at each of the major watershed outlet sites. Because correlations between concentration and flow exist for many of the monitored analytes, and because these relationships can shift between storms or with season, computation of accurate load estimates requires frequent sampling of all major runoff events. Low flow periods are also sampled and are well represented, but sampling frequency tends to be less as concentrations are generally more stable when compared to periods of elevated flow. Despite discharge related differences in sample collection frequency, this staggered approach to sampling generally results in samples being well distributed over the entire range of flows.

Annual water quality and daily average discharge data are coupled in the "Flux32," pollutant load model, originally developed by Dr. Bill Walker and recently upgraded by the U.S. Army Corp of Engineers and the MPCA. Flux32 allows the user to create seasonal or discharge constrained concentration/flow regression equations to estimate pollutant concentrations and loads on days when samples were not collected. Primary outputs include annual and daily pollutant loads and flow weighted mean concentrations (pollutant load/total flow volume). Loads and flow weighted mean oncentrations are calculated for total suspended solids (TSS), total phosphorus (TP), dissolved orthophosphate (DOP), and nitrate plus nitrite nitrogen (NO_3 + NO_2-N).

Stream water sampling

Twenty three water chemistry stations were sampled from May through September in 2011, and again June through August of 2012, to provide sufficient water chemistry data to assess all components of the Aquatic Life and Recreation Use Standards. Following the IWM design, water chemistry stations were placed at the outlet of each aggregated 12 HUC subwatershed that was >40 square miles in area (purple circles and green circles in Figure 3. A SWAG was awarded to the Pipestone SWCD, Nobles SWCD, Jackson SWCD, and Rock SWCD to conduct the monitoring in the Upper Big Sioux River, Lower Big Sioux River, Rock River, and Little Sioux River Watershed (See Appendix 2 for locations of stream water chemistry monitoring sites. See Appendix 1 for definitions of stream chemistry analytes monitored in this study). There are currently six volunteers enrolled in the MPCA's CSMP that are conducting stream monitoring within the watershed. The SWCDs and volunteers that collect the field samples followed a standard operating procedure. Those sampling methods for collecting field data (stream chemistry and bacteria) are described in a document that is found on the MPCA website: http://www.pca.state.mn.us/index.php/view-document.html?gid=16141.

Stream biological sampling

The biological monitoring component of the IWM in the Upper Big Sioux River, Lower Big Sioux River, Rock River, and Little Sioux River Watersheds was completed during the summer of 2011 and spring of 2012. These watersheds were completely sampled for invertebrates in 2011, but fish sampling was not finished due to a government shutdown in July. A total of 134 sites were newly established across the watersheds and sampled. These sites were located near the outlets of most minor HUC-14 watersheds. In addition, six existing biological monitoring stations within the watersheds were revisited in 2001 and one in 2012. These monitoring stations were initially established as part of a random Missouri River Basin wide survey in 2004, a statewide random sampling in 2010, or as part of a 2007 survey which investigated the quality of channelized streams with intact riparian zones. While data from the last 10 years contributed to the watershed assessments, the majority of data utilized for the 2013 assessment was collected in 2011. One AUID was sampled for biology in the Upper Big Sioux River Watershed, 33

AUIDs were sampled for biology in the Lower Big Sioux River Watershed, 46 AUIDs were sampled for biology in the Rock River Watershed, and 11 AUIDs were sampled for biology in the little Sioux River Watershed. Waterbody assessments were not deferred for any AUIDs in the Upper Big Sioux Watershed because criteria for channelized reaches had not been developed prior to the assessments or Class 7/limited water resource. Waterbody assessments were not conducted for 11 AUIDs in the Lower Big Sioux River Watershed, 16 AUIDs in the Rock River Watershed, and 11 AUIDs in the Little Sioux River Watershed because criteria for channelized reaches had not been developed prior to the assessments or Class 7/limited water resource. Nonetheless, the biological information that was not used in the assessment process will be crucial to the stressor identification process and will also be used as a basis for long term trend results in subsequent reporting cycles. Qualitative ratings for non-assessed reaches area included in Appendix 5.1.

To measure the health of aquatic life at each biological monitoring station, fish and macroinvertebrate IBIs were calculated based on monitoring data collected for each of these communities. A fish and macroinvertebrate classification framework was developed to account for natural variation in community structure which is attributed to geographic region, watershed drainage area, water temperature and stream gradient. As a result, Minnesota's streams and rivers were divided into seven distinct warm water classes and two cold water classes, with each class having its own unique fish IBI and macroinvertebrate IBI. Each IBI class uses a unique suite of metrics, scoring functions, impairment thresholds, and confidence intervals (CIs) (For IBI classes, thresholds and CIs, see Appendix 4.1). IBI scores higher than the impairment threshold and upper CI indicate that the stream reach supports aquatic life. Contrarily, scores below the impairment threshold and lower CI indicate that the stream reach does not support aquatic life. When an IBI score falls within the upper and lower confidence limits additional information may be considered when making the impairment decision such as the consideration of potential local and watershed stressors and additional monitoring information (e.g., water chemistry, physical habitat, observations of local land use activities). For IBI results for each individual biological monitoring station, see Appendix 4 and Appendix 5.

Fish contaminants

Mercury was analyzed in fish tissue samples collected from the Rock River and six lakes in the Missouri River Basin. All six lakes are in the Little Sioux River Watershed. Polychlorinated biphenyls (PCBs) were measured in four fish species from the river. MPCA biomonitoring staff collected the fish from the river in 2011. Minnesota Department of Natural Resources fisheries staff collected all other fish.

Captured fish were wrapped in aluminum foil and frozen until they were thawed, scaled, filleted, and ground. The homogenized fillets were placed in 125 mL glass jars with Teflon™ lids and frozen until thawed for mercury or PCBs analyses. The Minnesota Department of Agriculture laboratory performed all mercury and PCBs analyses of fish tissue.

The Impaired Waters List is submitted every even year to the U.S. Environmental Protection Agency (EPA) for the agencies approval. MPCA has included waters impaired for contaminants in fish on the Impaired Waters List since 1998. Impairment assessment for PCBs and perfluorooctane (PFOS) in fish tissue is based on the fish consumption advisories prepared by the Minnesota Department of Health (MDH). If the consumption advice is to restrict consumption of a particular fish species to less than a meal per week because of PCBs or PFOS, the MPCA considers the lake or river impaired. The threshold concentration for impairment (consumption advice of one meal per month) is an average fillet concentration of 0.22 mg/kg for PCBs and 0.200 mg/kg (200 ppb) for PFOS.

Prior to 2006, mercury concentrations in fish tissue were assessed for water quality impairment based on the MDH's fish consumption advisory. An advisory more restrictive than a meal per week was classified as impaired for mercury in fish tissue. Since 2006, a waterbody has been classified as impaired for mercury in fish tissue if 10% of the fish samples (measured as the 90th percentile) exceed 0.2 mg/kg

of mercury, which is one of Minnesota's water quality standards for mercury. At least five fish samples per species are required to make this assessment and only the last 10 years of data are used for statistical analysis. MPCA's Impaired Waters List includes waterways that were assessed as impaired prior to 2006 as well as more recent impairments.

PCBs in fish have not been monitored as intensively as mercury in the last three decades due to monitoring completed in the 1970s and 1980s. These earlier studies identified that high concentrations of PCBs were only a concern downstream of large urban areas in large rivers, such as the Mississippi River and in Lake Superior. Therefore, continued widespread frequent monitoring of smaller river systems was not necessary. The current watershed monitoring approach includes screening for PCBs in representative predator and forage fish collected at the pour point stations in each major watershed.

Lake water sampling

None of the major watersheds (Lower Big Sioux River Watershed, Upper Big Sioux River Watershed, Rock River Watershed, and Little Sioux River Watershed) have volunteers enrolled in the MPCA's CLMP. The Lower Big Sioux River Watershed contains one small lake (Split Rock Reservoir) but there is no data for it, therefore no recreation use assessment could be made. The Rock River Watershed only has nine lakes, all of which are less than 35 acres except for two (Chandler Marsh - 193 acres and Bigelow Slough - 88 acres). South Mound Springs which is only 20 acres has the only public access which is a carry-in access. A SWAG was awarded to the Nobles SWCD to monitor two lakes (Iowa 32-0084 and Indian 57-0007) within the Little Sioux River Watershed for the purpose of gathering a dataset for lake assessment of aquatic recreation. Sampling methods are similar among monitoring groups and are described in the document entitled "MPCA Standard Operating Procedure for Lake Water Quality" found at http://www.pca.state.mn.us/publications/wq-s1-16.pdf.

Groundwater monitoring

Groundwater quality

The MPCA's Ambient Groundwater Monitoring Program monitors trends in statewide groundwater quality by sampling for a comprehensive suite of chemicals including nutrients, metals, and volatile organic compounds. These ambient wells represent a mix of deeper domestic wells and shallow monitoring wells. The shallow wells interact with surface waters and exhibit impacts from human activities more rapidly. Available data from federal, state and local partners are used to supplement reviews of groundwater quality in the region.

Groundwater/surface water withdrawals

The MDNR permits all high capacity water withdrawals where the pumped volume exceeds 10,000 gallons/day or 1 million gallons/year. Permit holders are required to track water use and report back to the MDNR yearly. Information on the program and the program database are found at: http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/wateruse.html.

The changes in withdrawal volume detailed in this report are a representation of water use and demand in the watershed and are taken into consideration when theMDNR issues permits for water withdrawals. Other factors not discussed in this report but considered when issuing permits include: interactions between individual withdrawal locations, cumulative effects of withdrawals from individual aquifers, and potential interactions between aquifers. This holistic approach to water allocations is necessary to ensure the sustainability of Minnesota's groundwater resources.

Groundwater quantity

Monitoring wells from the MDNR Observation Well Network track the elevation of groundwater across the state. The elevation of groundwater is measured as depth to water in feet and reflects the fluctuation of the water table as it rises and falls with seasonal variations and anthropogenic influences. Data from these wells and others are available at: http://www.dnr.state.mn.us/waters/groundwater_section/obwell/waterleveldata.html.

Stream flow

The USGS maintains real-time streamflow gaging stations across the United States. Measurements can be viewed at http://waterdata.usgs.gov/nwis/rt.

Wetland monitoring

The MPCA began developing biological monitoring methods for wetlands in the early 1990s, focusing on wetlands with emergent vegetation (i.e., marshes) in a depressional geomorphic setting. This work has resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, and crustaceans) IBIs for the Temperate Prairies, Mixed Wood Plains, and the Mixed Wood Shield level II ecoregions in Minnesota. These IBIs are suitable for evaluating the ecological condition or health of depressional wetland habitats. All of the wetland IBIs are scored on a 0 to 100 scale with higher scores indicating better condition.Wetland sampling protocols can be viewed at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/wetlands/wetland-monitoring-and-assessment.html. Today, these indicators are used in a statewide survey of wetland condition where results can be summarized statewide and for each of Minnesota's three level II ecoregions (Genet 2012).

V. Individual subwatershed results

Aggregated HUC-12 subwatersheds

Assessment results for aquatic life and recreation use are presented for each subwatershed within the Upper Big Sioux River, Lower Big Sioux River, Rock River, and Little Sioux River Watersheds. The primary objective is to portray all the full support designations and impairment listings within a subwatershed resulting from the complex and multi-step assessment and listing process. (A summary table of assessment results for the entire watershed including aquatic consumption and drinking water assessments (where applicable) is included in Appendix 3). This scale provides a robust assessment of water quality condition at a practical size for the development, management, and implementation of effective TMDLs and protection strategies. The graphics presented for each of the subwatersheds contain the assessment results from the 2013 Assessment Cycle as well as any impairment listings from previous assessment cycles. Discussion of assessment results focuses primarily on the 2011 IWM effort, but also considers available data from the last 10 years.

The proceeding pages provide an account of each subwatershed. Each account includes a brief description of the subwatershed, and summary tables of the results for each of the following: a) stream aquatic life and aquatic recreation assessments, b) biological condition of channelized streams and ditches, c) stream habitat quality d) channel stability, and where applicable e) water chemistry for the subwatershed outlet, and g) lake aquatic recreation assessments. Following the tables is a narrative summary of the assessment results and pertinent water quality projects completed or planned for the subwatershed. A brief description of each of the summary tables is provided below.

Stream assessments

A table is provided in each section summarizing aquatic life and aquatic recreation assessments of all assessable stream reaches within the subwatershed (i.e., where sufficient information was available to make an assessment). Primarily, these tables reflect the results of the 2012 assessment process (2014 EPA reporting cycle); however, impairments from previous assessment cycles are also included and are distinguished from new impairments via cell shading (see footnote section of each table). These tables also denote the results of comparing each individual aquatic life and aquatic recreation indicator to their respective criteria (i.e., standards); these determinations were made during the desktop phase of the assessment process (see Figure 8). Assessment of aquatic life is derived from the analysis of biological (fish and macroinvertebrate IBIs), dissolved oxygen, turbidity, chloride, pH and un-ionized ammonia (NH_3) data, while the assessment of aquatic recreation in streams is based solely on bacteria (Escherichia coli or fecal coliform) data. Included in each table is the specific aquatic life use classification for each stream reach: cold water community (2A); cool or warm water community (2B); or indigenous aquatic community (2C). Stream reaches that do not have sufficient information for either an aquatic life or aquatic recreation assessment (from current or previous assessment cycles) are not included in these tables, but are included in Appendix 5.2 and Appendix 5.3. Where applicable and sufficient data exists, assessments of other designated uses (e.g., Class 7, drinking water, aquatic consumption) are discussed in the summary section of each subwatershed as well as in the Watershed-wide Results and Discussion section.

Channelized stream evaluations

Biological criteria have not been developed yet for channelized streams and ditches, therefore, assessment of fish and macroinvertebrate community data for aquatic life use support was not possible at some monitoring stations. A separate table provides a narrative rating of the condition of fish and macroinvertebrate communities at such stations based on IBI results. Evaluation criteria are based on aquatic life use assessment thresholds for each individual IBI class (see Appendix 5.1). IBI scores above

this threshold are given a "Good" rating, scores falling below this threshold by less than ~15 points (i.e., value varies slightly by IBI class) are given a "Fair" rating, and scores falling below the threshold by more than ~15 points are given a "Poor" rating. For more information regarding channelized stream evaluation criteria refer to Appendix 5.1.

Stream habitat results

Habitat information documented during each fish sampling visit is provided in each subwatershed section. These tables convey the results of the Minnesota Stream Habitat Assessment (MSHA) survey, which evaluates the section of stream sampled for biology and can provide an indication of potential stressors (e.g., siltation, eutrophication) impacting fish and macroinvertebrate communities. The MSHA score is comprised of five scoring categories including adjacent land use, riparian zone, substrate, fish cover and channel morphology, which are summed for a total possible score of 100 points. Scores for each category, a summation of the total MSHA score, and a narrative habitat condition rating are provided in the tables for each biological monitoring station. Where multiple visits occur at the same station, the scores from each visit have been averaged. The final row in each table displays average MSHA scores and a rating for the subwatershed.

Stream stability results

Stream channel stability information evaluated during each invertebrate sampling visit is provided in each subwatershed section. These tables display the results of the Channel Condition and Stability Index (CCSI) which rates the geomorphic stability of the stream reach sampled for biology. The CCSI rates three regions of the stream channel (upper banks, lower banks, and bottom) which may provide an indication of stream channel geomorphic changes and loss of habitat quality which may be related to changes in watershed hydrology, stream gradient, sediment supply, or sediment transport capacity. The CCSI was recently implemented in 2008, and is collected once at each biological station. Consequently, the CCSI ratings are only available for biological visits sampled in 2010 or later. The final row in each table displays the average CCSI scores and a rating for the subwatershed.

Subwatershed outlet water chemistry results

These summary tables display the water chemistry results for the monitoring station representing the outlet of the subwatershed. This data along with other data collected within the 10 year assessment window can provide valuable insight on water quality characteristics and potential parameters of concern within the watershed. Parameters included in these tables are those most closely related to the standards or expectations used for assessing aquatic life and recreation. While not all of the water chemistry parameters of interest have established water quality standards, McCollor and Heiskary (1993) developed ecoregion expectations for a number of parameters that provide a basis for evaluating stream water quality data and estimating attainable conditions for an ecoregion. For comparative purposes, water chemistry results for the Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux Watersheds are compared to expectations developed by McCollor and Heiskary (1993) that were based on the 75th percentile of a long-term dataset of least impacted streams within each ecoregion.

Lake assessments

A summary of lake water quality is provided in the subwatershed sections where available data exists. For lakes with sufficient data, basic modeling was completed. Assessment results for all lakes in the watershed are available in Appendix 3.2. Lake models and corresponding morphometric inputs can be found in Appendix 6.2.

Upper Big Sioux River Watershed HUC 10170202

Deer Creek Subwatershed HUC 1017020209-01

The Deer Creek Subwatershed Unit is the northern-most subwatershed in the Missouri River Basin, draining 9.14 miles^{2}of Lincoln County. This subwatershed is not a true complete watershed as a majority of the subwatershed is in South Dakota. 95.5% of the subwatershed's land use is utilized for agricultural production (cropland 40.14%, rangeland 55.4%). No waterbodies were monitored or assessed in this subwatershed due to their small size and drainage area.

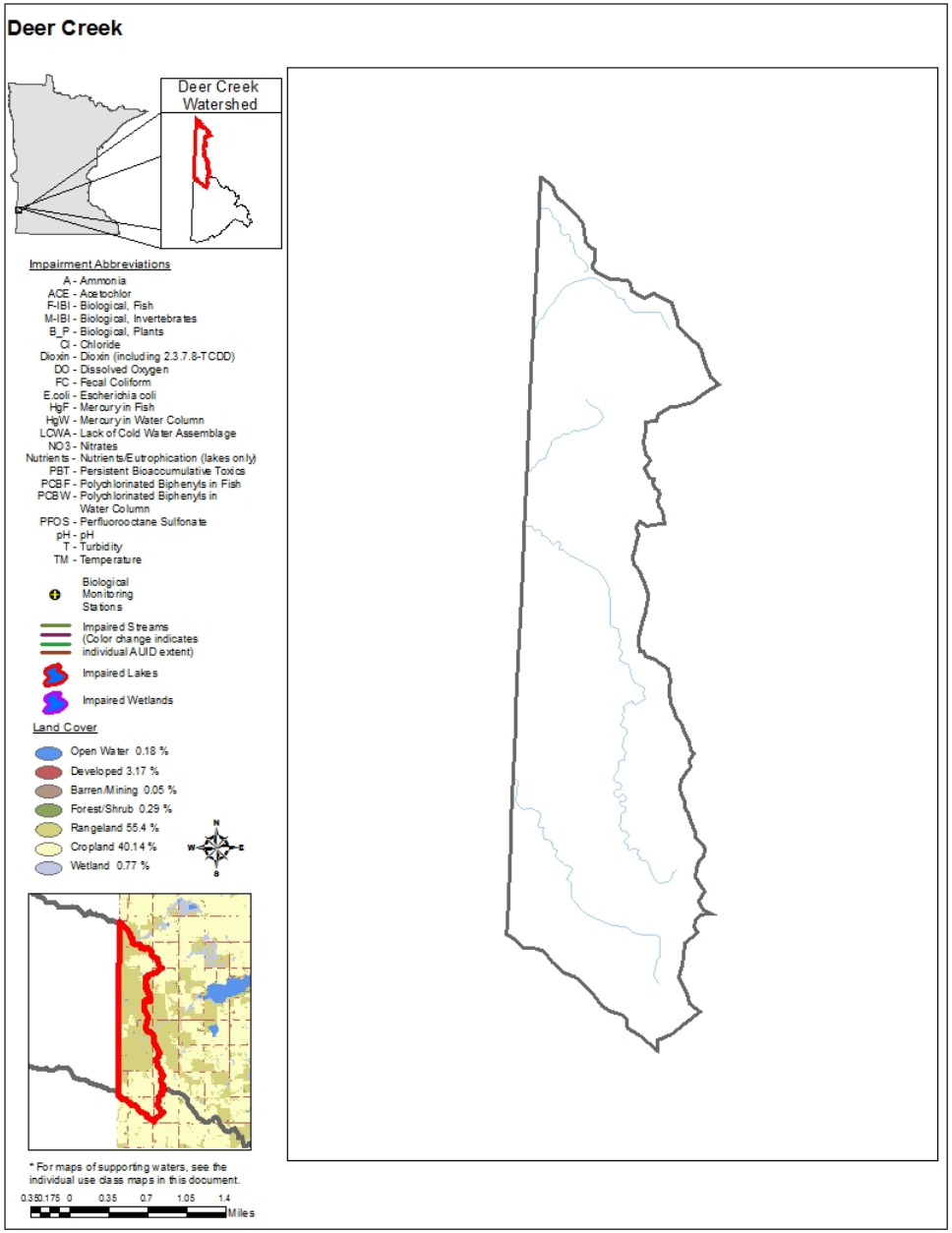

Figure 24. Currently listed impaired waters by parameter and land use characteristics in the Deer Creek Subwatershed.

Medary Creek Subwatershed HUC 1017020210-01

There are six stream reaches within the Upper Medary Creek subwatershed which drains 32.27 miles^{2}of Lincoln County. This subwatershed is not a true complete watershed, as a majority of the subwatershed is in South Dakota. Medary Creek is the only major stream that flows within this subwatershed and the only one that has chemistry data and biological data for assessment. Medary Creek flows west from near Lake Benton, but does not originate from the lake, for 2.8 miles, then flows south for 2.3 miles, then west for 8.8 miles before exiting into South Dakota. 82.96% of the subwatershed's land is utilized for agricultural production (cropland 67.23%, rangeland 25.73%).

Table 5. Aquatic life and recreation assessments on stream reaches: Medary Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
10170202-501 **Medary Creek**, Headwaters to MN/SD border	13.94	2C, 3C	11MS007 11MS026	Upstream of unnamed road, 8 mi. W of Lake Benton Downstream of CR 1, 7 mi. W of Lake Benton	MTS	EXS	IF	IF	-	MTS	MTS	-	IF	NS	IF

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 6. Minnesota Stream Habitat Assessment (MSHA): Medary Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS007	Medary Creek	0	8	17.3	14	24	63.3	Fair
1	11MS026	Medary Creek	0	6	14.4	12	28	60.4	Fair
Average Habitat Results: *Medary Creek Subwatershed*			**0**	**7**	**15.85**	**13**	**26**	**61.85**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 7. Channel Condition and Stability Assessment (CCSI): Medary Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS007	Medary Creek	20	22	15	3	60	moderately unstable
1	11MS026	Medary Creek	23	15	10	3	51	moderately unstable
Average Stream Stability Results: *Medary Creek Subwatershed*			**21.5**	**18.5**	**12.5**	**3**	**55.5**	moderately unstable

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 8. Outlet water chemistry results: Medary Creek Subwatershed.

Station location:	**MEDARY CK AT UNN ST (110TH AVE), S OF CR-119 AND W OF CSAH-1, 8 MI W OF LAKE BENTON, MN**
STORET/EQuIS ID:	**S006-582**
Station #:	**11MS007**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Chloride	mg/L	10	11.9	14.7	13.5	230	
Dissolved Oxygen (DO)	mg/L	19	5.4	14.9	8.7	5	
pH		19	7.9	8.6	8.2	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	19	13	86	29	>20	7
Escherichia coli (geometric mean)	MPN/100ml	13	159	159		126	1
Escherichia coli	MPN/100ml	13	39	1986	427	1260	1
Chlorophyll-a, Corrected	ug/L	17	1.9	56	11		
Inorganic nitrogen (nitrate and nitrite)	mg/L	19	2.4	7.3	4.3		
Kjeldahl nitrogen	mg/L	15	0.9	2.1	1.3		
Pheophytin-a	ug/L	16	1	36	7.6		
Phosphorus	ug/L	19	24	202	114		
Specific Conductance	uS/cm	19	601	813	688		
Temperature, water	deg °C	19	11	28	21		
Total suspended solids	mg/L	10	7	30	16		

Total volatile solids	mg/L	10	2	7	5		
Sulfate	mg/L	10	47	79	63		
Hardness	mg/L	10	310	413	368		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Medary Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Medary Creek, 10170202-501, Headwaters to MN/SD border

Water chemistry

For aquatic life use, only Medary Creek had sufficient data for an assessment but there is not enough chemistry data to determine whether the reach is supporting aquatic life. Dissolved oxygen shows a large flux and could indicate productivity issues within Medary Creek (i.e. high algal growth). The Escherichia coli dataset is limited with only one month having sufficient samples to compare to the geometric mean standard. In addition, many of the samples were flagged (exceeding holding times) and could not reliably be used for an assessment decision. There is only one sample that exceeds the individual daily standard. It is unknown at this time if bacteria is reaching problematic levels often enough to negatively impact recreation use.

Biology

The macroinvertebrate community of the Medary Creek subwatershed is similar to that found in other agriculture dominated streams in the Missouri River Basin. Despite having moderate habitat and flow conditions, both reaches sampled in this subwatershed had a high proportion of relatively tolerant taxa resulting in low MIBI scores. High suspended sediment values are indicative of unstable stream channels in the upstream watershed. Chronically high suspended sediment can be a direct cause, or be associated with conditions that result in unhealthy macroinvertebrate communities. The fish data at both of the sites was good and above the impairment threshold. There was good diversity and numbers of fish at each site. Sediment and large dissolved oxygen fluxes do not always have the same effect on fish as they are more mobile than invertebrates which could have caused the discrepancy in the high fish score and low invertebrate scores. Medary Creek is degraded from the amount of open pasture along the streams, but has potential for improvement and would likely benefit from habitat improvement and channel stabilization efforts to control sediment.

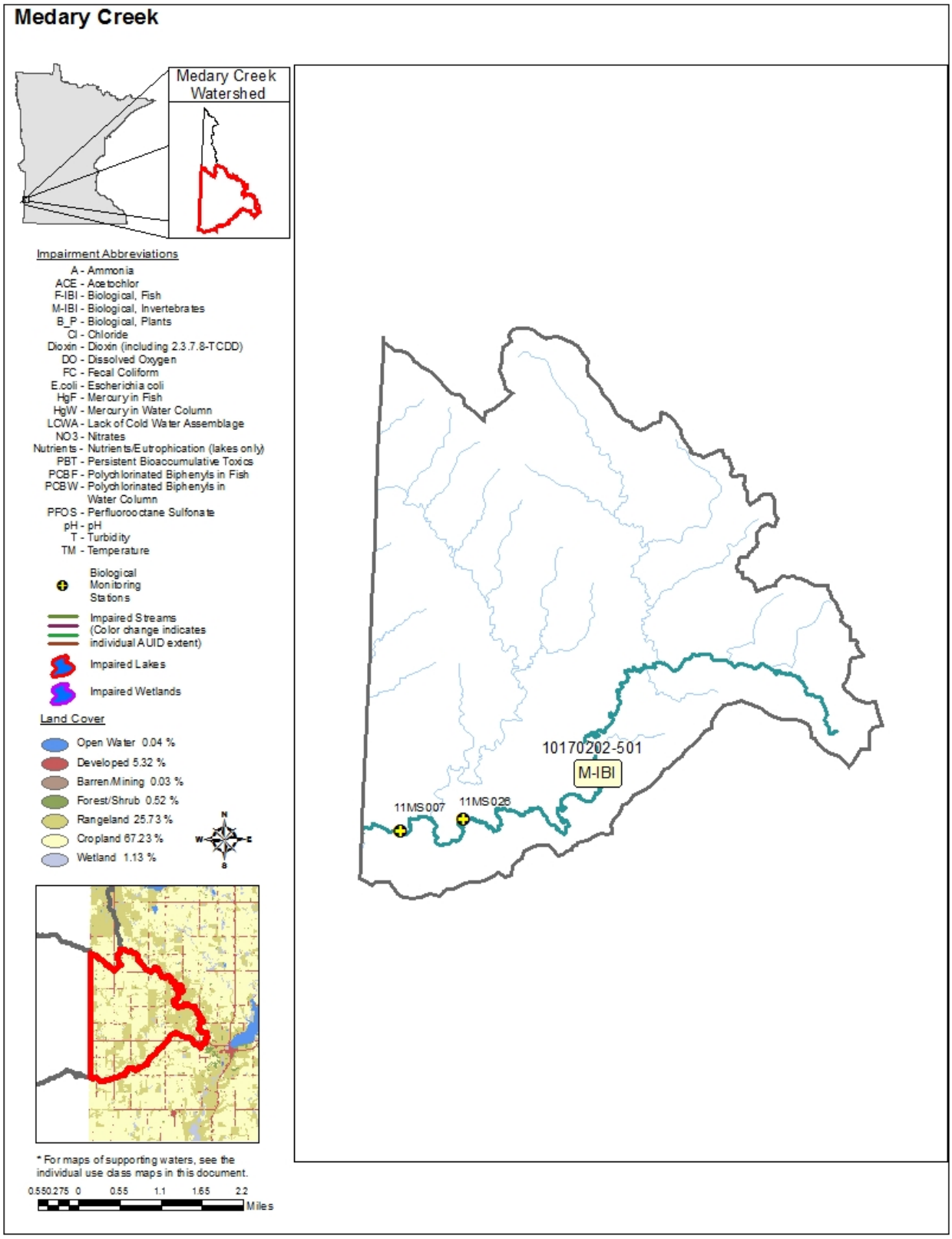

Figure 25. Currently listed impaired waters by parameter and land use characteristics in the Medary Creek Subwatershed.

Lower Big Sioux River Watershed HUC 10170203

Spring Creek Subwatershed HUC 1017020301-01

Spring Creek is the only stream reach in this subwatershed. It is 12.6 miles long and flows from the city of Lake Benton southwest to the South Dakota border, draining 13.36 mile^2 of Lincoln and Pipestone Counties. This subwatershed is not a true complete watershed, as a majority of the subwatershed is in South Dakota. There is no chemistry data for this stream and one biological station that was sampled for only invertebrates. 93.6% of the subwatershed's land is utilized for agricultural production (cropland 67.38%, rangeland 26.22%).

Table 9. Aquatic life and recreation assessments on stream reaches: Spring Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
10170203-518, **Spring Creek,** Headwaters to MN/SD border	12.65	2B,3C	11MS029	Upstream of 110th Ave, 4.5 mi. W of Verdi	-	EXS	IF	IF	-	IF	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 10. Channel Condition and Stability Assessment (CCSI): Spring Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS029	Spring Creek	11	11	16	5	43	fairly stable
Average Stream Stability Results: *Spring Creek Subwatershed*			**11**	**11**	**16**	**5**	**43**	**fairly stable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Summary

Spring Creek, 10170203-518, Headwaters to MN/SD border

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Despite having higher than average flows throughout the Missouri River Basin during the late summer of 2012, Spring Creek had very low flows. The macroinvertebrate community of Spring Creek reflected this low flow condition, with a depauperate community indicative of wetland-like conditions, and an MIBI score well below the impairment threshold. No fish were sampled at Spring Creek due to low flows. Spring Creek may go dry or partially dry on a regular basis. More water storage in this subwatershed may be helpful to stabilize flows.

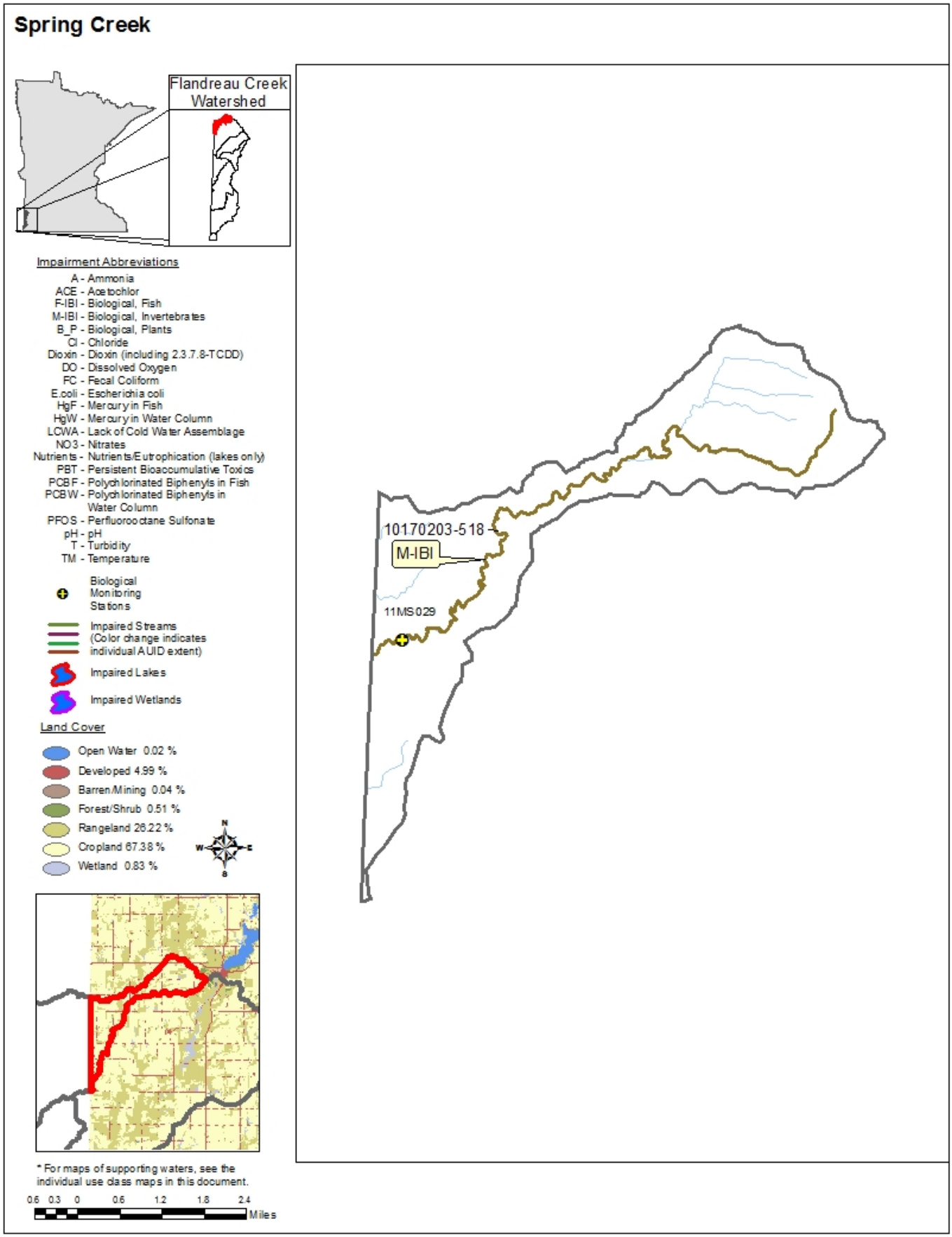

Figure 26. Currently listed impaired waters by parameter and land use characteristics in the Spring Creek Subwatershed.

Flandreau Creek Subwatershed HUC 1017020303-01

There are two main streams in the Flandreau Creek Subwatershed. Flandreau Creek starts south of Lake Benton and flows southwest to the border of South Dakota. It drains 96.23 miles^2 of Lincoln and Pipestone Counties. This subwatershed is not a true complete watershed, as a part of the subwatershed is in South Dakota. Willow Creek flows southwest from near Verdi and joins Flandreau Creek near Cresson. 93.68% of the subwatershed's land is utilized for agricultural production (cropland 62.68%, rangeland 31%).

Table 11. Aquatic life and recreation assessments on stream reaches: Flandreau Creek subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (mMTSes)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170203-502, **Flandreau Creek,** Willow Cr to MN/SD border	7.69	2C,3C	11MS005	Downstream of 10th Ave, 4 mi. W of Cazenovia	EXS	MTS	IF	EXS	-	MTS	IF		NS	NS	NS
10170203-515, **Willow Creek,** Headwaters to Flandreau Cr	15.33	2B, 3C	11MS035	Downstream of CR 8, 8 mi. SW of Verdi	EXS	EXS	IF	IF	-	IF	IF		-	NS	NA
10170203-516, **Flandreau Creek,** T109 R45W S30, north line to T108 R46W S11, south line	7.01	7	04MS052 11MS140	Upstream of CR 75, 6 miles S of Lake Benton Upstream of 70th Ave, 2 mi. S of Verdi	NA	NA	IF	IF	-	IF	IF	-	-	NA	NA
10170203-517, **Flandreau Creek,** T108 R46W S14, north line to Willow Cr	12.34	2C, 3C	11MS034	Upstream of CR 8, 11 mi. NW of Pipestone	EXS	EXP	IF	IF	-	IF	IF	-	-	NS	NA
10170203-531, **Unnamed creek,** Unnamed cr to Willow Cr	1.73	2B, 3C	11MS032	Downstream of CR 75, 2.5 mi. SW of Verdi	MTS	EXP	IF	IF	-	IF	IF	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 12. Non-assessed biological stations on channelized AUIDs: Flandreau Creek subwatershed

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170203-548, **East Branch,** Unnamed cr to Unnamed cr	2.08	2B, 3C	11MS031	Upstream of 70th Ave, 2.5 mi SE of Verdi	63	38.15

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 13. Minnesota Stream Habitat Assessment (MSHA): Flandreau Creek subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS005	Flandreau Creek	0	0	16.8	6	25	47.8	Fair
1	11MS035	Willow Creek	2	10.5	16.9	10	26	65.4	Fair
1	04MS052	Flandreau Creek	5	14	9	15	20	63	Fair
1	11MS140	Flandreau Creek	0	2	12.8	6	26	46.8	Fair
1	11MS034	Flandreau Creek	0	1	8	2	14	25	Poor
1	11MS032	Trib. to Willow Creek	0	9	4	12	7	32	Poor
1	11MS031	Flandreau Creek, East Branch	0	5	18.8	11	20	54.8	Fair
Average Habitat Results: *Flandreau Creek subwatershed*			**1**	**5.92**	**12.33**	**8.86**	**19.71**	**47.83**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 14. Channel Condition and Stability Assessment (CCSI): Flandreau Creek subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS005	Flandreau Creek	20	19	6	6	51	moderately unstable
1	11MS035	Willow Creek	25	17	10	7	59	moderately unstable
1	11MS140	Flandreau Creek	30	11	19	7	67	moderately unstable
1	11MS034	Flandreau Creek	19	16	10	7	52	moderately unstable

1	11MS032	Trib. to Willow Creek	13	13	22	3	51	moderately unstable
1	11MS031	Flandreau Creek, East Branch	27	17	19	7	70	moderately unstable
		Average Stream Stability Results: Flandreau Creek *subwatershed*	**22.33**	**15.5**	**14.33**	**6.17**	**58.33**	**moderately unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 15. Outlet water chemistry results: Flandreau Creek Subwatershed.

Station location:	**FLANDREAU CK AT CR-73 (AKA 10TH AVE), S OF 161ST ST, 4 MI W OF CAZENOVIA, MN**
STORET/EQuIS ID:	**S006-581**
Station #:	**11MS005**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	11	0.0037	0.0195	0.012	0.04	
Chloride	mg/L	10	14	18	15.64	230	
Dissolved Oxygen (DO)	mg/L	20	5.8	13.4	8.2	5	
pH		20	8	8.6	8.3	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	20	6	81	20	>20	15
Escherichia coli (geometric mean)	MPN/100ml	16	593	1667		126	3
Escherichia coli	MPN/100ml	16	159	>2419	1204	1260	7
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	1.9	3.6	3.1		
Kjeldahl nitrogen	mg/L	9	0.7	1.7	1.2		
Phosphorus	ug/L	10	27	397	193		
Specific Conductance	uS/cm	20	575	837	757		
Temperature, water	deg °C	20	11	27	21		
Total suspended solids	mg/L	10	7	97	39		
Total volatile solids	mg/L	10	2	18	10		
Sulfate	mg/L	10	49	93	66		
Hardness	mg/L	10	353	430	393		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Flandreau Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Flandreau Creek, 10170203-502, Willow Cr to MN/SD border, **Flandreau Creek, 10170203-516,** 109 R45W S30, north line to T108 R46W S11, south line, **Flandreau Creek, 10170203-517,** T108 R46W S14, north line to Willow Cr

Water chemistry

Flandreau Creek shows high levels of bacteria June through August with three out of three months exceeding the geometric standard and seven individual exceedances. The elevated bacteria levels warranted a "not supporting" listing for aquatic recreation use on Flandreau Creek. The data for aquatic life use was inconclusive; the sampling occurred during drought conditions and oxygen values were from later in the day. Even though samples were collected during these drought conditions we have confidence in listing Flandreau Creek for a bacteria impairment.

Biology

The macroinvertebrate community in Flandreau Creek is somewhat reflective of flow conditions present at the time of sampling. Throughout the agricultural parts of Minnesota, higher base flows are sometimes associated with more stable invertebrate communities even in the presence of relatively poor habitat and riparian conditions. This is not always the case, and typically streams with an overwhelming presence of agriculture in their upstream watershed have difficulty maintaining healthy invertebrate communities. The eastern part of the subwatershed and the downstream mainstem showed relatively higher flows compared to the Willow Creek part of the subwatershed, and the macroinvertebrate scores were higher relative to the impairment threshold. Two unassessed stations in the headwaters of Flandreau Creek (11MS140 and 11MS031) had scores above the threshold, despite being channelized and having relatively poor habitat. The lowermost reach also scored above the impairment threshold. All of these sites had relatively high flow patterns. The fish communities on Flandreau Creek follow a pattern which is present throughout the Missouri River Basin of fair to good habitat in streams with small drainage areas, like headwater streams, tending to have higher FIBI scores. The headwaters and its tributaries scored the best for fish in Flandreau Creek. Habitat scores were highest in the headwaters, including 11MS031 which is channelized. Stations 04MS052 and 11MS140 also scored well and would have been supporting if it was not for the Class 7 designation. Turbidity and siltation, which cause lack of habitat, could be a large factor explaining the declining fish community further downstream.

Willow Creek, 10170203-515, Headwaters to Flandreau Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

The eastern part of the subwatershed and the downstream mainstem showed relatively higher flows compared to the Willow Creek part of the subwatershed, and the macroinvertebrate scores were higher relative to the impairment threshold. 11MS035 had fauna more characteristic of low

gradient streams, with fairly diverse mayfly taxa. Fish assemblages also reflected a low gradient condition, with wetland-like fauna consisting of very tolerant fish species. Fish scores were well below the impairment threshold. Migration of less tolerant fish could be occurring through this area, but they don't reside here because the habitat is unsuitable. Higher numbers at Unnamed Creek, which is at the upstream end of Willow Creek, could reflect better habitat.

Unnamed Creek, 10170203-531, Unnamed Cr to Willow Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

The macroinvertebrate community in the Flandreau Creek Subwatershed is somewhat reflective of flow conditions present at the time of sampling. Throughout the agricultural parts of Minnesota, higher base flows are sometimes associated with more stable invertebrate communities even in the presence of relatively poor habitat and riparian conditions. This is not always the case, and typically streams with an overwhelming presence of agriculture in their upstream watershed have difficulty maintaining healthy invertebrate communities. The eastern part of the subwatershed and the downstream mainstem showed relatively higher flows compared to the Willow Creek part of the watershed, and the macroinvertebrate scores were higher relative to the impairment threshold. The fish score were well above the impairment threshold. This could be due to higher gradient flow conditions which create more dissolved oxygen. There is also more fish habitat than in Willow Creek, along with a smaller drainage area and less turbidity, and thus less sediment.

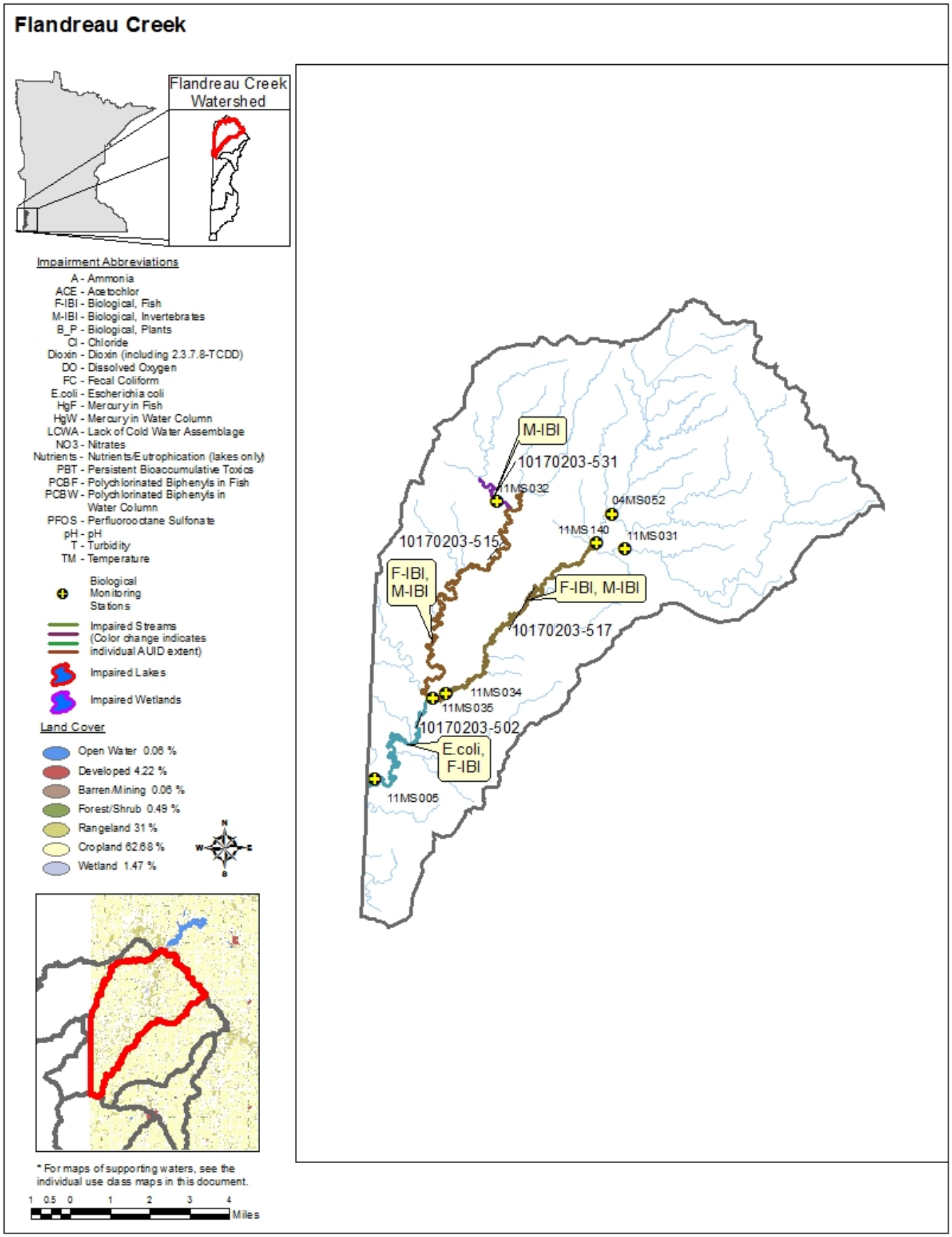

Figure 27. Currently listed impaired waters by parameter and land use characteristics in the Flandreau Creek Subwatershed.

North Branch Pipestone Creek Subwatershed HUC 1017020313-02

North Branch Pipestone Creek drains 64.04 miles^2 of Lincoln and Pipestone Counties. There are two main tributaries; both called Unnamed Creek, which flow south into North Branch Pipestone Creek. North Branch Pipestone Creek flows southwest into Pipestone Creek 4 miles west of Pipestone. This subwatershed is completely with in Minnesota's boundaries. 94.49% of the subwatershed's land is utilized for agricultural production (cropland 81.73%, rangeland 12.76%).

Table 16. Aquatic life and recreation assessments on stream reaches: North Branch Pipestone Creek Subwatershed.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170203-514, **Pipestone Creek, North Branch,** Headwaters to Pipestone Cr	28.34	2B, 3C	11MS056 11MS050	Upstream of CR 76, 4.5 mi N of Pipestone Downstream of CR 71, 5 mi. NW of Pipestone	EXS	EXP	EXP	EXS	-	MTS	IF	-	EX	NS	NS
10170203-549, **Unnamed creek,** Unnamed cr to N Br Pipestone Cr	2.27	2B, 3C	11MS049	Upstream of 181st St, 9 mi. SW of Ruthton	EXS	EXS	IF	IF	-	IF	-	-	-	NS	NA
10170203-550, **Unnamed creek,** Unnamed cr to N Br Pipestone Cr	3.16	2B, 3C	11MS055	Upstream of 161st St, 5.5 mi. NW of Pipestone	MTS	MTS	IF	IF	-	IF	IF	-	-	FS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 17. Minnesota Stream Habitat Assessment (MSHA): North Branch Pipestone Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS056	Pipestone Creek, North Branch	1	4	17.05	11	30	63.05	Fair
1	11MS050	Pipestone Creek, North Branch	0	6	12.6	5	22	45.6	Fair
1	11MS049	Trib. to Pipestone Creek, North	0	6	11.3	5	15	37.3	Poor
1	11MS055	Trib. to Pipestone Creek, North	0	4	16.8	11	20	51.8	Fair
Average Habitat Results: *North Branch Pipestone Creek Subwatershed*			**.25**	**5**	**14.44**	**8**	**21.75**	**49.44**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 18. Channel Condition and Stability Assessment (CCSI): North Branch Pipestone Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS056	Pipestone Creek, North Branch	27	22	18	7	74	Moderately Unstable
1	11MS050	Pipestone Creek, North Branch	16	13	17	5	51	Moderately Unstable
1	11MS055	Trib. to Pipestone Creek, North Branch	7	11	6	4	28	Fairly Stable
Average Stream Stability Results: *North Branch Pipestone Creek Subwatershed*			**16.67**	**15.34**	**13.67**	**5.34**	**51**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Summary

10170203-514, Pipestone Creek, North Branch, 10170203-514, Headwaters to Pipestone Cr

Water chemistry

North Branch Pipestone Creek has enough data for assessment. There are two previous listings for the reach - aquatic life impairment based on turbidity and aquatic recreation impairment based on fecal coliform. The recent sampling did not include bacteria so the existing impairment listing remains in place. There is sufficient data to confirm the existing turbidity impairment.

Biology

The North Branch Pipestone Creek Subwatershed showed signs of improvement in the western verses the eastern half of the subwatershed. As drainage areas increase, the higher volume of water can ameliorate the conditions necessary for healthier invertebrate communities. The easternmost station, in the headwaters of this subwatershed (11MS049) had a score well below the impairment threshold, while stations further downstream scored nearer (11MS056 and 11MS050), or above (11MS056) the impairment threshold. Flow conditions were relatively high at the time of sampling in 2011 (Figure 84), but suspended sediments values were also high, suggesting unstable stream channels throughout the subwatershed. Despite having relatively high flows, more stations had invertebrate communities reflective of lower gradient systems, indicating either a lack of quality habitat or flow not indicative of normal conditions. Fish followed the exact opposite trend. The stations with larger drainage areas (11MS056 and 11MS050) had lower FIBI scores than did the stations with smaller drainage areas (11MS049 and 11MS055). Better stream bank stability, which is often associated with lower suspended and bedded sediment, could be a factor contributing to the higher FIBI scores in these smaller drainage areas.

Unnamed creek, 10170203-549, Unnamed Cr to N Br Pipestone Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

In many cases, stations with very small drainage areas are not able to buffer the impact of highly modified, agriculture land use for invertebrates. The easternmost station in the headwaters of this subwatershed (11MS049) had a score well below the impairment threshold, while stations further downstream scored nearer (11MS056 and 11MS050) or above (11MS056) the impairment threshold. The better FIBI scores were in the smallest drainage areas of this subwatershed. The stations (11MS056 and 11MS050) had a lower FIBI scores than did the stations with smaller drainage areas (11MS049 and 11MS055). Bank instability, which may cause lower turbidity and sedimentation, seems to be a factor in these smaller drainage areas.

Unnamed creek, 10170203-550, Unnamed Cr to N Br Pipestone Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Both fish and invertebrates scored well at this station (11MS055), and it is one of three stations in the entire Missouri River Basin that was fully supporting of both assemblages. Channel stability is higher here than other places in the subwatershed, which may contribute to higher invertebrate and fish scores.

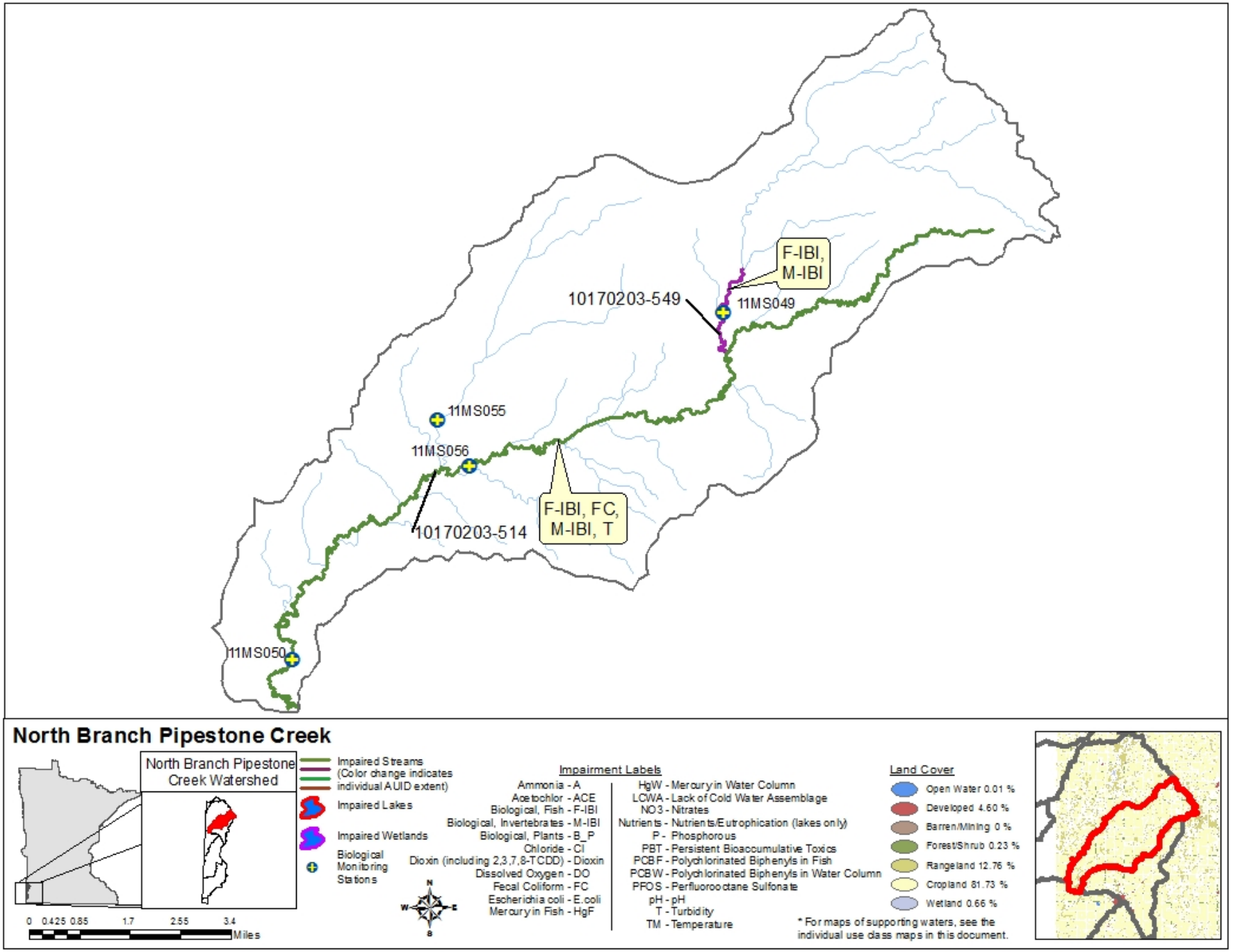

Figure 28. Currently listed impaired waters by parameter and land use characteristics in the North Branch Pipestone Creek Subwatershed.

Upper Pipestone Creek Subwatershed HUC 1017020313-03

Pipestone Creek has two main tributaries, and drains 44.91 miles^2 of Pipestone County. The tributaries are County Ditch A which flows southwest from Holland and Main Ditch which flows north. They both connect to Pipestone Creek in the city of Pipestone. Pipestone Creek flows west through Pipestone, which is one of largest cities in the basin, and combines with the North Branch of Pipestone Creek about 4 miles west of Pipestone. 90.12% of the subwatershed's land is utilized for agricultural production (cropland 82.2%, rangeland 7.92%). 8.81% of this subwatershed is comprised of the urban area of Pipestone, Minnesota.

Table 19. Aquatic life and recreation assessments on stream reaches: Upper Pipestone Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170203-506, **Pipestone Creek,** Headwaters to N Br Pipestone Cr	11.19	2C, 3C	11MS038 04MS021	Downstream of 40th Ave, 4.5 mi. NW of Pipestone Upstream of State Route 30, 3 mi. W of Pipestone	EXS	EXP	IF	IF	-	IF	IF	-	-	NS	NA
10170203-527, **Main Ditch,** CD A to Pipestone Cr	2.04	2B,3C	10EM124 04MS055	Downstream of CR 69, 0.5 mi. E of Pipestone Downstream of 9th St NE, in North Pipestone	*NA	*NA	MTS	EXP	MTS	MTS	MTS	MTS	EX	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 20. Non-assessed biological stations on channelized AUIDs: Upper Pipestone Creek Subwatershed

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170203-506, Pipestone Creek, Headwaters to N Br Pipestone Cr	11.19	2C, 3C	11MS038	Downstream of 40th Ave, 4.5 mi. NW of Pipestone	36	37.4
10170203-527, Main Ditch, CD A to Pipestone Cr	2.04	2B,3C	10EM124	Downstream of CR 69, 0.5 mi. E of Pipestone	33.5	22.3
10170203-527, Main Ditch, CD A to Pipestone Cr	2.04	2B,3C	04MS055	Downstream of 9th St NE, in North Pipestone	10	44.2
10170203-530, Main Ditch, Unnamed cr to CD A	3.61	2B,3C	11MS057	Downstream of CR 69, 1 mi. SE of Pipestone	22	17.0
10170203-545, County Ditch A, Unnamed ditch to Unnamed ditch	0.86	2B, 3C	07MS001	Upstream of CR 70, 2 mi. NE of Pipestone	31	24.3

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 21. Minnesota Stream Habitat Assessment (MSHA): Upper Pipestone Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS038	Pipestone Creek	0	3	10.3	2	13	28.3	Poor
1	04MS021	Pipestone Creek	0	5	13.5	9	22	49.5	Fair
2	10EM124	Unnamed ditch	0	8	17.5	6.5	12	44	Poor
1	11MS057	Main Ditch	0	7	16	10	5	38	Poor
1	07MS001	County Ditch A	0	8.5	14.5	6	21	50	Fair
Average Habitat Results: *Upper Pipestone Creek Subwatershed*			**0**	**6.3**	**14.4**	**6.7**	**14.6**	**42**	**Poor**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 22. Channel Condition and Stability Assessment (CCSI): Upper Pipestone Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS038	Pipestone Creek	16	13	13	5	47	Moderately Unstable
1	10EM124	Unnamed ditch	26	11	14	3	54	Moderately Unstable
1	11MS057	Main Ditch	15	13	9	3	40	Fairly Stable
Average Stream Stability Results: *Upper Pipestone creek Subwatershed*			**19**	**12.3**	**12**	**3.4**	**47**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Summary

10170203-506, Pipestone Creek, 10170203-506, Headwaters to N Br Pipestone Cr

Water chemistry

Pipestone Creek has a limited chemistry dataset and is not assessed**.**

Biology

The lowermost sites in the Upper Pipestone Creek subwatershed (11MS038 and 04MS021) had the highest MIBI and FIBI scores relative to impairment threshold of all sites sampled, and was the only site to score above the impairment threshold. This subwatershed was sampled four different years, with low MIBI and FIBI scores prevalent throughout. Consistently high nitrogen and suspended sediment values are reflective of highly modified land use and unstable bank conditions; both of these factors have been shown to have significant impacts on macroinvertebrate and fish community health.

Main Ditch, 10170203-527, CD A to Pipestone Cr, **Main Ditch, 10170203-530,** Unnamed Cr to CD A

Water chemistry

The Main Ditch has data confirming the previous listing of aquatic life as impaired based on turbidity data and aquatic recreation impairment due to bacteria.

Biology

This subwatershed was sampled three different years, with low MIBI and FIBI scores prevalent throughout the time period. Consistently high nitrogen and suspended sediment values are reflective of highly modified land use and unstable bank conditions; both of these factors have been shown to have significant impacts on macroinvertebrate and fish community health.

County Ditch A, 10170203-545, Unnamed ditch to Unnamed ditch

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

This channelized reach was not assessed but followed the pattern of all of the other sites in this subwatershed. Consistently high nitrogen and suspended sediment values are reflective of highly modified land use and unstable bank conditions; both of these factors have been shown to have significant impacts on macroinvertebrate and fish community health.

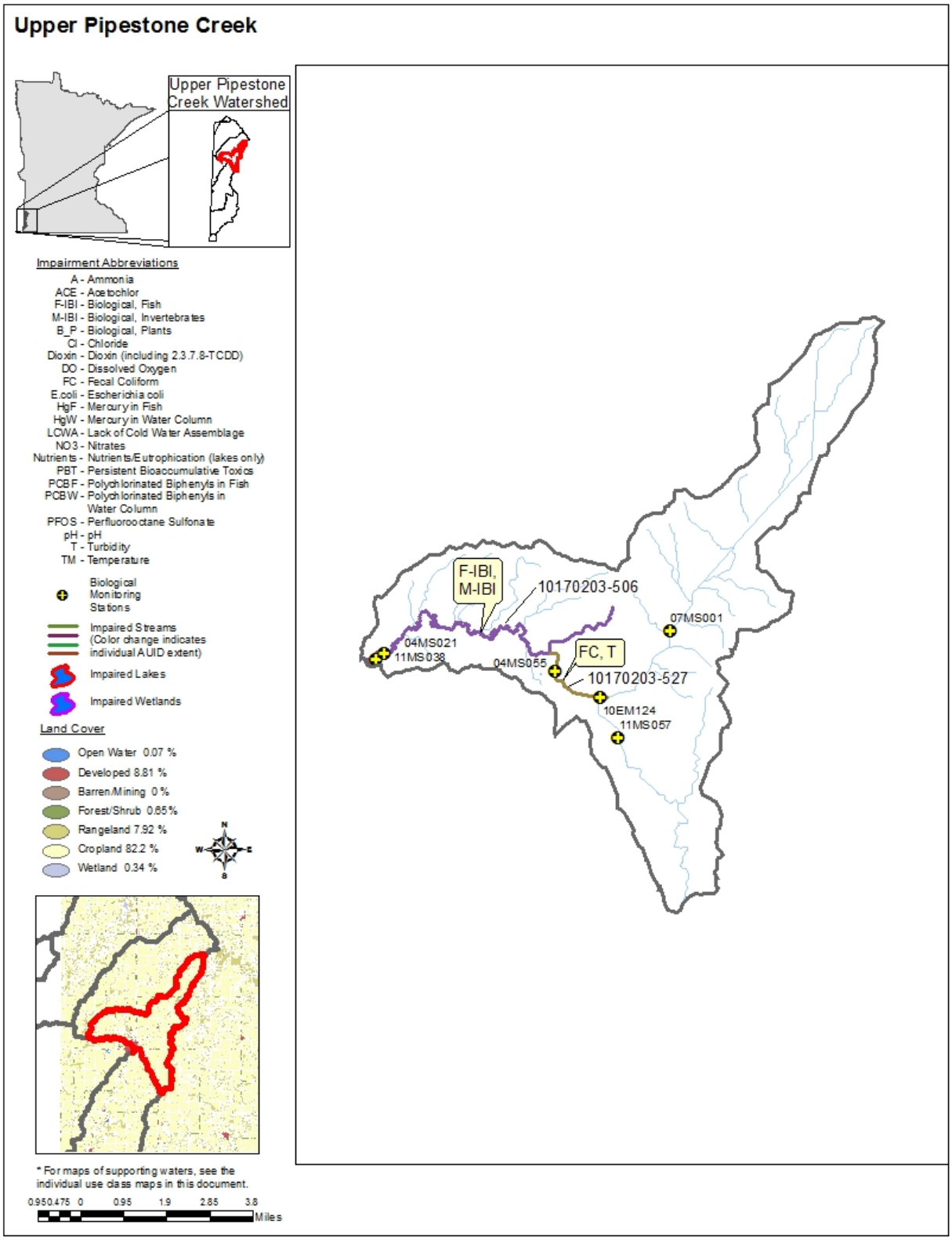

Figure 29. Currently listed impaired waters by parameter and land use characteristics in the Upper Pipestone Creek Subwatershed.

Lower Pipestone Creek Subwatershed Unit HUC 1017020313-01

There are five stream reaches within the Lower Pipestone Creek Subwatershed, but not all of them flow into Pipestone Creek in Minnesota. Pipestone Creek and the South Branch Pipestone Creek are the major streams in this subwatershed. Pipestone Creek flows into this subwatershed from the north (Upper Pipestone Creek Subwatershed and North Branch Pipestone Creek), crosses the South Dakota border, and comes back into Minnesota 11.5 miles south. The Lower Pipestone Creek Subwatershed drains 43.09 miles^2 of Pipestone and Rock Counties. 92.69% of the subwatershed's land is utilized for agricultural production (cropland 81.5%, rangeland 11.19%).

Table 23. Aquatic life and recreation assessments on stream reaches: Lower Pipestone Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170203-501, **Pipestone Creek,** N Br Pipestone Cr to MN/SD border (Pipestone County)	9.33	2C, 3C	11MS019	Upstream of CR 13, 6 mi W of Pipestone	EXS	EXP	IF	EXS	-	MTS	IF	-	EX	NS	NS
10170203-505, **Pipestone Creek,** MN/SD border to Split Rock Cr (Rock County)	1.09	2B, 3C	11MS015	South of Twp Rd 21, 3 mi. SW of Jasper	EXS	EXP	IF	EXS	-	MTS	MTS	-	EX	NS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 24. Non-assessed biological stations on channelized AUIDs: Lower Pipestone Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170203-551, **Unnamed creek,** Unnamed cr to MN/SD border	2.43	2B, 3C	11MS028	Downstream of 61st St, 6 mi NW of Ihlen	-	24.9

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 25. Minnesota Stream Habitat Assessment (MSHA): Lower Pipestone Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS019	Pipestone Creek	0	4	18	6	18	46	Fair
1	11MS015	Pipestone Creek	0	8	20	1	13	42	Poor
Average Habitat Results: *Lower Pipestone Creek Subwatershed*			**0**	**6**	**19**	**3.5**	**15.5**	**44**	**Poor**

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 26. Channel Condition and Stability Assessment (CCSI): Lower Pipestone Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS019	Pipestone Creek	20	19	13	6	58	Moderately Unstable
1	11MS015	Pipestone Creek	43	29	26	11	109	Severely Unstable
1	11MS028	Unnamed creek	12	11	9	1	33	Fairly Stable
Average Stream Stability Results: *Lower Pipestone Creek Subwatershed*			**25**	**19.7**	**16**	**6**	**66.7**	Moderately Unstable

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 27. Outlet water chemistry results: Lower Pipestone Creek Subwatershed.

Station location:	**PIPESTONE CK, SOUTH OF TOWNSHIP RD 21, 3 MI SW OF JASPER, MN T104N/R47W/S23**						
STORET/EQuIS ID:	**S006-580**						
Station #:	**11MS015**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	11	0.0031	0.0223	0.012	0.04	
Chloride	mg/L	10	12.7	31.6	23.9	230	
Dissolved Oxygen (DO)	mg/L	20	6.7	11	8.6	5	
pH		20	7.8	8.7	8.3	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	19	5	51	18	>20	13
Escherichia coli (geometric mean)	MPN/100ml	16	81	395		126	2
Escherichia coli	MPN/100ml	16	9	>2419	464	1260	2
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	3	8	6		
Kjeldahl nitrogen	mg/L	9	1	2.8	1.6		
Phosphorus	ug/L	10	38	579	234		
Specific Conductance	uS/cm	20	435	973	807		
Temperature, water	deg °C	20	10	28	21		
Total suspended solids	mg/L	10	18	185	71		
Total volatile solids	mg/L	10	3	31	15		
Sulfate	mg/L	**10**	74	170	130		
Hardness	mg/L	10	198	502	416		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Lower Pipestone Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 28. Outlet water chemistry results: Lower Pipestone Creek Subwatershed.

Station location:	**PIPESTONE CRK ON CSAH-13 4.5 MI W OF PIPESTONE**						
STORET/EQuIS ID:	**S000-510**						
Station #:	**11MS019**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	10	0.0076	0.0246	0.014	0.04	
Chloride	mg/L	10	21	32	26	230	
Dissolved Oxygen (DO)	mg/L	20	6.55	12.41	8.78	5	
pH		20	8.1	8.6	8.4	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	20	7	58	17	>20	16
Escherichia coli (geometric mean)	MPN/100ml	16	326	522		126	3
Escherichia coli	MPN/100ml	16	122	2142	653	1260	2
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	4	11	7.6		
Kjeldahl nitrogen	mg/L	9	0.7	2	1.5		
Phosphorus	ug/L	10	28	311	158		
Specific Conductance	uS/cm	20	710	919	810		
Temperature, water	deg °C	20	11	27	21		
Total suspended solids	mg/L	10	6	117	55		
Total volatile solids	mg/L	10	4	22	13		
Sulfate	mg/L	10	106	154	126		
Hardness	mg/L	10	378	460	426		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Lower Pipestone Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Pipestone Creek, 10170203-501, N Br Pipestone Cr to MN/SD border (Pipestone County), **Pipestone Creek, 10170203-505,** MN/SD border to Split Rock Cr (Rock County)

Water chemistry

Pipestone Creek (10170203-501 and 10170203-505) shows high levels of bacteria June through August. With two out of three months exceeding the geometric mean standard, Pipestone Creek (10170203-505) is impaired for aquatic recreation and will be listed for the first time on the 2014 Impaired Waters List, while new data for 10170203-501 is in agreement with the existing listing from 1994. 10170203-505 transparency data shows 13 samples that exceed the <20 standard out of the 19 samples taken, but will not be listed because there is low confidence in the data because the samples were collected during extreme drought conditions. 10170203-501 transparency data shows 16 samples that exceed the <20 standard out of the 20 samples taken. There is a previous impairment listing for turbidity and the current data confirms that listing; the reach is considered to be not supporting aquatic life use.

Biology

The stations sampled in the Lower Pipestone Creek Subwatershed all had invertebrate and fish communities indicative of highly modified, agricultural streams. Low flows, poor habitat diversity, and poor water quality conditions resulted in stations with low diversity and dominance by relatively tolerant taxa.

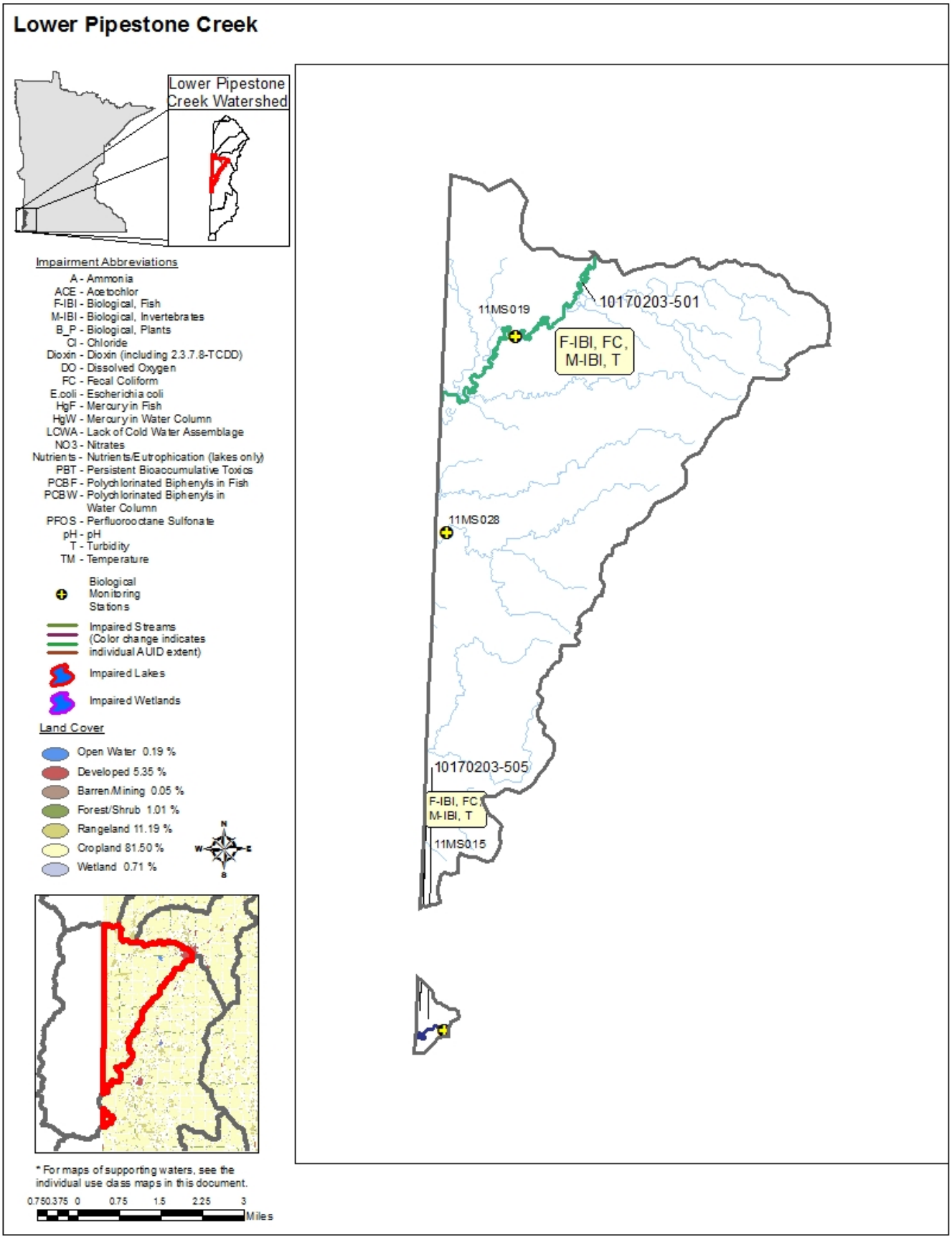

Figure 30. Currently listed impaired waters by parameter and land use characteristics in the Lower Pipestone Creek Subwatershed.

