DEPARTMENT OF TRANSPORTATION

Office of Freight and Commercial Vehicle Operations
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7/31/2020

Northstar Commuter Rail Extension Feasibility Assessment

An assessment of the feasibility to extend Northstar commuter rail service to St. Cloud was conducted by MnDOT and Metro Transit at the direction of the Minnesota State legislature during its 2019 session. This included evaluation of capital and service costs. Ridership forecasting was not included.

Background

Northstar Commuter Rail began operation in 2009 between downtown Minneapolis and Big Lake, serving seven stations (Target Field, Fridley, Coon Rapids, Anoka, Elk River, Big Lake) with six morning and six afternoon rush hour trains on weekdays; three trains each direction on Saturdays, Sundays and Holiday; special trains for each Minnesota Twins Game at Target Field and other special events. In October 2019, ridership averaged 2,550 on weekdays, 260 on Saturdays, and 166 on Sundays. Twins Game day ridership increased 800-1,000 over the average. Total project cost was $308.5 million.

In 2010, Metro Transit and the Northstar Corridor Development Authority (NCDA) evaluated the potential for extending commuter rail to St. Cloud. At that time the findings in capital, operating cost, infrastructure constraints and limited ridership led to a recommendation of deferring further development of rail service extension. The following criteria were identified as needed to trigger re-evaluation:

- **Ridership: >4,500 average daily Phase I and Northstar Link boardings:**
  As the **economy recovers**, if average daily Phase I ridership grows closer to initial projections and Northstar Link continues to grow, project reevaluation may be justified.
- **Corridor Capacity Improvements addressing infrastructure constraints:**
  Installation of a 3rd main line within the corridor (from Coon Creek Junction to Northtown Yards) or installation of a 2nd main line track between Becker and Big Lake would ease these constraints.
- **Changes to FTA Rating Criteria:**
  Any changes to the evaluation of extensions or projects that connect regional centers, or large-scale changes to criteria weighting and CEI thresholds would justify project reevaluation.
- **New Grant Opportunities of >$50 Million in alternate grant funding opportunities:**
  With no other changes that would strengthen a Small Starts submittal, other funding opportunities needed to allow Phase II to compete more effectively.
- **Major Economic Development: >3,000 new people or jobs in the Phase II corridor:**
  Significant population or employment increase along the corridor will potentially increase the demand for transit.

COVID 19 pandemic

In March 2020, Governor Tim Walz issued Emergency Executive Order 20-20 directing all persons living in the State of Minnesota to stay at home to reduce the spread of COVID-19 and resulting illness risks. Downtown Minneapolis office businesses began working remotely, and Metro Transit reduced bus and rail service to essential trips only. As of July 2020, two morning and afternoon weekday rush hour Northstar trains remain in operation. The downtown office commuter market is not expected to return to previous volumes in 2020. With many commuter bus routes reduced or suspended, Metro Transit continues to evaluate appropriate scale of commuter express bus routes and service on Northstar commuter rail as the market develops.

Service Alternatives

The Northstar Commuter Rail Extension Feasibility Assessment examined infrastructure, capital needs and operating cost estimates of four potential service alternatives for extending commuter rail service to St. Cloud, building on the existing Northstar service levels. Each of these service alternatives were determined to be operationally feasible when considering existing passenger train traffic; existing and future freight traffic; existing track and other infrastructure; efficient use of equipment (i.e. locomotives and coaches); operating rules; labor contracts and federal regulations. Ridership forecasting was not included in this study, and would be needed to consider cost benefit evaluation to determine merit of advancement.

The following table illustrates the number of weekday trains for each scenario operating between Minneapolis and Big Lake and between Minneapolis and St Cloud under each alternative.

Number of Weekday Trains Operating Between Minneapolis, Big Lake & St Cloud for Each Service Alternative

Operating Scenario	Weekday					
	Morning		Afternoon		Evening	
	SB	NB	SB	NB	SB	NB
Between Minneapolis and Big Lake						
Existing Service	5	1	1	5	-	-
Minimum Service Alternative	5	1	1	5	-	-
Minimum Bi-Directional Alternative	5	1	1	5	-	-
Express Service Alternative	5	1	1	5	-	-
Bi-Directional Service Alternative	5	2	4	6	-	1
Between Minneapolis and St. Cloud						
Existing Service	-	-	-	-	-	-
Minimum Service Alternative	1	-	-	1	-	-
Minimum Bi-Directional Alternative	1	1	1	1	-	-
Express Service Alternative	1 Express	1 Express	1 Express	1 Express	-	-
Bi-Directional Service Alternative	2	1	2	3	-	1

Note: Unless designated as Express, all trains stop at all stations. Express trains operate between Minneapolis and St Cloud without any intermediate stops.

Saturday, Sunday and Holiday service

Northstar Commuter Rail currently operates three trips from Minneapolis to Big Lake and three trips from Big Lake to Minneapolis on Saturdays, Sundays and Holidays. Each service alternative assumes the addition of two express trains (morning and afternoon) from St Cloud to Minneapolis and 2 express trains (morning and afternoon) from Minneapolis to St Cloud on Saturdays, Sundays and Holidays.

Capital Improvements

The operational analysis indicates that the following capital improvements would facilitate reliable passenger train operation without interfering with freight train traffic when service is first initiated.

Track, Signal and Equipment Improvements Needed to Implement Northstar Service to St Cloud

Service Alternative	Type of Improvement
Minimum Service	***Station Improvements*** – Track modifications at Big Lake and St Cloud stations. ***Track Improvements*** – Installation/upgrade of crossovers near Big Lake and St Cloud
Minimum Bi-Directional	-- All of the above plus the following -- ***Station Platform Modifications*** – An additional platform and overpass at Big Lake ***Locomotives and Coaches*** – One additional trainset (locomotive and coaches)
Express Service	-- All of the above plus the following * -- ***Mainline Track*** – A third main track between Northtown and Coon Rapids
Bi-Directional Service	-- All of the above plus the following -- ***Signal Improvements*** – Upgrade existing signals and add additional signals

**(An additional platform at Big Lake would not be necessary for Express Service.)*

To accommodate anticipated increases in freight traffic through 2040, BNSF will likely request additional improvements such as the installation/upgrade of additional crossovers, an additional main track between Northtown and Target Field Station and extension of the Big Lake siding to the west.

Estimated Costs

The estimated capital cost to implement each service alternative is shown in the following table. A range of costs is shown. The minimum investment represents the cost to implement each service alternative in the near term (2025). The maximum investment represents additional costs for capital improvements that BNSF will likely request to accommodate projected increases in freight traffic between now and 2040. Capital costs include engineering costs and professional services through design and construction.

Adjusting for inflation and based on existing service, Metro Transit's annual budget for Northstar operations would increase from $22 million to approximately $26.4 to 36.5 million in 2025. Operating & Maintenance costs do **not** include BNSF access fees or expensed maintenance costs for capital improvements. The estimated incremental annual operating cost for each service alternative is also shown in the following table.

Estimated Capital and Operating Costs for Each Service Alternative ($2025)

All costs are adjusted for inflation to the year 2025	Estimated Capital Cost	Incremental Annual Operating Cost
Minimum Service Alternative	$36 - $139 Million	$ 4.7 Million
Minimum Bi Directional Alternative	$96 - $207 Million	$ 7.7 Million
Express Service Alternative	$141 - $190 Million	$10.1 Million
Bi Directional Service Alternative	$188 - $257 Million	$ 14.7 Million

Note: Exact costs will depend upon negotiations with BNSF.

A preliminary estimate of the time required to complete preliminary engineering, environmental review, equipment acquisition, final design, construction, testing and commissioning for the 2040 Bi-Directional Service Alternative is 5½-7 years. Because the Minimum Service Alternative would need less infrastructure and no equipment acquisition to operate, the schedule for the same implementation steps could be less than 5½ years.

Northstar Commuter Rail Extension Feasibility Assessment

Summary Report

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

by

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

Northstar commuter rail passenger service currently provides peak hour train service on weekdays with five inbound trips and one outbound trip in the morning peak and five outbound trips and one inbound trip in the afternoon peak between Target Field Station in Minneapolis, MN and Big Lake, MN. Weekend service on a more limited schedule is also provided. The service operates over BNSF Railway's (BNSF) tracks and provides intermediate station stops in Fridley, Coon Rapids-Riverdale, Anoka, Ramsey, and Elk River, MN. A dedicated locomotive and passenger car maintenance facility for Northstar service is located at Big Lake, MN and is operated by Metro Transit. BNSF train crews that operate the Northstar commuter service are based at BNSF's Northtown Yard.

At the direction of the Minnesota State legislature, the Minnesota Department of Transportation (MnDOT) is studying the extension of Northstar service to St. Cloud, MN, a city located approximately 27 miles northwest of Big Lake, and approximately 67 miles from Target Field Station in Minneapolis. In furtherance of this legislative directive, MnDOT and Metro Transit convened a project team to assess the operational feasibility of a Northstar extension.

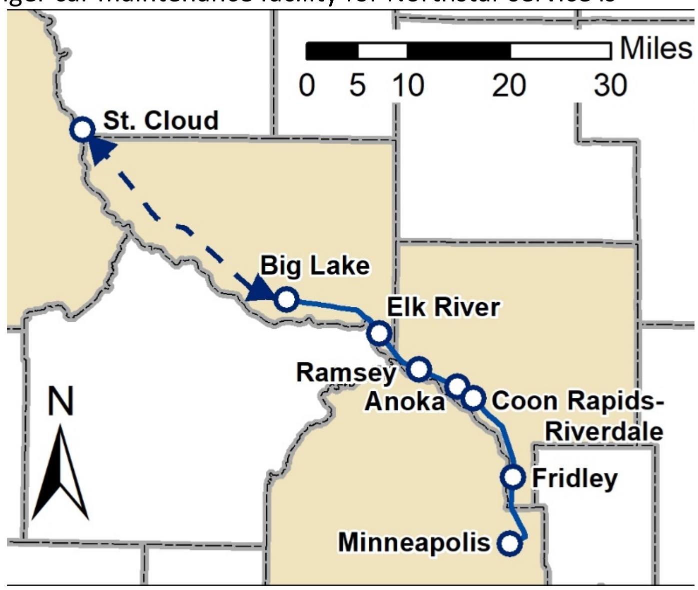


Figure 1: Northstar Corridor Map

2. Objective

The objective of this feasibility assessment is to provide decision makers with the estimated capital, operating, and maintenance costs of a range of service alternatives to extend Northstar service to St. Cloud that have been determined to be operationally feasible by BNSF. This was accomplished using the following analysis.

- Using Rail Traffic Controller™ (RTC) modeling software, identify the track and signal improvements required to operate the service alternative's schedule reliably and without undue impact on freight traffic.
- Identify additional equipment requirements and corresponding maintenance facility expansion needs.
- Prepare conceptual design plans for the anticipated track improvements.
- Estimate the capital cost for track, signal, equipment, and facilities for each service alternative.
- Estimate the direct operating and maintenance costs for each service alternative. (This excludes the cost associated with gaining access to the BNSF track.)

One or more of these service alternatives would then be carried forward for additional analysis including ridership, revenue, and cost-effectiveness studies. Governance and funding also need to be addressed.

3. Existing Conditions

This section defines the technical terms used throughout this report and describes the existing track, signal, and traffic conditions on BNSF between St. Cloud and Minneapolis.

3.1. Technical Terms

Several technical railroad terms, which are used in the description of Existing Conditions and the Proposed Capital Improvements, are explained below:

- **Main Track**: A track – not including yard or auxiliary tracks extending through yards and between stations – over which a railroad's trains operate under the authority of a train dispatcher (also known as a Centralized Traffic Control (CTC) control operator). See definition of 'CTC' below.
- **Subdivision:** The main track(s) from one station on the railroad to another. A Subdivision may be single track, or there are two or more parallel main tracks. See definition of 'station' below.
- **Siding:** A track that is parallel to the main track and is for the meeting or passing of trains. Siding track is used only under the authority of the train dispatcher or CTC control operator.
- **Junction:** A point where one or more railroad Subdivisions converge.
- **Wye Track:** A track configuration at a junction, generally in the shape of the letter "Y," that enables a train from one Subdivision to proceed onto another subdivision in either direction.
- **Milepost:** A sign located beside the main track bearing a number that indicates the number of miles from the beginning of the Subdivision, junction, or major terminal. Stations, CTC control points, junctions, and signals each are assigned a "milepost" (such as milepost 21.1) to indicate the specific location of the feature along the Subdivision. Milepost is shortened to "MP".
- **Station:** A place with a railroad feature designated by name and milepost location on the subdivision page of a railroad's operating timetable. (Example: "CP Interstate" is the name of a "station" at MP 15.5 on BNSF's Staples Subdivision at which a CTC control point is located.) There is no requirement for a "station" to have facilities to serve passengers, though some do.
- **Turnout**: Special trackwork with two movable rails, often referred to as a "switch," that enables a train to diverge onto another track. Turnouts are used in main tracks, in terminals, in yard tracks, and for access to industry, maintenance facilities, and storage tracks.
- **Crossover**: Special trackwork consisting of a turnout, a short segment of connecting track and another turnout, that connects two parallel main tracks so that a train moving *in one direction* (For example: westbound) at that location can switch from one track to the other while still moving in the same direction.
- **Universal Crossover**: Special trackwork that provides two connections between parallel main tracks. This allows a train moving *in either direction* (westbound or eastbound) to switch from one track to the other while still moving in the same direction.

- **Wayside Signals**: Color lights displayed along the track that display aspects visible to the locomotive engineer. Signals are located on high masts beside the track, on cantilever or signal bridge structures over the track or on ground level installations (often used in yards and terminals).
- **Signal Aspect:** The appearance of a wayside signal as viewed by a locomotive engineer that indicates the condition of the track ahead as well as speed and route information.
- **Centralized Traffic Control (CTC)**: Turnouts and crossovers may be operated manually or remotely. CTC is a signal system installed along the railroad that enables the control operator to operate track switches, crossovers, and display signals located at CTC control points (CP) from a remote office location. It enables the control operator to route trains from track to track without the need for the train crew to stop the train and operate track switches by hand. The CTC system relays information to the trains via indications displayed on wayside signals. These indications authorize train movements and provide warnings requiring a train to slow down or stop. CTC provides a railroad additional capacity compared to the same railroad without CTC installed.
- **CTC Control Point (CP)**: An installation with a specific name and milepost location (Example: CP Coon Creek-MP 21.0) on the railroad where the switches and signals are under the control of the train dispatcher or control operator. Within the limits of the CP, the switches are power-operated and controlled by the control operator. The signal aspects (what the locomotive engineer sees from the cab) indicate when it is permissible for a train or engine to proceed, the route to be used, and the maximum speed permitted over the switches on that route.
- **Positive Train Control (PTC):** A GPS-based safety system which enforces the signal indications displayed by the CTC signals. PTC tracks the locations of all trains in the PTC territory and uses their length, weight, and speed to ensure the CTC indications are enforced. PTC can slow down or stop trains in violation of CTC. The main purposes of PTC are to:
    - Prevent train accidents by enforcing maximum speed limits and speed restrictions;
    - Prevent a train from operating beyond its limit of authority by enforcing the indications displayed by the signals;
    - Prevent a train from passing over a turnout that is not properly lined for the train's movement; and
    - Prevent a train from entering the working limits of maintenance-of-way crews working on the tracks with men and equipment and where the track may also be impassable.
- **Diverging Route:** A track route by which a train or engine uses one or more turnouts and/or crossovers to leave the track it is on and move to another track or route created by their switches. (Example: At CP Coon Creek, a westbound train from Northtown Yard could use a diverging route to proceed from the Staples Subdivision onto the Hinckley Subdivision to Superior and Duluth.) The railroad prescribes the maximum speed for passenger and freight trains using diverging routes. These speeds are typically published in the railroad's System Timetable & Special Instructions. (For example: A Northstar commuter passenger train moving

along the BNSF main track may be permitted to proceed at 79 miles per hour. If the train needs to operate through a turnout or crossover on a diverging route (such as at CP Coon Creek), the maximum safe speed on that diverging route may be limited to a lower speed such as 40 miles per hour.)

- **Crew Change Point:** A location where a train will stop on either of the two main tracks or in the yard to change crews. The train crew's hours of service are regulated by FRA. Fresh outbound crews are scheduled to replace inbound crews on through-trains at designated crew change points such as Northtown Yard. The crew change includes exchange of information and instructions and requires a test of the PTC system. It may also require a test of the air brake system. Crew changes can take anywhere from 15-60 minutes depending on conditions and the availability of the outbound crew. If the crew change occurs on the main track, that track becomes unavailable for use by any other train in either direction until the stopped train departs with the fresh crew.
- **Changing Ends:** A term that, in this report, describes the activities of a Northstar commuter train crew which has arrived at the end of its trip and must prepare the train for changing its direction of travel. Once the train stops at the station and passengers have alighted, the locomotive engineer sets the brakes and controls in the locomotive, then walks back to the cab control car ("cab car") on the opposite end of the train, and sets the brakes and controls in the cab to the proper position. The engineer and conductor must make a test of the air brake system functionality and then the engineer must test the functionality of the PTC system which includes contacting the railroad's back office computer and ensuring that all electronic files for the planned movement are properly synchronized. Once passengers are aboard and the train has received an authorizing signal from the CTC system, it can depart. This process usually takes just under 15 minutes for a commuter train if no abnormalities are discovered during the process.
- **Trainset:** In this report, the term refers to the equipment that comprises one Northstar commuter train. A trainset typically includes one locomotive, three bi-level commuter passenger coaches, and one bi-level commuter cab control car. Northstar trains have a locomotive on the west end of the train facing away from Target Field Station on westbound trips (pulling the train). On eastbound trips, the locomotive engineer operates the train from the cab in the east end of the cab control car, which is the leading car of the inbound train with the locomotive pushing the train. Although Northstar trains normally have four coaches, the platforms at Northstar stations can accommodate a five-car Northstar train if necessary.
- **Z-Train:** BNSF's designation of an intermodal freight train that is usually the fastest and highest priority freight train on the railroad. Z-Trains carry time-sensitive cargo on carefully coordinated, high-performance, guaranteed delivery schedules. The trains normally carry cargo in Trailers-On-Flat-Car (TOFC) or double stack freight containers or both. Customers are required to deliver their trailer or containers to the railroad's terminal at origin by a specific time for loading. The railroad's terminal logistics, train operations, and track maintenance activities are arranged to ensure that the Z-Trains depart at the scheduled time, run without delays, connect only at certain major terminals with other trains, and arrive at their destinations on schedule. The customers' trailers or containers are then taken off the rail cars and made available to the customers' transport service at destination by a specific time so that they can

continue in the customer's logistical operations to their final destinations. Several of the nation's parcel delivery services, refrigerated transport carriers and high-priority freight consolidating companies move their commodities on BNSF's Z-Trains.

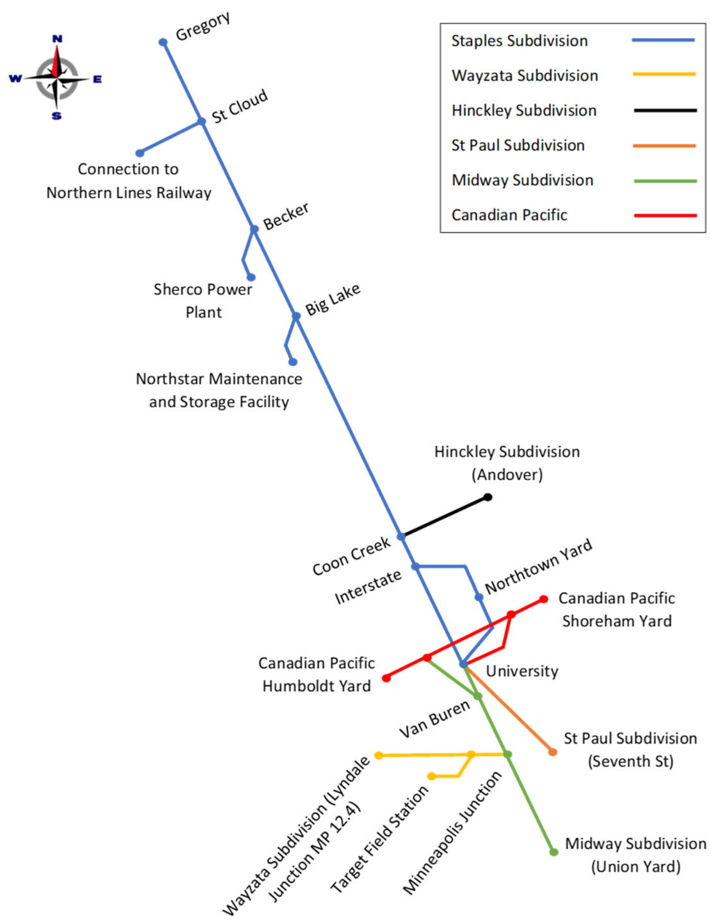
3.2. Existing Conditions

The Northstar corridor consists of the tracks owned by BNSF between St. Cloud, MN and Minneapolis, MN. For the feasibility assessment, the Northstar corridor was divided into three physical segments as follows:

- St. Cloud to Big Lake, including CP Big Lake
- Between CP Big Lake and CP Coon Creek, not including CP Coon Creek
- CP Coon Creek to Target Field Station in Minneapolis.

Figure 2 presents key locations within the Northstar corridor.

Figure 2: Northstar Corridor Key Locations



The sections below discuss the key locations in the Northstar corridor by segment.

3.2.1. St. Cloud to Big Lake

The segment between St. Cloud and Big Lake is on the BNSF Staples Subdivision. The railroad has two main tracks equipped with CTC and PTC. Track 1 is the north/east track and Track 2 is the south/west track. On the railroad, trains moving away from Minneapolis are considered "westbound" trains. Trains moving toward Minneapolis are considered "eastbound" trains. The maximum speed for passenger trains (Amtrak and Northstar) is 79 MPH and for freight trains is 60 MPH.

CTC control points with crossovers are currently located at St. Cloud (MP 73.6), MP 66 (MP 66.1), CP 528 (MP 52.8), and Big Lake (MP 46.6). BNSF's freight traffic in this segment consists of a high volume of time-sensitive, high-performance (guaranteed arrival/Z-Trains) intermodal trains, other intermodal trains of trailers-on-flat-cars, domestic and international cargo containers and automobiles, manifest trains of mixed freight car types and cargo, unit trains of coal, grain, ore, aggregates, sand, petroleum products, and other commodities. Approximately 293 freight trains per week are estimated to operate on this segment today, including 57 guaranteed arrival/Z-Trains.

Amtrak's Empire Builder intercity passenger train between Chicago and the Pacific Northwest has a station stop in St. Cloud. The station also serves as the base for a BNSF local freight train and the Northern Lines Railway, a short line railroad serving industries in the St. Cloud area. Unit trains of granite ballast originate at a large quarry southwest of St. Cloud and move through St. Cloud via the west and east wye tracks near the station to destinations on the BNSF system.