Upper Split Rock Creek Subwatershed HUC 1017020316-02

There are 11stream reaches within the Upper Split Rock Creek Subwatershed, which drains 127 miles^2 of Rock and Pipestone counties. Split Rock Creek is the major stream in this subwatershed. This subwatershed is not a true complete watershed as a part of the subwatershed is in South Dakota. Split Rock Creek flows from the town of Pipestone 11.9 miles to Split Rock Reservoir, then continues south 13.64 miles to Jasper where it joins with Pipestone Creek as its largest tributary, before traveling another 6.8 miles and entering South Dakota. There is one lake in this subwatershed, Split Rock Reservoir; however, no assessment data was collected in this basin. 91.76% of the subwatershed's land is utilized for agricultural production (cropland 76.79%, rangeland 14.97%).

Table 29. Aquatic life and recreation assessments on stream reaches: Upper Split Rock Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170203-507, **Split Rock Creek,** Split Rock Lk to Pipestone Cr	13.64	2C, 3C	04MS005 11MS052	Upstream of CR 53, 1.4 miles NE of Jasper Upstream of Twp Rd 21, 3.75 mi SW of Jasper	EXS	EXS	EXS	IF	-	MTS	IF	-	-	NS	NA
10170203-509, **Split Rock Creek,** Headwaters to Split Rock Lk	11.91	2B, 3C	04MS031	Downstream of Hwy 23, 0.75 mi. N of Ihlen	EXS	EXP	IF	IF		IF	IF	IF		NS	NA
10170203-512, **Split Rock Creek**, Pipestone Cr to MN/SD border	6.81	2C, 3C	11MS013	Downstream of CR 7, 8 mi. S of Jasper	EXS	MTS	EXP	EXS	-	MTS	MTS	-	EX	NS	NS
10170203-538, **Unnamed creek,** Unnamed cr to Unnamed cr	4.03	2B, 3C	11MS045	Upstream of CR 51, 7.5 mi. S of Japser	-	EXP	IF	IF	-	IF	IF	-	-	NS	NA
10170203-553, **Unnamed creek,** Unnamed cr to Unnamed cr	1.84	2B, 3C	11MS058	Downstream of TR 73, 4 mi. S of Jasper	EXS	EXS	IF	IF	-	IF	IF	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table30. Non-assessed biological stations on channelized AUIDs: Upper Split Rock Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170203-513, **Unnamed creek,** Headwaters to MN/SD border	10.64	2B, 3C	11MS042	Upstream of 448th Ave (10th Ave), 9 mi S of Jasper	0	20.9
10170203-543, **Unnamed creek,** T104 R46W S6, east line to Split Rock Cr	0.72	7	11MS060	Upstream of Hwy 23, 0.2 mi SW of Jasper	54	31.1
10170203-552, **Unnamed creek,** Unnamed creek to Split Rock Cr	3.42	2B, 3C	11MS046	Upstream of Twp Rd 73, 4 mi S of Jasper	58	21.08

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 31. Minnesota Stream Habitat Assessment (MSHA): Upper Split Rock Creek Subwatershed

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	04MS005	Split Rock Creek	0	5	20	13	26	64	Fair
1	11MS052	Split Rock Creek	0	5	21.2	11	33	70.2	Good
2	04MS031	Split Rock Creek	1.25	3.5	7.55	10	10	32.3	Poor
1	11MS013	Split Rock Creek	0	8	20.7	6	23	57.7	Fair
1	11MS042	Unnamed creek	0	4	4	6	1	15	Poor
1	11MS045	Trib. to Split Rock Creek	0	6	5	5	7	23	Poor
1	11MS060	Trib. to Split Rock Creek	0	6	24	13	21	64	Fair
1	11MS046	Trib. to Split Rock Creek	0	11	11.1	15	23	60.1	Fair
1	11MS058	Trib. to Split Rock Creek	0	12	12.6	15	22	61.6	Fair
Average Habitat Results: *Upper Split Rock Creek Subwatershed*			**0.1**	**6.7**	**14**	**10.4**	**18.4**	**49.8**	**Fair**

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 32. Channel Condition and Stability Assessment (CCSI): Upper Split Rock Creek Subwatershed

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS052	Split Rock Creek	34	28	24	7	93	Severely Unstable
1	04MS031	Split Rock Creek	24	17	17	3	61	Moderately Unstable
1	11MS013	Split Rock Creek	25	15	18	3	61	Moderately Unstable
1	11MS042	Unnamed creek	15	11	20	3	49	Moderately Unstable
1	11MS045	Trib. to Split Rock Creek	19	13	24	3	59	Moderately Unstable
1	11MS060	Trib. to Split Rock Creek	23	9	4	3	39	Fairly Stable
2	11MS046	Trib. to Split Rock Creek	11	17	22	3	53	Moderately Unstable
1	11MS058	Trib. to Split Rock Creek	11	11	20	3	45	Moderately Unstable
Average Stream Stability Results: *Upper Split Rock Creek Subwatershed*			**21.6**	**15.7**	**18.4**	**3.6**	**59.3**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 33. Outlet water chemistry results: Upper Split Rock Creek Subwatershed.

Station location:	**SPLIT ROCK CK AT CSAH-7, W OF MN-23, 8 MI S OF JASPER, MN**
STORET/EQuIS ID:	**S006-579**
Station #:	**11MS013**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	14	0.0025	0.0226	0.0124	0.04	
Chloride	mg/L	10	13.5	28.4	21.4	230	
Dissolved Oxygen (DO)	mg/L	20	6.7	10.9	8.6	5	
pH		20	7.8	8.6	8.3	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	20	5.7	40	16	>20	16
Escherichia coli (geometric mean)	MPN/100ml	16	136	869		126	3
Escherichia coli	MPN/100ml	16	48	>2419	489	1260	1

Chlorophyll-a, Corrected	ug/L	18	3	219	53		
Inorganic nitrogen (nitrate and nitrite)	mg/L	20	>0.2	10	4.7		
Kjeldahl nitrogen	mg/L	16	0.7	3.5	1.7		
Pheophytin-a	ug/L	18	>1	16	6		
Phosphorus	ug/L	20	51	765	224		
Specific Conductance	uS/cm	20	397	888	744		
Temperature, water	deg °C	20	11	28	20		
Total suspended solids	mg/L	10	20	288	87		
Total volatile solids	mg/L	10	4	52	17		
Sulfate	mg/L	10	80	152	110		
Hardness	mg/L	10	185	450	384		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Split Rock Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Split Rock Creek, 10170203-507, Split Rock Lk to Pipestone Cr, **Split Rock Creek, 10170203-509,** Headwaters to Split Rock Lk**, Split Rock Creek**, **10170203-512,** Pipestone Cr to MN/SD border

Water chemistry

Split Rock Creek (10170203-512) shows high levels of bacteria June through August with three out of three months exceeding the geometric standard. As a result Split Rock Creek is not supporting aquatic recreation use. The reach was listed in 2010 as not supporting aquatic life use due to excess turbidity. The recent transparency data shows 16 samples that exceed the <20 standard out of the 20 samples taken, confirming the existing impairment. Split Rock Creek (10170203-507) shows a previous impairment listing due to dissolved oxygen in 1994; the new data is inconclusive, and as a result the listing will not change.

Biology

The highest scoring invertebrate sample, in the Missouri River Basin, relative to impairment threshold, and the only sample to score above the impairment threshold in this subwatershed, was collected at the station with the highest drainage area (11MS013). The community at 11MS013 was dominated by a healthy mayfly community consisting of relatively sensitive taxa. All other assessable stations sampled for invertebrates and every stations sampled for fish in the subwatershed scored below the impairment threshold, with most having communities dominated by relatively few

intolerant taxa. As with other subwatersheds in the Missouri River Basin, most stations had high suspended sediment, indicative of unstable channel conditions throughout the drainage area.

Unnamed creek, 10170203-538, Unnamed cr to Unnamed cr, **Unnamed creek, 10170203-553,** Unnamed cr to Unnamed cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

These reaches followed the pattern of all of the other sites in this subwatershed. Consistently high nitrogen and suspended sediment values are reflective of highly modified land use and unstable bank conditions; both of these factors have been shown to have significant impacts on macroinvertebrate and fish community health. Site (11MS045) was not sampled for fish due to low flow.

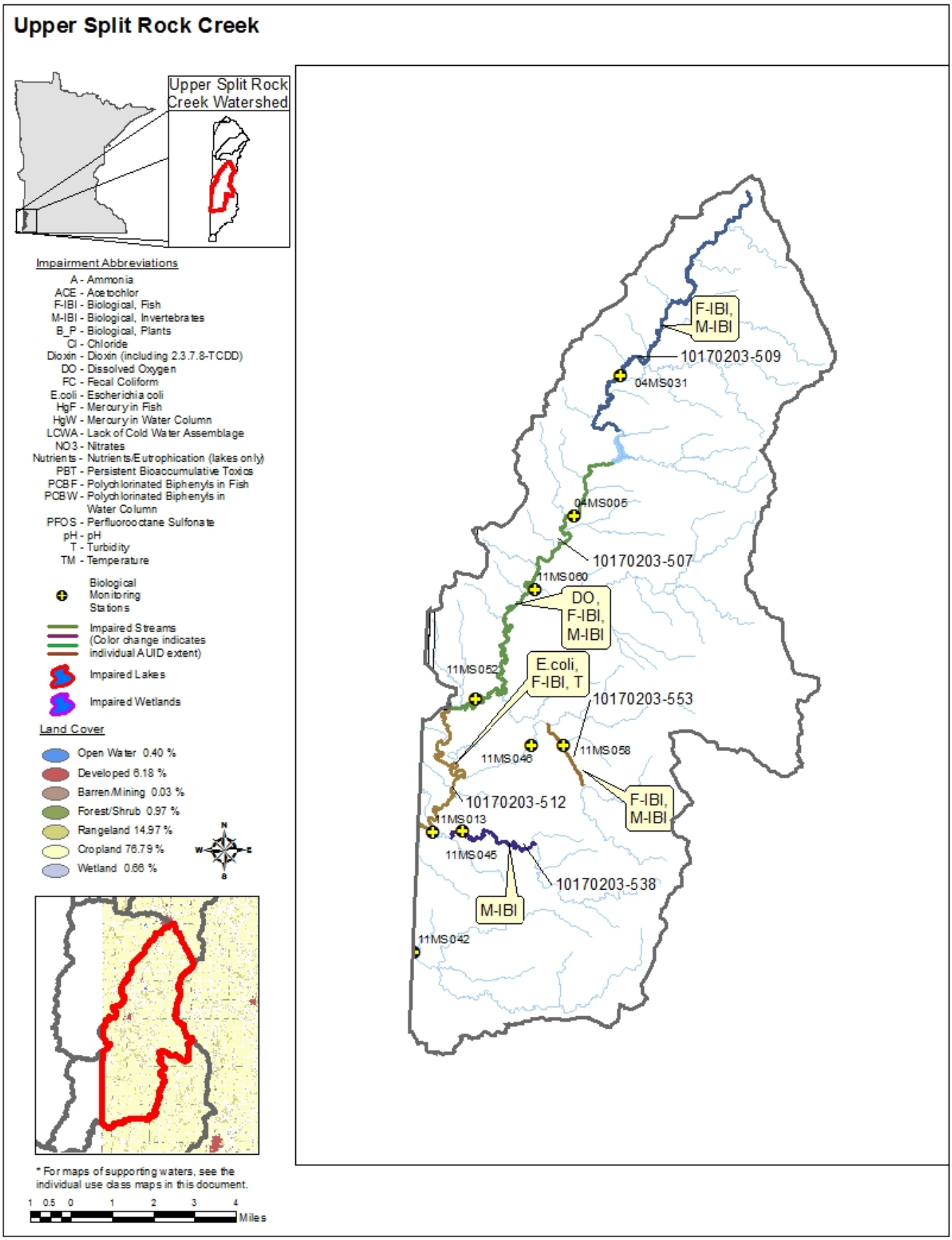

Figure 31. Currently listed impaired waters by parameter and land use characteristics in the Upper Split Rock Creek Subwatershed.

Beaver Creek Subwatershed Unit HUC 1017020315-01

There are 12 streams in the Beaver Creek Subwatershed, draining 114.43 miles^2 of Rock County. This subwatershed is not a true complete watershed as a part of the subwatershed is in South Dakota. Beaver Creek begins just west of the town of Hardwick and flows southwest to the border of South Dakota near Manley. Little Beaver Creek is the main tributary to Beaver Creek and flows southwest from near Hardwick to Beaver Creek just west of the town of Beaver Creek. Fourmile Creek is a larger stream in the subwatershed which flows out of Minnesota into South Dakota, where it joins Beaver Creek. 75.68% of the subwatershed's land is utilized for agricultural production (cropland 50.04%, rangeland 25.64%).

Table 34. Aquatic life and recreation assessments on stream reaches: Beaver Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170203-521, **Beaver Creek,** Headwaters to Little Beaver Cr	20.81	2C, 3C	11MS043 11MS040	Downstream of CR 11, 7 mi. NW of Luverne Downstream of 100th Ave, 4 mi. W of Luverne	MTS	EXS	IF	IF	-	IF	IF	-	-	NS	NA
10170203-522, **Beaver Creek,** Little Beaver Cr to MN/SD border	17.68	2C, 3C	11MS012	Upstream of 10th Ave, 1 mi. N of Manley	EXS	EXP	IF	EXS	-	MTS	MTS	-	EX	NS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 35. Non-assessed biological stations on channelized AUIDs: Beaver Creek Subwatershed.

AUID ***Reach Name***, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170203-520, **Little Beaver Creek,** Headwaters to Beaver Cr	15.24	2B, 3C	11MS039	Upstream of CR 11, 4.5 mi. W of Luverne	65	21.23
10170203-524, **Springwater Creek,** Headwaters to MN/SD border	13.65	2B, 3C	04MS027	Downstream of State Route 23, 3.2 mi. W of Beaver Creek	52	37.5

10170203-524, Springwater Creek, Headwaters to MN/SD border	13.65	2B, 3C	11MS036	Upstream of 10th Ave, 1 mi. N of Manley	50	16.1
10170203-526, Fourmile Creek, Headwaters to MN/SD border	4.99	2B, 3C	11MS041	Upstream of 448th Ave/10th Ave, 10 mi SW of Beaver Creek	61	23.8
10170203-554, Unnamed creek, Unnamed cr to Beaver Cr	2.42	2B, 3C	11MS044	Downstream of 171st St, 9 mi NW of Luverne	60	25.56

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 36. Minnesota Stream Habitat Assessment (MSHA): Beaver Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS039	Little Beaver Creek	1.5	6	20	12	25	64.5	Fair
1	11MS043	Beaver Creek	0	8.5	15.2	12	24	59.7	Fair
1	11MS012	Beaver Creek	0	1.5	15	2	17	35.5	Poor
1	04MS027	Springwater Creek	0	7	20.3	9	10	46.3	Fair
1	11MS036	Springwater Creek	0	6.5	10.05	8	17	41.55	Poor
1	11MS041	Four Mile Creek	3	6.5	7	14	18	48.5	Fair
1	11MS044	Trib. to Beaver Creek	5	11	20	12	28	76	Good
Average Habitat Results: *Beaver Creek Subwatershed*			**1.4**	**6.7**	**15.4**	**9.9**	**19.9**	**53.2**	**Fair**

Qualitative habitat ratings

- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 37. Channel Condition and Stability Assessment (CCSI): Beaver Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS039	Little Beaver Creek	31	15	12	7	65	Moderately Unstable
1	11MS043	Beaver Creek	10	11	10	3	34	Fairly Stable
1	11MS040	Beaver Creek	28	15	19	7	69	Moderately Unstable
1	11MS012	Beaver Creek	41	31	36	11	119	Extremely Unstable
1	11MS036	Springwater Creek	23	15	19	7	64	Moderately Unstable
1	11MS041	Four Mile Creek	13	13	14	3	43	Fairly Stable
1	11MS044	Trib. to Beaver Creek	10	9	6	3	28	Fairly Stable
Average Stream Stability Results: *Beaver Creek Subwatershed*			**22.3**	**15.6**	**16.6**	**5.9**	**60.3**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 38. Outlet water chemistry results: Beaver Creek Subwatershed.

Station location:	**BEAVER CK ON 10TH AVE BRG, 1 MI W OF MANLEY**
STORET/EQuIS ID:	**S004-811**
Station #:	**11MS012**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	88	0.0007	0.1208	0.0096	0.04	3
Chloride	mg/L	10	4.3	21.7	17.5	230	
Dissolved Oxygen (DO)	mg/L	88	7.03	13.12	9.33	5	
pH		88	7.4	9.6	8.1	6.5 - 9	2
Secchi tube/Transparency Tube	100 cm	88	3	40	15	>20	63
Escherichia coli (geometric mean)	MPN/100 ml	87	33	1414		126	6
Escherichia coli	MPN/100 ml	87	3	24196	1980	1260	34

Inorganic nitrogen (nitrate and nitrite)	mg/L	85	0.81	15.4	6.25		
Kjeldahl nitrogen	mg/L	85	>0.2	13	1.9		
Phosphorus	ug/L	85	55	1630	284		
Specific Conductance	uS/cm	53	359	943	735		
Temperature, water	deg °C	87	2	29	17		
Total suspended solids	mg/L	85	5	2040	170		
Total volatile solids	mg/L	48	2	275	29		
Sulfate	mg/L	10	21	129	81		
Hardness	mg/L	10	116	449	370		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Beaver Creek Subwatershed, a component of the IWM work conducted between May and September from 2008 through 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Beaver Creek, 10170203-521, Headwaters to Little Beaver Cr, **Beaver Creek, 10170203-522,** Little Beaver Cr to MN/SD border

Water chemistry

Beaver Creek (10170203-522) shows high levels of bacteria May through October, with six out of seven months exceeding the geometric standard. The reach was originally added to the 2010 Impaired Waters List, and recent data confirms the impaired condition. Beaver Creek (10170203-522) was also listed as not supporting aquatic life use in 2010 due to excess turbidity. The recent transparency data shows 63 samples that exceed the <20 standard out of the 88 samples taken, confirming the impairment. The dissolved oxygen flux is very large (6mg/L) which can cause a very stressful environment for the community of the stream. Beaver Creek contains elevated amounts of phosphorus, which varies from month to month but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

Most stations sampled during the 2011 sampling season showed either unseasonably high flows, and/or indication of a consistently high flow condition, as many sites were classified as high gradient. Despite the higher flows, sites did not show the higher quality invertebrate communities often associated with consistent flow patterns. As with many other subwatersheds in the Missouri River Basin, most sites had high nitrogen and/or high suspended sediment values, both of which can contribute to poor quality invertebrate community composition. The two most upstream biological sites (11MS040 and 11MS043) scored above the threshold and have a passing FIBI score. Progressing further down the subwatershed, the accumulating effects of high turbidity and nitrogen contributed to the declining FIBI scores. Bank and channel stability measures also follow a pattern of smaller drainage areas further upstream in the subwatershed having more stable banks and bed loads.

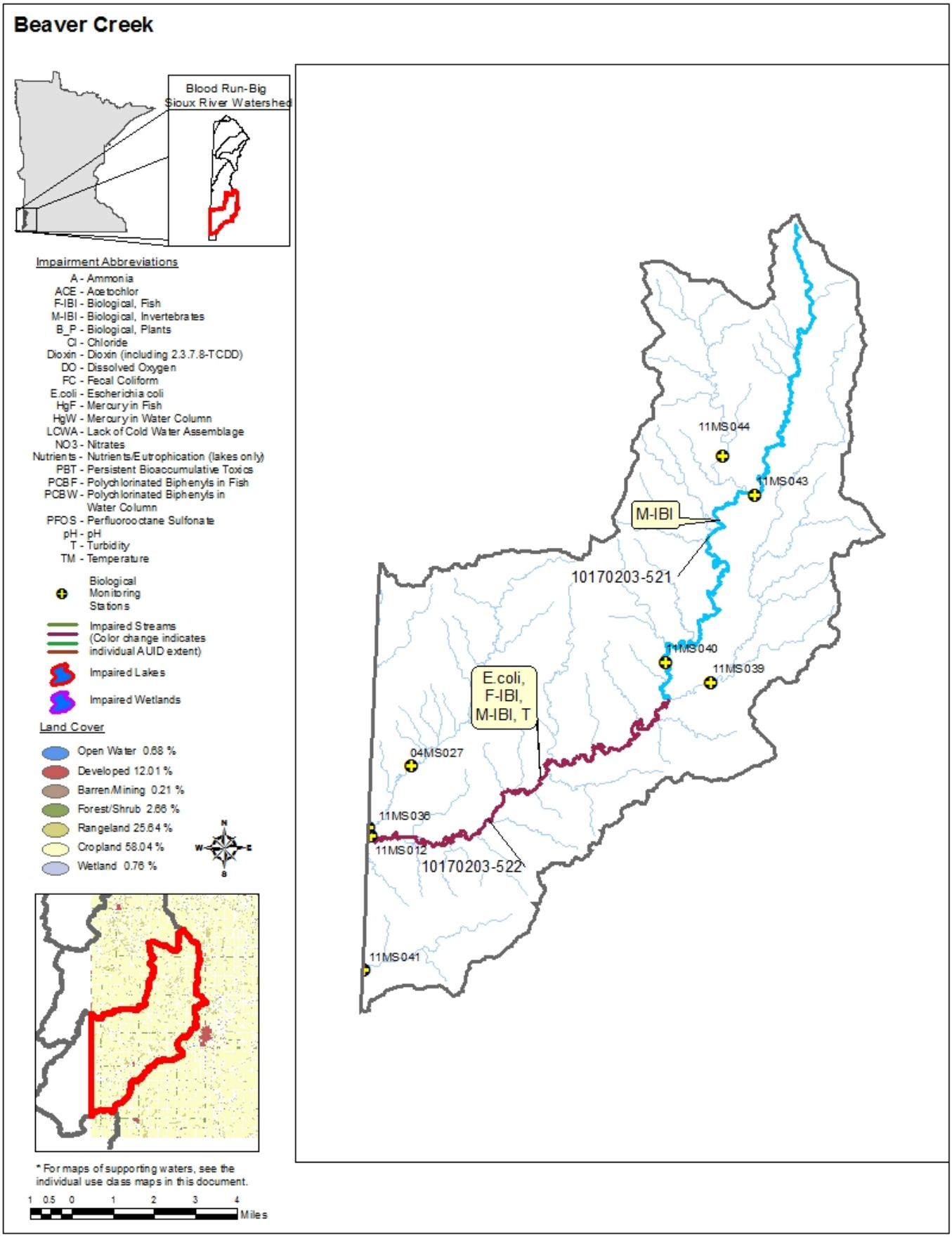

Figure 32. Currently listed impaired waters by parameter and land use characteristics in the Beaver Creek Subwatershed.

Blood Run-Big Sioux River Subwatershed HUC 1017020317-01

This is a small subwatershed that borders both South Dakota and Iowa, and drains 7.69 miles^2 of Rock County. This subwatershed is not a true complete watershed as a part of the subwatershed is in South Dakota and Iowa. The headwaters are just west of the town of Hills. Blood Run flows west for 1.75 miles before turning southwest and exiting Minnesota at the Minnesota, Iowa, and South Dakota state lines. 83.68% of the subwatershed's land is utilized for agricultural production (cropland 58.04%, rangeland 25.64%).

Table 39. Aquatic life and recreation assessments on stream reaches: Blood Run-Big Sioux River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170203-555, **Blood Run,** Unnamed cr to MN/SD border	1.86	2B, 3C	11MS030	Upstream of 448th Ave (10th Ave), 5 mi SW of Hills	MTS	EXS	IF	IF	-	IF	IF	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 40. Minnesota Stream Habitat Assessment (MSHA): Blood Run-Big Sioux River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS030	Blood Run	0	7	18	10	23	58	Fair
Average Habitat *Results: Blood Run-Big Sioux River Subwatershed*			**0**	**7**	**18**	**10**	**23**	**58**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 41. Channel Condition and Stability Assessment (CCSIBlood Run-Big Sioux River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS030	Blood Run	24	15	8	4	51	Moderately Unstable
Average Stream Stability Results: Blood Run-Big Sioux River *Subwatershed*			**24**	**15**	**8**	**4**	**51**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Summary

Blood Run, 10170203-555, Unnamed cr to MN/SD border

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Site 11MS030 scored well below the MIBI impairment threshold, despite having a community dominated by POET (Plecoptara, Odonata, Ephemeroptera, Trichoptera) taxa. This can occur when the dominant POET taxa are also known to be relatively tolerant. The high flow conditions and relatively high quality habitat conditions suggest this site has potential to have a higher quality community, but this could be being suppressed by high levels of suspended sediment and high nutrient conditions. High nutrients and suspended sediment often show a disproportionately negative effect on macroinvertebrates compared to fish, due to the less mobile nature of macroinvertabrates. Fish scored above threshold and confidence interval and had numbers of less tolerant fish and high numbers of species. Fair habitat and good flow may have contributed to the high FIBI score.

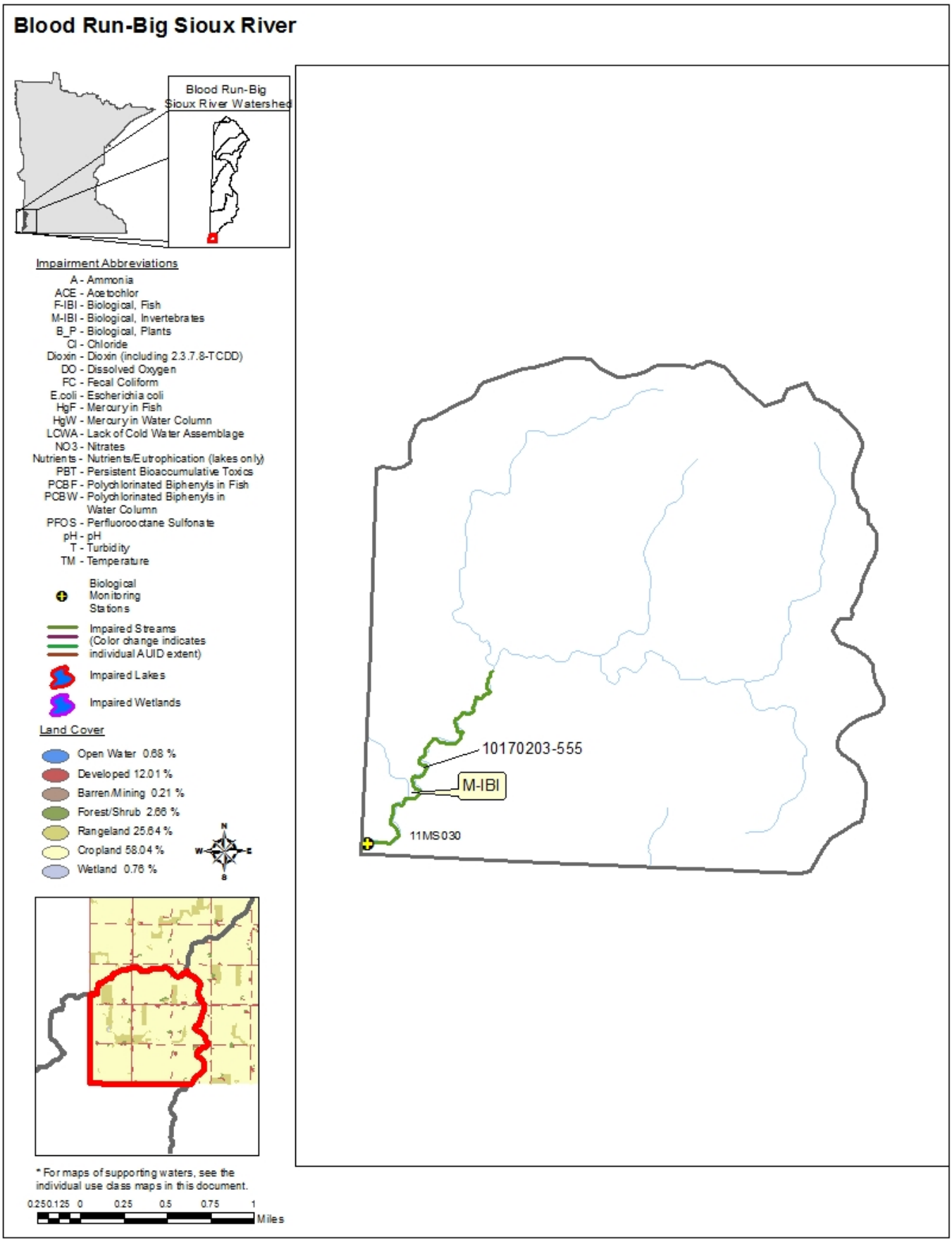

Figure 33. Currently listed impaired waters by parameter and land use characteristics in the Blood Run-Big Sioux River Subwatershed

Rock River Watershed HUC 10170204

Upper Headwaters Rock River Subwatershed HUC 1017020401-03

This is the northern most subwatershed in the Rock River Watershed; it drains 113.62 of Pipestone and Murray Counties. This subwatershed starts just north of Holland, flows south 18.5 miles, and ends in Edgerton where Chanarambi Creek subwatershed enters the Rock River. There are 11 stream reaches, and the Rock River is the main stream reach in the subwatershed. 93.21% of the subwatershed's land is utilized for agricultural production (cropland 72.08%, rangeland 21.13%).

Table 42. Aquatic life and recreation assessments on stream reaches Upper Headwaters Rock River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-504, **Rock River,** T107 R44W S30, east line to Chanarambie Cr	31.77	2C, 3C	11MS116 04MS051 04MS009 11MS147 04MS010 11MS011	Upstream of CSAH 6, 3 mi. NW of Woodstock 6 mi. ENE of Pipestone in WMA Downstream of SR 30, 7 mi. E of Pipestone Upstream of 160th Ave, 3 mi. SE of Hatfield Downstream of CR 2, 2.1 miles N of Edgerton Upstream of 105th Ave, 1 mi. S of Edgerton	EXS	EXS	IF	EXS	IF	MTS	MTS	-	EX	NS	NS
10170204-528, **Unnamed creek,** Unnamed cr to Rock R	6.98	7	11MS089	Upstream of CR 63 (150th Ave), 3 mi. NW of Edgerton	NA	NA	IF	-	-	IF	IF	-	IF	NA	NA
10170204-530, **Rock River, East Branch,** Headwaters to Rock R	17.22	2B, 3C	04MS035 11MS145 04MS012 11MS088	upstream of CR 6, 2.5 miles N. of Woodstock Upstream of CR 6, 1.5 mi. N of Woodstock Upstream of CR 6, 4 miles SE of Holland Upstream of State Route 30, 3 mi. N of Hatfield	MTS	EXP	IF	IF		IF	IF			NS	NA
10170204-593, **Unnamed cr,** Unnamed cr to T106 R45W S25, south line	0.13	2B, 3C	11MS138	Upstream of 71st St, 0.5 mi. S of Hatfield	EXS	EXS	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 43. Non-assessed biological stations on channelized AUIDs Upper Headwaters Rock River Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-503, **Rock River,** T107 R45W S12, east line to T107 R44W S29, west line	5.7	7	11MS136	Downstream of 150th Ave, 2.5 mi. SE of Holland	42	29.3
10170204-504, **Rock River,** T107 R44W S30, east line to Chanarambie Cr	31.77	2C, 3C	04MS051	6 mi. ENE of Pipestone in WMA	40	59.6
10170204-530, **Rock River, East Branch,** Headwaters to Rock R	17.22	2B, 3C	04MS012	Upstream of CR 6, 4 miles SE of Holland	56	15.2
10170204-594, **Unnamed creek,** Unnamed cr to Unnamed cr	1.78	2B, 3C	11MS117	Downstream of 91st St, 3 mi. S of Woodstock	63	29.4

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 44. Minnesota Stream Habitat Assessment (MSHA): Upper Headwaters Rock River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS136	Rock River	0	4	18.2	2	15	39.2	Poor
1	11MS116	Rock River	0	4	9.6	7	18	38.6	Poor
1	04MS051	Rock River	5	11	11.4	2	25	54.4	Fair
3	04MS009	Rock River	1.3	4	15	7	20	47.3	Fair
1	11MS147	Rock River	0	1	14.8	5	19	39.8	Poor
1	04MS010	Rock River	2	3	12	6	20	43	Poor
1	11MS011	Rock River	0	9.5	21.5	11	25	67	Good
1	11MS089	Trib. to Rock River	0	4	16	12	26	58	Fair
1	04MS035	Rock River, East Branch	0	4	14.7	12	20	50.7	Fair
1	11MS145	Rock River, East Branch	2	9	20.1	14	21	66.1	Good
1	04MS012	Rock River, East Branch	0	4.5	12.5	10	15	42	Poor

1	11MS088	Rock River, East Branch	0	4	18.6	10	25	57.6	Fair
	11MS138	Unnamed creek	1.25	7.5	11.6	9	18	47.35	Fair
	11MS117	Trib. to Rock River	0	12.5	16.6	14	17	60.1	Fair
Average Habitat Results: *Upper Headwaters Rock River Subwatershed*			**0.8**	**5.9**	**15.2**	**8.6**	**20.3**	**50.8**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 45. Channel Condition and Stability Assessment (CCSI): Upper Headwaters Rock River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS136	Rock River	14	19	4	5	42	Fairly Stable
1	11MS116	Rock River	5	19	10	3	37	Fairly Stable
1	04MS009	Rock River	33	21	16	7	77	Moderately Unstable
1	11MS147	Rock River	16	13	9	5	43	Fairly Stable
1	11MS011	Rock River	22	15	8	3	48	Moderately Unstable
1	11MS089	Trib. to Rock River	30	15	19	7	71	Moderately Unstable
1	11MS145	Rock River, East Branch	13	19	15	3	50	Moderately Unstable
1	11MS088	Rock River, East Branch	6	19	9	3	37	Fairly Stable
1	11MS117	Trib. to Rock River	15	15	8	3	41	Fairly Stable
Average Stream Stability Results: *Upper Headwaters Rock River Subwatershed*			**17.4**	**17.5**	**11.3**	**4.5**	**50.6**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 46. Outlet water chemistry results: Upper Headwaters Rock River Subwatershed.

Station location:	**ROCK R AT 165TH AVE, 1 MI S OF EDGERTON, MN**						
STORET/EQuIS ID:	**S006-577**						
Station #:	**11MS001**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	48	0.0019	0.0325	0.0118	0.04	
Chloride	mg/L	10	10.1	19.6	16.4	230	
Dissolved Oxygen (DO)	mg/L	53	5.5	11.9	8.6	5	
pH		53	7.6	9.6	8.4	6.5 - 9	2
Secchi tube/Transparency Tube	100 cm	53	4	84	23	>20	35
Turbidity	FNU	39	2.5	650	76	25	24
Escherichia coli (geometric mean)	MPN/100ml	49	28	686		126	5
Escherichia coli	MPN/100ml	49	20	>24196	2128	1260	10
Inorganic nitrogen (nitrate and nitrite)	mg/L	47	1	8	5		
Kjeldahl nitrogen	mg/L	46	0.5	8	2		
Phosphorus	ug/L	47	21	1950	257		
Specific Conductance	uS/cm	53	351	802	623		
Temperature, water	deg °C	53	6	29	19		
Total suspended solids	mg/L	47	5	1450	102		
Total volatile solids	mg/L	47	<2	187	18		
Sulfate	mg/L	10	37	53	44		
Hardness	mg/L	10	210	400	335		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Headwaters Rock River Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Rock River, 10170204-504, T107 R44W S30, east line to Chanarambie Cr, **Rock River, 10170204-530,** East Branch, Headwaters to Rock R

Water chemistry

The Rock River has an excess amount of bacteria throughout the months of June through September. All of these months exceed the geometric monthly mean of 126MPN/100ml and there are high individual samples as well. This stream reach is listed as impaired for not supporting aquatic recreation. The transparency data combined with the turbidity data shows over half of the datasets exceeding their corresponding standards, and because of this data the stream is listed as not supporting aquatic life. The Rock River contains elevated amounts of phosphorus, which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

The only station in this subwatershed to show a consistently healthy invertebrate community was an unassessed channelized reach (04MS051). Visits both in 2004 and 2011 showed MIBI scores well above the impairment threshold. One additional location in the subwatershed (11MS089) also had a supporting MIBI score. Both stations had diverse POET taxa relative to most stations in the Missouri River Basin, as well as relatively high overall diversity. All stations on the Rock River had low FIBI scores and high numbers of tolerant fish species. Poor habitat scores along with high sediment levels may be the cause of the impairments.

Rock River, East Branch, 10170204-530, Headwaters to Rock R

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

The biological stations on this stretch of river had low to very low MIBI scores, with accompanying high suspended sediment loads. As with other subwatersheds sampled in 2011, the high flows experienced at the time of sampling lead to difficulty assigning stream classes, as they seemed uncharacteristically high for agricultural streams in late summer. But based on 2004 sampling, streams in this basin tend to have relatively high base flows compared to other similar agricultural areas, so the apparent confusion may be unmerited. The same pattern for fish also appears in the East Branch Rock River. All of the sites had scores above the threshold. The biological stations with smaller drainage areas tended to have higher FIBI scores. Again, this may be due to the fact that there is less accumulating sediment because of the smaller drainage area. Even the channelized reach in this stream section had a good fish score.

Unnamed cr, 10170204-593, Unnamed cr to T106 R45W S25, south line

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Both the fish and invertebrates scored well below the threshold at this very small segment of stream. Because this is so far up in the headwaters, previous low flow conditions could have been an issue in fish and invertebrate colonization.

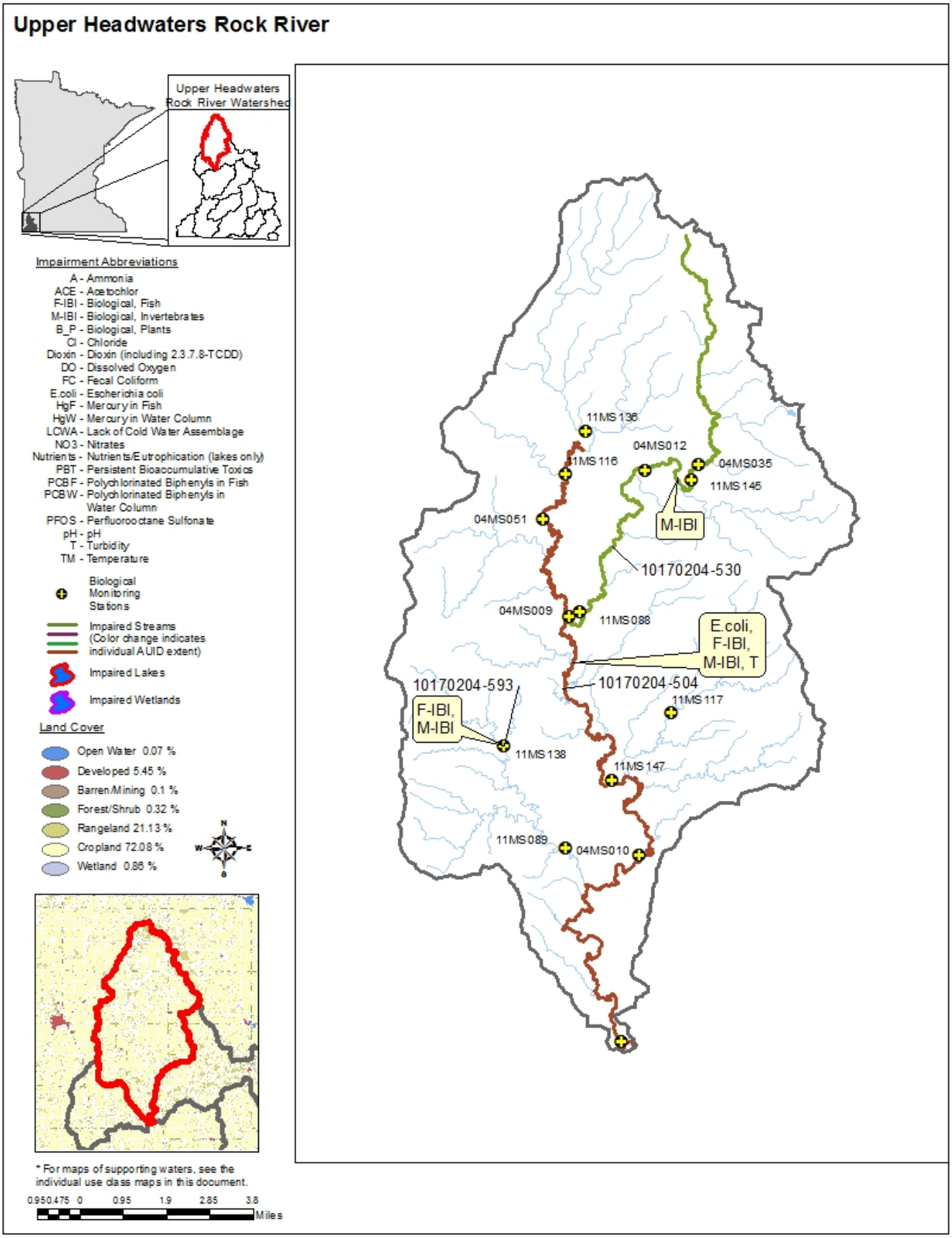

Figure 34. Currently listed impaired waters by parameter and land use characteristics in the Upper Headwaters Rock River Subwatershed.

Chanarambie Creek Subwatershed HUC 1017020401-04

Chanarambie Creek is the main stream reach in the subwatershed, which drains 74.87 miles^2 of Murray and Pipestone Counties. There are seven other streams in the Chanarambie Creek Subwatershed. Chanarambie Creek starts in Chandler and flows southwest 20.5 miles to Edgerton. Chanarambie Creek exits the subwatershed south of Edgerton and flows into the Rock River. The largest tributary is North Branch Chanarambie Creek which flows south from Woodstock and enters Chanarambie Creek five miles west of Chandler. There are five lakes in the subwatershed, none of which have enough data for assessments. 92.22% of the subwatershed's land is utilized for agricultural production (cropland 68.95%, rangeland 23.27%).

Table 47. Aquatic life and recreation assessments on stream reaches: Chanarambie Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-522, Chanarambie Creek, Headwaters to Rock R	20.51	2B, 3C	11MS091 04MS026 11MS121 11MS016	Downstream of 300th Ave, 3 mi. SW of Chandler 2.5 miles NE of edgerton, Osborne Township Upstream of 26th St, 1.5 mi. NE of Edgerton Downstream of CR 1 (Mill St), SE of Edgerton	EXP	EXP	IF	EXS	IF	MTS	IF	-	EX	NS	NS
10170204-559, Unnamed creek, Unnamed cr to N Br Chanarambie Cr	1.32	2B, 3C	10EM142	Upstream of CSAH 5, 4 mi. NW of Chandler	MTS	EXS	IF	IF	-	IF	IF	IF	-	NS	NA
10170204-560, Chanarambie Creek, North Branch, Unnamed cr to Unnamed cr	0.95	2B, 3C	11MS123	Upstream of CSAH 5, 3 mi. SW of Lake Wilson	MTS	EXP	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 48. Non-assessed biological stations on channelized AUIDs: Chanarambie Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-522, Chanarambie Creek, Headwaters to Rock R	20.51	2B, 3C	11MS091	Downstream of 300th Ave, 3 mi. SW of Chandler	59	29.4
10170204-522, Chanarambie Creek, Headwaters to Rock R	20.51	2B, 3C	11MS121	Upstream of 26th St, 1.5 mi. NE of Edgerton	48	24.6
10170204-590, Unnamed creek, Unnamed cr to Chanarambie Cr	2.84	2B, 3C	11MS122	Upstream of MN 91,0.5 mi. E of Chandler	53	39.9
10170204-591, Unnamed creek, Headwaters to Unnamed cr	6.8	2B, 3C	11MS124	Downstream of 70th Ave, 6.5 mi. W of Iona	51	24.06

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 49. Minnesota Stream Habitat Assessment (MSHA): Chanarambie Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS091	Chanarambie Creek	0	7	10	2	6	25	Poor
1	04MS026	Chanarambie Creek	2	3	15.7	6	19	45.7	Fair
1	11MS121	Chanarambie Creek	0	1	14	3	22	40	Poor
1	11MS016	Chanarambie Creek	0.5	1	14.7	5	18	39.2	Poor
1	10EM142	Chanarambie Creek, North	0	10	13	12	14	49	Fair
1	11MS123	Chanarambie Creek, North	2.5	11	16.4	11	25	65.9	Fair
1	11MS122	Trib. to Chanarambie Creek	0	10	17.7	6	16	49.7	Fair
1	11MS124	Unnamed creek	0	14	19	12	16	61	Fair
Average Habitat Results: *Chamarambie Creek Subwatershed*			**.6**	**7.1**	**15.1**	**7.1**	**17**	**46.9**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table50. Channel Condition and Stability Assessment (CCSI): Chanarambie Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS091	Chanarambie Creek	24	13	10	3	50	Moderately Unstable
1	11MS121	Chanarambie Creek	27	15	26	7	75	Moderately Unstable
1	11MS016	Chanarambie Creek	36	17	26	7	86	Severely Unstable
1	10EM142	Chanarambie Creek, North Branch	12	8	6	3	29	Fairly Stable
1	11MS123	Chanarambie Creek, North Branch	6	13	11	3	33	Fairly Stable
1	11MS122	Trib. to Chanarambie Creek	9	13	8	5	35	Fairly Stable
1	11MS124	Unnamed creek	17	17	13	3	50	Moderately Unstable
Average Stream Stability Results: *Chanarambie Creek Subwatershed*			**18.7**	**13.7**	**14.3**	**4.4**	**51.1**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 51. Outlet water chemistry results: Chanarambie Creek Subwatershed.

Station location:	**CHANARAMBIE CK AT COUNTY ROUTE 1/MILL ST, SE OF EDGERTON, MN**
STORET/EQuIS ID:	**S006-576**
Station #:	**11MS016**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	14	0.0024	0.0138	0.0074	0.04	
Chloride	mg/L	10	8.2	19	14.7	230	
Dissolved Oxygen (DO)	mg/L	46	4.5	17	9.1	5	1
pH		46	7.7	8.9	8.2	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	46	4	55	20	>20	30
Turbidity	FNU	27	6	160	40	25	17
Escherichia coli (geometric mean)	MPN/100ml	42	96	2075		126	3
Escherichia coli	MPN/100ml	42	33	4611	1739	1260	26

Inorganic nitrogen (nitrate and nitrite)	mg/L	10	2.5	6	4.5		
Kjeldahl nitrogen	mg/L	9	0.8	2.4	1.4		
Phosphorus	ug/L	10	36	502	202		
Specific Conductance	uS/cm	46	271	1164	702		
Temperature, water	deg °C	46	6	27	18		
Total suspended solids	mg/L	36	6	218	59		
Total volatile solids	mg/L	26	3	58	14		
Sulfate	mg/L	10	42	76	61		
Hardness	mg/L	10	211	714	367		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Chanarambie Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Chanarambie Creek, 10170204-522, Headwaters to Rock R

Water chemistry

The bacteria dataset indicates over half of the individual samples do not meet the standard, and three out of the four months exceed the geometric mean. As a result the stream is impaired for aquatic recreation use. The turbidity and transparency data both exceed their standards in over half of the samples and this is resulting in a "not supporting" listing for aquatic life use.

Biology

In regions with very high proportions of modified streams and agricultural land uses, even good habitat and water quality conditions cannot always provide adequate support for high quality invertebrate communities. All sites in this stream reach failed to meet biological standards for invertebrate and fish IBIs, with most sites showing dominance by relatively tolerant individuals, and low overall diversity. High suspended sediment values throughout suggest modified and/or unstable channel conditions.

Unnamed creek, 10170204-559, Unnamed cr to N Br Chanarambie Cr, **Chanarambie Creek, North Branch**, **10170204-560,** Unnamed cr to Unnamed cr
No water chemistry data was assessed on this section of stream.

Biology

The invertebrate station in this subwatershed (11MS123) had relatively high quality riparian area and in-stream habitat, and high flows, and yet failed to meet the impairment threshold. Both fish sites (10EM142 and 11MS123) scored above the threshold and are supporting for aquatic life. This follows a pattern of headwater streams with good flow and fair to good habitat having higher FIBI scores.

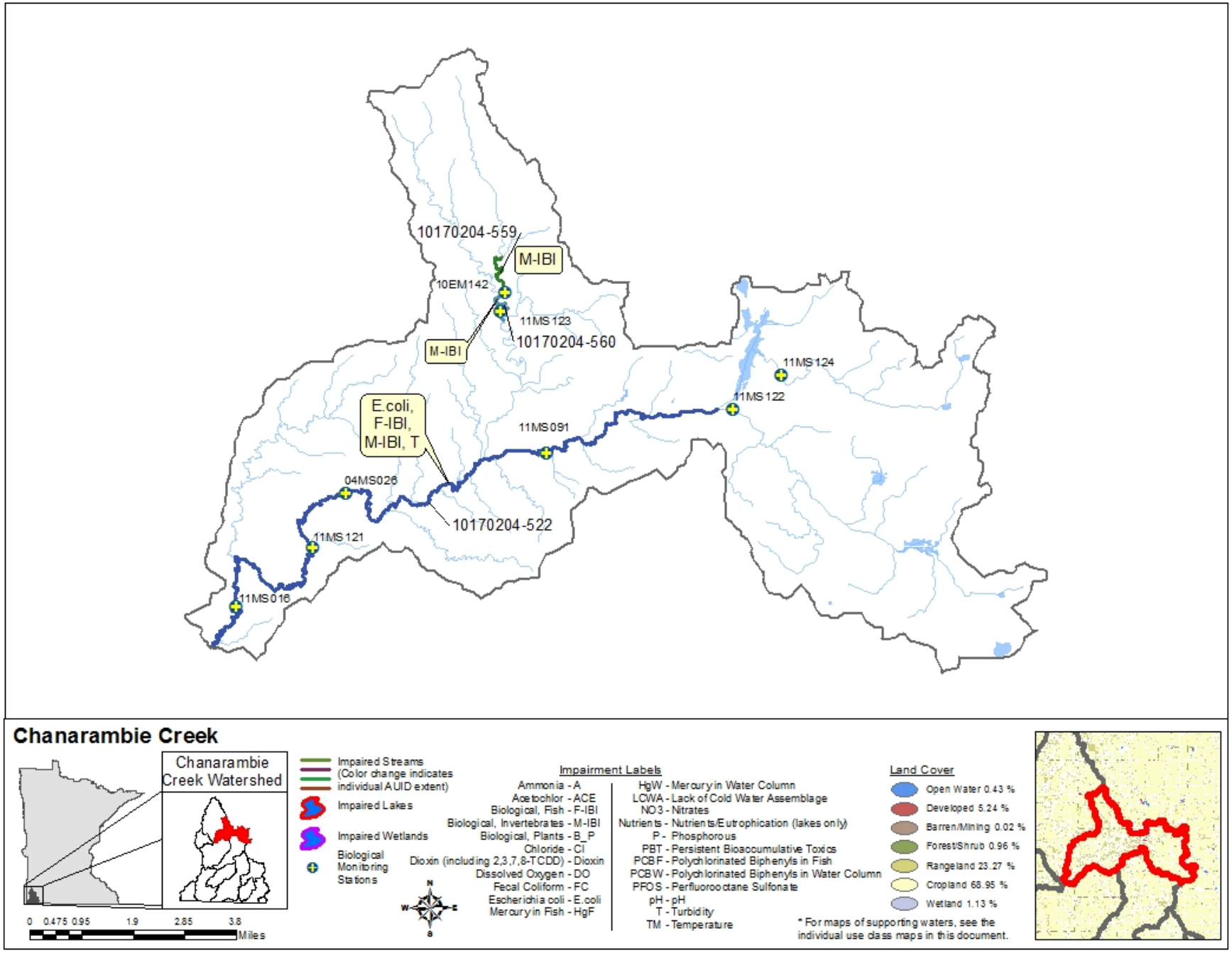

Figure 35. Currently listed impaired waters by parameter and land use characteristics in the Chanarambie Creek Subwatershed.

Poplar Creek Subwatershed HUC 1017020401-02

The Poplar Creek subwatershed drains 34.94 miles^2 of Rock and Pipestone Counties. Poplar Creek is the main stream reach in the subwatershed; it flows for 19 miles starting in the southwest corner of the subwatershed, north towards Trosky. Before reaching the town it turns back south and empties into the Rock River, which is in the Lower Headwaters Rock River Subwatershed. 91.79% of the subwatershed's land is utilized for agricultural production (cropland 77.33%, rangeland 14.46%).

Table 52. Aquatic life and recreation assessments on stream reaches: Poplar Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-523, **Poplar Creek,** Headwaters to Rock R	19.18	2B, 3C	11MS014	Downstream of CSAH 1, 2 mi. S of Edgerton	EXS	EXP	IF	EXS	IF	MTS	IF	-	EX	NS	NS
10170204-588, **Unnamed creek,** Unnamed cr to Poplar Cr	5.04	2B, 3C	11MS093	Downstream of CR 9, 1 mi. SE of Trosky	EXS	EXP	-	-	-	-	-	-	-	NS	NA
10170204-589, **Unnamed creek,** Unnamed cr to Poplar Cr	0.58	2B, 3C	11MS096	East of 130th Ave, downstream of trib., 3 mi. W of Edgerton	MTS	EXS	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 53. Minnesota Stream Habitat Assessment (MSHA): Poplar Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS014	Poplar Creek	0	8	18	11	30	67	Good
1	11MS093	Trib. to Poplar Creek	0	11.5	12.6	12	23	59.1	Fair
1	11MS096	Trib. to Poplar Creek	0	12	16.8	11	31	70.8	Good
Average Habitat Results: *Poplar Creek Subwatershed*			**0**	**10.5**	**15.8**	**11.3**	**28**	**65.6**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 54. Channel Condition and Stability Assessment (CCSI): Poplar Creek subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
	11MS014	Poplar Creek	16	19	12	3	50	Moderately Unstable
	11MS093	Trib. to Poplar Creek	18	17	12	7	54	Moderately Unstable
	11MS096	Trib. to Poplar Creek	21	13	10	3	47	Moderately Unstable
Average Stream Stability Results: *Poplar Creek Subwatershed*			**18.3**	**16.3**	**11.3**	**4.3**	**50.3**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 55. Outlet water chemistry results: Poplar Creek Subwatershed.

Station location:	**POPLAR CK AT CSAH 1/CSAH-12 (AKA 160TH AVE), 2 MI S OF EDGERTON, MN**
STORET/EQuIS ID:	**S006-578**
Station #:	**11MS014**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	10	0.003	0.0146	0.0096	0.04	
Chloride	mg/L	10	14.3	27.7	23.2	230	

Dissolved Oxygen (DO)	mg/L	46	4.3	13.4	8.4	5	3
pH		46	7.8	8.7	8.2	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	46	3	77	20	>20	29
Turbidity	FNU	26	7.5	170	36	25	13
Escherichia coli (geometric mean)	MPN/100ml	42	96	1054		126	3
Escherichia coli	MPN/100ml	42	21	11199	1116	1260	7
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	2.5	15	7.5		
Kjeldahl nitrogen	mg/L	9	0.5	3.7	1.6		
Phosphorus	ug/L	10	35	754	227		
Specific Conductance	uS/cm	46	446	1181	691		
Temperature, water	deg °C	46	7	27	18		
Total suspended solids	mg/L	36	4	254	44		
Total volatile solids	mg/L	26	2	46	11		
Sulfate	mg/L	10	60	97	74		
Hardness	mg/L	10	195	441	358		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Poplar Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Poplar Creek, 10170204-523, Headwaters to Rock R

Water chemistry

There are elevated bacteria levels within the Poplar Creek Subwatershed, and geometric monthly means and individual exceedances show that this stream is impaired for aquatic recreation use. The turbidity and transparency data show exceedances throughout the dataset. Poplar Creek is also impaired for aquatic life use. The dissolved oxygen flux is very large (9mg/L) which can cause a very stressful environment for the biological community of the stream. Poplar Creek contains elevated amounts of phosphorus which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions

Biology

The most downstream station in this subwatershed (11MS014) had high diversity of POET taxa relative to other streams in the Missouri River Basin, but scored below impairment threshold for regional high gradient streams. The presence of riffles in the stream suggest a continuous higher flow condition, but unseasonably high flow conditions at the time of sampling can lead to confusion regarding proper stream classification. This station scored poorly due to fish samples having all tolerant species, even though the habitat could have supported less tolerant species. High suspended sediment values throughout suggest modified and/or unstable channel conditions.

Unnamed creek, 10170204-588, Unnamed cr to Poplar Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Invertebrate and fish IBI scores showed highly impaired conditions, with low diversity and dominance by few taxa, accompanied by high suspended sediment - all indicators of streams in highly modified, agricultural drainages.

Unnamed creek, 10170204-589, Unnamed cr to Poplar Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Invertebrate MIBI scores showed highly impaired conditions, with low diversity and dominance by few taxa, accompanied by high suspended sediment - all indicators of streams in highly modified, agricultural drainages. FIBI scores followed a trend of smaller drainage areas, with good flow and moderate to good habitat supporting a healthy fish community. The contrasting fish and invertebrate scores are an indicator that different stressors can affect biological communities in different ways, and it demonstrates the need to have more than one assemblage when assessing biological health.

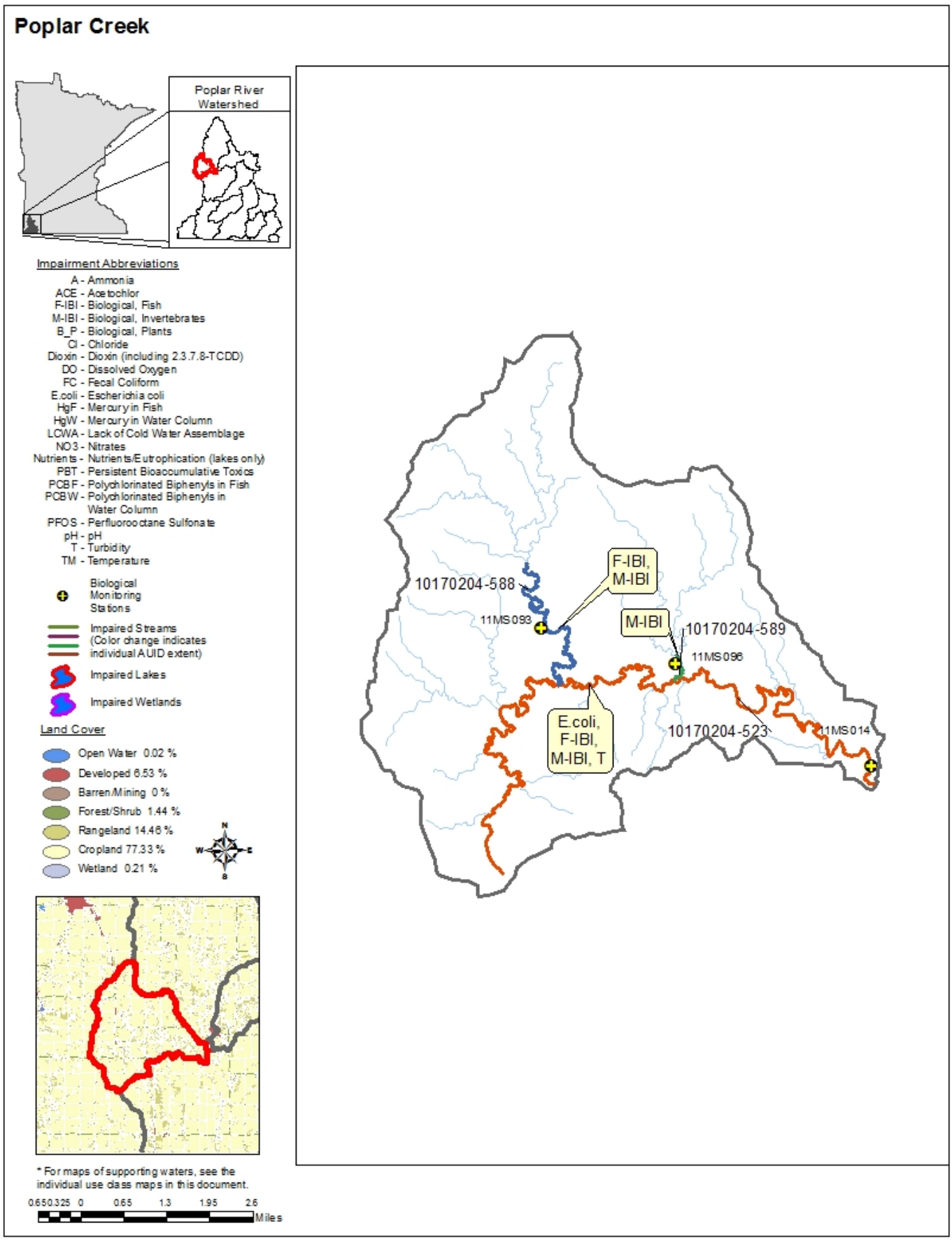

Figure 36. Currently listed impaired waters by parameter and land use characteristics in the Poplar Creek Subwatershed.

Lower Headwaters Rock River Subwatershed HUC 1017020401-01

There are 14 stream reaches in the Lower Headwaters Rock River Subwatershed, which has a drainage area of 101.18 miles2. The Rock River is the largest and flows from the north 15.7 miles south, and collects water from a large, unnamed tributary (unnamed creek). The Rock River then flows less than a mile before being joined by another large, unnamed creek. The last section of the Rock River in this subwatershed flows south 4.3 miles into the Upper Rock River Subwatershed. The two unnamed creeks are located on the east side of the subwatershed. Mound Creek flows into the Rock River from the west side of the Lower Headwaters Rock River Subwatershed. 92.58% of the subwatershed's land is utilized for agricultural production (cropland 80.27%, rangeland 12.31%).

Table 56. Aquatic life and recreation assessments on stream reaches: Lower Headwaters Rock River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-506, **Rock River,** Poplar Cr to Unnamed cr	15.7	2C, 3C	04MS032 11MS114	Downstream of CR 21, 4 miles NE of Kenneth Upstream of 175th St, 2.5 mi. SE of Hardwick	EXS	EXS	IF	EXP	-	MTS	IF	-	EX	NS	NS
10170204-508, **Rock River,** Unnamed cr to Champepadan Cr	4.35	2C, 3C	11MS003	Downstream of CR 8, 3.5 mi. NE of Luverne	EXS	EXS	IF	EXP	MTS	MTS	IF	-	EX	NS	NS
10170204-521, **Unnamed creek,** Headwaters to Rock R	18.37	2B, 3C	11MS084	Upstream of CR 9, 3 mi. SW of Kenneth	EXP	EXP	IF	EXS		MTS	MTS		EX	*IF	NS
10170204-545, **Unnamed creek,** Unnamed cr to Rock R	0.57	2B, 3C					IF	IF	IF	IF	IF		EX	NA	NS
10170204-551, **Mound Creek,** Unnamed cr to T103 R45W S24, east line	4.07	2C	11MS082	Upstream of CR 8, 3.5 mi. N of Luverne	MTS	EXS	EXP	IF		MTS	IF		EX	*IF	NS
10170204-571, **Unnamed creek,** Unnamed cr to Unnamed cr	1.93	2B, 3C	11MS113	Upstream of CR 2, 4 mi. S of Edgerton	MTS	EXS	-	-	-	-	-	-	-	NS	NA
10170204-572, **Unnamed creek,** Unnamed cr to Unnamed cr	2.59	2B, 3C	11MS083	Upstream of CR 2, 4 mi. NW of Hardwick	MTS	EXS	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 57. Non-assessed biological stations on channelized AUIDs: Lower Headwaters Rock River Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-521, **Unnamed creek,** Headwaters to Rock R	18.37	2B, 3C	11MS084	Upstream of CR 9, 3 mi. SW of Kenneth	51	30.8
10170204-524, **Unnamed creek,** Headwaters to Rock R	13.34	2B, 3C	11MS081	Downstream of Twp Rd 55, 2 mi. SE of Hardwick	50	30.7
10170204-551, **Mound Creek,** Unnamed cr to T103 R45W S24, east line	4.07	2C	11MS082	Upstream of CR 8, 3.5 mi. N of Luverne	57	26.2

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 58. Minnesota Stream Habitat Assessment (MSHA): Lower Headwaters Rock River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	04MS032	Rock River	2	2.5	18	6	15	43.5	Poor
1	11MS114	Rock River	0	7.5	20.05	6	24	57.55	Fair
1	11MS003	Rock River	0	5.5	19.8	10	23	58.3	Fair
1	11MS084	Trib. to Rock River	0	4	9.6	5	17	35.6	Poor
1	11MS081	Trib. to Rock River	0	7	7.6	6	7	27.6	Poor
1	11MS082	Mound Creek	5	8	15	12	18	58	Fair
1	11MS113	Trib. to Rock River	0	4	16.4	6	22	48.4	Fair
1	11MS083	Trib. to Rock River	0	11.5	12.8	10	17	51.3	Fair
Average Habitat Results: *Lower Headwaters Rock River Subwatershed*			**0.9**	**6.3**	**14.9**	**7.6**	**17.9**	**47.5**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 59. Channel Condition and Stability Assessment (CCSI): Lower Headwaters Rock River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS114	Rock River	17	21	32	7	77	Moderately Unstable
1	11MS084	Trib. to Rock River	14	7	23	3	47	Moderately Unstable
1	11MS081	Trib. to Rock River	26	17	24	7	74	Moderately Unstable
1	11MS113	Trib. to Rock River	20	13	12	3	48	Moderately Unstable
1	11MS083	Trib. to Rock River	18	9	6	3	36	Fairly Stable
Average Stream Stability Results: *Lower Headwaters Rock River Subwatershed*			**19**	**13.4**	**19.4**	**4.6**	**56.4**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 60. Outlet water chemistry results: Lower Headwaters Rock River Subwatershed.

Station location:	**ROCK R AT CSAH-8 BRG, 3 MI N OF LUVERNE**
STORET/EQuIS ID:	**S004-390**
Station #:	**11MS003**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	17	0.0025	0.020	0.0083	0.04	
Chloride	mg/L	10	14.3	22.7	18.6	230	
Dissolved Oxygen (DO)	mg/L	54	6.3	13.3	9.3	5	
pH		54	6.9	11.1	8.1	6.5 - 9	1
Secchi tube/Transparency Tube	100 cm	54	7	50	23	>20	23
Escherichia coli (geometric mean)	MPN/100ml	38	74	488		126	3
Escherichia coli	MPN/100ml	38	9	>2419	544	1260	4
Inorganic nitrogen (nitrate and nitrite)	mg/L	46	0.9	8	5		
Kjeldahl nitrogen	mg/L	10	0.8	2.6	1.5		
Orthophosphate	ug/L	20	9	159	47		
Phosphorus	ug/L	45	26	512	136		
Specific Conductance	uS/cm	28	485	763	633		
Temperature, water	deg °C	54	6	27	18		
Total suspended solids	mg/L	45	<0.5	254	51		

Total volatile solids	mg/L	10	3	34	14		
Sulfate	mg/L	10	49	63	55		
Hardness	mg/L	10	262	409	355		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Lower Headwaters Rock River Subwatershed, a component of the IWM work conducted between May and September from 2007 through 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Rock River, 10170204-506, Poplar Cr to Unnamed cr, **Rock River, 10170204-508,** Unnamed cr to Champepadan Cr

Water chemistry

The Rock River (10170204-506 and 10170204-508) and the unnamed stream (10170204-521) have elevated levels of bacteria impacting aquatic recreation use, and low transparency which limits aquatic life use.

Biology

All stations within this subwatershed had MIBI and FIBI scores below the impairment threshold. Relatively high flow conditions were present throughout, along with some very high suspended sediment and nutrient levels. This suggests the presence of unstable channel conditions and poor channel stability that are known to have negative impacts on invertebrate community structure. Higher than average flow conditions led to difficulty regarding the classification of streams as either high or low gradient. Two streams in this subwatershed (04MS032 and 11MS084) were classified as high gradient, and both had what appeared as healthy EPT communities relative to other streams in the Missouri River Basin. Had either stream been classified as low-gradient, they would have scored above the impairment threshold, but compared to the regional standards for high gradient streams, they scored below the impairment threshold.

Unnamed creek, 10170204-521,Headwaters to Rock R, **Unnamed creek, 10170204-545,**Unnamed cr to Rock R, **Mound Creek, 10170204-551,** Unnamed cr to T103 R45W S24, east line

Water chemistry

Unnamed stream (10170204-521) has excess bacteria impacting aquatic recreation use, and low transparency which limits aquatic life use. Due to extensive stream channel modification, the unnamed stream (10170204-521) turbidity listing is being deferred. A small stream (10170204-545) reach of .57 miles is unnamed and is impaired for aquatic recreation use. The individual samples exceed the standard one-third of the time with a high value of 5,475 MPN/100ml which is well above the standard (1,260 MPN/10ml). Mound Creek's (10170204-551) dataset contains 40 samples of bacteria and six of them exceed the 1260 MPN/100ml individual standard which calculates into a 15% exceedance rate. The highest value in the dataset is 15,531 MPN/100ml which occurred on 5/7/2012. April, June, July and August all have enough values to calculate a geometric monthly mean. April (25 MPN/100ml) and August (57 MPN/100ml) meet the 126 MPN/100ml monthly geometric mean standard. June (154 MPN/100ml) and July (181 MPN/100ml) exceed the 126 MPN/100ml standard. Therefore the stream is impaired for aquatic recreation use.

Biology

No biological stations were assessed due to channelization of the stream segments.

Unnamed creek, 10170204-571, Unnamed cr to Unnamed cr, **Unnamed creek, 10170204-572,** Unnamed cr to Unnamed cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Macroinvertebrate IBI scores showed a highly impaired condition, with low diversity and dominance by few taxa accompanied by high suspended sediment, all of which are indicators of streams in highly modified, agricultural drainages. FIBI scores followed a trend of smaller drainage areas with good flow and moderate to good habitat supporting a healthy fish population. The contrast in fish and invertebrate scores demonstrates the differing response sometimes displayed by different biological indicators.

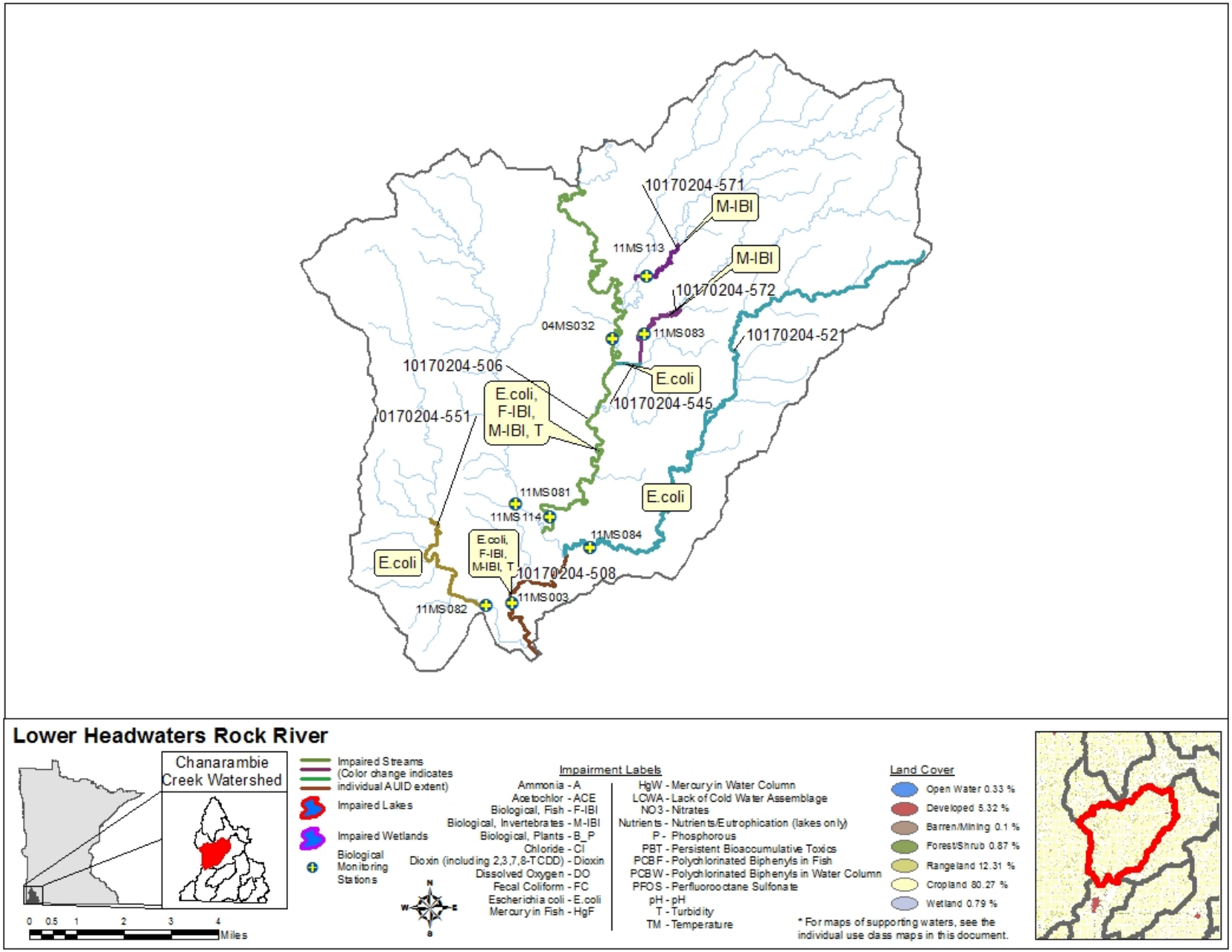

Figure 37. Currently listed impaired waters by parameter and land use characteristics in the Lower Headwaters Rock River Subwatershed.

Champepadan Creek Subwatershed HUC 1017020403-03

Champepadan Creek is a large stream reach that drains 75.86 miles^2 of Murray, Rock, and Nobles Counties. There are four other streams reaches in the Champepadan Creek Subwatershed**.** Champedan Creek begins 1.2 miles south of Chandler; it flows southwest passing south of Kenneth and exiting the subwatershed into the Rock River just northeast of Luverne**.** 92.76% of the subwatershed's land is utilized for agricultural production (cropland 83.09%, rangeland 9.67%).

Table 61. Aquatic life and recreation assessments on stream reaches: Champepadan Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:** Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	**Aquatic Life**	**Aquatic Rec.**
10170204-520, Champepadan Creek, Headwaters to Rock R	37.98	2B, 3C	11MS097 11MS098 10EM014	Downstream of 120th St, 4.5 mi. N of Lismore Downstream of County Route Creek, 1.5 mi. E of Kenneth Upstream of CSAH 9, 5 mi. NE of Luverne	EXS	EXS	IF	EXS	-	IF	MTS	IF	EX	NS	NS
10170204-583, Unnamed creek, Unnamed cr to Champepadan Cr	1.83	2B, 3C	11MS094	Downstream of Cory Ave, 4 mi. N of Lismore	MTS	EXS	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 62. Non-assessed biological stations on channelized AUIDs: Champepadan Creek Subwatershed.

AUID ***Reach Name***, *Reach Description*	**Reach length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Fish IBI**	**Invert IBI**
10170204-582, Unnamed creek, Unnamed cr to Champepadan Cr	1.21	2B, 3C	11MS095	Downstream of Ahlers Ave., 4 mi. W of Lismore	80	25.2

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 63. Minnesota Stream Habitat Assessment (MSHA): Champepadan Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS097	Champepadan Creek	1.25	7.5	19	13	24	64.75	Fair
1	11MS098	Champepadan Creek	0	5	10.3	5	19	39.3	Poor
2	10EM014	Champepadan Creek	0	9.25	14.3	10.5	31	65.05	Fair
1	11MS095	Trib. to Chanarambie Creek	0	6.5	17.2	6	20	49.7	Fair
1	11MS094	Trib. to Champepadan Creek	2.5	13	16.2	11	29	71.7	Good
Average Habitat Results: *Champepadan Creek Subwatershed*			**0.8**	**8.3**	**15.4**	**9.1**	**24.6**	**58.1**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 64. Channel Condition and Stability Assessment (CCSI): Champepadan Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS098	Champepadan Creek	38	27	30	7	102	Extremely Unstable
1	10EM014	Champepadan Creek	34	31	25	11	101	Extremely Unstable
1	11MS095	Trib. to Chanarambie Creek	21	17	18	7	63	Moderately Unstable
1	11MS094	Trib. to Champepadan Creek	9	9	8	3	29	Fairly Stable
Average Stream Stability Results: *Champepadan Creek Subwatershed*			**25.5**	**21**	**20.3**	**7**	**73.8**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 65. Outlet water chemistry results: Lower Champepadan Creek Subwatershed.

Station location:	CHAMPEPADAN CK AT CSAH-9 BRG, 5 MI NE OF LUVERNE						
STORET/EQuIS ID:	S006-167						
Station #:	10EM014						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	18	0.0018	0.02	0.0045	0.04	
Dissolved Oxygen (DO)	mg/L	60	5.8	14.4	9.9	5	
pH		60	6.9	9.2	8	6.5 - 9	1
Secchi tube/Transparency Tube	100 cm	60	4	55	29	>20	21
Turbidity	FNU	47	6	220	25	25	12
Escherichia coli (geometric mean)	MPN/100 ml	36	130	833		126	6
Escherichia coli	MPN/100 ml	36	6.1	14136	1202	1260	4
Inorganic nitrogen (nitrate and nitrite)	mg/L	14	3	1	7		
Kjeldahl nitrogen	mg/L	14	0.2	2.1	1		
Phosphorus	ug/L	14	19	185	79		
Specific Conductance	uS/cm	46	418	783	669		
Temperature, water	deg °C	60	6	27	16		
Total suspended solids	mg/L	40	4	290	37		
Total volatile solids	mg/L	30	<2	50	9		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Lower Champepadan Creek Subwatershed, a component of the IWM work conducted between May and September from 2010 through 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Champepadan Creek, 10170204-520, Headwaters to Rock R

Water chemistry

Champepadan Creek will be listed for not supporting aquatic recreation use based on the high levels of bacteria that were found in the stream throughout the summer months. The stream also has high levels of turbidity and low transparency readings, resulting in Champepadan Creek not supporting aquatic life. The dissolved oxygen flux is very large (>8mg/L) which can cause a very stressful environment for the community of the stream.

Biology

Invertebrate stations in this subwatershed were characterized by high flows, and corresponding riffle habitat throughout. Most streams had signs of unstable banks, and correspondingly high levels of suspended sediment as well as high levels of nutrients. Site 11MS094 had very high quality in stream and riparian habitat, and yet a poor MIBI score. All sites sampled in this subwatershed failed to meet the MIBI and FIBI biocriteria despite having the stable flows and in-stream habitat often associated with higher MIBI and FIBI scores in agricultural regions of Minnesota. Stations 10EM014 and 11MS098 have very unstable channel conditions causing bed shifting and severe bank erosion, both of which are detrimental to fish and invertebrate community health.

Unnamed creek, 10170204-583, Unnamed Cr to Champepadan Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Macroinvertebrate IBI scores showed a highly impaired condition, with low diversity and dominance by few taxa accompanied by high suspended sediment, all indicators of streams in highly modified, agricultural drainages. Fish scores followed a trend of smaller drainage areas with good flow and moderate to good habitat supporting a healthy fish community.

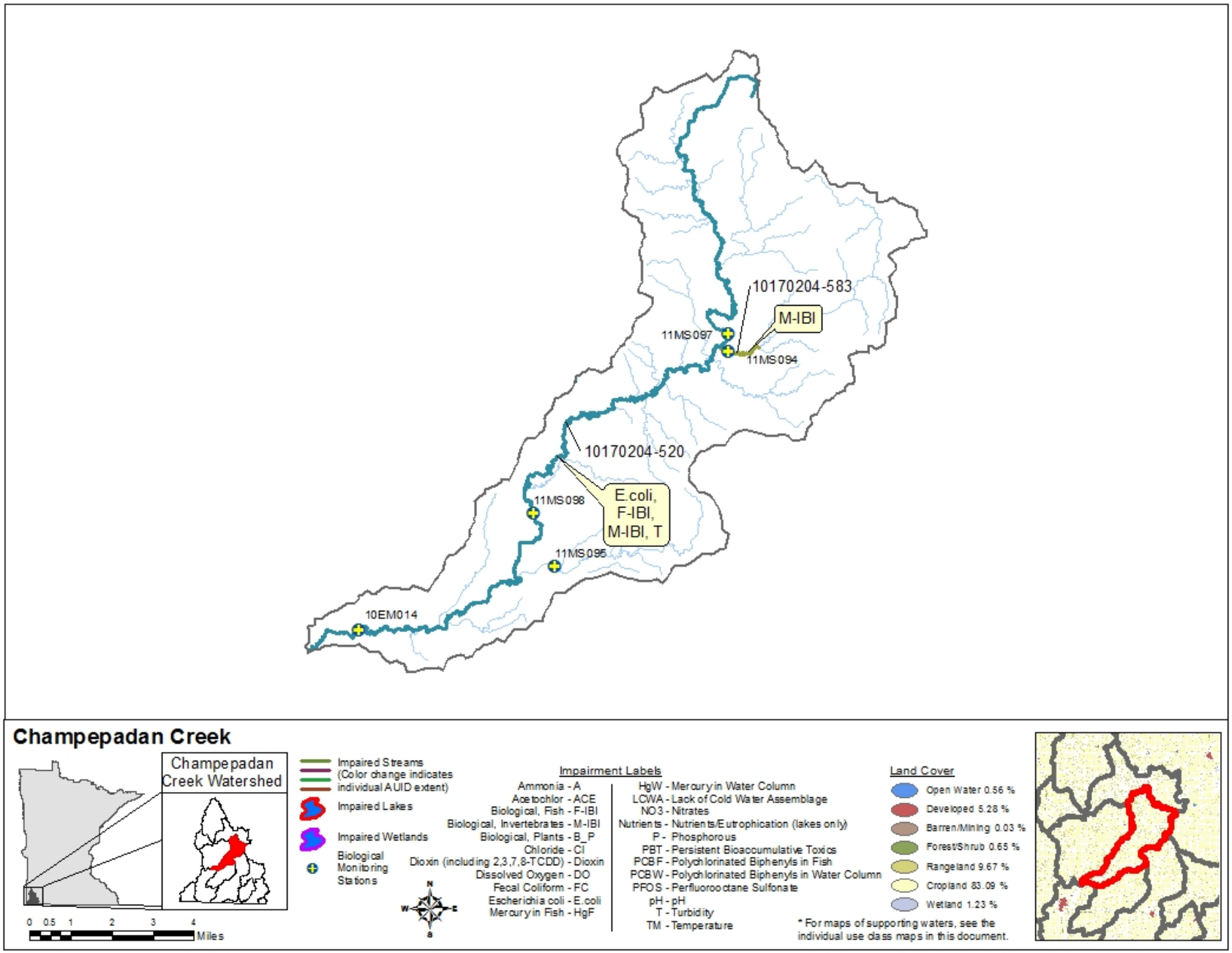

Figure 38. Currently listed impaired waters by parameter and land use characteristics in the Champepadan Creek Subwatershed.

Elk Creek Subwatershed HUC 1017020403-02

Elk Creek Subwatershed has one assessable stream (Elk Creek) out of the five in the subwatershed; it drains 64.41 miles^2 of Nobles and Rock counties. Elk Creek is the major stream that flows through this subwatershed stretching 31 miles from northeast to southwest. It runs north of Magnolia and flows into the Rock River 2.6 miles south of Luverne. 91.40% of the subwatershed's land is utilized for agricultural production (cropland 86.53%, rangeland 4.87%).

Table 66. Aquatic life and recreation assessments on stream reaches: Elk Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
10170204-519, **Elk Creek,** Headwaters to Rock R	31.43	2B, 3C	11MS118 11MS100 11MS020	Downstream of Ahlers Ave, 2.5 mi. NE of Magnolia Upstream of 101st St, 2 mi. SW of Magnolia Upstream of CR 9, 3 mi. S of Luverne	EXS	EXP	MTS	EXS	IF	MTS	MTS		EX	NS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).
Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 67. Non-assessed biological stations on channelized AUIDs: Elk Creek Subwatershed.

AUID ***Reach Name***, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-519, **Elk Creek,** Headwaters to Rock R	31.43	2B, 3C	11MS100	Upstream of 101st St, 2 mi. SW of Magnolia	36	25.6
10170204-557, **County Ditch A,** Unnamed ditch to Unnamed ditch	3.51	2B, 3C	07MS002	Upstream of CR 56, 1 mi. S of Magnolia	54	37.3
10170204-573, **Unnamed creek,** Unnamed cr to Elk Cr	1.38	2B, 3C	11MS099	Downstream of 210th St, 3 mi. N of Magnolia	73	30.5
10170204-574, **Unnamed creek,** Unnamed cr to Elk Cr	2.88	2B, 3C	11MS119	Downstream of Ahlers Ave, 2 mi. NE of Magnolia	46	38.31

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 68. Minnesota Stream Habitat Assessment (MSHA): Elk Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS118	Elk River	0	8	12.85	7	19	46.85	Fair
1	11MS100	Elk River	0	7	16.8	6	24	53.8	Fair
1	11MS020	Elk River	0	1	20.1	9	19	49.1	Fair
2	07MS002	Trib. to Elk Creek	0	8	17.8	13.5	17	56.3	Fair
1	11MS099	Trib. to Elk River	0	8.5	17.4	7	21	53.9	Fair
1	11MS119	Trib. to Elk River	0	6	10	13	11	40	Poor
Average Habitat Results: *Elk Creek Subwatershed*			**0**	**6.4**	**15.8**	**9.3**	**18.5**	**50**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 69. Channel Condition and Stability Assessment (CCSI): Elk Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
	11MS020	Elk River	37	29	30	11	107	Severely Unstable
Average Stream Stability Results: *Elk Creek Subwatershed*			**37**	**29**	**30**	**11**	**107**	**Severely Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 70. Outlet water chemistry results: Elk Creek Subwatershed.

Station location:	**ELK CK 3 MI SE OF LUVERNE, MN**						
STORET/EQuIS ID:	**S001-360**						
Station #:	**11MS020**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	11	0.0021	0.0291	0.0112	0.04	
Chloride	mg/L	10	17.6	24.1	21.8	230	
Dissolved Oxygen (DO)	mg/L	37	3.9	13.5	8.4	5	2
pH		37	7.5	8.9	8.2	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	71	4	49	14	>20	63
Escherichia coli (geometric mean)	MPN/100ml	34	185	3191		126	6
Escherichia coli	MPN/100ml	34	14	12997	3524	1260	25
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	6	14	11		
Kjeldahl nitrogen	mg/L	10	0.8	5.3	1.83		
Phosphorus	ug/L	10	21	1850	342		
Specific Conductance	uS/cm	37	421	957	731		
Temperature, water	deg °C	37	7	26	17		
Total suspended solids	mg/L	36	4	427	74		
Total volatile solids	mg/L	25	<2	74	16		
Sulfate	mg/L	10	45	75	55		
Hardness	mg/L	10	311	415	387		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Elk Creek Subwatershed, a component of the IWM work conducted between May and September from 2003, 2005, 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Elk Creek, 10170204-519, Headwaters to Rock R

Water chemistry

Elk Creek shows over 50% of individual exceedances of the E. coli standard, and April through September observations are all over the geometric monthly mean standard. These high levels of bacteria area cause of concern and Elk Creek is considered impaired for aquatic recreation use. The new chemistry data confirms a 2006 listing for turbidity, which impacts aquatic life use. The dissolved oxygen flux is very large (>9mg/L), which

may cause a very stressful environment for the community of the stream. Elk Creek contains elevated amounts of phosphorus which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

All macroinvertebrate stations on the main stem of Elk Creek were classified as high gradient with good habitat. The presence of riffles throughout suggests a normal high flow condition, but unseasonably high flows caused some difficulty regarding proper stream classification. All Elk Creek sites (11MS020, 11MS100, 11MS119), had the higher POET diversity commonly associated with gradient systems, yet none attained the MIBI biocriterion. Site 11MS119 had a relatively healthy POET community for a low gradient stream and it barely met the biocriterion, despite having relatively poor in-stream habitat and high values for suspended sediment and nutrients, which was common to all sites within the subwatershed. Fish scores followed a trend of smaller drainage areas with good flow and moderate to good habitat supporting a healthy fish community. Biological station 11MS118 which is the most upstream station on Elk Creek has a fair habitat score (46.85), but the most downstream station (11MS020) has a habitat score of 49.1. The most upstream site with the smaller drainage area again scored well above the threshold, while the most downstream site scores well below the threshold. Turbidity and sediment accumulation seem to be associated with the trend in low FIBI scores.

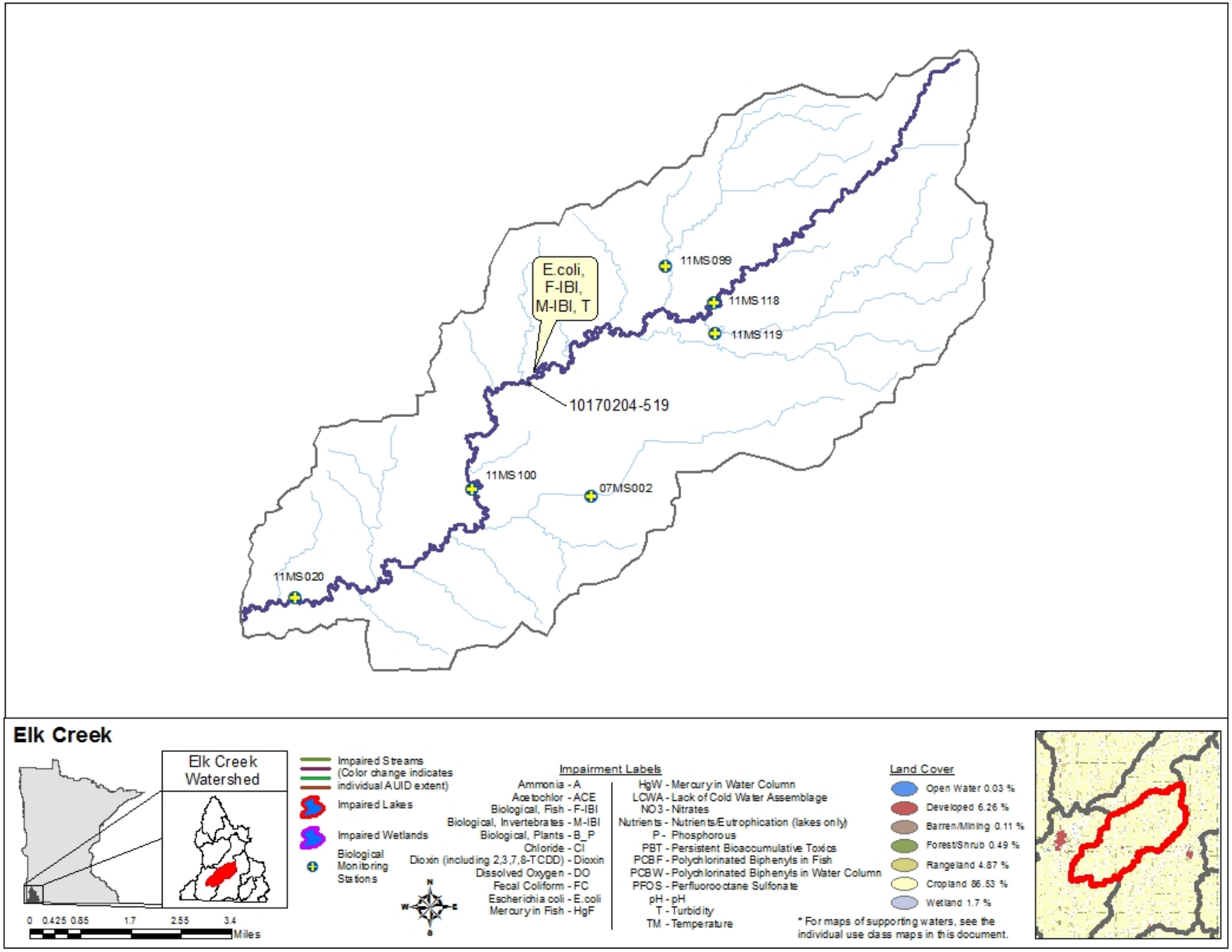

Figure 39. Currently listed impaired waters by parameter and land use characteristics in the Elk Creek Subwatershed.

Upper Rock River Subwatershed HUC 1017020403-01

There are twelve stream reaches within the Upper Rock River Subwatershed; it drains 93.02 miles^2 of Rock County. This subwatershed is not a true complete watershed as a part of the subwatershed is in Iowa. The Rock River and Ash Creek are the major streams that flow in this subwatershed. The Rock River flows from the north where Champepadan Creek enters the Rock River and continues south through Luverne until Elk Creek enters the river. The Rock River then flows south 11.5 miles from Elk Creek to where it exits into Iowa. 87.36% of the subwatershed's land use is utilized for agricultural production (cropland 80.367%, rangeland 7%). Because the river flows through the town of Luverne which is one of the largest cities in the basin, 8.64% of the land use is urban/developed.

Table 71. Aquatic life and recreation assessments on stream reaches: Upper Rock River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-501, **Rock River,** Elk Cr to MN/IA border	11.55	2C, 3C	04MS016 11MS001	Upstream of CR 1, Clinton Township Upstream of Stateline Rd, 10 mi. S of Luverne	EXS	EXS	MTS	EXS	MTS	MTS	MTS	MTS	EX	NS	NS
10170204-509, **Rock River,** Champepadan Cr to Elk Cr	12.75	2C, 3C	04MS019 11MS148	Upstream of CR 4, 1 mile E of Luverne Downstream of CR 16, 2 mi. S of Luverne	EXS	EXP	MTS	EXS	MTS	MTS	MTS	MTS	-	NS	NA
10170204-539, **Ash Creek,** Unnamed cr to Unnamed cr	2.4	2C	04MS002	Upstream of US 75, 2 miles NE of Steen	EXS	EXP	-	IF		IF	IF	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 72. Non-assessed biological stations on channelized AUIDs: Upper Rock River Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-540, **Ash Creek,** Unnamed cr to Rock R	2.62	2C	11MS085	Downstream of 140th Ave, 3.5 mi NE of Steen	57	27.5
10170204-569, **Unnamed creek,** Unnamed cr to Rock R	1.62	2B, 3C	11MS108	Downstream of 140th Ave, 3 mi. E of Steen	33	37.9

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 73. Minnesota Stream Habitat Assessment (MSHA): Upper Rock River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	04MS016	Rock River	0	6	14.8	5	17	42.8	Poor
1	11MS001	Rock River	1.25	9	19.95	12	24	66.2	Good
3	04MS019	Rock River	1.7	8.3	19.3	9.7	24.7	63.6	Fair
1	04MS002	Ash Creek	0	8	12	14	7	41	Poor
1	11MS085	Ash Creek	0	9	17.6	13	22	61.6	Fair
1	11MS108	Trib. to Rock River	5	11	8	14	16	54	Fair
Average Habitat Results: *Upper Rock River Subwatershed*			**1.3**	**8.6**	**15.3**	**11.3**	**18.5**	**54.9**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 74. Channel Condition and Stability Assessment (CCSI): Upper Rock River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
	11MS085	Ash Creek	23	17	4	7	51	Moderately Unstable
	11MS108	Trib. to Rock River	11	15	26	3	55	Moderately Unstable
Average Stream Stability Results: *Upper Rock River Subwatershed*			**17**	**16**	**15**	**5**	**53**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 75. Outlet water chemistry results: Ash Creek-Rock River Subwatershed.

Station location:	**ROCK RIVER BR ON STATELINE RD 10 MI S OF LUVERNE**						
STORET/EQuIS ID:	**S000-097**						
Station #:	**11MS001**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	51	0.0004	0.0274	0.0069	0.04	
Chloride	mg/L	19	16.6	40.9	25.6	230	
Dissolved Oxygen (DO)	mg/L	87	5.4	14.2	9.8	5	
pH		102	6.9	11.7	8.3	6.5 - 9	2
Secchi tube/Transparency Tube	100 cm	77	4	100	30	>20	26
Turbidity	FNU	33	6	161	47	25	22
Escherichia coli (geometric mean)	MPN/100ml	56	35	578		126	5
Escherichia coli	MPN/100ml	56		>2419	534	1260	6
Chlorophyll-a, Corrected	ug/L	32	3	117	31		
Inorganic nitrogen (nitrate and nitrite)	mg/L	84	0.34	10	5		
Kjeldahl nitrogen	mg/L	20	0.8	2.4	1.4		
Orthophosphate	ug/L	20	8	212	62		
Pheophytin-a	ug/L	22	<1	14	5		
Phosphorus	ug/L	84	30	662	159		
Specific Conductance	uS/cm	65	348	1500	704		
Temperature, water	deg ℃	87	0	30	17		
Total suspended solids	mg/L	76	5	450	58		
Total volatile solids	mg/L	22	2.4	39	11		
Sulfate	mg/L	24	55	87	69		
Hardness	mg/L	12	328	404	367		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Ash Creek-Rock River Subwatershed, a component of the IWM work conducted between May and September from 2003 through 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Rock River, 10170204-501, Elk Cr to MN/IA border, **Rock River, 10170204-509,** Champepadan Cr to Elk Cr

Water chemistry

The Rock River (10170204-501) shows high levels of bacteria June through October. The geometric mean is exceeded five out of the seven months and there are six individual exceedances of the bacteria standards. This stream reach was listed for excessive bacteria in 1994 and the current data confirms that the stream is still impaired and will continue to be listed for not supporting aquatic recreation. The Rock River was previously listed as not supporting aquatic life use due to excess turbidity in 2002. The new data confirms the listing; therefore the Rock River will continue to be listed for not supporting aquatic life. The Rock River (10170204-509) is 12 miles long and has been listed for turbidity in 2006 and the current data supports the impairment. The dissolved oxygen flux is very large (>8mg/L) which can cause a very stressful environment for the community of the stream. The Rock River contains elevated amounts of phosphorus which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

The Rock River contains the only invertebrate stations classified as rivers within the Missouri River Basin (11MS001 and 04MS016). Site 04MS016 had a very diverse POET community relative to the rest of the Basin, and yet was still dominated by relatively few tolerant taxa. The high number of POET taxa suggests that this stream, much like other larger rivers in the state, has the ability to support a healthy assemblage of invertebrates, but is likely being imbalanced by poor habitat, water quality, and/or flow conditions. Along the extent of the mainstem Rock River there was a trend of lower FIBI scores with increasing drainage area. This is the most downstream section of the Rock River, and the low FIBI scores continued this trend. High turbidity and high nutrient values resulting from unstable channels and highly modified land use conditions create assemblages of only tolerant fishes.

Ash Creek, 10170204-539, Unnamed cr to Unnamed cr

Water chemistry

No water chemistry was assessed on this stream reach.

Biology

The impaired invertebrate and fish communities in the reach were likely related to poor habitat conditions, high TSS and high nutrient values resulting from an unstable channels and highly modified land use conditions.

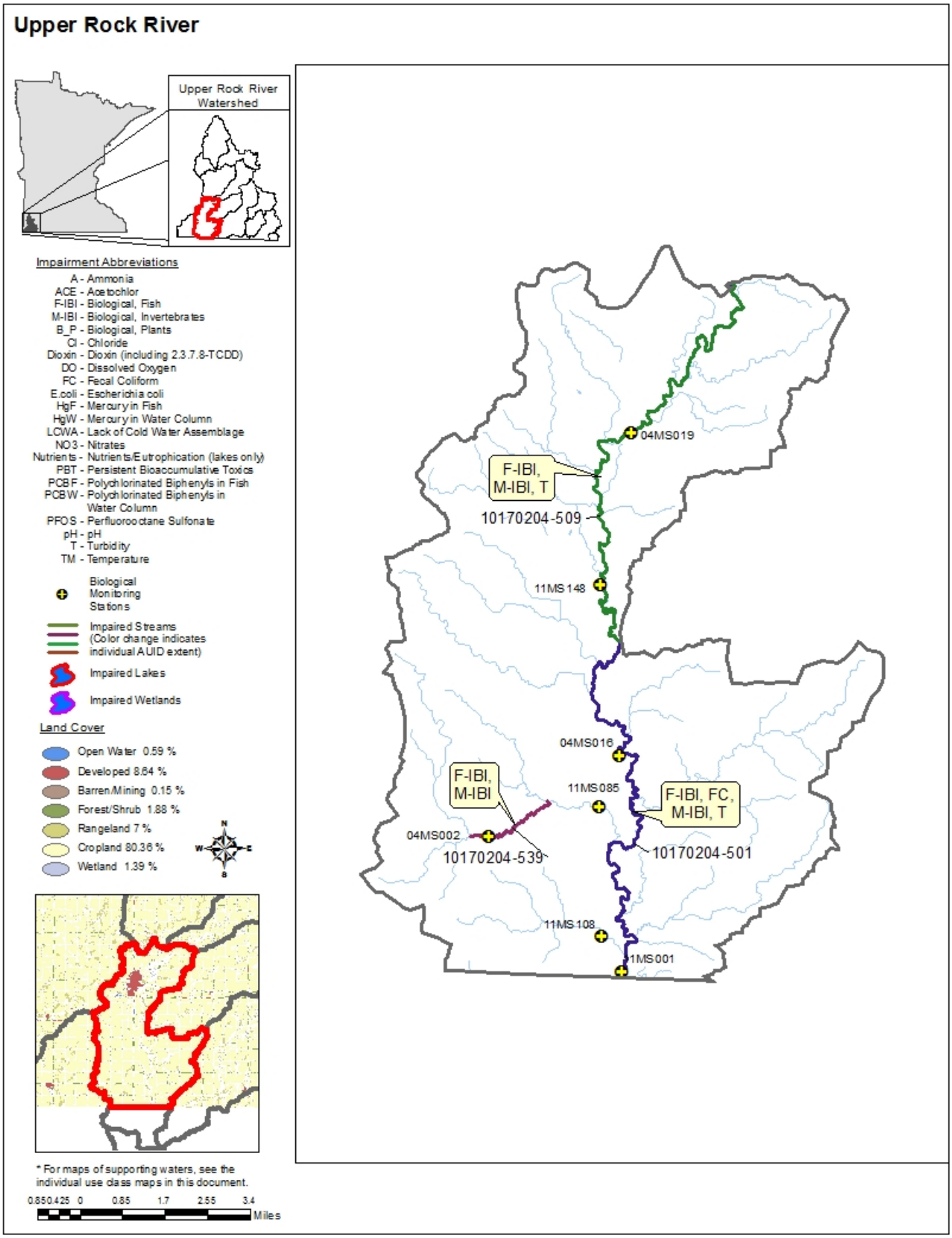

Figure 40. Currently listed impaired waters by parameter and land use characteristics in the Upper Rock River Subwatershed.

Mud Creek Subwatershed HUC 1017020404-01

There are six stream reaches in the Mud Creek Subwatershed, which drain 40.59 miles2 Rock County. This subwatershed is not a true complete watershed as a part of the subwatershed is in Iowa. Mud Creek is the main stream reach in the Mud Creek Subwatershed and flows 16.3 miles from the north to south, passing on the east side of Hills and eventually exiting into Iowa. There is one lake (Hills Reservoir) in thesub watershed that is used locally for fishing. The basin is very small, and not protected as a water of the state; as a result, no assessment for aquatic recreation use will be made. 92.80% of the subwatershed's land is utilized for agricultural production (cropland 82.25%, rangeland 6.55%).

Table 76. Aquatic life and recreation assessments on stream reaches: Mud Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-525, **Mud Creek,** Headwaters to MN/IA border	16.33	2C, 3C	11MS106 11MS021	Downstream of 41st St, 1 mi. NE of Hills Upstream of 21st St, 1 mi. SE of Hills	EXS	EXP	EXP	EXS	IF	MTS	IF	-	EX	NS	NS
10170204-568, **Unnamed creek,** Unnamed cr to Mud Cr	2.64	2B, 3C	11MS107	Upstream of 70th St, 1 mi. E of Hills	EXP	MTS	-	-	-	-	-	-	-	FS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 77. Non-assessed biological stations on channelized AUIDs: Mud Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-558, Unnamed creek, Unnamed cr to Unnamed ditch	1.18	2B, 3C	10EM001	Upstream of 11th St, 1.5 mi. S of Hills	44	21.4

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 78. Minnesota Stream Habitat Assessment (MSHA): Mud Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS106	Mud Creek	0	2	10.7	11	16	39.7	Poor
1	11MS021	Mud Creek	0	2	4	6	9	21	Poor
1	10EM001	Unnamed ditch	0	4	4	9	5	22	Poor
1	11MS107	Trib. to Mud Creek	0	11	18.6	14	29	72.6	Good
Average Habitat Results: *Mud Creek Subwatershed*			**0**	**4.8**	**9.38**	**10**	**14.8**	**38.8**	**Poor**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 79. Channel Condition and Stability Assessment (CCSI): Mud Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS106	Mud Creek	28	28	25	7	88	Severely Unstable
1	11MS121	Chanarambie Creek	27	15	26	7	75	Moderately Unstable
1	10EM001	Unnamed ditch	12	11	26	7	56	Moderately Unstable
1	11MS107	Trib. to Mud Creek	17	15	26	7	65	Moderately Unstable
Average Stream Stability Results: *Mud Creek Subwatershed*			**21**	**17.3**	**25.8**	**7**	**71**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 80. Outlet water chemistry results: Mud Creek Subwatershed.

Station location:	**MUD CK ON 21ST STREET BRG, 0.5 MI S OF HILLS**
STORET/EQuIS ID:	**S004-391**
Station #:	**11MS021**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	18	0.0008	0.0157	0.0054	0.04	
Chloride	mg/L	10	19.8	27.2	22.3	230	
Dissolved Oxygen (DO)	mg/L	66	1.6	15.4	8.7	5	7
pH		66	5.4	8.6	7.8	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	66	4	52	16	>20	51
Escherichia coli (geometric mean)	MPN/100 ml	58	15	2023		126	3
Escherichia coli	MPN/100 ml	58	3	19863	1739	1260	30
Inorganic nitrogen (nitrate and nitrite)	mg/L	46	<0.2	18	12		
Kjeldahl nitrogen	mg/L	10	0.9	2.7	1.4		
Orthophosphate	ug/L	20	19	296	116		
Phosphorus	ug/L	45	28	791	183		
Specific Conductance	uS/cm	28	758	888	834		
Temperature, water	deg °C	66	3.3	25	17		
Total suspended solids	mg/L	45	6.8	194	60		
Total volatile solids	mg/L	10	5	21	13		
Sulfate	mg/L	10	72	98	81		
Hardness	mg/L	10	397	443	422		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Mud Creek Subwatershed, a component of the IWM work conducted between May and September from 2007 through 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Mud Creek, 10170204-525, Headwaters to MN/IA border

Water chemistry

Mud Creek has high levels of bacteria throughout the summer months and over half of the dataset shows individual exceedances. The stream reach will be listed for aquatic recreation use impairment. There is a turbidity impairment affecting aquatic life use dating back to 2008 and the current data shows confirmation of that impairment. The dissolved oxygen flux is very large (>14mg/L) which can cause a very stressful environment for the community of the stream. Mud Creek contains elevated amounts of phosphorus which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

At the time of sampling of the invertebrate and fish stations on the mainstem of Mud Creek (11MS106 and 11MS021), cattle were present in the entire reach, and the impact of their presence was clear from the trampling of banks and modified in-stream habitat throughout. Both sites failed to meet the biocriteria.

Unnamed creek, 10170204-568, Unnamed cr to Mud Cr

Water chemistry

No water chemistry was assessed on this stream reach.

Biology

Site 11MS107 had a relatively stable channel, as well as very cold water temperatures, suggesting a steady groundwater source. The macroinvertebrate community had a slight coldwater signature and indicated the stream was fully supporting of aquatic life. Fish also scored well, and this AUID was one of three AUIDs in the entire Missouri River Basin to be show full support for aquatic life. Lower turbidity and a steady flow of water, along with good habitat, allowed both fish and invertebrates to thrive in this stream.

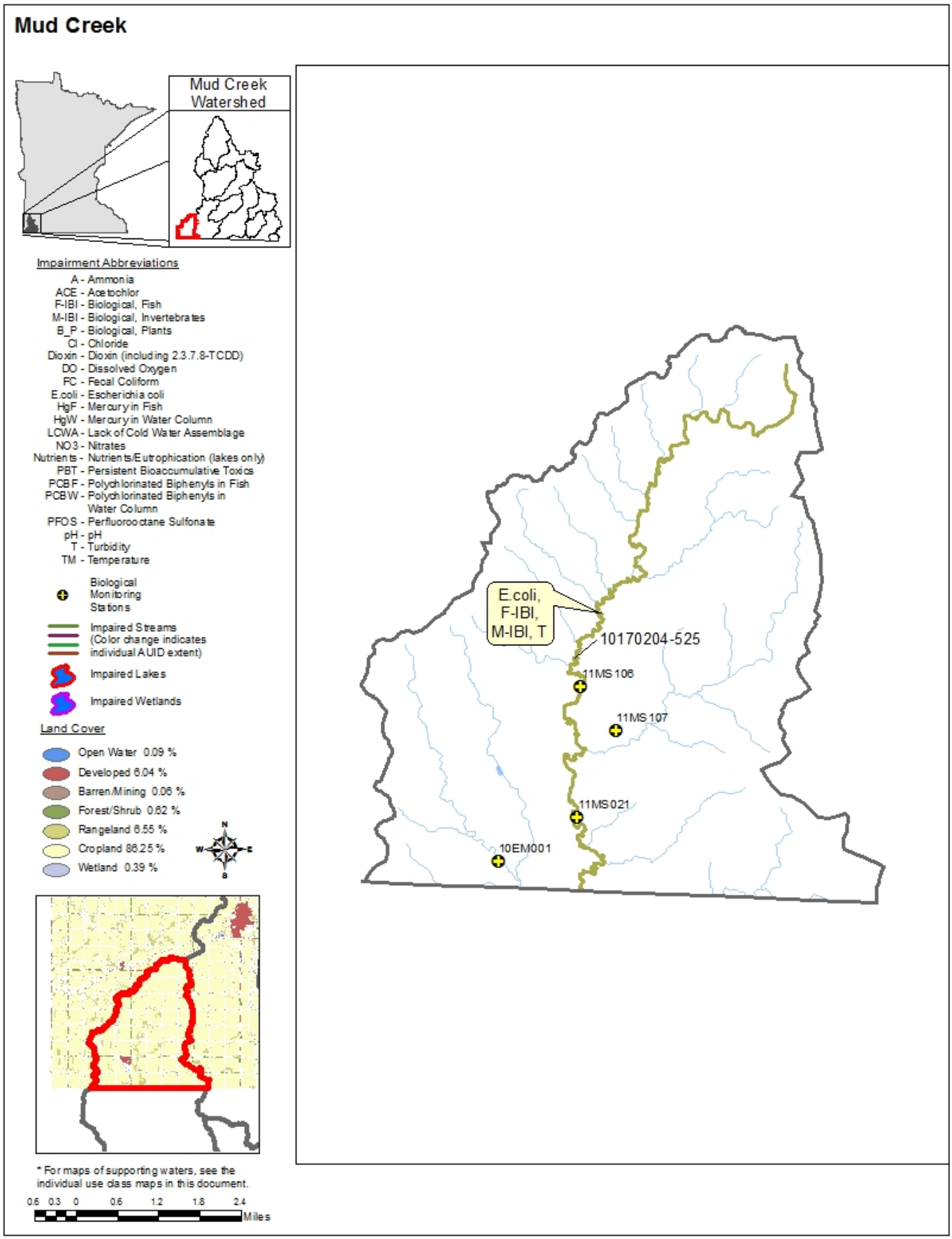

Figure 41. Currently listed impaired waters by parameter and land use characteristics in the Mud Creek Subwatershed.

Kanaranzi Creek Subwatershed HUC 1017020402-01

There are 12 stream reaches in Kanaranzi Creek Subwatershed; it is the largest subwatershed in the Missouri River Basin, draining 137.63 miles^2. This subwatershed is not a true complete watershed, as a part of the subwatershed is in Iowa. Kanaranzi Creek flows from the north subwatershed 16 miles until it joins with the East Branch Kanaranzi Creek. Kanaranzi Creek flows from where Norwegian Creek enters the creek and travels 6.7 miles until it exits into Iowa. Norwegian Creek is 9.7 miles long and flows from the east into Kanaranzi Creek. 90.97% of the subwatershed's land is utilized for agricultural production (cropland 83.24%, rangeland 7.73%).

Table 81. Aquatic life and recreation assessments on stream reaches: Kanaranzi Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-515, **Kanaranzi Creek,** Headwaters to E Br Kanaranzi Cr	16.42	2C, 3C	11MS126 11MS004	Downstream of 170th St, 1.5 mi. E of Lismore Upstream of 210th St, 4 mi. N of Adrian	EXS	EXS	IF	IF	MTS	MTS	IF		EX	NS	NS
10170204-516, **Kanaranzi Creek,** E Br Kanaranzi Cr to Norwegian Cr	25.98	2C, 3C	04MS020 11MS101	Upstream of State Route 91, 1 mile N of Adrian Downstream of Ahlers Ave (CR 11), 3 mi NE of Kanaranzi	EXS	EXP	IF	IF		IF	IF			NS	NA
10170204-517, **Kanaranzi Creek,** Norwegian Cr to MN/IA border	6.77	2C, 3C	11MS006	Upstream of 11th St, 4 mi. W of Ellsworth	EXS	EXS	IF	EXS	IF	IF	MTS		EX	NS	NS
10170204-518, **Norwegian Creek,** Headwaters to Kanaranzi Cr	9.79	2B, 3C	11MS102 11MS086	Downstream of Bulick Ave, 1.5 mi. NE of Ellsworth Upstream of CR 1, 1 mi. NW of Ellsworth	MTS	EXP	IF	EXS		IF	IF		EX	*IF	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 82. Non-assessed biological stations on channelized AUIDs: Kanaranzi Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-516, Kanaranzi Creek, E Br Kanaranzi Cr to Norwegian Cr	25.98	2C, 3C	11MS101	Downstream of Ahlers Ave (CR 11), 3 mi NE of Kanaranzi	36	23.4
10170204-518, Norwegian Creek, Headwaters to Kanaranzi Cr	9.79	2B, 3C	11MS102	Downstream of Bulick Ave, 1.5 mi. NE of Ellsworth	67	35.65
10170204-518, Norwegian Creek, Headwaters to Kanaranzi Cr	9.79	2B, 3C	11MS086	Upstream of CR 1, 1 mi. NW of Ellsworth	66	27.53
10170204-534, Unnamed creek, Headwaters to Unnamed cr	2.9	2B, 3C	04MS008	Downstream of CR 69, 1.2 miles WNW of Wilmont	15	14.9
10170204-575, Unnamed creek, Unnamed cr to Kanaranzi Cr	2.53	2B, 3C	11MS129	Upstream of CSAH 11 (Ahlers Ave), 4.5 mi. N of Ellsworth	64	35.4
10170204-576, Unnamed creek, Headwaters to Kanaranzi Cr	10.78	2B, 3C	11MS128	Downstream of CSAH 8, 3.5 mi. NW of Ellsworth	64	32.9
10170204-584, Unnamed creek, Unnamed cr to Kanaranzi Cr	2.35	2B, 3C	11MS127	Downstream of Durfee Ave, 5 mi. N of Adrian	64	35.2
10170204-587, Unnamed creek, Unnamed cr to Unnamed cr	0.13	2B, 3C	11MS125	Upstream of 170th Ave, 1 mi. E of Lismore	56	24.7

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 83. Minnesota Stream Habitat Assessment (MSHA): Kanaranzi Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS126	Kanaranzi Creek	0	10	7	6	16	39	Poor
1	11MS004	Kanaranzi Creek	0	9	17.85	11	17	54.9	Fair
1	04MS020	Kanaranzi Creek	0	7.5	14.1	7	20	48.6	Fair
1	11MS101	Kanaranzi Creek	0	6	17.1	6	21	50.1	Fair
1	11MS006	Kanaranzi Creek	0	0	8.6	1	13	22.6	Poor
1	11MS102	Norwegian Creek	1.5	13.5	18.4	11	24	68.4	Good
1	11MS086	Norwegian Creek	0	7	17.75	13	25	62.8	Fair
1	04MS008	Trib. to Kanaranzi Creek	0	9	7	5	13	34	Poor
1	11MS129	Trib. to Kanaranzi Creek	0	3.5	16.6	6	30	56.1	Fair
1	11MS128	Trib. to Kanaranzi Creek	0	13	10	10	18	51	Fair
1	11MS127	Trib. to Kanaranzi Creek	0	8	15.4	5	8	36.4	Poor
1	11MS125	Trib. to Kanaranzi Creek	0	9.5	18.35	6	24	57.9	Fair
Average Habitat Results: *Kanaranzi Creek Subwatershed*			**0.1**	**8**	**14**	**7.3**	**19.1**	**48.5**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 84. Channel Condition and Stability Assessment (CCSI): Kanaranzi Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS004	Kanaranzi Creek	25	21	32	5	83	Severely Unstable
1	11MS101	Kanaranzi Creek	19	17	19	7	62	Moderately Unstable
1	11MS006	Kanaranzi Creek	30	28	28	6	92	Severely Unstable
1	11MS102	Norwegian Creek	16	13	13	3	45	Moderately Unstable
1	11MS086	Norwegian Creek	33	32	22	11	98	Severely Unstable
1	11MS129	Trib. to Kanaranzi Creek	18	13	13	3	47	Moderately Unstable

1	11MS125	Trib. to Kanaranzi Creek	28	15	11	3	57	Moderately Unstable
Average Stream Stability Results: *Kanaranzi Creek Subwatershed*			**24.1**	**19.9**	**19.7**	**5.4**	**69.1**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 85. Outlet water chemistry results: Kanaranzi Creek Subwatershed.

Station location:	**KANARANZI CK AT MN/IA BORDER, 5.25 MI NW OF ELLSWORTH, MN**						
STORET/EQuIS ID:	**S004-717**						
Station #:	**11MS006**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	51	0	0.039	0.013	0.04	
Chloride	mg/L	5	18.7	25.5	22.3	230	
Dissolved Oxygen (DO)	mg/L	71	6.6	12.4	9.4	5	
pH		59	7	9.3	8.4	6.5 - 9	2
Secchi tube/Transparency Tube	100 cm	226	2	64	23	>20	119
Escherichia coli (geometric mean)	MPN/100 ml	79	178	2376		126	7
Escherichia coli	MPN/100 ml	79	19	>24196	3053	1260	49
Inorganic nitrogen (nitrate and nitrite)	mg/L	78	0.44	14	7.6		
Kjeldahl nitrogen	mg/L	78	0.6	6.1	1.7		
Phosphorus	ug/L	78	30	1210	219		
Specific Conductance	uS/cm	39	385	892	680		
Temperature, water	deg °C	191	1	29	17		
Total suspended solids	mg/L	78	4	927	106		
Total volatile solids	mg/L	36	4	133	29		
Sulfate	mg/L	5	64	71	67		
Hardness	mg/L	4	351	437	408		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Kanaranzi Creek Subwatershed, a component of the IWM work conducted between May and September from 2007 through 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 86. Outlet water chemistry results: Kanaranzi Creek Subwatershed.

Station location:	**KANARANZI CK AT 210TH ST, 3 MI N OF ADRIAN, MN.**						
STORET/EQuIS ID:	**S006-904**						
Station #:	**11MS004**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	12	0.0032	0.03	0.0152	0.04	
Chloride	mg/L	10	18.4	40.3	23.4	230	
Dissolved Oxygen (DO)	mg/L	7	5.3	10.9	8.6	5	
pH		15	7.6	9.5	8.5	6.5 - 9	1
Secchi tube/Transparency Tube	100 cm	13	10	>100	35	>20	3
Escherichia coli	MPN/100ml	11	365	19863	2598	1260	3
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	5.2	16.4	11.6		
Kjeldahl nitrogen	mg/L	10	0.9	2.2	1.4		
Phosphorus	ug/L	10	28	448	158		
Specific Conductance	uS/cm	15	437	874	700		
Temperature, water	deg °C	15	10	24	19		
Total suspended solids	mg/L	10	2	128	31		
Total volatile solids	mg/L	10	<2	387	46		
Sulfate	mg/L	10	58	370	101		
Hardness	mg/L	8	333	434	389		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Kanaranzi Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Kanaranzi Creek, 10170204-515, Headwaters to E Br Kanaranzi Cr, **Kanaranzi Creek, 10170204-516,**E Br Kanaranzi Cr to Norwegian Cr, **Kanaranzi Creek, 10170204-517**

Water chemistry

Norwegian Cr to MN/IA border Kanaranzi Creek (10170204-517) shows very high levels of bacteria throughout the dataset. The individual exceedances of the bacteria standard occur over half of the time, and all of the months exceed the geometric mean standard. Bacteria and turbidity were both listed

as impairment causes in 2010 and the current data confirms each of the impairments. Kanaranzi Creek (10170204-515) shows high levels of bacteria that exceed the standard; therefore this stream reach is also impaired for aquatic recreation use. There is not enough data to calculate a geometric monthly mean, but August has four values and if another sample had been taken so the minimum number samples was met (5), the standard would have been violated. There is a previous impairment listing for bacteria from 2010 and the current data show support of this listing for Norwegian Creek. The dissolved oxygen flux is very large (>14mg/L) which can cause a very stressful environment for the community of the stream. Kanaranzi Creek contains elevated amounts of phosphorus which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

The Kanaranzi Creek subwatershed showed consistently low scores throughout for both fish and invertebrates. Site 11MS101 on the main stem of Kanaranzi Creek had high flows with marginal riffle habitat, and yet was classified as high gradient. The relatively robust POET community still did not provide a supporting MIBI score, but would have had it been classified as low gradient. The remainder of the Kanaranzi Creek subwatershed showed channelized and/or impaired invertebrate and fish communities throughout, with most sites having communities dominated by intolerant taxa, and low overall diversity. High suspended sediment values throughout the subwatershed suggest unstable channel conditions susceptible to erosion during high flow conditions.

Norwegian Creek, 10170204-518, Headwaters to Kanaranzi Cr

Water chemistry

No water chemistry was assessed on this stream reach.

Biology

The stations sampled on Norwegian Creek (11MS086 and 11MS102) had some of the highest quality in-stream and riparian habitat present in the Missouri River Basin, and yet were not able to support a robust macroinvertebrate community. Monitoring at site 11MS086 was duplicated, and while one of the MIBI scores was supporting, the other was not. The high degree of channelization in the upstream portions of Norwegian Creek likely contributes to the poor water quality conditions, and the impaired invertebrate community. Fish scores followed a trend of smaller drainage areas, with good flow and moderate to good habitat allowing for a healthy fish community. Both biological stations (11MS086 and 11MS102) had FIBI scores above the threshold and are fully supporting of aquatic life use for FIBI.

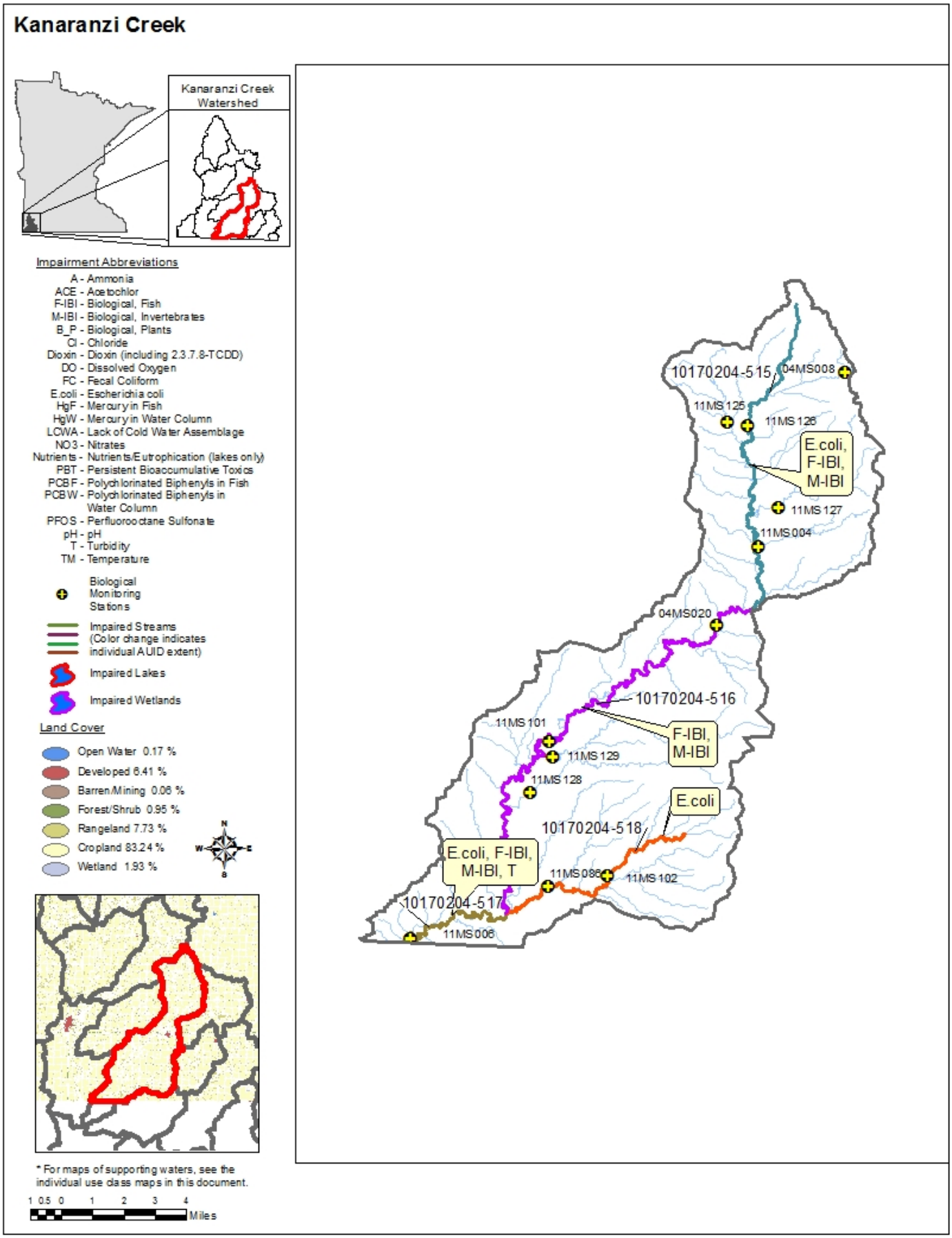

Figure 42. Currently listed impaired waters by parameter and land use characteristics in the Kanaranzi Creek Subwatershed.

East Branch Kanaranzi Creek Subwatershed HUC 1017020402-02

East Branch Kanaranzi Creek is the main stream reach and drains 56.94 miles^2 of the East Branch Kanaranzi Creek Subwatershed. East Branch Kanaranzi Creek flows 3.2 miles from the south to north, then turns west for 8 miles and drains into Kanaranzi Creek. 91.80% of the subwatershed's land is utilized for agricultural production (cropland 84.06%, rangeland 7.74%).

Table 87. Aquatic life and recreation assessments on stream reaches: East Branch Kanaranzi Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators: Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides	Bacteria	Aquatic Life	Aquatic Rec.
10170204-514, Kanaranzi Creek, East Branch, Headwaters to Kanaranzi Cr	17.15	2B, 3C	11MS109 04MS050 11MS018	Upstream of CR 13, 3 mi. N of Rushmore E of CR 15, 3 mi. ENE of Adrian Upstream of Dolan Ave, 2 mi. NE of Adrian	EXS	EXP	IF	EXP	MTS	IF	MTS		EX	NS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 88. Non-assessed biological stations on channelized AUIDs: East Branch Kanaranzi Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-514, Kanaranzi Creek, East Branch, Headwaters to Kanaranzi Cr	17.15	2B, 3C	11MS018	Upstream of Dolan Ave, 2 mi. NE of Adrian	34	21.5
10170204-541, Unnamed creek, Headwaters to E Br Kanaranzi Cr	4.91	2B, 3C	04MS034	Downstream of I-90, 2.5 miles E. of Adrian	43	17.6

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 89. Minnesota Stream Habitat Assessment (MSHA): East Branch Kanaranzi Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS109	Kanaranzi Creek, East Branch	1	6	22.3	11	33	73.3	Good
1	04MS050	Kanaranzi Creek, East Branch	0	9	18.1	8	24	59.1	Fair
1	11MS018	Kanaranzi Creek, East Branch	0	4	17.25	6	25	52.25	Fair
3	04MS034	Trib. to Kanaranzi Creek, East	0	7.3	17.4	6.7	21.	52.7	Fair
Average Habitat Results: *East Branch Kanaranzi Creek Subwatershed*			**0.3**	**6.6**	**18.8**	**7.9**	**25.8**	**59.3**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 90. Channel Condition and Stability Assessment (CCSI): East Branch Kanaranzi Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS018	Kanaranzi Creek, East Branch	37	36	22	5	100	Severely Unstable
Average Stream Stability Results: *East Branch Kanaranzi Creek Subwatershed*			**37**	**36**	**22**	**5**	**100**	**Severely Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 91. Outlet water chemistry results: East Branch Kanaranzi Subwatershed.

Station location:	**KANARANZI CK E BR AT DOLAN AVE, 2 MI NE OF ADRIAN**						
STORET/EQuIS ID:	**S004-927**						
Station #:	**11MS018**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	35	0.0013	0.029	0.011	0.04	
Chloride	mg/L	10	16.4	23.5	20.3	230	
Dissolved Oxygen (DO)	mg/L	41	4.9	13.6	8.6	5	1
pH		54	7.7	9.6	8.7	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	53	8	>100	29	>20	18
Turbidity	FNU	43	3.9	73	25	25	14
Escherichia coli (geometric mean)	MPN/100 ml	53	67	1208		126	6
Escherichia coli	MPN/100 ml	53	13	>24196	1531	1260	12
Inorganic nitrogen (nitrate and nitrite)	mg/L	52	1.6	16	9		
Kjeldahl nitrogen	mg/L	52	0.7	8.7	1.6		
Phosphorus	ug/L	52	11	748	115		
Specific Conductance	uS/cm	14	356	856	694		
Temperature, water	deg °C	55	4	25	16		
Total suspended solids	mg/L	52	<2	176	34		
Total volatile solids	mg/L	10	2	350	46		
Sulfate	mg/L	10	59	83	70		
Hardness	mg/L	8	328	441	395		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the East Branch Kanaranzi Creek Subwatershed, a component of the IWM work conducted between May and September from 2008, 2009, 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Kanaranzi Creek, 10170204-514, East Branch, Headwaters to Kanaranzi Cr

Water chemistry

Bacteria levels in East Branch Kanaranzi Creek are very high and confirm a recent impairment listing from 2010. April is the only month that doesn't exceed the standard, but there are individual exceedances throughout the dataset. The turbidity levels exceed the standard one-third of the time across the dataset. This stream is impaired for aquatic life use based on the turbidity and transparency data. The dissolved oxygen flux is very large (>9mg/L), which can cause a very stressful environment for the community of the stream. Kanaranzi Creek contains elevated amounts of phosphorus which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

The invertebrate stations in this subwatershed were all classified as high gradient, with quality in-stream invertebrate habitat present throughout. Despite this, all sites sampled scored below the impairment threshold. Site 04MS050 had a relatively healthy assemblage of POET taxa, but was dominated by few, relatively intolerant taxa. Contrastingly, FIBI scores drop from the most upstream end (11MS109) of East Branch Kanaranzi Creek to the lowest FIBI Score at (11MS018) at the most downstream end of the creek. This follows a trend of headwater streams having less accumulating detrimental effect on fish community health. The differing trends in invertebrate and fish community scores suggest that the stressors present in this subwatershed have different impacts on each assemblage. High suspended sediment and nutrient values indicate potentially unstable channel conditions and highly modified land use in the upstream subwatershed, all of which are known to be associated with unhealthy invertebrate and fish communities.

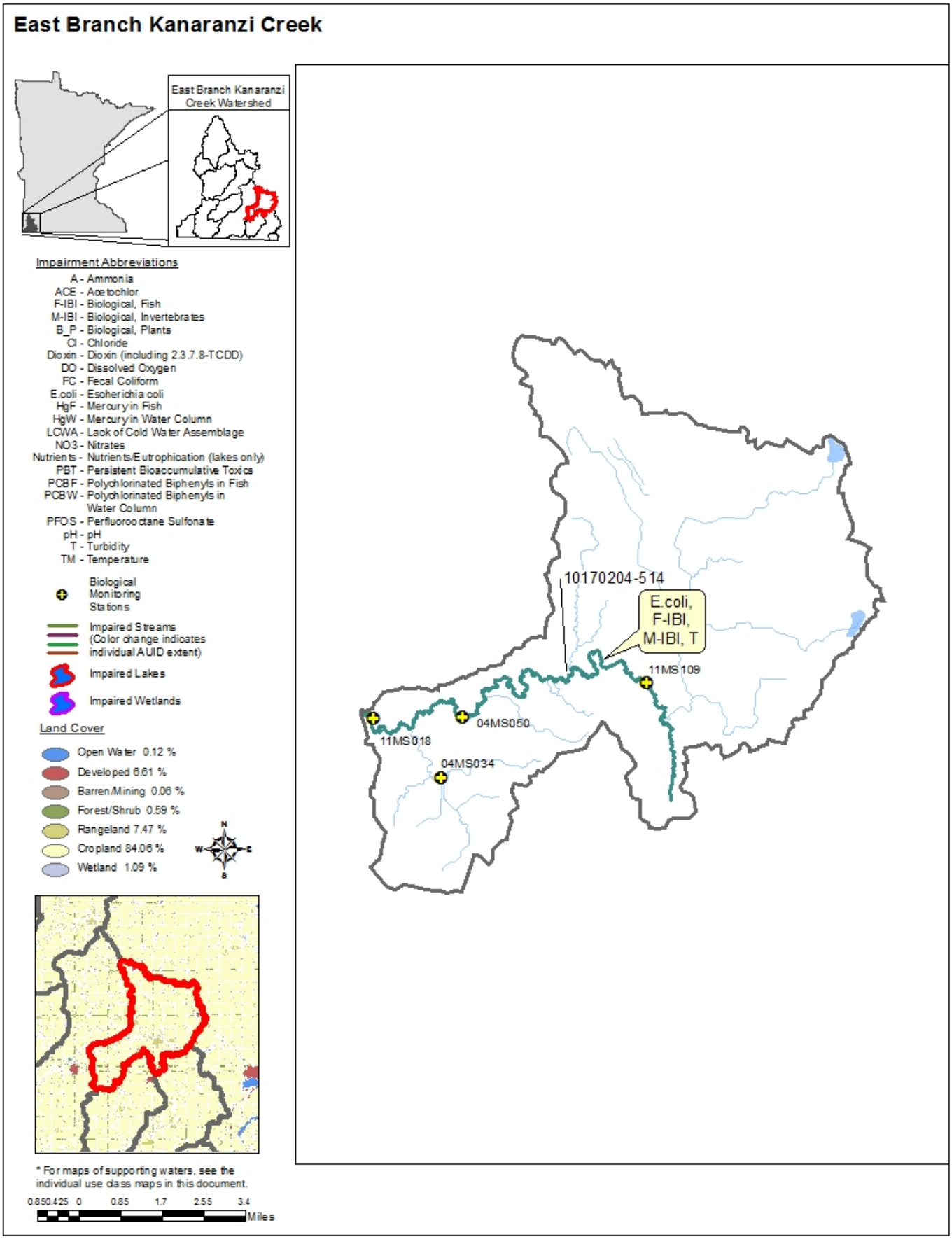

Figure 43. Currently listed impaired waters by parameter and land use characteristics in the East Branch Kanaranzi Creek Subwatershed.

Little Rock Creek Subwatershed HUC 1017020406-03

Little Rock Creek is the main stream reach in the Little Rock Creek Subwatershed and drains 42.09 miles^2 of the subwatershed. It is one out of four stream reaches in the subwatershed. Little Rock Creek is 17.4 miles long and flows from the northern part of Little Rock Creek Subwatershed. It drains into the Little Rock River which is located in the Upper Little Rock River Subwatershed. Three other unnamed streams drain into the Little Rock Creek, mainly from the east. 91.77% of the subwatershed's land is utilized for agricultural production (cropland 87.27%, rangeland 4.5%).

Table 92. Aquatic life and recreation assessments on stream reaches: Little Rock Creek Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name*,** *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:**								**Bacteria**	**Aquatic Life**	**Aquatic Rec.**
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-511, **Little Rock Creek,** Headwaters to Little Rock R	17.37	2B, 3C	11MS132 11MS009	Upstream of 280th St, 2.5 mi. SW of Rushmore Downstream of 320th St, 8 mi. NW of Bigelow	MTS	EXS	IF	EXP	IF	MTS	IF	-	EX	NS	NS
10170204-526, **Unnamed creek,** Headwaters to Little Rock R	7.12	2B, 3C	11MS104	Upstream of Erickson Ave, 3 mi. SW of Rushmore	MTS	MTS	IF	IF	-	IF	-	-	-	FS	NA
10170204-579, **Unnamed creek,** Unnamed cr to Little Rock Cr	1.67	2B, 3C	11MS105	Upstream of Erickson Ave, 8 mi. NW of Bigelow	MTS	EXP	-	-	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 93. Non-assessed biological stations on channelized AUIDs: Little Rock Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-538, Unnamed creek, Unnamed cr to Unnamed cr	2.54	2B, 3C	04MS011	Upstream of CR 34, 2.5 mi. SSE of Rushmore	46	22.5

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 94. Minnesota Stream Habitat Assessment (MSHA): Little Rock Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS132	Little Rock Creek	0	8	16.35	12	18	54.4	Fair
1	11MS009	Little Rock Creek	0	0	18.5	11	30	59.5	Fair
1	11MS104	Unnamed creek	0	8	10.7	5	15	38.7	Poor
2	04MS011	Trib. to Rock River, West Branch	0	8.8	19.1	10	22	59.9	Fair
1	11MS105	Trib. to Little Rock Creek	0	5	20.25	12	27	64.3	Fair
Average Habitat Results: *Little Rock Creek Subwatershed*			**0**	**6**	**17**	**10**	**22.4**	**55.3**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 95. Outlet water chemistry results: Little Rock Creek Subwatershed.

Station location:	**LITTLE ROCK CREEK, CROSSING OF CREEK AT 320TH STREET, APPROXIMATELY 1.5 MILES NORTH OF IOWA STATE LINE, 9.5 MILES WEST/NORTHWEST OF BIGELOW, MINNESOTA. T101N, R42W, S26**
STORET/EQuIS ID:	**S006-271**
Station #:	**11MS009**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	12	0.0009	0.0254	0.0133	0.04	
Chloride	mg/L	10	17.7	26.5	21.2	230	
Dissolved Oxygen (DO)	mg/L	12	7.1	9.2	8.2	5	
pH		16	6.5	8.8	8.2	6.5 - 9	

Secchi tube/Transparency Tube	100 cm	20	10	>100	22	>20	13
Escherichia coli (geometric mean)	MPN/100 ml	15	644	1037		126	2
Escherichia coli	MPN/100 ml	15	112	14136	2834	1260	3
Inorganic nitrogen (nitrate and nitrite)	mg/L	10	2	16	10		
Kjeldahl nitrogen	mg/L	10	0.5	2	1		
Phosphorus	ug/L	10	18	294	129		
Specific Conductance	uS/cm	20	743	889	804		
Temperature, water	deg °C	20	8.4	25	19		
Total suspended solids	mg/L	10	7	83	33		
Total volatile solids	mg/L	10	<2	383	46		
Sulfate	mg/L	10	59	87	67		
Hardness	mg/L	8	359	423	395		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Little Rock Creek Subwatershed, a component of the IWM work conducted between May and September from 2010 and 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Little Rock Creek, 10170204-511, Headwaters to Little Rock R

Water chemistry

Excessive bacteria were noted in the most recent dataset and Little Rock Creek is not supporting aquatic recreation use. The transparency data shows exceedances for most of the dataset and this stream will be listed as not supporting aquatic life due to excess turbidity.

Biology

Stations in the subwatershed differed greatly, with high flows and high gradient habitat present at site 11MS009 near the bottom of the subwatershed, and low flows at site 11MS132 which was the uppermost stream in the subwatershed. Despite having a relatively high POET diversity, site 11MS009 scored below the biocriterion, as did site 11MS132. During the fish sampling, there were good flows and fair habitat at both biological stations (11MS109 and 11MS132). Fish scores followed a trend of smaller drainage areas with good flow and moderate to good habitat allowing for a healthy fish

community. The differing flow conditions between fish and invertebrate samples are a reflection of different index periods, and this can occasionally be reflected in the associated IBI scores. When streams appear to have an unnatural or uncharacteristic flow pattern, an attempt is made to discern the "normal" condition, and data will only be assessed if it is determined that a characteristic sample was collected.

Unnamed creek, 10170204-526, Headwaters to Little Rock R

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Site 11MS104, Unnamed Creek, was one of the few stations in the entire Missouri River Basin to have supporting IBI scores for both fish and macroinvertebrates. Flows were low, but relatively stable, which likely contributed to the higher scores. This station is one of three in the entire Missouri River Basin totally supporting aquatic life. Despite the supporting biological score, poor habitat scores suggest that there is room for restoration.

Unnamed creek, 10170204-579, Unnamed cr to Little Rock Cr

Water chemistry

No water chemistry data was assessed on this section of stream.

Biology

Macroinvertebrate IBI scores showed a highly impaired condition, with low diversity and dominance by few taxa, accompanied by high suspended sediment -all indicators of streams in highly modified, agricultural drainages. Better fish scores followed a trend of smaller drainage areas, with good flow and moderate to good habitat allowing for a healthy fish community.

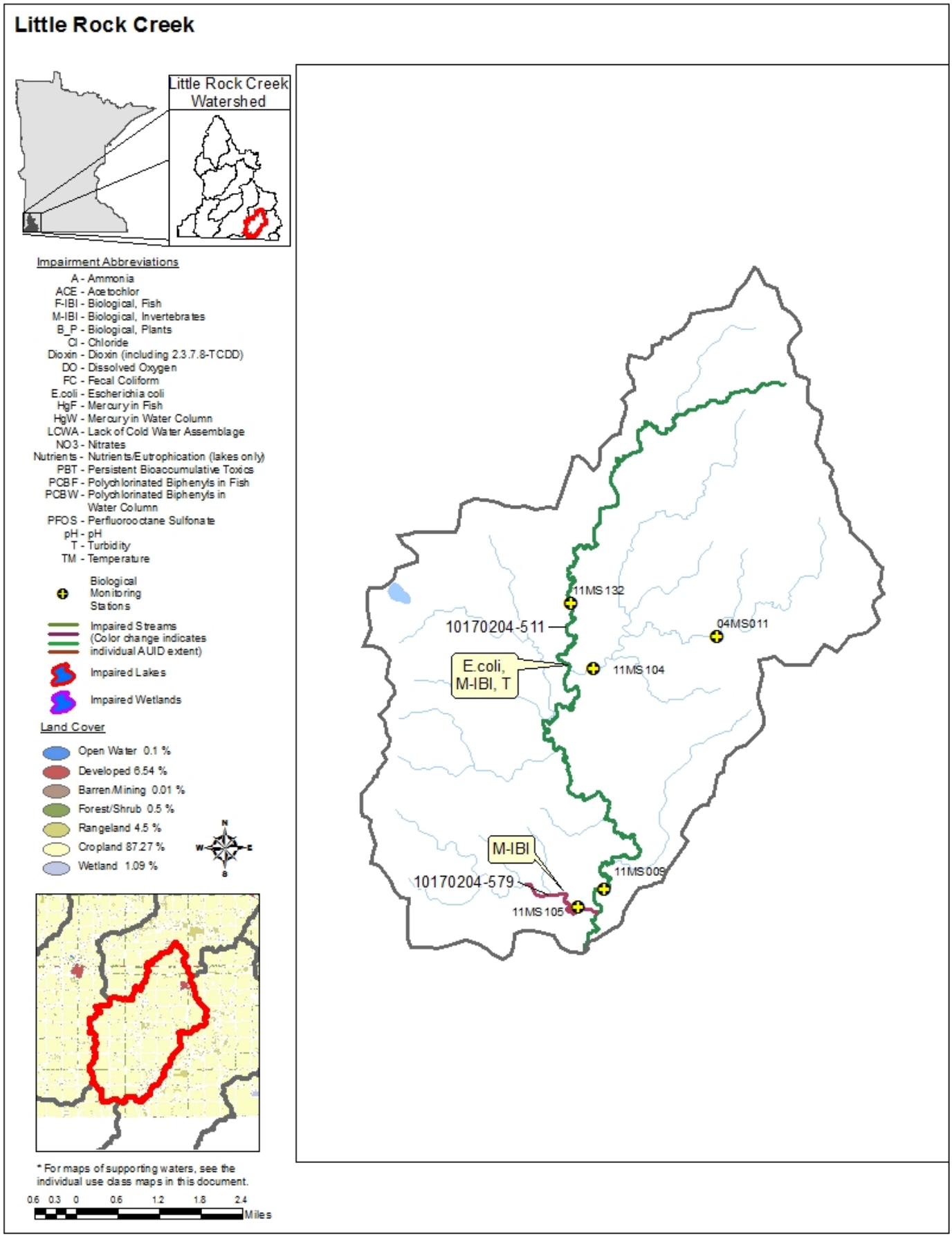

Figure 44. Currently listed impaired waters by parameter and land use characteristics in the Little Rock Creek Subwatershed.

Tom Creek Subwatershed HUC 1017020407-02

The Tom Creek Subwatershed Unit drains 9.44 miles^{2}of Nobles County. This subwatershed is not a true complete watershed as a majority of the subwatershed is in Iowa. There are no biological or water chemistry stations due to its small size. 92.70% of the subwatershed's land is utilized for agricultural production (cropland 87.22%, rangeland 5.48%).

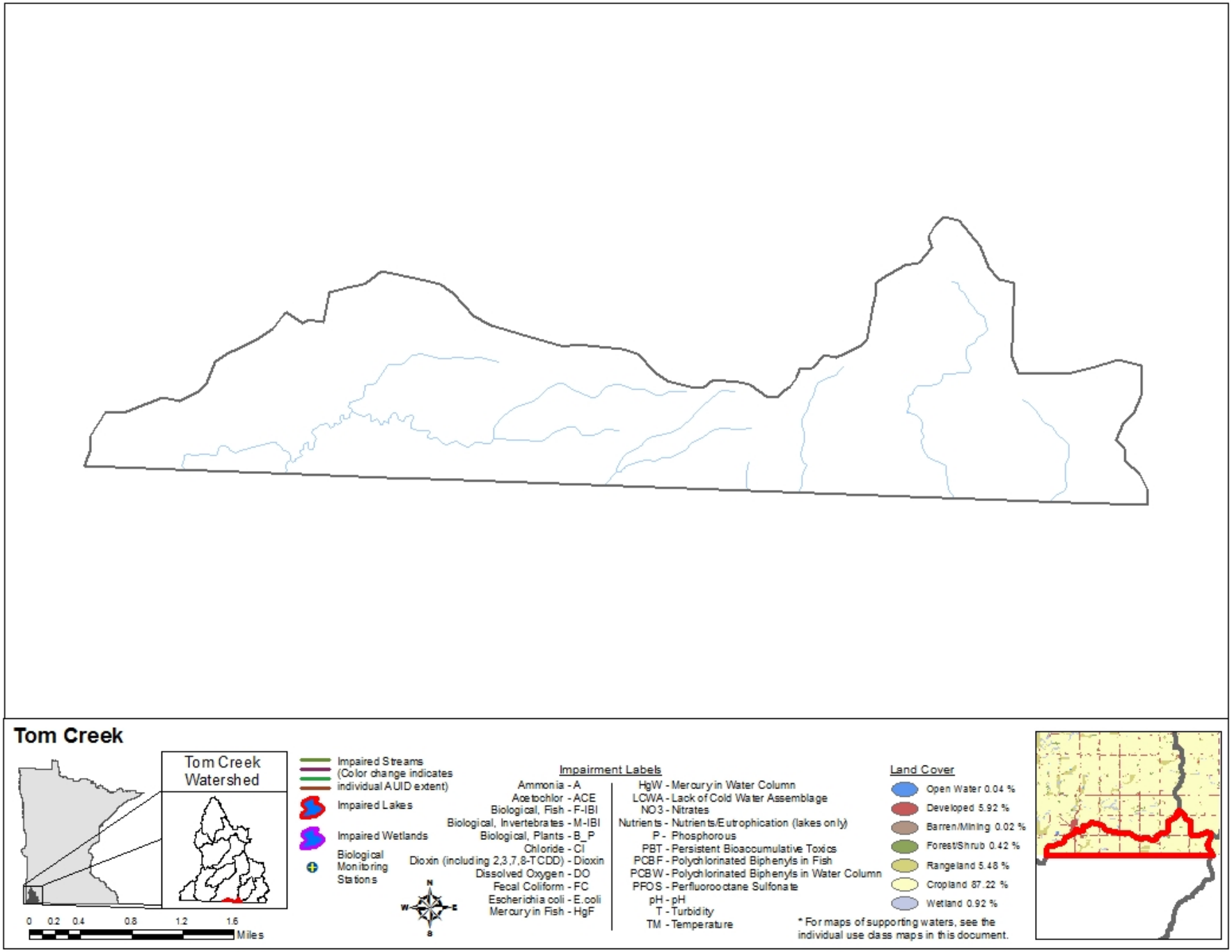

Figure 45. Currently listed impaired waters by parameter and land use characteristics in the Tom Creek Subwatershed.

Upper Little Rock River Subwatershed HUC 1017020406-02

Little Rock River is the main stream reach in the Upper Little Rock River Subwatershed and drains 57.4 miles^2 of Nobles County. This subwatershed is not a true complete watershed, as part of the subwatershed is in Iowa. The Little Rock River travels 23.7 miles from the northern part of the subwatershed to where Little Rock Creek enters the stream from the east. The remaining river runs 2.2 miles draining into Iowa. 92.14% of the subwatershed's land is utilized for agricultural production (cropland 85.44%, rangeland 6.70%).