Another major freight customer, the Sherco coal-fired electrical generating station is located at Becker, 16.4 miles southeast of St. Cloud. Trains serving Sherco normally arrive loaded from the west and depart empty back to the west via one manually operated turnout located on Main Track 2 at MP 57.2 (Becker). The St. Cloud-Northtown Yard BNSF local freight train stops at the Becker siding off Track 1, twice daily, to set out and pick up freight cars. Because there are no crossovers between main tracks at Becker, the area becomes very congested with trains accessing Sherco.

Existing Northstar commuter rail service currently terminates at the Big Lake Station. The Big Lake Northstar station serves passengers on a stub track off Main Track 2 at MP 48.8. Northstar equipment is inspected, serviced, maintained, and stored at the Big Lake Maintenance Facility (BLMF) located on a group of tracks off the Big Lake Station track about one-half mile east of the Big Lake Station. The BLMF is currently operating at its maximum capacity for Northstar trainset storage.

3.2.2. Between CP Big Lake and CP Coon Creek

The segment between CP Big Lake and CP Coon Creek is also on the BNSF Staples Subdivision. Maximum train speeds and track designations are the same as in the St. Cloud to CP Big Lake segment. CTC control points are located at CP 421 (MP 42.1), West Elk River (MP 36.9), East Elk River (MP 36.7), Ramsey (MP 29.3), West Anoka (MP 27.3), East Anoka (MP 27.0), CP 254 (MP 25.4) and CP 251 (MP 25.1 at Coon Rapids-Riverdale). The east end of this segment terminates at and does not include CP Coon Creek (MP 21.0).

Between Big Lake and Coon Creek, the train traffic, volume, and speed limits are generally the same as in the St. Cloud to CP Big Lake segment with three important exceptions:

- Coal trains to and from Becker do not travel via this segment and there are no major industrial customers in this segment that receive or generate a high volume of rail traffic.
- Northstar commuter service between Big Lake and Minneapolis currently provides service to four stations including Elk River, Ramsey, Anoka, and Coon Rapids-Riverdale with 12 trains each weekday and 6 trains on Saturdays, Sundays, and holidays. Extra Northstar trains are operated to serve some sporting events in Minneapolis. Northstar trains normally stop at all stations in both directions.
- Amtrak's Empire Builder intercity trains have no scheduled stops in this segment.

Approximately 251 freight trains per week operate in this segment, including 57 guaranteed arrival/Z-Trains.

3.2.3. CP Coon Creek and Target Field Station in Minneapolis

The segment beginning with CP Coon Creek at MP 21 and ending at Target Field Station in Minneapolis is complex, congested, and constrained. Between CP Coon Creek and CP University, the track is part of the BNSF Staples Subdivision, and includes Northtown Yard and its lead tracks stretching from MP 16.3 to MP 11.5 at CP University. East of CP University, two tracks of the BNSF Midway Subdivision are parallel to two tracks of the BNSF St. Paul Subdivision to about MP 11.0. From CP Van Buren around the wye at Minneapolis Junction through CP Harrison Street to Target Field Station, the track is part of the BNSF Wayzata Subdivision.

The railroad has two main tracks with CTC and PTC from CP Coon Creek to CP Van Buren and a single main track from CP Van Buren through Minneapolis Junction to Target Field Station. Train speeds reduce from 79 MPH for passenger trains at CP Coon Creek to 40 miles per hour around Northtown Yard. Freight trains speeds reduce from 60 MPH at CP Coon Creek to speeds as low as 10 miles per hour in the Northtown area as trains go through turnouts and crossovers at junctions and while entering and leaving Northtown Yard. Through-freight trains, most of which are well over one mile long, stop on the main tracks near MP 15 at Northtown Yard to change crews. Frequently, freight trains are stopped alongside Northtown Yard on both main tracks simultaneously changing crews. Following trains often que up behind the trains changing crews, blocking junctions and access to connecting tracks.

During the AM and PM peak periods, BNSF normally reserves one main track paralleling Northtown Yard for Northstar commuter trains to operate unimpeded. This restricts freight trains to one track, creating congestion and delaying freight trains until a track is available for them to operate. Amtrak's eastbound Empire Builder Train No. 8 operates through the Northstar Corridor in the AM peak period along with Northstar commuter trains. The westbound Empire Builder, Train No. 7, normally operates after 10:00 PM and avoids both peak periods and Northstar commuter trains. Amtrak trains have no scheduled stops in this segment.

This segment has several key junctions and connections with other BNSF lines and other freight railroads. It begins with the junction at CP Coon Creek (MP 21.0). The single-track Hinckley Subdivision diverges to the north at CP Coon Creek and extends to Superior, WI and Duluth, MN. At CP MP 16.3, the two long lead tracks extending from the west end of Northtown Yard join the parallel two-main-track Staples Subdivision. The Northstar Fridley station is located at MP 16.0 on the west side of Main Track

2. Northstar trains in both directions use Track 2 at this point to serve Fridley. CP Interstate (MP 15.5) is the west end of Northtown Yard where several crossovers are located to enable freight trains to enter and leave the yard and to change main tracks while remaining on the Staples Subdivision. At CP 35th Avenue (MP 12.6), a new connecting track from the Canadian Pacific Railway (CPR) joins the recently reconstructed BNSF lead to CP Van Buren, providing a direct main track connection for CPR freight trains to and from the west to connect with BNSF.

CP University (MP 11.5) is the busiest of the junctions in this segment. It is the east end of Northtown Yard where BNSF switching movements frequently use the lead tracks and main tracks to assemble outbound freight trains. It is also the connection with CPR's Shoreham Yard. The Staples Subdivision terminates at CP University, with the two-main-track St. Paul Subdivision diverging to the east/southeast and the two main track Midway Subdivision continuing southeast to CP Van Buren. At CP Van Buren (MP 10.3), the Midway Subdivision becomes single track for a short distance, continues east to BNSF's busy Union Yard and on to 7th Street in St. Paul and Chicago. Union Pacific Railroad (UPRR) and CPR freight trains also use this route. At CP Van Buren, Northstar trains use the west leg of the wye at Minneapolis Junction to reach the Wayzata Subdivision at CP Harrison Street. Northstar trains continue down the Wayzata Subdivision, crossing the Mississippi River, and entering Target Field Station at CP Stadium. The Wayzata Subdivision continues to the southwest linking BNSF's Midwest grain lines to the Twin Cities. Freight trains of the Twin Cities & Western Railroad (operating the former Milwaukee Road lines in Minnesota) also use the Wayzata Subdivision to access the Twin Cities.

Approximately 411 freight train movements currently operate in various portions of this segment each week. Some are through-trains, including Z-Trains, that only change crews at Northtown Yard. Others originate or terminate at Northtown Yard, and others stop, set out, and pick up cars, change locomotives and crews, and then continue through. The number of trains varies each day. Some through-trains are counted twice; first as an inbound movement to Northtown and hours later as an outbound movement from Northtown Yard. Both scheduled and on-demand trains (coal, grain, aggregate, petroleum, etc.) move in this segment. Because of the many junctions and freight yard connections, all the freight trains move more slowly and/or stop in this segment. Many of the train movements in and out of yard tracks, through diverging movements at junctions and following other trains, are made at only 10 miles per hour. At junctions, trains must frequently stop and wait for other trains to clear before they are able to proceed. As a result, the combination of more trains, conflicting routes, and trains moving more slowly creates a system bottleneck for BNSF.

4. Alternatives Considered

Initially, four Service Alternatives were identified by MnDOT for evaluation. The Service Alternatives covered a range of options to extend rail service to St. Cloud from the very minimum (two trips per day serving St. Cloud) to the maximum (12 trips per day serving St. Cloud); all trips would have been extensions of existing Northstar service trains.

In coordination with BNSF, Quandel Consultants developed schedules for the initial Service Alternatives, reflecting the constraints of the BNSF corridor (**Appendix A** discusses the existing constraints in detail). As this work progressed, schedules for an "intermediate" Service Alternative and the "maximum" Service Alternative were determined to be infeasible because of the potential impacts to BNSF operations and to operating and maintenance costs. Two additional Service Alternatives were developed to replace the two determined to be infeasible.

The final four Service Alternatives include a minimum service option, an option that would provide four trips per day to St. Cloud, an option that would provide four Express trips per day to St. Cloud, and an option that would provide nine trips per day to St. Cloud, including a later evening train from Minneapolis to St. Cloud. Except for minor schedule adjustments, the four Service Alternatives preserved the existing Northstar service between Minneapolis and Big Lake.

The Service Alternatives considered in this Feasibility Assessment include:

- Minimum Service Alternative
    - One peak direction trip – morning and afternoon peak periods
- Minimum Bi-Directional Service Alternative
    - One peak direction, one off-peak direction – morning and afternoon peak period
- Northstar Express Service Alternative
    - One peak direction Express, one off-peak direction Express – morning peak period
    - One peak direction Express, one off-peak direction Express – afternoon peak period
- Bi-Directional Service Alternative
    - Two peak direction, one off-peak direction – morning peak period
    - Three peak direction, two off-peak direction – afternoon peak period
    - One additional SB train from Big Lake to Minneapolis
    - One late evening NB trip from Minneapolis to St Cloud

Each Service Alternative includes two inbound and two outbound Express service trains between Minneapolis and St. Cloud on Saturdays and Sundays/holidays in addition to the current level of service offered on weekends and holidays.

Table 1 presents the number of trains operating on weekdays by Service Alternative.

Table 1: Trains Operating between Minneapolis (Mpls) and St. Cloud by Service Alternative

	Weekday							
	Morning				Afternoon			
	Local		Express		Local		Express	
	St. Cloud to Mpls	Mpls to St. Cloud	St. Cloud to Mpls	Mpls to St. Cloud	St. Cloud to Mpls	Mpls to St. Cloud	St. Cloud to Mpls	Mpls to St. Cloud
Minimum Service	1	-	-	-	-	1	-	-
Minimum Bi-Directional Service	1	1	-	-	1	1	-	-
Northstar Express Service	-	-	1	1	-	-	1	1
Bi-Directional Service	2	1	-	-	2	4*	-	-

*One NB trip would operate in the evening

5. Development of Operating Assumptions

Operating assumptions reflect a variety of factors considered in the operations analysis of the proposed service. Assumptions were developed for the operation of each of the four Service Alternatives considering Federal Railroad Administration (FRA) regulations, physical limitations of the railroad, operating requirements of the railroad, locomotive and passenger car fleet needs, existing service contracts between BNSF and Metro Transit, labor agreements, and more. The following appendices document the operating assumptions for the four Service Alternatives:

- **Appendix B** – Technical Memorandum on Operating Assumptions for the Minimum Service Alternative
- **Appendix C** – Technical Memorandum on Operating Assumptions for the Minimum Bi-Directional Service Alternative
- **Appendix D** – Technical Memorandum on Operating Assumptions for the Northstar Express Service Alternative
- **Appendix E** – Technical Memorandum on Operating Assumptions for the Bi-Directional Service Alternative

Discussions of the removal of the original "intermediate" alternative and the original "maximum" alternative are included in Appendix C and Appendix E, respectively.

6. Rail Operations Modeling

Once the Service Alternatives' operating assumptions were reviewed by BNSF, Rail Traffic Controller™ (RTC) software was utilized to evaluate the impact that each Service Alternative had on current and future BNSF traffic. Track and signal improvements and passenger train equipment required to operate each Service Alternative schedule reliably and without undue impact on freight traffic were identified.

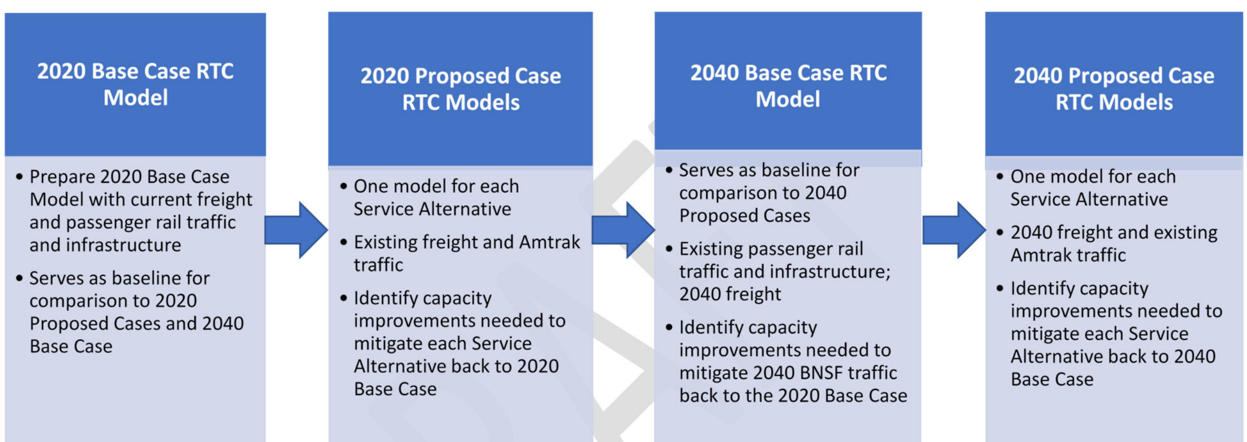
Using an RTC model provided by BNSF in 2013, new models were developed to replicate existing conditions (2020) and future conditions in a horizon year (2040). The following elements were updated in the models to reflect changes in rail infrastructure and traffic since 2013:

- Track
- Signal types, locations, and aspects
- Speed limits on main track and through turnouts and crossovers
- Weekly train counts and schedules for Northstar and Amtrak intercity passenger rail services
- Weekly freight counts and train types

For 2040 analyses, freight traffic was projected to grow through the 20-year horizon period by increasing the number of freight cars by 2% per year compounded. Each train type was evaluated separately as certain traffic is expected to remain constant (i.e., coal traffic), while other train types are expected to grow or fluctuate (i.e., grain traffic depends on U.S. trade agreements).

A four-part analysis was used to evaluate the impacts of the proposed Northstar Service Alternatives on existing and future BNSF traffic. Using RTC, any significant impact caused by the service expansion was measured and mitigated. Through this process, the infrastructure needed to implement the proposed Service Alternatives was identified. Figure 3 presents the methodology.

Figure 3: RTC Methodology



6.1. 2020 Observations

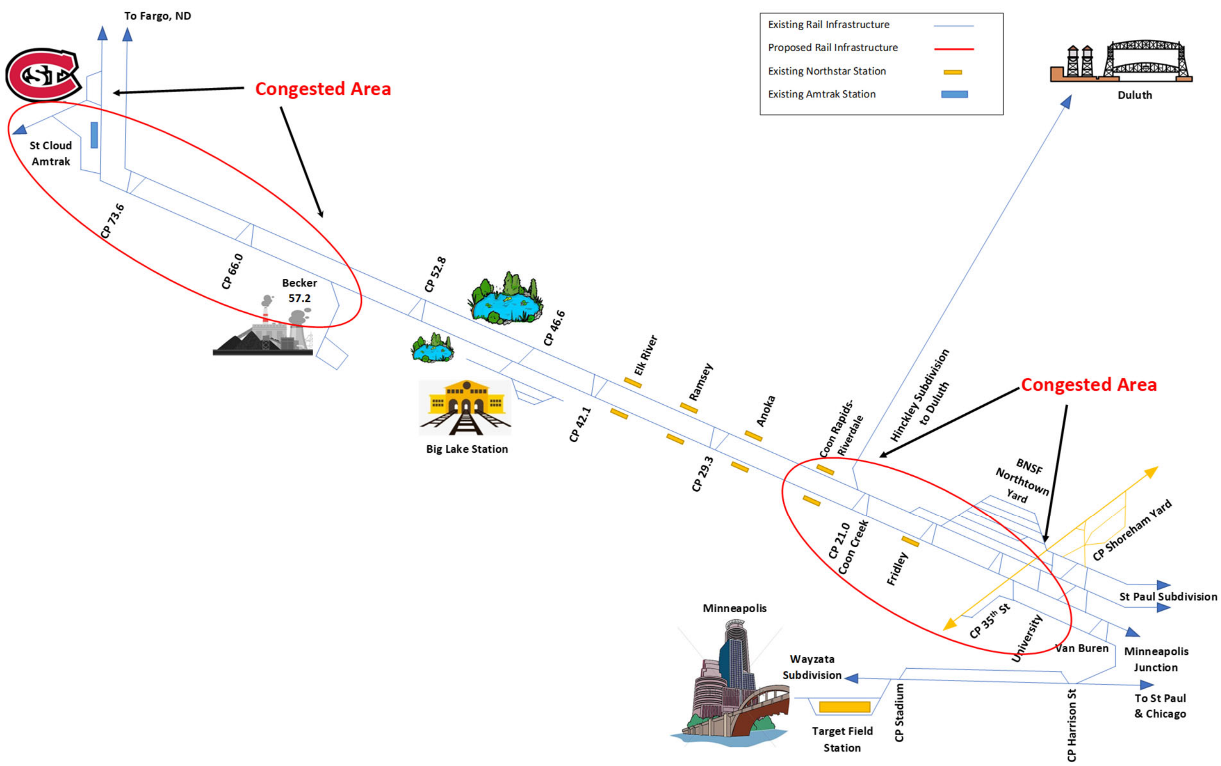
In the 2020 Base Case RTC Model, congestion was observed near Becker, where loaded and empty unit coal trains arrive at and leave from the Sherco power plant, and between CP Coon Creek and CP Harrison St, where several hundred freight train movements occur per day, traversing the track and accessing BNSF's Northtown Yard.

The 2020 Minimum Service Alternative and the 2020 Minimum Bi-Directional Service Alternative models showed that additional congestion would occur at the proposed St. Cloud Station and at the Big Lake Station. Because these alternatives propose extending existing Northstar trains from Big Lake to St. Cloud, new corridor congestion was only observed between Big Lake and St. Cloud resulting from interference between the new Northstar service and freight trains.

The 2020 Northstar Express Service Alternative and the 2020 Bi-Directional Service Alternative propose to add new trains throughout the entire corridor. In addition to the congested segments discussed for the Minimum and Minimum Bi-Directional Service Alternatives, congestion was observed between CP Coon Creek and CP Interstate.

Figure 4 illustrates the congested areas in the corridor in 2020.

Figure 4: 2020 Congested Areas



6.2. 2040 Observations

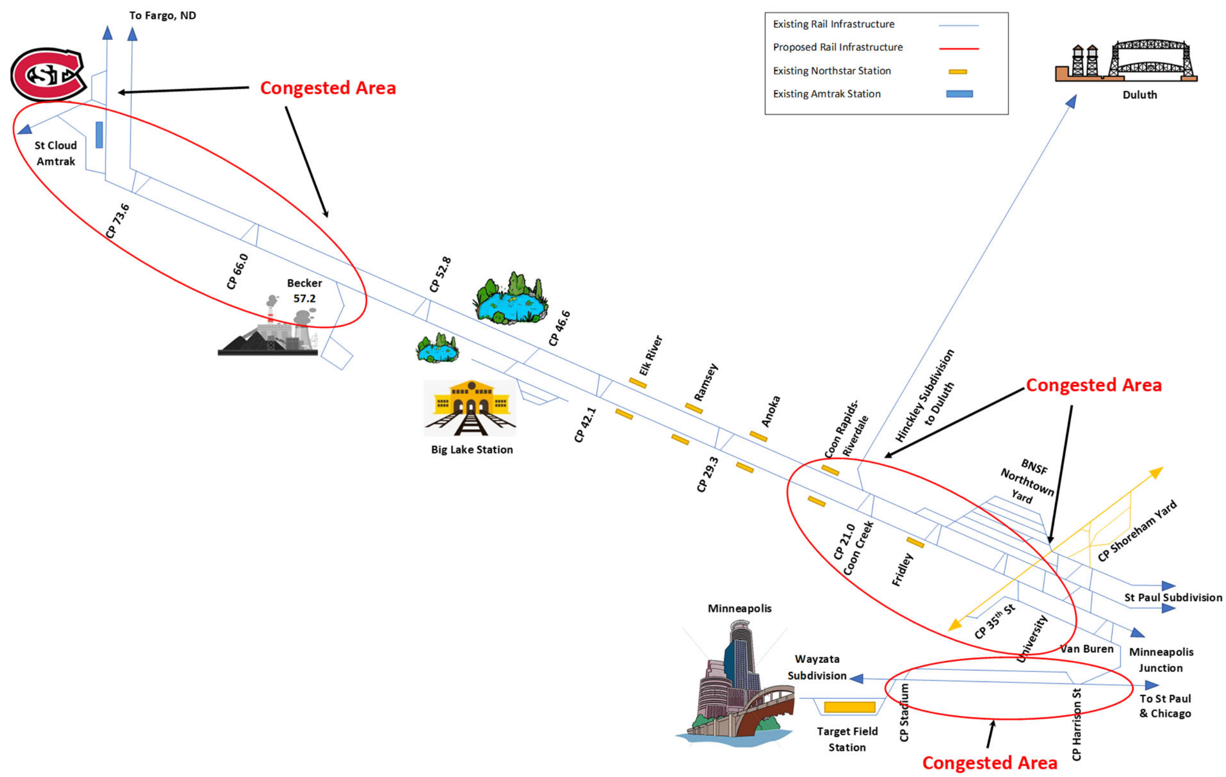
In 2040, the number of freight trains operating in the corridor would increase by about 10% over 2020 levels. Areas that were congested in existing conditions would see more congestion. In addition, the CP Van Buren to CP Stadium segment of track was observed to become more of a bottleneck.

The 2040 Minimum Service Alternative and the 2040 Minimum Bi-Directional Service Alternative models showed that additional congestion would occur at St. Cloud and Big Lake, near Northtown Yard, and between CP Van Buren and CP Stadium.

The 2040 Northstar Express Service Alternative and the 2040 Bi-Directional Service Alternative models showed that additional congestion would occur between St. Cloud and Big Lake and between CP Coon Creek and CP Stadium.

Figure 5 illustrates the congested areas in the corridor in 2040.

Figure 5: 2040 Congested Areas



A detailed discussion of the RTC modeling methodology and results is presented in **Appendix F**.

7. Recommended Capital Improvements

Based on the results of the RTC modeling, the following track, signal, equipment, and facilities improvements are recommended for each Service Alternative for initial operation.

- Minimum Service Alternative
  - Extend and connect north end of Big Lake station track to BNSF main track
  - Add station track to St. Cloud station
  - Upgrade universal crossover east of St. Cloud Station
  - Install new CTC Control Point and universal crossover west of St. Cloud station
- Minimum Bi-Directional Service Alternative
  - *All the above plus*:
    - Add a center platform at Big Lake Station
    - Acquire one additional trainset
    - Expand Big Lake Maintenance Facility to accommodate additional trainset
- Northstar Express Service Alternative
  - *All the above plus*
    - Third main track between CP Coon Creek and CP Interstate
    - (Exclude center platform at Big Lake Station)

- Bi-Directional Service Alternative
  - *All the above plus*:
    - Upgrade universal crossover at MP 66
    - Install new CTC Control Point at Becker
    - Center platform at Big Lake Station

In addition,

- All options require upgrade of fare collection systems.