Table 96. Aquatic life and recreation assessments on stream reaches: Upper Little Rock River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10170204-512, **Little Rock River,** Headwaters to Little Rock Cr	23.67	2C, 3C	11MS110 04MS053 11MS047	Upstream of 270th St, 2.5 mi. SE of Rushmore CR 61 & 280th St., 7 mi. WSW of Worthington Upstream of Fellows Ave, 6.5 mi. W of Biglow	EXS	EXP	IF	EXS	IF	MTS	IF		EX	NS	NS
10170204-513, **Little Rock River,** Little Rock Cr to MN/IA border	2.22	2C, 3C	11MS002	Upstream of CR 58, 7 mi. W of Bigelow	EXP	EXP	IF	EXS	IF	MTS	MTS		EX	NS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 97. Non-assessed biological stations on channelized AUIDs: Upper Little Rock River Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-512, Little Rock River, Headwaters to Little Rock Cr	23.67	2C, 3C	11MS110	Upstream of 270th St, 2.5 mi. SE of Rushmore	52	24
10170204-577, Unnamed creek, Unnamed cr to Unnamed cr	1.74	2B, 3C	11MS115	Downstream of CR 54 (330th St), 6 mi. W of Bigelow	53	38.1
10170204-580, Judicial Ditch 1, Unnamed cr to Unnamed cr	3.75	2B, 3C	11MS111	Downstream of Lais Ave, 3 mi. SW of Rushmore	11	12.9

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 98. Minnesota Stream Habitat Assessment (MSHA): Upper Little Rock River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS110	Little Rock River	0	4	19.85	7	20	50.85	Fair
1	04MS053	Little Rock River	0	8	20.2	7	18	53.2	Fair
1	11MS047	Little Rock River	0	5.5	13.7	6	20	45.2	Fair
1	11MS002	Little Rock River	0	0	13.55	5	11	29.55	Poor
1	11MS115	Unnamed creek	0	8.5	16	7	16	47.5	Fair
1	11MS111	Trib. to Little Rock River	0	8	9	12	4	33	Poor
Average Habitat Results: *Upper Little Rock River Subwatershed*			**0**	**5.7**	**15.4**	**7.3**	**14.8**	**43.2**	**Poor**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 99. Channel Condition and Stability Assessment (CCSI): Upper Little Rock River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS047	Little Rock River	28	24	21	7	80	Severely Unstable
1	11MS002	Little Rock River	24	25	28	9	86	Severely Unstable
1	11MS115	Unnamed creek	16	27	30	7	80	Severely Unstable
Average Stream Stability Results: *Upper Little Rock River Subwatershed*			**22.7**	**25.3**	**26.3**	**7.7**	**82**	**Severely Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 100. Outlet water chemistry results: Upper Little Rock River Subwatershed.

Station location:	**LITTLE ROCK RIVER ON 340TH ST, 8 1/2 MI S OF RUSHMORE**
STORET/EQuIS ID:	**S004-928**
Station #:	**11MS002**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	36	0.0017	0.0375	0.0119	0.04	
Chloride	mg/L	5	16.9	23.4	19.9	230	
Dissolved Oxygen (DO)	mg/L	51	6.5	12.2	9.1	5	
pH		55	7.6	9.2	8.3	6.5 - 9	2
Secchi tube/Transparency Tube	100 cm	54	2	>100	23	>20	29
Turbidity	FNU	36	6	560	88	25	
Escherichia coli (geometric mean)	MPN/100 ml	55	90	1433		126	5
Escherichia coli	MPN/100 ml	55	4.1	>24196	1934	1260	24
Inorganic nitrogen (nitrate and nitrite)	mg/L	42	<0.2	15	9.1		
Kjeldahl nitrogen	mg/L	42	0.7	5.6	1.9		
Phosphorus	ug/L	42	30	1280	264		
Specific Conductance	uS/cm	36	324	905	670		
Temperature, water	deg °C	56	3	25	16		

Total suspended solids	mg/L	42	8	867	127		
Total volatile solids	mg/L	42	2	150	21		
Sulfate	mg/L	5	53	62	57		
Hardness	mg/L	4	334	409	383		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Little Rock River Subwatershed, a component of the IWM work conducted between May and September from 2008, 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Little Rock River, 10170204-512, Headwaters to Little Rock Cr, **Little Rock River, 10170204-513,** Little Rock Cr to MN/IA border

Water chemistry

The Little Rock River (10170204-513) has two previous impairment listings due to bacteria (2010) and turbidity (2008). The current data confirms both listings and this stream reach will remain listed for impairment of aquatic life and aquatic recreation. Little Rock River (10170204-512) data shows excess bacteria throughout the summer months and in 2010 a high value of 8,664 MPN/100ml was taken, which is far above the individual standard of 1,260 MPN/100ml. This stretch of the Little Rock River is impaired for aquatic recreation use. The water in this stream is very turbid and exceeds the standard over half of the time, resulting in this stream being impaired for aquatic life use as well. The Little Rock River contains elevated amounts of phosphorus which varies from month to month, but these high levels of phosphorus can produce rapid rates of plant growth. This could create unsightly and potentially toxic conditions.

Biology

The three uppermost Little Rock River invertebrate stations (11MS047, 04MS053, and 11MS110) were classified as high gradient, with high flows and riffle habitat present throughout. All three sites had relatively similar invertebrate communities, but differed slightly in the relative abundance of tolerant taxa. Site 11MS110 was channelized and not assessed, site 04MS053 scored just above the impairment threshold, and 11MS047 scored just below. Site 11MS002, the lowermost reach in the subwatershed, was classified as low gradient and did not meet the MIBI biocriterion. All sites sampled in this subwatershed had relatively unstable stream channels and corresponding higher levels of suspended sediment, which often corresponds to poor invertebrate community health. For being a small drainage area for these stream segments, the FIBI scores were very far below the impairment threshold, possibly due to excessively high turbidity and poor habitat.

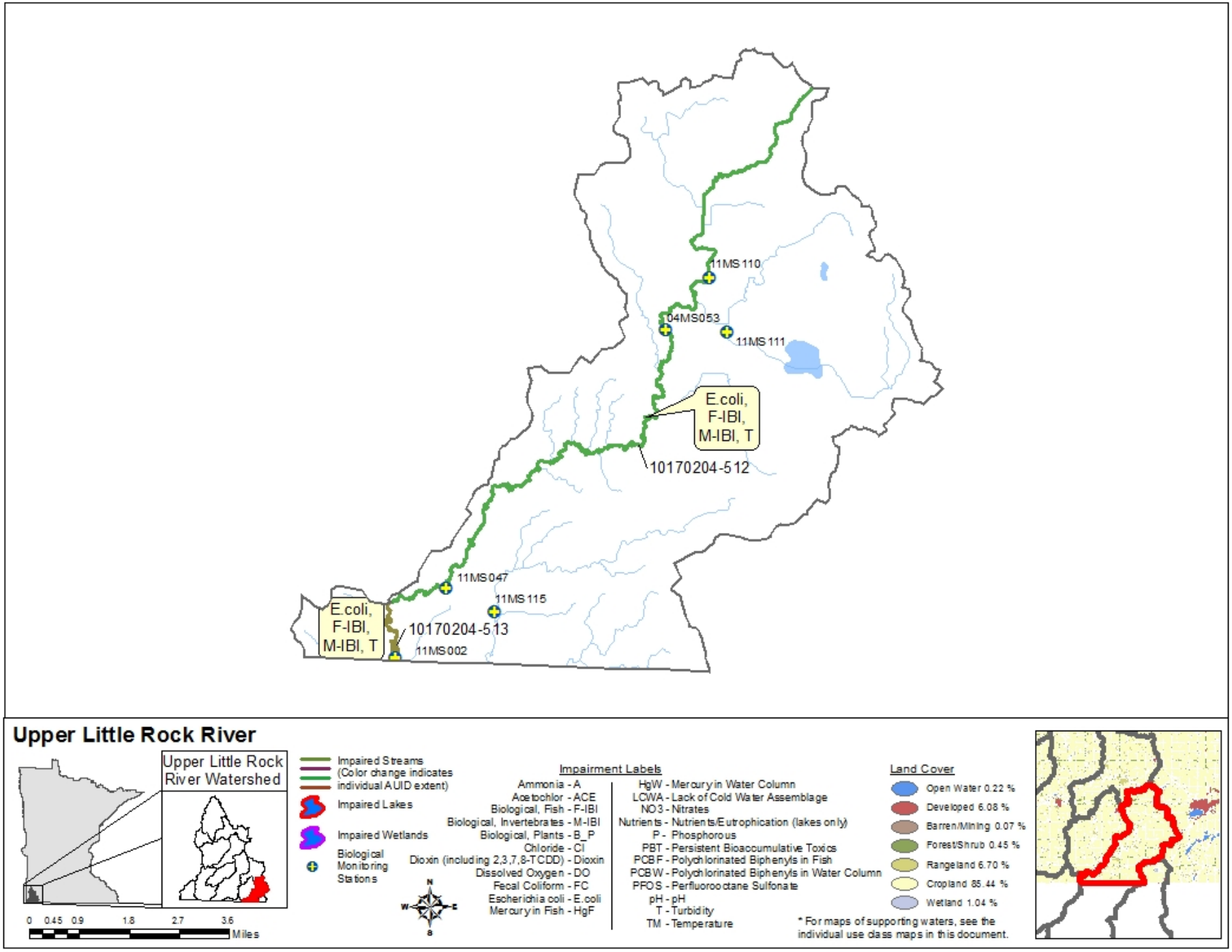

Figure 46. Currently listed impaired waters by parameter and land use characteristics in the Upper Little Rock River Subwatershed.

Upper Otter Creek Subwatershed HUC 1017020405-02

The Upper Otter Creek Subwatershed Unit drains 7.64 miles^2 of Nobles County. This subwatershed is not a true complete watershed as a majority of the subwatershed is in Iowa. 90.57% of the subwatershed's land is utilized for agricultural production (cropland 87.34%, rangeland 3.23%).

Table 101. Non-assessed biological stations on channelized AUIDs: Upper Otter Creek Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10170204-510, Otter Creek, Headwaters to MN/IA border	4.08	2B, 3C	11MS087	Upstream of CR 2, 1 mi. W of Bigelow	30	19

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 102. Minnesota Stream Habitat Assessment (MSHA): Upper Otter Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS087	Otter Creek	0	7	12	2	9	30	Poor
Average Habitat Results: *Upper Otter Creek Subwatershed*			**0**	**7**	**12**	**2**	**9**	**30**	**Poor**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Summary

Water chemistry

No water chemistry was assessed on this stream reach.

Biology

The lone biological station in the Otter Creek subwatershed (11MS087) was channelized and not assessed. It scored well below the MIBI and FIBI biocriteria. High nutrient levels appear to be causing abundant algal growth.

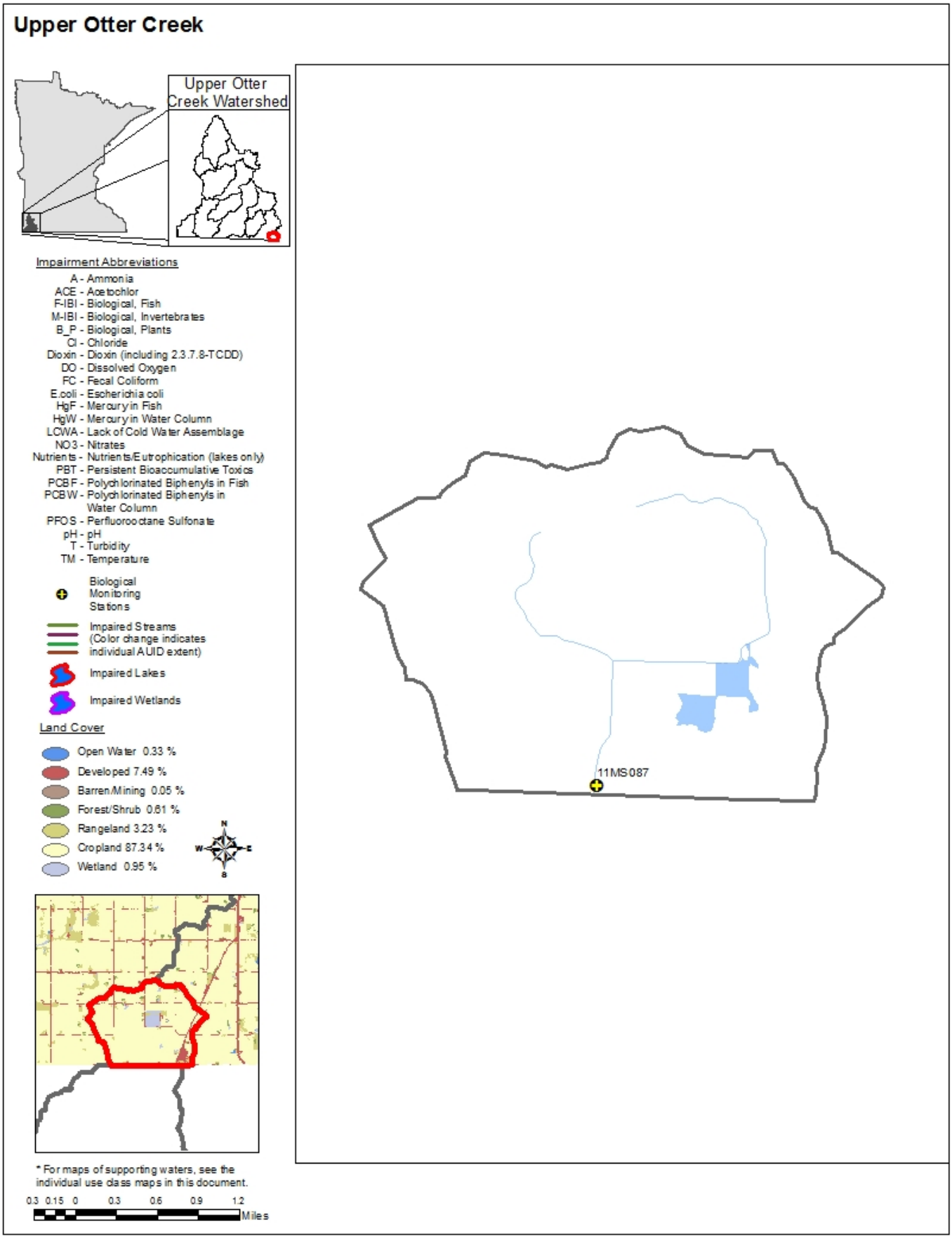

Figure 47. Currently listed impaired waters by parameter and land use characteristics in the Upper Otter Creek Subwatershed.

Little Sioux River Watershed HUC 10230003

Upper Ocheyedan River Subwatershed HUC 1023000305-02

The Upper Ocheyedan River Subwatershed flows through part of the city of Worthington. This subwatershed is not a true complete watershed as a part of the subwatershed is in Iowa. It begins northwest of the town and extends south and west across Worthington to Iowa draining 72.69 miles^2 of Nobles County. Judicial Ditch 6 (Lake Okabena Outflow) is a small stream that starts in Worthington at Okabena and flows south into Ocheda (Middle Bay). The Ocheyedan River flows from Ocheda (West Basin) 5.5 miles south into Lake Bella, then into Iowa. There are 10 lakes in the subwatershed, three (Lake Okabena, Lake Ocheda (West Basin) and Lake Bella) of which have data for assessments. Lake Okabena is located in the town of Worthington. Lake Ocheda (West Basin) is located in the middle of the subwatershed, and Lake Bella is a long lake stretching north and south along the border of Minnesota and Iowa. 86.48% of the subwatershed's land is utilized for agricultural production (cropland 80.33%, rangeland 6.15%).

Table 103. Aquatic life and recreation assessments on stream reaches: Upper Ocheyedan River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID *Reach Name*, *Reach Description*	**Reach Length (miles)**	**Use Class**	**Biological Station ID**	**Location of Biological Station**	**Aquatic Life Indicators:**								**Bacteria**	**Aquatic Life**	**Aquatic Rec.**
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10230003-501, Ocheyedan River, Ocheda Lk to MN/IA border	5.53	2B, 3C	11MS022	Upstream of 320th Ave, 3 mi. NW of Bigelow	EXS	EXP	IF	IF	MTS	MTS	-	-	MTS	NS	FS
10230003-502, Judicial Ditch 6 (Lake Okabena Outflow), Okabena Lk to Ocheda Lk	2.38	2B, 3C	11MS063	Upstream of Quine Ave, 1 mi. S of Worthington	*NA	*NA	-	EXS	-	-	-	-	-	NS	NA

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 104. Non-assessed biological stations on channelized AUIDs: Upper Ocheyedan River Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10230003-502, Judicial Ditch 6 (Lake Okabena Outflow), Okabena Lk to Ocheda Lk	2.38	2B, 3C	11MS063	Upstream of Quine Ave, 1 mi. S of Worthington	48	19.3
10230003-520, Okabena Creek, Unnamed cr to Whisky Ditch	2.15	2C	11MS075	Downstream of Industrial Ln, in Worthington	58	26.5
10230003-522, Unnamed creek, Unnamed cr to Okabena Lk	0.38	2B, 3C	04MS025	Just upstream of inlet to Okabena Lake, above Olson Park, 1 mi. SE of Worthington	64	23.5
10230003-541, Unnamed creek, Headwaters to Ocheda Lk	3.05	2B, 3C	11MS076	Downstream of Palm Ave, 3 mi. S of Worthington	44	51.86

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 105. Minnesota Stream Habitat Assessment (MSHA): Upper Ocheyedan River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS022	Ocheyedan River	5	6.5	19.7	7	11	49.2	Fair
1	11MS063	Judicial Ditch 6	0	7.5	14.4	6	16	43.9	Poor
1	11MS075	Okabena Creek	1	10.5	11	8	17	47.5	Fair
1	04MS025	Trib. to Okabena Lake	0	10	12.95	11	19	53	Fair
1	11MS076	Trib. to Ocheda Lake	0	6	8.65	13	24	51.7	Fair
1	04MS003	Trib. to Rock River	0	10	8	8	6	32	Poor
Average Habitat Results: *Upper Ocheyedan River Subwatershed*			**1**	**8.42**	**12.45**	**8.83**	**15.5**	**46.22**	**Fair**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 106. Channel Condition and Stability Assessment (CCSI): Upper Ocheyedan River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS022	Ocheyedan River	17	12	11	3	43	Fairly Stable
1	11MS076	Trib. to Ocheda Lake	34	27	16	11	88	Severely Unstable
Average Stream Stability Results: *Upper Ocheyedan River Subwatershed*			**25.5**	**19.5**	**13.5**	**7**	**65.5**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 107. Outlet water chemistry results: Upper Ocheyedan River Subwatershed.

Station location:	**OCHEYEDAN R AT CO. RD 4 (320TH ST), 6.5 MI S WORTHINGTON**
STORET/EQuIS ID:	**S002-862**
Station #:	**11MS022**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	7	0.0006	0.0212	0.0126	0.04	
Chloride	mg/L	9	15.5	20.7	18.1	230	
Dissolved Oxygen (DO)	mg/L	2	5.1	6.2	5.7	5	
pH		9	6.9	8.95	8.3	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	9	7	>100	29.7	>20	
Escherichia coli	MPN/100 ml	5	40	411	143	1260	
Inorganic nitrogen (nitrate and nitrite)	mg/L	9	<0.2	6.9	1.4		
Kjeldahl nitrogen	mg/L	9	1.4	4.1	2.6		
Phosphorus	ug/L	9	34	438	235		
Specific Conductance	uS/cm	9	451	655	518		
Temperature, water	deg °C	9	13	26	21		
Total suspended solids	mg/L	9	8	222	62.9		
Total volatile solids	mg/L	9	6	280	50.7		
Sulfate	mg/L	9	54	83	66		
Hardness	mg/L	7	214	333	244		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Ocheyedan River Subwatershed, a component of the IWM work conducted between May and September from 2011. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 108. Lake assessments: Upper Ocheyedan River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Avg. Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (m)	AQR Support Status	AQL Support Status
Okabena	53-0028-00	759	H	100	5.18	1	I	119	31	0.6	NS	
Ocheda (West Basin)	53-0024-01	464	H		1.5	1		236	133	0.2	NS	
Bella	53-0045-00	164	H	100	4.27	1		176	111	0.4	NS	

Abbreviations: D -- Decreasing/Declining Trend; I -- Increasing/Improving Trends; NT – No Trend; **H** – Hypereutrophic; **E** – Eutrophic; **M** – Mesotrophic; **FS** – Full Support; **NS** – Non-Support; **IF** – Insufficient Information

Summary

Lakes

Lake Okabena is located with the town of Worthington. Okabena receives over 14,000 acres of agricultural drainage and has a watershed to lake ratio of 19 to 1. Nearly all of the shoreline is developed and there are miles of riprap on the shoreline to stop erosion. Lake Okabena was listed as impaired for aquatic recreation use (excess nutrients) in 2010. Recent data confirms the existing impairment. The lake is shallow and relatively unprotected. Wind mixing on shallow lakes can lead to resuspension of sediment; under high temperatures, this can add phosphorus to the water column (internal loading). The lake is used recreationally, including an annual national windsurfing competition. Current water quality indicates that severe algal bloom conditions are prevalent much of the summer months and will impact recreational use.

Lake Ocheda (West Basin) exceeds all the of the lake standards for TP, chl-A and Secchi transparency. The poor lake quality was evaluated in 2010 for restoration potential. There is now an aeration system in place to bring the dissolved oxygen level up during the winter and prevent winter kill. The area is heavily dominated by agriculture and is a concern moving forward for how to improve the water quality.

Lake Bella is a reservoir located in Nobles County on the Minnesota Iowa boarder. Lake Bella is surrounded by grassland and herbaceous areas but the drainage area of 38,678 acres, which is a 236 to 1 ratio, is very large. These areas allow a good buffer to the heavily dominated agricultural subwatershed, but are not enough to keep the water quality of Lake Bella in a healthy condition. The large watershed, combined with the shallow,

windswept nature of the lake, will likely result in internal loading as phosphorus is resuspended in the water column. Severe algae blooms will occur throughout the summer months impeding recreational use of the basin.

10230003-501, Ocheyedan River, Ocheda Lk to MN/IA border

Water chemistry

The water in this stream is very turbid and exceeds the standard over half of the time, resulting in this stream being listed as impaired for aquatic life use. The Ocheyedan River flows from Lake Ocheda through Peterson Slough and Lake Bella, which could help contain the bacteria and result in the low levels that are being recorded. Based on the data the Ocheyedan River is fully supporting the aquatic recreation standard.

Biology

The only biological station assessable for aquatic life in this subwatershed (11MS022) had an MIBI and FIBI score well below the biocriteria. Low habitat diversity and poor channel conditions likely contributed to the low diversity and uneven dominance of tolerant taxa.

Judicial Ditch 6 (Lake Okabena Outflow), 10230003-502, Okabena Lk to Ocheda Lk

Water chemistry

Judicial Ditch 6 (Lake Okabena Outflow) has a previous impairment listing due to turbidity and the current data supports that impairment. The bacteria levels are very low in this stream reach, even though based on the land use the values would be expected to be the opposite.

Biology

All sites sampled were channelized and deferred for assessment of aquatic life.

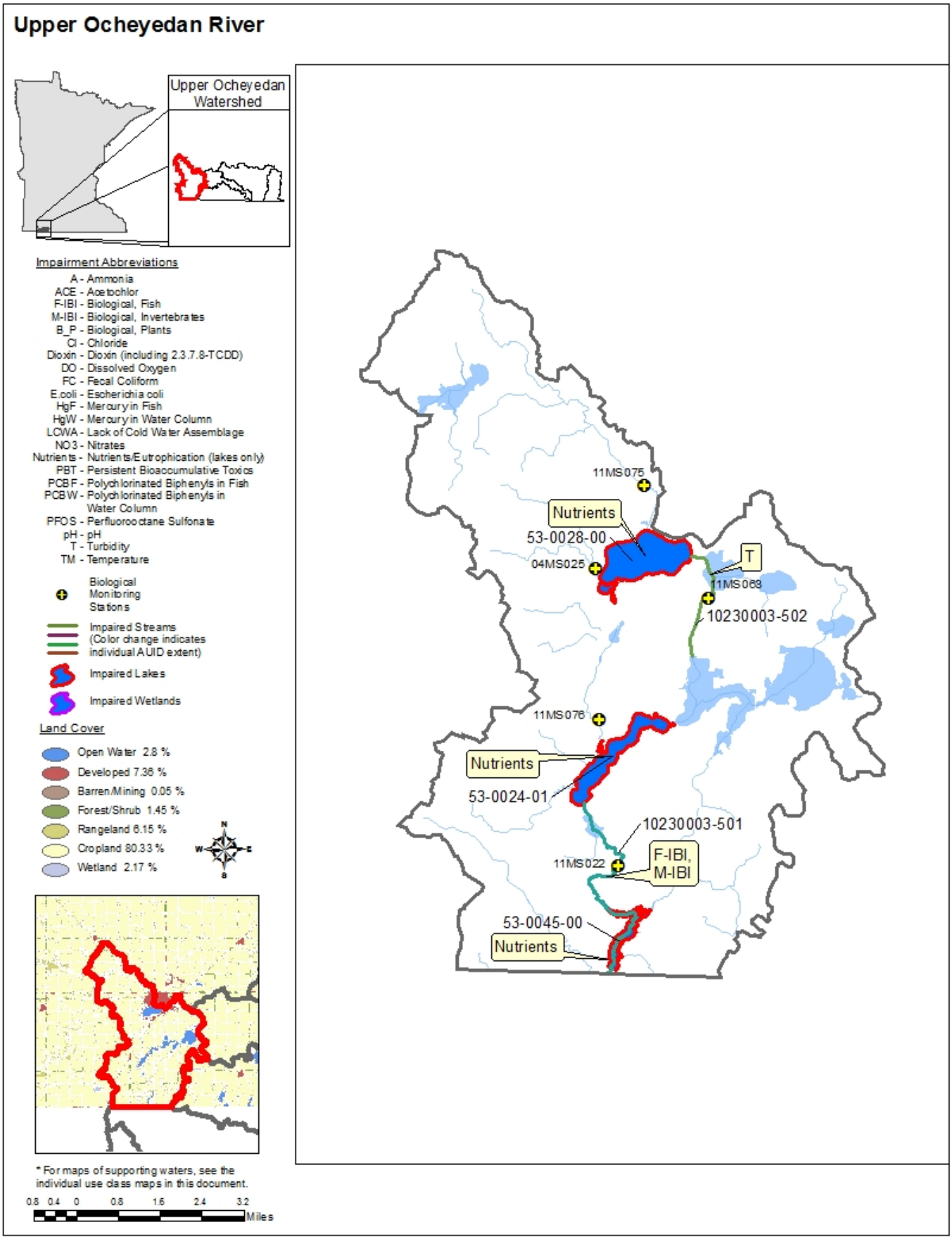

Figure 48. Currently listed impaired waters by parameter and land use characteristics in the Upper Ocheyedan River Subwatershed.

Judicial Ditch 13 (Skunk Creek) Subwatershed HUC 1023000301-02

There are two stream reaches in the Judicial Ditch 13 (Skunk Creek) Subwatershed that drain 45.25 miles^2 of Nobles and Jackson counties. Judicial Ditch 13, otherwise known as Skunk Creek, stretches 21 miles and is the major stream reach, which flows southeast from just west of Worthington to the West Fork Little Sioux River near Sioux Valley. There are three lakes in this subwatershed, but none of them have sufficient data for aquatic recreation use assessment. 91.77% of the subwatershed's land is utilized for agricultural production (cropland 90.09%, rangeland 1.68%).

Table 109. Aquatic life and recreation assessments on stream reaches: Judicial Ditch 13 (Skunk Creek) Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10230003-511, **Judicial Ditch 13 (Skunk Creek),** Headwaters to W Fk Little Sioux R	20.87	2C	11MS079 04MS018 11MS066	Downstream of 770th St, 8 mi. E of Worthington ~1.2 mi. NE of Sioux Valley, Sioux Valley Township Downstream of 400th Ave, 10.5 mi. E of Round Lake	*NA	*NA	IF	EXS	-	MTS	-	-	EX	NS	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 110. Non-assessed biological stations on channelized AUIDs: Judicial Ditch 13 (Skunk Creek) Subwatershed.

AUID ***Reach Name***, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10230003-511, **Judicial Ditch 13 (Skunk Creek),** Headwaters to W Fk Little Sioux R	20.87	2C	11MS079	Downstream of 770th St, 8 mi. E of Worthington	28	22.1
10230003-511, **Judicial Ditch 13 (Skunk Creek),** Headwaters to W Fk Little Sioux R	20.87	2C	04MS018	~1.2 mi. NE of Sioux Valley, Sioux Valley Township	19	34.9

10230003-511, Judicial Ditch 13 (Skunk Creek), Headwaters to W Fk Little Sioux R	20.87	2C	11MS066	Downstream of 400th Ave, 10.5 mi. E of Round Lake	20	35.1
10230003-540, Judicial Ditch 9, Unnamed cr to JD 13	3.38	2B, 3C	11MS023	Upstream of CR 264, 2 mi. N of Round Lake	3	21.7

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 111. Minnesota Stream Habitat Assessment (MSHA): Judicial Ditch 13 (Skunk Creek) Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS079	Judicial Ditch 13	0	0	4	0	1	5	Poor
1	04MS018	Skunk Creek (Judicial Ditch 13)	0	9	16	8	4	37	Poor
1	11MS066	Judicial Ditch 13	0	7.5	13.5	6	14	41	Poor
1	11MS023	Trib. to Judicial Ditch 13 (Skunk Creek)	0	7	4	12	1	24	Poor
Average Habitat Results: *Judicial Ditch 13 (Skunk Creek) [HUC Name] Subwatershed*			**0**	**5.9**	**9.4**	**6.5**	**5**	**26.8**	**Poor**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 112. Channel Condition and Stability Assessment (CCSI): Judicial Ditch 13 (Skunk Creek) Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS066	Judicial Ditch 13	17	15	22	5	59	Moderately Unstable
Average Stream Stability Results: *Judicial Ditch 13 (Skunk Creek) Subwatershed*			**17**	**15**	**22**	**5**	**59**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Summary

Judicial Ditch 13 (Skunk Creek), 10230003-511, Headwaters to W Fk Little Sioux R

Water chemistry

Skunk Creek has existing impairments for aquatic life use (due to turbidity) and aquatic recreation use (due to bacteria) from the 2010 list. Bacteria levels were very high and the turbidity values exceed the standard over one-third of the time in the most recent dataset, sothe current data show that these impairments still exist.

Biology

All biological sites sampled in the Judicial Ditch 13 subwatershed were channelized and deferred for assessment of aquatic life. All sites were in poor condition.

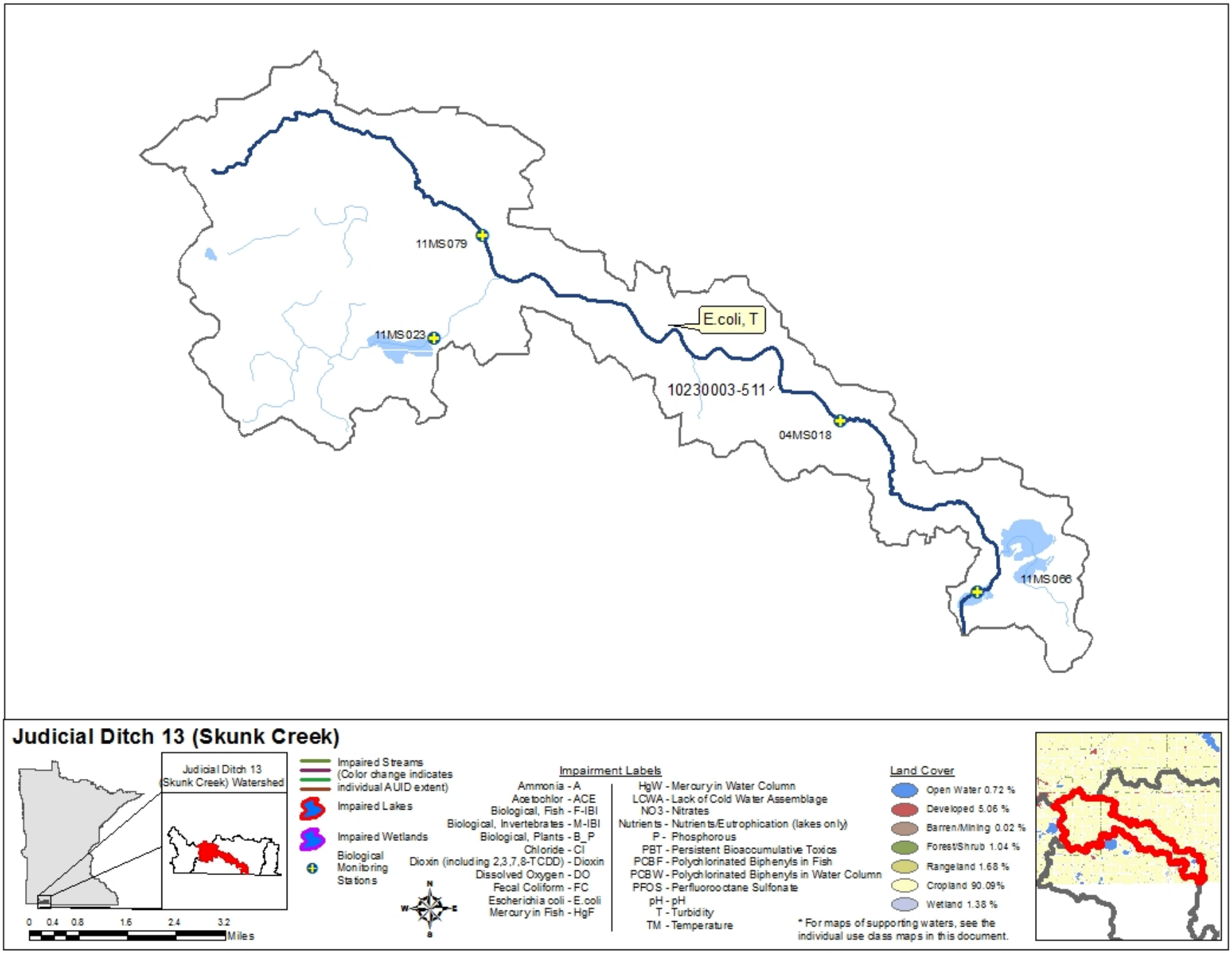

Figure 49. Currently listed impaired waters by parameter and land use characteristics in the Judicial Ditch 13 (Skunk Creek) Subwatershed.

West Fork Little Sioux River Subwatershed HUC 1023000301-01

The West Fork Little Sioux River Subwatershed is located near Round Lake. This subwatershed is not a true complete watershed as a part of the subwatershed is in Iowa. There are four stream reaches in this subwatershed that drain 56.96 miles^2. The Little Sioux River, West Fork is the major stream reach of the West Fork Little Sioux River Subwatershed, and eventually flows into Iowa. Judicial Ditch 24 flows into the Little Sioux River and Judicial Ditch 13 (Skunk Creek) exits from the Judicial Ditch No 13 Subwatershed into the Little Sioux River, West Fork. Round Lake is the largest (1,014) of 10 lakes in the West Fork Little Sioux River Subwatershed. Iowa Lake and Indian Lake are two other significant lakes which run north and south near the Minnesota-Iowa border in the town of Round Lake. 87.18% of the subwatershed's land is utilized for agricultural production (cropland 82.52%, rangeland 4.66%).

Table 113. Aquatic life and recreation assessments on stream reaches: West Fork Little Sioux River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10230003-508, **Little Sioux River, West Fork,** JD 24 to JD 13	6.32	2C, 3C	11MS062	Upstream of 710th St, 10 mi. E of Round Lake	*NA	*NA	IF	EXS	-	MTS	-	-	EX	*IF	NS
10230003-509, **Little Sioux River, West Fork,** JD 13 to MN/IA border	0.65	2C, 3C	11MS008	Upstream of CR 62, 10 mi. E of Round Lake	EXS	EXS	IF	EXS	IF	MTS	-	-	EX	*IF	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 114. Non-assessed biological stations on channelized AUIDs: West Fork Little Sioux River Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10230003-507, **Little Sioux River,** West Fork, Round Lk to JD 24	6.75	2C, 3C	11MS073	Downstream of CR 5, 5 mi. E of Round Lake	46	10.7
10230003-508, **Little Sioux River, West Fork,** JD 24 to JD 13	6.32	2C, 3C	11MS062	Upstream of 710th St, 10 mi. E of Round Lake	47	24.8
10230003-510, **Judicial Ditch 24,** Headwaters to W Fk Little Sioux R	6.19	2B, 3C	11MS065	Upstream of CR 24, 5 mi. SE of Round Lake	38	37.6

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 115. Minnesota Stream Habitat Assessment (MSHA): West Fork Little Sioux River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS073	Little Sioux River, West	0	7.5	15.9	11	20	54.4	fair
1	11MS062	Little Sioux River, West	0	7	19	7	3	36	Poor
1	11MS008	Little Sioux River, West	0	5.5	19.8	11	25	61.3	Fair
1	11MS065	Judicial Ditch 24	0	4.5	7.75	5	4	21.25	Poor
Average Habitat Results: *West Fork Little Sioux River Subwatershed*			**0**	**6.1**	**15.6**	**8.5**	**13**	**43.2**	**Poor**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 116. Channel Condition and Stability Assessment (CCSI): West Fork Little Sioux River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS073	Little Sioux River, West Fork	33	19	10	3	65	Moderately Unstable
Average Stream Stability Results: *West Fork Little Sioux River Subwatershed*			**33**	**19**	**10**	**3**	**65**	**Moderately Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 117. Outlet water chemistry results: West Fork Little Sioux River Subwatershed.

Station location:	**LITTLE SIOUX R-W FK 12 MI S OF LAKEFIELD**						
STORET/EQuIS ID:	**S000-100**						
Station #:	**11MS008**						
Parameter	**Units**	**# of Samples**	**Minimum**	**Maximum**	**Mean**	**WQ Standard[1]**	**# of WQ Exceedances[2]**
Ammonia-nitrogen	mg/L	26	0.0018	0.0313	0.0081	0.04	
Chloride	mg/L	8	8.2	18.3	13.8	230	
Dissolved Oxygen (DO)	mg/L	34	3.3	11.5	7.3	5	3
pH		35	7.4	9	8	6.5 - 9	1
Secchi tube/Transparency Tube	100 cm	71	6	60	21	>20	37
Turbidity	FNU	57	5	100	33	25	29
Escherichia coli	MPN/100 ml	38	5	3448	489	1260	3
Chlorophyll-a, Corrected	ug/L						
Inorganic nitrogen (nitrate and nitrite)	mg/L	28	0.3	11.4	6.5		
Kjeldahl nitrogen	mg/L	65	0.4	2.9	1.7		
Phosphorus	ug/L	65	67	478	199		
Specific Conductance	uS/cm	34	413	773	636		
Temperature, water	deg °C	35	10	26	19		
Total suspended solids	mg/L	28	15	111	60		
Total volatile solids	mg/L	28	5	26	13		
Sulfate	mg/L	8	48	106	81		
Hardness	mg/L	8	184	397	311		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the West Fork Little Sioux River Subwatershed, a component of the IWM work conducted between May and September from 2002 through 2008, 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 118. Lake assessments: West Fork Little Sioux River Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Avg. Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (m)	AQR Support Status	AQL Support Status
Round	32-0069-00	906	H		2.7	1		119	14.9	0.5	NS	
Iowa	32-0084-00	220	H					221	75	0.2	NS	
Indian	53-0007-00	191	H	100	2.0	1		336	61	1.4	NS	

Abbreviations: D -- Decreasing/Declining Trend; I -- Increasing/Improving Trends; NT – No Trend; **H** – Hypereutrophic; **E** – Eutrophic; **M** – Mesotrophic; **O** - Oligotrophic; **FS** – Full Support; **NS** – Non-Support; I**F** – Insufficient Information

Summary

Lakes

Total phosphorus and Secchi exceed the lake eutrophication standard for Round Lake. Chlorophyll-a is lower than expected, however the high TSS values indicate mixing of sediment which limits the algal growth. The catchment area of 5,707 acres is dominated by agriculture and is likely a source of phosphorus through watershed runoff. The lake is also very shallow, having a maximum depth of 2.7 meters. The area of the lake is large at 906 acres and the shore is relatively unprotected; this allows for wind mixing which resuspends sediment and under high temperature conditions can lead to the release of phosphorus (internal loading). Round Lake does contain an aeration system that provides oxygen which could help the quality of the water, but based on the data Round Lake is not supporting aquatic recreation use.

Iowa Lake and Indian Lake are both shallow lakes and hypertrophic, which results in algal blooms during the hot summer months. Both lakes have watersheds dominated by agricultural land use; watershed runoff is likely contributing phosphorus to the systems. Shallow lakes are susceptible to internal loading; as wind mixing resuspends sediment, high temperatures can facilitate the release of phosphorus into the water column. Both lakes have smaller catchment areas (Iowa: 4316 acres and Indian: 7723 acres), but their resulting ratios (Iowa: 20 to 1 and Indian: 40 to 1) are still large. The amount of agricultural land that the watersheds cover is over 80% per watershed. Both of these lakes are impaired for aquatic recreation use and will remain this way until reductions in watershed runoff and management of internal loading can be accomplished.

Little Sioux River, West Fork, 10230003-508, JD 24 to JD 13, **Little Sioux River, West Fork, 10230003-509,** JD 13 to MN/IA border

Water chemistry

The Little Sioux River, West Fork stream reaches (10230003-508 and 10120003-509) both show the same impairments. High levels of bacteria throughout the datasets make these streams impaired for aquatic recreation use. The reaches show exceedances for turbidity, but the reach is highly channelized and a formal impairment decision will not be made until Tiered Aquatic Life Use assessments can be completed.

Biology

All sites sampled in the Little Sioux, West Fork subwatershed were channelized and deferred for assessment of aquatic life use support.

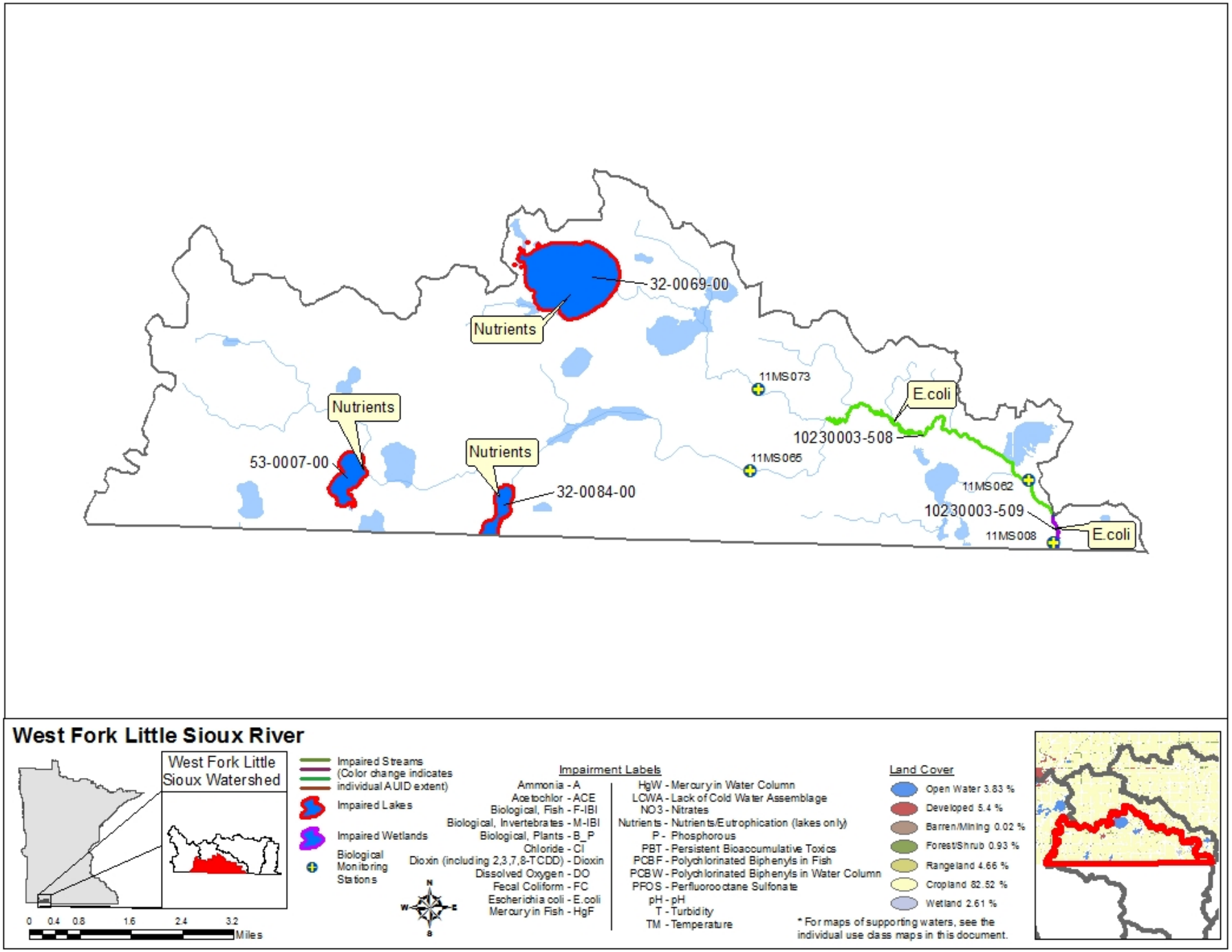

Figure 50. Currently listed impaired waters by parameter and land use characteristics in the West Fork Little Sioux River Subwatershed.

Upper Headwaters Little Sioux River Subwatershed HUC 1023000303-02

There are 11 stream reaches in the Upper Headwaters Little Sioux River Subwatershed that drain 107.25 miles^2 of Jackson County. This subwatershed is not a true complete watershed, as a part of the subwatershed is in Iowa. The Little Sioux River, County Ditch 11, an unnamed creek, and Judicial Ditch 28 are the major stream reaches in the Upper Headwaters Little Sioux River Subwatershed. The Little Sioux River (17 miles) stretches from the north of the subwatershed into an Unnamed Lake 8 miles south of Lakefield, and flows south into Iowa. County Ditch 11 is smaller (4 miles) than the other stream reaches and flows into the Little Sioux River directly after the Little Sioux River exits the unnamed lake. The large unnamed creek starts in the northeast corner of the subwatershed and flows 13 miles into an unnamed lake on the south end of the subwatershed. Judicial Ditch 28 flows from the northwest corner of the subwatershed and exits into the Little Sioux River 4.5 miles from the headwaters of the Little Sioux River. There are twelve lakes greater than 10 acres in this subwatershed, but none of them have data to be assessed for aquatic recreation. 89.40% of the subwatershed's land use is utilized for agricultural production (cropland 84.76%, rangeland 4.64%).

Table 119. Aquatic life and recreation assessments on stream reaches: Upper Headwaters Little Sioux River Subwatershed. Reaches are organized upstream to downstream in the table.

AUID ***Reach Name***, *Reach Description*	Reach Length (miles)	Use Class	Biological Station ID	Location of Biological Station	Aquatic Life Indicators:								Bacteria	Aquatic Life	Aquatic Rec.
					Fish IBI	Invert IBI	Dissolved Oxygen	Turbidity	Chloride	pH	NH_3	Pesticides			
10230003-514, **Little Sioux River,** JD 28 to Unnamed cr	7.22	2C, 3C	11MS143 11MS072	Upstream of CR 68, 9 mi. NE of Round Lake Downstream of CR 66, 8 mi. S of Lakefield	EXS	EXP	IF	EXS	-	MTS	-	-	EX	*IF	NS
10230003-515, **Little Sioux River,** Unnamed cr to MN/IA border	4.05	2C, 3C	11MS010	Downstream of CR 4 (715th St), 10 mi. S of Lakefield	EXS	MTS	EXP	EXS	IF	MTS	-	-	EX	NS	NS
10230003-516, **Unnamed creek,** Headwaters to Little Sioux R	12.72	2B, 3C					IF	MTS		MTS			EX	NA	NS

Abbreviations for Indicator Evaluations: **--** = No Data, **NA** = Not Assessed, **IF** = Insufficient Information, **MTS** = Meets criteria; **EXP** = Exceeds criteria, potential impairment; **EXS** = Exceeds criteria, potential severe impairment; **EX** = Exceeds criteria (Bacteria).

Abbreviations for Use Support Determinations: **NA** = Not Assessed, **IF** = Insufficient Information, **NS** = Non-Support, **FS** = Full Support

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.

*Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

Table 120. Non-assessed biological stations on channelized AUIDs: Upper Headwaters Little Sioux River Subwatershed.

AUID *Reach Name*, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10230003-512, Judicial Ditch 28, Headwaters to Little Sioux R	11.65	2B, 3C	11MS068	Downstream of CR 9 (400th Ave), 4.5 mi. SW of Lakefield	41	25.7
10230003-514, Little Sioux River, JD 28 to Unnamed cr	7.22	2C, 3C	11MS072	Downstream of CR 66, 8 mi. S of Lakefield	21	15.3
10230003-525, Unnamed creek, Headwaters to Unnamed cr	4.66	2B, 3C	04MS014	Upstream of CR 5, 5 miles SE of Brewster	20	30.9
10230003-526, Unnamed creek, Unnamed cr to Little Sioux R	4.84	2B, 3C	11MS067	Upstream of CSAH 9 (380th Ave), 7 mi. SW of Lakefield	36	23.42
10230003-538, County Ditch 11, Headwaters to Little Sioux R	4.22	2B, 3C	11MS078	Downstream of 790th St, 4 mi. SW of Lakefield	15	17.1
10230003-539, Unnamed creek, Headwaters to Big Sioux R	5.88	2B, 3C	11MS077	Downstream of 750th St, 7 mi. SW of Lakefield	31	30.4

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 121. Minnesota Stream Habitat Assessment (MSHA): Upper Headwaters Little Sioux River Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS068	Judicial Ditch 28	1	7	18	11	19	56	Fair
1	11MS143	Little Sioux River	0	5	7	1	11	24	Poor
1	11MS072	Little Sioux River	0	5	14.8	7	8	34.8	Poor
1	11MS010	Little Sioux River	0	7.5	11	12	12	42.5	Poor
1	04MS014	Trib. to Little Sioux River	0	11	8	13	10	42	Poor
1	11MS067	Trib. to Little Sioux River	0	4	10	11	19	44	Poor
1	11MS078	County Ditch 11	2	7	9	9	7	34	Poor
1	11MS077	Trib. to Little Sioux River	0	5	18	6	20	49	Fair
Average Habitat Results: *Upper Headwaters Little Sioux River Subwatershed*			**0.4**	**6.4**	**12**	**8.8**	**13.3**	**40.8**	**Poor**

Qualitative habitat ratings

= Good: MSHA score above the median of the least-disturbed sites (MSHA>66)

= Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)

= Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table 122. Channel Condition and Stability Assessment (CCSI): Upper Headwaters Little Sioux River Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS143	Little Sioux River	40	29	24	7	100	Severely Unstable
1	11MS072	Little Sioux River	21	15	20	3	59	Moderately Unstable
1	11MS010	Little Sioux River	19	17	26	3	65	Moderately Unstable
1	11MS067	Trib. to Little Sioux River	40	40	23	7	110	Severely Unstable
1	11MS077	Trib. to Little Sioux River	40	34	28	11	113	Severely Unstable
Average Stream Stability Results: *Upper Headwaters Little Sioux River Subwatershed*			**32**	**27**	**24.2**	**6.2**	**89.4**	**Severely Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 123. Outlet water chemistry results: Upper Headwaters Little Sioux River Subwatershed.

Station location:	**LITTLE SIOUX R AT CSAH-4 (715TH ST), 12 MI S OF LAKEFIELD, MN**
STORET/EQuIS ID:	**S006-549**
Station #:	**11MS010**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	8	0.0016	0.011	0.0054	0.04	
Chloride	mg/L	8	6.6	21.9	16.11	230	
Dissolved Oxygen (DO)	mg/L	18	1.83	10.15	5.74	5	7
pH		18	7.32	8.55	7.96	6.5 - 9	
Secchi tube/Transparency Tube	100 cm	18	5	45	19.33	>20	11
Escherichia coli (geometric mean)	MPN/100ml	13	121	256		126	2
Escherichia coli	MPN/100ml	13	5.5	>2419.6	329	1260	1
Chlorophyll-a, Corrected	ug/L	15	1.5	46	15		
Inorganic nitrogen (nitrate and nitrite)	mg/L	16	<0.2	11	4.5		
Kjeldahl nitrogen	mg/L	16	1	2.8	1.7		
Pheophytin-a	ug/L	15	<1	40	12		
Phosphorus	ug/L	16	57	687	287		
Specific Conductance	uS/cm	18	338	805	663		
Temperature, water	deg °C	18	10	26	22		
Total suspended solids	mg/L	8	6	79	30		

Total volatile solids	mg/L	8	4	13	7		
Sulfate	mg/L	8	36	111	80		
Hardness	mg/L	8	150	416	341		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Upper Headwaters Little Sioux River Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Summary

Little Sioux River, 10230003-514, JD 28 to Unnamed cr, **Little Sioux River, 10230003-515,** Unnamed cr to MN/IA border

Water chemistry

The Little Sioux River is split into three stream reaches (10230003-513, 10230003-514 and 10230003-515) because there are major stream reaches that flow into the river. The Little Sioux River (10230003-515) shows high levels of bacteria in July and August and values approaching the standard in May and June; as a result the reach is listed as impaired for aquatic recreation use. The turbidity data shows exceedances throughout the dataset and impairs the stream reach for aquatic life use. The dissolved oxygen levels also show exceedances, however the dataset was not large enough to determine aquatic life use nonsupport. The Little Sioux River (10230003-513, 10230003-514) contains high levels of bacteria June through October; as a result, the stream is impaired for aquatic recreation use. The turbidity data exceeds the standard over half of the time, indicating impaired conditions. However, the reach is highly modified; as a result the impairment is noted, but not placed on the impaired waters list. The reach will be reevaluated when Tiered Aquatic Life Uses are available to determine the appropriate standard.

Biology

The only invertebrate station determined to be assessable for aquatic life (11MS010) had a MIBI score above the biocriterion. The site was classified as low gradient, as very low flows were present at the time of sampling, yet the site had a predominately rocky substrate, as well as wood debris present. The high quality in-stream invertebrate habitat provided an adequate means to support a more robust invertebrate community, despite relatively high suspended sediment and nutrient concentrations. The only fish station determined to be assessable for aquatic life (11MS010) had a FIBI score below the biocriterion. Low flow along with very poor fish habitat creates a poor environment for healthy fish assemblages.

Unnamed creek, 10230003-516, Headwaters to Little Sioux R

Water chemistry

This unnamed creek (10230003-516) show high levels of bacteria during the June and July months. Based on the geometric monthly means and the individual exceedances this stream reach is impaired for aquatic recreation use. Due to the location of the sampling station for this reach, no aquatic life assessment was made. Wetland influences were very strong (low dissolved oxygen) and the data was considered not suitable for a stream aquatic life use assessment.

Biology

There is no biological station on this stream segment.

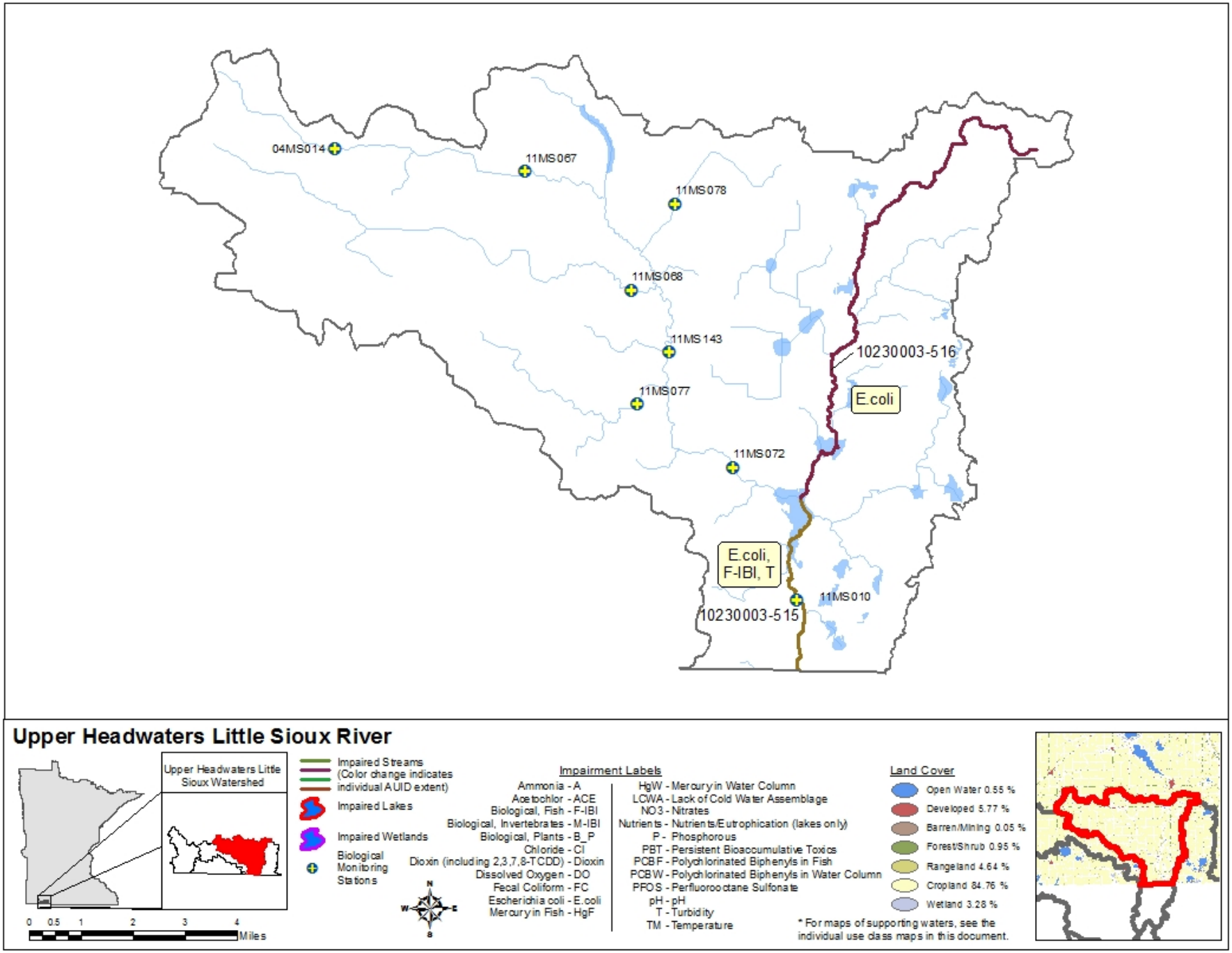

Figure 51. Currently listed impaired waters by parameter and land use characteristics in the Upper Headwaters Little Sioux River Subwatershed.

Milford Creek Subwatershed HUC 1023000302-01

Loon Creek is the only stream reach out of seven stream reaches in the Milford Creek Subwatershed that has enough data for assessments. This subwatershed is not a true complete watershed as a part of the subwatershed is in Iowa. Milford Creek Subwatershed drains 39.48 miles^2 of Jackson County. Loon Creek flows 1.8 miles from Loon Lake into Spirit Lake which then exits into Iowa. Loon Lake, Clear Lake and Little Spirit Lake are the three largest out of nine lakes in this subwatershed, and the only lakes that have data to be assessed for aquatic recreation. Loon Lake is about two times the size of Clear Lake. Clear Lake is located at the north of the subwatershed and flows through Judicial Ditch 8 (7 miles) to Loon Lake, which is located on the south end of the Milford Creek Subwatershed. Little Spirit Lake is a large lake located about 12 miles south of Lakefield and resides in Jackson County. 62.14% of the subwatershed's land is utilized for agricultural production (cropland 50.77%, rangeland 11.37%). The Milford Creek Subwatershed is the most lake-rich subwatershed in the entire Missouri River Basin with 17.6% of the land use open water.

Table 124. Non-assessed biological stations on channelized AUIDs: Milford Creek Subwatershed.

AUID ***Reach Name***, *Reach Description*	Reach length (miles)	Use Class	Biological Station ID	Location of Biological Station	Fish IBI	Invert IBI
10230003-517, Judicial Ditch 8, Clear Lk to Loon Lk	7.18	2B, 3C	11MS024	W of CR 17, 4 mi. SW of Jackson	38	21.9
10230003-531, Judicial Ditch 35, Headwaters to Rush Lk	7.36	2B, 3C	11MS144	Downstream of 750th St, 5 mi. SW of Jackson	17	42.7

See Appendix 5.1 for clarification on the good/fair/poor thresholds and Appendix 5.2 and Appendix 5.3 for IBI results.

Table 125. Minnesota Stream Habitat Assessment (MSHA): Milford Creek Subwatershed.

# Visits	Biological Station ID	Reach Name	Land Use (0-5)	Riparian (0-15)	Substrate (0-27)	Fish Cover (0-17)	Channel Morph. (0-36)	MSHA Score (0-100)	MSHA Rating
1	11MS024	Judicial Ditch 8	0	8	20.7	10	26	64.7	Fair
1	11MS144	Judicial Ditch 35	0	9.5	3	6	9	27.5	Poor
Average Habitat Results: *Milford Creek Subwatershed*			**0**	**8.8**	**11.9**	**8**	**17.5**	**46.1**	**Fair**

Qualitative habitat ratings
- = Good: MSHA score above the median of the least-disturbed sites (MSHA>66)
- = Fair: MSHA score between the median of the least-disturbed sites and the median of the most-disturbed sites (45 < MSHA < 66)
- = Poor: MSHA score below the median of the most-disturbed sites (MSHA<45)

Table126. Channel Condition and Stability Assessment (CCSI): Milford Creek Subwatershed.

# Visits	Biological Station ID	Stream Name	Upper Banks (43-4)	Lower Banks (46-5)	Substrate (37-3)	Channel Evolution (11-1)	CCSI Score (137-13)	CCSI Rating
1	11MS024	Judicial Ditch 8	36	34	19	7	96	Severely Unstable
Average Stream Stability Results: *Milford Creek Subwatershed*			**36**	**34**	**19**	**7**	**96**	**Severely Unstable**

Qualitative channel stability ratings

= stable: CCSI < 27 = fairly stable: 27 < CCSI < 45 = moderately unstable: 45 < CCSI < 80 = severely unstable: 80 < CCSI < 115 = extremely unstable: CCSI > 115

Table 127. Outlet water chemistry results: Milford Creek Subwatershed.

Station location:	**LOON CK (AKA LOON LAKE OUTLET) AT CSAH-4 (715TH ST), 13 MI SE OF LAKEFIELD, MN**
STORET/EQuIS ID:	**S006-550**
Station #:	**11MS017**

Parameter	Units	# of Samples	Minimum	Maximum	Mean	WQ Standard[1]	# of WQ Exceedances[2]
Ammonia-nitrogen	mg/L	6	0.042	0.0277	0.018	0.04	
Chloride	mg/L	8	13.1	16.8	14.5	230	
Dissolved Oxygen (DO)	mg/L	15	5.4	9.8	8.2	5	
pH		15	8.1	9	8.5	6.5 - 9	1
Secchi tube/Transparency Tube	100 cm	15	10	42	21	>20	8
Escherichia coli	MPN/100ml	10	1	46	17	1260	
Chlorophyll-a, Corrected	ug/L	1	4.9	4.9	4.9		
Inorganic nitrogen (nitrate and nitrite)	mg/L	8	<0.2	2.8	1.5		
Kjeldahl nitrogen	mg/L	8	0.7	2.3	1.5		
Pheophytin-a	ug/L	1	2.6	2.6	2.6		
Phosphorus	ug/L	8	87	175	120		
Specific Conductance	uS/cm	15	321	533	444		
Temperature, water	deg °C	15	11	27	23		
Total suspended solids	mg/L	8	10	65	31		
Total volatile solids	mg/L	8	4	20	12		
Sulfate	mg/L	8	26	40	24		
Hardness	mg/L	8	155	263	2167		

[1]Secchi Tube/Transparency tube standards are surrogate standards derived from the turbidity standard of 25.

****Data found in the table above was compiled using the results from data collected at the outlet monitoring station in the Milford Creek Subwatershed, a component of the IWM work conducted between May and September from 2011 and 2012. This specific data does not necessarily reflect all data that was used to assess the AUID.**

Table 128. Lake assessments: Milford Creek Subwatershed.

Name	DNR Lake ID	Area (acres)	Trophic Status	Percent Littoral	Max. Depth (m)	Avg. Depth (m)	CLMP Trend	Mean TP (µg/L)	Mean chl-a (µg/L)	Secchi Mean (m)	AQR Support Status	AQL Support Status
Little Spirit	32-0024-00	599	H	100	2.4	1	I	259	66.7	0.8	NS	
Loon	32-0020-00	698	H	100	1.8	1	NT	332	93	0.5	NS	
Clear	32-0022-00	426	H	100	2.7	1	NT	112	56	0.6	NS	

Abbreviations:
D -- Decreasing/Declining Trend
I -- Increasing/Improving Trends
NT – No Trend
H – Hypereutrophic
E – Eutrophic
M – Mesotrophic
O - Oligotrophic
FS – Full Support
NS – Non-Support
IF – Insufficient Information

Summary

Lakes

Little Spirit Lake is in the Windom Fish Management area that borders Minnesota and Iowa. There is an aeration system in place on the lake that can potentially increase oxygen in the winter to prevent fish kills. When the algal production is at its highest in the summer there have been recorded fish kills. The catchment is small at 2,678 acres and the ratio of catchment to lake is 4 to 1. Even though the catchment is small, it is heavily dominated by agriculture; watershed runoff will provide additional sources of phosphorus to the lake. The lake is shallow, and has a significant fetch; as a result, resuspension of sediment due to wind mixing, coupled with high temperatures, will result in internal loading as phosphorus is released into the water column. Little Spirit Lake was listed for eutrophication impairment in 2004 and is still not supporting recreation use based on current data. Watershed runoff and internal loading will need to be managed for improved conditions to be achieved.

Loon and Clear lakes are both shallow lakes and hypertrophic, which results in algal blooms during the hot summer months. Both lakes are shallow and wind swept, with little shoreland protection from wind and watersheds dominated by agricultural land uses. Wind mixing will resuspend sediments; under high temperatures this results in phosphorus being released into the water column (internal loading). Loon Lake has a considerably larger watershed to lake ratio (29:1, compared to 3:1 for Clear Lake) and will be impacted more significantly by watershed contributions than Clear Lake. Both of these lakes are impaired for aquatic recreation use and will remain this way until watershed runoff and internal loading are managed.

Water chemistry

The Loon Creek stream reach monitored is at the outlet of Loon Lake; the data is representing the lake and not far enough downstream to be without lake influence. As a result, the data is not used for aquatic life use assessments. However, bacteria data used for recreation assessments is available. Counts of bacteria are low and based on the limited dataset bacteria do not appear to be negatively impacting recreation use.

Biology

All sites sampled in the Milford Creek subwatershed were channelized and deferred for assessment of aquatic life use support.

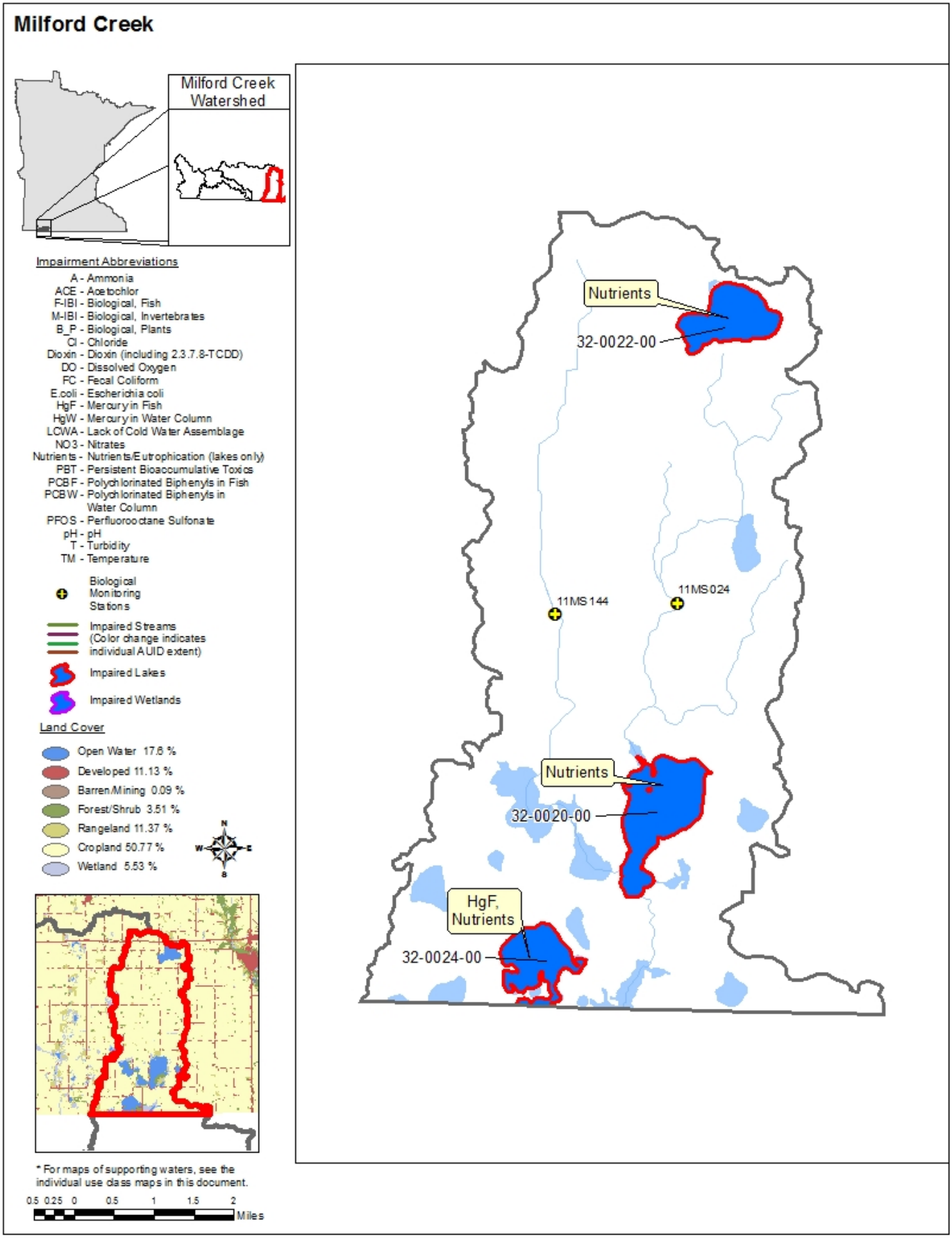

Figure 52. Currently listed impaired waters by parameter and land use characteristics in the Milford Creek Subwatershed.

VI. Watershed-wide results and discussion

Assessment results and data summaries are included below for the entire HUC-8 watershed units of the Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux Rivers, grouped by sample type. Summaries are provided for load monitoring data results on Split Rock Creek, Rock River, and Pipestone Creek. Aquatic life and recreation uses in streams and lakes throughout the Missouri River Basin, and for aquatic consumption results on the Rock River are summarized. Additionally, groundwater monitoring results and long-term monitoring trends are included where applicable.

Following the results are a series of graphics that provide an overall summary of assessment results by designated use, impaired waters, and fully supporting waters within the entire Upper Big Sioux, Lower Big Sioux, Rock, and Little Sioux River Watersheds.

Wetland condition

The MPCA began biological monitoring of wetlands in the early 1990s, focusing on wetlands with emergent vegetation in a depressional geomorphic setting (i.e., marshes). This work resulted in the development of plant and macroinvertebrate (aquatic bugs, snails, leeches, & crustaceans) indices of biological integrity (IBIs) to evaluate biological condition or "health" of depressional wetlands. Recently the MPCA wetland monitoring program has begun transitioning toward greater use of Floristic Quality Assessment to assess wetland condition based on the plant community. Future watershed wetland assessment reports will begin to use FQA wetland assessment approaches. One advantage to the FQA approach is the methods have been developed to apply to all Minnesota wetland types.

Both the invertebrate and plant IBIs are scored on a 0 to 100 scale with higher scores indicating better condition. These indicators have been used in surveys of wetland condition where results can be summarized statewide and for Minnesota's three Level II Ecoregions (Genet 2012). Minnesota's portion of the Missouri River drainage occurs entirely within the Temperate Prairie Ecoregion that is characteristic of the upper Midwest.

Statewide estimates have found depressional wetlands in the Temperate Prairies Ecoregion to typically be in poor condition when compared to regional reference sites. The wetland plant community integrity results suggest 17% of the depressional wetlands in this ecoregion are estimated to be in good condition, 28% are in fair condition and 54% are in poor condition. Invasive plants, particularly narrow-leaved (Typha angustifolia) and hybrid cattail (Typha X glauca) as well as reed canary grass (Phalaris arundinacea) are important wetland stressors and can respond strongly to disturbed watershed conditions including nutrient enrichment, hydrologic alterations and toxic pollutants such as chloride loading (Galatowitsch 2012). Unfortunately, cattails and reed canary grass are very common, often dominating marshes within this region of the state and are detrimental to plant community health (Genet 2012). Survey condition estimates of depressional wetland condition in the Temperate Prairies Ecoregion based on the macroinvertebrate IBI reported 33% of the wetlands in this region are in good condition, 20% in fair condition and 47% are recognized as being in poor condition.

Pollutant load monitoring

Watershed Pollutant Load Monitoring Network

Pipestone Creek

During 2009-2011, there were between 25-30 samples per year collected at Pipestone Creek at Pipestone on State Highway 23 (Figure 53). Many years of water quality data from throughout Minnesota combined with

the previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR), each with unique nutrient standards (MPCA, 2008). Of the state's three RNRs (North, Central, South), the Pipestone Creek monitoring station is located within the South RNR.

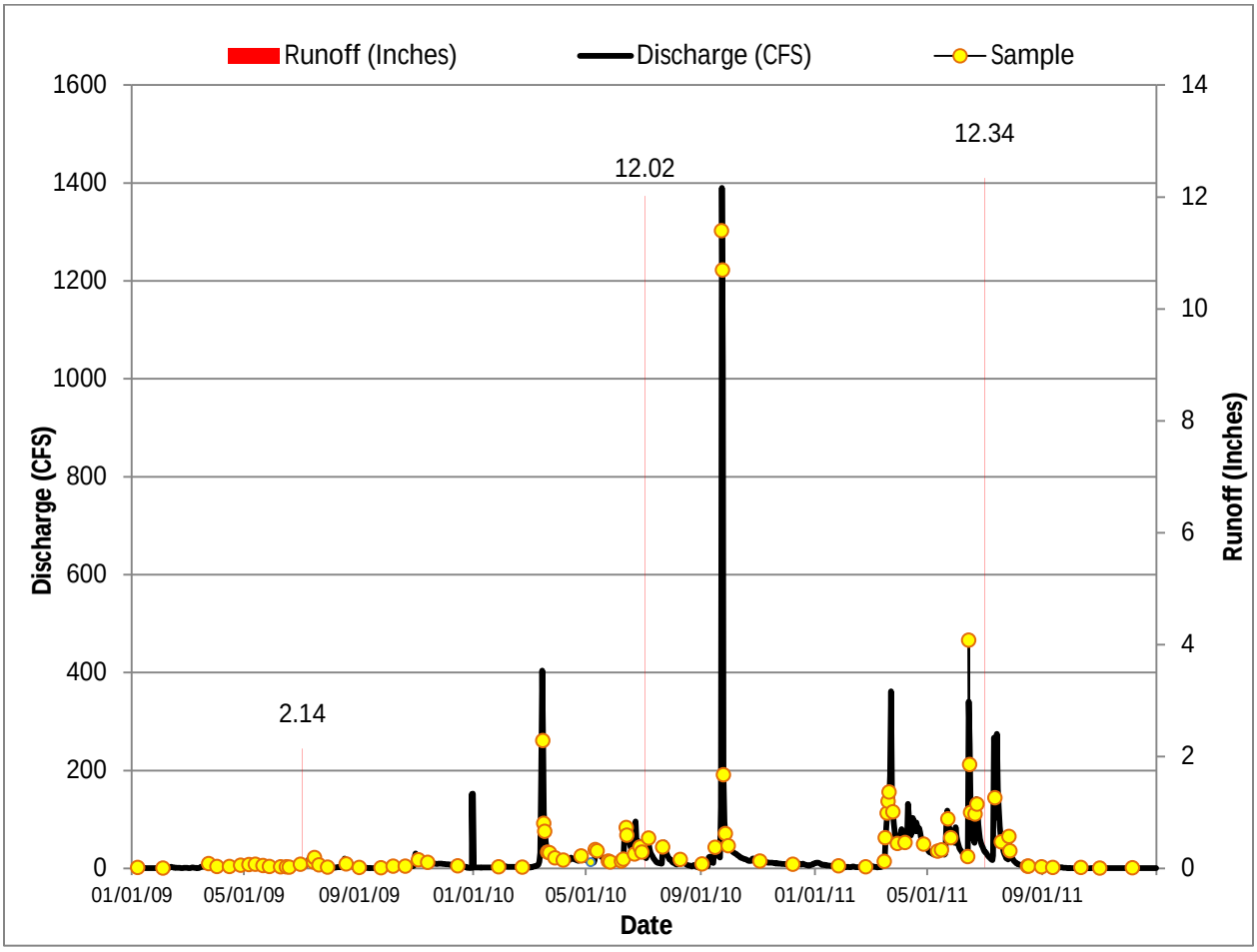

Figure 53. 2009-2011 Hydrograph, Sampling Regime and Annual Runoff for Pipestone Creek at Pipestone

Annual flow weighted mean concentrations (FWMCs) were calculated and compared for years 2009-2011 (Figures 54-57) and compared to the RNR standards (only draft TP and TSS standards are available for the South RNR). It should be noted that while a FWMC exceeding a given water quality standard is generally a good indicator that the water body is out of compliance with the RNR standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10% and greater, over the most recent 10 year period and not based on comparisons with FWMCs (MPCA, 2012). A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10% of the individual samples collected over the assessment period were above the standard.

Pollutant sources affecting rivers are often diverse and can be quite variable from one watershed to the next depending on land use, climate, soils, slopes, and other watershed factors. However, as a general rule, elevated levels of total suspended solids (TSS) and nitrate plus nitrite-nitrogen (NO_3 + NO_2-N) are generally regarded as "nonpoint" source derived pollutants originating from many small diffuse sources such as urban or agricultural runoff. Excess total phosphorus (TP) and dissolved orthophosphate (DOP)

can be attributed to both "nonpoint" as well as "point", or end of pipe, sources such as industrial or municipal wastewater treatment plants. Major "nonpoint" sources of phosphorus include dissolved phosphorus from fertilizers and phosphorus adsorbed to and transported with sediment during runoff.

Within a given watershed, pollutant sources and source contributions can also be quite variable from one runoff event to the next depending on factors such as canopy development, soil saturation level, and precipitation type and intensity. Surface erosion and in-stream sediment concentrations, for example, will typically be much higher following high intensity rain events prior to canopy development, rather than after low intensity post-canopy events where less surface

runoff and more infiltration occur. Precipitation type and intensity influence the major course of storm runoff, routing water through several potential pathways including overland, shallow and deep groundwater, and/or tile flow. Runoff pathways along with other factors determine the type and levels of pollutants transported in runoff to receiving waters and help explain between-storm and temporal differences in FWMCs and loads, barring differences in total runoff volume. During years when high intensity rain events provide the greatest proportion of total annual runoff, concentrations of TSS and TP tend to be higher and DOP and $NO_3 + NO_2$-N concentrations tend to be lower. In contrast, during years with high snow melt runoff and less intense rainfall events, TSS levels tend to be lower while TP, DOP, and $NO_3 + NO_2$-N levels tend to be elevated.

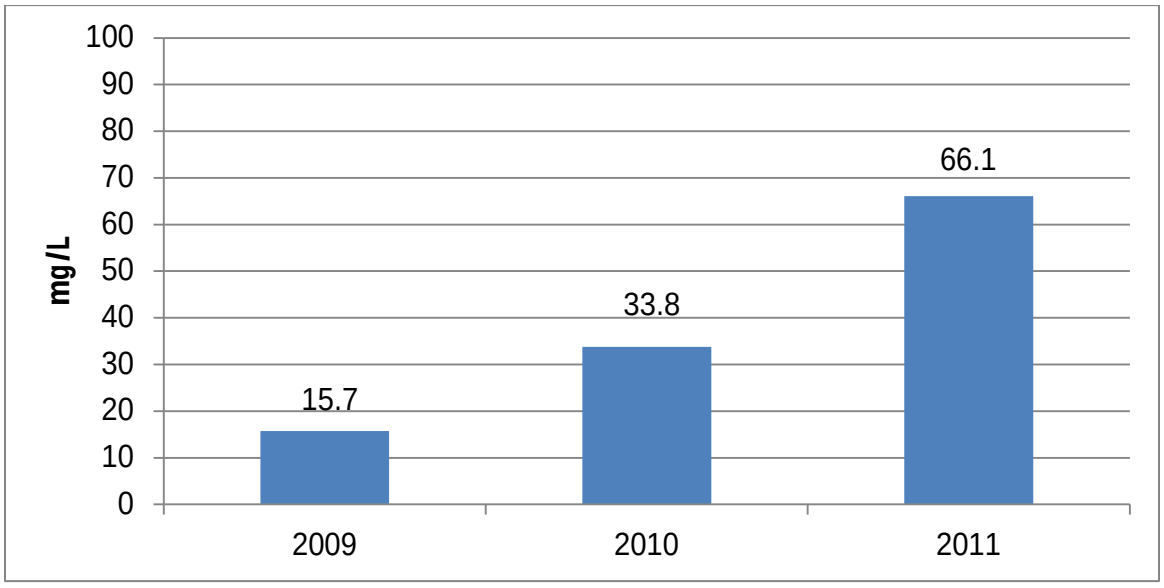

Figure 54. Total Suspended Solids (TSS) Flow Weighted Mean Concentrations for Pipestone Creek.

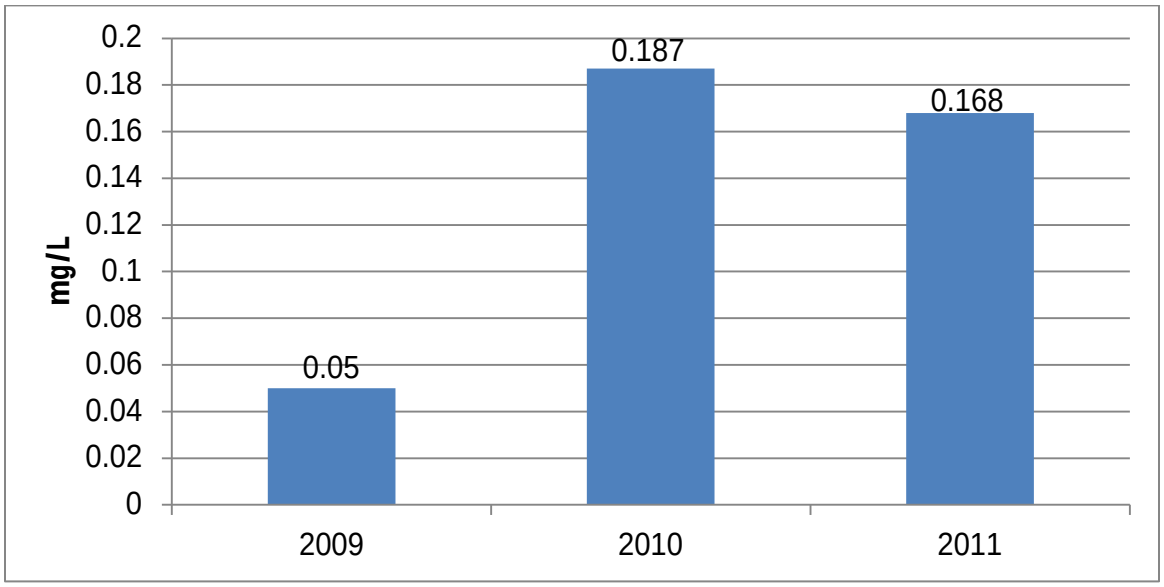

Figure 55. Total Phosphorus (TP) Flow Weighted Mean Concentrations for Pipestone Creek

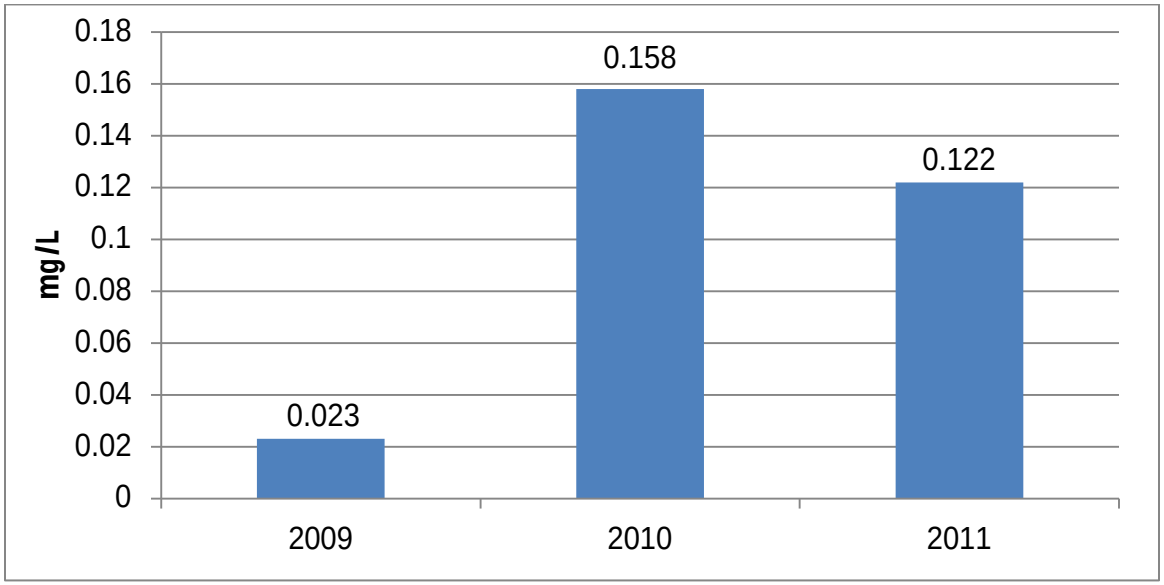

Figure 56. Dissolved Orthophosphate (DOP) Flow Weighted Mean Concentrations for Pipestone Creek.

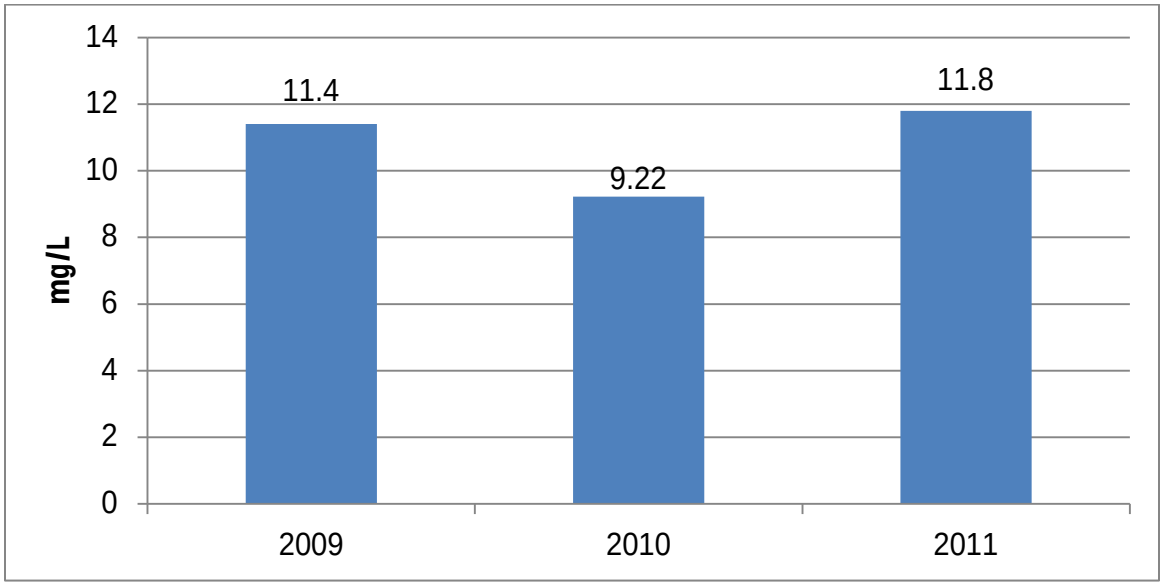

Figure 57. Nitrate + Nitrite Nitrogen (NO_3 + NO_2-N) Flow Weighted Mean Concentrations for Pipestone Creek.

Table 129. Annual Pollutant Loads by Parameter Calculated for Pipestone Creek.

	2009	2010	2011
Parameter	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**
Total Suspended Solids	67,037	812,170	1,632,623
Total Phosphorus	216	4,492	4,144
Dissolved Orthophosphate	100	3,811	3,022
Nitrate + Nitrite Nitrogen	48,990	221,826	291,670

Total Suspended Solids

Water clarity refers to the transparency of water. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter, and plankton or other microscopic organisms. By definition, turbidity is caused primarily by suspension of particles that are smaller than one micron in diameter in the water column.

Analysis has shown a strong correlation to exist between the measures of TSS and turbidity. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity. High turbidity results in reduced light penetration that harms beneficial aquatic species and favors undesirable algae species (MPCA and MSUM, 2009). An overabundance of algae can lead to increases in turbidity, further compounding the problem. Periods of high turbidity often occur when heavy rains fall on unprotected soils. Upon impact, raindrops dislodge soil particles and overland flow transports fine particles of silt and clay into rivers and streams (MPCA and MSUM, 2009).

At the time of this watershed monitoring effort, the state of Minnesota's TSS draft standards were under development and considered to be draft standards until approved. Within the South RNR, a stream would be considered impaired when greater than 10% of the individual samples exceed the TSS draft standard of 65 mg/L (MPCA, 2011). From 2009 - 2011, only 13% (2010) and 12% (2011) of samples exceeded the 65 mg/L draft standard. There were no exceedances in 2009. The computed FWMC only exceeded the 65 mg/L draft standard in 2011, as shown in Figure 54. In 2009, there were very few rainfall events; the highest daily average flow for the year was 31 cubic feet per second (cfs) on October 31. In 2010, the highest daily average flow (1,390 cfs) was in response to the late September rain event. That event was sampled daily and only one sample exceeded the draft standard. In 2011, the highest daily average flow was 341 cfs during a June rain event. In July 2011, there was also another rain event. This rain event was not sampled due to the state government shutdown. In summary, Table 129 displays the total annual loads which indicate TSS loads to be highest in 2011 even though there were more exceedances of the draft standard in 2010. Often, there is a strong correlation between pollutant loads and annual runoff volume; the differences may be due strictly to differences in annual runoff volume (Figure 53).

Total Phosphorus

Nitrogen, phosphorus, and potassium are essential macronutrients and are required for growth by all animals and plants. Lack of sufficient nutrient levels in surface water often restricts the growth of aquatic plant species (University of Missouri Extension, 1999). In freshwaters such as lakes and streams, phosphorus is typically the nutrient limiting growth; increasing the amount of phosphorus entering a stream or lake will increase the growth of aquatic plants and other organisms. Although phosphorus is a necessary nutrient, excessive levels overstimulate aquatic growth in lakes and streams resulting in reduced water quality. The progressive deterioration of water quality from overstimulation of nutrients is called eutrophication where, as nutrient concentrations increase, the surface water quality is degraded (University of Missouri Extension, 1999). Elevated levels of phosphorus in rivers and streams can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries, and toxins from cyanobacteria (blue green algae) which can affect human and animal health (University of Missouri Extension, 1999). In nonpoint source dominated watersheds, TP concentrations are strongly correlated with stream flow. During years of above average precipitation, TP loads are generally highest.

Total phosphorus standards for Minnesota's rivers also must be considered draft standards until approved. Within the South RNR, the TP draft standard is 0.150 mg/L as a summer average. Summer average violations of one or more "response" variables (pH, biological oxygen demand, dissolved oxygen flux, chlorophyll-a) must also occur along with the numeric TP violation for the water to be listed. A comparison of the data collected from June through September showed 47% (2010) and 21% (2011) of samples exceeded the draft standard. There were no exceedances in 2009. Figure 55 illustrates FWMCs greater than the draft standard in 2010 and 2011; this includes all data throughout the year (not just summer values). Table 129 shows annual loads which exhibit similar traits as the FWMCs.

Dissolved Orthophosphate

Dissolved Orthophosphate is a water soluble form of phosphorus that is readily available for plant uptake (MPCA and MSUM, 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The DOP: TP ratio of FWMCs from the three years were 46%, 85%, and 73%, respectively. Figure 56 and Table 129 shows similar trends between years as seen in TP and TSS.

Nitrate plus Nitrite - Nitrogen

Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems, and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, they too, like phosphorus, can stimulate excessive levels of some algae species in streams (MPCA, 2008). Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-N to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen, with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however concentrations can vary drastically depending on season, biological activity, and anthropogenic inputs.

Nitrate-N can also be a common toxicant to aquatic organisms in Minnesota's surface waters, with invertebrates appearing to be the most sensitive to nitrate toxicity. Draft nitrate-N standards have been proposed for the protection of aquatic life in lakes and streams. The draft acute value (maximum standard) for all Class 2 surface waters is 41 mg/L nitrate-N for a 1-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L nitrate-N for a 4-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate-N (4-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA, 2010).

Figure 57 shows NO_3 + NO_2-N FWMCs over the three-year period for the Pipestone Creek monitoring site. The FWMC for all three years were well above the draft acute and chronic nitrate-N standards. In each of the three years, there were only two samples per year that were below the draft chronic standard. Table 129 displays the annual loads which increased over the three year period. This may be related to the increase of runoff volume and the magnitude of the exceedances from 2009-2011.

Split Rock Creek

During 2009-2011, there were approximately 30 samples per year collected at Split Rock Creek near Jasper on 201st Street (Figure 1). Many years of water quality data from throughout Minnesota combined with the previous analysis of Minnesota's ecoregion patterns, resulted in the development of three "River Nutrient Regions" (RNR), each with unique nutrient standards (MPCA, 2008). Of the state's three RNRs (North, Central, South), the Split Rock Creek monitoring station is located within the South RNR.

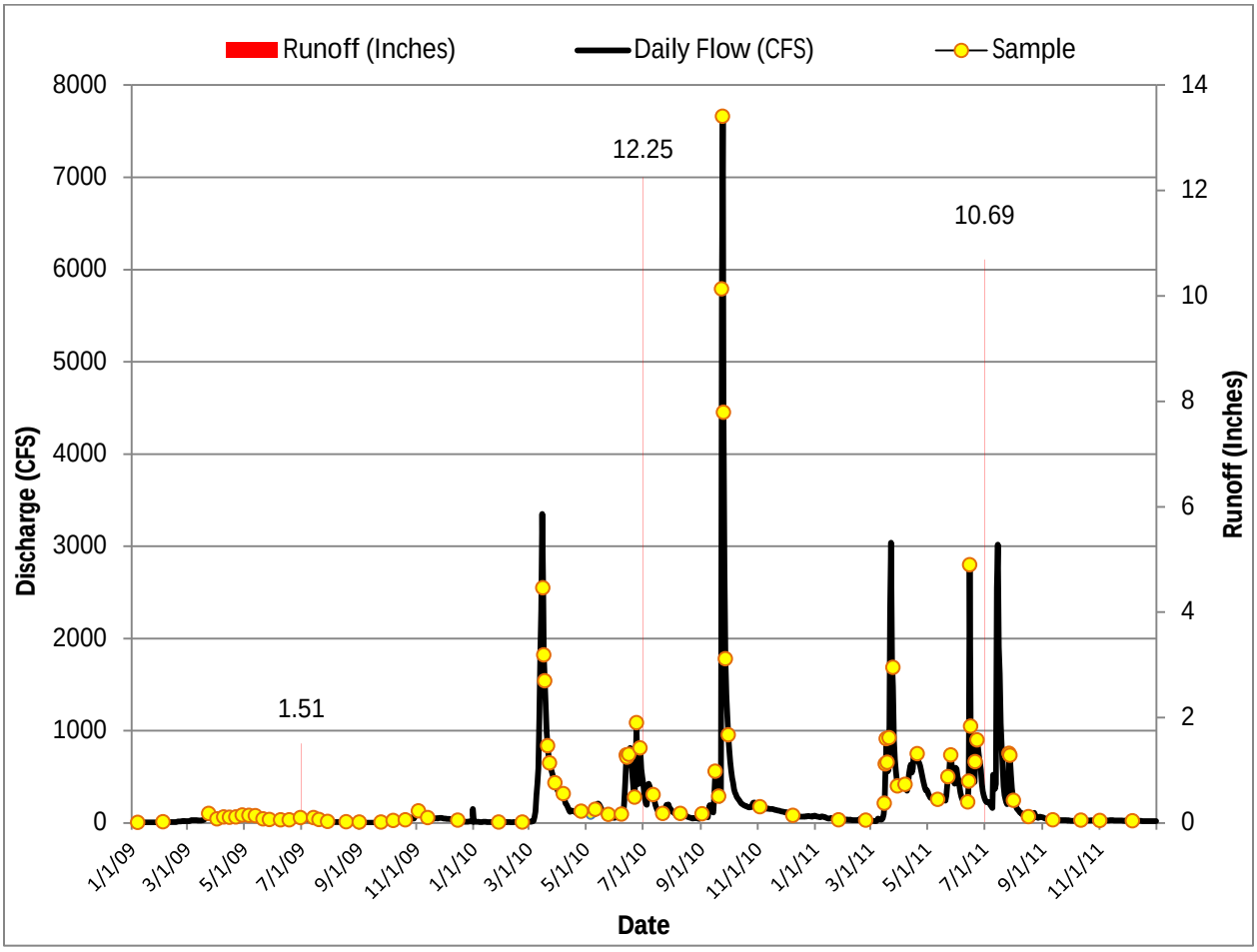

Figure 58. 2009-2011 Hydrograph, Sampling Regime and Annual Runoff for Split Rock Creek

Annual flow weighted mean concentrations (FWMCs) were calculated and compared for years 2009-2011 (Figures 59-62) and compared to the RNR standards (only TP and TSS draft standards are available for the South RNR). It should be noted that while a FWMC exceeding a given water quality standard is generally a good indicator that the water body is out of compliance with the RNR standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10% and greater, over the most recent ten year period and not based on comparisons with FWMCs (MPCA, 2012). A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10% of the individual samples collected over the assessment period were above the standard.

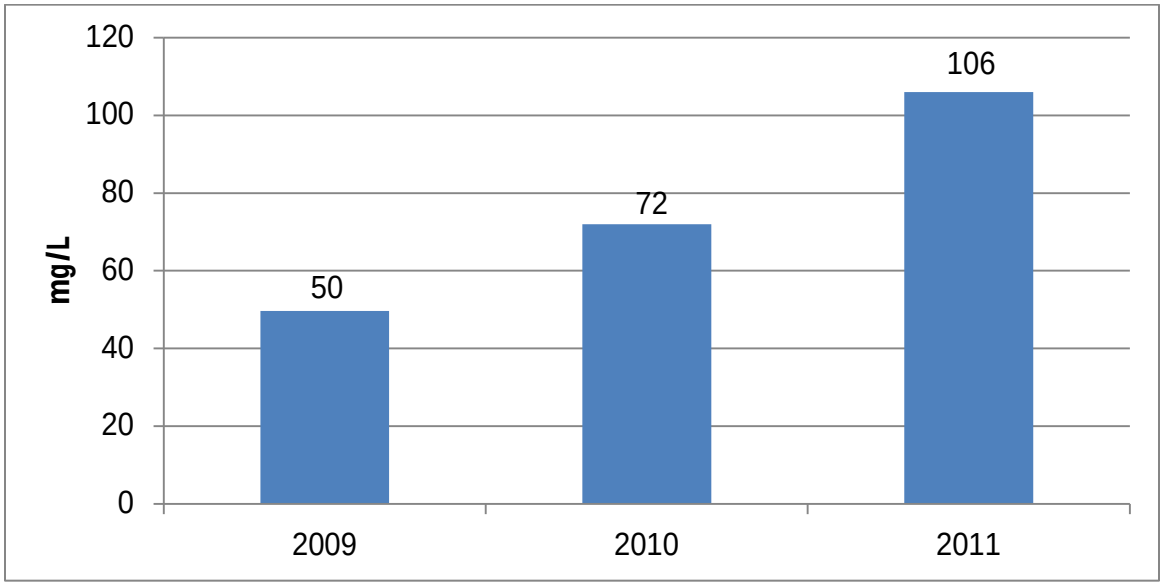

Figure 59. Total Suspended Solids (TSS) Flow Weighted Mean Concentrations for Split Rock Creek

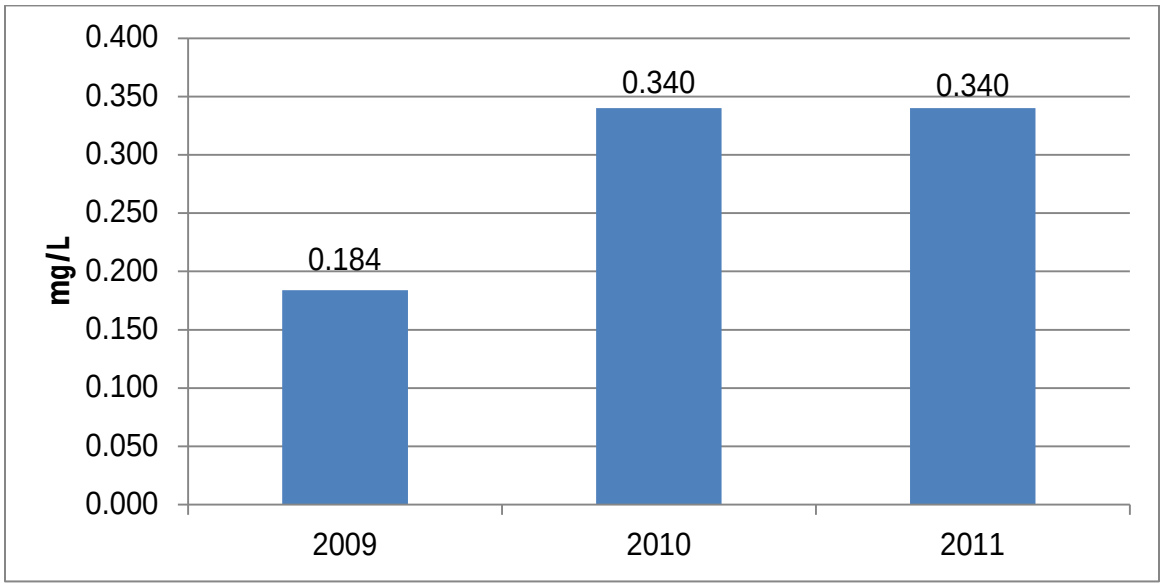

Figure 60. Total Phosphorus (TP) Flow Weighted Mean Concentrations for Split Rock Creek

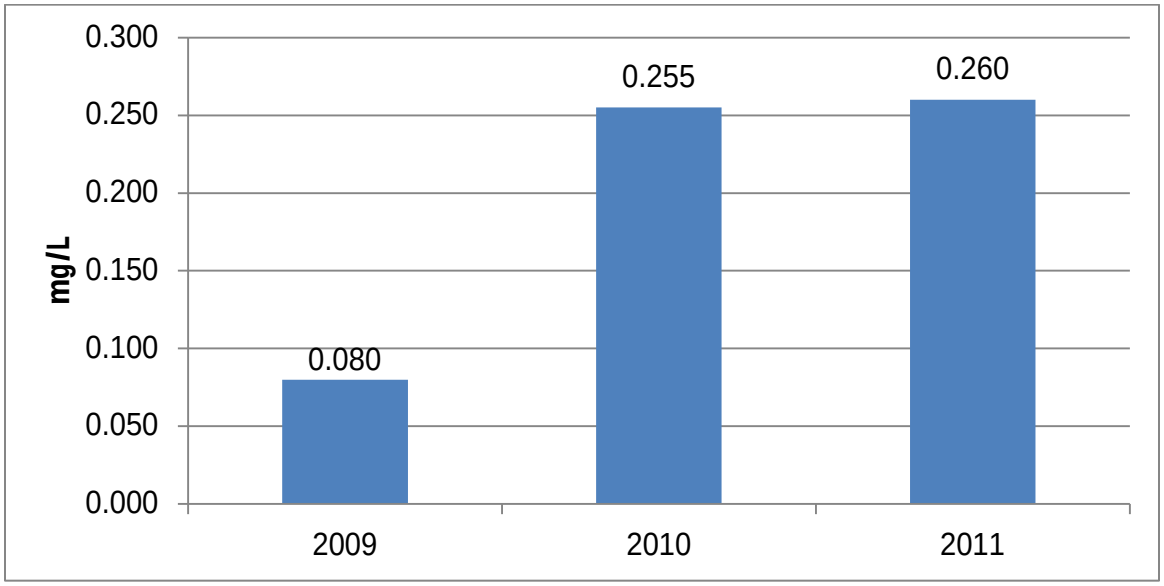

Figure 61. Dissolved Orthophosphate (DOP) Flow Weighted Mean Concentrations for Split Rock Creek

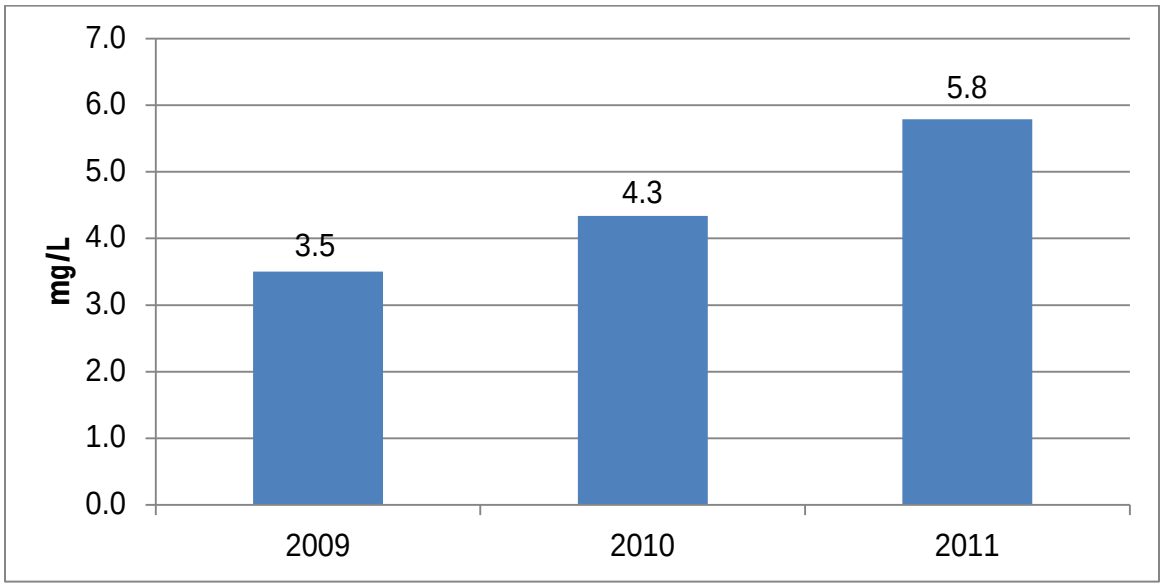

Figure 62. Nitrate + Nitrite Nitrogen (NO_3 + NO_2-N) Flow Weighted Mean Concentrations for Split Rock Creek

Table 130. Annual Pollutant Loads by Parameter Calculated for Split Rock Creek.

	2009	2010	2011
Parameter	**Mass (kg)**	**Mass (kg)**	**Mass (kg)**
Total Suspended Solids	1,527,994	17,984,350	2,309,320
Total Phosphorus	5,660	85,037	74,414
Dissolved Orthophosphate	2,480	63,619	56,129
Nitrate + Nitrite Nitrogen	107,680	1,083,652	1,262,551

Total Suspended Solids

Within the South RNR, a stream would be considered impaired when greater than 10% of the individual samples exceed the TSS draft standard of 65 mg/L. (MPCA, 2011). Samples collected from 2009 – 2011 show that 19%, 34% and 39%, exceeded the draft standard, respectively. The computed FWMC exceeded the 65 mg/L draft standard in 2010 and 2011, as shown in Figure 59. In 2009, there were very few rainfall events; the highest daily average flow for the year was 126 cfs on November 3. In 2010, the highest daily average flow (7,660 cfs) was in response to the late September rain event where exceedances were seen as the water levels increased. In 2011, the highest daily average flow was 3,040 cfs during spring runoff. Again, there were exceedances as the water levels increased. The second highest daily average flow occurred during the state government shut down and no samples were collected. In summary, Table 1 displays the total annual loads which indicate TSS loads to be highest in 2010 even though the FWMC is higher in 2011. This likely is due to a strong correlation between pollutant loads and annual runoff volume; the differences may be due strictly to differences in annual runoff volume (Figure 58).

Total Phosphorus

Within the South RNR, the TP draft standard is 0.150 mg/L as a summer average. Summer average violations of one or more "response" variables (pH, biological oxygen demand, dissolved oxygen flux, chlorophyll-a) must also occur along with the numeric TP violation for the water to be listed. A comparison of the data collected from June through September showed 27% (2009), 56% (2010), 38% (2011) of samples exceeded the draft standard. Figure 60 illustrates FWMCs greater than the draft standard each year; this includes all data throughout the year (not just summer values). Table 130 shows annual loads which exhibit similar traits to TSS loads.

Dissolved Orthophosphate

Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available for plant uptake (MPCA and MSUM, 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The DOP: TP ratio of FWMCs from the three years were 46%, 85%, and 73%, respectively. Figure 61 and Table 130 shows similar trends between years as seen in TP and TSS.

Nitrate plus Nitrite - Nitrogen

The draft acute value (maximum standard) for all Class 2 surface waters is 41 mg/L nitrate-N for a 1-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L nitrate-N for a 4-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate-N (4-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA, 2010). Figure 62 shows NO_3 + NO_2-N FWMCs over the three-year period for the Split Rock Creek monitoring site. The FWMC only exceeded the draft chronic standard in 2011. From 2009 to 2011 the number of exceedances to the draft chronic standard increased; 14% in 2009, 41% in 2010, 52% in 2011. The exceedances were all fairly low (less than 10 mg/L) except one value of 13 mg/L on May 6, 2009. Table 1 displays the annual loads which exhibit a similar trend, increasing over the three year period.

Rock River

During 2010-2011, there were approximately 30 samples per year collected at the Rock River at Luverne on County Road 4 (Figure 1). Many years of water quality data from throughout Minnesota combined with the previous analysis of Minnesota's ecoregion patterns, resulted in the development of three RNRs, each with unique nutrient standards (MPCA, 2008). Of the state's three RNRs (North, Central, South), the Rock River monitoring station is located within the South RNR.

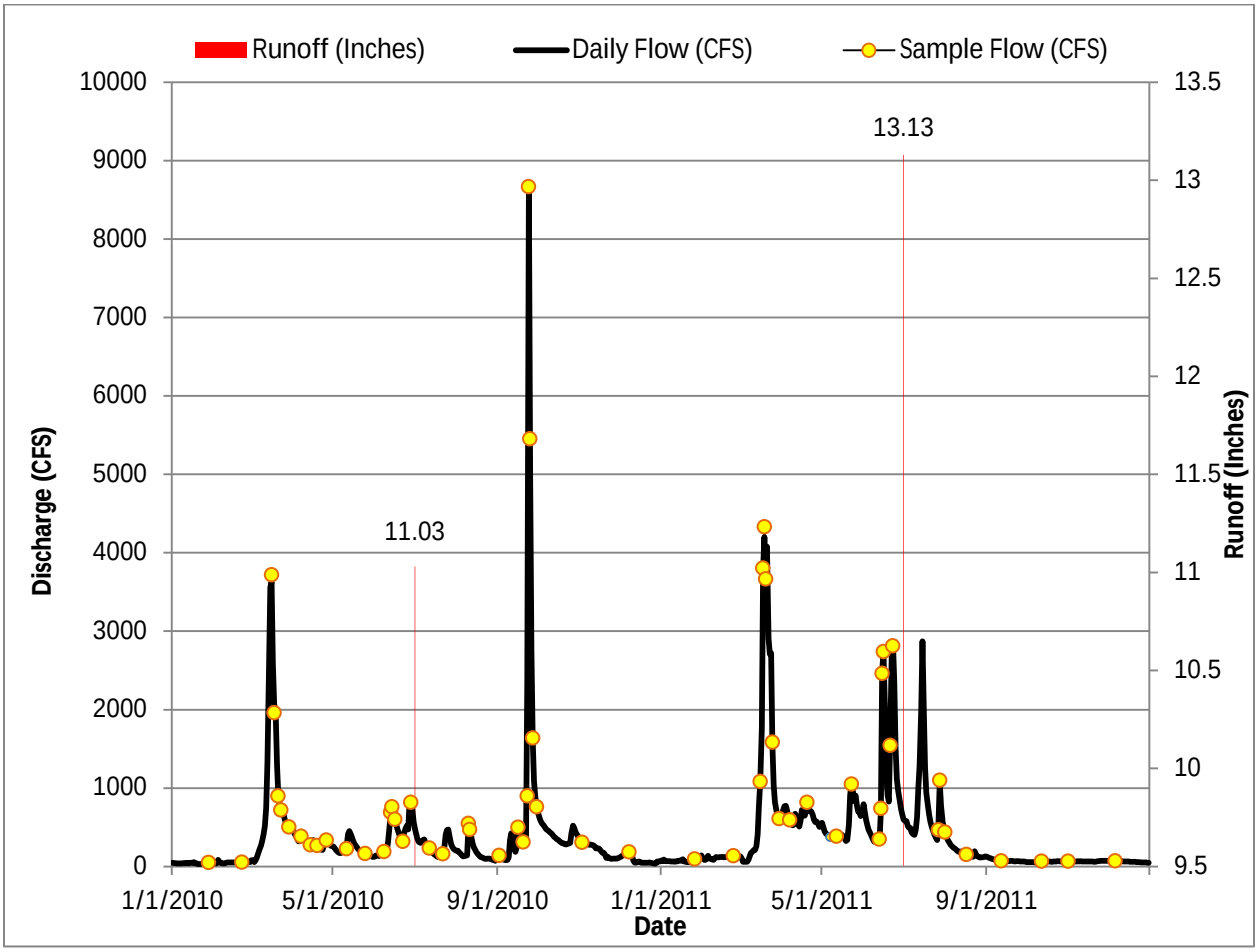

Figure 63. 2010-2011 Hydrograph, Sampling Regime and Annual Runoff for Rock River

Annual flow weighted mean concentrations (FWMCs) were calculated and compared for years 2010-2011 (Figures 12-15) and compared to the RNR standards (only TP and TSS draft standards are available for the South RNR). It should be noted that while a FWMC exceeding a given water quality standard is generally a good indicator that the water body is out of compliance with the RNR standard, the rule does not always hold true. Waters of the state are listed as impaired based on the percentage of individual samples exceeding the numeric standard, generally 10% and greater, over the most recent ten year period and not based on comparisons with FWMCs (MPCA, 2012). A river with a FWMC above a water quality standard, for example, would not be listed as impaired if less than 10% of the individual samples collected over the assessment period were above the standard.

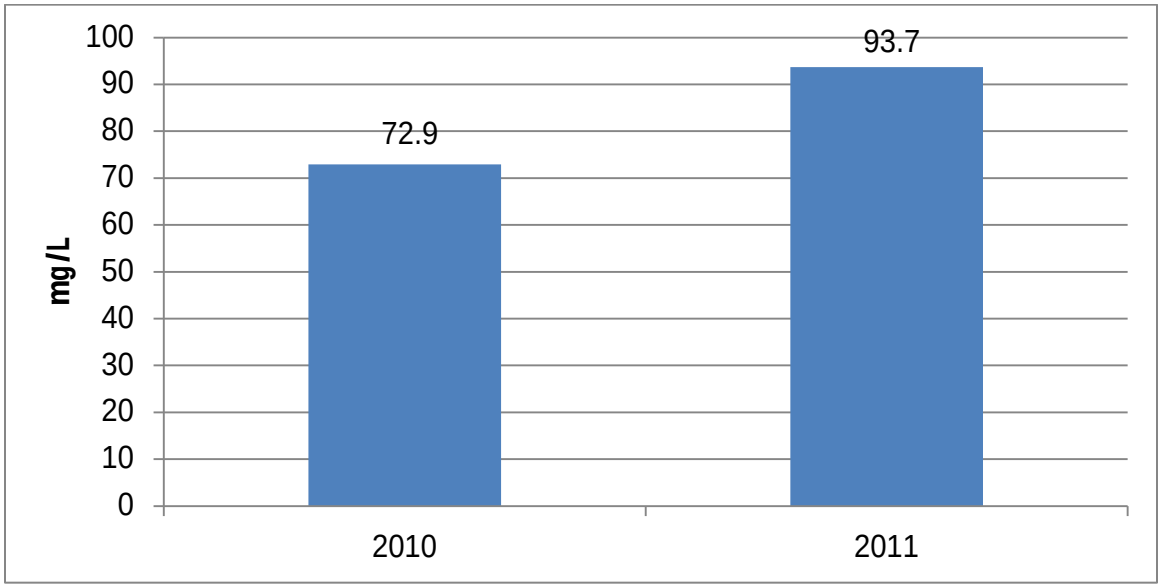

Figure 64. Total Suspended Solids (TSS) Flow Weighted Mean Concentrations for the Rock River

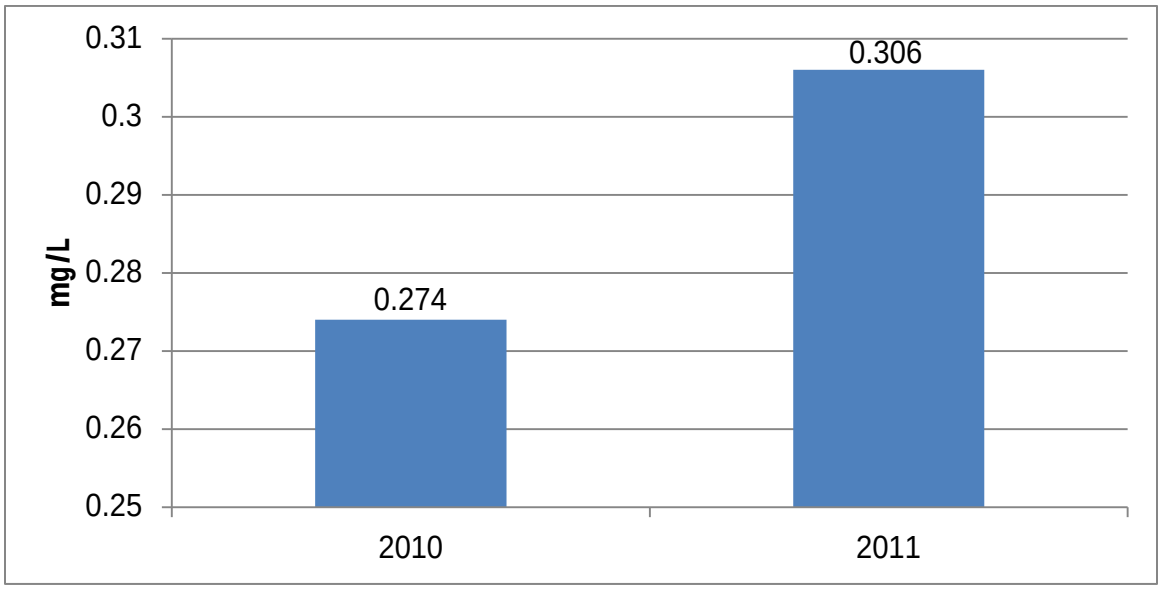

Figure 65. Total Phosphorus (TP) Flow Weighted Mean Concentrations for the Rock River

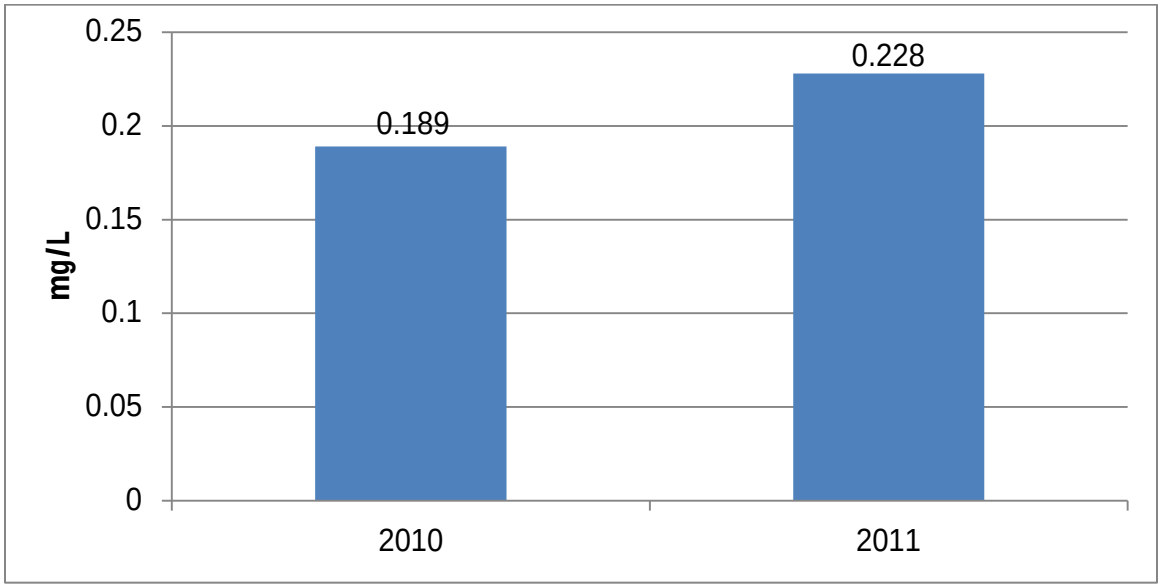

Figure 66. Dissolved Orthophosphate (DOP) Flow Weighted Mean Concentrations for the Rock River

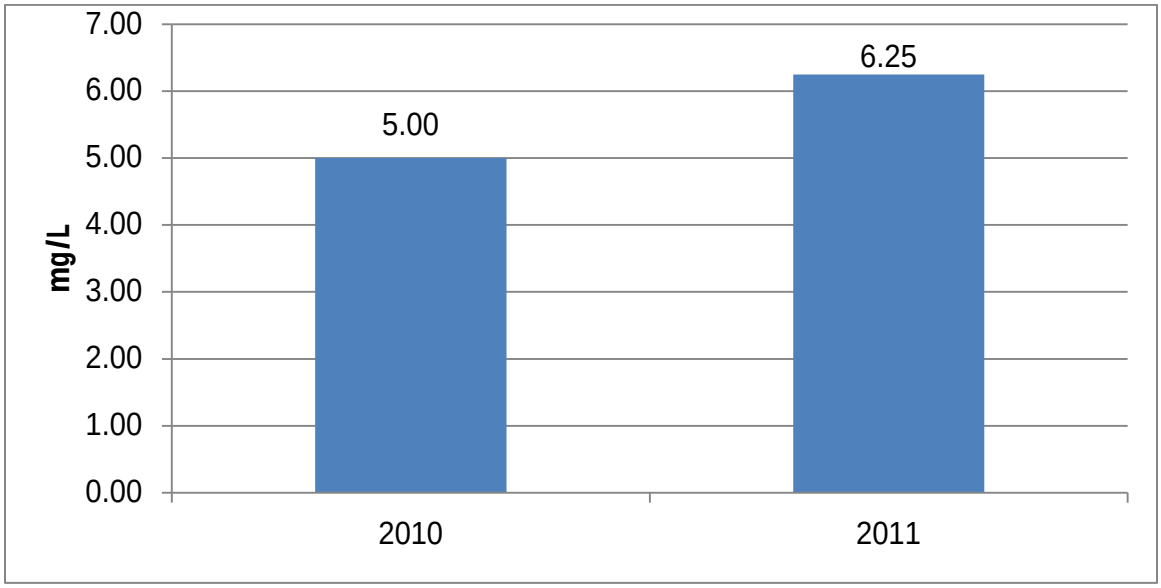

Figure 67. Nitrate + Nitrite Nitrogen (NO_3 + NO_2-N) Flow Weighted Mean Concentrations for the Rock River

Table 131. Annual Pollutant Loads by Parameter Calculated for the Rock River

	2010	2011
Parameter	**Mass (kg)**	**Mass (kg)**
Total Suspended Solids	22,156,140	33,890,350
Total Phosphorus	83,317	110,551
Dissolved Orthophosphate	57,367	82,557
Nitrate + Nitrite Nitrogen	1,519,589	2,259,228

Total Suspended Solids

Within the South RNR, a watercourse would be considered impaired when greater than 10% of the individual samples exceed the TSS draft standard of 65 mg/L. (MPCA, 2011). Samples collected in 2010 and 2011 show that 45% and 59%, exceeded the draft standard, respectively. The computed FWMC exceeded the 65 mg/L draft standard in 2010 and 2011, as shown in Figure 12. In 2010, a large rain event in September saw elevated TSS concentrations as the water levels increased. On September 23, 2010, TSS was 350 mg/L as the water level increased. The following day, the water level peaked and TSS was 84 mg/L. In 2010, the highest TSS concentration (560 mg/L) was on August 10 following a 2.2 inch rain storm (Luverne, Minnesota) that fell in less than an hour. In 2011, the highest daily average flow was 3,040 cfs during spring runoff. Again, there were exceedances as the water levels increased. The highest concentration (310 mg/L) in 2011 occurred on June 21, in response to a rain storm. Typically, rain events occurring before the crop canopy is fully enclosed because more surface erosion when compared to events after canopy closure. This often results in higher TSS concentrations in the river. Even though the highest concentrations and highest daily average flow occurred in 2010, there were more rain events in 2011 which resulted in higher loads (Table 131) and FWMC (Figure 64).

Total Phosphorus

Within the South RNR, the TP draft standard is 0.150 mg/L as a summer average. Summer average violations of one or more "response" variables (pH, biological oxygen demand, dissolved oxygen flux, chlorophyll-a) must also occur along with the numeric TP violation for the water to be listed. A comparison of the data collected from June through September in 2010 and 2011 showed 48% and 33% of samples exceeded the draft standard, respectively. The highest reported concentrations were collected on August 10, 2010 (0.783 mg/L) and March 18, 2011 (0.803 mg/L), both occurring during events described above. Figure 65 illustrates FWMCs greater than the draft standard each year; this includes all data throughout the year (not just summer values). Table 131 shows annual loads which exhibit similar traits.

Dissolved Orthophosphate

Dissolved Orthophosphate (DOP) is a water soluble form of phosphorus that is readily available for plant uptake (MPCA and MSUM, 2009). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater treatment plants, noncompliant septic systems, and fertilizers in urban and agricultural runoff. The DOP:TP ratio of FWMCs was 69% in 2010 and 75% in 2011. Figure 66 and Table 131 shows similar trends between years as seen in TP and TSS.

Nitrate plus Nitrite - Nitrogen

The draft acute value (maximum standard) for all Class 2 surface waters is 41 mg/L nitrate-N for a 1-day duration, and the draft chronic value for Class 2B (warm water) surface waters is 4.9 mg/L nitrate-N for a 4-day duration. In addition, a draft chronic value of 3.1 mg/L nitrate-N (4-day duration) was determined for protection of Class 2A (cold water) surface waters (MPCA, 2010). Figure 67 shows NO_3 + NO_2-N FWMCs over the two-year period for the Rock River monitoring site. The FWMC exceeded the draft chronic standard both years. The number of exceedances to the draft chronic standard increased from 2010 to 2011; 66% in 2010 and 77% in 2011. The highest reported value was on December 8, 2010 (8.7 mg/L). There were several 8.5 mg/L concentrations reported in June of both years. Table 131 displays the annual loads which exhibit a similar trend, increasing over the two year period.

Stream water quality

Upper Big Sioux River Watershed

One of the six stream AUIDs were able to be assessed (Table 132). It was considered to not be supporting aquatic life, and a decision was not made on whether or not it is supporting aquatic recreation.

The streams travel through a watershed that is 60% covered by agricultural land and 34% pasture, which can lead to high turbidity levels within the streams. The low transparency values in the data are an indicator of the turbid water.

Medary Creek flows through many agricultural landscapes and has small amounts of buffer strips. Channelization and runoff from these landscapes can cause the degradation of the streams and poor water quality.

Table 132. Assessment summary for stream water quality in the Upper Big Sioux River Watershed.

				Supporting		Non-supporting				
Watershed	Area (acres)	# Total AUIDs	# Assessed AUIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	Not Assessed	# Delistings
10170202 **HUC 8**	**26459**	**6**	**1**	**0**	**0**	**1**	**0**	**1**		**0**
1017020209-01	5827	0	0	0	0	0	0	0		0
1017020210-01	20632	6	1	0	0	1	0	1		0

Lower Big Sioux River Watershed

Thirty-three of the 51 stream AUIDs were assessed (Table 133). Of the assessed streams, only one stream was considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Two AUIDs are classified as limited resource waters but have limited data, therefore no assessments were made. Three AUIDS were not assessed for aquatic biology because greater than 50% of the AUID is channelized or the biological station fell on a channelized stream reach on the AUID.

Throughout the watershed, twenty-three AUIDs are non-supporting for aquatic life and/or recreation. Of those AUIDs, eighteen are non-supporting for aquatic life and five are non-supporting for aquatic recreation.

There are high levels of bacteria in almost every stream reach in the Lower Big Sioux Watershed. Turbidity in the watershed is a concern as well. The land use in the Lower Big Sioux Watershed is dominated by agriculture on 77% of its landscape. The lack of buffers and the high amounts of agriculture could be contributing to the turbid conditions in the streams. Channelization of streams can lead to souring of the stream bed which can lead to more degradation of stream reaches.

Table 133. Assessment summary for stream water quality in the Lower Big Sioux River Watershed.

				Supporting		Non-supporting				
Watershed	Area (acres)	# Total AUIDs	# Assessed AUIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	Not Assessed	# Delistings
10170203 **HUC 8**	**326852**	**51**	**33**	**1**	**0**	**19**	**5**	**3**	**35**	**0**
1017020301-01	8546	1	1	0	0	1	0	0	1	0
1017020303-01	61583	10	6	0	0	4	1	0	5	0
1017020313-01	27584	6	3	0	0	2	2	0	2	0
1017020313-02	40985	4	3	1	0	2	0	0	3	0
1017020313-03	28740	6	5	0	0	2	0	0	8	0
1017020315-01	73223	12	6	0	0	2	1	2	7	0
1017020316-02	81296	11	8	0	0	5	1	1	8	0
1017020317-01	4895	1	1	0	0	1	0	0	1	0

Rock River Watershed

Forty-six of the 92 stream AUIDs were assessed (Table 134). Of the assessed streams, only two streams were considered to be fully supporting of aquatic life and no streams were fully supporting of aquatic recreation. Three AUIDs are classified as limited resource waters. All three of them have limited datasets and were not assessed. Six AUIDS were not assessed for aquatic biology because greater than 50% of the AUID is channelized or the biological station fell on a channelized stream reach on the AUID.

Throughout the watershed, 47 AUIDs are non-supporting of aquatic life and/or recreation. Of those AUIDs, 28 are non-supporting of aquatic life and 19 are non-supporting of aquatic recreation.

The Rock River Watershed contains high levels of bacteria throughout it and many times the individual exceedances for bacteria are far beyond the standard. May through October are months where the bacteria levels are increasing at alarming rates and have been as high as >24,196 MPN/100ml, which is over 19 times higher than the individual standard of 1,260 MPN/100ml. Agricultural land is dominating the landscape at over 80% and there is about 10% of pastured land use within the Rock River Watershed. The watershed does have developed areas (6%); all of these altered land uses can negatively impact water quality, specifically if runoff is not managed properly.

Table 134. Assessment summary for stream water quality in the Rock River Watershed.

				Supporting		Non-supporting				
Watershed	Area (acres)	# Total AUIDs	# Assessed AUIDs	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	Not Assessed	# Delistings
10170204 **HUC 8**	582128	**92**	**46**	**2**	**0**	**28**	**19**	**6**	**33**	**0**
1017020401-01	64753	14	8	0	0	4	5	2	5	0
1017020401-02	22364	5	3	0	0	3	1	0	2	0
1017020401-03	72719	11	5	0	0	3	1	1	4	0
1017020401-04	47915	7	4	0	0	3	1	1	3	0
1017020402-01	88059	12	5	0	0	3	3	1	3	0
1017020402-02	36444	3	2	0	0	1	1	0	2	0
1017020403-01	59511	12	5	0	0	3	1	1	5	0
1017020403-02	41220	5	2	0	0	1	1	0	1	0
1017020403-03	48553	5	2	0	0	2	1	0	1	0
1017020404-01	25951	7	3	1	0	1	1	0	1	0
1017020405-02	4899	1	1	0	0	0	0	0	2	0
1017020406-02	36761	6	2	0	0	2	2	0	0	0
1017020406-03	26934	4	4	1	0	2	1	0	4	0
1017020407-02	6045	0	0	0	0	0	0	0	0	0

Little Sioux River Watershed

Thirteen of the 32 stream AUIDs were assessed (Table 135). Of the assessed streams, no streams were considered to be fully supporting of aquatic life and one stream was fully supporting of aquatic recreation. Thirteen AUIDS were not assessed for aquatic biology because greater than 50% of the AUID is channelized or the biological station fell on a channelized stream reach on the AUID.

Throughout the watershed, 12 AUIDs are non-supporting for aquatic life and/or recreation. Of those AUIDs, 5 are non-supporting for aquatic life and seven are non-supporting for aquatic recreation.

The high levels of bacteria across the watershed are a concern for almost every stream reach. The fully supporting aquatic recreation stream reach (The Ocheyedan River) flows from Lake Ocheda through Peterson Slough and Lake Bella, which could help contain the bacteria, therefore resulting in the low levels that are being recorded. There are some areas of the stream that have grassland and herbaceous areas that could serve as a buffer. The sample location for this stream is located near an area where those buffers are heavily present, along with a large wetland north (1.0 mile) of the location. These factors could also result in those low bacteria values that were being recorded. Sources of bacteria include underperforming septic systems and animal life (e.g. pets, livestock, and wildlife).

Turbidity is another concern in this watershed. Many streams are impaired due to turbidity, and the lack of buffers and high amounts of agriculture (83%) in the Little Sioux River Watershed are likely contributing to the turbid conditions in the streams. The high amounts of channelization can lead to additional scouring of the stream beds.

Table 135. Assessment summary for stream water quality in the Little Sioux River Watershed.

				Supporting		Non-supporting				
Watershed	**Area (acres)**	**# Total AUIDs**	**# Assessed AUIDs**	**# Aquatic Life**	**# Aquatic Recreation**	**# Aquatic Life**	**# Aquatic Recreation**	**Insufficient Data**	**Not Assessed**	**# Delistings**
10230003 **HUC 8**	**205854**	**32**	**13**	**0**	**1**	**5**	**7**	**5**	**8**	**0**
1023000301-01	36471	5	2	0	0	0	2	2	0	0
1023000301-02	28962	2	1	0	0	1	1	0	0	0
1023000302-01	25266	4	1	0	0	1	0	0	2	0
1023000303-02	68617	11	4	0	0	0	3	2	2	0
1023000305-02	46538	10	5	0	1	3	1	1	4	0

Lake water quality

Little Sioux River Watershed contains 44 lakes greater than 10 acres (Table 136). Nine of them were assessed and all of them are not supporting the aquatic recreation standard. Two lakes had insufficient information for an assessment. All of the lakes are shallow, and shallow lakes are susceptible to mixing throughout the open water season. The mixing resuspends bottom sediments, which when combined with high temperatures and high pH, can result in continued release of phosphorus into the water column (i.e. internal loading). The watershed is heavily dominated by agricultural land use (83%) with the open water only covering 4% of the watershed. With every heavy rain event the overland runoff is contributing to the current water quality in a negative way by depositing phosphorus and sediment. The watershed does have developed areas (6%) that can also negatively impact the water quality. Some lakes do have a small buffer of land surrounding parts of the shoreline, but other waterbodies are heavily rip-rapped with reduces rooted aquatic vegetation buffers. If aquatic recreation is to improve, increased application of agricultural BMPs must occur – including buffer strips and shoreline buffers on lakes. In addition, lakes will require management of internal loading and rough fish to reduce resuspension of the sediments.

Table 136. Assessment summary for lake water chemistry in the Little Sioux River Watershed.

			Supporting		Non-supporting				
Watershed	Area (acres)	Lakes >10 Acres	# Aquatic Life	# Aquatic Recreation	# Aquatic Life	# Aquatic Recreation	Insufficient Data	Not Assessed	# Delistings
10230003 **HUC 8**	**205854**	**44**	**0**	**0**	**0**	**9**	**4**	**11**	**0**
1023000301-01	36471	10	0	0	0	3	0	2	0
1023000301-02	28962	3	0	0	0	0	0	0	0
1023000302-01	25266	9	0	0	0	3	0	3	0
1023000303-02	68617	12	0	0	0	0	0	0	0
1023000305-02	46538	10	0	0	0	3	2	6	0

Fish contaminant results

Eleven fish species from the Rock River and 6 lakes were tested for mercury and/or PCBs. A total of 150 fish were tested from between 1981 and 2011. Fish species are identified by codes that are defined by their common and scientific names in Table BM1.

Table BM2 is a summary of contaminant concentrations by waterway, fish species, and year. The table shows which contaminants, species, and years were sampled. “No. Fish” indicates the total number of fish analyzed and “N” indicates the number of samples. The number of fish exceeds the number of samples when fish are combined into a composite sample. This was typically done for panfish, such as bluegill sunfish (BGS) and yellow perch (YP). Since 1989, most of the samples have been skin-on fillets (FILSK) or for fish without scales (catfish and bullheads), skin-off fillets (FILET).

PCBs were analyzed in northern pike (NP), redhorse (RHS), and white sucker (WSU) in 1981 from the Rock River. In 2011, the common carp (C) were analyzed for PCBs. In all cases, the PCBs concentrations were below the reporting limits (0.02 mg/kg in 1981 and 0.025 mg/kg in 2011). Also, PCBs were tested in channel catfish (CHC) from Okabena Lake (Lake ID: 53-0028) in 2000 and northern pike from Split Rock Reservoir (Lake ID: 59-0001) in 1986 and found to below or near the reporting limit.

Mercury concentrations were low in all fish except walleye (WE) from Little Spirit Lake (Lake ID: 32-0024). The higher mercury levels in the walleye resulted in Little Spirit Lake being classified as impaired due to mercury in fish tissue in the 2010 Impaired Waters List. Three of the five walleye collected in 2008 from Little Spirit lake exceeded the 0.2 mg/kg water quality standard for mercury in edible fish tissue. The other three fish species collected from Little Spirit Lake in 2008 were below the impairment threshold. The other five lakes, as well as Rock River, are not classified as impaired due to mercury in fish tissue. The highest individual mercury concentration was 0.239 mg/kg in a 18.3 inch (total length) walleye from Little Spirit Lake.

Overall, the fish contaminant results shows PCBs are not a concern in the Rock River or the two lakes tested (Okabena and Split Rock Reservoir). Mercury concentrations in fish tissue were generally low. The exception were walleye from Little Spirit Lake, which is the only waterbody from the Missouri River watersheds tested for mercury in fish that was sufficiently high to merit classification as impaired due to mercury in fish tissue.

Table 137. Fish species codes, common names, and scientific names

Species	Common Name	Scientific Name
BGS	Bluegill sunfish	*Lepomis macrochirus*
BKB	Black bullhead	Ameiurus melas
BKS	Black crappie	*Pomoxis nigromaculatis*
C	Common Carp	*Cyprinus carpio*
CHC	Channel catfish	*Ictalurus punctatus*
NP	Northern pike	*Esox Lucius*
RHS	Redhorse, unknown species	*Moxostoma sp.*
SF	Pumpkinseed sunfish	*Lepomis gibbosus*
WE	Walleye	*Sander vitreus*
WSU	White sucker	*Catostomus commersoni*
YP	Yellow perch	*Perca flavescens*

Table 138. Summary statistics of mercury and PCBs, by waterway-species-year

WATERWAY	AUID	LOCATION	SPECIES[1]	YEAR	ANATOMY[2]	No. fish	Length (in)			Mercury (mg/kg)				PCBs (mg/kg)		
							Mean	Min	Max	N	Mean	Min	Max	N	Mean	Max
ROCK RIVER	10170204-502, -503, -504, -505, -506, -507, -508, -509, -501, -530	Near headwaters (1981); 11MS001 (2011)	C	2011	FILSK	5	22.4	19.5	25.0	5	0.101	0.058	0.154	2	< 0.025	< 0.025
			NP	1981	FILSK	7	18.3	14.4	22.1	2	0.170	0.150	0.190	2	< 0.02	< 0.02
				2011	FILSK	1	18.0			1	0.075					
			RHS	1981	FILSK	2	15.7	15.7	15.7	1	0.210			1	< 0.02	
			WSU	1981	FILSK	6	13.2	12.5	13.9	2	0.130	0.070	0.190	2	< 0.02	< 0.02
LOON	32002000		BKS	2008	FILSK	9	9.6	9.6	9.6	1	0.030					
			C	2008	FILSK	3	21.9	21.9	21.9	1	0.027					
			WE	2008	FILSK	5	14.9	11.9	17.3	5	0.056	0.037	0.075			
LITTLE SPIRIT*	32002400		BKS	2008	FILSK	3	8.9	8.9	8.9	1	0.053					
			C	2008	FILSK	3	26.7	26.7	26.7	1	0.022					
			WE	2008	FILSK	5	18.0	17.2	19.0	5	0.191	0.132	0.239			
			YP	2008	FILSK	3	10.7	10.7	10.7	1	0.043					
ROUND	32006900		BKS	2009	FILSK	8	12.7	12.1	13.2	2	0.047	0.046	0.047			
			C	2009	FILSK	3	25.5	25.5	25.5	1	0.041					
			WE	2009	FILSK	8	18.6	15.5	21.0	8	0.045	0.031	0.076			
OCHEDA	53002400		C	2009	FILSK	3	17.4	17.4	17.4	1	0.013					
			WE	2009	FILSK	8	10.4	9.6	11.4	8	0.020	0.014	0.024			

OKABENA	53002800	BKS	2000	FILSK	10	7.4	7.4	7.4	1	0.010					
		CHC	2000	FILET	4	22.9	20.0	25.1	4	0.080	0.010	0.150	4	0.011	0.014
		SF	2000	FILSK	10	6.4	6.4	6.4	1	0.010					
		WE	2000	FILSK	7	17.5	12.6	22.4	7	0.093	0.030	0.170			
		WSU	2000	FILSK	4	19.6	19.6	19.6	1	0.130					
SPLIT ROCK RES.	59000100	BGS	2007	FILSK	8	6.4	6.4	6.4	1	0.048					
		BKB	1986	FILET	9	8.1	8.1	8.1	1	0.200					
		NP	1986	FILSK	4	16.9	16.9	16.9	1	0.510			1	< 0.05	
			2007	FILSK	3	19.8	18.2	23.1	3	0.162	0.137	0.175			
		WE	2007	FILSK	5	17.3	14.2	21.8	5	0.059	0.036	0.109			
		YP	2007	WHORG	4	6.1	6.1	6.1	1	0.053					

* Impaired for mercury in fish tissue as of 2012 Draft Impaired Waters List and categorized as EPA Class 4a (covered under the Statewide Mercury TMDL).

1 Species codes are defined in Table BM1

2 Anatomy codes: FILSK – edible fillet, skin-on; FILET—edible fillet, skin-off; PLUG—dorsal muscle piece, without skin; WHORG—whole organism

Groundwater monitoring

Stream flow

Groundwater/surface water withdrawals

The three largest permitted consumers of water in the state (in order) are municipalities, industry and irrigation. The withdrawals across all four of the watersheds are mostly for irrigation and municipal use.

Little Sioux River Watershed

Figure 17 displays the locations of permitted groundwater and surface water withdrawals within the Little Sioux River Watershed from 1991-2011. During this time period, both groundwater and surface water withdrawals exhibit a significant rising trend (p=0.001).

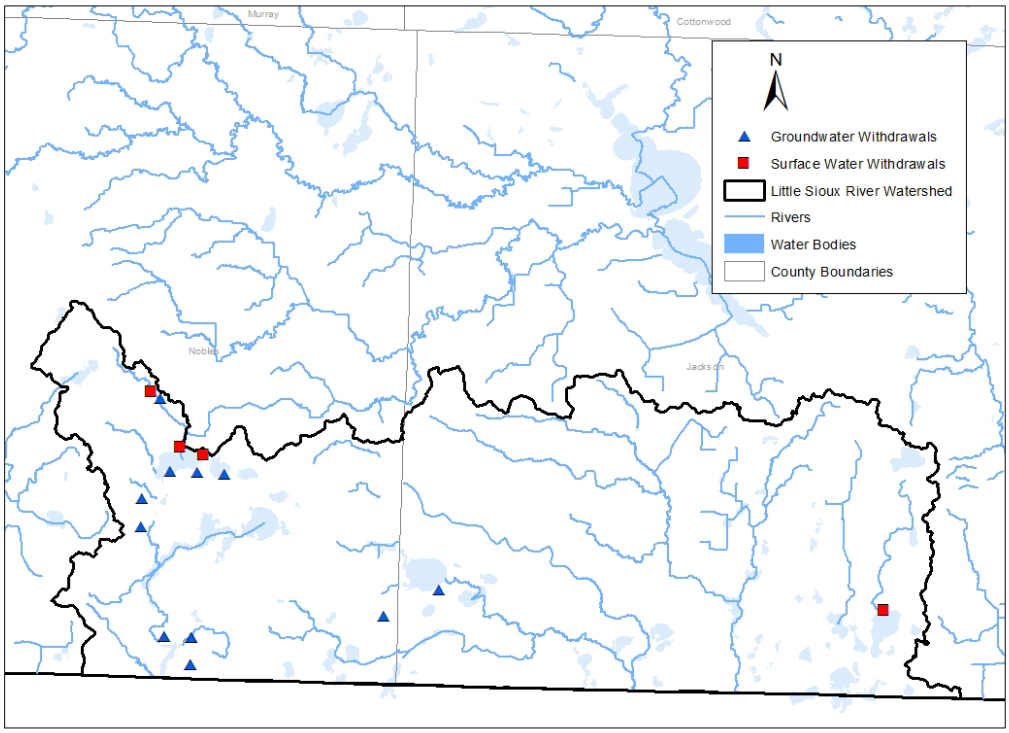

Figure 68. Locations of permitted groundwater withdrawals in the Little Sioux River Watershed.

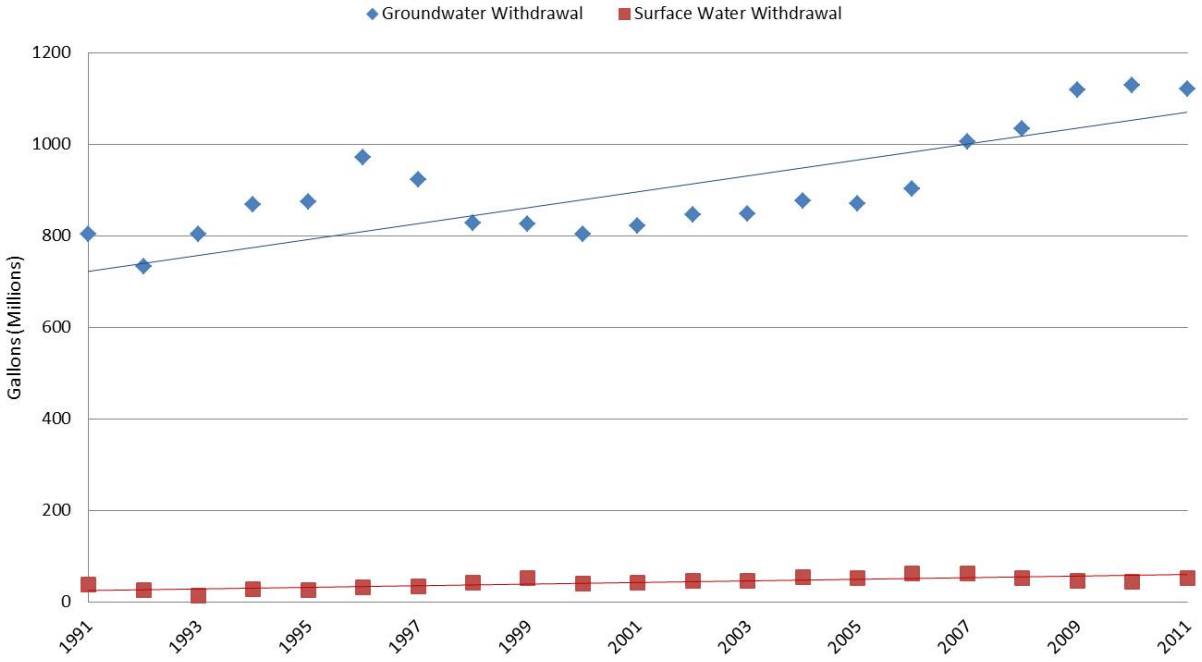

Figure 69. Total annual groundwater and surface water withdrawals in the Little Sioux River Watershed (1991-2011).