Table 2 provides an overview of the capital improvements needed for each Service Alternative. Cells in blue indicate improvements needed for initial operation and orange cells indicate improvements needed by 2040.

Table 2: Capital Improvements by Service Alternative

Improvements Needed for Initial Operation Improvements Needed by 2040	Minimum Service Alternative	Minimum Bi directional Alternative	Northstar Express Alternative	Bi Directional Alternative
Overhead and Equipment Costs				
Upgrade Fare Collection Systems				
Acquire one additional Northstar trainset				
Expand Big Lake Maintenance Facility				
Station Improvements				
Extend and connect Big Lake Station spur track to the north				
Build station siding at St Cloud Station				
Construct center through platform at Big Lake Station				
Control Points, Crossovers and Sidings				
Upgrade existing universal crossover east of St Cloud station				
Install new CTC Control Point and universal crossover west of St Cloud station				
New CTC Control Point at Becker				
Upgrade Universal Crossover in CTC Control Point MP 66				
Big Lake West Siding				
Additional Mainline Track				
Third Main track CP Coon Creek to CP Interstate				
Third Main Track CP Interstate to CP Van Buren				
Second Main Track CP Van Buren to CP Stadium				

Conceptual engineering plans and documentation of engineering standards and assumptions are included in **Appendix G**.

8. Estimated Capital Costs for Track, Systems, and Equipment

Capital costs were estimated for the Northstar Commuter Rail Extension Feasibility Assessment based on a quantification of the infrastructure improvements necessary to accommodate the expanded

Northstar service on the existing BNSF rail corridor.

Capital costs were prepared in 2020 dollars and were forecasted to 2025 dollars using FRA's Standard Cost Category and inflation worksheet. The overall capital costs include professional services fees to cover design costs, program management costs, construction management and oversight costs, and integration, testing and commissioning costs. These costs are included in the estimate as a percentage of construction cost. Contingency costs were also included and were calculated as a percentage of the total capital cost. Contingencies are an allowance for unexpected costs added to the estimated construction costs based on past experience for projects in early stages of definition. Their purpose is to account for items and conditions that cannot be identified with certainty during the conceptual design phase of the project. Contingency percentages vary depending on the level of design completed for the work elements included in a particular category.

Estimated capital costs range from $36 to $188 million (2025$) for capacity improvements required for initial operation.

- Minimum Service Alternative $36 million
- Minimum Bi-Directional Service Alternative $96 million
- Northstar Express Service Alternative $141 million
- Bi-Directional Service Alternative $188 million

As BNSF freight train traffic rises, additional improvements will be required to maintain service. Total capital costs through year 2040 range from $139 million to $257 million.

- Minimum Service Alternative $139 million
- Minimum Bi-Directional Service Alternative $207 million
- Northstar Service Express Alternative $190 million
- Bi-Directional Service Alternative $257 million

Costs for the individual capital improvements are shown in Table 3.

Table 3: Costs for Capital Improvements (2025$)

Capital Improvements	Cost (2025$)
St. Cloud Improvements	$25.9 million
Upgrade Universal Crossovers at CP MP 66	$7.6 million
New Becker CTC Control Point	$7.8 million
Big Lake West Siding	$36.2 million
Big Lake Track Connection	$9.6 million
Big Lake Station Expansion	$31.1 million
Big Lake Maintenance Facility Expansion	$8.0 million
Third Main Track CP Coon Creek to CP Interstate	$76.5 million
Third Main Track CP Interstate to CP Van Buren	$14.0 million
Two Main Tracks CP Van Buren to CP Stadium	$19.2 million
Equipment Procurement	$21.0 million

The Technical Memorandum on Capital Cost Estimates is included as **Appendix H** and the Capital Cost Estimating Methodology is **Appendix I**.

9. Operating and Maintenance Costs

Operating and Maintenance Costs (O&M costs) represent the expenditures necessary to provide daily commuter rail service and to keep the railroad and equipment in safe operating condition. O&M costs include fuel, salaries and benefits for personnel, cleaning, inspection and minor repair of equipment, track inspection, minor tie and rail replacement, bridge inspection, and maintenance of signal, communications, and grade crossing warning equipment. Annual O&M costs for each Service Alternative were developed in partnership with Metro Transit and were based on their 2020 Northstar O&M budget.

Annual O&M costs are based directly on the operating characteristics of a service. As the number of train miles increases, for instance, the O&M costs increase. The following operating characteristics were used to estimate the annual O&M costs for the Service Alternatives:

1. Number of Stations
1. Maintenance and Storage Facility
2. Operating Train Sets
3. Locomotives
4. Train Cars
5. Staffing

6. BNSF Train Crews
7. Weekly Crew Van Trips
8. Scheduled Miles

Annual O&M costs were calculated for the following Northstar budget categories:

1. Labor and Benefits
2. Contracted Services
3. Materials, Parts & Supplies
4. Other Expenses
5. Allocated Expenses

Table 4 presents the estimated annual O&M costs in 2025 dollars for existing Northstar service and the four Service Alternatives.

Table 4: Annual O&M Costs for Existing Northstar and Proposed Service Alternatives (2025$)

	Existing Northstar Service (millions)	Minimum Service Alternative (millions)	Minimum Bi-Directional Service Alternative (millions)	Northstar Express Service Alternative (millions)	Bi-Directional Service Alternative (millions)
Labor and Benefits	$5.9	$5.9	$6.6	$6.6	$6.6
Contracted Services	$9.5	$11.7	$13.3	$13.6	$15.2
Materials, Parts & Supplies	$2.8	$4.0	$4.3	$5.3	$6.8
Other Expenses	$3.8	$5.1	$5.5	$6.6	$8.2
Allocated Expenses	$3.0	$3.0	$3.0	$3.0	$3.0
Total O&M Costs	**$25.0**	**$29.7**	**$32.7**	**$35.1**	**$39.7**

The cost for a future operator to gain access to the BNSF infrastructure to operate trains between Big Lake and St. Cloud and to operate additional trains between Minneapolis and Big Lake has not been estimated and was not included in the above O&M estimates.

The O&M cost estimating methodology and detailed breakdown of annual O&M costs are presented in **Appendix J**.

10. Summary of Next Steps

The analysis described above is limited to operational feasibility and does not address ridership forecasts, revenue projections, cost-effectiveness evaluation, governance, funding, or other analyses that may be necessary to evaluate the appropriateness of proceeding with the Northstar extension project. Once a decision is made to proceed with implementation and prior to the commencement of extended Northstar train service to St. Cloud, additional actions would need to be undertaken.

10.1. Preliminary Engineering/NEPA

Preliminary Engineering (PE) will need to be completed for the proposed capital improvements to support the identified Service Alternative(s). To support PE, the following activities would be undertaken or refined:

1. Documentation of alternatives and selection of preferred alternative
2. Operations modeling
3. Station and Access Analysis
4. Operating and Maintenance Costs
5. Capital Replacement Forecast
6. Capital Cost Estimates

PE will identify any unanticipated engineering issues and confirm the preliminary capital, operating, and maintenance cost estimates. Completion of PE is necessary to complete an environmental review of the project.

In addition, an environmental review of the project will need to be conducted. A determination will need to be made as to which Federal agency has jurisdiction. Typically, the Federal Transit Administration (FTA) is responsible for reviewing commuter rail projects and FRA reviews intercity passenger rail projects.

Once the appropriate Federal agency is identified, the level of environmental review required will be determined. It is possible that the proposed capital improvements in the corridor could be reviewed as Categorical Exclusions. Capacity improvements for the third main between CP Coon Creek and CP Interstate were included as part of the Northern Lights Express Environmental Assessment (EA) and are included in the Finding of No Significant Impact (FONSI) issued by FRA in February 2018.

10.2. Equipment Acquisition

Equipment Acquisition for the locomotive(s) and passenger cars is considered a "long lead time item" which must be carefully addressed at the outset of the project. The agency that will own the equipment is normally the agency that undertakes the acquisition process. Specifications and performance requirements for the equipment must be established and approved by the agency in cooperation with BNSF and the operator. The principal categories of equipment acquisition activity normally include:

- Locomotives
- Passenger Coaches
- Control Cab Passenger Coaches (cab cars)
- Spare Parts Inventory
- Special Tooling & Equipment Required to Test & Maintain locomotives and cars

Timing of the Equipment Acquisition is important. Once the vendor selection process has been completed, the equipment (potentially from several vendors on separate purchase orders) must be constructed to approved specifications (with agency inspectors at the plants to observe construction), delivered, tested, and commissioned before the start of system testing with the trains in the field. If the equipment is being added to an existing fleet, then the equipment should, to the extent possible, meet the specifications of the existing fleet.

If the existing fleet has been in service several years and may be nearing the period when it is due for a mid-life rebuild, the acquisition of new equipment for the service extension can be scheduled as the first step in the fleet rebuild process. The trainset planned for the service extension could be purchased earlier than needed and used to replace an existing trainset so that train can released to vendors for mid-life rebuild. When the first rebuilt train is completed, the second train to be rebuilt is sent away, and the process continues until all locomotives and cars of the existing fleet have been rebuilt. The train set purchased for the extension would then become available to fulfill its original role. Using this approach has many advantages both in cost and in system dependability.

If the new equipment to be purchased is for a new fleet and a new service that is not integrated with an existing fleet, then a different schedule would be established. That schedule would need to ensure that the new equipment arrives after track and facilities have been constructed to receive it, and before it is needed for testing and commissioning, new employee training, and system testing and acceptance.

Equipment is normally leased from another railroad equipment owner or purchased new or used from one or equipment manufacturers or re-manufacturers. If used equipment is acquired from an equipment owner, then there should be an expectation that the equipment may have to be rebuilt and modified to meet the needs of the new service. In all cases, delivery inspection, correction of defects, testing and commissioning will be required for the equipment. This can be a time when disputes may arise between the acquiring agency and the vendors(s), so it may be prudent to build time in the project schedule to anticipate and manage these events, should they occur.

10.3. Final Design/ Construction

Once PE/NEPA is completed and approved, Final Design (100% design) and construction will be performed in accordance with PE design and environmental documents[1]. Final Design (FD) includes a complete set of plans, specifications, schedules, and cost estimates. FD could be prepared for individual capital improvement projects or for a package of projects within the corridor. FD documents would include sufficient documentation for a contractor to bid and complete work.

For this type of project, BNSF may choose to prepare FD documents for work inside the BNSF right-of-way themselves or may contract with an engineering firm (Contractor) to prepare FD. Once FD is complete and BNSF approves the FD plans, MnDOT (or a federal funding grantee, if applicable) would review and approve FD plans. Once the FD package has been approved and signed by all Stakeholders, it would be submitted to FTA or FRA for approval. BNSF typically constructs improvements within its own right-of-way through BNSF force accounts.

For improvements outside the BNSF right-of-way, such as stations and maintenance facilities, FD could be prepared, and improvements constructed by Contractor(s) through a competitive bidding process conducted by MnDOT or the facility owner.

[1] Construction, Operating, and Maintenance agreements are typically required by funding agencies prior to the commencement of Final Design and construction

The following elements could be part of an FD plan set:

- *Geotechnical Survey.* The Contractor would perform geotechnical investigation services to support the design of structural elements, such as bridges, culverts, and other structures included in the project. The work could include, among other things, soil borings, geotechnical analysis, and recommendations for FD and construction.
- *Track and Siding.* The Contractor would prepare FD drawings sufficient for construction of main track and siding track. FD will include development of plan sheets, specifications, schedules, and construction cost estimates for the track and siding improvements.
- *Turnouts and Crossovers.* The Contractor would prepare FD drawings sufficient for construction of turnouts and crossovers. FD will include development of plan sheets, specifications, schedules, and construction cost estimates for the turnouts and crossovers.
- *Grade Crossings.* The Contractor would prepare FD drawings sufficient for modifications and improvements at grade crossings. FD would include development of plan sheets and descriptions as required to improve the crossings. FD will include development of plan sheets, specifications, schedules, and construction cost estimates for the crossing improvements.
- *Hydrology and Hydraulic.* The Contractor would prepare FD for culvert and bridge improvements based on field investigations and PE deliverables. FD would include development of plan sheets and descriptions as required to construct the structural improvements and to document that all work will be in compliance with NEPA requirements and that the property impacts are consistent with the approved PE/NEPA documents.
- *Utilities.* The Contractor would identify the need for relocation of utilities based on conflicts between existing utility locations and the proposed infrastructure improvements. The specific utility relocation needs determined in the FD phase would be implemented. The determination of responsibility, including costs and scheduling utility work, is dependent on the utility occupancy agreement between the host railroad, roadway jurisdiction, or property owner and the utility.
- *Station and Maintenance Facilities*. The Contractor would prepare FD for the following areas: site work, grading, utility coordination and utility work, storm-water management, station building (including architectural features), elevator towers, pedestrian walkway (overpass), ramps, and elevators/escalators. Finishes, required ramps and railings, fencing, signage, ticketing machine installations, ITS/Signage/public address system/train warning system and GPS location installation, conduit installation, landscaping, lighting, markings, station platforms and canopies (if needed), and other elements required for the construction of station improvements. The station would be designed to meet ADA requirements for passenger rail facilities. FD documentation would include plans, specifications, schedules, and cost estimates for all components of station and maintenance facility improvements that would be incorporated into construction bid packages.
- *Signals and Communication.* The scope of signals and communication improvements includes the installation of CTC and PTC associated with new track, turnouts/crossovers, new signals, and new control points. FD documentation would include drawings, specifications, and cost

estimates. Design of PTC equipment would conform to BNSF and FRA requirements.

Capital improvements would be constructed in accordance with the environmental review and approved FD documentation prepared for the projects.

10.4. Testing/Commissioning

Capital improvements needed to support the extension of Northstar commuter service to St. Cloud would be constructed in accordance with detailed final design plans previously approved by BNSF, MnDOT, Metro Transit and any other Stakeholders specifically involved. During construction, field inspection and oversight would be conducted by the railroad and by the senior agency with whom the railroad has contracted to construct the improvements. Prior to initiating revenue service over a capital improvement, BNSF inspectors would carefully measure and examine all elements of track construction, including any required ultrasonic inspection to identify any rail or welding defects. All aspects of track construction must meet or exceed the FRA track standards for the speeds to be operated. Coordination would also be required with the BNSF signal department to ensure that all signal improvements function properly before revenue service could begin.

Construction and testing for new or modified signal installations would follow a similar, but far more detailed process, using final design plans and procedures approved by BNSF's signal department. After construction and initial testing and before revenue operations could begin, BNSF and signal contractors would conduct a detailed signal cut-over and testing following a step-by-step, circuit-by-circuit plan to ensure that all portions of the system function properly. Approved, accurate signal drawings must be placed or placed on file at the required locations and BNSF must ensure that all FRA system configuration management requirements have been met. No revenue trains would be permitted to operate through the affected area during a signal cut-over and testing process. Once the railroad has confirmed that the signal system functions correctly, it would be turned over to the train dispatcher to enable the beginning or resumption of revenue train operations. This process would be used for each new or modified signal installation.

10.5. Potential Schedule

A preliminary estimate of the time required to complete the above steps for the 2040 Bi-Directional Service Alternative is as follows:

1.	Preliminary Engineering/Environmental Review	18-24 months
2.	Equipment Acquisition (concurrent with PE/NEPA and FD/Construction)	36 months
3.	Final Design/Construction	3½-4½ years
4.	Testing/Commissioning (overlaps with construction)	6 months

A preliminary estimate of the time required to complete the above steps is 5½-7 years.

Because the Minimum Service Alternative would need less infrastructure and no equipment acquisition to operate, the schedule for PE/NEPA, FD/Construction, and Testing Commissioning could be less than 5½ years.

Northstar Commuter Rail Extension Feasibility Assessment

Appendix A – Technical Memorandum on Existing Constraints

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

by

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum documents existing conditions that may constrain the extension of Northstar commuter rail service to St. Cloud.

2. Corridor Capacity Constraints

2.1. Accommodating High-Priority Freight Trains

Northstar commuter rail service operates over BNSF's busy Northern Transcon route between Chicago and the Pacific Northwest. Northstar commuter trains currently share the corridor with over 50 BNSF, Union Pacific, Canadian Pacific, and short line freight trains per day. Amtrak's long-distance Empire Builder Train Numbers 7 and 8 between Chicago, the Twin Cities, and the Pacific Northwest also operate in the corridor.

Many of BNSF's trains are high-speed intermodal trains providing premium service for double-stack containers, Container-on-Flat-Car (COFC) and Trailer-on-Flat-Car (TOFC) traffic on long-distance high-performance schedules. Train density and the complexity of the train operations in the Northstar corridor are both important limiting factors which directly affect the ability to add new passenger train service in the corridor.

The long-distance high-performance intermodal trains have complex schedules which include deadlines for shippers tendering freight to the railroad at origin, specific loading and departure times from rail yards, and pick-up times at junctions with other railroads where cars are added to the trains. The trains must all travel over the railroad at their scheduled speeds without delays so that they arrive in the yards at each city on schedule. At those cities, unloading crews are scheduled to make the trailers, containers and/or vehicles available to the customers' highway transport connections at specific times so that the carriers can deliver the priority shipments to the customers on time. In some cases, the cargo is parcel shipments that must be delivered to customers awaiting the packages by specific times for their business needs. Other cargo may be shipping containers to be transferred to one or more ocean vessels before their sailing times from ports. New vehicles must make the connections to scheduled vehicle transport destined to car dealers so that vehicles are delivered to customers when promised.

The railroad schedules its operations and the maintenance of the railroad and equipment to prioritize the high-priority trains, ensuring that other trains are organized to run without causing delays to these trains. A delay incurred by one train at one point in its trip can cause domino-effect delays to other trains in the network and the failure to make guaranteed or promised deliveries. When scheduling the proposed revisions and additions to Northstar commuter trains as a part of the study, these constraints were carefully considered to ensure that BNSF's ability to provide its rail service would not be unduly impaired by the proposed extension of service to St. Cloud.

As a result of BNSF's needs to maintain the schedule performance of its trains and the need to maintain its infrastructure to support the operations, proposing additional Northstar trains with closer service frequencies and during certain time periods was not feasible. The Service Alternatives were developed to maintain BNSF's ability to operate and maintain its railroad while providing alternatives to extend service to St. Cloud in ways that would meet the requests expressed by the public.

2.2. Capacity Needs

Along BNSF's Staples Subdivision, Northstar and Amtrak trains operate an average of 19 MPH faster than the fastest freight trains. Due to the difference in operating speeds, passenger trains cannot operate behind freight trains without receiving a speed-limiting signal indication which prevents them from maintaining their schedule. To optimize speeds for both passenger and freight traffic, during peak periods, freight trains typically operate on one track, while passenger trains operate on the other. Extending Northstar service to St. Cloud will likely increase the overall number of passenger trains operating in the corridor at a time. Service Alternatives proposing the operation of two passenger trains in opposing directions at the same time would consume capacity on both tracks, resulting in freight trains holding outside of the passenger territory and encountering delay to their schedules. Capacity improvements are proposed in areas where two passenger trains operate in opposing directions to mitigate the impact to freight operations.

2.3. Congestion near Northtown Yard

BNSF's Northtown Yard is located along the Staples Subdivision between railroad control points at University (MP 11.5) and Interstate (MP 15.5). The Yard serves as an origination and termination point for trains to and from other major system yards on the BNSF network and originates and terminates local freight trains and switch runs that service local industries. Northtown Yard is also an interchange point between BNSF and trains of other railroads. Northtown Yard also serves as a through-train crew change point and a maintenance point for BNSF locomotives. Currently, a significant number of trains stop and dwell on the main tracks adjacent to Northtown Yard including the following:

- BNSF through freight trains changing crews on the mainline near Fridley Station (15 to 20 minutes of dwell per train)
- BNSF trains setting off and/or picking up cars in Northtown Yard and occupying the mainline near Fridley Station
- Westbound BNSF freight trains waiting for eastbound Northstar trains to pass at CP 21-Coon Creek (20 to 40 minutes of dwell per train)

In the existing two-track area surrounding Northstar's Fridley Station, BNSF trains stopping and waiting on the main tracks create a single-track configuration for other freight trains, Northstar commuter trains, and Amtrak to use for through movements. On occasion, BNSF freight trains in both directions stop to change crews at the same time leaving no main track clear for other trains. Because BNSF must maintain the on-time performance of passenger rail operations in the corridor, freight trains experience the bulk of the impact from the dwelled trains. However, Amtrak and Northstar trains also experience delays.

Freight trains dwelling on the mainline and the movements into and out of Northtown Yard exacerbate an already-congested segment of track and additional Northstar trains could impact BNSF's operations, driving the need for a third track in this area.

3. FRA Regulations

The Federal Railroad Administration (FRA) of the United States Department of Transportation (USDOT) regulates most safety aspects of railroad operations. FRA's regulations apply to BNSF as the owner and operating manager of the railroad in the Northstar corridor and the operator of Northstar commuter trains. The FRA rules also apply to Metro Transit as the entity that maintains the Northstar locomotives and passenger cars and maintains Northstar commuter stations. Bodies of FRA rules apply to train crew and certain other workers qualifications and hours of service limitations. They apply to track, bridge, and signal safety standards including Positive Train Control, locomotive and passenger car inspection and maintenance standards, blue signal safety for locomotive and car workers, roadway worker protection, grade crossing safety, and many others. Several of these standards are discussed below.

3.1. Hours of Service Limitations

3.1.1. FRA Regulations

FRA regulation of train crew hours of service affects scheduling and operating expenses for the proposed extension to St. Cloud. FRA's rule limits train crews to a maximum of twelve hours on duty in one duty period. Twelve hours are not enough to work both the early morning and late afternoon peak period commuter trains without exceeding the 12-hour maximum. A provision in the FRA rules allows crews that work a few hours in the morning peak period and have an undisturbed midday rest period where the crews are relieved from duty for at least four hours off duty at a qualified (quiet) location, to return to service to operate late afternoon peak hours trains. The crew's actual on duty working hours must not exceed 12 hours, but the total number of compensated duty hours may exceed 12 hours.

3.1.2. Constraints on Proposed Northstar Service

Using this rule, a Northstar's crew may work 3 hours in the morning peak period, have 8 hours off duty at Target Field Station midday, and then work 3 hours in the afternoon peak period. Total on duty working hours are 6, but total compensated hours are 14. However, when the crew goes off duty at the end of the workday, FRA rules require that the crew must have at least 10 hours off duty undisturbed rest before returning to duty the following day. In this case, if the crew regularly went on duty at Big Lake at 4:00 A.M., worked 3 hours until 7:00 A.M., took 8 hours off at Target Field Station until 3:00 P.M., and then worked 3 more hours and completed its afternoon peak period trip back to Big Lake by 6:00 P.M., it would have used 14 hours and would have only the minimum 10-hour rest period available before returning to duty at the same time (4:00 A.M.) the next day. Because of the additional time needed to operate to and from St. Cloud, this crew would not be able to have its morning and afternoon trip extended to St. Cloud. As a result, the workday would have to be split, and two train crews would have to be used to operate extended service. For this reason, three of the four service alternatives presented each use two additional crews to extend commuter train service to St. Cloud.

3.2. Locomotive and Passenger Car Maintenance

3.2.1. FRA Regulations

FRA regulations require the periodic safety inspections of locomotives and passenger cars. These begin with a required daily inspection of each vehicle in service and continue at specific intervals such as 92-day inspections and additional time-based inspections specific to locomotives and passenger cars. In addition to the FRA requirements, other mileage-based maintenance requirements, normally specified by the manufacturer or by service experience, are required.

3.2.2. Constraints on Proposed Northstar Service

Metro Transit forces accomplish nearly all the inspection and maintenance requirements at the Big Lake Vehicle Maintenance Facility. Certain specialized functions requiring specialized shop facilities, such as locomotive wheel-truing, are accomplished by BNSF at Northtown Yard or by other contractors available to Metro Transit.

To maintain Northstar performance reliability and comply with FRA regulations, one or more locomotives and passenger cars are scheduled to undergo periodic inspection and maintenance at the Big Lake Vehicle Maintenance Facility each day. In addition, other locomotives, cab control cars, or commuter coaches may have to be brought to the Maintenance Facility for unscheduled repairs. As a result, Metro Transit maintains several pieces of spare equipment to replace those units held for maintenance so that it can maintain the number of train sets in service required by the Northstar schedules.

Metro Transit also maintains the Positive Train Control (PTC) equipment on Northstar locomotives and cab control commuter coaches. The BNSF crews that operate Northstar trains, and the Metro Transit crews that maintain the PTC equipment are specially trained and qualified to do so.

3.3. Track Safety Standards

3.3.1. FRA Regulations

FRA has established track safety standards that apply to the condition and spacing of track ties and fastenings, the condition of rail, the surface and alignment of track, and many other specific details of track. All standards must be met for the segment of track to qualify for a specific speed for passenger and freight trains.

Under FRA rules, if a segment of track met all the requirements for FRA Class 4 track, then the maximum speed for passenger trains would be 80 miles per hour and the maximum speed for freight trains would be 60 miles per hour. If any aspect of the track in the segment fails to meet the minimum standard for the track class, then the segment of track drops to the next lower track class and the maximum permissible train operating speeds drop accordingly. For example, if a segment of track were classified by the railroad as FRA Class 4 track, but inspection revealed a section of deteriorated ties in the segment that did not meet the standard for FRA Class 4, then the segment of track would be reduced to FRA Class 3, and train speeds would be reduced to 60 miles for passenger trains and 40 miles per hour for freight trains. Train delays, train congestion, and the failure to meet service performance standards would result.

3.3.2. Constraints on Proposed Northstar Service

As a policy, BNSF normally builds and maintains the track in its mainline corridors to one FRA track class higher than the posted speeds require. This allows for the normal deterioration of track between scheduled maintenance cycles without resulting slow orders and associated speed reductions. This policy is key to maintaining maximum train speeds which are necessary to maintain system train schedules and performance.

BNSF achieves its required track maintenance through scheduled inspection and maintenance activities that occur during the midday in order to avoid interfering with Northstar service. The midday maintenance window is a critical and short period of daylight when BNSF maintenance forces must conduct most of their maintenance activities. The replacement of ties, dumping of track ballast, track surfacing, changeout of switches and switch components, and repairs to signal and communications equipment occurs primarily during this midday window. When one track is out of service for maintenance, all trains in both directions must use the single remaining main track between available control points and past the work areas. This causes extreme congestion and train delays.

Adding new passenger trains during this midday maintenance window would only increase the congestion and train delays. It would also result in passenger dissatisfaction with the Northstar service. Additional trains would also shorten the maintenance time available, degrade maintenance productivity, and extend the time needed to perform maintenance activities. This would increase the cost of the maintenance work, a portion of which is allocated to the agencies operating the passenger trains. The inability to complete needed maintenance can also contribute to track and signal failures which can delay all trains in the corridor.

BNSF requested that Northstar crews from the existing crew base location at Northtown Yard, which go on and off duty at Big Lake, be used to operate any Northstar service extension. This is an important factor in preserving service dependability and maintaining control of operating expenses. Continuing to use the Northtown crew base, with crews reporting at Big Lake, will require trains to deadhead 27 miles north to St. Cloud before inbound service begins. For each train operating to or from St. Cloud, an additional 54 miles would be traveled. The increased train mileage could result in the need for more frequent equipment maintenance.

4. Existing Rolling Stock Limitations

Northstar's existing equipment fleet of six locomotives and 18 passenger coaches and cab cars can accommodate one round trip to and from St. Cloud each day. Service Alternatives proposing more than one round trip to St. Cloud will require an additional trainset to operate. Purchasing one additional trainset drives the need for an additional track at the Big Lake Maintenance Facility and additional train crews. Target Field Station can accommodate four trainsets with its existing configuration. No improvements are needed to accommodate the additional trainset because, in all four of the proposed Service Alternatives, no more than four train sets are scheduled into Target Field Station at the same time. At Big Lake, a new storage track is proposed north of the existing track to accommodate an additional trainset.

Northstar's existing fleet consists of six MP36PH-3C locomotives and 18 Bombardier bilevel coaches and cab cars. Consistency of the fleet is key to the current equipment maintenance plan. The current and future availability of additional locomotives and cars matching the existing fleet is uncertain. To maintain a homogenous fleet of cars and locomotives, the entire fleet may need to be replaced. For the purposes of the Feasibility Assessment, it is assumed that an additional trainset, matching the existing fleet, can be leased or purchased.

Northstar Commuter Rail Extension Feasibility Assessment

Appendix B – Technical Memorandum on Operating Assumptions for the Minimum Service Alternative

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

By

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum describes the **Minimum Service Alternative** and presents the preliminary proposed Operating Plan for the extension of Northstar commuter service to St. Cloud. The extended service would be provided within the existing Northstar Commuter service framework now provided by BNSF and Metro Transit.

This proposal has been designed to minimize the amount of additional capital investment that would be needed to operate the proposed **Minimum** service. It has also considered the description of existing conditions provided by BNSF that may constrain the extension of Northstar service to St. Cloud. These constraints are documented in the Technical Memorandum on Existing Constraints (Appendix A).

By carefully considering the constraints described by BNSF, which directly affect the feasibility and cost of providing a new service, and incorporating them into the proposal as part of the Operating Assumptions presented below, this proposal has endeavored to meet the requirements of the railroad, the public agencies, and the public stakeholders involved.

2. Description of Proposed Service

The **Minimum Service Alternative** provides Northstar commuter service from St. Cloud to Minneapolis by starting one existing morning peak period southbound Northstar train from St. Cloud instead of Big Lake. In the afternoon peak period, one existing northbound Northstar commuter train from Minneapolis has been extended from Big Lake to St. Cloud.

On Saturdays and Sundays/holidays, two new round trip **Northstar Express** trains have been scheduled between Minneapolis and St. Cloud, one operating in the morning and one in the afternoon. These trains are in addition to the existing Northstar local train service between Big Lake and Minneapolis on Saturdays and Sundays/holidays.

Minimum Service Alternative –

a. **Weekday Morning** Peak Period - One existing Northstar train would be rescheduled to begin in St. Cloud rather than Big Lake
b. **Weekday Afternoon** Peak Period - One existing Northstar train would be rescheduled to terminate in St Cloud rather than Big Lake
c. **Saturday and Sunday/Holiday** – two new northbound and two new southbound trains would operate Express between Minneapolis and St. Cloud

The **Minimum Service Alternative** has an option for new non-stop midday bus service, designated as the ***Northstar Midday Shuttle Bus***. The shuttle bus would depart St. Cloud mid-morning and would return to St. Cloud in mid-afternoon.

3. Operating Assumptions

Operating Assumptions are a critical part of this feasibility assessment. Operating assumptions reflect a variety of factors considered in the operations analysis of the proposed service including:

- Service requests (i.e., frequencies, departure/arrival times) from the public stakeholders (prospective passengers, the communities, etc.);
- Physical limitations of the railroad and its environment;

- Capacity limitations and the operating requirements of the railroad;
- Effects of new service on the existing passenger and freight services operating in the corridor;
- Non-revenue "deadhead" equipment train trips which are needed to position train sets and crews for revenue service and/or enable crews to go on and off duty at appropriate times and locations;
- Effects of new service on the railroad's ability to expand its freight service to meet increased traffic demands in the future;
- Northstar locomotive and passenger car fleet considerations;
- Existing collective bargaining agreements in effect on BNSF affecting railroad train crew members;
- Existing service contract between Metro Transit and BNSF;
- Capital expenditures that would be needed to initiate the extended service;
- Operating and maintenance expenses that would be needed to run the new service;
- Budget limitations affecting the State and municipal agencies;
- Federal Railroad Administration (FRA) regulations and their effects on service planning; and
- The safety and reliability of the proposed extended Northstar commuter service.

The following sub-sections discuss the Operating Assumptions for the **Minimum Service Alternative**.

3.1. Train Crews and Equipment

1. FRA regulations affect most aspects of the safety of operation of the BNSF, Amtrak, and Northstar train operations and maintenance. Compliance with applicable FRA regulations has been built into the proposal as a basic requirement and assumption. The FRA Hours of Service regulations limit the length of the train crew workdays and specify the minimum rest period between workdays.

2. The extended Northstar commuter service to St. Cloud would be operated as a part of the existing Northstar commuter rail service, a cooperative effort by Metro Transit and BNSF Railway.

3. The **Minimum Service Alternative** proposal anticipates that the extended service would require the same four operational train sets that are currently in service.

4. BNSF train crews from the existing BNSF crew district base at Northtown Yard would continue to be used to operate the service and would support the train crew requirements of the **Minimum Service Alternative:**

    a. Crews would continue to go on and off duty at the same locations they presently use.
    b. No BNSF crews would go on and off duty at St. Cloud.
    c. Train crew work schedules included in the **Minimum Service Alternative** are preliminary and primarily for cost estimating purposes. They are subject to revision. When BNSF addresses the actual train crew scheduling for the extended service, the work schedules and the number of additional train crews may be revised, and the estimated costs of the proposed service could change.
    d. BNSF train crews each consist of one engineer and one conductor. These employees are members of a trained and qualified passenger train crew base at BNSF's Northtown Yard. The crew members in the passenger pool may also operate freight trains when not being

used in passenger service.

e. Train crew compensation would be in accordance with BNSF agreements in effect for locomotive engineers and conductors.
f. The Northstar train schedules in this preliminary proposal are conceptual and are subject to revision.
g. The standard Northstar weekday train consist currently includes one locomotive, three passenger coaches and one cab control passenger car. Weekend, holiday and special event Northstar commuter trains currently include a second locomotive to ensure service reliability.

5. The train crew facility at Target Field Station is currently the only location where crews can be relieved from duty during the day for a midday rest break of at least four (compensated) hours before resuming service in the afternoon peak period. Train crews cannot be relieved from duty for a midday break at the BLMF because there are currently no facilities that meet FRA requirements for rest at that location.

6. The crew sheets must be reviewed to identify the deadhead commuter train movements and the total crew hours of service that are a part of the **Minimum Service Alternative**.

7. To avoid the use of two additional train crews to operate the last portion of the two extended train trips for St. Cloud on weekdays, two weekday train crew assignments contain reduced on duty times before departures from BLMF and/or reduced off duty times after arrivals at BLMF. These two crews (Crews 2 and 3) operate at the maximum hours of service permitted and receive the exact minimum undisturbed overnight rest periods required. The weekend Northstar Express and existing Northstar trains would be operated with the same two crews that BNSF currently uses to operate weekend service. The ability to provide extra board capability during the weekdays with the two weekend crews has been preserved.

3.2. Stations and Maintenance Facility

1. All Northstar locomotives and passenger cars would continue to be maintained at the Big Lake Maintenance Facility (BLMF). The BLMF is located at 19699 County Road 43, southeast of the existing Big Lake Northstar station.

2. No additional train layover or storage capacity is expected to be needed at Target Field Station or at a nearby location in Minneapolis.

3. The St. Cloud Northstar station is assumed to be located at the existing Amtrak station at 555 East Saint Germain Street in St. Cloud.

4. No overnight train storage capacity is needed at St. Cloud since no Northstar trains lay over at night at St. Cloud. However, a station siding off Main Track 2 at St. Cloud station is assumed as part of the **Minimum Service Alternative** to enable Northstar trains to clear the main track during their daytime layovers. On Saturdays and Sundays/holidays, one **Northstar Express** train lays over on the proposed station track at St. Cloud from 10:25 A.M. to 1:40 P.M.

5. No requirement for additional passenger stations is anticipated.

6. Proposed station improvements include:
    a. At St. Cloud station, a station siding off Main Track 2, signage, platform changes, additional parking facilities and other amenities associated with the Northstar commuter service may be needed, and some station upgrading may be required.
    b. All Northstar stations would require changes in displayed train schedules and maps.
7. The **Minimum Service Alternative** assumes that a satisfactory agreement can be arranged with Amtrak for the shared use of the Amtrak St. Cloud passenger station, waiting room, rest rooms and parking facilities by the Northstar trains and their passengers, at the hours they will need them.

3.3. General Operations

1. Amtrak's Empire Builder Train Number 8 from the Pacific Northwest is currently scheduled to leave St. Cloud at 5:19 A.M. each day. It operates eastbound (in the peak direction) through the Northstar commuter territory during the morning peak period and, if Amtrak Train 8 is off schedule, it can cause delays to other trains in the corridor including Northstar trains. Amtrak Train 8 is shown for information purposes in the train schedules presented in Sections 4 and 5. The westbound Amtrak Empire Builder Train Number 7 currently departs from St. Paul Union Depot at 10:20 P.M., does not affect Northstar scheduling, and has not been shown in the train schedules.
2. No Northstar commuter trains currently operate during the midday period from about 9:00 A.M. to about 3:00 P.M. The extended weekday service between Minneapolis and St. Cloud in the **Minimum Service Alternative** would not include any trains during the midday period.
    a. The midday maintenance window is a critical and short (especially short in the winter) period of daylight when BNSF maintenance forces must conduct most of their maintenance activities.
    b. The replacement of ties, dumping of track ballast, track surfacing, changeout of switches and switch components, and repairs to signal and communications equipment occurs primarily during this midday window.
    c. When one track is out of service for maintenance, all trains in both directions must use the single remaining main track between available control points and past the work areas. This causes extreme congestion and train delays.
    d. Adding new passenger trains during this midday maintenance window would only increase the congestion and train delays. It would also result in passenger dissatisfaction with the Northstar service.
    e. Additional trains would also shorten the maintenance time available, degrade maintenance productivity, and extend the time needed to perform maintenance activities. This would increase the cost of the maintenance work, a portion of which is allocated to the agencies operating the passenger trains. The inability to complete needed maintenance can also contribute to track and signal failures which can delay all trains in the corridor.

3. The **Minimum Service Alternative** includes non-revenue ("deadhead") train miles for one train between BLMF and St. Cloud before the trip from St. Cloud to Minneapolis, and then one deadhead trip back to BLMF after the arrival of the evening train to St. Cloud. The deadhead miles are needed to avoid the capital cost and long lead time required to plan and construct additional maintenance and/or train layover facilities. It is also important to ensure that all Northstar trains are operated by BNSF train crews from the same centrally located Northtown Yard crew base, thereby preserving the reliability of the service and minimizing the train crew costs.

4. To avoid the need for a reverse movement of revenue trains moving between BLMF and St. Cloud, and to enable extended Northstar trains operating between St. Cloud and Minneapolis to stop at the existing Big Lake station, the Big Lake Station track is proposed to be extended to a power-operated turnout, a power-operated universal main track crossover, and the necessary signaling at the north end of the Big Lake station track to enable straight-through movements to access the main tracks.

3.4. Schedule Assumptions

1. The existing Saturday and Sunday/Holiday Northstar commuter schedules have each been augmented with one new morning round trip and one new afternoon round trip non-stop **Northstar Express** train between St. Cloud and Minneapolis. No changes to the existing Northstar weekend commuter train schedules or crew assignments are proposed.

2. The Northstar Midday Shuttle Bus service option would depart St. Cloud at 10:30 A.M. and arrive at Minneapolis at 12:15 P.M. It would return as a non-stop bus in the early afternoon leaving Minneapolis at 2:00 P.M. arriving at St. Cloud at 3:45 P.M. The bus schedules are preliminary and may need to be adjusted depending on the route selected for the service.

3. BNSF and Metro Transit currently operate extra train service for special events throughout the year. The **Minimum Service Alternative** operating assumptions do not include requirements for accommodating special events, but special event service can be evaluated separately. The requirements for operating extra train service for special events would be in addition to the requirements shown above.

3.5. Other Assumptions

1. The electronic train information system requires updating to reflect the new service territory, train schedules, and days of operation.

2. On-train electronic display systems and public information would also require updating to reflect the extended service.

3. The proposal does not include a discussion of any of the opportunities for coordination (or additional coordination) of local transit services at Target Field Station, St. Cloud, or the other Northstar stations.

4. In the weekend schedules shown in Section 5, new train numbers are identified by higher numbers so they may be easily recognized. When final schedules are issued, it is likely that the train numbers will be renumbered to follow in the correct numerical sequences (even numbers for trains to

Minneapolis and odd numbered trains from Minneapolis).

4. Weekday Service Train Schedules

Southbound-Weekday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
A-1900	**---b---**	**b**5:00	5:10	5:16	5:21	5:25	5:33	5:52
A-1902	**---b---**	**b**5:48	5:58	6:04	6:09	6:13	6:21	6:40
	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago>>						
A-1904	**d**5:48	6:18	6:28	6:34	6:39	6:43	6:51	7:10
A-1906	**---b---**	**b**6:48	6:58	7:04	7:09	7:13	7:21	7:40
A-1908	**---b---**	**b**7:18	7:28	7:34	7:39	7:43	7:51	8:10
	PM							
A-1910	**---b---**	**b**5:03	5:13	5:19	5:24	5:28	5:36	5:55

Notes:

1. Highlighted time is the departure time of existing Train A-1904 extended from St. Cloud to Minneapolis.
2. The symbol "d" indicates the train deadheads from BLMF prior to the revenue trip.
3. The symbol "b" indicates existing Northstar Shuttle bus from St. Cloud connects with this train at Big Lake Station.

Northbound-Weekday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1901	6:15	6:30	6:39	6:43	6:48	6:54	7:07**b**	**---b---**
	PM							
A-1903	3:57	4:11	4:20	4:24	4:29	4:34	4:49**b**	**---b---**
A-1905	4:27	4:41	4:50	4:54	4:59	5:04	5:19**b**	**---b---**
A-1907	4:57	5:11	5:20	5:24	5:29	5:34	5:44	6:15**d**
A-1909	5:30	5:44	5:53	5:57	6:02	6:07	6:22**b**	**---b---**
A-1911	6:15	6:29	6:38	6:42	6:47	6:52	7:07**b**	**---b---**

Notes:

1. Highlighted times are the adjusted departure time at Big Lake and the new arrival time at St. Cloud for existing Train A-1907 extended from Minneapolis to St. Cloud.
2. The symbol "d" indicates the train deadheads to BLMF after the revenue trip.
3. The symbol "b" indicates existing Northstar Shuttle bus from St. Cloud connects with this train at Big Lake Station.

Southbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
AM								
BUS	*10:30*	***-------------------- Northstar Midday Shuttle Bus --------------------***						*12:15*

BUS indicates times of non-stop ***Northstar Midday Shuttle Bus*** option from St. Cloud to Minneapolis.

Northbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	PM							
BUS	2:00	***-------------------- Northstar Midday Shuttle Bus --------------------***						3:45

BUS indicates times of non-stop ***Northstar Midday Shuttle Bus*** option from Minneapolis to St. Cloud.

5. Saturday, Sunday, and Holiday Service Train Schedules

Southbound- Saturday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago >>						
A-1936	**d**8:00	**<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						9:05
A-1930	------	10:20	10:30	10:36	10:41	10:45	10:53	11:12
	PM							
A-1932	------	12:50	1:00	1:06	1:11	1:15	1:23	1:42
A-1938	1:40	**<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						2:45
A-1934	------	5:10	5:20	5:26	5:31	5:35	5:43	6:02

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1936 and A-1938) operated from St. Cloud to Minneapolis.
2. The symbol “d” indicates that a deadhead trip from BLMF precedes the scheduled revenue trip.
3. Train A-1938’s equipment lays over clear of the main track 10:25 A.M. to 1:40 P.M.

Northbound-Saturday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1937	9:20	**<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>>**						10:25
A-1931	11:30	11:44	11:53	11:57	12:02	12:07	12:22	------
	PM							
A-1939	3:00	**<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>>**						4:05**d**
A-1933	4:00	4:14	**4:23**	4:27	4:32	4:37	4:52	------
A-1935	7:00	7:14	7:23	7:27	7:32	7:37	7:52	------

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1937 and A-1939) operated from Minneapolis to St. Cloud.
2. The symbol "d" indicates that a deadhead trip to BLMF follows the scheduled revenue trip.
3. Train A-1937 has a midday layover at St. Cloud clear of the main track from 10:25 A.M. to 1:40 P.M.

Southbound-Sunday/Holiday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
	5:19	>>Amtrak Empire Builder Train Number 8> St. Cloud>St. Paul U.D.>Chicago >>						
A-1946	**d**8:00	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						9:05
A-1940	------	9:30	9:40	9:46	9:51	9:55	10:03	10:22
A-1942	------	11:50	12:00	12:06	12:11	12:15	12:23	12:42
	PM							
A-1948	1:40	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						2:45
A-1944	------	2:40	2:50	2:56	3:01	3:05	3:13	3:32

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1946 and A-1948) operated from St. Cloud to Minneapolis.
2. The symbol "d" indicates that a deadhead trip from BLMF precedes the scheduled revenue trip.
3. Train A-1948's equipment lays over clear of the main track 10:25 A.M. to 1:40 P.M.

Northbound-Sunday/Holiday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1947	9:20	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						10:25
A-1941	10:40	10:54	11:03	11:07	11:12	11:17	11:32	------
	PM							
A-1943	1:20	1:34	1:43	1:47	1:52	1:57	2:12	------
A-1949	3:00	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						4:05**d**
A-1945	4:55	5:09	5:18	5:22	5:27	5:32	5:47	------

Notes:

1. Highlighted times are the times of the two new Northstar commuter trains (A-1947 and A-1949) operated from Minneapolis to St. Cloud.
2. The symbol “d” indicates that a deadhead trip to BLMF follows the scheduled revenue trip.
3. Train A-1947 has a midday layover at St. Cloud clear of the main track from 10:25 A.M. to 1:40 P.M.