More specifically, withdrawals from the shallow water table aquifer within the watershed have increased significantly (p=0.001) over the same time period (1991-2011).

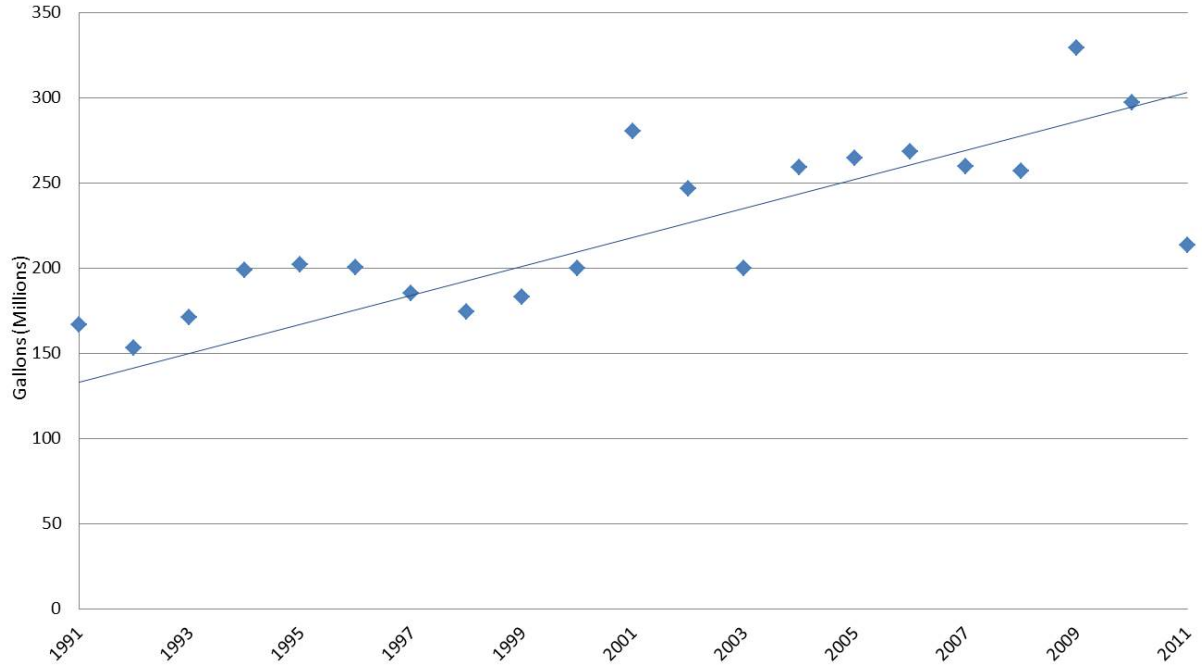

Figure 18. Total Quaternary Water Table Aquifer withdrawals in the Little Sioux River Watershed (1991-2011).

Rock River Watershed

Figure 71 displays the locations of permitted groundwater and surface water withdrawals within the Rock River Watershed from 1991-2011. During this time period, groundwater withdrawals exhibit a significant rising trend (p=0.001) while surface water withdrawals exhibit no trend.

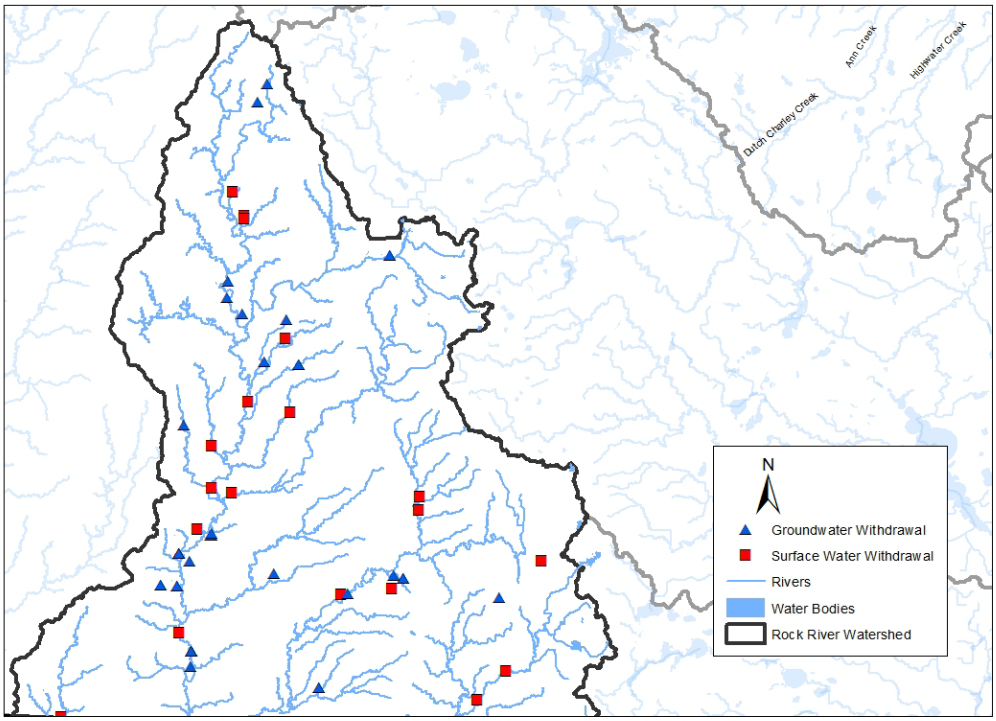

Figure 71. Locations of permitted groundwater withdrawals in the Rock River Watershed.

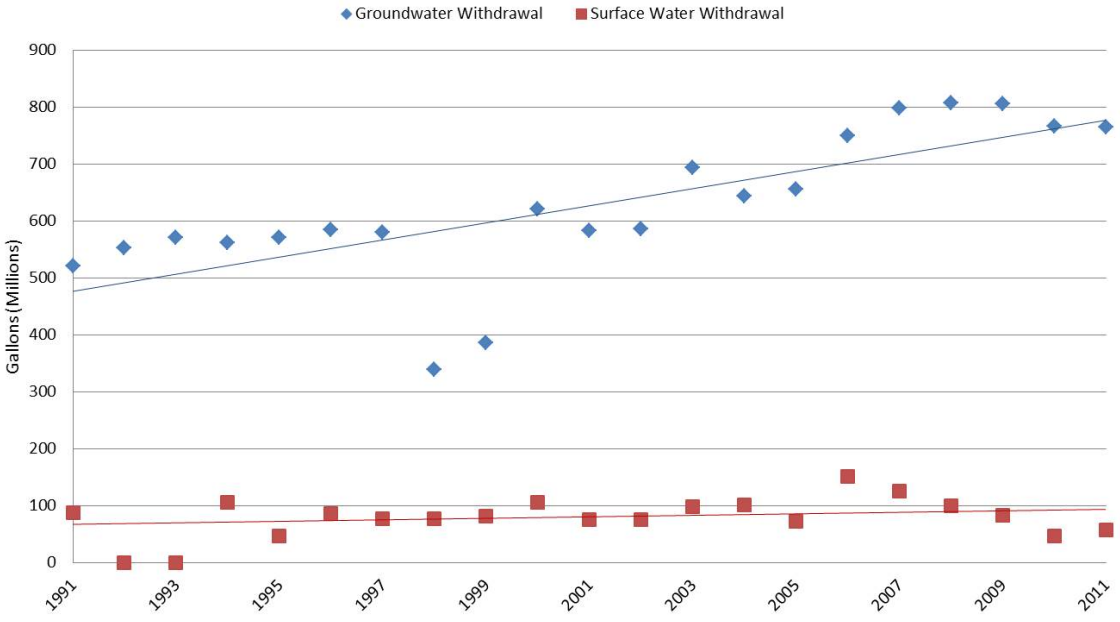

Figure 72. Total annual groundwater and surface water withdrawals in the Rock River Watershed (1991-2011).

More specifically, withdrawals from the shallow water table aquifer within the watershed have increased significantly (p=0.001) over the same time period (1991-2011).

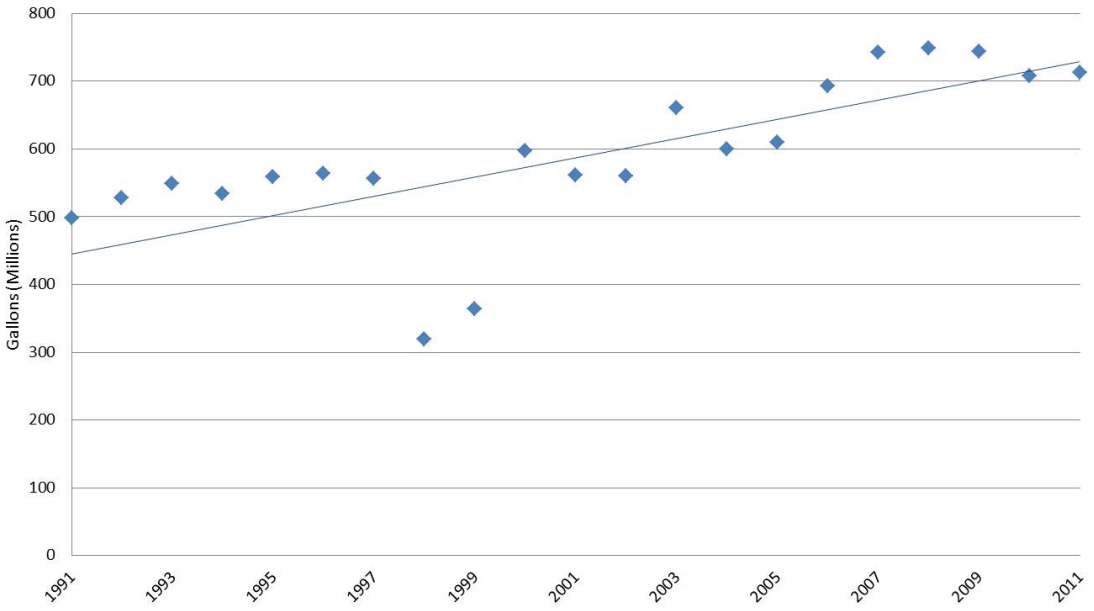

Figure 73. Total Quaternary Water Table Aquifer withdrawals in the Rock River Watershed (1991-2011).

Lower Big Sioux Watershed

Figure 74 displays the locations of permitted groundwater and surface water withdrawals within the Lower Big Sioux River Watershed from 1991-2011. During this time period, groundwater withdrawals exhibit a statistically significant rising trend (p=0.001). Surface water withdrawals also exhibit a significant rising trend (p=0.01).

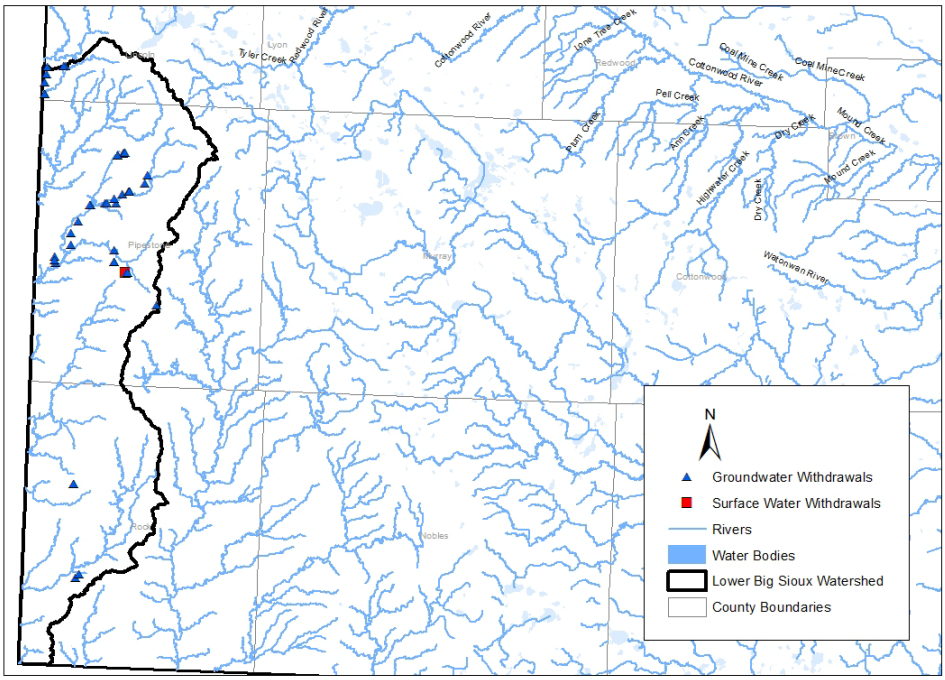

Figure 74. Locations of Permitted Groundwater and Surface Water Withdrawals in the Lower Big Sioux River Watershed.

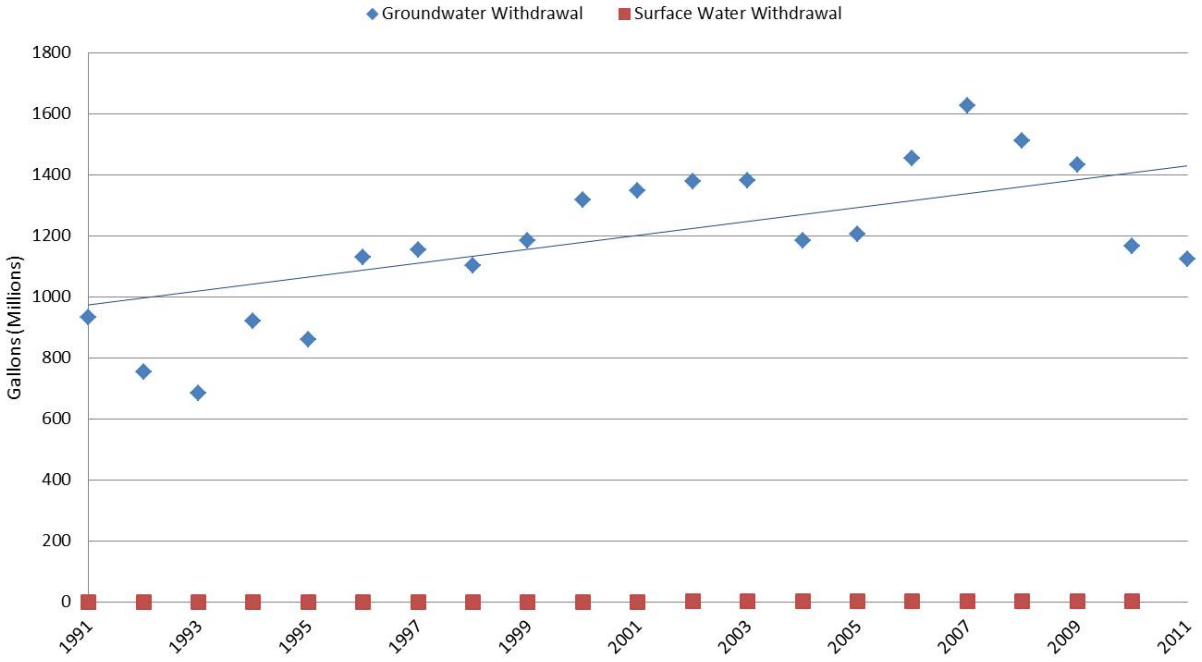

Figure 75. Total annual groundwater and surface water withdrawals in the Lower Big Sioux River Watershed (1991-2011).

More specifically, withdrawals from the shallow water table aquifer within the watershed have increased significantly (p=0.001) over the same time period (1991-2011).

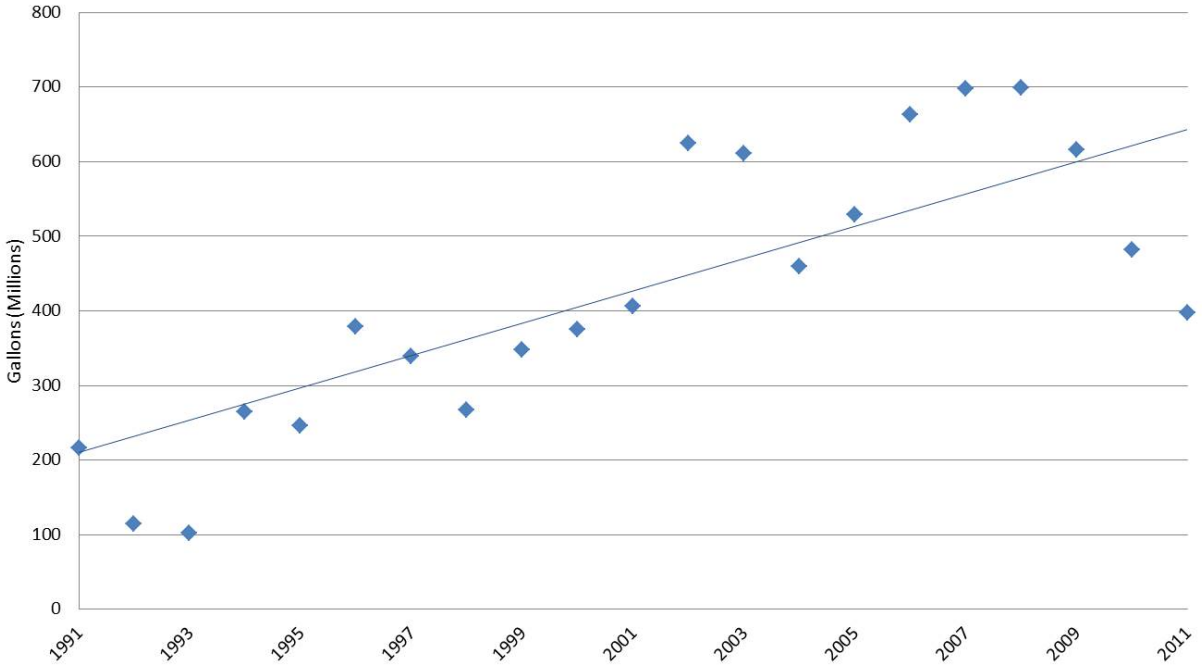

Figure 76. Total Quaternary Water Table Aquifer withdrawals in the Lower Big Sioux River Watershed (1991-2011).

Upper Big Sioux Watershed

Figure 77 Displays the locations of permitted groundwater and surface water withdrawals within the Upper Big Sioux River Watershed from 1990-2010. During this time period, groundwater withdrawals exhibit a significant rising trend (p=0.001).

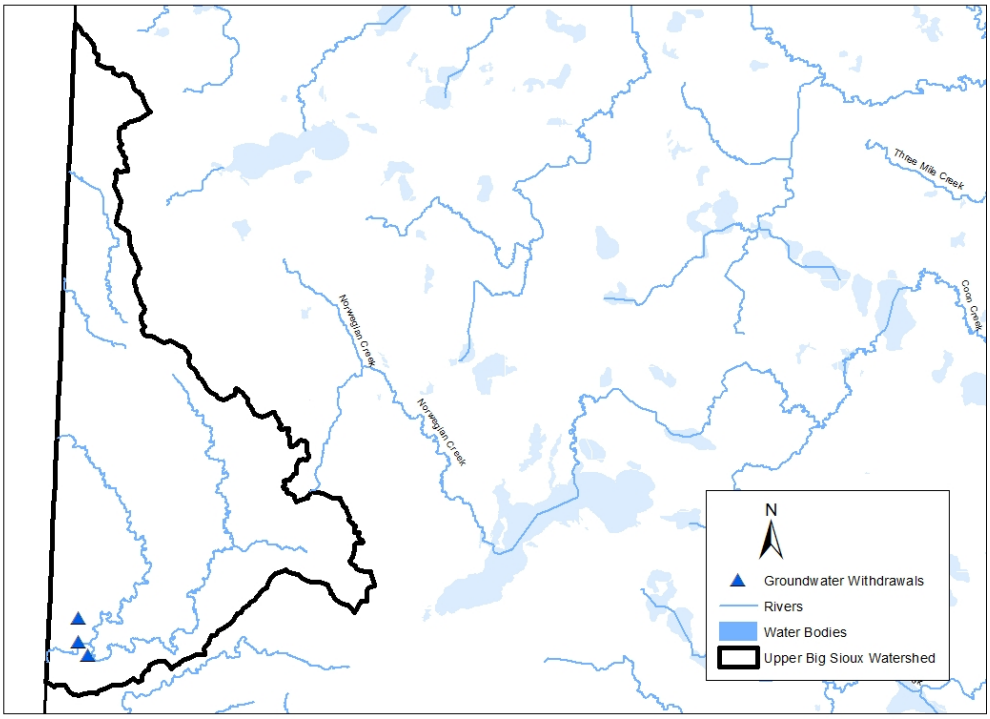

Figure 77. Locations of permitted groundwater withdrawals in the Upper Big Sioux River Watershed.

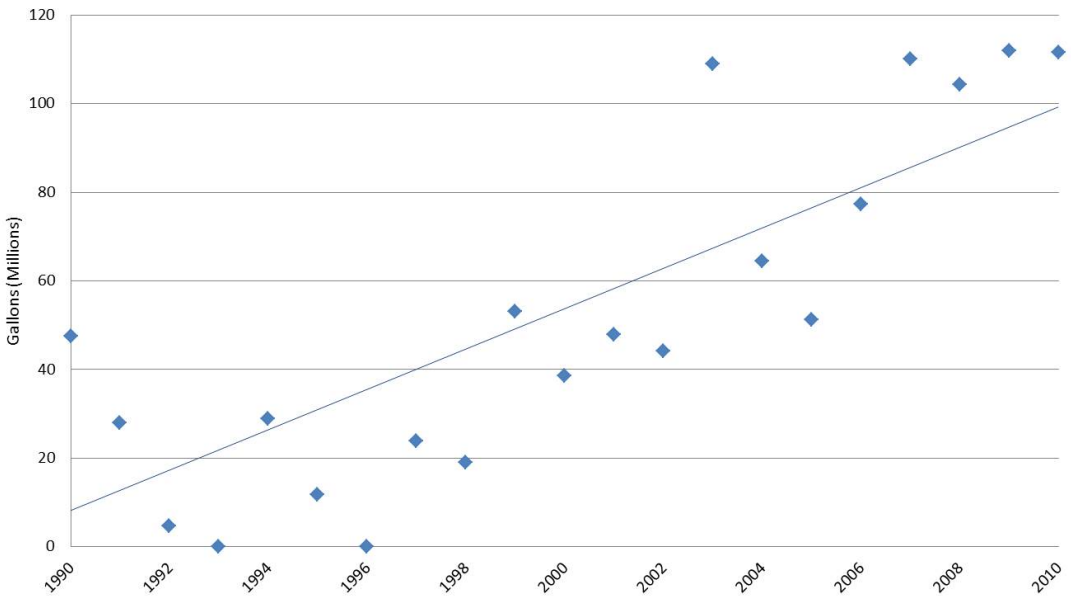

Figure 78. Total annual groundwater withdrawals in the Upper Big Sioux River Watershed (1990-2010).

Groundwater quantity

Little Sioux River Watershed

Two observation wells (53012 and 32004) in the Little Sioux River Watershed were chosen based on data availability and geologic location within the watershed. Neither observation well exhibits a statistically significant trend in groundwater elevation change.

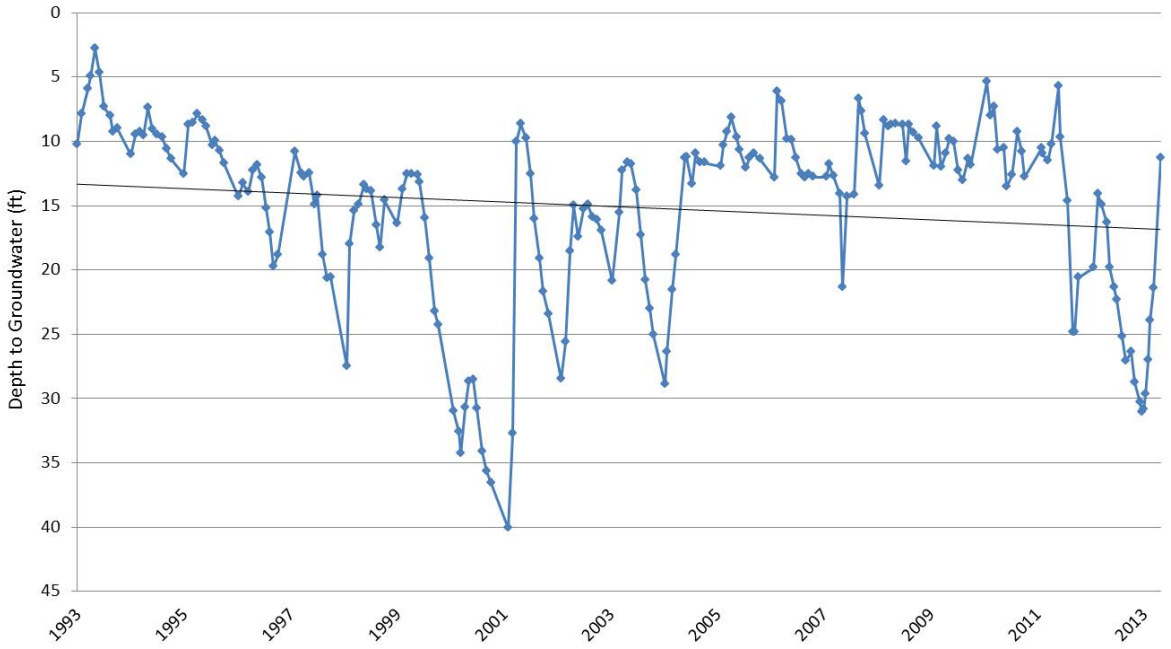

Figure 79. Observation Well 53012, located in the central area of Little Sioux River Watershed near Worthington in Nobles County (1993-2013).

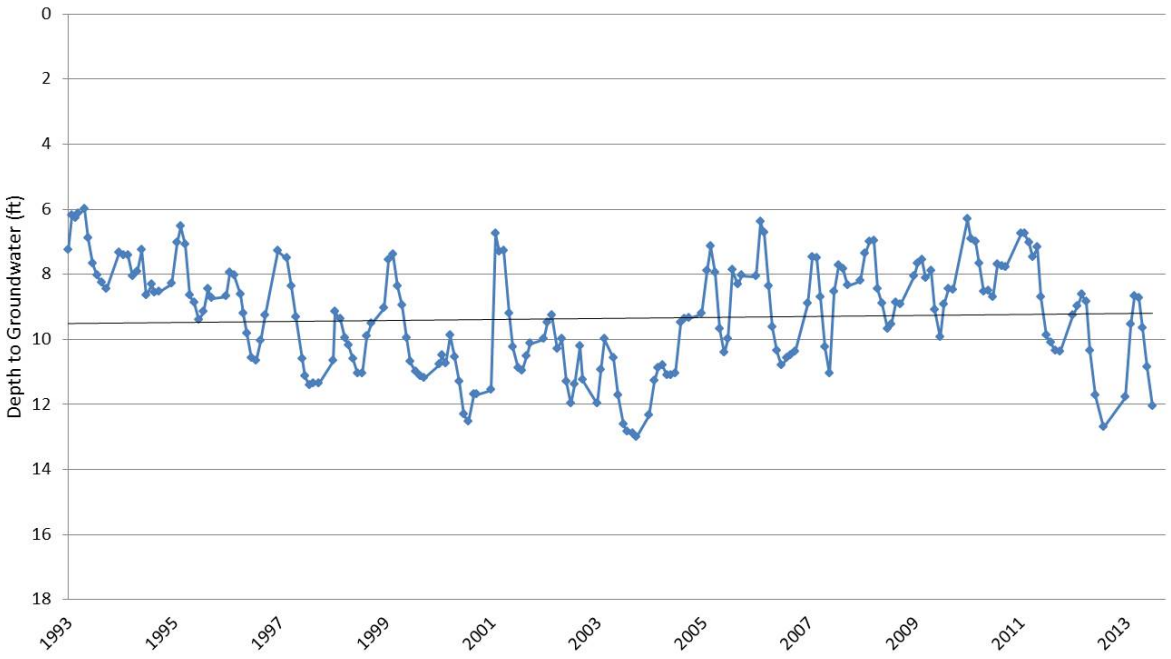

Figure 80. Observation Well 32004, located in the eastern area of Little Sioux River Watershed near Lakefield in Jackson County (1993-2013).

Rock River Watershed

Three observation wells (51004, 53011, and 67005) in the Rock River Watershed were chosen based on data availability and geologic location within the watershed. None of the observation wells exhibits a statistically significant trend in groundwater elevation change.

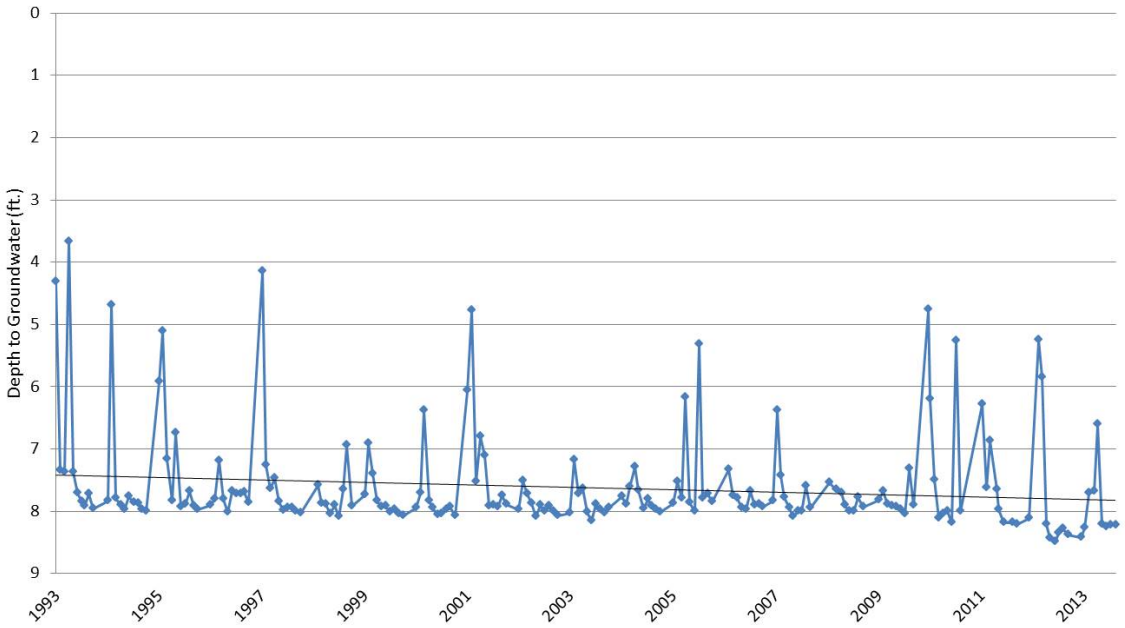

Figure 81. Observation Well 51004, located in the northern area of Rock River Watershed near Chandler in Murray County (1993-2013).

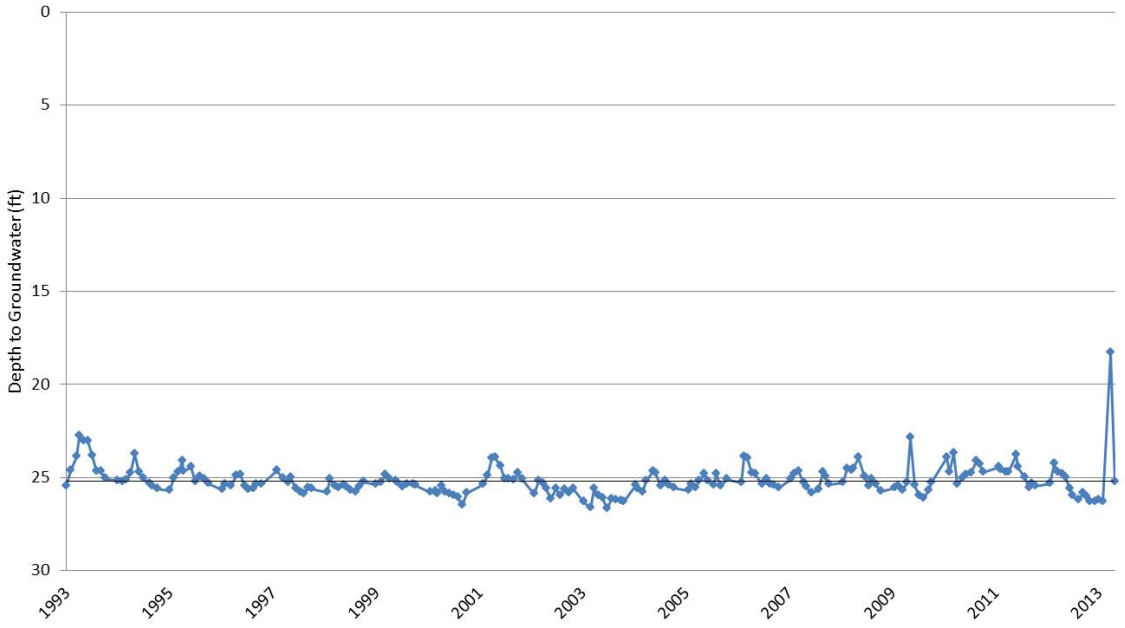

Figure 82. Observation Well 53011, located in the south central area of Rock River Watershed near Ellsworth in Nobles County (1993-2013).

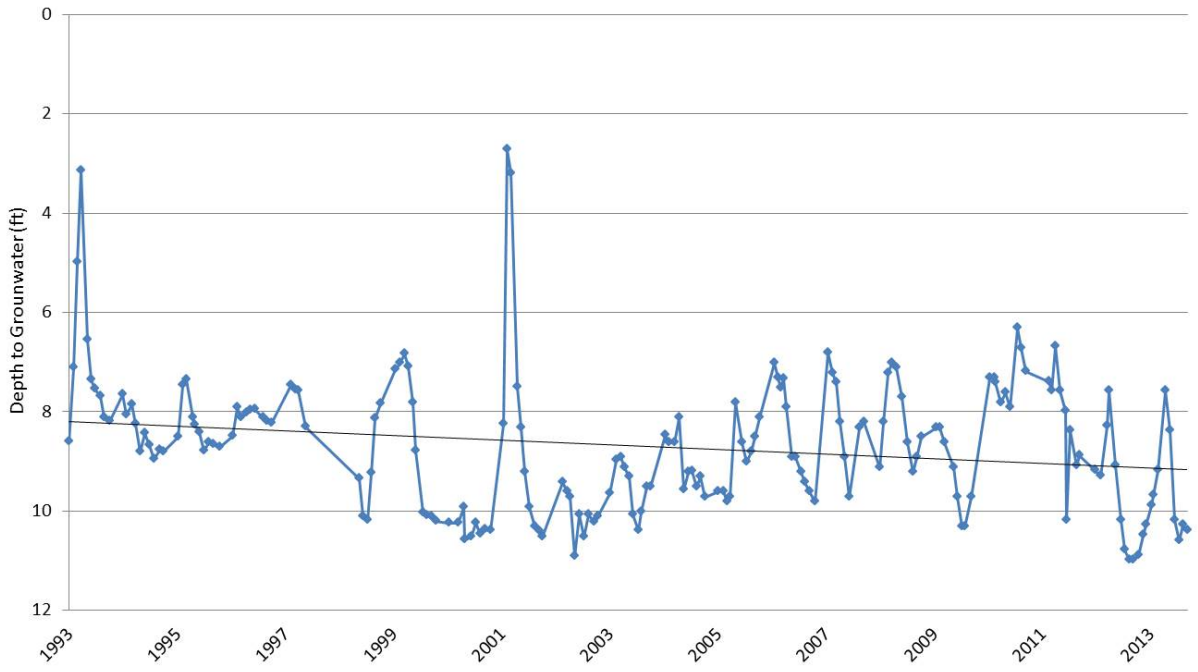

Figure 83. Observation Well 67005, located in the southwest area of Rock River Watershed near Luverne in Rock County (1993-2013).

Lower Big Sioux Watershed

Two observation wells (67009 and 59009) within the Lower Big Sioux River Watershed were chosen based on data availability and geologic location within the watershed. Neither observation well exhibits a statistically significant trend in groundwater elevation change.

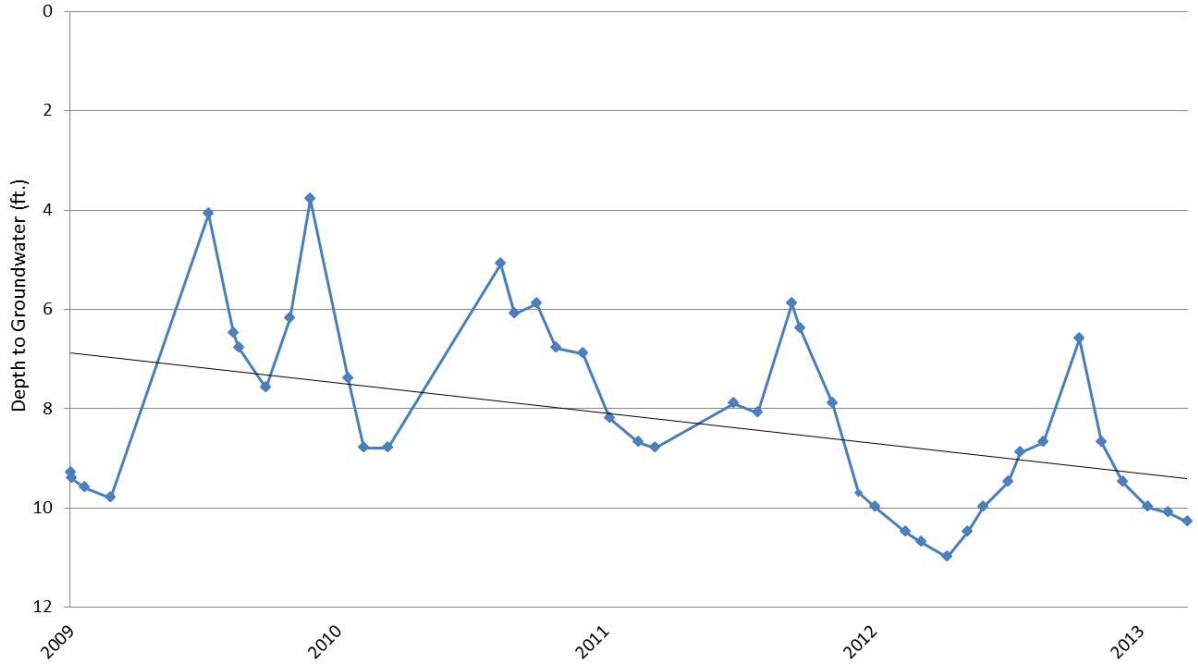

Figure 84. Observation Well 67009, located in the southern area of Lower Big Sioux River Watershed near Beaver Creek in Rock County (2009-2013).

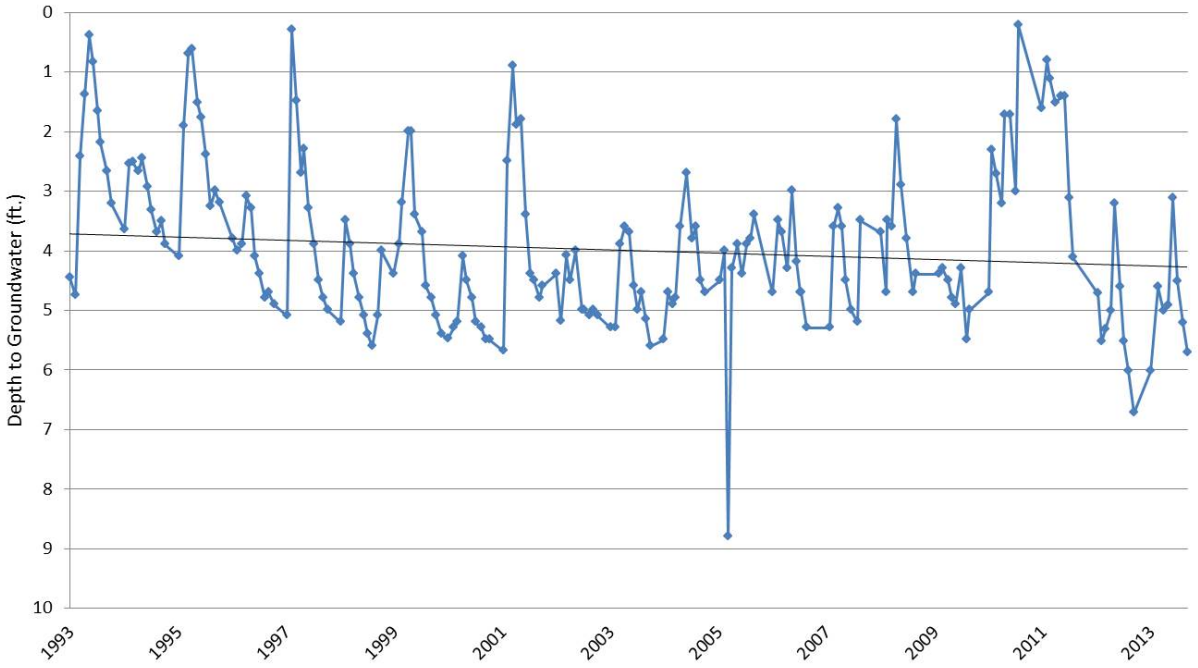

Figure 19. Observation Well 59009, located in the central area of Lower Big Sioux River Watershed near Pipestone in Pipestone County (1993-2013).

Stream flow

There is currently no long term stream flow data available for the Minnesota portions of the Little Sioux River and Upper Big Sioux River Watersheds. Flow data for streams in the Rock and Lower Big Sioux River Watersheds were analyzed.

Rock River Watershed

Figure 86 is a display of the annual mean discharge for Rock River at Rock Rapids, Iowa from 2003 to 2013. The data shows that there is an increase in stream flow over time, but there is no statistically significant trend. Figure 87 displays July and August mean flows for the last ten years for the same water body. Although July months appear to be increasing, neither it nor August exhibit a statistically significant trend over this time period.

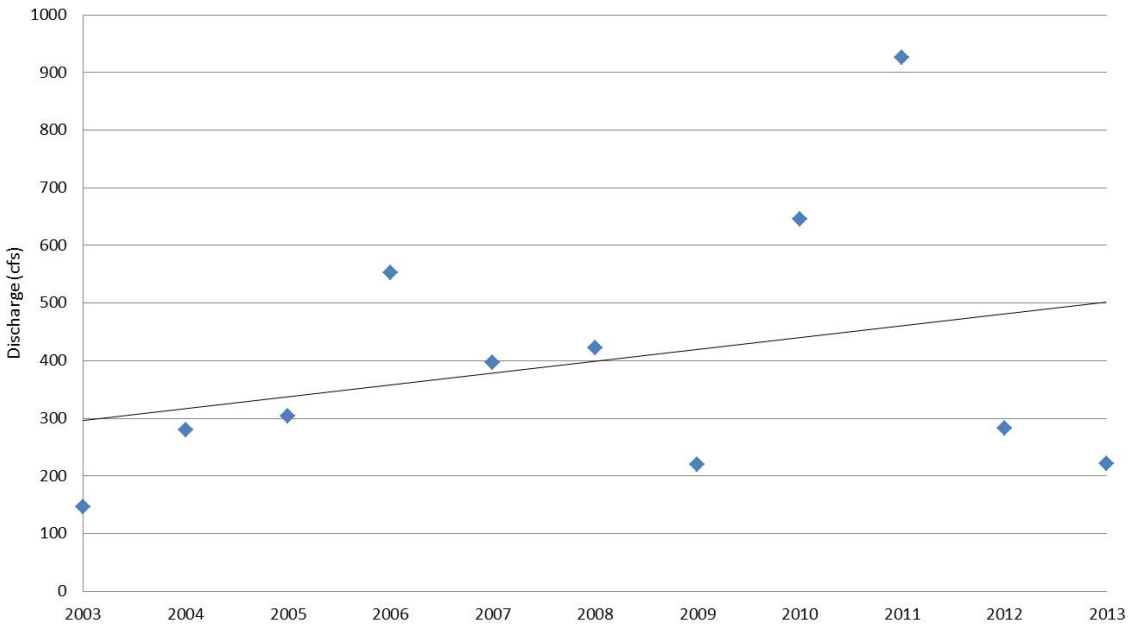

Figure 86. Annual Mean Discharge for Rock River at Rock Rapids, Iowa (2003-2013).

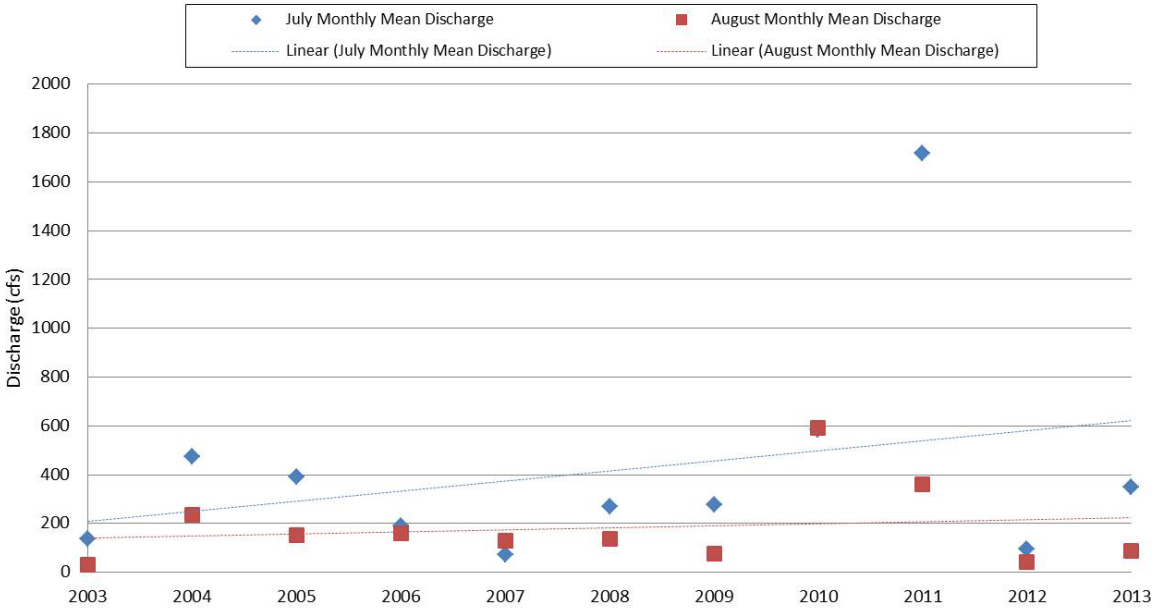

Figure 87. Mean monthly discharge measurements for July and August flows for Rock River at Rock Rapids, Iowa (2003-2013).

Lower Big Sioux River Watershed

Figure 88 is a display of the annual mean discharge for Split Rock Creek, just across the Minnesota border at Corson, South Dakota from 2002 to 2012. The data shows that there is an increase in stream flow over time, but the level of significance is not high (p=0.1). Figure 89 displays July and August mean flows for the last ten years for the same water body. Although July discharge appears to increase, it does not exhibit a statistically significant trend.

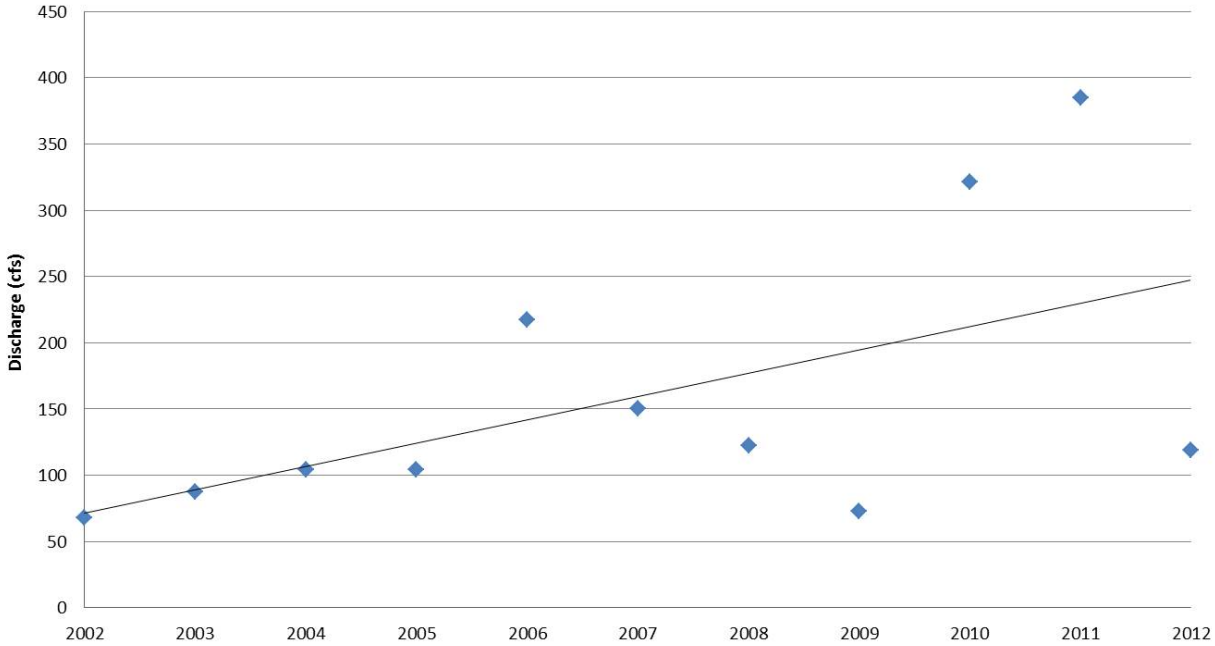

Figure 88. Annual Mean Discharge for Split Rock Creek at Corson, South Dakota (2002-2012).

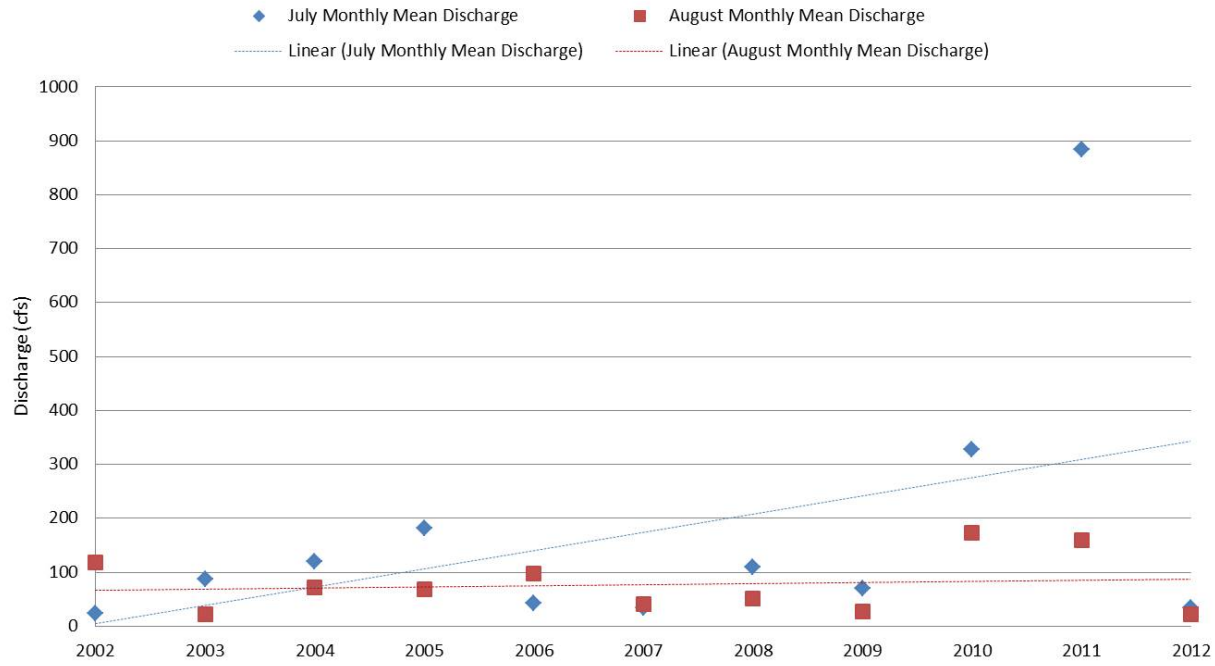

Figure 89. Mean monthly discharge measurements for July and August flows for Split Rock Creek at Corson, South Dakota (2002-2012).

Groundwater

Local conditions may vary, but due to the region's geology, arsenic may be a contaminant of concern. Because of heavy agricultural use, nitrate is a contaminant of concern in the southwest corner of Minnesota. To monitor this, the MDA regularly samples groundwater across the region for nitrate. To protect human health, the Minnesota Department of Health encourages well owners to test their water supply for arsenic at least once and nitrate on a regular basis.

In recent years, decreased groundwater quantity across Southwest Minnesota has been a topic of concern. Periods of seasonal drought have made it particularly difficult for citizens to obtain water for consumptive use. Low recharge rates coupled with increasing groundwater withdrawals heighten the need for water conservation and a more complete understanding of groundwater in the region. However, to provide a detailed cause and effect between withdrawals and water quantity is beyond the scope of this report.

Stressor ID for Missouri River Basin

The Stressor ID Monitoring plan is based on the best currently available information from the Assessment results. All reaches listed as impaired will be considered in the TMDL study to be completed based on the Stressor ID findings. Due to the vast number of impairments found throughout the Missouri River Basin during the IWM project, there is a great need for exploration of major stressors in the watersheds comprising this basin. Portions of the Missouri River Basin have been ditched and tiled since Western settlement to utilize the landscape for agricultural and residential development. Impaired channelized streams will be considered in the future under the Tiered Aquatic Life Use (TALU) framework, which will account for the changes in habitat through the channelization process.

Stressor Identification work and reporting will be completed at the 8-digit HUC scale. The watersheds and number of biological impairments in the Missouri River basin are: Upper Big Sioux (1), Lower Big Sioux River (18), Little Sioux River (2), and Rock River (28). The stressor ID process will help to identify the causes of biological impairments within the watershed so that the TMDL study can be completed to address the pollutants and contributing mechanisms that have led to the impaired state.

Goals of the Stressor ID work for the Missouri River Basin should include a thorough evaluation of existing biological monitoring data to characterize the extent and nature of the impairments. Where information is lacking, additional biological data should be collected to strengthen the case for impairment and improve watershed coverage. In addition to the biological work, additional sampling of geomorphology and chemistry should be conducted to study the hydrologic pathways and processes of the watershed. Once these stressors have been identified and thoroughly examined, the next step would be the development and implementation of TMDLs to help remedy the impairments.

Pollutant trends for the Lower Big Sioux and Rock River

Water quality trends at long-term monitoring stations

Water chemistry data were analyzed for trends (Table 139) for the long-term period of record (1963-2009) for Pipestone Creek and (1963-2011) for the Rock River, and the near-term period of record (1995-2010) for both. There were significant increases in nitrite/nitrates during the long-term period of record for both stations and additionally for the short-term period for Rock River. Chloride also had a significant increase in the Rock River in the long-term trend. Conversely, there were significant decreases in total suspended solids, TP, ammonia, and biological oxygen demand for the long-term period of record, while there was no trend with the near-term period.

Pollutant trends in Minnesota rivers

Data is from Minnesota Pollution Control Agency "Milestone" monitoring sites.

Table 139. Trends in the Lower Big Sioux River Watershed.

Pipestone Creek at Br on N Line of S24 (T106N/R47W) (S000-099)(PC-1.5) (period of record 1963 - 2009)

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
overall trend	**no trend**	**decrease**	**increase**	**decrease**	**decrease**	**no trend**
estimated average annual change		-6.3%	2.0%	-7.8%	-2.8%	
estimated total change		-95%	91%	-91%	-73%	
1995 - 2010 trend	**decrease**	**no trend**	**no trend**	**no trend**	**no trend**	little data
estimated average annual change	-5.4%					
estimated total change	-58%					
median concentrations first 10 years	57	1.9	2.4	0.24	9	87
median concentrations most recent 10 years	39	0.2	3.8	0.07	5	26

(Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90% confidence level. Percentage changes are statistical estimates based on the available data. Actual changes could be higher or lower. A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data.)

(Concentrations are median summer (Jun-Aug) values, except for chlorides, which are median year-round values. All concentrations are in mg/L.)

Data is from Minnesota Pollution Control Agency "Milestone" monitoring sites.

Table 140. Trends in the Rock River Watershed.

Rock River at Br on Stateline Rd 10 Mi. S of Luverne (S000-097)(RO-0) (period of record 1962 - 2011)

	Total Suspended Solids	Total Phosphorus	Nitrite/ Nitrate	Ammonia	Biochemical Oxygen Demand	Chloride
overall trend	**decrease**	**decrease**	**increase**	**decrease**	**decrease**	**increase**
estimated average annual change	-1.6%	-2.4%	4.3%	-4.6%	-2.7%	3.0%
estimated total change	-55%	-70%	334%	-74%	-73%	335%
1995 - 2010 trend	**no trend**	**no trend**	**increase**	**no trend**	**no trend**	little data
estimated average annual change			1.5%			
estimated total change			29%			
median concentrations first 10 years	110	0.4	0.8	0.09	9	23
median concentrations most recent 10 years	30	0.1	5.4	<0.03	2	26

(Analysis was performed using the Seasonal Kendall Test for Trends. Trends shown are significant at the 90% confidence level. Percentage changes are statistical estimates based on the available data. Actual changes could be higher or lower. A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data.)

(Concentrations are median summer (Jun-Aug) values, except for chlorides, which are median year-round values. All concentrations are in mg/L.)

Water clarity trends at citizen monitoring sites

Citizen monitoring occurs at only three streams (Pipestone Creek, North Branch; Main Ditch; and Unnamed Creek) and zero lakes in the Lower Big Sioux Watershed. Both Pipestone Creek, North Branch and the Unnamed Creek are in the North Branch Pipestone Creek Subwatershed and Main Ditch is in the Upper Pipestone Creek Subwatershed. The water clarity has shown no trend.

Table 141. Water clarity trends at stream monitoring sites.

Lower Big Sioux River Watershed HUC 10170203	Stream Monitoring Program	Lake Monitoring Program
number of sites w/ increasing trend	0	0
number of sites w/ decreasing trend	0	0
number of sites w/ no trend	3	0

Monitoring trends can be helpful in determining where the direction of the water quality is headed, but in the Rock River Watershed clarity has shown no trend on one stream.

Table 142. Water clarity trends at stream monitoring sites.

Rock River Watershed HUC 10230003	Stream Monitoring Program	Lake Monitoring Program
number of sites w/ increasing trend	0	0
number of sites w/ decreasing trend	0	0
number of sites w/ no trend	1	0

Monitoring occurs at only two streams and four lakes in the Little Sioux River Watershed. Water clarity has shown no trend.

Table 143. Water clarity trends at lake and stream monitoring sites.

Little Sioux River Watershed HUC 10230003	Stream Monitoring Program	Lake Monitoring Program
number of sites w/ increasing trend	0	2
number of sites w/ decreasing trend	0	0
number of sites w/ no trend	2	2

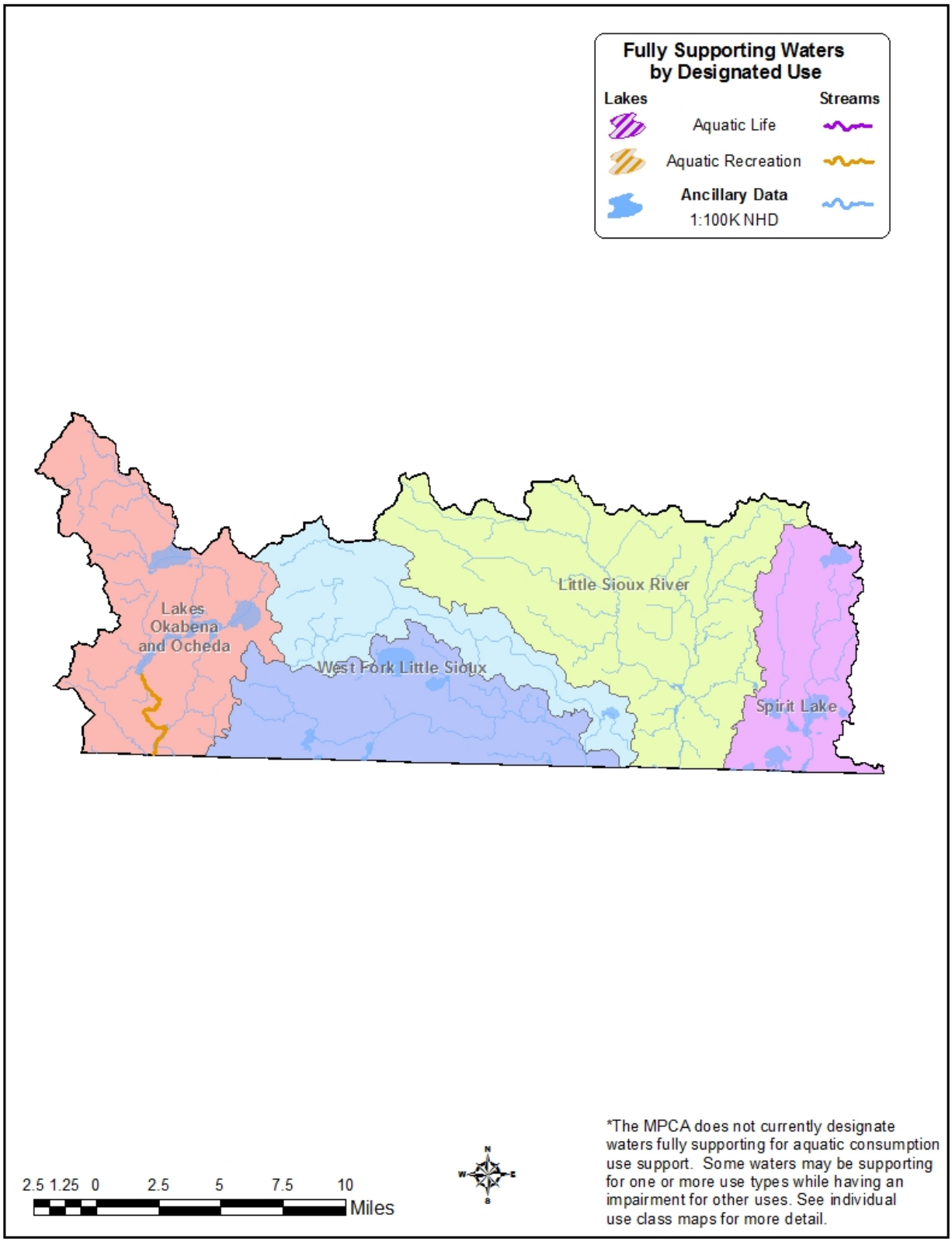

Figure 90. Fully supporting waters by designated use in the Little Sioux River Watershed.

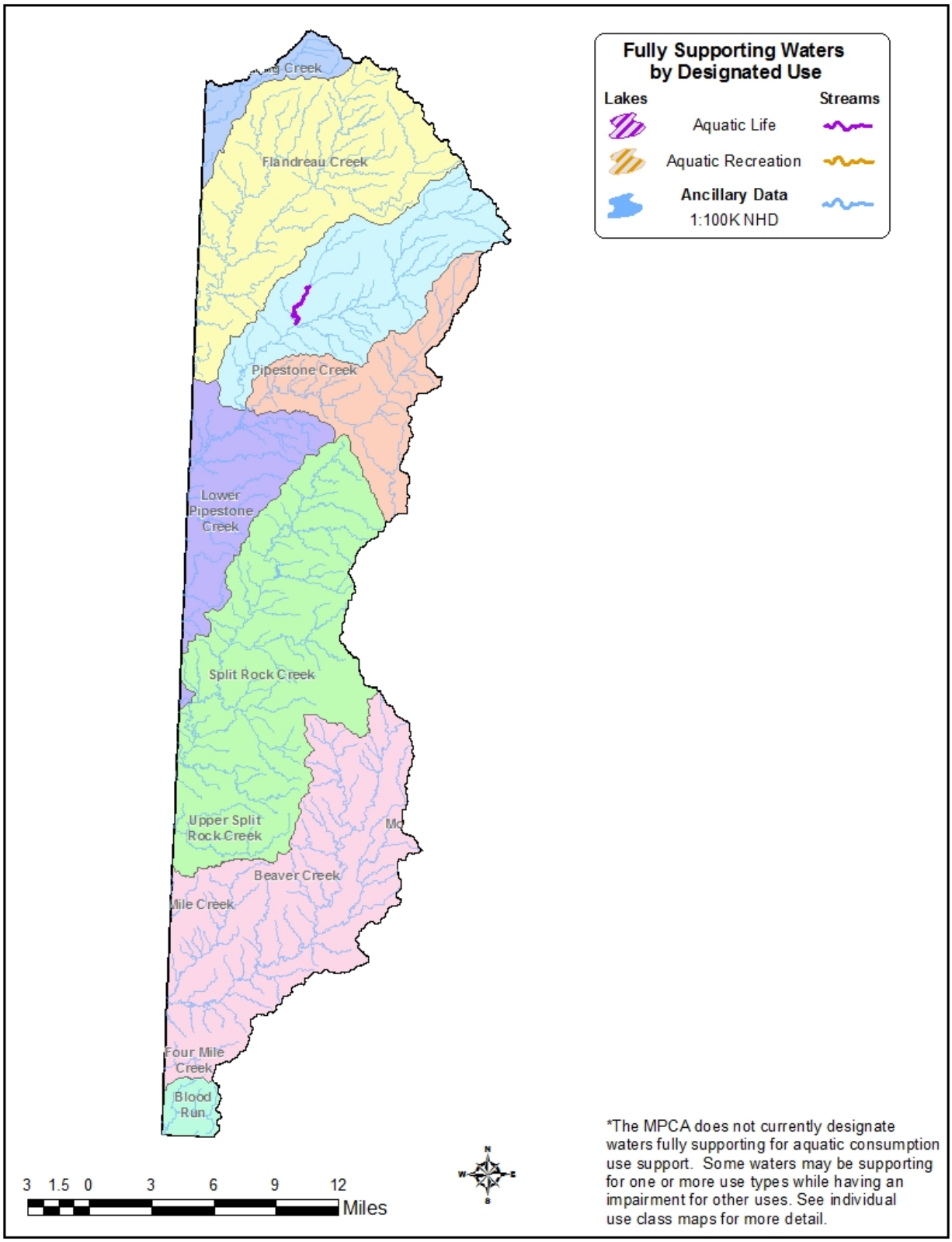

Figure 91. Fully supporting waters by designated use in the Lower Big Sioux River Watershed.

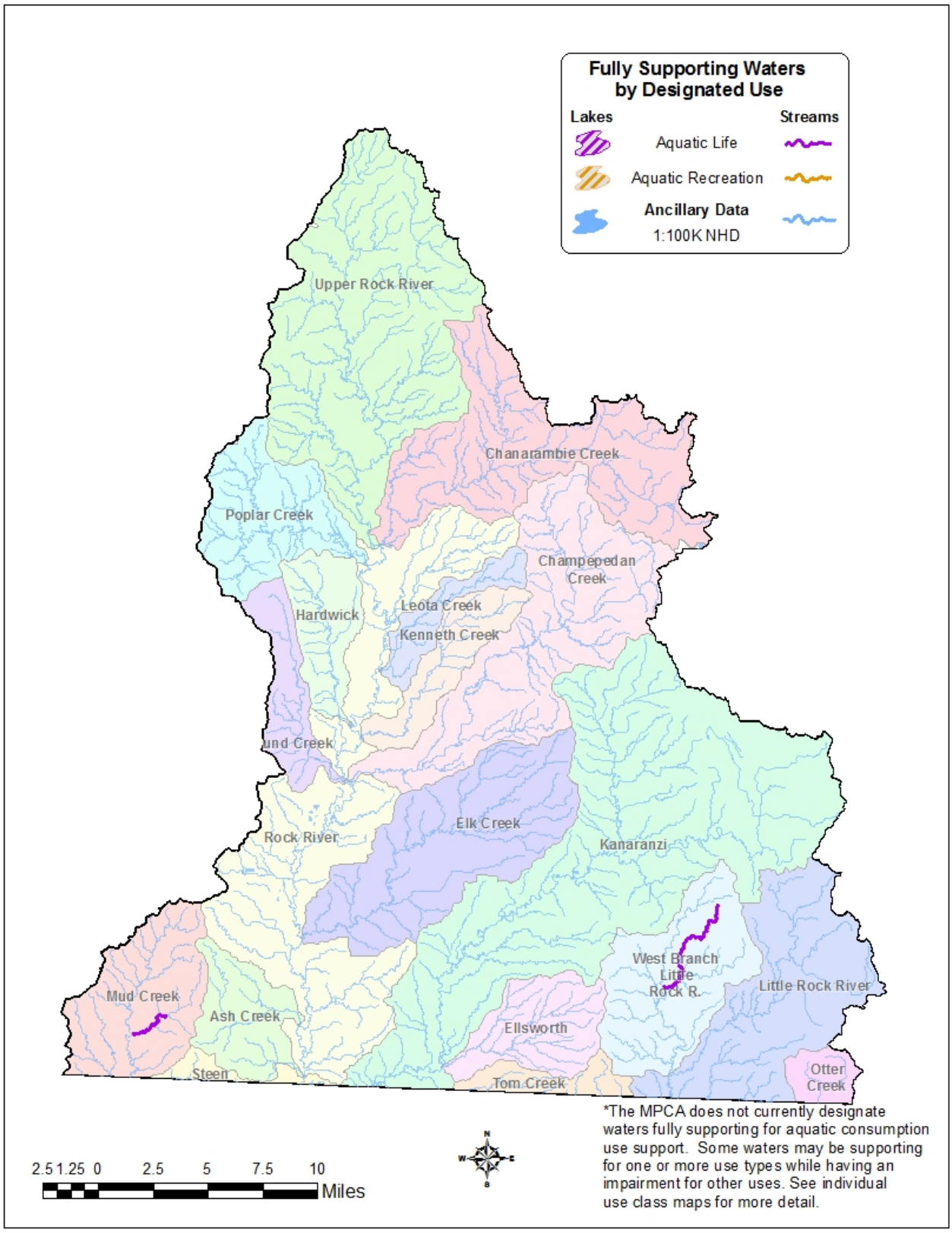

Figure 92. Fully supporting waters by designated use in the Rock River Watershed.

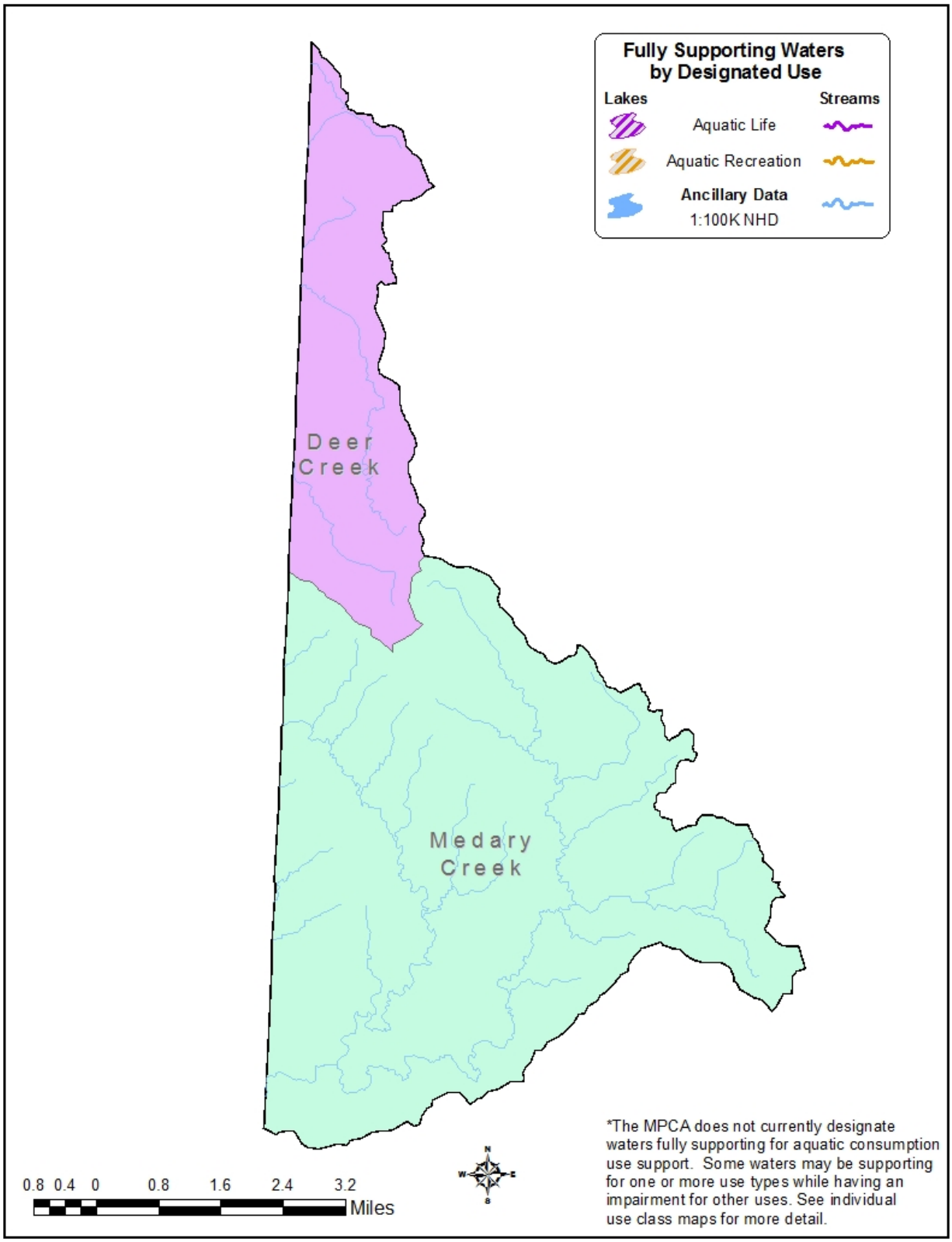

Figure 93. Fully supporting waters by designated use in the Upper Big Sioux River Watershed. (None were found)

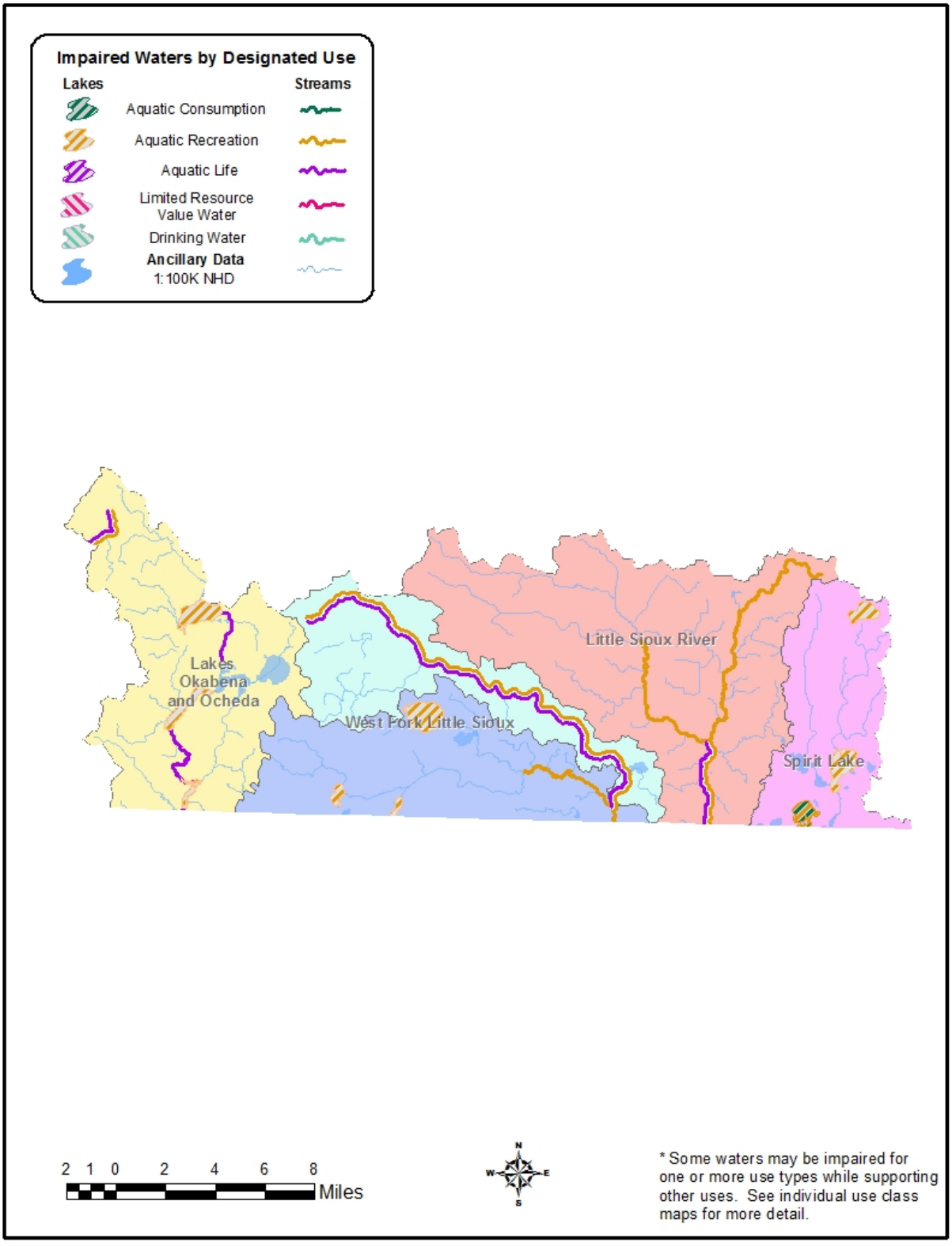

Figure 94. Impaired waters by designated use in Little Sioux River.