6. BNSF Train Crew Assignments for Weekday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to ‘TFS’ for ease of description**

Crew 1:

On Duty BLMF	4:15 A.M.	Operates 5:00 A.M. Train A-1900 Big Lake to TFS.
		Operates 6:15 A.M. Train A-1901 TFS to Big Lake.
		Operates 7:18 A.M. Train A-1908 Big Lake to TFS.
Arrive TFS	8:10 A.M.	Secure equipment at TFS.
Off Duty TFS	8:25 A.M.	Rest period at TFS Crew Facility: 8:25 A.M.-3:57 P.M. (7’32”).
On Duty TFS	3:57 P.M.	Operates 4:27 P.M. Train A-1905 TFS to Big Lake.
Arrive Big Lake	5:19 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:49 P.M.	Total Compensated Hours: 13’34”. Rest Period: 10’26”.

Crew 2:

On Duty BLMF	5:18 A.M.	Operates 5:48 A.M. Train A-1902 Big Lake to TFS. (30” On Duty)
Arrive TFS	6:40 A.M.	Secure equipment at TFS.
Off Duty TFS	6:55 A.M.	Rest Period at TFS Crew Facility: 6:55 A.M.-4:27 P.M. (9’32”).
On Duty TFS	4:27 P.M.	Operates 4:57 P.M. Train A-1907 TFS to St. Cloud.
		Operates 6:30 P.M. deadhead Train A-1907 St. Cloud to BLMF.
Arrive BLMF	7:00 P.M.	Secure equipment at BLMF. (18” Off Duty)
Off Duty BLMF	7:18 P.M.	Total Compensated Hours: 14’00”. Rest Period: 10’00”.

<u>**Crew 3:**</u>

On Duty BLMF	4:33 A.M.	Operates 5:03 A.M. deadhead Train A-1904 BLMF to St. Cloud. (30" On Duty)
		Operates Train A-1904 St. Cloud to TFS.
Arrive TFS	7:10 A.M.	Secure equipment at TFS.
Off Duty TFS	7:25 A.M.	Rest Period at TFS Crew Facility: 7:25 A.M.- 5:00 P.M. (9'35").
On Duty TFS	5:00 P.M.	Operates 5:30 P.M. Train A-1909 TFS to Big Lake.
Arrive Big Lake	6:07 P.M.	Secure equipment at BLMF. (26" Off Duty)
Off Duty BLMF	6:33 P.M.	Total Compensated Hours: <u>14'00". Rest Period: 10'00".</u>

<u>**Crew 4:**</u>

On Duty BLMF	6:03 A.M.	Operates 6:48 A.M. Train A-1906 Big Lake to TFS.
Arrive TFS	7:40 A.M.	Secure equipment at TFS.
Off Duty TFS	7:55 A.M.	Rest Period at TFS Crew Facility: 7:55 A.M.-3:27 P.M. (7'32").
On Duty TFS	3:27 P.M.	Operates 3:57 P.M. Train A-1903 TFS to Big Lake.
		Operates 5:03 P.M. Train A-1910 Big Lake to TFS.
		Operates 6:15 P.M. Train A-1911 TFS to Big Lake.
Arrive Big Lake	7:07 P.M.	Secure equipment at BLMF.
Off Duty BLMF	7:37 P.M.	Total Compensated Hours: <u>13'34". Rest Period: 10'26".</u>

7. BNSF Train Crew Assignments for Saturday, Sunday, and Holiday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to 'TFS' for ease of description**

Saturday

<u>**Crew 5:**</u>

On Duty BLMF	6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1936 to St. Cloud.
		Operates 8:00 A.M. Northstar Express Train A-1936 St. Cloud to TFS.
		Operates 9:20 A.M. Northstar Express Train A-1937 TFS to St. Cloud.
Arrive St. Cloud	10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1938.)
		Operates 1:40 P.M. Northstar Express Train A-1938 St. Cloud to TFS.
		Operates 3:00 P.M. Northstar Express Train A-1939 TFS to St. Cloud.
		Operates 4:20 P.M. deadhead Train A-1939 to BLMF.
Arrive BLMF	4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:20 P.M.	Total On-Duty Hours: <u>10'50". Rest Period: 13'10".</u>

<u>**Crew 6:**</u>	Operates Trains A-1930, A-1931, A-1932, A-1933, A-1934 and A1935.

NOTES:
Crew 5 operates the Northstar Express weekend service on Saturday and Sunday/Holiday. Crew 5 is in addition to Crew 6 which currently operates existing the Northstar Sunday/Holiday commuter service. Crews 5 and 6 also provide weekday extra board capability.

The Rest Period may vary from the time shown depending on the starting time of the assignment for this crew on the following day.

Sunday/Holiday

Crew 5:

On Duty BLMF	6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1946 to St. Cloud.
		Operates 8:00 A.M. Northstar Express Train A-1946 St. Cloud to TFS.
		Operates 9:20 A.M. Northstar Express Train A-1947 TFS to St. Cloud.
Arrive St. Cloud	10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1948)
		Operates 1:40 P.M. Northstar Express Train A-1948 St. Cloud to TFS.
		Operates 3:00 P.M. Northstar Express Train A-1949 TFS to St. Cloud.
		Operates 4:20 P.M. deadhead Train A-1949 to BLMF.
Arrive BLMF	4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:20 P.M.	Total On-Duty Hours: 10’50”. Rest Period: 13’10”.

Crew 6: Operates Trains A-1940, A-1941, A-1942, A-1943, A-1944 and A-1945.

NOTES:
Crew 5 operates the Northstar Express weekend service on Saturday and Sunday/Holiday. Crew 5 is in addition to Crew 6 which currently operates existing the Northstar Sunday/Holiday commuter service. Crews 5 and 6 also provide weekday extra board capability.

The Rest Period may vary from the time shown depending on the start time of the assignment for this crew on the following day.

Northstar Commuter Rail Extension Feasibility Assessment

Appendix C – Technical Memorandum on Operating Assumptions for the Minimum Bi-Directional Service Alternative

July 31, 2020

Photo Credit: Dave Gonzalez

Prepared for

DEPARTMENT OF TRANSPORTATION

By

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum describes the **Minimum Bi-Directional Service Alternative** and presents the preliminary proposed Operating Plan for the extension of Northstar commuter service to St. Cloud. The extended service would be provided within the existing Northstar Commuter service framework now provided by BNSF and Metro Transit. The **Minimum Bi-Directional Service Alternative** is a hybrid alternative that extends minimum Northstar service to St. Cloud while providing a minimum bi-directional service that enables passengers traveling in either direction to work a full day at destination.

This proposal has been designed to minimize the amount of additional capital investment that would be needed to operate the proposed **Minimum Bi-Directional** service. It has also considered the description of existing conditions provided by BNSF that may constrain the extension of Northstar service to St. Cloud. These constraints are documented in the Technical Memorandum on Existing Constraints (Appendix A).

By carefully considering the constraints described by BNSF, which directly affect the feasibility and cost of providing a new service, and incorporating them into the proposal as part of the Operating Assumptions presented below, this proposal has endeavored to meet the requirements of the railroad, the public agencies, and the public stakeholders involved.

2. Description of Proposed Service

The **Minimum Bi-Directional Service Alternative** provides Northstar commuter service between St. Cloud and Minneapolis by originating one existing morning peak period southbound Northstar train (A-1904) from St. Cloud instead of Big Lake. For passengers traveling to St. Cloud, existing northbound Northstar train (A-1901) from Minneapolis, which currently terminates at Big Lake, has been extended to St. Cloud, arriving at 7:28 A.M. Also, southbound peak period Northstar Train A-1908 from Big Lake has been rescheduled 20" later to provide a peak period slot between Northstar Trains A-1906 and A-1908 long enough to operate at least one eastbound BNSF freight trains through the Northstar commuter territory without delaying Northstar trains.

<u>**Minimum Bi-Directional Service Alternative**</u> –

a. **Weekday Morning** Peak Period - One existing Northstar train would be rescheduled to begin in St. Cloud rather than Big Lake; one existing Northstar train would be rescheduled to terminate in St. Cloud rather than Big Lake
b. **Weekday Afternoon** Peak Period - One existing Northstar train would be rescheduled to terminate in St. Cloud rather than Big Lake; one existing Northstar train would be rescheduled to begin in St. Cloud rather than Big Lake
c. **Saturday and Sunday/Holiday** – two new northbound and two new southbound trains would operate Express between Minneapolis and St. Cloud

The **Minimum Bi-Directional Service Alternative** has an option for new non-stop midday bus service, designated as the ***Northstar Midday Shuttle Bus.*** The shuttle bus would depart St. Cloud mid-morning and would return to St. Cloud in mid-afternoon.

In the afternoon peak period, one existing northbound Northstar commuter train (A-1909) from Minneapolis has been extended from Big Lake to St. Cloud. For passengers returning from St. Cloud to

Minneapolis, one existing Northstar train (A-1910), which currently originates at Big Lake, has been extended to originate at St. Cloud at 4:32 P.M.

On Saturdays and Sundays/holidays, two new round trip **Northstar Express** trains have been scheduled between Minneapolis and St. Cloud, one operating in the morning and one in the afternoon. These trains are in addition to the existing Northstar local train service between Big Lake and Minneapolis on Saturdays, and Sundays/holidays.

3. Operating Assumptions

Operating Assumptions are a critical part of this feasibility assessment. Operating assumptions reflect a variety of factors considered in the operations analysis of the proposed service including:

- Service requests (i.e., frequencies, departure/arrival times) from the public stakeholders (prospective passengers, the communities, etc.);
- Physical limitations of the railroad and its environment;
- Capacity limitations and the operating requirements of the railroad;
- Effects of new service on the existing passenger and freight services operating in the corridor;
- Non-revenue “deadhead” equipment train trips which are needed to position train sets and crews for revenue service and/or enable crews to go on and off duty at appropriate times and locations;
- Effects of new service on the railroad’s ability to expand its freight service to meet increased traffic demands in the future;
- Northstar locomotive and passenger car fleet considerations;
- Existing collective bargaining agreements in effect on BNSF affecting railroad train crew members;
- Existing service contract between Metro Transit and BNSF;
- Capital expenditures that would be needed to initiate the extended service;
- Operating and maintenance expenses that would be needed to run the new service;
- Budget limitations affecting the State and municipal agencies;
- Federal Railroad Administration (FRA) regulations and their effects on service planning; and
- The safety and reliability of the proposed extended Northstar commuter service.

The following sub-sections discuss the Operating Assumptions for the **Minimum Bi-Directional Service Alternative**.

3.1. Train Crews and Equipment

1. FRA regulations affect most aspects of the safety of operation of the BNSF, Amtrak, and Northstar train operations and maintenance. Compliance with applicable FRA regulations has been built into the proposal as a basic requirement and assumption. The FRA Hours of Service regulations limit the length of the train crew workdays and specify the minimum rest period between workdays.

2. The extended Northstar commuter service to St. Cloud would be operated as a part of the existing Northstar commuter rail service, a cooperative effort by Metro Transit and BNSF Railway.

3. The **Minimum Bi-Directional Service Alternative** proposal anticipates that the extended service would require five operational train sets, one more than is currently needed. It is suggested that the additional train set consist of one locomotive, two bi-level passenger coaches and two bi-level cab control passenger cars. The second cab control passenger car is important to provide a replacement should one of the existing cab control cars be damaged or require a period out of service for maintenance or repairs. Additional spare equipment may also be required to augment the two locomotives and two cab control passenger cars now available as spares. This will permit the substitution of equipment as needed for the required inspections and maintenance on a timely basis and will support the dependability of the Northstar commuter service.

4. The additional locomotive(s), passenger cars, and cab control passenger cars that would be added to the Northstar fleet would increase the workload on the forces at the BLMF. Additional employees have been proposed to augment the current Metro Transit staffing at the BLMF.

5. **Minimum Bi-Directional Service Alternative** anticipates the leasing of surplus equipment of the same types now in use by Northstar from other commuter agencies at favorable pricing. The cost would include rehabilitating, painting (or wrapping) the locomotive(s) and passenger cars to match the appearance and operation of the existing Northstar fleet inside and out as much as possible. Using this alternative is important to maintain the simplified maintenance and parts inventory programs (and employee training and qualification) which are now important operating, maintenance, and budget advantages for Northstar. Leasing surplus equipment from other carriers also avoids the delay and cost involved with a capital procurement until such time as the demand for the new service has been proven by ridership levels. It has been assumed that the installation of the appropriate Positive Train Control apparatus in the additional locomotives and cab control passenger cars would be part of the expense of acquiring the additional rolling stock.

6. BNSF train crews from the existing BNSF crew district base at Northtown Yard would continue to be used to operate the service and would support the train crew requirements of the **Minimum Bi-Directional Service Alternative:**

   a. Crews would continue to go on and off duty at the same locations they presently use. However, one weekday morning Northstar crew (Crew 2) would be transported from St. Cloud to BLMF by crew van to complete their assignment. In the afternoon, another Northstar crew (Crew 6) would be transported by crew van from BLMF to St. Cloud to begin their assignment. Train A-1901 which arrives at St. Cloud at 7:28 A.M. would have a long midday layover on the proposed St. Cloud station track at the St. Cloud Amtrak station and would stand for Train A-1910 to leaving St. Cloud at 4:32 P.M. and arriving at Target Field Station at 5:55 P.M. The cost of the crew van expense is included in the operating expenses for this alternative.
   b. No BNSF crews would originate or terminate their workday at St. Cloud, though one train would lay over on the St. Cloud station track during the midday on weekdays and weekends/holidays.
   c. Train crew work schedules included in the **Minimum Bi-Directional Service Alternative** are preliminary and primarily for cost estimating purposes. They are subject to revision. When BNSF addresses the actual train crew scheduling for the extended service, the work

schedules and the number of additional train crews may be revised, and the estimated costs of the proposed service could change.

d. BNSF train crews each consist of one engineer and one conductor. These employees are members of a trained and qualified passenger train crew base at BNSF's Northtown Yard. The crew members in the passenger pool may also operate freight trains when not being used in passenger service.
e. Train crew compensation would be in accordance with BNSF agreements in effect for locomotive engineers and conductors.
f. The Northstar train schedules in this preliminary proposal are conceptual and are subject to revision.
g. The standard Northstar weekday train consist currently includes one locomotive, three passenger coaches and one cab control passenger car. Weekend, holiday and special event Northstar commuter trains currently include a second locomotive to ensure service reliability. The length of the proposed St. Cloud station track has been designed to accommodate two locomotives and 4 Northstar cars.

5. The train crew facility at Target Field Station in Minneapolis is currently the only location where crews can be relieved from duty during the day for a midday rest break of at least four (compensated) hours before resuming service in the afternoon peak period. Train crews cannot be relieved from duty for a midday break at the BLMF because there are currently no facilities that meet FRA requirements for rest at that location.

6. The proposed train schedules and train crew work assignments may require BNSF to train and qualify additional locomotive engineers and conductors for passenger service at the Northtown Yard crew base.

7. The crew sheets must be reviewed to identify the deadhead commuter train movements and the total crew hours of service that are a part of the **Minimum Bi-Directional Service Alternative**.

3.2. Stations and Maintenance Facility

1. All Northstar locomotives and passenger cars would continue to be maintained at the Big Lake Maintenance Facility (BLMF). Additional storage and servicing track capacity would be required at the BLMF to accommodate the additional train set. The BLMF is located at 19699 County Road 43, southeast of the existing Big Lake Northstar station.

2. No additional train layover or storage capacity is expected to be needed at Target Field Station or at a nearby location in Minneapolis.

3. The St. Cloud Northstar station is assumed to be located at the existing Amtrak station at 555 East Saint Germain Street in St. Cloud.

4. No overnight train storage capacity is needed at St. Cloud since no Northstar trains lay over at night at St. Cloud. However, a station siding off Main Track 2 at St. Cloud station is assumed as part of the **Minimum Bi-Directional Service Alternative** to enable Northstar trains to clear the main track during their daytime layovers. On weekdays, one Northstar commuter train has a long mid-day

layover at St. Cloud. On weekends/holidays, one **Northstar Express** train lays over during the midday. Both trains remain clear of the main track on the proposed station siding during their layovers.

5. Additional passenger station facilities are anticipated to be needed at St. Cloud and Big Lake as follows:

    a. At St. Cloud station, a station siding off Main Track 2, signage, platform changes, additional parking facilities and other amenities associated with the Northstar commuter service may be needed, and some station upgrading may be required. The station siding will allow Northstar trains to clear the main track during their layovers. Their layover position would not interfere with loading/unloading of Amtrak Trains 7 and 8, both of which use a "double spot" procedure to accommodate coach and sleeper passengers while using the short St. Cloud platform which is much shorter than the Amtrak trains. There is an alternative to place a Northstar platform on the east/south leg of the wye at St. Cloud and have Northstar trains use that location for arrivals, changing ends and departures. Doing so would clear Main Track 2 and provide BNSF more operational flexibility. Northstar trains approaching St. Cloud would get an Approach Restricting signal indication which would minimize delays to arriving trains that would clear the main track. Because the station siding off Track 2 is now part of the **Minimum Bi-Directional Service Alternative**, the previously suggested alternative to use the west wye track is not currently being considered.

    b. A new Northstar station at Big Lake with a platform between Main Tracks 1 and 2 is proposed to avoid the need for trains stopping at Big Lake to crossover from one main track to the other.

    c. All Northstar stations would require changes in displayed train schedules and maps.

6. The **Minimum Bi-Directional Service Alternative** assumes that a satisfactory agreement can be arranged with Amtrak for the shared use of the Amtrak St. Cloud passenger station, waiting room, rest rooms and parking facilities by the Northstar trains and their passengers, at the hours they will need them.

3.3. General Operations

1. Amtrak's Empire Builder Train Number 8 from the Pacific Northwest is currently scheduled to leave St. Cloud at 5:19 A.M. each day. It operates eastbound (in the peak direction) through the Northstar commuter territory during the morning peak period. Because of Amtrak's scheduling practices, Amtrak Train 8 can arrive early at St. Cloud. Also, if Amtrak Train 8 is late, it can cause delays to other trains in the corridor including Northstar trains. Amtrak Train 8 is shown for information purposes in the train schedules presented in Sections 4 and 5. The westbound Amtrak Empire Builder Train Number 7 currently departs from St. Paul Union Depot at 10:20 P.M., does not affect Northstar scheduling, and has not been shown in the train schedules.

2. No Northstar commuter trains currently operate during the midday period from about 9:00 A.M. to about 3:00 P.M. The train schedules proposed for the **Minimum Bi-Directional Service Alternative**

maintain the existing BNSF midday window free of commuter trains. Observations of the midday maintenance window are:

   a. The midday maintenance window is a critical and short (especially short in the winter) period of daylight when BNSF maintenance forces must conduct most of their maintenance activities.

   b. The replacement of ties, dumping of track ballast, track surfacing, changeout of switches and switch components, and repairs to signal and communications equipment occurs primarily during this midday window.

   c. When one track is out of service for maintenance, all trains in both directions must use the single remaining main track between available control points and past the work areas. This causes extreme congestion and train delays.

   d. Adding new passenger trains during this midday maintenance window would only increase the congestion and train delays. It would also result in passenger dissatisfaction with the Northstar service.

   e. Additional trains would also shorten the maintenance time available, degrade maintenance productivity, and extend the time needed to perform maintenance activities. This would increase the cost of the maintenance work, a portion of which is allocated to the agencies operating the passenger trains. The inability to complete needed maintenance can also contribute to track and signal failures which can delay all trains in the corridor.

3. The **Minimum Bi-Directional Service Alternative** includes non-revenue ("deadhead") train miles between BLMF and St. Cloud for one train in the morning and one train in the evening peak period both on weekdays and on weekends. No other deadhead miles are anticipated. The deadhead miles are needed to avoid the capital cost and long lead time required to plan and construct additional maintenance and/or train overnight layover facilities. It is also important to ensure that all Northstar trains are operated by BNSF train crews from the same centrally located Northtown Yard crew base, thereby preserving the reliability of the service and minimizing the train crew costs.

4. To avoid the need for a reverse movement of revenue trains moving between BLMF and St. Cloud, and to enable extended Northstar trains operating between St. Cloud and Minneapolis to stop at the existing Big Lake station, the Big Lake Station track is proposed to be extended to a power-operated turnout, a power-operated universal main track crossover, and the necessary signaling at the north end of the Big Lake station track to enable straight-through movements to access the main tracks.

3.4. Schedule Assumptions

1. The existing Saturday and Sunday/Holiday Northstar commuter schedules have each been augmented with one new morning round trip and one new afternoon round trip non-stop **Northstar Express** train between St. Cloud and Minneapolis. No changes to the existing Northstar weekend commuter train schedules or crew assignments are proposed.

2. The Northstar Midday Shuttle Bus service option would depart St. Cloud at 10:30 A.M. and arrive at

Minneapolis at 12:15 P.M. It would return as a non-stop bus in the early afternoon leaving Minneapolis at 2:00 P.M. arriving at St. Cloud at 3:45 P.M. The bus schedules are preliminary and may need to be adjusted depending on the route selected for the service.

3. BNSF and Metro Transit currently operate extra train service for special events throughout the year. The **Minimum Bi-Directional Service Alternative** operating assumptions do not include requirements for accommodating special events, but special event service can be evaluated separately. The requirements for operating extra train service for special events would be in addition to the requirements shown above.

3.5. Other Assumptions

1. The electronic train information system requires updating to reflect the new service territory, train schedules, and days of operation.
2. On-train electronic display systems and public information would also require updating to reflect the extended service.
3. The proposal does not include a discussion of any of the opportunities for coordination (or additional coordination) of local transit services at Target Field Station, St. Cloud, or the other Northstar stations.
4. In the weekend schedules shown in Section 5, new train numbers are identified by higher numbers so they may be easily recognized. When final schedules are issued, it is likely that the train numbers will be renumbered to follow in the correct numerical sequences (even numbers for trains to Minneapolis and odd numbered trains from Minneapolis).

4. Weekday Service Train Schedules

Southbound-Weekday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
A-1900	---**b**---	**b**5:00	5:10	5:16	5:21	5:25	5:33	5:52
A-1902	---**b**---	**b**5:48	5:58	6:04	6:09	6:13	6:21	6:40
A-8	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago>>						
A-1904	**d**5:47	6:18	6:28	6:34	6:39	6:43	6:51	7:10
A-1906	---**b**---	**b**6:48	6:58	7:04	7:09	7:13	7:21	7:40
A-1908	---**b**---	**b**7:38	7:48	7:54	7:59	8:03	8:11	8:30
	PM							
A-1910	**x**4:32	5:03	5:13	5:19	5:24	5:28	5:36	5:55

Notes:

1. Highlighted times indicates existing Northstar train is extended to originate at St. Cloud.
2. The symbol "**d**" indicates train deadheads from BLMF to St. Cloud and has 30" layover before the revenue

trip of Train A-1904.
3. The symbol “**b**” indicates Northstar Shuttle bus from St. Cloud connects with this train at Big Lake Station.
4. The symbol “**x**” indicates train has long midday layover on St. Cloud station track after arrival on Train A-1901.

Northbound-Weekday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1901	6:10	6:24	6:33	6:37	6:42	6:47	6:57	7:28**x**
	PM							
A-1903	3:57	4:11	4:20	4:24	4:29	4:34	4:49**b**	---**b**---
A-1905	4:27	4:41	4:50	4:54	4:59	5:04	5:19**b**	---**b**---
A-1907	4:57	5:11	5:20	5:24	5:29	5:34	5:49**b**	---**b**---
A-1909	5:30	5:44	5:53	5:57	6:02	6:07	6:17	6:48**d**
A-1911	6:10	6:24	6:33	6:37	6:42	6:47	7:02**b**	---**b**---

Notes:
1. Highlighted times indicates existing Northstar train is extended to St. Cloud.
2. The symbol “**d**” indicates train deadheads from St. Cloud to BLMF after the revenue trip of Train A-1909.
3. The symbol “**b**” indicates Northstar Shuttle bus to St. Cloud connects with this train at Big Lake Station.
4. The symbol “**x**” indicates train has long midday layover at St. Cloud station track prior to departure as Train A-1904.

Southbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
BUS	*10:30*	***-------------------- Northstar Midday Shuttle Bus --------------------***						*12:15*

BUS indicates times of new non-stop ***Northstar Midday Shuttle Bus*** from St. Cloud to Minneapolis.

Northbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	PM							
BUS	2:00	***-------------------- Northstar Midday Shuttle Bus --------------------***						3:45

BUS indicates times of new non-stop ***Northstar Midday Shuttle Bus*** from Minneapolis to St. Cloud.

5. Saturday, Sunday, and Holiday Service Train Schedules

Southbound-Saturday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
A-8	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago >>						
A-1936	**d**8:00	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						9:05
A-1930	------	10:20	10:30	10:36	10:41	10:45	10:53	11:12
	PM							
A-1932	------	12:50	1:00	1:06	1:11	1:15	1:23	1:42
A-1938	**x**1:40	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						2:45
A-1934	------	5:10	5:20	5:26	5:31	5:35	5:43	6:02

Notes:
1. Highlighted times are new non-stop ***Northstar Express*** trains from St. Cloud to Minneapolis
2. The symbol "**d**" indicates train deadheads from BLMF to St. Cloud before the revenue trip of Train A-1936.
3. The symbol "**x**" indicates train has long midday layover on St. Cloud station track before departure of Train A-1938.

Northbound-Saturday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1937	9:20	**<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>>**						10:25**x**
A-1931	11:30	11:44	11:53	11:57	12:02	12:07	12:22	------
	PM							
A-1939	3:00	**<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>>**						4:05**d**
A-1933	4:00	4:14	4:23	4:27	4:32	4:37	4:52	------
A-1935	7:00	7:14	7:23	7:27	7:32	7:37	7:52	------

Notes:
1. Highlighted times are new non-stop ***Northstar Express*** trains from Minneapolis to St. Cloud.
2. The symbol "**d**" indicates train deadheads from St. Cloud to BLMF after the revenue trip of Train A-1939.
3. The symbol "**x**" indicates train has long midday layover on St. Cloud station track and relays to Train A-1938.

Southbound-Sunday & Holiday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
	5:19	>>Amtrak Empire Builder Train Number 8> St. Cloud>St. Paul U.D.>Chicago >>						
A-1946	**d**8:00	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						9:05
A-1940	------	9:30	9:40	9:46	9:51	9:55	10:03	10:22
A-1942	------	11:50	12:00	12:06	12:11	12:15	12:23	12:42
	PM							
A-1948	**x**1:40	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						2:45
A-1944	------	2:40	2:50	2:56	3:01	3:05	3:13	3:32

Notes:

1. Highlighted times are new non-stop ***Northstar Express*** trains from St. Cloud to Minneapolis.
2. The symbol "**d**" indicates train deadheads from BLMF to St. Cloud before the revenue trip of Train A-1946.
3. The symbol "**x**" indicates train has long midday layover on St. Cloud station track before departure of Train A-1948.

Northbound-Sunday & Holiday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1947	9:20	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						10:25**x**
A-1941	10:40	10:54	11:03	11:07	11:12	11:17	11:32	------
	PM							
A-1943	1:20	1:34	1:43	1:47	1:52	1:57	2:12	------
A-1949	3:00	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						4:05**d**
A-1945	4:55	5:09	5:18	5:22	5:27	5:32	5:47	------

Notes:

1. Highlighted times are new non-stop ***Northstar Express*** trains Minneapolis to St. Cloud.
2. The symbol "**d**" indicates train deadheads from St. Cloud to BLMF after the revenue trip of Train A-1949.
3. The symbol "**x**" indicates train has long midday layover on St. Cloud station track and relays to Train A-1948.

6. BNSF Train Crew Assignments for Weekday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to 'TFS' for ease of description**

Crew 1:

On Duty BLMF	3:35 A.M.	Operates 4:20 A.M. deadhead Train A-1904 to St. Cloud. (30" layover)
		Operates 5:47 A.M. Train A-1904 St. Cloud to TFS.
Arrive TFS	7:10 A.M.	Secure equipment at TFS.
Off Duty TFS	7:25 A.M.	Rest period at TFS Crew Facility: 7:25 A.M.-3:27 P.M. (8'02").
On Duty TFS	3:27 P.M.	Operates 3:57 P.M. Train A-1903 TFS to Big Lake.
Arrive Big Lake	4:49 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:19 P.M.	Total Compensated Hours: 13'44". Rest Period: 10'16".

Crew 2:

On Duty BLMF	4:15 A.M.	Operates 5:00 A.M. Train A-1900 Big Lake to TFS.
		Operates 6:10 A.M. Train A-1901 TFS to St. Cloud.
Arrive St. Cloud	7:28 A.M.	Secure train on St. Cloud station track.
Leave St. Cloud	8:00 A.M.	Crew van St. Cloud to BLMF. Arrive 8:45 A.M.
Off Duty BLMF	9:00 A.M.	Total On-Duty Hours: 4' 45". Basic Day Rule applies. Rest Period: 19"15".

Crew 3:

On Duty BLMF	5:03 A.M.	Operates 5:48 A.M. Train A-1902 Big Lake to TFS.
Arrive TFS	6:40 A.M.	Secure equipment at TFS.
Off Duty TFS	6:55 A.M.	Rest period at TFS Crew Facility: 6:55 A.M.-3:57 P.M. (9'02").
On Duty TFS	3:57 P.M.	Operates 4:27 P.M. Train A-1905 TFS to Big Lake.
Arrive Big Lake	5:19 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:49 P.M.	Total Compensated Hours: 12'46". Rest Period: 11'14".

Crew 4:

On Duty BLMF	6:03 A.M.	Operates 6:48 A.M. Train A-1906 Big Lake to TFS.
Arrive TFS	7:40 A.M.	Secure equipment at TFS.
Off Duty TFS	7:55 A.M.	Rest period at TFS Crew Facility: 7:55 A.M.-4:27 P.M. (8'32").
On Duty TFS	4:27 P.M.	Operates 4:57 P.M. Train A-1907 TFS to Big Lake.
Arrive Big Lake	5:49 P.M.	Secure equipment at BLMF.
Off Duty BLMF	6:19 P.M.	Total Compensated Hours: 12'16". Rest Period: 11'44".

Crew 5:

On Duty BLMF	6:53 A.M.	Operates 7:38 A.M. Train A-1908 Big Lake to TFS.
Arrive TFS	8:30 A.M.	Secure equipment at TFS.
Off Duty TFS	8:45 A.M.	Rest Period at TFS Crew Facility: 8:45 A.M.-5:00 P.M. (8’15”).
On Duty TFS	5:00 P.M.	Operates 5:30 P.M. Train A-1909 TFS to St. Cloud.
		Operates 7:03 P.M. deadhead train A-1909 St. Cloud to BLMF.
Arrive BLMF	7:33 P.M.	Secure equipment at BLMF.
Off Duty BLMF	8:03 P.M.	Total Compensated Hours: 11’10”. Rest Period: 12’50”.

Crew 6:

On Duty BLMF	2:45 P.M.	Crew van BLMF to St. Cloud. Arrive 3:30 P.M.
		Operates 4:32 P.M. Train A-1910 St. Cloud to TFS.
		Operates 6:10 P.M. Train A-1911 TFS to Big Lake.
Arrive Big Lake	7:02 P.M.	Secure equipment at BLMF.
Off Duty BLMF	7:32 P.M.	Total On-Duty Hours: 4’47”. Basic Day Rule applies. Rest Period: 19’13”.

7. BNSF Train Crew Assignments for Saturday, Sunday, and Holiday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to ‘TFS’ for ease of description**

Saturday

Crew 7:

On Duty BLMF	6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1936 to St. Cloud.
		Operates 8:00 A.M. Northstar Express Train A-1936 St. Cloud to TFS.
		Operates 9:20 A.M. Northstar Express Train A-1937 TFS to St. Cloud.
Arrive St. Cloud	10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1938.)
		Operates 1:40 P.M. Northstar Express Train A-1938 St. Cloud to TFS.
		Operates 3:00 P.M. Northstar Express Train A-1939 TFS to St. Cloud.
		Operates 4:20 P.M. deadhead Train A-1939 to BLMF.
Arrive BLMF	4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:20 P.M.	Total On-Duty Hours: 10’50”. Rest Period: 13’10”.

Crew 8: Operates Trains A-1930, A-1931, A-1932, A-1933, A-1934 and A1935.

NOTES:
Crew 7 operates the Northstar Express weekend service on Saturday and Sunday/Holiday. Crew 7 is in addition to Crew 8 which currently operates existing the Northstar Saturday commuter service and provides for extra board capability.

The Rest Period may vary from the time shown depending on the starting time of the assignment for this crew on the following day.

Sunday/Holiday

Crew 7:

On Duty BLMF 6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1946 to St. Cloud.
	Operates 8:00 A.M. Northstar Express Train A-1946 St. Cloud to TFS.
	Operates 9:20 A.M. Northstar Express Train A-1947 TFS to St. Cloud.
Arrive St. Cloud 10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1948)
	Operates 1:40 P.M. Northstar Express Train A-1948 St. Cloud to TFS.
	Operates 3:00 P.M. Northstar Express Train A-1949 TFS to St. Cloud.
	Operates 4:20 P.M. deadhead Train A-1949 to BLMF.
Arrive BLMF 4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF 5:20 P.M.	Total On-Duty Hours: 10'50". Rest Period: 13'10".

Crew 8: Operates Trains A-1940, A-1941, A-1942, A-1943, A-1944 and A-1945.

NOTES:
Crew 7 operates the Northstar Express weekend service on Saturday and Sunday/Holiday. Crew 7 is in addition to Crew 8 which currently operates existing the Northstar Sunday/Holiday commuter service and provides for extra board capability.

The Rest Period may vary from the time shown depending on the start time of the assignment for this crew on the following day.

8. Alternative Considered and Removed

An "intermediate" Service Alternative was initially considered that proposed originating two morning peak trains in St. Cloud instead of at Big Lake and extending two afternoon peak trains to St. Cloud. To operate this alternative, eight crews were required and multiple non-revenue (deadhead) movements were scheduled throughout the morning and afternoon peak periods to ensure that train crews would go on and off duty at Big Lake. Additionally, the "intermediate" train schedules encroached into the BNSF midday maintenance window at the end of the morning peak and before the afternoon peak. For these reasons, the alternative was removed from further analysis and was replaced with the Minimum Bi-Directional Service Alternative.

Northstar Commuter Rail Extension Feasibility Assessment

Appendix D – Technical Memorandum on Operating Assumptions for the Northstar Express Service Alternative

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

by

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum describes the **Northstar Express Service Alternative** and presents the preliminary proposed Operating Plan for the introduction of **Northstar Express** service between Minneapolis and St. Cloud. The extension of service to St. Cloud would be provided within the existing Northstar commuter service framework now provided by BNSF and Metro Transit.

This proposal has been designed to minimize the amount of additional capital investment that would be needed to operate the proposed **Northstar Express** service. It has also considered the description of existing conditions provided by BNSF that may constrain the extension of Northstar service to St. Cloud. These constraints are documented in the Technical Memorandum on Existing Constraints (Appendix A).

By carefully considering the constraints described by BNSF, which directly affect the feasibility and cost of providing a new service and incorporating them into the proposal as part of the Operating Assumptions presented below, this proposal has endeavored to meet the requirements of the railroad, the public agencies and the public stakeholders involved.

2. Description of Proposed Service

The **Northstar Express Alternative** provides two new round-trip non-stop **Northstar Express** trains, one in the morning and one in the afternoon peak period between Minneapolis and St. Cloud. Three existing Northstar commuter trains have minor schedule changes to accommodate the **Northstar Express** service.

On Saturdays and Sundays/holidays, two new round trip **Northstar Express** trains have been scheduled between Minneapolis and St. Cloud, one operating in the morning and the other in the afternoon. These trains are in addition to the existing Northstar commuter service on Saturdays and Sundays/holidays.

The **Northstar Express Service Alternative** has an option for new non-stop midday bus service, designated as the ***Northstar Midday Shuttle Bus.*** The shuttle bus would depart St. Cloud mid-morning and would return to St. Cloud in mid-afternoon.

<u>Northstar Express Service Alternative</u> –

a. **Weekday Morning** Peak Period - One new train operating Express from St. Cloud to Minneapolis; one new train operating Express from Minneapolis to St. Cloud
b. **Weekday Afternoon** Peak Period - One new train operating Express from St. Cloud to Minneapolis; one new train operating Express from Minneapolis to St. Cloud
c. **Saturday and Sunday/Holiday** – two new northbound and two new southbound trains would operate Express between Minneapolis and St. Cloud

3. Operating Assumptions

Operating Assumptions are a critical part of this feasibility assessment. Operating assumptions reflect a variety of factors considered in the operations analysis of the proposed service including:

- Service requests (i.e., frequencies, departure/arrival times) from the public stakeholders (prospective passengers, the communities, etc.);

- Physical limitations of the railroad and its environment;
- Capacity limitations and the operating requirements of the railroad;
- Effects of new service on the existing passenger and freight services operating in the corridor;
- Non-revenue "deadhead" equipment train trips which are needed to position train sets and crews for revenue service and/or enable crews to go on and off duty at appropriate times and locations;
- Effects of new service on the railroad's ability to expand its freight service to meet increased traffic demands in the future;
- Northstar locomotive and passenger car fleet considerations;
- Existing collective bargaining agreements in effect on BNSF affecting railroad train crew members;
- Existing service contract between Metro Transit and BNSF;
- Capital expenditures that would be needed to initiate the extended service;
- Operating and maintenance expenses that would be needed to run the new service;
- Budget limitations affecting the State and municipal agencies;
- Federal Railroad Administration (FRA) regulations and their effects on service planning; and
- The safety and reliability of the proposed extended Northstar commuter service.

The following sub-sections discuss the Operating Assumptions for the **Northstar Express Service Alternative**.

3.1. Train Crews and Equipment

1. FRA regulations affect most aspects of the safety of operation of the BNSF, Amtrak, and Northstar train operations and maintenance. Compliance with applicable FRA regulations has been built into the proposal as a basic requirement and assumption. The FRA Hours of Service regulations limit the length of the train crew workdays and specify the minimum rest period between workdays.

2. The **Northstar Express** trains would be operated as a part of the existing Northstar commuter rail service, a cooperative effort by Metro Transit and BNSF Railway.

3. The **Northstar Express Service Alternative** proposal anticipates that the extended service would require five operational train sets, one more than is currently needed. It is suggested that the additional train set consist of one locomotive, two bi-level passenger coaches and two bi-level cab control passenger cars. The second cab control passenger car is important to provide a replacement should one of the existing cab control cars be damaged or require a period out of service for maintenance or repairs. Additional spare equipment may also be required to augment the two locomotives and two cab control passenger cars now available as spares. This will permit the substitution of equipment as needed for the required inspections and maintenance on a timely basis and will support the dependability of the Northstar commuter service.

4. The additional locomotive(s), passenger cars, and cab control passenger cars that would be added to the Northstar fleet would increase the workload on the forces at the BLMF. Additional employees have been proposed to augment the current Metro Transit staff at the BLMF.

5. The **Northstar Express Service Alternative** anticipates the leasing of surplus equipment of the same types now in use by Northstar from other commuter agencies at favorable pricing. The cost would include rehabilitating, painting (or wrapping) the locomotive(s) and passenger cars to match the appearance and operation of the existing Northstar fleet inside and out as much as possible. Using this alternative is important to maintain the simplified maintenance and parts inventory programs (and employee training and qualification) which are now important operating, maintenance, and budget advantages for Northstar. Leasing surplus equipment from other carriers also avoids the delay and cost involved with a capital procurement until such time as the demand for the new service has been proven by ridership levels. It has been assumed that the installation of the appropriate Positive Train Control apparatus in the additional locomotives and cab control passenger cars would be part of the expense of acquiring the additional rolling stock.

6. BNSF train crews from the existing BNSF crew district base at Northtown Yard would continue to be used to operate the service and would support the train crew requirements of the **Northstar Express Service Alternative:**

   a. Crews would continue to go on and off duty at the same locations they presently use.
   b. No BNSF crews would go on and off duty at St. Cloud.
   c. Train crew work schedules included in the **Northstar Express Service** Alternative are preliminary and primarily for cost estimation purposes. They are subject to revision. When BNSF addresses the actual train crew scheduling for the extended service, the work schedules and the number of additional train crews may be revised, and the estimated costs of the proposed service could change.
   d. BNSF train crews each consist of one engineer and one conductor. These employees are members of a trained and qualified passenger train crew pool based at BNSF's Northtown Yard. The crew members in the passenger pool may also operate freight trains when not being used in passenger service.
   e. Train crew compensation would be in accordance with the BNSF agreements currently in effect for locomotive engineers and conductors.
   f. The Northstar and **Northstar Express** train schedules are conceptual and are subject to revision.
   g. The standard Northstar weekday train consist includes one locomotive, three passenger coaches and one cab control passenger car. The weekend and special event Northstar commuter trains include a second locomotive to ensure service reliability. **Northstar Express** trains would use the same train consists as Northstar commuter trains.

5. The train crew facility at Target Field Station is currently the only location where crews can be relieved from duty during the day for a midday rest break of at least four (compensated) hours before resuming service in the afternoon peak period. Train crews cannot be relieved from duty for a midday break at the BLMF because there are currently no facilities that meet FRA requirements for rest at that location.

6. The proposed train schedules and train crew work assignments may require BNSF to train and qualify additional locomotive engineers and conductors for passenger service at the Northtown Yard crew base.

7. The crew sheets must be reviewed to identify the deadhead commuter train movements and the total crew hours of service that are a part of the **Northstar Express Service Alternative**.

3.2. Stations and Maintenance Facility

1. All Northstar locomotives and passenger cars would continue to be maintained at the Big Lake Maintenance Facility (BLMF). Additional storage and servicing track capacity would be required at the BLMF to accommodate the additional train set. The BLMF is located at 19699 County Road 43, southeast of the existing Big Lake Northstar station.
2. No additional train layover or storage capacity is expected to be needed at Target Field Station or at a nearby location in Minneapolis.
3. The St. Cloud Northstar station is assumed to be located at the existing Amtrak station at 555 East Saint Germain Street in St. Cloud.
4. No overnight train storage capacity is needed at St. Cloud since no Northstar trains lay over at night at St. Cloud. However, a station siding off Main Track 2 at St. Cloud station is assumed as part of **Northstar Express Service Alternative** to enable **Northstar Express** trains to clear the main track during their daytime layovers. On weekends/holidays, one **Northstar Express** train lays over during the midday clear of the main track on the proposed station siding.
5. Additional passenger station facilities are anticipated to be needed at St. Cloud and Big Lake as follows:
    a. At St. Cloud station, a station siding off Main Track 2, signage, platform changes, additional parking facilities and other amenities associated with the extended Northstar commuter service may be needed, and some station upgrading may be required. The station siding will allow **Northstar Express** trains to clear the main track during their layovers. Their layover position would not interfere with the loading/unloading of Amtrak Trains 7 and 8, both of which use a “double spot” procedure to accommodate coach and sleeper passengers while using the St. Cloud platform, which is much shorter than the Amtrak trains. There is an alternative to place a Northstar platform on the east/south leg of the wye at St. Cloud and have Northstar trains use that location for arrivals, changing ends and departures. Doing so would clear Main Track 2 and provide BNSF more operational flexibility. Northstar trains approaching St. Cloud would get an Approach Restricting signal indication which would minimize delays to arriving trains that would clear the main track. The proposed St. Cloud station improvements include the station siding off Main Track 2; the alternative to use the west wye track is not currently being considered as part of the **Northstar Express** alternative.
    b. All Northstar stations would require changes in displayed train schedules and maps.
6. The **Northstar Express Service Alternative** assumes that a satisfactory agreement can be arranged with Amtrak for the shared use of the Amtrak St. Cloud passenger station, waiting room, rest rooms

and parking facilities by the Northstar trains and their passengers, at the hours they will need them.

3.3. General Operations

1. Amtrak's Empire Builder Train Number 8 from the Pacific Northwest is currently scheduled to leave St. Cloud at 5:19 A.M. each day. It operates eastbound (in the peak direction) through the Northstar commuter territory during the morning peak period and, if Amtrak Train 8 is off schedule, it can cause delays to other trains in the corridor including Northstar trains. Amtrak Train 8 is shown for information purposes in the train schedules presented in Sections 0 and 0. The westbound Amtrak Empire Builder Train Number 7 currently departs from St. Paul Union Depot at 10:20 P.M., does not affect Northstar scheduling, and has not been shown in the train schedules.
2. No Northstar commuter trains currently operate during the midday period from about 9:00 A.M. to about 3:00 P.M. The **Northstar Express** Service Alternative between Minneapolis and St. Cloud would not include any trains during the midday period. Observations of the midday maintenance window are:
    a. The midday maintenance window is a critical and short (especially short in the winter) period of daylight when BNSF maintenance forces must conduct most of their maintenance activities.
    b. The replacement of ties, dumping of track ballast, track surfacing, changeout of switches and switch components, and repairs to signal and communications equipment occurs primarily during this midday window.
    c. When one track is out of service for maintenance, all trains in both directions must use the single remaining main track between available control points and past the work areas. This causes extreme congestion and train delays.
    d. Adding new passenger trains during this midday maintenance window would only increase the congestion and train delays. It would also result in passenger dissatisfaction with the Northstar service.
    e. Additional trains would also shorten the maintenance time available, degrade maintenance productivity, and extend the time needed to perform maintenance activities. This would increase the cost of the maintenance work, a portion of which is allocated to the agencies operating the passenger trains. The inability to complete needed maintenance can also contribute to track and signal failures which can delay all trains in the corridor.
3. The **Northstar Express Service Alternative** includes non-revenue ("deadhead") train miles between BLMF and St. Cloud at either the start or end of some of the new **Northstar Express** train trips. The deadhead miles are needed to avoid the capital cost and long lead time required to plan and construct additional maintenance and/or train layover facilities. It is also important to ensure that all Northstar trains are operated by BNSF train crews from the same centrally located Northtown Yard crew base, thereby preserving the reliability of the service and minimizing the train crew costs.