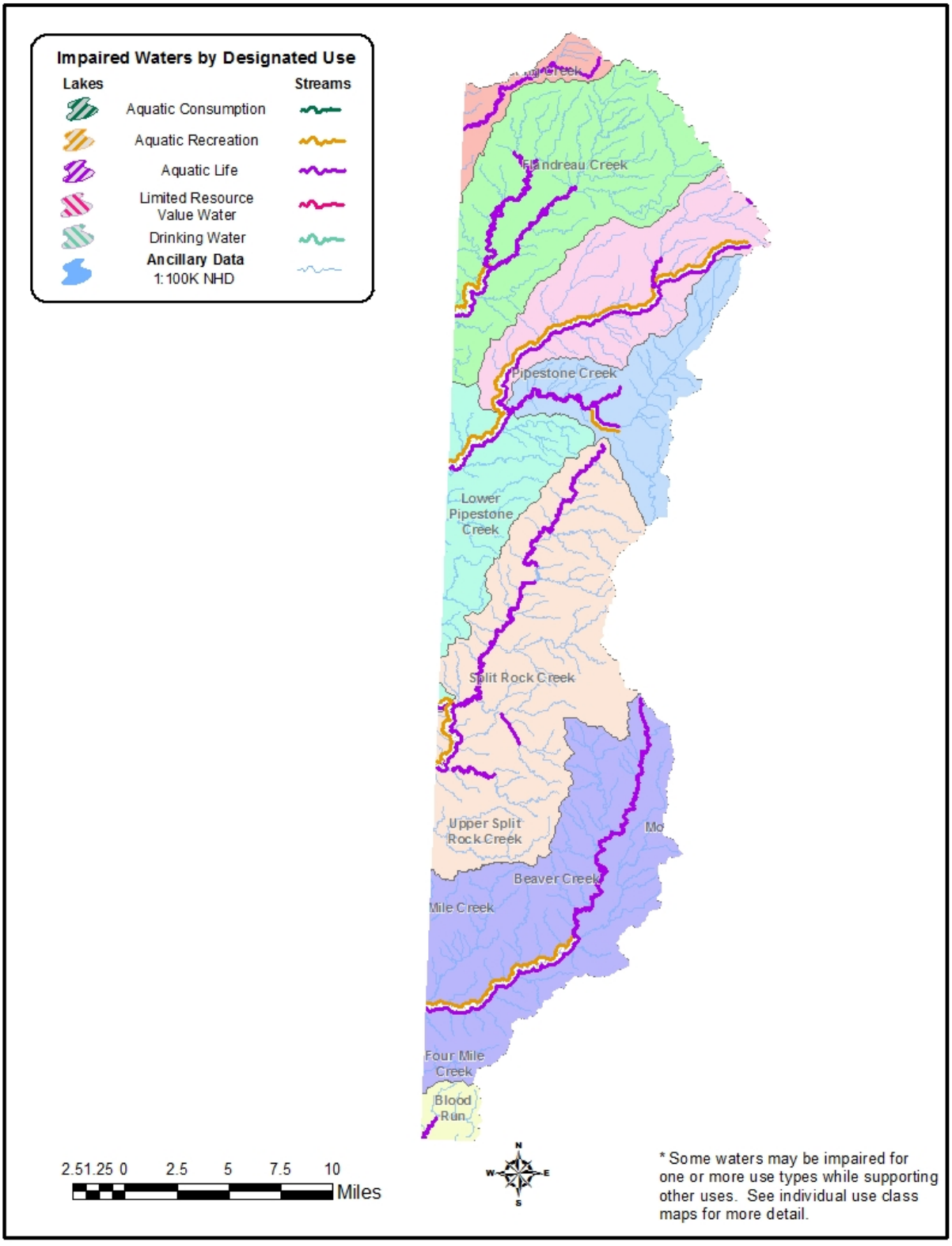

Figure 95. Impaired waters by designated use in the Lower Big Sioux River.

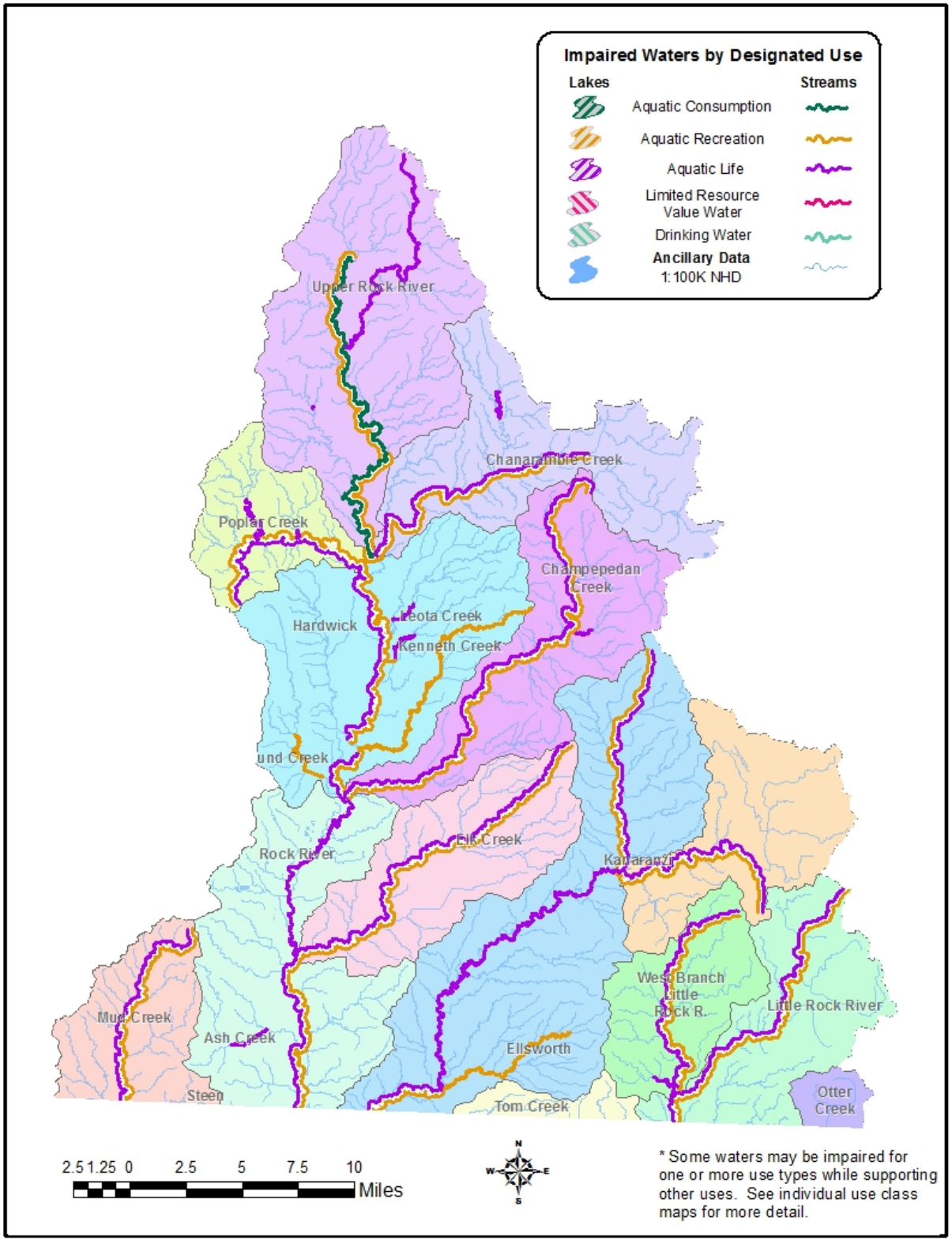

Figure 96. Impaired waters by designated use in the Rock River.

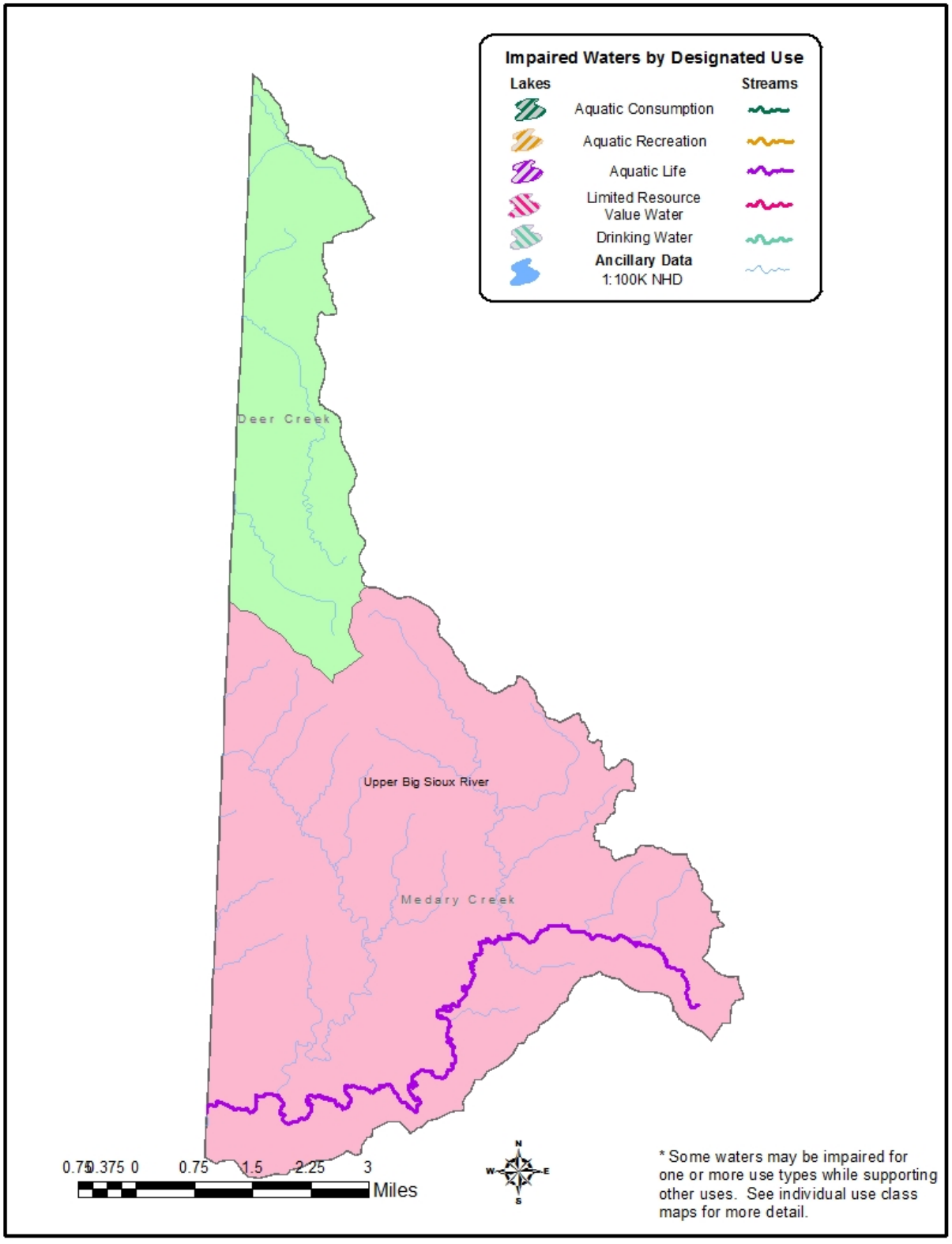

Figure 97. Impaired waters by designated use in the Upper Big Sioux River.

Figure 98. Aquatic consumption use support in the Little Sioux River Watershed.

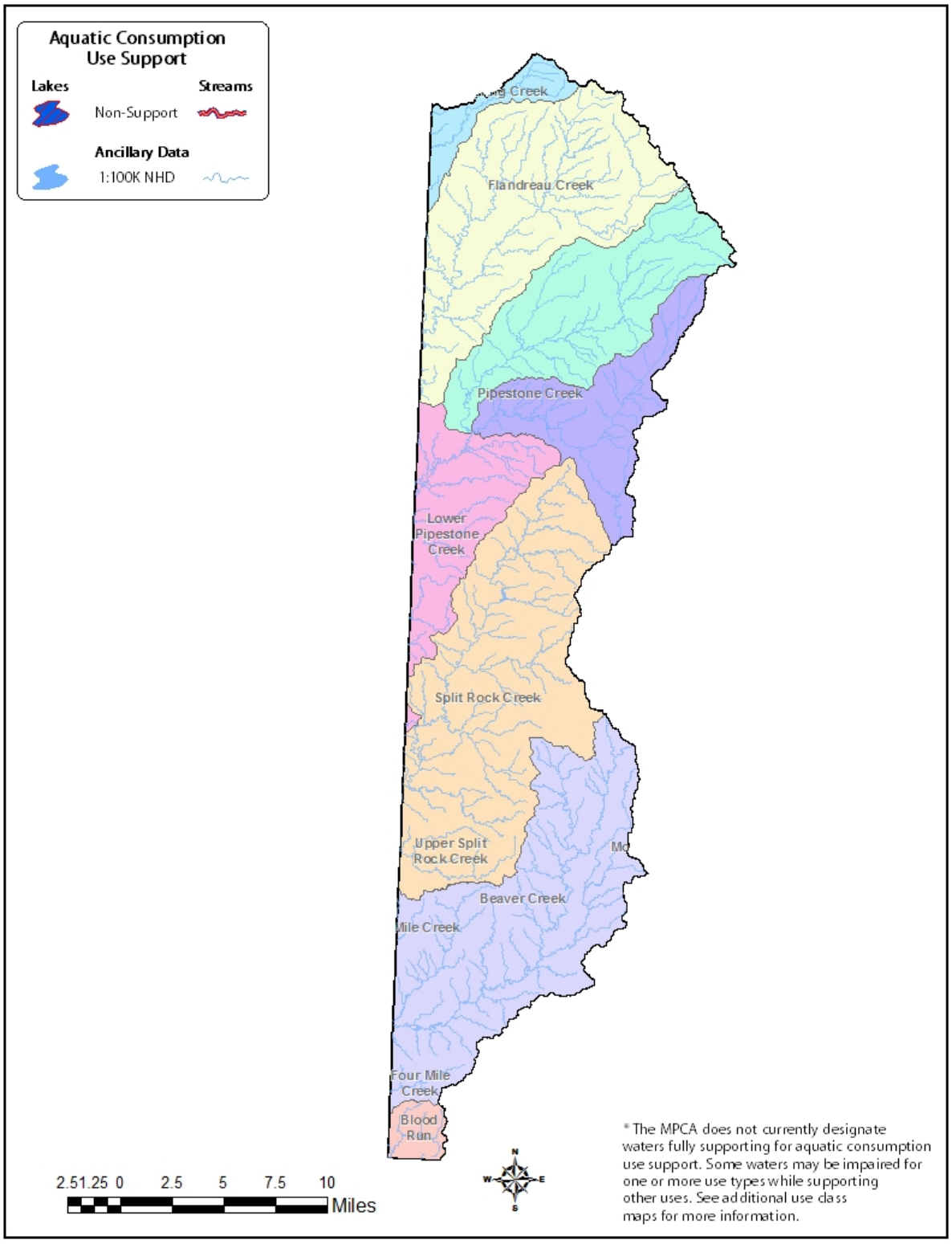

Figure 99. Aquatic consumption use support in the Lower Big Sioux River Watershed. (None were found)

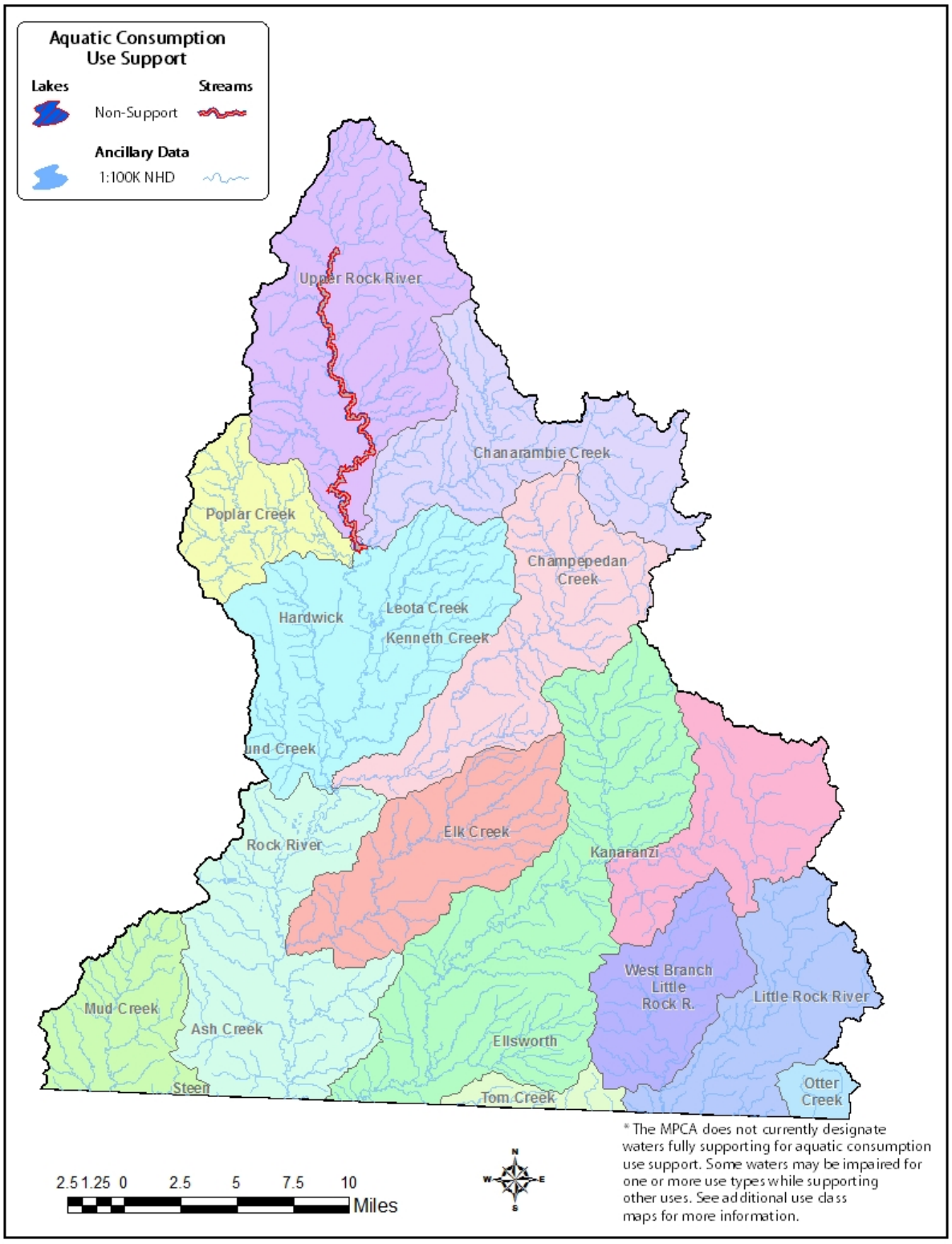

Figure 100. Aquatic consumption use support in the Rock River Watershed.

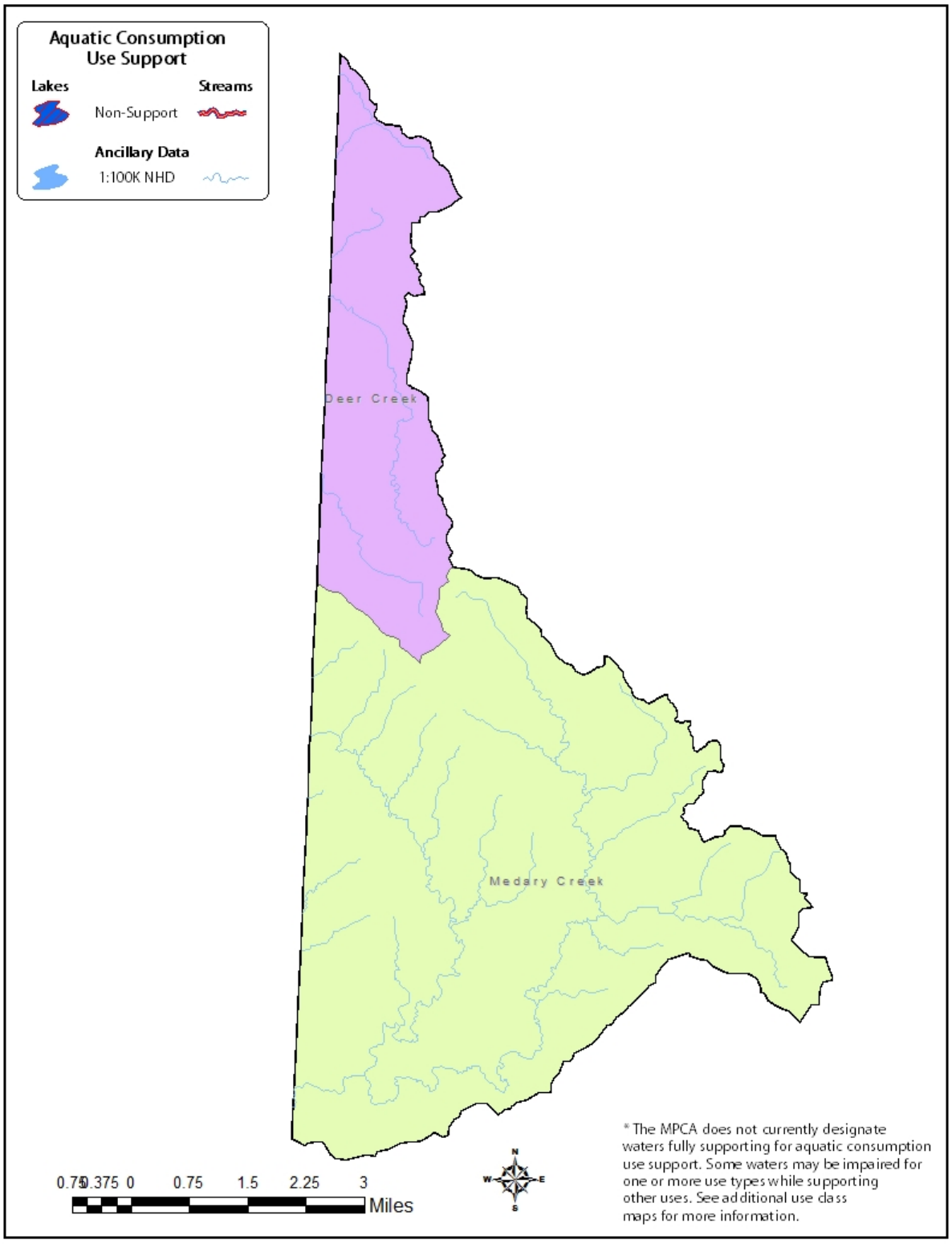

Figure 101. Aquatic consumption use support in the Upper Big Sioux River Watershed. (None were found)

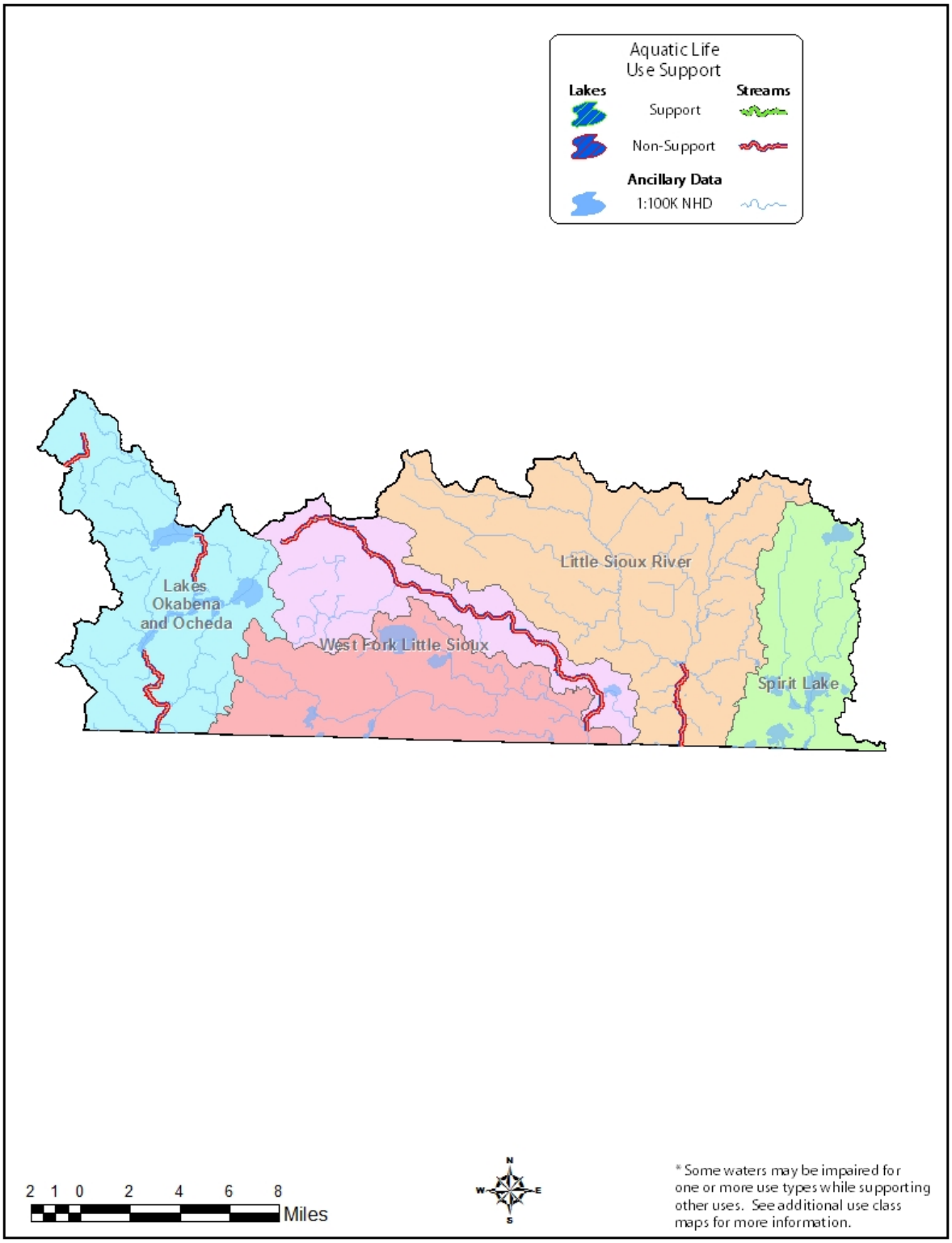

Figure 102. Aquatic life use support in the Little Sioux River Watershed.

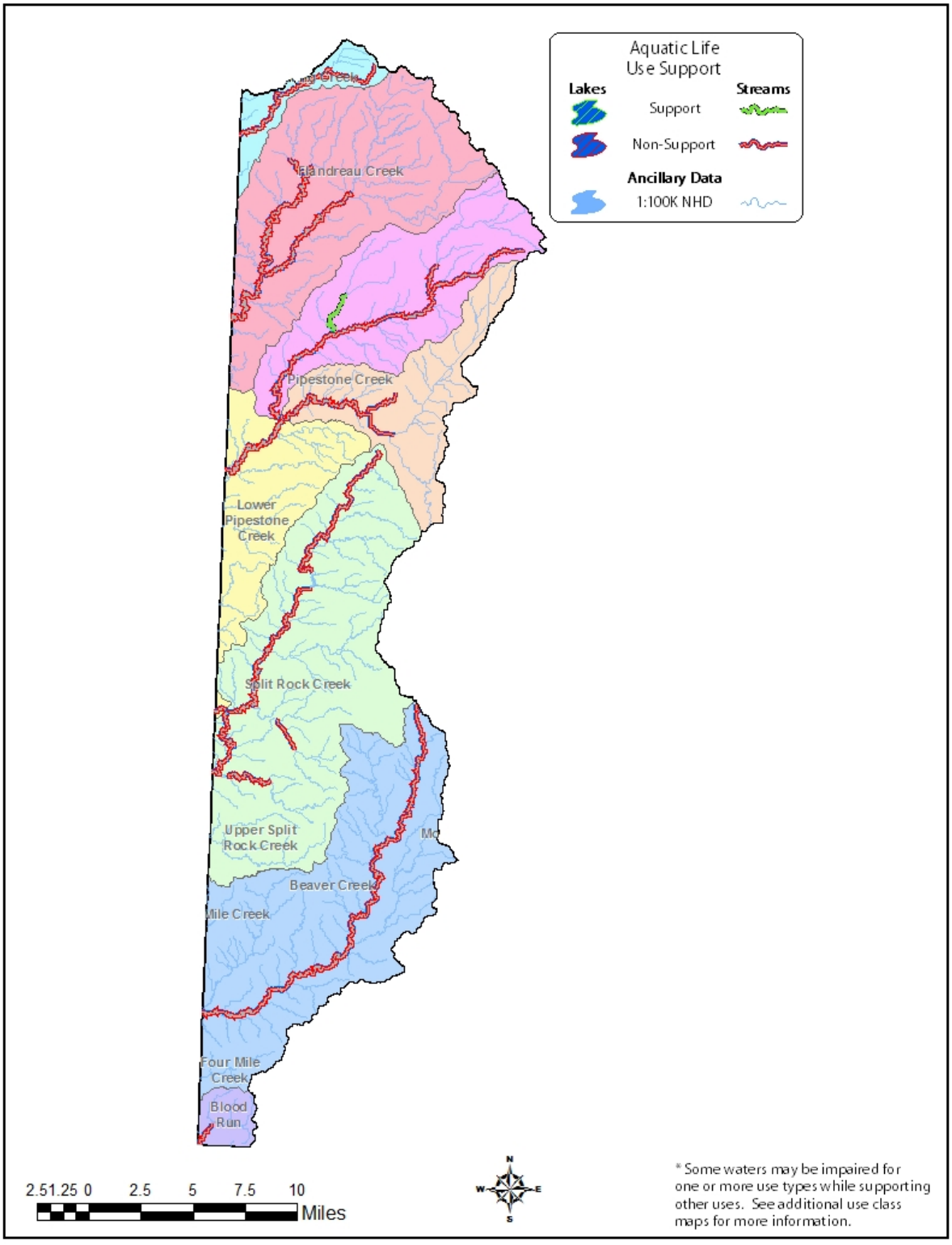

Figure 103. Aquatic life use support in the Lower Big Sioux River Watershed.

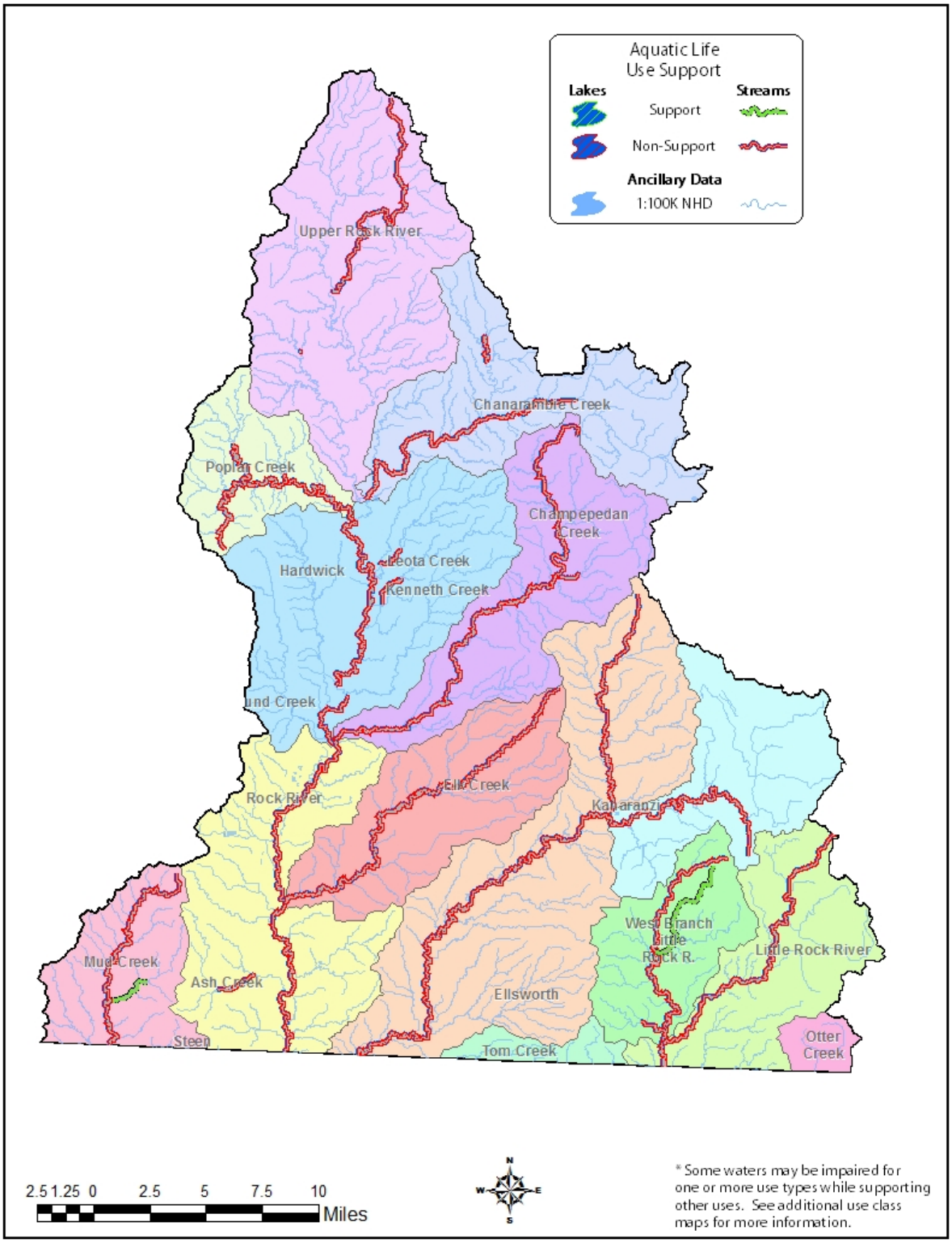

Figure 104. Aquatic life use support in the Rock River Watershed.

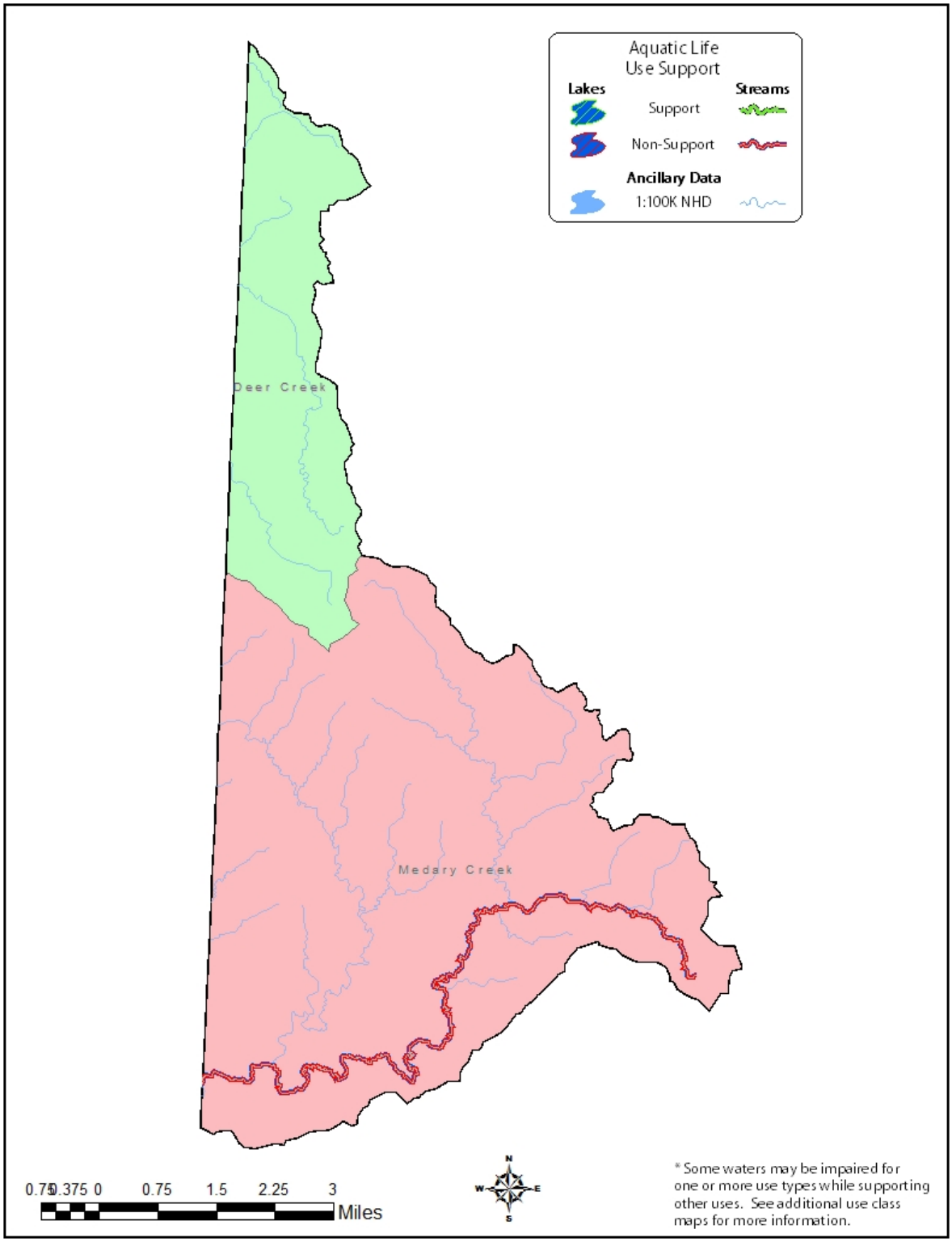

Figure 105. Aquatic life use support in the Upper Big Sioux River Watershed.

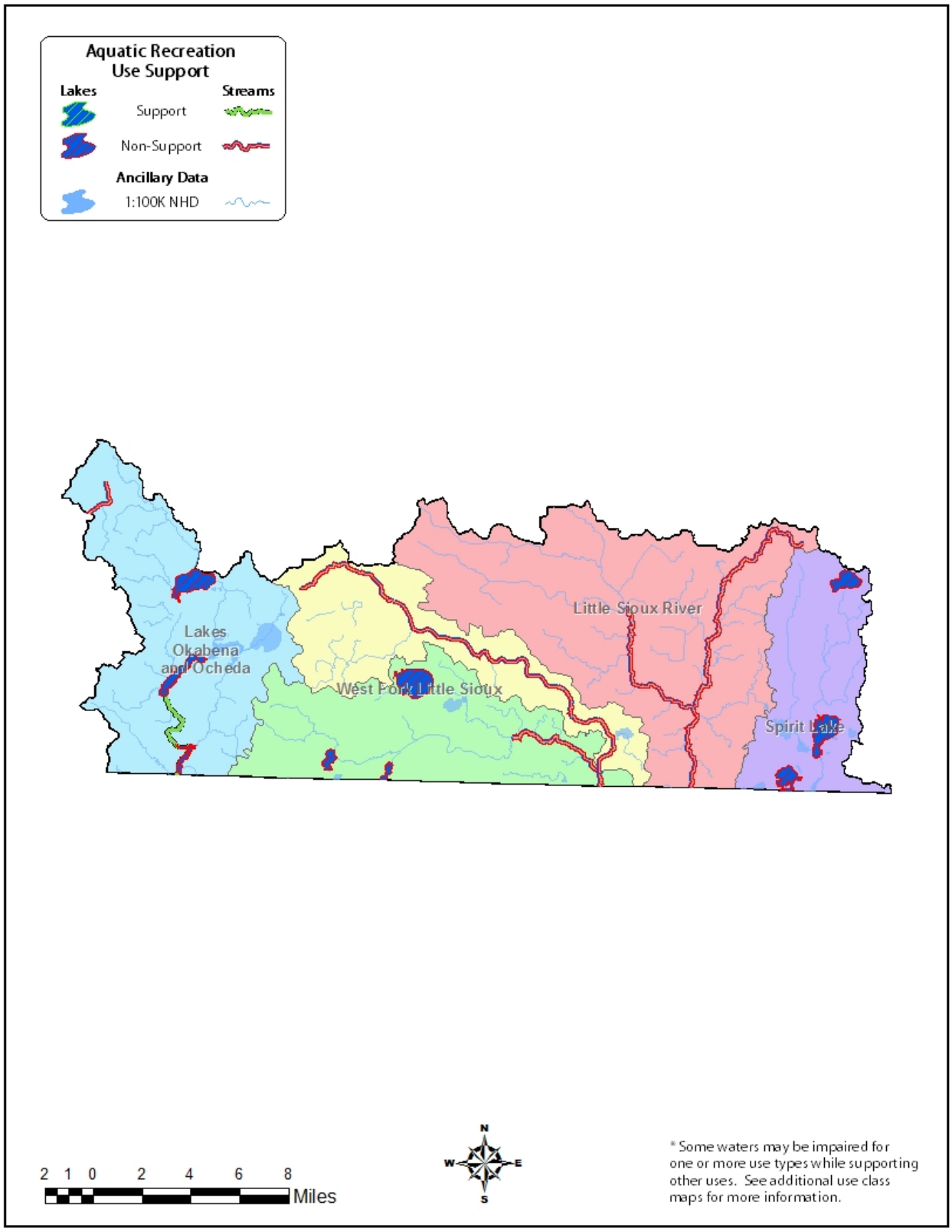

Figure 106. Aquatic recreation use support in the Little Sioux River Watershed.

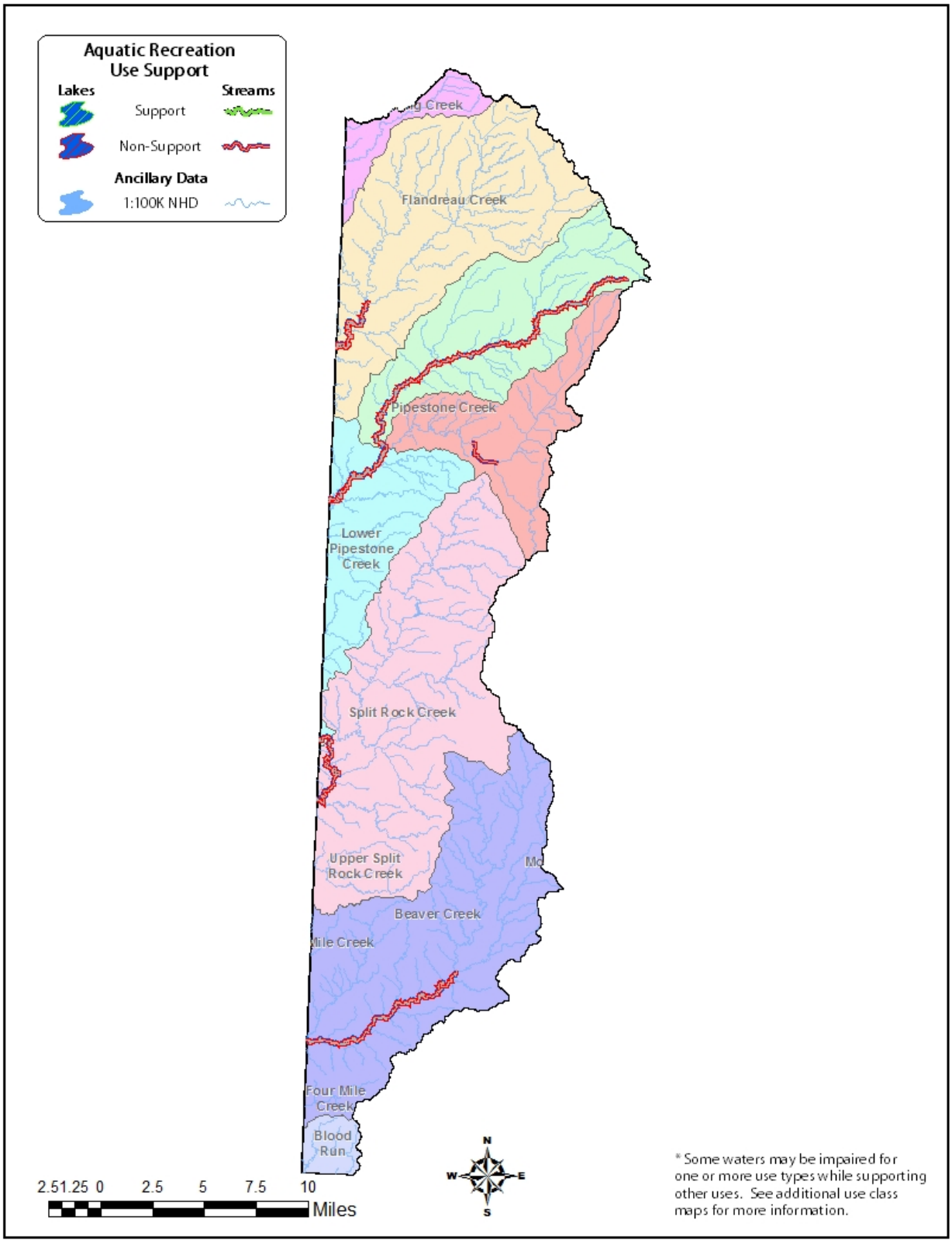

Figure 107. Aquatic recreation use support in the Lower Big Sioux River Watershed.

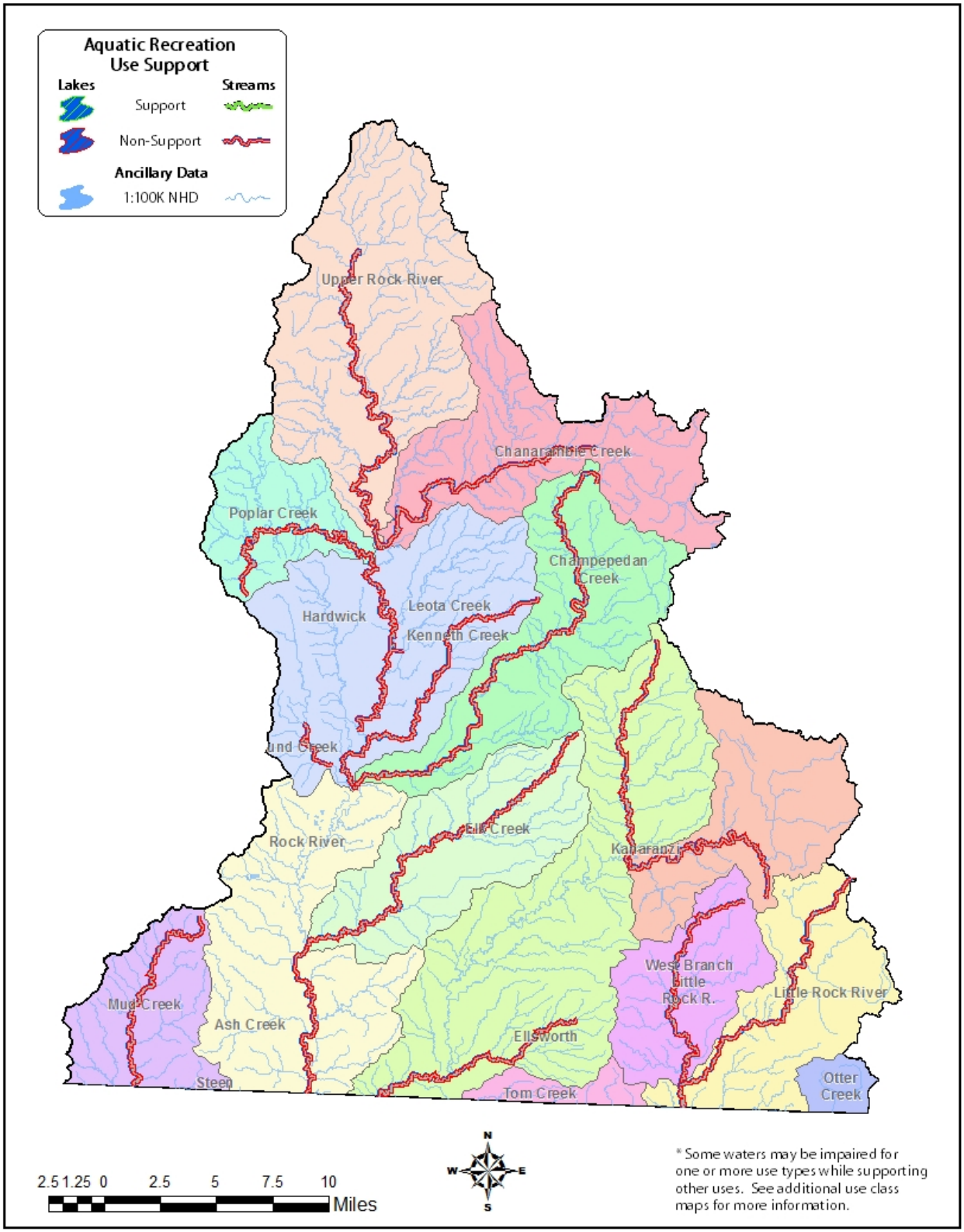

Figure 108. Aquatic recreation use support in the Rock River Watershed.

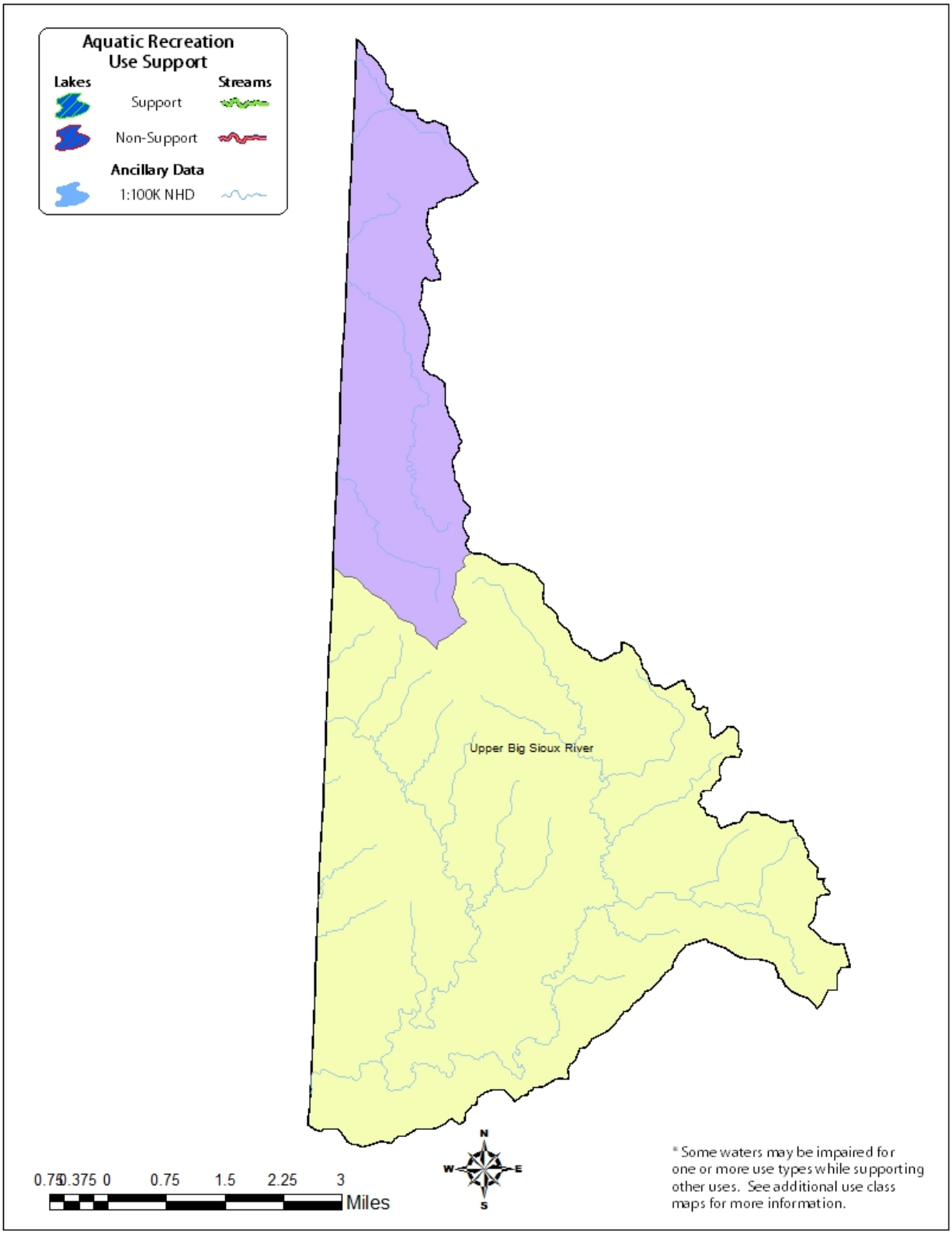

Figure 109. Aquatic recreation use support in the Upper Big Sioux River Watershed. (None were found)

VII. Summaries and recommendations

Measures need to be taken to reduce land use impacts on water resources in the Missouri River Basin. Nonpoint source pollution from the agricultural practices is likely negatively impacting immediate and downstream water quality uses for aquatic life, recreation, consumption and drinking water. Ninety three of the 181 stream AUIDs were assessed for aquatic life and/or aquatic recreation (Tables 125-128). Of the assessed streams, only 3 AUIDs were considered to be fully supporting of aquatic life and 1 stream is fully supporting of aquatic recreation. Eighty four AUIDs are non-supporting for aquatic life and/or recreation uses.

Impairment for aquatic recreation due to elevated bacteria levels, including sometimes incredibly high levels, is widespread across the basin, impacting all the assessed streams in the Missouri River Basin, except one AUID where sufficient data was available to make an assessment of full support. The abundance of rangeland with cattle having largely unimpeded access to watercourses indicates that impairments are likely more widespread than Figures 104-107 and the IWM suggests. High bacteria levels could also be contributed to by failing septic systems, which are not well quantified across the watersheds.

None of the lakes in the Missouri River Basin are meeting the aquatic recreation standard. The Little Sioux River Watershed is the only watershed that had lakes for assessment. All of these lakes are very shallow and are susceptible to mixing from wind throughout the open water season. The Missouri River Basin is dominated by vast open areas, mainly cropland, which can lead to increased sediment; under high temperatures, this can add phosphorus to the water column (internal loading). Most lakes in this basin will likely have severe algal blooms throughout the summer. Runoff and internal loading are the major contributors of phosphorus leading to the impairment of lakes in this basin. The use of buffer strips, shoreline management and other BMPs are going to be important to implement to restore the water quality for lakes in this basin.

Aquatic life use impairments within the Missouri River Basin are widespread. Macroinvertebrate impairments surpass fish impairments. Biotic impairments are likely a result of nonpoint source pollution and localized stress linked to unstable channels conditions and poor in-stream habitat, both of which can be associated with high suspended and bedded sediment loads. High nitrogen levels are also potentially impacting macroinvertebrate communities, as seen in other watersheds across southern Minnesota. Data shows increased levels of invertebrate impairment were most common in upper and middle reaches of the subwatershed and generally decrease moving downstream. The inverse is mainly true for fish. The reason for the opposing response of fish and macroinvertebrate indicators is likely due to a combination of differing flow regimes associated with different index periods, as well as differing stressor responses associated with each assemblage. It is not expected that fish and invertebrate communities will respond the same to all stressors; this is the primary reason that two or more indicators are recommended when assessing biological integrity. FIBI scores were mainly dominated by tolerant fish, which lowers the IBI scores. The most upstream sites and sites with smaller drainage areas tended to have more intolerant lithophils, and therefore had higher FIBI scores.

Turbidity concerns are prolific and are as universal as impairments due to E. coli. Improvements need to be made in the watersheds to significantly reduce overland erosion by implementing soil conservation efforts and restoring natural vegetation along riparian zones. High levels of turbidity are likely stemming from stream bank erosion as streams cut into banks. Poor habitat conditions observed across many biological stations may be linked to turbidity and sedimentation issues, as well as poor riparian land use.

While impairments are prevalent across the watersheds, efforts to restore water quality and bring surface waters into attainment for designated uses are not impossible. Future efforts to control sediment should include measures to stabilize stream bank channels, largely by allowing less access to streams by cattle. Addressing nonpoint source pollution would benefit from a targeted approach to BMP

placement, identifying those features in the watersheds that are more prone to be pathways of contamination, and working with landowners to limit potential contaminants from reaching those sensitive areas. Only by collaborating with landowners will the agricultural economy of the region move forward in a sustainable way that does not neglect water quality.

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Appendix 1 - Water chemistry definitions

Dissolved oxygen (DO) - Oxygen dissolved in water required by aquatic life for metabolism. Dissolved oxygen enters into water from the atmosphere by diffusion and from algae and aquatic plants when they photosynthesize. Dissolved oxygen is removed from the water when organisms metabolize or breathe. Low DO often occurs when organic matter or nutrient inputs are high, and light inputs are low.

Escherichia coli (E. coli) - A type of fecal coliform bacteria that comes from human and animal waste. E. coli levels aid in the determination of whether or not fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of E. coli.

Nitrate plus Nitrite – Nitrogen - Nitrate and nitrite-nitrogen are inorganic forms of nitrogen present within the environment that are formed through the oxidation of ammonia-nitrogen by nitrifying bacteria (nitrification). Ammonia-nitrogen is found in fertilizers, septic systems and animal waste. Once converted from ammonia-nitrogen to nitrate and nitrite-nitrogen, these species can stimulate excessive levels of algae in streams. Because nitrate and nitrite-nitrogen are water soluble, transport to surface waters is enhanced through agricultural drainage. The ability of nitrite-nitrogen to be readily converted to nitrate-nitrogen is the basis for the combined laboratory analysis of nitrate plus nitrite-nitrogen (nitrate-N), with nitrite-nitrogen typically making up a small proportion of the combined total concentration. These and other forms of nitrogen exist naturally in aquatic environments; however concentrations can vary drastically depending on season, biological activity, and anthropogenic inputs.

Orthophosphate - Orthophosphate (OP) is a water soluble form of phosphorus that is readily available to algae (bioavailable). While orthophosphates occur naturally in the environment, river and stream concentrations may become elevated with additional inputs from wastewater treatment plants, noncompliant septic systems and fertilizers in urban and agricultural runoff.

pH - A measure of the level of acidity in water. Rainfall is naturally acidic, but fossil fuel combustion has made rain more acid. The acidity of rainfall is often reduced by other elements in the soil. As such, water running into streams is often neutralized to a level acceptable for most aquatic life. Only when neutralizing elements in soils are depleted, or if rain enters streams directly, does stream acidity increase.

Specific Conductance - The amount of ionic material dissolved in water. Specific conductance is influenced by the conductivity of rainwater, evaporation and by road salt and fertilizer application.

Temperature - Water temperature in streams varies over the course of the day similar to diurnal air temperature variation. Daily maximum temperature is typically several hours after noon, and the minimum is near sunrise. Water temperature also varies by season as doe's air temperature.

Total Kjehldahl nitrogen (TKN) - The combination of organically bound nitrogen and ammonia in wastewater. TKN is usually much higher in untreated waste samples then in effluent samples.

Total Phosphorus (TP) - Nitrogen (N), phosphorus (P) and potassium (K) are essential macronutrients and are required for growth by all animals and plants. Increasing the amount of phosphorus entering the system therefore increases the growth of aquatic plants and other organisms. Excessive levels of Phosphorous over stimulate aquatic growth and resulting in the progressive deterioration of water quality from overstimulation of nutrients, called eutrophication. Elevated levels of phosphorus can result in: increased algae growth, reduced water clarity, reduced oxygen in the water, fish kills, altered fisheries and toxins from cyanobacteria (blue green algae) which can affect human and animal health.

Total Suspended Solids (TSS) – TSS and turbidity are highly correlated. Turbidity is a measure of the lack of transparency or "cloudiness" of water due to the presence of suspended and colloidal materials such as clay, silt, finely divided organic and inorganic matter and plankton or other microscopic organisms. The greater the level of TSS, the murkier the water appears and the higher the measured turbidity.

Higher turbidity results in less light penetration which may harm beneficial aquatic species and may favor undesirable algae species. An overabundance of algae can lead to increases in turbidity, further compounding the problem.

Total Suspended Volatile Solids (TSVS) - Volatile solids are solids lost during ignition (heating to 500 degrees C.) They provide an approximation of the amount of organic matter that was present in the water sample. ''Fixed solids'' is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. The weight loss on ignition is called ''volatile solids.''

Unnionized Ammonia (NH3) - Ammonia is present in aquatic systems mainly as the dissociated ion $NH4^{+}$, which is rapidly taken up by phytoplankton and other aquatic plants for growth. Ammonia is an excretory product of aquatic animals. As it comes in contact with water, ammonia dissociates into $NH4^{+}$ ions and ^{-}OH ions (ammonium hydroxide). If pH levels increase, the ammonium hydroxide becomes toxic to both plants and animals.

Appendix 2 - Intensive watershed monitoring water chemistry stations in the Missouri River Basin

Biological Station ID	STORET/ EQuIS ID	Waterbody Name	Location	Subwatershed
10EM014	S006-167	Champepadan Creek	Upstream of CR 9, 3.5 mi. NE of Luverne	Champepadan Creek 1017020403-03
11MS001	S000-097	Rock River	Upstream of Stateline Rd., 10 mi. S of Luverne	Upper Rock River 1017020403-01
11MS002	S004-928	Little Rock River	Upstream of CR 58, 7 mi. W of Bigelow	Upper Little Rock River 1017020406-02
11MS003	S004-390	Rock River	Downstream of CR 8, 3.5 mi NE of Luverne	Lower Headwaters Rock River 1017020401-01
11MS004	S006-904	Kanaranzi Creek	Upstream of 210th St., 4 mi. N of Adrian	Kanaranzi Creek 1017020402-01
11MS005	S006-581	Flandreau Creek	Downstream of CR 73, 4 mi W of Cazenovia	Flandreau Creek 1017020303-01
11MS006	S004-717	Kanaranzi Creek	Upstream of 11th St., 4 mi. W of Ellsworth	Kanaranzi Creek 1017020402-01
11MS007	S006-582	Medary Creek	Upstream of unnamed Rd, 8 mi. W of Lake Benton	Medary Creek 1017020210-01
11MS008	S000-100	Little Sioux River, West Fork	Upstream of CR 62, 10 mi. E of Round Lake	West Fork Little Sioux River 1023000301-01
11MS009	S006-271	Little Rock Creek	Downstream of 320th Street, 8 mi. NW of Bigelow	Little Rock Creek 1017020406-03
11MS010	S004-219	Little Sioux River	Downstream of CR 4 (7175th St.), 10 mi. S of Lakefield	Upper Headwaters Little Sioux River 1023000303-02
11MS011	S006-577	Rock River	Upstream of 165th Ave, 1 mi. S of Edgerton	Upper Headwaters Rock River 1017020401-03
11MS012	S004-811	Beaver Creek	Upstream of 10th Ave, 1 mi. N of Manley	Beaver Creek 1017020315-01
11MS013	S006-579	Split Rock Creek	Downstream of CR 7, 8 mi. S of Jasper	Upper Split Rock Creek 1017020316-02
11MS014	S006-578	Poplar Creek	Downstream of CSAH 1, 2 mi. S of Edgerton	Poplar Creek 1017020401-02
11MS015	S006-580	Pipestone Creek	South of Twp Rd 21, 3 mi. SW of Jasper	Poplar Creek 1017020401-02
11MS016	S006-576	Chanarambie Creek	Downstream of CR 1 (Mill St.), SE of Edgerton	Chanarambie Creek 1017020401-04
11MS017	S006-550	Trib. to Spirit Lake	Downstream of CR 4, 8.5 mi. SW of Jackson	Milford Creek 1023000302-01
11MS018	S004-927	Kanaranzi Creek, East Branch	Upstream of Dolan Ave., 2 mi. NE of Adrian	East Branch Kanaranzi Creek 1017020402-02
11MS019	S000-510	Pipestone Creek	Upstream of CR 13, 6 mi W of Pipestone	Lower Pipestone Creek 1017020313-01
11MS020	S006-606	Elk River	Upstream of CR 9, 3 mi. S of Luverne	Elk Creek 1017020403-02
11MS021	S004-391	Mud Creek	Upstream of 21st St., 1 mi. SE of Hills	Mud Creek 1017020404-01
11MS022	S002-862	Ocheyedan River	Upstream of 320th Ave., 3 mi. NW of Bigelow	Upper Ocheyedan 1023000305-02

Appendix 3.1 - AUID table of stream assessment results (by parameter and beneficial use)

AUID DESCRIPTIONS				USES							BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	Turbidity	Chloride	pH	NH3	Pesticides	Bacteria (Aquatic Recreation)
Upper Big Sioux River Watershed																			
Aggregated HUC 12: 1017020209-1 (Deer Creek)																			
None																			
Aggregated HUC 12: 1017020210-01 (Medary Creek)																			
10170202-501	Medary Creek	Headwaters to MN/SD border	13.94	2C, 3B	NS	IF	-	-	B_I		MTS	EXS	IF	IF	-	MTS	MTS	-	IF

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedance (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use. *Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

AUID DESCRIPTIONS				USES							BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	Turbidity	Chloride	pH	NH3	Pesticides	Bacteria (Aquatic Recreation)
Lower Big Sioux River Watershed																			
Aggregated HUC 12: 1017020301-01(Spring Creek)																			
10170203-518	Spring Creek	Headwaters to MN/SD border	12.65	2B, 3C	NS	NA	-	-	B_I		-	EXS	IF	IF	-	IF	-	-	-
Aggregated HUC 12: 1017070302-01(Flandreau Creek)																			
10170203-502	Flandreau Creek	Willow Cr to MN/SD border	7.69	2C, 3B	NS	NS	-	-	E.coli, B_F		EXS	MTS	IF	EXS	-	MTS	IF	-	EX
10170203-515	Willow Creek	Headwaters to Flandreau Cr	15.33	2B, 3C	NS	NA	-	-	B_F, B_I		EXS	EXS	IF	IF	-	IF	IF	-	-
10170203-516	Flandreau Creek	T109 R45W S30, north line to T108 R46W S11, south line	7.01	7	-	-	-	-	-		NA	NA	IF	-	-	IF	IF	-	-
10170203-517	Flandreau Creek	T108 R46W S14, north line to Willow Cr	12.34	2C, 3B	NS	NA	-	-	B_F, B_I		EXS	EXP	IF	IF	-	IF	IF	-	-
10170203-531	Unnamed creek	Unnamed cr to Willow Cr	1.73	2B, 3C	NS	NA	-	-	B_I		MTS	EXP	IF	IF	-	IF	IF	-	-

10170203-548	East Branch	Unnamed cr to Unnamed cr	2.08	2B, 3C	*NA	NA	-	-	-		NA	NA	IF	IF	-	IF	IF	-	-
Aggregated HUC 12: 1017020313-02 (North Branch Pipestone Creek)																			
10170203-514	Pipestone Creek	Headwaters to Pipestone Cr	28.34	2B, 3C	NS	NA	-	-	T, FC, B_F, B_I		EXS	EXP	EXP	EXS	-	MTS	IF	-	IF
10170203-549	Unnamed creek	Unnamed cr to N Br Pipestone Cr	2.27	2B, 3C	NS	NA	-	-	B_F, B_I		EXS	EXS	IF	IF	-	IF	-	-	-
10170203-550	Unnamed creek,	Unnamed cr to N Br Pipestone Cr	3.16	2B, 3C	FS	NA	-	-	-		MTS	MTS	IF	IF	-	IF	IF	-	-
Aggregated HUC 12: 1017020313-03 (Upper Pipestone Creek)																			
10170203-506	Pipestone Creek	Headwaters to N Br Pipestone Cr	11.19	2C, 3B	NS	NA	-	-	B_F, B_I		EXS	EXP	IF	IF	-	IF	IF	-	-
10170203-527	Main Ditch	CD A to Pipestone Cr	2.04	2B, 3C	NS	NA	-	-	T, FC		-	-	MTS	EXP	-	MTS	MTS	-	-
10170203-530	Main Ditch,	Unnamed cr to CD A	3.61	2B, 3C	*NA	NA	-	-	-		*NA	* NA	IF	IF	-	IF	IF	-	-
10170203-545	County Ditch A	Unnamed ditch to Unnamed dtich	0.86	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	-	-	-
Aggregated HUC 12: 1017020313-01 (Lower Pipestone Creek)																			
10170203-501	Pipestone Creek,	N Br Pipestone Cr to MN/SD border (Pipestone County)	9.33	2C, 3B	NS	NS	-	-	-		EXS	EXP	IF	EXS	-	MTS	IF	-	EX
10170203-505	Pipestone Creek	MN/SD border to Split Rock Cr (Rock County)	1.09	2B, 3C	NS	NS	-	-	E.coli B_F, B_I		EXS	EXP	IF	EXS	-	MTS	MTS	-	EX
10170203-551	Unnamed creek,	Unnamed cr to MN/SD border	2.43	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	-	2.43	2B, 3C
Aggregated HUC 12: 1017020316-02 (Upper Split Rock Creek)																			
10170203-507	Split Rock Creek,	Split Rock Lk to Pipestone Cr	13.64	2C, 3B	NS	NA	-	-	DO, B_F, B_I		EXS	EXS	EXS	IF	-	MTS	IF	-	-
10170203-509	Split Rock Creek	Headwaters to Split Rock Lk	11.91	2B, 3C	NS	NA	-	-	B_F, B_I		EXS	EXP	IF	IF	-	IF	IF	-	-
10170203-512	Split Rock Creek	Pipestone Cr to MN/SD border	6.81	2C, 3C	NS	NS	-	-	T, E.coli , B_F		EXS	MTS	EXP	EXS	-	MTS	MTS	-	EX
10170203-513	Unnamed creek	Headwaters to MN/SD border	10.64	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
10170203-538	Unnamed creek,	Unnamed cr to Unnamed cr	4.03	2B, 3C	NS	NA	-	-	B_I			EXP	IF	IF	-	IF	IF	-	-
10170203-543	Unnamed creek	T104 R46W S6, east line to Split Rock Cr	0.72	7	-	-	-	-	-		NA	NA	IF	-	-	IF	IF	-	-
10170203-552	Unnamed creek	Unnamed creek to Split Rock Cr	3.42	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
10170203-553	Unnamed creek	Unnamed cr to Unnamed cr	1.84	2B,	NS	NA	-	-	B_F,		EXS	EXS	IF	IF	-	IF	IF	-	-

				3C					B_I										

Aggregated HUC 12: 1017020315-01 (Beaver Creek)																			
10170203-520	Little Beaver Creek	Headwaters to Beaver Cr	15.24	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
10170203-521	Beaver Creek	Headwaters to Little Beaver Cr	20.81	2C, 3C	NS	NA	-	-	- B_I		MTS	EXS	IF	IF	-	IF	IF	-	-
10170203-522	Beaver Creek	Little Beaver Cr to MN/SD border	17.68	2C, 3B	NS	NS	-	-	T, E.coli B_F, B_I		EXS	EXP	IF	EXS	-	MTS	MTS	-	EX
10170203-524	Springwater Creek	Headwaters to MN/SD border	13.65	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
10170203-526	Fourmile Creek	Headwaters to MN/SD border	4.99	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
10170203-554	Unnamed creek,	Unnamed creek,	2.42	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
Aggregated HUC 12: 1017020317-01 (Blood Run-Big Sioux River)																			
10170203-555	Blood Run	Unnamed cr to MN/SD border	1.86	2B, 3C	NS	NA	-	-	B_I		MTS	EXS	IF	IF	-	IF	IF	-	-

Full Support (FS); Not Supporting (NS); Insufficient Data (IF); Not Assessed (NA); Meets standards or ecoregion expectations (MT/MTS), Potential Exceedance (EXP), Exceeds standards or ecoregion expectations (EX/EXS).
Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use. *Aquatic Life assessment and/or impairments have been deferred until the adoption of Tiered Aquatic Life Uses due to the AUID being predominantly (>50%) channelized or having biological data limited to a station occurring on a channelized portion of the stream.