4. To avoid the need for a reverse movement of revenue trains moving between BLMF and St. Cloud, and to enable extended Northstar trains operating between St. Cloud and Minneapolis to stop at the existing Big Lake station, the Big Lake Station track is proposed to be extended to a power-operated turnout, a power-operated universal main track crossover, and the necessary signaling at the north end of the Big Lake station track to enable straight-through movements to access the main tracks.

3.4. Schedule Assumptions

1. The existing Saturday and Sunday/Holiday Northstar commuter train schedules have each been augmented with one new morning round trip and one new afternoon round trip **Northstar Express** train between St. Cloud and Minneapolis. No changes to the existing Northstar weekend commuter train schedules or crew assignments are proposed.
2. The Northstar Midday Shuttle Bus service option would depart St. Cloud at 10:30 A.M. and arrive at Minneapolis at 12:15 P.M. It would return as a non-stop bus in the early afternoon leaving Minneapolis at 2:00 P.M. arriving at St. Cloud at 3:45 P.M. The bus schedules are preliminary and may need to be adjusted depending on the route selected for the service.
3. BNSF and Metro Transit currently operate extra train service for special events throughout the year. The **Northstar Express Service Alternative** operating assumptions do not include requirements for accommodating special events, but special event service can be evaluated separately. The requirements for operating extra train service for special events would be in addition to the requirements shown above.
4. **Northstar Express** trains have been scheduled to operate between existing Northstar commuter trains in the same direction. No "overtakes" are included in this proposal.

3.5. Other Assumptions

1. The electronic train information system requires updating to reflect the new service territory, train schedules, and days of operation. On-train electronic display systems and public information would also require updating to reflect the extended service.
2. The proposal does not include a discussion of any of the opportunities for coordination (or additional coordination) of local transit services at Target Field Station, St. Cloud, or the other Northstar stations.
3. In the schedules shown in Sections 0 and 5, new train numbers are identified by higher numbers so they may be easily recognized. When final schedules are issued, it is likely that the train numbers will be revised to follow in the correct numerical sequences (even numbers for trains to Minneapolis and odd numbered trains from Minneapolis).

4. Weekday Service Train Schedules

Southbound-Weekday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
A-1900	---**b**---	**b**5:00	5:10	5:16	5:21	5:25	5:33	5:52
	5:19	>>Amtrak Empire Builder Train Number 8> St. Cloud> St. Paul U.D.> Chicago>>						
A-1902	---**b**---	**b**5:43	5:53	5:59	6:04	6:09	6:16	6:35
A-1904	---**b**---	**b**6:18	6:28	6:34	6:39	6:43	6:51	7:10
A-1960	**d**6:15	**>>>>>>>>>>>>>>>>>>>> Northstar Express >>>>>>>>>>>>>>>>>>**						7:20
A-1906	---**b**---	**b**6:48	6:58	7:04	7:09	7:13	7:21	7:40
A-1908	---**b**---	**b**7:18	7:28	7:34	7:39	7:43	7:51	8:10
	PM							
A-1962	**d**4:05	**>>>>>>>>>>>>>>>>>>>> Northstar Express >>>>>>>>>>>>>>>>>>**						5:10
A-1910	---**b**---	**b**5:03	5:13	5:19	5:24	5:28	5:36	5:55

Notes:

1. Highlighted times are the revised times of one existing Northstar morning train (A-1902) between Big Lake and Minneapolis, and the times of the two new **Northstar Express** trains (A-1960 and A-1962) operated from St. Cloud to Minneapolis.
2. The symbol "d" indicates train deadheads from BLMF prior to revenue trip.
3. The symbol "b" indicates Northstar Shuttle bus from St. Cloud connects with this train at Big Lake Station.

Northbound-Weekday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1901	6:15	6:29	6:38	6:42	6:47	6:52	7:07**b**	---**b**---
A-1961	6:50	>>>>>>>>>>>>>>>>>>>>> **Northstar Express** >>>>>>>>>>>>>>>>>>						7:55dh
	PM							
A-1903	3:57	4:11	4:20	4:24	4:29	4:34	4:49**b**	---**b**---
A-1905	4:27	4:41	4:50	4:54	4:59	5:04	5:19**b**	---**b**---
A-1907	4:52	5:06	5:15	5:19	5:24	5:29	5:44**b**	---**b**---
A-1963	5:25	>>>>>>>>>>>>>>>>>>>> **Northstar Express** >>>>>>>>>>>>>>>>>>>						6:30**d**
A-1909	5:30	5:44	5:53	5:57	6:02	6:07	6:22**b**	---**b**---
A-1911	6:10	6:24	6:33	6:37	6:42	6:47	7:02**b**	---**b**---

Notes:

1. Highlighted times are the revised times of two existing Northstar afternoon trains (A-1907 and A-1911) between Minneapolis and Big Lake, and the times of two new **Northstar Express** trains (A-1961 and A-1963) operated from Minneapolis to St. Cloud.
2. The symbol "d" indicates train deadheads to BLMF after revenue trip.
3. The symbol "b" indicates Northstar Shuttle bus from St. Cloud connects with this train at Big Lake Station.

Southbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
AM								
BUS	*10:30*	--------------------- ***Northstar Midday Shuttle Bus*** --------------------						*12:15*

BUS indicates times of new non-stop ***Northstar Midday Shuttle Bus*** from St. Cloud to Target Field Station.

Northbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	PM							
BUS	2:00	--------------------- ***Northstar Midday Shuttle Bus*** --------------------						3:45

BUS indicates times of new non-stop ***Northstar Midday Shuttle Bus*** from Target Field Station to St. Cloud.

5. Saturday, Sunday, and Holiday Service Train Schedules

Southbound-Saturday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago >>						
A-1936	**d**8:00	>>>>>>>>>>>>>>>>>> **Northstar Express** >>>>>>>>>>>>>>>>>>>						9:05
A-1930		10:20	10:30	10:36	10:41	10:45	10:53	11:12
	PM							
A-1932		12:50	1:00	1:06	1:11	1:15	1:23	1:42
A-1938	1:40	>>>>>>>>>>>>>>>>>> **Northstar Express** >>>>>>>>>>>>>>>>>>>						2:45
A-1934		5:10	5:20	5:26	5:31	5:35	5:43	6:02

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1936 and A-1938) operated from St. Cloud to Minneapolis.
2. The symbol "d" indicates that train deadheads from BLMF prior to revenue trip.
3. Train A-1938's equipment lays over clear of the main track 10:25 A.M. to 1:40 P.M.

Northbound-Saturday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1937	9:20	>>>>>>>>>>>>>>>>>>> **Northstar Express** >>>>>>>>>>>>>>>>>>						10:25
A-1931	11:30	11:44	11:53	11:57	12:02	12:07	12:22	
	PM							
A-1939	3:00	>>>>>>>>>>>>>>>>>>> **Northstar Express** >>>>>>>>>>>>>>>>>>						4:05d
A-1933	4:00	4:14	4:23	4:27	4:32	4:37	4:52	
A-1935	7:00	7:14	7:23	7:27	7:32	7:37	7:52	

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1937 and A-1939) operated from Minneapolis to St. Cloud.
2. The symbol "d" indicates that train deadheads to BLMF after revenue trip.
3. Train A-1937 has a midday layover at St. Cloud clear of the main track from 10:25 A.M. to 1:40 P.M.

Southbound-Sunday & Holiday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago >>						
A-1946	**d**8:00	**>>>>>>>>>>>>>>>>>>> Northstar Express >>>>>>>>>>>>>>>>>>**						9:05
A-1940		9:30	9:40	9:46	9:51	9:55	10:03	10:22
A-1942		11:50	12:00	12:06	12:11	12:15	12:23	12:42
	PM							
A-1948	1:40	**>>>>>>>>>>>>>>>> Northstar Express >>>>>>>>>>>>>>>>>>>>**						2:45
A-1944		2:40	2:50	2:56	3:01	3:05	3:13	3:32

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1946 and A-1948) operated from St. Cloud to Minneapolis.
2. The symbol "d" indicates that train deadheads from BLMF prior to revenue trip.
3. Train A-1948's equipment lays over clear of the main track 10:25 A.M. to 1:40 P.M.

Northbound- Sunday & Holiday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1947	9:20	**>>>>>>>>>>>>>>>>> Northstar Express >>>>>>>>>>>>>>>>>>>**						10:25
A-1941	10:40	10:54	11:03	11:07	11:12	11:17	11:32	
	PM							
A-1943	1:20	1:34	1:43	1:47	1:52	1:57	2:12	
A-1949	3:00	**>>>>>>>>>>>>>>>> Northstar Express >>>>>>>>>>>>>>>>>>>>**						4:05**d**
	4:55	5:09	5:18	5:22	5:27	5:32	5:47	

Notes:

1. Highlighted times are the times of the two new Northstar commuter trains (A-1947 and A-1949) operated from Minneapolis to St. Cloud.
2. The symbol "d" indicates that train deadheads to BLMF after revenue trip.
3. Train A-1947 has a midday layover at St. Cloud clear of the main track from 10:25 A.M. to 1:40 P.M.

6. BNSF Train Crew Assignments for Weekday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to 'TFS' for ease of description**

Crew 1:

On Duty BLMF	4:15 A.M.	Operates 5:00 A.M. Train A-1900 Big Lake to TFS.
		Operates 6:15 A.M. Train A-1901 TFS to Big Lake.
		Operates 7:18 A.M. Train A-1908 Big Lake to TFS.
Arrive TFS	8:10 A.M.	Secure equipment at TFS.
Off Duty TFS	8:25 A.M.	Rest period at TFS Crew Facility: 8:25 A.M.-4:27 P.M. (8'02").
On Duty TFS	4:27 P.M.	Operates 4:52 P.M. Train A-1907 TFS to Big Lake.
Arrive Big Lake	5:44 P.M.	Secure equipment at BLMF.
Off Duty BLMF	6:14 P.M.	Total Compensated Hours: 13'59". Rest Period: 10'01".

Crew 2:

On Duty BLMF	4:48 A.M.	Operates 5:43 A.M. Train A-1902 Big Lake to TFS.
		Operates 6:50 A.M. **Northstar Express** Train A-1961 TFS to St. Cloud.
		Operates 8:10 A.M. deadhead Train A-1961 St. Cloud to BLMF.
Arrive BLMF	8:40 A.M.	Secure equipment at BLMF.
Off Duty BLMF	9:10 A.M.	Total On-Duty Hours: 4'22". Basic day rule applies. Rest Period: 19'38".

Crew 3:

On Duty BLMF	4:45 A.M.	Operates 5:30 A.M deadhead Train A-1960 BLMF to St. Cloud.
		Operates 6:15 A.M. **Northstar Express** Train A-1960 St. Cloud to TFS.
Arrive TFS	7:20 A.M.	Secure equipment at TFS.
Off Duty TFS	7:35 A.M.	Rest period at TFS crew facility: 7:35 A.M.-3:57 P.M. (8'22").
On Duty TFS	3:57 P.M.	Operates 4:27 P.M. Train A-1905 TFS to Big Lake.
Arrive Big Lake	5:19 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:49 P.M.	Total Compensated Hours: 13'04". Rest Period: 10'56".

Crew 4:

On Duty BLMF	5:33 A.M.	Operates 6:18 A.M. Train A-1904 Big Lake to TFS.
Arrive TFS	7:10 A.M.	Secure equipment at TFS.
Off Duty TFS	7:25 A.M.	Rest period at TFS Crew Facility: 7:25 A.M.-3:27 P.M. (8'02").
On Duty TFS	3:27 P.M.	Operates 3:57 P.M. Train A-1903 TFS to Big Lake.
		Operates 5:03 P.M. Train A-1910 Big Lake to TFS.
		Operates 6:10 P.M. Train A-1911 TFS to Big Lake.
Arrive Big Lake	7:02 P.M.	Secure equipment at BLMF.
Off Duty BLMF	7:32 P.M.	Total Compensated Hours: 13'59". Rest Period: 10'01".

Crew 5:

On Duty BLMF	6:03 A.M.	Operates 6:48 A.M. Train A-1906 Big Lake to TFS.
Arrive TFS	7:40 A.M.	Secure equipment at TFS.
Off Duty TFS	7:55 A.M.	Rest Period at TFS Crew Facility: 7:55 A.M.-5:00 P.M. (9’05”).
On Duty TFS	5:00 P.M.	Operates 5:30 P.M. Train A-1909 TFS to Big Lake.
Arrive Big Lake	6:22 P.M.	Secure equipment at BLMF.
Off Duty BLMF	6:52 P.M.	Total Compensated Hours: 12’49”. Rest Period: 11’11”.

Crew 6:

On Duty BLMF	2:45 P.M.	Operates 3:20 P.M. deadhead Train A-1962 BLMF to St. Cloud.
		Operates 4:05 P.M. **Northstar Express** Train A-1962 St. Cloud to TFS.
		Operates 5:25 P.M. **Northstar Express** Train A-1963 TFS to St. Cloud.
		Operates 6:45 P.M. deadhead Train A-1963 St. Cloud to BLMF.
Arrive BLMF	7:15 P.M.	Secure equipment at BLMF.
Off Duty BLMF	7:45 P.M.	Total On-Duty Hours: 5’00”. Basic day rule applies. Rest Period: 19’00”.

7. BNSF Train Crew Assignments for Saturday, Sunday, and Holiday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to ‘TFS’ for ease of description**

Saturday

Crew 7:

On Duty BLMF	6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1936 to St. Cloud.
		Operates 8:00 A.M. **Northstar Express** Train A-1936 St. Cloud to TFS.
		Operates 9:20 A.M. **Northstar Express** Train A-1937 TFS to St. Cloud.
Arrive St. Cloud	10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1938.)
		Operates 1:40 P.M. **Northstar Express** Train A-1938 St. Cloud to TFS.
		Operates 3:00 P.M. **Northstar Express** Train A-1939 TFS to St. Cloud.
		Operates 4:20 P.M. deadhead Train A-1939 to BLMF.
Arrive BLMF	4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:20 P.M.	Total On-Duty Hours: 10’50”. Rest Period: 13’10”.

Crew 8: Operates Trains A-1930, A-1931, A-1932, A-1933, A-1934 and A1935.

NOTES:
Crew 7 operates the **Northstar Express** weekend service on Saturday and Sunday/Holiday. Crew 7 is in addition to Crew 8 which currently operates existing the Northstar Saturday commuter service and provides for extra board capability.

The Rest Period may vary from the time shown depending on the starting time of the assignment for this crew on the following day.

Sunday/Holiday

<u>**Crew 7:**</u>

On Duty BLMF	6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1946 to St. Cloud.
		Operates 8:00 A.M. **Northstar Express** Train A-1946 St. Cloud to TFS.
		Operates 9:20 A.M. **Northstar Express** Train A-1947 TFS to St. Cloud.
Arrive St. Cloud	10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1948)
		Operates 1:40 P.M. **Northstar Express** Train A-1948 St. Cloud to TFS.
		Operates 3:00 P.M. **Northstar Express** Train A-1949 TFS to St. Cloud.
		Operates 4:20 P.M. deadhead Train A-1949 to BLMF.
Arrive BLMF	4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:20 P.M.	Total On-Duty Hours: <u>10’50”. Rest Period: 13’10”.</u>

<u>**Crew 8:**</u> Operates Trains A-1940, A-1941, A-1942, A-1943, A-1944 and A-1945.

<u>**NOTES:**</u>

Crew 7 operates the **Northstar Express** weekend service on Saturday and Sunday/Holiday. Crew 7 is in addition to Crew 8 which currently operates existing the Northstar Sunday/Holiday commuter service and provides for extra board capability.

The Rest Period may vary from the time shown depending on the start time of the assignment for this crew on the following day.

Northstar Commuter Rail Extension Feasibility Assessment

Appendix E – Technical Memorandum on Operating Assumptions for the Bi-Directional Service Alternative

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

by

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum describes the **Bi-Directional Service Alternative** and presents the preliminary proposed Operating Plan for the extension of Northstar commuter service to St. Cloud. The extended service would be provided within the existing Northstar Commuter service framework now provided by BNSF and Metro Transit. The **Bi-Directional Service Alternative** provides service that enables passengers traveling in either direction to work a full day at destination.

This proposal has been designed to minimize the amount of additional capital investment that would be needed to operate the proposed **Bi-Directional** service. It has also considered the description of existing conditions provided by BNSF that may constrain the extension of Northstar service to St. Cloud. These constraints are documented in the Technical Memorandum on Existing Constraints (Appendix A).

By carefully considering the constraints described by BNSF, which directly affect the feasibility and cost of providing a new service and incorporating them into the proposal as part of the Operating Assumptions presented below, this proposal has endeavored to meet the requirements of the railroad, the public agencies and the public stakeholders involved.

2. Description of Proposed Service

The **Bi-Directional Service Alternative** provides Northstar commuter service from St. Cloud to Minneapolis by starting two existing morning peak period southbound Northstar trains from St. Cloud instead of Big Lake. The first of the two morning trains from St. Cloud operates five minutes earlier than currently scheduled (from Big Lake to Minneapolis) to avoid a conflict with the southbound Amtrak Empire Builder intercity train at St. Cloud. One new morning northbound Northstar commuter train is operated between Minneapolis and St. Cloud.

In the afternoon peak period, two existing northbound Northstar commuter trains have been extended from Big Lake to St. Cloud and two new northbound Northstar commuter trains are operated Minneapolis to St. Cloud. Three new southbound Northstar commuter trains are operated; two between St. Cloud and Minneapolis and one between Big Lake and Minneapolis. One northbound evening train has been rescheduled five minutes earlier to avoid an FRA Hours of Service limitation issue at the end of the crew's workday. The morning schedules require four train sets in service, while the afternoon schedules require five train sets in service.

<u>**Bi-Directional Service Alternative**</u> –

a. **Weekday Morning** Peak Period –
    i. Two existing Northstar trains would be rescheduled to begin in St. Cloud rather than Big Lake
    ii. One new train would operate from Minneapolis to St. Cloud
b. **Weekday Afternoon** Peak Period –
    i. Two trains from St. Cloud to Minneapolis
        1. One new train
        2. One existing train rescheduled to begin in St. Cloud rather than Big Lake
    ii. One new train from Big Lake to Minneapolis
    iii. Four trains from Minneapolis to St. Cloud
        1. Two new trains
        2. Two existing Northstar trains extended to St. Cloud
c. **Saturday and Sunday/Holiday** – two new northbound and two new southbound trains would operate Express between Minneapolis and St. Cloud

On Saturdays and Sundays/holidays, two new round trip **Northstar Express** trains have been scheduled between Minneapolis and St. Cloud, one operating in the morning and one in the afternoon. These trains are in addition to the existing Northstar local train service between Big Lake and Minneapolis on Saturdays and Sundays/holidays.

The **Bi-Directional Service Alternative** has an option for new non-stop midday bus service, designated as the ***Northstar Midday Shuttle Bus.***

3. Operating Assumptions

Operating Assumptions are a critical part of this feasibility. Operating assumptions reflect a variety of factors considered in the operations analysis of the proposed service including:

- Service requests (i.e., frequencies, departure/arrival times) from the public stakeholders (prospective passengers, the communities, etc.);
- Physical limitations of the railroad and its environment;
- Capacity limitations and the operating requirements of the railroad;
- Effects of new service on the existing passenger and freight services operating in the corridor;
- Non-revenue "deadhead" equipment train trips which are needed to position train sets and crews for revenue service and/or enable crews to go on and off duty at appropriate times and locations;
- Effects of new service on the railroad's ability to expand its freight service to meet increased traffic demands in the future;
- Northstar locomotive and passenger car fleet considerations;
- Existing collective bargaining agreements in effect on BNSF affecting railroad train crew members;
- Existing service contract between Metro Transit and BNSF;
- Capital expenditures that would be needed to initiate the extended service;
- Operating and maintenance expenses that would be needed to run the new service;
- Budget limitations affecting the State and municipal agencies;
- Federal Railroad Administration (FRA) regulations and their effects on service planning; and
- The safety and reliability of the proposed extended Northstar commuter service.

The following sub-sections discuss the Operating Assumptions for the **Bi-Directional Service Alternative**.

3.1. Train Crews and Equipment

1. FRA regulations affect most aspects of the safety of operation of the BNSF, Amtrak, and Northstar train operations and maintenance. Compliance with applicable FRA regulations has been built into the proposal as a basic requirement and assumption. The FRA Hours of Service regulations limit the length of the train crew workdays and specify the minimum rest period between workdays.

2. The extended Northstar commuter service to St. Cloud would be operated as a part of the existing Northstar commuter rail service, a cooperative effort by Metro Transit and BNSF Railway.

3. The **Bi-Directional Service Alternative** proposal anticipates that the extended service would require five operational train sets, one more than is currently needed. The morning peak period only requires four train sets in service, but the afternoon peak period requires five train sets in service. It is suggested that the additional train set consist of one locomotive, two bi-level passenger coaches and two bi-level cab control passenger cars. The second cab control passenger car is important to provide a replacement should one of the existing cab control cars be damaged or require a period out of service for maintenance or repairs. Additional spare equipment may also be required to augment the two locomotives and two cab control passenger cars now available as spares. This will permit the substitution of equipment as needed for the required inspections and maintenance on a timely basis and will support the dependability of the Northstar commuter service.

4. The additional locomotive(s), passenger cars, and cab control passenger cars that would be added to the Northstar fleet would increase the workload on the forces at the BLMF. Additional employees have been proposed to augment the current Metro Transit staffing at the BLMF.

5. **Bi-Directional Service Alternative** proposal anticipates the leasing of surplus equipment of the same types now in use by Northstar from other commuter agencies at favorable pricing. The cost would include rehabilitating, painting (or wrapping) the locomotive(s) and passenger cars to match the appearance and operation of the existing Northstar fleet inside and out as much as possible. Using this alternative is important to maintain the simplified maintenance and parts inventory programs (and employee training and qualification) which are now important operating, maintenance, and budget advantages for Northstar. Leasing surplus equipment from other carriers also avoids the delay and cost involved with a capital procurement until such time as the demand for the new service has been proven by ridership levels. It has been assumed that the installation of the appropriate Positive Train Control apparatus in the additional locomotives and cab control passenger cars would be part of the expense of acquiring the additional rolling stock.