AUID DESCRIPTIONS				USES							BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
Assessment Unit ID (AUID)	**Stream Reach Name**	**Reach Description**	**Reach Length (Miles)**	**Use Class**	**Aquatic Life**	**Aquatic Recreation**	**Aquatic Consumption**	**Drinking Water**	**303d listed impairments 2014**		**Fish**	**Macroinvertebrates**	**Dissolved Oxygen**	**Turbidity**	**Chloride**	**pH**	**NH3**	**Pesticides**	**Bacteria (Aquatic Recreation)**
Rock River Watershed																			
Aggergated HUC 12: 1017020401-03 (Upper Headwaters Rock River)																			
10170204-503	Rock River	T107 R45W S12, east line to T107 R44W S29, west line	5.7	7	NA	-	-	-	-		NA	NA	IF	-	-	IF	IF	--	-
10170204-504	Rock River	T107 R44W S30, east line to Chanarambie Cr	31.77	2C, 3C	NS	NS	-	-	E.coli B_F, T, B_I		EXS	EXS	IF	EXS	IF	MTS	MTS	-	EX
10170204-528	Unnamed creek	Unnamed cr to Rock R	6.98	7	NA	-	-	-			NA	NA	IF	-	-	IF	IF	-	IF
10170204-530	Rock River, East Branch	Headwaters to Rock R	17.22	2B, 3C	NS	NA	-	-	B_I		MTS	EXP	IF	IF	-	IF	IF	-	-
10170204-593	Unnamed cr	Unnamed cr to T106 R45W S25, south line	0.13	2B, 3C	NS	NA	-	-	B_F, B_I		EXS	EXS	-	-	-	-	-	-	
10170204-594	Unnamed creek	Unnamed cr to Unnamed cr	1.78	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-

Aggregated HUC 12: 1017020401-04 (Chanarambie Creek)																			
10170204-522	Chanarambie Creek	Headwaters to Rock R	20.51	2B, 3C	NS	NS	-	-	E.coli B_F, T, B_I		EXP	EXP	IF	EXS	IF	MTS	IF	-	EX
10170204-559	Unnamed creek	Unnamed cr to N Br Chanarambie Cr	1.32	2B, 3C	NS	NA	-	-	B_I		MTS	EXS	IF	IF	-	IF	IF	-	-
10170204-560	Chanarambie Creek, North Branch	Unnamed cr to Unnamed cr	0.95	2B, 3C	NS	NA		-	B_I		MTS	EXP	-	-	-	-	-	-	-
10170204-590	Unnamed creek	Unnamed cr to Chanarambie Cr	2.84	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-591	Unnamed creek	Headwaters to Unnamed cr	6.8	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
Aggregated HUC 12: 1017020401-02 (Poplar Creek)																			
10170204-523	Poplar Creek	Headwaters to Rock R	19.18	2B, 3C	NS	NS	-	-	E.coli B_F, T, B_I		EXS	EXP	IF	EXS	IF	MTS	IF	-	EX
10170204-588	Unnamed creek	Unnamed cr to Poplar Cr	5.04	2B, 3C	NS	NA	-	-	B_F, B_I		EXS	EXP	-	-	-	-	-	-	-
10170204-589	Unnamed creek	Unnamed cr to Poplar Cr	0.58	2B, 3C	NS	NA	-	-	B_I		MTS	EXS	-	-	-	-	-	-	-
Aggregated HUC 12: 1017020401-01 (Lower Headwaters Rock River)																			
10170204-506	Rock River	Poplar Cr to Unnamed cr	15.7	2C, 3C	NS	NS	-	-	E.coli B_F, T, B_I		EXS	EXS	IF	EXP	-	MTS	IF	-	EX
10170204-508	Rock River	Unnamed cr to Champepadan Cr	4.35	2C, 3C	NS	NS	-	-	E.coli B_F, T, B_I		EXS	EXS	IF	EXP	MTS	MTS	IF	-	EX
10170204-521	Unnamed creek	Headwaters to Rock R	18.37	2B, 3C	*NA	NS	-	-	E.coli		*NA	*NA	IF	*NA	-	MTS	MTS	-	EX
10170204-524	Unnamed creek	Headwaters to Rock R	13.34	2B, 3C	*NA	NA	-	-			*NA	*NA	IF	IF	--	IF	IF	-	
10170204-545	Unnamed creek	Unnamed cr to Rock R	0.57	2B, 3C	NA	NS	-	-	-				IF	IF	IF	IF	IF	-	EX
10170204-551	Mound Creek	Unnamed cr to T103 R45W S24, east line	4.07	2C	*NA	NS	-	-	E.coli		*NA	*NA	EXP	IF	-	MTS	IF	-	EX
10170204-571	Unnamed creek	Unnamed cr to Unnamed cr	1.93	2B, 3C	NS	NA	-	-	B_I		MTS	EXS	-	-	-	-	-	-	-
10170204-572	Unnamed creek	Unnamed cr to Unnamed cr	2.59	2B, 3C	NS	NA	-	-	-		MTS	EXS	-	-	-	-	-		-

Aggregated HUC 12: 1017020403-03 (Champepadan Creek)																			
10170204-520	Champepadan Creek	Headwaters to Rock R	37.98	2B, 3C	NS	NS	-	-	E.coli ,B_F, T, B_I		EXS	EXS	IF	EXS	-	IF	MTS	-	EX
10170204-582	Unnamed creek	Unnamed cr to Champepadan Cr	1.21	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-583	Unnamed creek	Unnamed cr to Champepadan Cr	1.83	2B, 3C	NS	NA	-	-	B_I		MTS	EXS	-	-	-	-	-	-	-
Aggregated HUC 12: 1017020403-02 (Elk Creek)																			
10170204-519	Elk Creek	Headwaters to Rock R	31.43	2B, 3C	NS	NS	-	-	E.coli ,B_F, B_I		EXS	EXP	MTS	EXS	IF	MTS	MTS	-	EX
10170204-557	County Ditch A	Unnamed ditch to Unnamed dtich	3.51	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-573	Unnamed creek	Unnamed cr to Elk Cr	1.38	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-574	Unnamed creek	Unnamed cr to Elk Cr	2.88	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
Aggergated HUC 12: 1017020403-01 (Upper Rock)																			
10170204-501	Rock River	Elk Cr to MN/IA border	11.55	2C, 3C	NS	NS	-	-	T, FC, B_F, B_I		EXS	EXS	MTS	EXS	MTS	MTS	MTS	-	EX
10170204-509	Rock River	Champepadan Cr to Elk Cr	12.75	2C, 3C	NS	NA	-	-	B_F, B_I		EXS	EXP	MTS	EXS	MTS	MTS	MTS	-	
10170204-539	Ash Creek	Unnamed cr to Unnamed cr	2.4	2C	NS	NA	-	-	B_F, B_I		EXS	EXP	-	IF	-	IF	IF	-	-
10170204-540	Ash Creek	Unnamed cr to Rock R	2.62	2C	*NA	NA					*NA	*NA	IF	IF		IF	IF		
10170204-569	Unnamed creek	Unnamed cr to Rock R	1.62	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
Aggregated HUC 12: 1017020404-01 (Mud Creek)																			
10170204-525	Mud Creek	Headwaters to MN/IA border	16.33	2C, 3C	NS	NS	-	-	E.coli B_F, B_I		EXS	EXP	EXP	EXS	IF	MTS	IF	-	EX
10170204-558	Unnamed creek	Unnamed cr to Unnamed ditch	1.18	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-568	Unnamed creek	Unnamed cr to Mud Cr	2.64	2B, 3C	FS	NA	-	-	-		EXP	MTS	-	-	-	-	-	-	-
Aggregated HUC 12: 1017020402-01 (Kanaranzi Creek																			
10170204-515	Kanaranzi Creek	Headwaters to E Br Kanaranzi Cr	16.42	2C, 3C	NS	NS	-	-	E.coli ,B_F, B_I		EXS	EXS	IF	IF	MTS	MTS	IF	-	EX
10170204-516	Kanaranzi Creek	E Br Kanaranzi Cr to Norwegian Cr	25.98	2C,	NS	NA	-	-	B_F,		EXS	EXP	IF	IF	-	IF	IF	-	-

				3C					B_I										
10170204-517	Kanaranzi Creek	Norwegian Cr to MN/IA border	6.77	2C, 3C	NS	NS	-	-	T, E.coli B_F, B_I		EXS	EXS	IF	EXS	IF	IF	MTS	-	EX
10170204-518	Norwegian Creek	Headwaters to Kanaranzi Cr	9.79	2B, 3C	*NS	NS	-	-	-		*NS	*NS	IF	EXS	-	IF	IF	-	EX
10170204-534	Unnamed creek	Headwaters to Unnamed cr	2.9	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	-	-	-
10170204-575	Unnamed creek	Unnamed cr to Kanaranzi Cr	2.53	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-576	Unnamed creek	Headwaters to Kanaranzi Cr	10.78	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-584	Unnamed creek	Unnamed cr to Kanaranzi Cr	2.35	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-587	Unnamed creek	Unnamed cr to Unnamed cr	0.13	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
Aggregated HUC 12: 1017020402-02 (East Branch Kanaranzi Creek)																			
10170204-514	Kanaranzi Creek, East Branch	Headwaters to Kanaranzi Cr	17.15	2B, 3C	NS	NS	-	-	E.coli B_F, T, B_I		EXS	EXP	IF	EXP	MTS	IF	MTS	-	EX
10170204-541	Unnamed creek	Headwaters to E Br Kanaranzi Cr	4.91	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
Aggergated HUC 12: 1017020403-03 (Little Rock Creek)																			
10170204-511	Little Rock Creek	Headwaters to Little Rock R	17.37	2B, 3C	NS	NS	-	-	E.coli , T, B_I		MTS	EXS	IF	EXP	IF	MTS	IF	-	EX
10170204-526	Unnamed creek	Headwaters to Little Rock R	7.12	2B, 3C	FS	NA	-	-	-		MTS	MTS	IF	IF		IF	-	-	-
10170204-538	Unnamed creek	Unnamed cr to Unnamed cr	2.54	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-
10170204-579	Unnamed creek	Unnamed cr to Little Rock Cr	1.67	2B, 3C	NS	NA	-	-	B_I		MTS	EXP	-	-	-			-	-
Aggregated HUC 12: 1017020407-02 (Tom Creek																			
None																			
Aggregated HUC 12: 1017020406-02 (Upper Little Rock River)																			
10170204-512	Little Rock River	Headwaters to Little Rock Cr	23.67	2C, 3C	NS	NS	-	-	E.coli B_F, T, B_I		EXS	EXP	IF	EXS	IF	MTS	IF	-	EX
10170204-513	Little Rock River	Little Rock Cr to MN/IA border	2.22	2C, 3C	NS	NS	-	-	T, E.coli B_F, B_I		EXP	EXP	IF	EXS	IF	MTS	MTS	-	EX
10170204-577	Unnamed creek	Unnamed cr to Unnamed cr	1.74	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10170204-580	Judicial Ditch 1	Unnamed cr to Unnamed cr	3.75	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-

Aggergated HUC 12: HUC Code (Upper Otter Creek)																			
10170204-510	Otter Creek	Headwaters to MN/IA border	4.08	2B, 3C	*NA	NA	-	-	-		*NA	*NA	IF	IF	-	IF	IF	-	-

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AUID DESCRIPTIONS				USES							BIOLOGICAL CRITERIA		WATER QUALITY STANDARDS						
Assessment Unit ID (AUID)	Stream Reach Name	Reach Description	Reach Length (Miles)	Use Class	Aquatic Life	Aquatic Recreation	Aquatic Consumption	Drinking Water	303d listed impairments 2014		Fish	Macroinvertebrates	Dissolved Oxygen	Turbidity	Chloride	pH	NH3	Pesticides	Bacteria (Aquatic Recreation)
Little Rock River Watershed																			
Aggregated HUC 12: 1023000305-02 (Upper Ocheyedan River)																			
10230003-501	Ocheyedan River	Ocheda Lk to MN/IA border	5.53	2B, 3C	NS	FS	-	-	B_F, B_I		EXS	EXP	IF	IF	MTS	MTS	-	-	MTS
10230003-502	Judicial Ditch 6 (Lake Okabena Outflow)	Okabena Lk to Ocheda Lk	2.38	2B, 3C	NS	NA	-	-	T		*NA	*NA	-	EXS	-	-	-	-	-
10230003-520	Okabena Creek	Unnamed cr to Whisky Ditch	2.15	2C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10230003-522	Unnamed creek	Unnamed cr to Okabena Lk	0.38	2B, 3C	*NA	-	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10230003-541	Unnamed creek	Headwaters to Ocheda Lk	3.05	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
Aggregated HUC 12: 102300301-02 (Judicial Ditch 13-Skunk Creek)																			
10230003-511	Judicial Ditch 13 (Skunk Creek)	Headwaters to W Fk Little Sioux R	20.87	2C	NS	NS	-	-			*NA	*NA	IF	EXS	-	MTS	-	-	EX
10230003-540	Judicial Ditch 9	Unnamed cr to JD 13	3.38	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
Aggergated HUC 12: 102300301-01 (West Fork Little Sioux River)																			
10230003-507	Little Sioux River	West Fork, Round Lk to JD 24	6.75	2C, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10230003-508	Little Sioux River, West Fork	JD 24 to JD 13	6.32	2C, 3C	*NA	NS	-	-	-		*NA	*NA	IF	*EXS		MTS	-	-	EX
10230003-509	Little Sioux River, West Fork	JD 13 to MN/IA border	0.65	2C, 3C	*NA	NS	-	-	-		*EXS	*EXS	IF	*EXS	IF	MTS	-	-	EX
10230003-510	Judicial Ditch 24	Headwaters to W Fk Little Sioux R	6.19	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-

Aggregated HUC 12: 1023000303-02 (Upper Headwaters Little Sioux River)																			
10230003-512	Judicial Ditch 28	Headwaters to Little Sioux R	11.65	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10230003-514	Little Sioux River	JD 28 to Unnamed cr	7.22	2C, 3C	*NA	NS	-	-	-		*EXS	*EXP	IF	*EXS	-	MTS	-	-	EX
10230003-515	Little Sioux River	Unnamed cr to MN/IA border	4.05	2C, 3C	NS	NS		-	-		EXS	MTS	EXP	EXS	IF	MTS	-	-	EX
10230003-516	Unnamed creek	Headwaters to Little Sioux R	12.72	2B, 3C	NA	NS	-	-	-		-	-	IF	MTS	-	MTS	-	-	EX
10230003-525	Unnamed creek	Headwaters to Unnamed cr	4.66	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10230003-526	Unnamed creek	Unnamed cr to Little Sioux R	4.84	2B, 3C	*NA	NA	-	-	-		*EXS	*MTS	-	-	-	-	-	-	-
10230003-538	County Ditch 11	Headwaters to Little Sioux R	4.22	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10230003-539	Unnamed creek	Headwaters to Big Sioux R	5.88	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
Aggregated HUC 12: 1023000302-01 (Milford Creek)																			
10230003-517	Judicial Ditch 8	Clear Lk to Loon Lk	7.18	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-
10230003-531	Judicial Ditch 35,	Headwaters to Rush Lk	7.36	2B, 3C	*NA	NA	-	-	-		*NA	*NA	-	-	-	-	-	-	-

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Appendix 3.2 - Assessment results for lakes in the Missouri River Basin

Upper Big Sioux River Watershed

None

Lower Big Sioux River Watershed

Lake ID	Lake Name	County	HUC-12	Ecoregion	Lake Area (acres)	Max Depth (m)	Watershed Area (acres)	% Littoral	Mean depth (m)	AQR Support Status	AQL Support Status
59-0001-00	Split Rock Reservoir	Pipestone	101702031602	WCBP	93	5.5		98.4			

Rock River Watershed

None

Little Rock River Watershed

Lake ID	Lake Name	County	Aggregated HUC-12	Ecoregion	Lake Area (acres)	Max Depth (m)	Watershed Area (acres)	% Littoral	Mean depth (m)	AQR Support Status	AQL Support Status
32-0008-00	Chandler	Jackson	1023000302-01	WCBP	72						
32-0020-00	Loon	Jackson	1023000302-01	WCBP	698	6	20498	100	1*	NS	NA
32-0021-00	Unnamed	Jackson	1023000302-01	WCBP	39.9						
32-0022-00	Clear	Jackson	1023000302-01	WCBP	426	9	1343	100	1*	NS	NA
32-0023-00	Spirit	Jackson	1023000302-01	WCBP	173.7						
32-0024-00	Little Spirit	Jackson	1023000302-01	WCBP	599	8	2678	100	1*	NS	NA
32-0025-00	Grovers	Jackson	1023000302-01	WCBP	250.5						
32-0027-00	Pletz Marsh	Jackson	1023000303-02	WCBP	66						
32-0028-00	Unnamed	Jackson	1023000303-02	WCBP	74.1						
32-0029-00	Unnamed	Jackson	1023000303-02	WCBP	36.1						

32-0031-00	Rush	Jackson	1023000302-01	WCBP	274.6						
32-0033-00	Pearl	Jackson	1023000302-01	WCBP	125.1						
32-0037-00	Unnamed	Jackson	1023000303-02	WCBP	33.1						
32-0038-00	Sangls Marsh	Jackson	1023000303-02	WCBP	35.3						
32-0039-00	Big Injun Slough	Jackson	1023000303-02	WCBP	33						
32-0040-00	Summer Marsh	Jackson	1023000303-02	WCBP	68.7						
32-0042-00	Husen Marsh	Jackson	1023000303-02	WCBP	44.9						
32-0055-00	Unnamed	Jackson	1023000303-02	WCBP	328.8						
32-0059-00	Skunk	Jackson	1023000301-02	WCBP	251.6						
32-0060-00	Unnamed	Jackson	1023000301-02	WCBP	89.6						
32-0061-00	Unnamed	Jackson	1023000301-02	WCBP	80.7						
32-0062-00	Unnamed	Jackson	1023000301-01	WCBP	203						
32-0063-00	Rush	Jackson	1023000301-01	WCBP	180						
32-0064-00	Unnamed	Jackson	1023000301-01	WCBP	34.9						
32-0069-00	Round	Jackson	1023000301-01	WCBP	906	9	5707	100	1*	NS	IF
32-0070-00	Unnamed	Jackson	1023000301-01	WCBP	21						
32-0071-00	Plum	Jackson	1023000301-01	WCBP	116.8						
32-0072-00	Illinois	Jackson	1023000301-01	WCBP	295.8						
32-0084-00	Iowa	Jackson	1023000301-01	WCBP	220		4316	100	1*	NS	NA
32-0088-00	Unnamed	Jackson	1023000301-01	WCBP	22.5						
32-0090-00	Unnamed	Jackson	1023000303-02	WCBP	45.7						
32-0093-00	Unnamed	Jackson	1023000303-02	WCBP	119.8						

32-0096-00	Unnamed	Jackson	1023000303-02	WCBP	115.5						
53-0007-00	Indian	Nobles	1023000301-01	WCBP	191	6.5	7723	100	1*	NS	NA
53-0009-00	Maroney	Nobles	1023000305-02	WCBP	130.2						
53-0024-00	Ocheda	Nobles	1023000305-02	WCBP	1955						
53-0024-01	Ocheda (West Basin)	Nobles	1023000305-02	WCBP	464	5	31376	100	1*	NS	NA
53-0024-02	Ocheda (Middle Bay)	Nobles	1023000305-02	WCBP	715	5	31376	100	1*	IF	IF
53-0024-03	Ocheda (East Basin)	Nobles	1023000305-02	WCBP	749	5	31376	100	1*	IF	NA
53-0026-00	Peterson Slough	Nobles	1023000305-02	WCBP	68						
53-0027-00	Wachter Marsh	Nobles	1023000305-02	WCBP	50.4						
53-0028-00	Okabena	Nobles	1023000305-02	WCBP	759	17	10010	100	1*	NS	NA
53-0033-00	Boote-Herlein Marsh	Nobles	1023000305-02	WCBP	309.1		4187	100	1*	NA	NA
53-0045-00	Bella	Nobles	1023000305-02	WCBP	164	14	38678	100	1*	NS	NA

Abbreviations:

FS – Full Support
NS – Non-Support
IF – Insufficient Information
NA – Not Assessed

Key for Cell Shading: = existing impairment, listed prior to 2012 reporting cycle; = new impairment; = full support of designated use.
*These depths were created by MPCA Staff.

Appendix 4.1 - Minnesota statewide IBI thresholds and confidence limits

Class #	Class Name	Use Class	Threshold	Confidence Limit	Upper	Lower
Fish						
1	Southern Rivers	2B, 2C	39	±11	50	28
2	Southern Streams	2B, 2C	45	±9	54	36
3	Southern Headwaters	2B, 2C	51	±7	58	44
10	Southern Coldwater	2A	45	±9	58	32
4	Northern Rivers	2B, 2C	35	±9	44	26
5	Northern Streams	2B, 2C	50	±9	59	41
6	Northern Headwaters	2B, 2C	40	±16	56	24
7	Low Gradient	2B, 2C	40	±10	50	30
11	Northern Coldwater	2A	37	±10	47	27
Invertebrates						
1	Northern Forest Rivers	2B, 2C	51.3	±10.8	62.1	40.5
2	Prairie Forest Rivers	2B, 2C	30.7	±10.8	41.5	19.9
3	Northern Forest Streams RR	2B, 2C	50.3	±12.6	62.9	37.7
4	Northern Forest Streams GP	2B, 2C	52.4	±13.6	66	38.8
5	Southern Streams RR	2B, 2C	35.9	±12.6	48.5	23.3
6	Southern Forest Streams GP	2B, 2C	46.8	±13.6	60.4	33.2
7	Prairie Streams GP	2B, 2C	38.3	±13.6	51.9	24.7
8	Northern Coldwater	2A	26	±12.4	38.4	13.6
9	Southern Coldwater	2A	46.1	±13.8	59.9	32.3

Appendix 4.2 - Biological monitoring results – fish IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
Upper Big Sioux River Watershed							
Aggregated HUC 12: 1017020209-01 (Deer Creek)							
None							
Aggregated HUC 12: 1017020210-01 (Medary Creek)							
10170202-501	11MS007	Medary Creek	28.89	3	51	61	30-Aug-11
10170202-501	11MS026	Medary Creek	16.72	3	51	55	31-Aug-11
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Fish Class**	**Threshold**	**FIBI**	**Visit Date**
Lower Big Sioux River Watershed							
***Aggregated* HUC 12: 1017020303-01 (Flandreau Creek)**							
10170203-502	11MS005	Flandreau Creek	92.29	2	45	33	03-Aug-04
10170203-515	11MS035	Willow Creek	29.07	3	51	17	19-Jun-12
10170203-516	04MS052	Flandreau Creek	12.05	3	51	19	12-Jun-12
10170203-516	11MS140	Flandreau Creek	20.12	3	51	61	09-Aug-11
10170203-517	11MS034	Flandreau Creek	53.07	2	45	63	17-Aug-11
10170203-531	11MS032	Unnamed creek	6.99	3	51	58	02-Aug-11
***Aggregated* HUC 12: 1017020313-02 (North Branch Pipestone Creek)**							
10170203-514	11MS050	Pipestone Creek, North Branch	62.75	2	45	25	13-Jun-12
10170203-514	11MS056	Pipestone Creek, North Branch	38.23	2	45	10	19-Jun-12
10170203-549	11MS049	Unnamed creek	14.04	3	51	66	31-Aug-11
10170203-550	11MS055	Unnamed creek	11.50	3	51	41	07-Sep-11
***Aggregated* HUC 12: 1017020313-03 (Upper Pipestone Creek)**							
10170203-506	04MS021	Pipestone Creek	44.70	2	45	43	11-Aug-04
***Aggregated* HUC 12: 1017020313-01 (Lower Pipestone Creek)**							
10170203-501	11MS019	Pipestone Creek	118.13	2	45	26	11-Aug-04

10170203-505	11MS015	Pipestone Creek	220.81	2	45	52	11-Aug-04
***Aggregated* HUC 12: 1017020316-02 (Upper Split Rock Creek)**							
10170203-507	04MS005	Split Rock Creek	36.24	2	45	55	04-Aug-04
10170203-507	11MS052	Split Rock Creek	67.80	2	45	10	10-Aug-04
10170203-509	04MS031	Split Rock Creek	15.80	3	51	31	04-Sep-07
10170203-509	04MS031	Split Rock Creek	15.80	3	51	32	17-Aug-10
10170203-512	11MS013	Split Rock Creek	331.11	1	39	35	03-Aug-11
10170203-553	11MS058	Unnamed creek	6.75	3	51	34	02-Aug-11
***Aggregated* HUC 12: 1017020315-01 (Beaver Creek)**							
10170203-521	11MS040	Beaver Creek	35.53	2	45	31	09-Aug-11
10170203-521	11MS043	Beaver Creek	9.55	3	51	42	07-Sep-11
10170203-522	11MS012	Beaver Creek	85.52	2	45	50	04-Aug-11
***Aggregated* HUC 12: 1017020317-01 (Blood Run-Big Sioux River)**							
10170203-555	11MS030	Blood Run	8.83	3	51	43	30-Aug-11
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Fish Class**	**Threshold**	**FIBI**	**Visit Date**
Rock River Watershed							
***Aggregated* HUC 12: 1017020401-03 (Upper Headwaters Rock River)**							
10170204-503	11MS136	Rock River	12.66	3	51	33	07-Jul-04
10170204-504	04MS009	Rock River	33.09	2	45	37	17-Aug-04
10170204-504	04MS009	Rock River	33.09	2	45	47	09-Aug-11
10170204-504	04MS009	Rock River	33.09	2	45	28	13-Jul-04
10170204-504	04MS010	Rock River	87.59	2	45	46	11-Aug-04
10170204-504	11MS011	Rock River	113.51	2	45	21	27-Jul-04
10170204-504	11MS116	Rock River	18.00	3	51	18	20-Jun-12
10170204-504	11MS147	Rock River	69.24	2	45	21	16-Aug-04
10170204-528	11MS089	Unnamed creek	15.53	3	51	63	11-Aug-11
10170204-530	04MS035	Rock River, East Branch	9.86	3	51	55	02-Aug-11
10170204-530	11MS088	Rock River, East Branch	23.89	3	51	55	11-Aug-11

10170204-530	11MS145	Rock River, East Branch	10.29	3	51	35	10-Aug-11
10170204-593	11MS138	Unnamed creek	5.19	3	51	42	10-Aug-11
***Aggregated* HUC 12: 1017020401-04 (Chanarambie Creek)**							
10170204-522	04MS026	Chanarambie Creek	62.67	2	45	69	10-Aug-11
10170204-522	11MS016	Chanarambie Creek	73.61	2	45	51	15-Aug-11
10170204-559	10EM142	Unnamed creek	4.15	3	51	11	08-Aug-11
10170204-560	11MS123	Chanarambie Creek, North Branch	8.92	3	51	66	16-Aug-11
***Aggregated* HUC 12: 1017020401-02 (Poplar Creek)**							
10170204-523	11MS014	Poplar Creek	34.80	2	45	30	18-Jun-12
10170204-588	11MS093	Unnamed creek	7.70	3	51	66	27-Jul-11
10170204-589	11MS096	Unnamed creek	5.24	3	51	42	12-Jun-12
***Aggregated* HUC 12: 1017020401-01 (Lower Headwaters Rock River)**							
10170204-506	04MS032	Rock River	244.75	2	45	22	21-Jul-04
10170204-506	11MS114	Rock River	264.41	2	45	32	27-Jul-04
10170204-508	11MS003	Rock River	306.30	1	39	27	12-Aug-04
10170204-571	11MS113	Unnamed creek	10.90	3	51	49	30-Aug-11
10170204-572	11MS083	Unnamed creek	7.40	3	51	63	16-Aug-11
***Aggregated* HUC 12: 1017020403-03 (Champepadan Creek)**							
10170204-520	10EM014	Champepadan Creek	74.81	2	45	19	12-Jun-12
10170204-520	10EM014	Champepadan Creek	74.81	2	45	48	04-Aug-11
10170204-520	11MS097	Champepadan Creek	20.35	3	51	23	19-Jun-12
10170204-520	11MS098	Champepadan Creek	55.44	2	45	50	10-Aug-11
10170204-583	11MS094	Unnamed creek	10.83	3	51	64	25-Jul-11
***Aggregated* HUC 12: 1017020403-02 (Elk Creek)**							
10170204-519	11MS020	Elk Creek	61.87	2	45	44	16-Aug-11
10170204-519	11MS118	Elk Creek	6.34	3	51	34	11-Aug-11

***Aggregated* HUC 12: 1017020403-01 (Upper Rock River)**							
10170204-501	04MS016	Rock River	513.11	1	39	13	14-Jul-04
10170204-501	11MS001	Rock River	555.82	1	39	15	07-Jul-04
10170204-509	04MS019	Rock River	414.98	1	39	26	22-Jul-04
10170204-509	04MS019	Rock River	414.98	1	39	43	17-Aug-04
10170204-509	04MS019	Rock River	414.98	1	39	45	12-Jul-04
10170204-509	11MS148	Rock River	431.82	1	39	58	27-Jul-11
10170204-539	04MS002	Ash Creek	7.73	7	40	36	11-Aug-11
***Aggregated* HUC 12: 1017020404-01 (Mud Creek)**							
10170204-525	11MS021	Mud Creek	25.87	3	51	62	30-Aug-11
10170204-525	11MS106	Mud Creek	16.04	3	51	59	17-Aug-11
10170204-568	11MS107	Unnamed creek	7.06	3	51	40	18-Jun-12
***Aggregated* HUC 12: 1017020402-01 (Kanaranzi Creek)**							
10170204-515	11MS004	Kanaranzi Creek	34.63	2	45	28	31-Aug-11
10170204-515	11MS126	Kanaranzi Creek	8.14	3	51	44	19-Jun-12
10170204-516	11MS101	Kanaranzi Creek	124.47	2	45	28	13-Jun-12
10170204-517	11MS006	Kanaranzi Creek	193.09	2	45	38	31-Aug-11
***Aggregated* HUC 12: 1017020402-02 (East Branch Kanaranzi Creek)**							
10170204-514	04MS050	Kanaranzi Creek, East Branch	46.28	2	45	38	17-Aug-10
10170204-514	11MS109	Kanaranzi Creek, East Branch	35.82	2	45	69	17-Aug-10
***Aggregated* HUC 12: 1017020406-03 (Little Rock Creek)**							
10170204-511	11MS009	Little Rock Creek	36.05	2	45	27	21-Jul-04
10170204-511	11MS132	Little Rock Creek	7.06	3	51	40	07-Jul-04
10170204-526	11MS104	Unnamed creek	12.59	3	51	39	31-Aug-11
10170204-579	11MS105	Unnamed creek	5.40	3	51	51	01-Aug-11
***Aggregated* HUC 12: 1017020407-02 (Tom Creek)**							
None							

***Aggregated* HUC 12: 1017020406-02 (Upper Little Rock River)**							
10170204-512	04MS053	Little Rock River	31.22	2	45	52	11-Aug-04
10170204-512	11MS047	Little Rock River	41.28	2	45	57	06-Sep-07
10170204-513	11MS002	Little Rock River	84.44	2	45	44	17-Aug-10
***Aggregated* HUC 12: 1017020405-02 (Upper Otter Creek)**							
None							

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Threshold	FIBI	Visit Date
Little Sioux Watershed							
***Aggregated* HUC 12: 1023000305-02 (Upper Ocheyedan River)**							
10230003-501	11MS022	Ocheyedan River	57.59	2	45	20	03-Aug-04
***Aggregated* HUC 12: 1023000301-02 (Judicial Ditch 13(Skunk Creek))**							
None							
***Aggregated* HUC 12: 1023000301-01 (West Fork Little Sioux River)**							
None							
***Aggregated* HUC 12: 1023000301-01 (Upper Headwaters Little Sioux River)**							
None							
***Aggregated* HUC 12: 1023000302-01 (Milford Creek)**							
None							

Appendix 4.3 - Biological monitoring results-macroinvertebrate IBI (assessable reaches)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
Upper Big Sioux River Watershed							
Aggregated HUC 12: 1017020209-01 (Deer Creek)							
None							
Aggregated HUC 12: 1017020210-01 (Medary Creek)							
10170202-501	11MS007	Medary Creek	28.89	5	35.9	33.39	09-Aug-11
10170202-501	11MS026	Medary Creek	16.72	5	35.9	21.29	08-Aug-11
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Invert Class**	**Threshold**	**MIBI**	**Visit Date**
Lower Big Sioux River Watershed							
***Aggregated* HUC 12: 1017020301-01 (Spring Creek)**							
10170203-518	11MS029	Spring Creek	9.04	7	38.3	38.15	09-Aug-11
***Aggregated* HUC 12: 1017020303-01 (Flandreau Creek)**							
10170203-502	11MS005	Flandreau Creek	92.29	7	38.3	29.30	01-Sep-04
10170203-502	11MS005	Flandreau Creek	92.29	7	38.3	29.30	01-Sep-04
10170203-502	11MS005	Flandreau Creek	92.29	7	38.3	29.30	01-Sep-04
10170203-502	11MS005	Flandreau Creek	92.29	7	38.3	29.30	01-Sep-04
10170203-502	11MS005	Flandreau Creek	92.29	7	38.3	29.30	01-Sep-04
10170203-502	11MS005	Flandreau Creek	92.29	7	38.3	29.30	01-Sep-04
10170203-502	11MS005	Flandreau Creek	92.29	7	38.3	29.30	01-Sep-04
10170203-531	11MS032	Unnamed creek	6.99	7	38.3	25.56	10-Aug-11
***Aggregated* HUC 12: 1017020313-02 (North Branch Pipestone Creek)**							
10170203-514	06MS001	Pipestone Creek, North Branch	26.70	7	38.3	21.83	18-Aug-10
10170203-514	06MS002	Pipestone Creek, North Branch	33.95	7	38.3	22.85	03-Aug-11
10170203-514	11MS050	Pipestone Creek, North Branch	62.75	7	38.3	39.06	04-Aug-11
10170203-514	11MS056	Pipestone Creek, North Branch	38.23	5	35.9	32.82	09-Aug-11
10170203-549	11MS049	Unnamed creek	14.04	7	38.3	13.46	04-Aug-11
10170203-549	11MS049	Unnamed creek	14.04	7	38.3	23.81	03-Aug-11

10170203-550	11MS055	Unnamed creek	11.50	7	38.3	21.08	05-Aug-11
***Aggregated* HUC 12: 1017020313-03 (Upper Pipestone Creek)**							
10170203-506	04MS021	Pipestone Creek	44.70	5	35.9	30.22	31-Aug-04
***Aggregated* HUC 12: 1017020313-01 (Lower Pipestone Creek)**							
10170203-501	11MS019	Pipestone Creek	118.13	7	38.3	30.80	31-Aug-04
10170203-505	11MS015	Pipestone Creek	220.81	7	38.3	37.46	31-Aug-04
***Aggregated* HUC 12: 1017020316-02 (Upper Split Rock Creek)**							
10170203-507	04MS005	Split Rock Creek	36.24	5	35.9	31.19	01-Sep-04
10170203-507	11MS052	Split Rock Creek	67.80	5	35.9	23.20	31-Aug-04
10170203-509	04MS031	Split Rock Creek	15.80	7	38.3	44.24	08-Sep-04
10170203-509	04MS031	Split Rock Creek	15.80	7	38.3	43.68	02-Oct-06
10170203-512	11MS013	Split Rock Creek	331.11	7	38.3	34.99	02-Oct-06
10170203-538	11MS045	Unnamed creek	8.17	7	38.3	29.33	10-Aug-11
10170203-553	11MS058	Unnamed creek	6.75	5	35.9	9.18	10-Aug-11
***Aggregated* HUC 12: 1017020315-01 (Beaver Creek)**							
10170203-521	11MS040	Beaver Creek	35.53	5	35.9	15.97	09-Aug-11
10170203-521	11MS043	Beaver Creek	9.55	5	35.9	26.08	09-Aug-11
10170203-522	11MS012	Beaver Creek	85.52	7	38.3	30.05	04-Aug-11
***Aggregated* HUC 12: 1017020317-01 (Blood Run-Big Sioux River)**							
10170203-555	11MS030	Blood Run	8.83	5	35.9	47.86	09-Aug-11

Rock River Watershed

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
***Aggregated* HUC 12: 1017020401-03 (Upper Headwaters Rock River)**							
10170204-503	11MS136	Rock River	12.66	7	38.3	25.39	09-Aug-11
10170204-504	04MS009	Rock River	33.09	5	35.9	32.01	01-Sep-04
10170204-504	04MS009	Rock River	33.09	5	35.9	23.84	02-Sep-04

10170204-504	04MS010	Rock River	87.59	5	35.9	22.49	24-Aug-04
10170204-504	11MS011	Rock River	113.51	5	35.9	26.30	08-Sep-04
10170204-504	11MS116	Rock River	18.00	7	38.3	30.45	31-Aug-04
10170204-504	11MS147	Rock River	69.24	7	38.3	21.26	08-Sep-04
10170204-528	11MS089	Unnamed creek	15.53	7	38.3	25.24	04-Aug-11
10170204-530	04MS035	Rock River, East Branch	9.86	5	35.9	22.55	16-Aug-11
10170204-530	11MS088	Rock River, East Branch	23.89	5	35.9	26.45	04-Aug-11
10170204-530	11MS145	Rock River, East Branch	10.29	7	38.3	28.28	04-Aug-11
10170204-593	11MS138	Unnamed cr	5.19	7	38.3	39.06	02-Aug-11
10170204-593	11MS138	Unnamed cr	5.19	7	38.3	28.59	03-Aug-11
***Aggregated* HUC 12: 1017020401-04 (Chanarambie Creek)**							
10170204-559	10EM142	Unnamed creek	4.15	7	38.3	23.96	12-Aug-11
10170204-560	11MS123	Chanarambie Creek, North Branch	8.92	7	38.3	12.88	12-Aug-11
***Aggregated* HUC 12: 1017020401-02 (Poplar Creek)**							
10170204-523	11MS014	Poplar Creek	34.80	5	35.9	30.91	02-Aug-11
10170204-588	11MS093	Unnamed creek	7.70	7	38.3	29.30	11-Aug-11
10170204-589	11MS096	Unnamed creek	5.24	5	35.9	19.99	02-Aug-11
***Aggregated* HUC 12: 1017020401-01 (Lower Headwaters Rock River)**							
10170204-506	04MS032	Rock River	244.75	5	35.9	25.66	24-Aug-04
10170204-506	11MS114	Rock River	264.41	5	35.9	20.30	02-Sep-04
10170204-508	11MS003	Rock River	306.30	5	35.9	31.81	31-Aug-04
10170204-571	11MS113	Unnamed creek	10.90	5	35.9	38.07	02-Aug-11
10170204-572	11MS083	Unnamed creek	7.40	5	35.9	11.77	02-Aug-11
***Aggregated* HUC 12: 1017020403-03 (Champepadan Creek)**							
10170204-520	10EM014	Champepadan Creek	74.81	5	35.9	32.64	03-Aug-11
10170204-520	10EM014	Champepadan Creek	74.81	5	35.9	20.27	02-Aug-11
10170204-520	10EM014	Champepadan Creek	74.81	5	35.9	30.72	08-Aug-11
10170204-520	11MS097	Champepadan Creek	20.35	5	35.9	21.20	08-Aug-11

10170204-520	11MS098	Champepadan Creek	55.44	5	35.9	31.26	08-Aug-11
10170204-583	11MS094	Unnamed creek	10.83	5	35.9	35.21	11-Aug-11

***Aggregated* HUC 12: 1017020403-02 (Elk Creek)**							
10170204-519	11MS020	Elk Creek	61.87	5	35.9	26.88	09-Aug-11
10170204-519	11MS118	Elk Creek	6.34	5	35.9	27.93	04-Aug-11
***Aggregated* HUC 12: 1017020403-01 (Upper Rock River)**							
10170204-501	04MS016	Rock River	513.11	2		32.14	31-Aug-04
10170204-501	11MS001	Rock River	555.82	2		14.94	25-Aug-04
10170204-509	04MS019	Rock River	414.98	5	35.9	9.71	08-Sep-04
10170204-509	04MS019	Rock River	414.98	5	35.9	19.38	11-Aug-11
10170204-509	11MS148	Rock River	431.82	7	38.3	23.59	27-Aug-04
10170204-539	04MS002	Ash Creek	7.73	7	38.3	23.38	04-Aug-11
***Aggregated* HUC 12: 1017020404-01 (Mud Creek)**							
10170204-525	11MS021	Mud Creek	25.87	7	38.3	29.37	02-Aug-11
10170204-525	11MS106	Mud Creek	16.04	7	38.3	28.23	09-Aug-11
10170204-568	11MS107	Unnamed creek	7.06	7	38.3	20.62	10-Aug-11
***Aggregated* HUC 12: 1017020402-01 (Kanaranzi Creek)**							
10170204-515	11MS004	Kanaranzi Creek	34.63	5	35.9	8.71	18-Aug-10
10170204-515	11MS126	Kanaranzi Creek	8.14	7	38.3	18.98	31-Aug-11
10170204-516	11MS101	Kanaranzi Creek	124.47	5	35.9	7.09	11-Aug-11
10170204-517	11MS006	Kanaranzi Creek	193.09	7	38.3	23.49	03-Aug-11
***Aggregated* HUC 12: 1017020402-02 (East Branch Kanaranzi Creek)**							
10170204-514	04MS050	Kanaranzi Creek, East Branch	46.28	5	35.9	19.23	09-Aug-11
10170204-514	11MS109	Kanaranzi Creek, East Branch	35.82	5	35.9	30.31	18-Aug-10
***Aggregated* HUC 12: 1017020406-03 (Little Rock Creek)**							
10170204-511	11MS009	Little Rock Creek	36.05	5	35.9	28.08	24-Aug-04
10170204-511	11MS132	Little Rock Creek	7.06	7	38.3	46.90	01-Sep-04
10170204-526	11MS104	Unnamed creek	12.59	7	38.3	17.94	16-Aug-11

10170204-579	11MS105	Unnamed creek	5.40	5	35.9	24.06	02-Aug-11
***Aggregated* HUC 12: 1017020407-02 (Tom Creek)**							
None							
***Aggregated* HUC 12: 1017020406-02 (Upper Little Rock River)**							
10170204-512	04MS053	Little Rock River	31.22	5	35.9	72.38	08-Sep-04
10170204-512	11MS047	Little Rock River	41.28	5	35.9	36.64	24-Aug-04
10170204-513	11MS002	Little Rock River	84.44	7	38.3	21.36	18-Aug-10
***Aggregated* HUC 12: 1017020405-02 (Upper Otter Creek)**							
None							

Little Sioux River Watershed

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Threshold	MIBI	Visit Date
***Aggregated* HUC 12: 1023000305-02 (Upper Ocheyedan River)**							
10230003-501	11MS022	Ocheyedan River	57.59	7	38.3	37.61	09-Aug-11
***Aggregated* HUC 12: 1023000301-02 (Judicial Ditch 13(Skunk Creek))**							
None							
***Aggregated* HUC 12: 1023000301-01 (West Fork Little Sioux River)**							
None							
***Aggregated* HUC 12: 1023000301-01 (Upper Headwaters Little Sioux River)**							
None							
***Aggregated* HUC 12: 1023000302-01 (Milford Creek)**							
None							

Appendix 5.1 - Good/fair/poor thresholds for biological stations on non-assessed channelized AUIDs

Ratings of **Good** for channelized streams are based on Minnesota's general use threshold for aquatic life (Appendix 4.1). Stations with IBIs that score above this general use threshold would be given a rating of **Good**. The **Fair** rating is calculated as a 15 point drop from the general use threshold. Stations with IBI scores below the general use threshold, but above the **Fair** threshold would be given a rating of **Fair**. Stations scoring below the Fair threshold would be considered **Poor**.

Class #	Class Name	Good	Fair	Poor
Fish				
1	Southern Rivers	>38	38-24	<24
2	Southern Streams	>44	44-30	<30
3	Southern Headwaters	>50	50-36	<36
4	Northern Rivers	>34	34-20	<20
5	Northern Streams	>49	49-35	<35
6	Northern Headwaters	>39	39-25	<25
7	Low Gradient Streams	>39	39-25	<25
Invertebrates				
1	Northern Forest Rivers	>51	52-36	<36
2	Prairie Forest Rivers	>31	31-16	<16
3	Northern Forest Streams RR	>50	50-35	<35
4	Northern Forest Streams GP	>52	52-37	<37
5	Southern Streams RR	>36	36-21	<21
6	Southern Forest Streams GP	>47	47-32	<32
7	Prairie Streams GP	>38	38-23	<23

Appendix 5.2 - Channelized stream reach and AUID IBI scores-fish (non-assessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
Upper Big Sioux River Watershed									
Aggregated HUC 12: 1017020209-01 (Deer Creek)									
None									
Aggregated HUC 12: 1017020210-01 (Medary Creek)									
None									
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Fish Class**	**Good**	**Fair**	**Poor**	**FIBI**	**Visit Date**
Lower Big Sioux River Watershed									
***Aggregated* HUC 12: 1017020301-01 (Spring Creek)**									
None									
***Aggregated* HUC 12: 1017020303-01 (Flandreau Creek)**									
10170203-548	11MS031	East Branch	17.15	3	>50	50-36	<36	39	20-Jun-12
***Aggregated* HUC 12: 1017020313-02 (North Branch Pipestone Creek)**									
None									
***Aggregated* HUC 12: 1017020313-03 (Upper Pipestone Creek)**									
10170203-506	11MS038	Pipestone Creek	44.52	2	>44	44-30	<30	46	03-Aug-11
10170203-527	04MS055	Main Ditch	30.85	2	>44	44-30	<30	61	09-Aug-11
10170203-527	10EM124	Main Ditch	20.64	3	>50	50-36	<36	0	16-Aug-11
10170203-527	10EM124	Main Ditch	20.64	3	>50	50-36	<36	66	10-Aug-11
10170203-530	11MS057	Main Ditch	8.11	3	>50	50-36	<36	60	10-Aug-11
10170203-545	07MS001	County Ditch A	15.60	3	>50	50-36	<36	39	09-Aug-11
***Aggregated* HUC 12: 1017020313-01 (Lower Pipestone Creek)**									
None									

***Aggregated* HUC 12: 1017020316-02 (Upper Split Rock Creek)**									
10170203-513	11MS042	Unnamed creek	17.13	3	>50	50-36	<36	37	30-Aug-11
10170203-543	11MS060	Unnamed creek	15.40	3	>50	50-36	<36	44	17-Aug-11
10170203-552	11MS046	Unnamed creek	20.16	3	>50	50-36	<36	22	03-Aug-11
***Aggregated* HUC 12: 1017020315-01 (Beaver Creek)**									
10170203-520	11MS039	Little Beaver Creek	16.18	3	>50	50-36	<36	67	18-Aug-11
10170203-524	04MS027	Springwater Creek	13.65	3	>50	50-36	<36	36	09-Aug-11
10170203-524	11MS036	Springwater Creek	15.95	3	>50	50-36	<36	65	02-Aug-11
10170203-526	11MS041	Fourmile Creek	6.53	3	>50	50-36	<36	41	11-Jun-12
10170203-554	11MS044	Unnamed creek	9.28	3	>50	50-36	<36	54	03-Aug-11
***Aggregated* HUC 12: 1017020317-01 (Blood Run-Big Sioux River)**									
None									

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
Rock River Watershed									
***Aggregated* HUC 12: 1017020401-03 (Upper Headwaters Rock River)**									
10170204-504	04MS051	Rock River	23.13	3	>50	50-36	<36	56	13-Jul-04
10170204-530	04MS012	Rock River, East Branch	17.87	3	>50	50-36	<36	80	02-Aug-11
10170204-594	11MS117	Unnamed creek	6.62	3	>50	50-36	<36	12	14-Jun-12
***Aggregated* HUC 12: 1017020401-04 (Chanarambie Creek)**									
10170204-522	11MS091	Chanarambie Creek	34.38	2	>44	44-30	<30	57	26-Jul-11
10170204-522	11MS121	Chanarambie Creek	64.26	2	>44	44-30	<30	66	28-Jul-11
10170204-590	11MS122	Unnamed creek	17.23	3	>50	50-36	<36	16	12-Jun-12
10170204-591	11MS124	Unnamed creek	6.14	3	>50	50-36	<36	60	07-Sep-11
***Aggregated* HUC 12: 1017020401-02 (Poplar Creek)**									

None									
***Aggregated* HUC 12: 1017020401-01 (Lower Headwaters Rock River)**									
10170204-521	11MS084	Unnamed creek	17.74	3	>50	50-36	<36	57	04-Aug-11
10170204-524	11MS081	Unnamed creek	18.44	3	>50	50-36	<36	80	03-Aug-11
10170204-551	11MS082	Mound Creek	16.91	3	>50	50-36	<36	48	26-Jul-11
***Aggregated* HUC 12: 1017020403-03 (Champepadan Creek)**									
10170204-582	11MS095	Unnamed creek	6.17	3	>50	50-36	<36	53	26-Jul-11
***Aggregated* HUC 12: 1017020403-02 (Elk Creek)**									
10170204-519	11MS100	Elk Creek	39.24	2	>44	44-30	<30	38	10-Aug-11
10170204-557	07MS002	County Ditch A	6.86	3	>50	50-36	<36	33	14-Jun-11
10170204-557	07MS002	County Ditch A	6.86	3	>50	50-36	<36	37	08-Sep-11
10170204-573	11MS099	Unnamed creek	7.41	3	>50	50-36	<36	56	02-Aug-11
10170204-574	11MS119	Unnamed creek	6.53	3	>50	50-36	<36	46	26-Jul-11
***Aggregated* HUC 12: 1017020403-01 (Upper Rock River)**									
10170204-540	11MS085	Ash Creek	13.49	3	>50	50-36	<36	67	03-Aug-11
10170204-569	11MS108	Unnamed creek	5.69	3	>50	50-36	<36	53	03-Aug-11
***Aggregated* HUC 12: 1017020404-01 (Mud Creek)**									
10170204-558	10EM001	Unnamed creek	3.96	3	>50	50-36	<36	52	04-Aug-11
***Aggregated* HUC 12: 1017020402-01 (Kanaranzi Creek)**									
10170204-518	11MS086	Norwegian Creek	21.37	3	>50	50-36	<36	46	20-Jun-12
10170204-518	11MS102	Norwegian Creek	6.96	3	>50	50-36	<36	37	13-Jun-12
10170204-534	04MS008	Unnamed creek	1.04	3	>50	50-36	<36	73	26-Jul-11
10170204-575	11MS129	Unnamed creek	8.65	3	>50	50-36	<36	48	18-Aug-11
10170204-576	11MS128	Unnamed creek	6.10	3	>50	50-36	<36	53	17-Aug-11
10170204-584	11MS127	Unnamed creek	7.35	3	>50	50-36	<36	64	08-Aug-11

10170204-587	11MS125	Unnamed creek	4.59	3	>50	50-36	<36	64	28-Jul-11

***Aggregated* HUC 12: 1017020402-02 (East Branch Kanaranzi Creek)**									
10170204-541	04MS034	Unnamed creek	6.01	3	>50	50-36	<36	60	01-Aug-11
10170204-541	04MS034	Unnamed creek	6.01	3	>50	50-36	<36	57	27-Jul-11
10170204-541	04MS034	Unnamed creek	6.01	3	>50	50-36	<36	34	09-Aug-11
***Aggregated* HUC 12: 1017020406-03 (Little Rock Creek)**									
10170204-538	04MS011	Unnamed creek	4.72	3	>50	50-36	<36	36	09-Aug-11
***Aggregated* HUC 12: 1017020407-02 (Tom Creek)**									
None									
***Aggregated* HUC 12: 1017020406-02 (Upper Little Rock River)**									
10170204-557	07MS002	County Ditch A	6.86	3	>50	50-36	<36	37	08-Sep-11
10170204-580	11MS111	Judicial Ditch 1	9.20	3	>50	50-36	<36	56	01-Aug-11
***Aggregated* HUC 12: 1017020405-02 (Upper Otter Creek)**									
10170204-510	11MS087	Otter Creek	7.88	3	>50	50-36	<36	73	26-Jul-04

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Fish Class	Good	Fair	Poor	FIBI	Visit Date
Little Sioux River Watershed									
***Aggregated* HUC 12: 1023000305-02 (Upper Ocheyedan River)**									
10230003-502	11MS063	Judicial Ditch 6 (Lake Okabena Outflow)	26.39	3	>50	50-36	<36	19	28-Jul-04
10230003-520	11MS075	Okabena Creek	14.23	3	>50	50-36	<36	21	21-Jun-12
10230003-522	04MS025	Unnamed creek	4.13	3	>50	50-36	<36	46	06-Sep-11
10230003-541	11MS076	Unnamed creek	5.78	3	>50	50-36	<36	17	13-Jun-11
***Aggregated* HUC 12: 1023000301-02 (Judicial Ditch 13(Skunk Creek))**									
10230003-511	04MS018	Judicial Ditch 13 (Skunk Creek)	37.22	2	>44	44-30	<30	3	28-Jul-11
10230003-511	11MS066	Judicial Ditch 13 (Skunk Creek)	44.69	2	>44	44-30	<30	38	13-Jun-11

10230003-511	11MS079	Judicial Ditch 13 (Skunk Creek)	15.51	3	>50	50-36	<36	47	20-Jun-12
10230003-540	11MS023	Judicial Ditch 9	8.52	3	>50	50-36	<36	32	06-Sep-11
***Aggregated* HUC 12: 1023000301-01 (West Fork Little Sioux River)**									
10230003-507	11MS073	Little Sioux River, West Fork	14.44	3	>50	50-36	<36	64	28-Jul-04
10230003-508	11MS062	Little Sioux River, West Fork	65.13	2	>44	44-30	<30	42	20-Jun-12
10230003-509	11MS008	Little Sioux River, West Fork	112.18	2	>44	44-30	<30	29	18-Jun-12
10230003-510	11MS065	Judicial Ditch 24	33.84	2	>44	44-30	<30	27	19-Jun-12
***Aggregated* HUC 12: 1023000301-01 (Upper Headwaters Little Sioux River)**									
10230003-512	11MS068	Judicial Ditch 28	16.36	3	>50	50-36	<36	48	25-Jul-11
10230003-514	11MS072	Little Sioux River	59.53	2	>44	44-30	<30	38	20-Jun-12
10230003-514	11MS143	Little Sioux River	43.26	2	>44	44-30	<30	20	20-Jun-12
10230003-515	11MS010	Little Sioux River	104.48	2	>44	44-30	<30	36	13-Jun-11
10230003-525	04MS014	Unnamed creek	3.22	3	>50	50-36	<36	58	13-Jun-11
10230003-526	11MS067	Unnamed creek	7.76	3	>50	50-36	<36	44	27-Jul-11
10230003-538	11MS078	County Ditch 11	6.92	7	>39	39-25	<25	15	13-Jun-11
10230003-539	11MS077	Unnamed creek	11.13	3	>50	50-36	<36	28	07-Sep-11
***Aggregated* HUC 12: 1023000302-01 (Milford Creek)**									
10230003-517	11MS024	Judicial Ditch 8	8.16	3	>50	50-36	<36	41	13-Jun-11
10230003-531	11MS144	Judicial Ditch 35	8.96	3	>50	50-36	<36	31	25-Jul-11

Appendix 5.3 - Channelized stream reach and AUID IBI scores-macroinvertebrate (non-unassessed)

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
Upper Big Sioux River Watershed									
Aggregated HUC 12: 1017020209-01 (Deer Creek)									
None									
Aggregated HUC 12: 1017020210-01 (Medary Creek)									
None									
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Invert Class**	**Good**	**Fair**	**Poor**	**MIBI**	**Visit Date**
Lower Big Sioux River Watershed									
***Aggregated* HUC 12: 1017020301-01 (Spring Creek)**									
None									
***Aggregated* HUC 12: 1017020303-01 (Flandreau Creek)**									
10170203-548	11MS031	East Branch	17.15	5	>36	36-21	<21	11.85	04-Aug-11
***Aggregated* HUC 12: 1017020313-02 (North Branch Pipestone Creek)**									
None									
***Aggregated* HUC 12: 1017020313-03 (Upper Pipestone Creek)**									
10170203-506	11MS038	Pipestone Creek	44.52	7	>38	38-23	<23	39.97	09-Aug-11
10170203-527	04MS055	Main Ditch	30.85	7	>38	38-23	<23	21.23	10-Aug-11
10170203-527	04MS055	Main Ditch	30.85	7	>38	38-23	<23	16.08	10-Aug-11
10170203-527	10EM124	Main Ditch	20.64	7	>38	38-23	<23	23.78	03-Aug-11
10170203-527	10EM124	Main Ditch	20.64	7	>38	38-23	<23	20.87	10-Aug-11
10170203-530	11MS057	Main Ditch	8.11	7	>38	38-23	<23	32.17	10-Aug-11
10170203-545	07MS001	County Ditch A	15.60	7	>38	38-23	<23	30.49	10-Aug-11

***Aggregated* HUC 12: 1017020313-01 (Lower Pipestone Creek)**									
10170203-551	11MS028	Unnamed creek	6.84	7	>38	38-23	<23	38.55	04-Aug-11
***Aggregated* HUC 12: 1017020316-02 (Upper Split Rock Creek)**									
10170203-513	11MS042	Unnamed creek	17.13	7	>38	38-23	<23	24.35	11-Sep-07
10170203-543	11MS060	Unnamed creek	15.40	5	>36	36-21	<21	27.40	10-Aug-11
10170203-552	11MS046	Unnamed creek	20.16	5	>36	36-21	<21	34.81	16-Aug-11
10170203-552	11MS046	Unnamed creek	20.16	5	>36	36-21	<21	16.98	03-Aug-11
***Aggregated* HUC 12: 1017020315-01 (Beaver Creek)**									
10170203-520	11MS039	Little Beaver Creek	16.18	5	>36	36-21	<21	24.87	09-Aug-11
10170203-524	04MS027	Springwater Creek	13.65	5	>36	36-21	<21	33.06	04-Aug-11
10170203-524	11MS036	Springwater Creek	15.95	7	>38	38-23	<23	16.08	09-Aug-11
10170203-526	11MS041	Fourmile Creek	6.53	7	>38	38-23	<23	37.43	03-Aug-11
10170203-554	11MS044	Unnamed creek	9.28	5	>36	36-21	<21	31.11	05-Aug-11
***Aggregated* HUC 12: 1017020317-01 (Blood Run-Big Sioux River)**									
None									

National Hydrography Dataset (NHD) Assessment Segment AUID	Biological Station ID	Stream Segment Name	Drainage Area Mi^2	Invert Class	Good	Fair	Poor	MIBI	Visit Date
Rock River Watershed									
***Aggregated* HUC 12: 1017020401-03 (Upper Headwaters Rock River)**									
10170204-504	04MS051	Rock River	23.13	7	>38	38-23	<23	15.21	01-Sep-04
10170204-504	04MS051	Rock River	23.13	7	>38	38-23	<23	13.56	31-Aug-04
10170204-530	04MS012	Rock River, East Branch	17.87	5	>36	36-21	<21	21.09	09-Aug-11
10170204-594	11MS117	Unnamed creek	6.62	5	>36	36-21	<21	34.57	09-Aug-11
***Aggregated* HUC 12: 1017020401-04 (Chanarambie Creek)**									
10170204-522	11MS091	Chanarambie Creek	34.38	7	>38	38-23	<23	31.23	03-Aug-11
10170204-522	11MS121	Chanarambie Creek	64.26	7	>38	38-23	<23	18.95	15-Aug-11
10170204-590	11MS122	Unnamed creek	17.23	7	>38	38-23	<23	25.06	03-Aug-11

10170204-591	11MS124	Unnamed creek	6.14	5	>36	36-21	<21	34.30	03-Aug-11
***Aggregated* HUC 12: 1017020401-02 (Poplar Creek)**									
None									
***Aggregated* HUC 12: 1017020401-01 (Lower Headwaters Rock River)**									
10170204-521	11MS084	Unnamed creek	17.74	5	>36	36-21	<21	20.60	10-Aug-11
10170204-524	11MS081	Unnamed creek	18.44	7	>38	38-23	<23	49.91	09-Aug-11
10170204-551	11MS082	Mound Creek	16.91	7	>38	38-23	<23	36.20	03-Aug-11
10170204-551	11MS082	Mound Creek	16.91	7	>38	38-23	<23	46.69	03-Aug-11
***Aggregated* HUC 12: 1017020403-03 (Champepadan Creek)**									
10170204-582	11MS095	Unnamed creek	6.17	5	>36	36-21	<21	37.37	11-Aug-11
***Aggregated* HUC 12: 1017020403-02 (Elk Creek)**									
10170204-519	11MS100	Elk Creek	39.24	5	>36	36-21	<21	21.46	11-Aug-11
10170204-557	07MS002	County Ditch A	6.86	7	>38	38-23	<23	37.89	03-Aug-11
10170204-557	07MS002	County Ditch A	6.86	7	>38	38-23	<23	23.63	11-Aug-11
10170204-573	11MS099	Unnamed creek	7.41	5	>36	36-21	<21	29.41	03-Aug-11
10170204-573	11MS099	Unnamed creek	7.41	5	>36	36-21	<21	26.13	04-Aug-11
10170204-574	11MS119	Unnamed creek	6.53	7	>38	38-23	<23	38.31	04-Aug-11
***Aggregated* HUC 12: 1017020403-01 (Upper Rock River)**									
10170204-540	11MS085	Ash Creek	13.49	5	>36	36-21	<21	29.76	09-Aug-11
10170204-569	11MS108	Unnamed creek	5.69	7	>38	38-23	<23	13.67	08-Aug-11
***Aggregated* HUC 12: 1017020404-01 (Mud Creek)**									
10170204-558	10EM001	Unnamed creek	3.96	7	>38	38-23	<23	22.97	12-Aug-11
***Aggregated* HUC 12: 1017020402-01 (Kanaranzi Creek)**									
10170204-518	11MS086	Norwegian Creek	21.37	5	>36	36-21	<21	23.19	02-Aug-11
10170204-518	11MS102	Norwegian Creek	6.96	7	>38	38-23	<23	17.84	09-Aug-11

10170204-518	11MS102	Norwegian Creek	6.96	7	>38	38-23	<23	23.05	09-Aug-11
10170204-534	04MS008	Unnamed creek	1.04	7	>38	38-23	<23	32.63	04-Aug-11
10170204-575	11MS129	Unnamed creek	8.65	7	>38	38-23	<23	24.56	09-Aug-11
10170204-576	11MS128	Unnamed creek	6.10	7	>38	38-23	<23	39.88	02-Aug-11
10170204-584	11MS127	Unnamed creek	7.35	5	>36	36-21	<21	32.92	03-Aug-11
10170204-587	11MS125	Unnamed creek	4.59	7	>38	38-23	<23	35.36	04-Aug-11
***Aggregated* HUC 12: 1017020402-02 (East Branch Kanaranzi Creek)**									
10170204-541	04MS034	Unnamed creek	6.01	5	>36	36-21	<21	41.54	09-Aug-11
10170204-541	04MS034	Unnamed creek	6.01	5	>36	36-21	<21	42.08	02-Aug-11
10170204-541	04MS034	Unnamed creek	6.01	5	>36	36-21	<21	24.20	09-Aug-11
***Aggregated* HUC 12: 1017020406-03 (Little Rock Creek)**									
10170204-538	04MS011	Unnamed creek	4.72	7	>38	38-23	<23	25.58	04-Aug-11
***Aggregated* HUC 12: 1017020407-02 (Tom Creek)**									
None									
***Aggregated* HUC 12: 1017020406-02 (Upper Little Rock River)**									
10170204-577	11MS115	Unnamed creek	6.62	7	>38	38-23	<23	27.83	02-Aug-11
10170204-580	11MS111	Judicial Ditch 1	9.20	7	>38	38-23	<23	24.74	11-Aug-11
***Aggregated* HUC 12: 1017020405-02 (Upper Otter Creek)**									
10170204-510	11MS087	Otter Creek	7.88	7	>38	38-23	<23	24.15	01-Sep-04
National Hydrography Dataset (NHD) Assessment Segment AUID	**Biological Station ID**	**Stream Segment Name**	**Drainage Area Mi^2**	**Invert Class**	**Good**	**Fair**	**Poor**	**MIBI**	**Visit Date**
Little Sioux River Watershed									
***Aggregated* HUC 12: 1023000305-02 (Upper Ocheyedan River)**									
10230003-502	11MS063	Judicial Ditch 6 (Lake Okabena Outflow)	26.39	7	>38	38-23	<23	34.86	30-Aug-04
10230003-520	11MS075	Okabena Creek	14.23	5	>36	36-21	<21	17.10	11-Aug-11
10230003-522	04MS025	Unnamed creek	4.13	7	>38	38-23	<23	30.38	11-Aug-11

10230003-541	11MS076	Unnamed creek	5.78	7	>38	38-23	<23	51.86	09-Aug-11

***Aggregated* HUC 12: 1023000301-02 (Judicial Ditch 13(Skunk Creek))**									
10230003-511	04MS018	Judicial Ditch 13 (Skunk Creek)	37.22	7	>38	38-23	<23	24.76	09-Aug-11
10230003-511	11MS079	Judicial Ditch 13 (Skunk Creek)	15.51	7	>38	38-23	<23	19.41	10-Aug-11
10230003-511	11MS066	Judicial Ditch 13 (Skunk Creek)	44.69	7	>38	38-23	<23	24.39	10-Aug-11
10230003-540	11MS023	Judicial Ditch 9	8.52	7	>38	38-23	<23	28.41	09-Aug-11
***Aggregated* HUC 12: 1023000301-01 (West Fork Little Sioux River)**									
10230003-507	11MS073	Little Sioux River, West Fork	14.44	5	>36	36-21	<21	22.12	09-Aug-11
10230003-508	11MS062	Little Sioux River, West Fork	65.13	7	>38	38-23	<23	21.70	09-Aug-11
10230003-509	11MS008	Little Sioux River, West Fork	112.18	5	>36	36-21	<21	35.06	09-Aug-11
10230003-510	11MS065	Judicial Ditch 24	33.84	7	>38	38-23	<23	11.71	09-Aug-11
***Aggregated* HUC 12: 1023000301-01 (Upper Headwaters Little Sioux River)**									
10230003-512	11MS068	Judicial Ditch 28	16.36	5	>36	36-21	<21	42.74	10-Aug-11
10230003-514	11MS143	Little Sioux River	43.26	7	>38	38-23	<23	25.67	11-Aug-11
10230003-514	11MS072	Little Sioux River	59.53	7	>38	38-23	<23	32.97	10-Aug-11
10230003-515	11MS010	Little Sioux River	104.48	7	>38	38-23	<23	23.42	11-Aug-11
10230003-525	04MS014	Unnamed creek	3.22	7	>38	38-23	<23	15.33	10-Aug-11
10230003-526	11MS067	Unnamed creek	7.76	7	>38	38-23	<23	41.74	10-Aug-11
10230003-526	11MS067	Unnamed creek	7.76	7	>38	38-23	<23	24.83	24-Aug-04
10230003-538	11MS078	County Ditch 11	6.92	7	>38	38-23	<23	26.47	02-Aug-11
10230003-539	11MS077	Unnamed creek	11.13	7	>38	38-23	<23	23.54	24-Aug-04
***Aggregated* HUC 12: 1023000302-01 (Milford Creek)**									
10230003-517	11MS024	Judicial Ditch 8	8.16	5	>36	36-21	<21	39.44	11-Aug-11
10230003-517	11MS024	Judicial Ditch 8	8.16	5	>36	36-21	<21	30.91	30-Aug-04
10230003-531	11MS144	Judicial Ditch 35	8.96	7	>38	38-23	<23	19.33	02-Aug-11

Appendix 6.1 - Minnesota's ecoregion-based lake eutrophication standards

Ecoregion	TP µg/L	Chl-a µg/L	Secchi meters
NLF – Lake Trout (Class 2A)	< 12	< 3	> 4.8
NLF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NLF – Aquatic Rec. Use (Class 2B)	< 30	< 9	> 2.0
NCHF – Stream trout (Class 2A)	< 20	< 6	> 2.5
NCHF – Aquatic Rec. Use (Class 2B)	< 40	< 14	> 1.4
NCHF – Aquatic Rec. Use (Class 2B) Shallow lakes	< 60	< 20	> 1.0
WCBP & NGP – Aquatic Rec. Use (Class 2B)	< 65	< 22	> 0.9
WCBP & NGP – Aquatic Rec. Use (Class 2B) Shallow lakes	< 90	< 30	> 0.7

Appendix 6.2 - MINLEAP model estimates of phosphorus loads for lakes in the Little Sioux River Watershed

Lake ID	Lake Name	Obs TP (µg/L)	MINLEAP TP (µg/L)	Obs Chl-a (µg/L)	MINLEAP Chl-a (µg/L)	Obs Secchi (m)	MINLEAP Secchi (m)	Avg. TP Inflow (µg/L)	TP Load (kg/yr)	Background TP (µg/L)	%P Retention	Outflow (hm3/yr)	Residence Time (yrs)	Areal Load (m/yr)	Trophic Status
32-0020-00	Loon	331.81	235	93	192	0.46	0.3	569	6232	0	0.59	10.95	0.3	3.88	H
32-0022-00	Clear	112.49	103	55.88	58	0.55	0.7	561	454	0	0.82	0.81	2.1	0.47	H
32-0024-00	Little Spirit	259.49	119	66.73	71	0.83	0.6	563	876	0	0.79	1.55	1.6	0.64	H
32-0069-00	Round	118.64	136	14.9	86	0.52	0.6	565	1821	0	0.76	3.22	1.1	0.88	H
32-0084-00	Iowa	221.13	206	75.16	158	0.24	0.4	568	1321	0	0.64	2.32	0.4	2.61	H
53-0007-00	Indian	335.71	259	61.24	221	1.35	0.3	569	2339	0	0.54	4.11	0.2	5.32	H
53-0024-01	Ocheda (West Basin)	235.94	298	133.3	271	0.21	0.3	570	9465	0	0.48	16.62	0.1	8.85	H
53-0024-02	Ocheda (Middle Bay)	243	265	259	228	0.14	0.3	569	9496	0	0.53	16.68	0.2	5.76	H
53-0028-00	Okabena	118.71	179	31.03	129	0.55	0.4	568	3094	0	0.68	5.45	0.6	1.77	H
53-0045-00	Bella	175.88	390	111.31	400	0.37	0.2	570	11618	0	0.32	20.39	12*	30.72	H

Abbreviations: **H** – Hypereutrophic **M** – Mesotrophic --- No data
E – Eutrophic **O** – Oligotrophic *Days

Appendix 7 – Fish species found during biological monitoring surveys

Upper Big Sioux River

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
bigmouth shiner	1	2
black bullhead	2	44
blacknose dace	2	376
bluntnose minnow	2	439
brassy minnow	1	1
brook stickleback	1	6
central stoneroller	2	377
common carp	1	4
common shiner	2	99
creek chub	2	377
fathead minnow	1	380
green sunfish	2	11
Iowa darter	1	1
johnny darter	2	295
northern pike	2	15
orangespotted sunfish	1	2
red shiner	1	33
sand shiner	2	14
stonecat	2	7
tadpole madtom	2	19
Topeka shiner	1	14
white sucker	2	649
yellow bullhead	2	18
yellow perch	1	3

Upper Big Sioux River

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
banded darter	1	3
bigmouth shiner	25	246
black bullhead	23	298
black crappie	1	1
blacknose dace	21	788
blackside darter	6	12
bluegill	1	1
bluntnose minnow	18	456
brassy minnow	7	195
brook stickleback	13	181
central stoneroller	29	2302
channel catfish	3	11

common carp	19	201
common shiner	28	1437
creek chub	41	2582
fathead minnow	35	1747
Gen: redhorses	3	6
green sunfish	29	399
hybrid sunfish	1	1
Iowa darter	8	36
johnny darter	31	618
largemouth bass	1	1
northern pike	18	55
orangespotted sunfish	12	145
quillback	6	41
red shiner	17	534
sand shiner	23	2311
shorthead redhorse	15	154
smallmouth bass	1	1
southern redbelly dace	1	3
stonecat	17	86
tadpole madtom	15	124
Topeka shiner	5	23
trout-perch	1	1
white sucker	40	1932
yellow bullhead	3	4
yellow perch	1	1

Rock River

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
bigmouth buffalo	1	1
bigmouth shiner	45	1025
black bullhead	27	329
black crappie	2	2
blacknose dace	55	1114
blackside darter	31	131
bluegill	11	37
bluntnose minnow	65	1603
brassy minnow	30	342
brook stickleback	36	374
central stoneroller	83	5888
channel catfish	4	17
common carp	41	196
common shiner	81	3261
creek chub	90	7572

fathead minnow	76	2313
freshwater drum	2	6
Gen: redhorses	2	38
gizzard shad	9	19
golden shiner	1	1
goldeye	1	3
green sunfish	62	671
hybrid minnow	1	1
hybrid sunfish	2	3
Iowa darter	99	158
johnny darter	150	1101
largemouth bass	84	39
northern pike	93	62
orangespotted sunfish	100	211
plains topminnow	80	36
pumpkinseed	5	6
quillback	16	155
red shiner	25	1027
river carpsucker	3	4
sand shiner	57	4073
shorthead redhorse	39	489
shortnose gar	2	3
smallmouth bass	2	5
smallmouth buffalo	2	3
southern redbelly dace	16	161
stonecat	40	193
tadpole madtom	27	91
Topeka shiner	14	133
trout-perch	15	65
white sucker	89	3607
yellow bullhead	1	1
yellow perch	16	28

Little Sioux River

Common Name	Quantity of Stations Where Present	Quantity of Individuals Collected
bigmouth buffalo	2	20
bigmouth shiner	3	11
black bullhead	14	263
black crappie	3	4
blacknose dace	7	84
bluntnose minnow	6	12
brassy minnow	4	22
brook stickleback	8	169

central stoneroller	3	5
channel catfish	3	6
common carp	16	136
creek chub	13	163
fathead minnow	20	1030
freshwater drum	3	73
golden shiner	3	8
green sunfish	14	157
hybrid sunfish	1	2
Iowa darter	8	82
johnny darter	8	36
largemouth bass	2	15
northern pike	9	18
orangespotted sunfish	11	150
pumpkinseed	1	6
quillback	2	2
red shiner	7	77
sand shiner	5	219
shorthead redhorse	3	33
stonecat	2	4
tadpole madtom	4	18
walleye	7	15
white sucker	16	167
yellow bullhead	13	145
yellow perch	10	54