6. BNSF train crews from the existing BNSF crew district base at Northtown Yard would continue to be used to operate the service and would support the train crew requirements of the **Bi-Directional Service Alternative:**

    a. Crews would continue to go on and off duty at the same locations they presently use.
    b. No BNSF crews would go on and off duty at St. Cloud.
    c. Train crew work schedules included in this proposal are preliminary and primarily for cost estimating purposes. They are subject to revision. When BNSF addresses the actual train crew scheduling for the extended service, the work schedules and the number of additional train crews may be revised, and the estimated costs of the proposed service could change.
    d. BNSF train crews each consist of one engineer and one conductor. These employees are members of a trained and qualified passenger train crew base at BNSF's Northtown Yard. The crew members in the passenger pool may also operate freight trains when not being used in passenger service.
    e. Train crew compensation would be in accordance with BNSF agreements in effect for locomotive engineers and conductors.
    f. The Northstar train schedules in this preliminary proposal are conceptual and are subject to revision.

g. The standard Northstar weekday train consist currently includes one locomotive, three passenger coaches and one cab control passenger car. The weekend, holiday and special event Northstar commuter trains currently include a second locomotive to ensure service reliability.

5. The train crew facility at Target Field Station in Minneapolis is currently the only location where crews can be relieved from duty during the day for a midday rest break of at least four (compensated) hours before resuming service in the afternoon peak period. Train crews cannot be relieved from duty for a midday break at the BLMF because there are currently no facilities that meet FRA requirements for rest at that location.

6. The proposed train schedules and train crew work assignments may require BNSF to train and qualify additional locomotive engineers and conductors for passenger service at the Northtown Yard crew base.

7. The crew sheets must be reviewed to identify the deadhead commuter train movements and the total crew hours of service that are a part of the **Bi-Directional Service Alternative**.

3.2. Stations and Maintenance Facility

1. All Northstar locomotives and passenger cars would continue to be maintained at the Big Lake Maintenance Facility (BLMF). Additional storage and servicing track capacity would be required at the BLMF to accommodate the additional train set. The BLMF is located at 19699 County Road 43, southeast of the existing Big Lake Northstar station.

2. No additional train layover or storage capacity is expected to be needed at Target Field Station or at a nearby location in Minneapolis.

3. The St. Cloud Northstar station is assumed to be located at the existing Amtrak station at 555 East Saint Germain Street in St. Cloud.

4. No overnight train storage capacity is needed at St. Cloud since no Northstar trains lay over at night at St. Cloud. However, a station siding off Main Track 2 at St. Cloud station is assumed as part of the **Bi-Directional** service to enable Northstar trains to clear the main track during their layovers. On weekends/holidays, one **Northstar Express** train lays over on the proposed station siding during the midday.

5. Additional passenger station facilities are anticipated to be needed at St. Cloud and Big Lake as follows:

    a. At St. Cloud station, a station siding off Main Track 2, signage, platform changes, additional parking facilities and other amenities associated with the Northstar commuter service may be needed, and some station upgrading may be required. The station siding will allow Northstar trains to clear the main track during their layovers. Their layover position would not interfere with loading/unloading of Amtrak Trains 7 and 8, both of which use a "double spot" procedure to accommodate coach and sleeper passengers while using the short St. Cloud platform which is much shorter than the Amtrak trains. There is an alternative to place a Northstar platform on the east/south leg of the wye at St. Cloud and have Northstar trains use that location for arrivals, changing ends and departures. Doing so would clear Main Track 2 and provide BNSF more operational flexibility. Northstar trains approaching St. Cloud would get an Approach Restricting signal indication which would minimize delays to arriving trains that would clear the main track. The proposed St. Cloud station improvements include the station siding off Main Track 2; the alternative to use the west wye track is not currently being considered as part of the **Bi-Directional Service Alternative**.

   b. A new Northstar station at Big Lake with a platform between Main Tracks 1 and 2 is proposed to avoid the need for trains stopping at Big Lake to crossover from one main track to the other.

   c. All Northstar stations would require changes in displayed train schedules and maps.

6. The **Bi-Directional Service Alternative** assumes that a satisfactory agreement can be arranged with Amtrak for the shared use of the Amtrak St. Cloud passenger station, waiting room, rest rooms and parking facilities by the Northstar trains and their passengers, at the hours they will need them.

3.3. General Operations

1. Amtrak's Empire Builder Train Number 8 from the Pacific Northwest is currently scheduled to leave St. Cloud at 5:19 A.M. each day. It operates eastbound (in the peak direction) through the Northstar commuter territory during the morning peak period and, if Amtrak Train 8 is off schedule, it can cause delays to other trains in the corridor including Northstar trains. In the morning peak period, extending inbound Northstar Train A-1902 to operate from St. Cloud results in a potential schedule conflict with Amtrak Empire Builder Train Number 8 at St. Cloud. As a result, Northstar Train A-1902 which now departs Big Lake at 5:48 A.M. will depart St. Cloud at 5:12 A.M. and leave existing Northstar stations five minutes earlier than shown in current schedules (Example: 5:43 A.M. departure from Big Lake instead of the current 5:48 A.M. departure). Amtrak Train 8 is shown for information purposes in the train schedules presented in Sections 4 and 5. The westbound Amtrak Empire Builder Train Number 7 currently departs from St. Paul Union Depot at 10:20 P.M., does not affect Northstar scheduling, and has not been shown in the train schedules.

2. No Northstar commuter trains currently operate during the midday period from about 9:00 A.M. to about 3:00 P.M. The extended weekday service between Minneapolis and St. Cloud in the **Bi-Directional Service Alternative** would not include any trains during the midday period except one deadhead train operating from BLMF to St. Cloud between 2:35 P.M. and 3:05 P.M. Observations of the midday maintenance window are:

   a. The midday maintenance window is a critical and short (especially short in the winter) period of daylight when BNSF maintenance forces must conduct most of their maintenance activities.

   b. The replacement of ties, dumping of track ballast, track surfacing, changeout of switches and switch components, and repairs to signal and communications equipment occurs primarily during this midday window.

c. When one track is out of service for maintenance, all trains in both directions must use the single remaining main track between available control points and past the work areas. This causes extreme congestion and train delays.

d. Adding new passenger trains during this midday maintenance window would only increase the congestion and train delays. It would also result in passenger dissatisfaction with the Northstar service.

e. Additional trains would also shorten the maintenance time available, degrade maintenance productivity, and extend the time needed to perform maintenance activities. This would increase the cost of the maintenance work, a portion of which is allocated to the agencies operating the passenger trains. The inability to complete needed maintenance can also contribute to track and signal failures which can delay all trains in the corridor.

3. The **Bi-Directional Service Alternative** includes non-revenue (“deadhead”) train miles between BLMF and St. Cloud at either the start or end of some of the new and/or extended Northstar commuter train trips. The deadhead miles are needed to avoid the capital cost and long lead time required to plan and construct additional maintenance and/or train layover facilities. It is also important to ensure that all Northstar trains are operated by BNSF train crews from the same centrally located Northtown Yard crew base, thereby preserving the reliability of the service and minimizing the train crew costs.
4. To avoid the need for a reverse movement of revenue trains moving between BLMF and St. Cloud, and to enable extended Northstar trains operating between St. Cloud and Minneapolis to stop at the existing Big Lake station, the Big Lake Station track is proposed to be extended to a power-operated turnout, a power-operated universal main track crossover, and the necessary signaling at the north end of the Big Lake station track to enable straight-through movements to access the main tracks.

3.4. Schedule Assumptions

1. The existing Saturday and Sunday/Holiday Northstar commuter schedules have each been augmented with one new morning round trip and one new afternoon round trip non-stop **Northstar Express** train between St. Cloud and Minneapolis. No changes to the existing Northstar weekend commuter train schedules or crew assignments are proposed.
2. The Northstar Midday Shuttle Bus service option would depart St. Cloud at 10:30 A.M. and arrive at Minneapolis at 12:15 P.M. It would return as a non-stop bus in the early afternoon leaving Minneapolis at 2:00 P.M. arriving at St. Cloud at 3:45 P.M. These bus schedules are preliminary and may need to be adjusted depending on the route selected for the service.
3. BNSF and Metro Transit currently operate extra train service for special events throughout the year. The **Bi-Directional Service Alternative** operating assumptions do not include requirements for accommodating special events, but special event service can be evaluated separately. The requirements for operating extra train service for special events would be in addition to the requirements shown above.

3.5. Other Assumptions

1. The electronic train information system to reflect the new service territory, train schedules, and days of operation.
2. On-train electronic display systems and public information would also require updating to reflect the extended service.
3. The proposal does not include a discussion of any of the opportunities for coordination (or additional coordination) of local transit services at Target Field Station, St. Cloud, or the other Northstar stations.
4. In the schedules shown in Sections 4 and 5, new train numbers are identified by higher numbers so they may be easily recognized. When final schedules are issued, it is likely that the train numbers will be renumbered to follow in the correct numerical sequences (even numbers for trains to Minneapolis and odd numbered trains from Minneapolis).

4. Weekday Service Train Schedules

Southbound-Weekday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
A-1900	**---b---**	**b**5:00	5:10	5:16	5:21	5:25	5:33	5:52
A-1902	**d**5:12	5:43	5:53	5:59	6:04	6:09	6:16	6:35
	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago>>						
A-1904	**---b---**	**b**6:18	6:28	6:34	6:39	6:43	6:51	7:10
A-1906	**d**6:18	6:48	6:58	7:04	7:09	7:13	7:21	7:40
A-1908	**---b---**	**b**7:18	7:28	7:34	7:39	7:43	7:51	8:10
	PM							
A-1912	**d**3:20	3:50	4:00	4:06	4:11	4:15	4:23	4:42
A-1914	**---b---**	**b**4:23	4:33	4:39	4:44	4:48	4:56	5:15
A-1910	**---b---**	**b**5:03	5:13	5:19	5:24	5:28	5:36	5:55
A-1916	7:03	7:33	7:43	7:49	7:54	7:58	8:06	8:25

Notes:

1. Highlighted times are the revised times of one existing Northstar morning train (A-1902) between St. Cloud and Minneapolis, the times of two existing Northstar trains (A-1902 and A-1906) extended from St. Cloud to Minneapolis and the times of three new afternoon Northstar trains (A-1912, A-1916) operated from St. Cloud to Minneapolis and (A-1914) operated from Big Lake to Minneapolis.
2. The symbol "d" indicates train deadheads from BLMF prior to revenue trip.
3. The symbol "b" indicates existing Northstar Shuttle bus from St. Cloud connects with this train at Big Lake Station.

Northbound-Weekday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1901	6:15	6:29	6:38	6:42	6:47	6:52	7:07**b**	---**b**---
A-1913	6:50	7:04	7:13	7:17	7:22	7:27	7:37	8:08**d**
	PM							
A-1915	3:27	3:41	3:50	3:54	3:59	4:04	4:14	4:45**d**
A-1903	3:57	4:11	4:20	4:24	4:29	4:34	4:49**b**	**---b---**
A-1905	4:27	4:41	4:50	4:54	4:59	5:04	5:19**b**	**---b---**
A-1907	4:57	5:11	5:20	5:24	5:29	5:34	5:44	6:15**d**
A-1909	5:30	5:44	5:53	5:57	6:02	6:07	6:17	6:48
A-1911	6:10	6:24	6:33	6:37	6:42	6:47	7:02**b**	**---b---**
A-1917	8:40	8:54	9:03	9:07	9:12	9:17	9:27	9:58**d**

Notes:

1. Highlighted times are the times of three new Northstar trains (A-1913, A-1915 and A-1917) operated Minneapolis to St. Cloud, and two existing Northstar trains (A-1907 and A-1909) extended from Big Lake to St. Cloud.
2. Highlighted times are the times of one existing Northstar train (A-1911) which is operated five minutes earlier than the existing schedule.
3. The symbol "d" indicates train deadheads to BLMF after revenue trip.
4. The symbol "b" indicates existing Northstar Shuttle bus from St. Cloud connects with this train at Big Lake Station.

Southbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
AM								
BUS	*10:30*	***-------------------- Northstar Midday Shuttle Bus --------------------***						*12:15*

BUS indicates times of new non-stop ***Northstar Midday Shuttle Bus*** from St. Cloud to Target Field Station.

Northbound-Weekday Northstar Midday Shuttle Bus Option Schedule

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	PM							
BUS	2:00	***-------------------- Northstar Midday Shuttle Bus --------------------***						3:45

BUS indicates times of new non-stop ***Northstar Midday Shuttle Bus*** from Target Field Station to St. Cloud.

5. Saturday, Sunday, and Holiday Service Train Schedules

Southbound-Saturday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
	5:19	>>Amtrak Empire Builder Train Number 8>St. Cloud>St. Paul U.D.> Chicago >>						
A-1936	**d**8:00	<<<<<<<<<<<<<<<<<<<< **Northstar Express** >>>>>>>>>>>>>>>>>>						9:05
A-1930	------	10:20	10:30	10:36	10:41	10:45	10:53	11:12
	PM							
A-1932	------	12:50	1:00	1:06	1:11	1:15	1:23	1:42
A-1938	1:40	<<<<<<<<<<<<<<<<<<<< **Northstar Express** >>>>>>>>>>>>>>>>>>						2:45
A-1934	------	5:10	5:20	5:26	5:31	5:35	5:43	6:02

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1936 and A-1938) operated from St. Cloud to Minneapolis.
2. The symbol "d" indicates that a deadhead trip from BLMF precedes the scheduled revenue trip.
3. Train A-1938's equipment lays over clear of the main track 10:25 A.M. to 1:40 P.M.

Northbound-Saturday Option Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1937	9:20	<<<<<<<<<<<<<<<<<<< **Northstar Express** >>>>>>>>>>>>>>>>>>>						10:25
A-1931	11:30	11:44	11:53	11:57	12:02	12:07	12:22	------
	PM							
A-1939	3:00	<<<<<<<<<<<<<<<<<<< **Northstar Express** >>>>>>>>>>>>>>>>>>>						4:05**d**
A-1933	4:00	4:14	**4:23**	4:27	4:32	4:37	4:52	------
A-1935	7:00	7:14	7:23	7:27	7:32	7:37	7:52	------

Notes:

1. Highlighted times are the times of the two new **Northstar Express** trains (A-1937 and A-1939) operated from Minneapolis to St. Cloud.
2. The symbol "d" indicates that a deadhead trip to BLMF follows the scheduled revenue trip.
3. Train A-1937 has a midday layover at St. Cloud clear of the main track from 10:25 A.M. to 1:40 P.M.

Southbound-Sunday & Holiday Train Schedules

Northstar Train Number	St. Cloud Amtrak Station	Big Lake Station	Elk River Station	Ramsey Station	Anoka Station	Coon Rapids-Riverdale Station	Fridley Station	Target Field Station
	AM							
	5:19	>>Amtrak Empire Builder Train Number 8> St. Cloud>St. Paul U.D.>Chicago >>						
A-1946	**d**8:00	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						9:05
A-1940	------	9:30	9:40	9:46	9:51	9:55	10:03	10:22
A-1942	------	11:50	12:00	12:06	12:11	12:15	12:23	12:42
	PM							
A-1948	1:40	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						2:45
A-1944	------	2:40	2:50	2:56	3:01	3:05	3:13	3:32

Notes:
1. Highlighted times are the times of the two new **Northstar Express** trains (A-1946 and A-1948) operated from St. Cloud to Minneapolis.
2. The symbol “d” indicates that a deadhead trip from BLMF precedes the scheduled revenue trip.
3. Train A-1948’s equipment lays over clear of the main track 10:25 A.M. to 1:40 P.M.

Northbound- Sunday & Holiday Train Schedules

Northstar Train Number	Target Field Station	Fridley Station	Coon Rapids-Riverdale Station	Anoka Station	Ramsey Station	Elk River Station	Big Lake Station	St. Cloud Amtrak Station
	AM							
A-1947	9:20	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						10:25
A-1941	10:40	10:54	11:03	11:07	11:12	11:17	11:32	------
	PM							
A-1943	1:20	1:34	1:43	1:47	1:52	1:57	2:12	------
A-1949	3:00	**<<<<<<<<<<<<<<<<<<< Northstar Express >>>>>>>>>>>>>>>>>>**						4:05**d**
A-1945	4:55	5:09	5:18	5:22	5:27	5:32	5:47	------

Notes:
1. Highlighted times are the times of the two new Northstar commuter trains (A-1947 and A-1949) operated from Minneapolis to St. Cloud.
2. The symbol “d” indicates that a deadhead trip to BLMF follows the scheduled revenue trip.
3. Train A-1947 has a midday layover at St. Cloud clear of the main track from 10:25 A.M. to 1:40 P.M.

6. BNSF Train Crew Assignments for Weekday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to 'TFS' for ease of description**

Crew 1:

On Duty BLMF	4:15 A.M.	Operates 5:00 A.M. Train A-1900 Big Lake to TFS.
		Operates 6:15 A.M. Train A-1901 TFS to Big Lake.
		Operates 7:18 A.M. Train A-1908 Big Lake to TFS.
Arrive TFS	8:10 A.M.	Secure equipment at TFS.
Off Duty TFS	8:25 A.M.	Rest period at TFS Crew Facility: 8:25 A.M.-2:57 P.M. (6'32").
On Duty TFS	2:57 P.M.	Operates 3:27 P.M. Train A-1915 TFS to St. Cloud.
		Operates 5:00 P.M. deadhead Train A-1915 to BLMF
Arrive Big Lake	5:30 P.M.	Secure equipment at BLMF.
Off Duty BLMF	6:00 P.M.	Total Compensated Hours: 13'45". Rest Period: 10'15".

Crew 2:

On Duty BLMF	3:42 A.M.	Operates 4:27 A.M. deadhead Train A-1902 to St. Cloud
		Operates 5:12 A.M. Train A-1902 St. Cloud to TFS.
		Operates 6:50 A.M. Train A-1913 TFS to St. Cloud.
		Operates 8:23 A.M. deadhead Train A-1913 to BLMF.
		Equipment stands for Crew 5 Train A-1912 in the afternoon.
Arrive BLMF	8:53 A.M.	Secure equipment at BLMF.
Off Duty BLMF	9:03 A.M.	Total On-Duty Hours: 5'21". Basic day rule applies. Rest Period: 18'39".

Crew 3:

On Duty BLMF	5:33 A.M.	Operates Train A-1904 Big Lake to TFS.
Arrive TFS	7:10 A.M.	Secure equipment at TFS.
Off Duty TFS	7:25 A.M.	Rest Period at TFS Crew Facility: 7:25 A.M-2:57 P.M. (7'32")
On Duty TFS	2:57 P.M.	Operates 3:27 P.M. Train A-1903 TFS to Big Lake.
		Operates 5:03 P.M. Train A-1910 Big Lake to TFS.
		Operates 6:10 P.M. Train A-1911 TFS to Big Lake.
Arrive Big Lake	7:02 P.M.	Secure equipment at BLMF.
Off Duty BLMF	7:32 P.M.	Total Compensated Hours: 13'59". Rest Period: 10'01".

Crew 4:

On Duty BLMF	4:48 A.M.	Operates 5:33 A.M. deadhead Train A-1906 to St. Cloud.
		Operates 6:18 A.M. Train A-1906 St. Cloud to TFS.
Arrive TFS	7:40 A.M.	Secure equipment at TFS.
Off Duty TFS	7:55 A.M.	Rest Period at TFS Crew Facility: 7:55 A.M.-3:57 P.M. (8'02").
On Duty TFS	3:57 P.M.	Operates 4:27 P.M. Train A-1905 TFS to Big Lake.
Arrive Big Lake	5:19 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:39 P.M.	Total Compensated Hours: 12'51". Rest Period: 11'09".

Crew 5:

On Duty BLMF	2:20 P.M.	Operates 2:35 P.M. deadhead Train A-1912 to St. Cloud.
		Operates 3:20 P.M. Train A-1912 St. Cloud to TFS.
		Operates 4:57 P.M. Train A-1907 TFS to St. Cloud.
		Operates 6:30 P.M. deadhead Train A-1907 to BLMF.
Arrive BLMF	7:00 P.M.	Secure equipment at BLMF.
Off Duty BLMF	7:30 P.M.	Total On-Duty Hours: 5'10". Basic day rule applies. Rest period: 18'50".

Crew 6:

On Duty BLMF	3:38 P.M.	Operates 4:23 P.M. Train A-1914 Big Lake to TFS. (Uses 5th train set.)
		Operates 5:30 P.M. Train A-1909 TFS to St. Cloud.
		Operates 7:03 P.M. Train A-1916 St. Cloud to TFS.
		Operates 8:40 P.M. Train A-1917 TFS to St. Cloud.
		Operates 10:13 P.M. deadhead Train A-1917 to BLMF.
Arrive BLMF	10:33 P.M.	Secure equipment at BLMF.
Off Duty BLMF	11:03 P.M.	Total On-Duty Hours: 7'25". Basic day rule applies. Rest Period: 16'35".

7. BNSF Train Crew Assignments for Saturday, Sunday, and Holiday Train Schedules

****For Train Crew Assignments, Target Field Station in Minneapolis, MN is shortened to 'TFS' for ease of description**

Saturday

Crew 7:

On Duty BLMF	6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1936 to St. Cloud.
		Operates 8:00 A.M. Northstar Express Train A-1936 St. Cloud to TFS.
		Operates 9:20 A.M. Northstar Express Train A-1937 TFS to St. Cloud.
Arrive St. Cloud	10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1938.)
		Operates 1:40 P.M. Northstar Express Train A-1938 St. Cloud to TFS.
		Operates 3:00 P.M. Northstar Express Train A-1939 TFS to St. Cloud.
		Operates 4:20 P.M. deadhead Train A-1939 to BLMF.
Arrive BLMF	4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:20 P.M.	Total On-Duty Hours: 10'50". Rest Period: 13'10".

Crew 8: Operates Trains A-1930, A-1931, A-1932, A-1933, A-1934 and A1935.

NOTES:
Crew 7 operates the Northstar Express weekend service on Saturday and Sunday/Holiday. Crew 7 is in addition to Crew 8 which currently operates existing the Northstar Saturday commuter service and also provides for extra board capability.

The Rest Period may vary from the time shown depending on the starting time of the assignment for this crew on the following day.

Sunday/Holiday

Crew 7:

On Duty BLMF	6:30 A.M.	Operates 7:15 A.M. deadhead Train A-1946 to St. Cloud.
		Operates 8:00 A.M. Northstar Express Train A-1946 St. Cloud to TFS.
		Operates 9:20 A.M. Northstar Express Train A-1947 TFS to St. Cloud.
Arrive St. Cloud	10:25 A.M.	Clears main track 10:25 A.M. to 1:40 P.M. (Stands for Train A-1948)
		Operates 1:40 P.M. Northstar Express Train A-1948 St. Cloud to TFS.
		Operates 3:00 P.M. Northstar Express Train A-1949 TFS to St. Cloud.
		Operates 4:20 P.M. deadhead Train A-1949 to BLMF.
Arrive BLMF	4:50 P.M.	Secure equipment at BLMF.
Off Duty BLMF	5:20 P.M.	Total On-Duty Hours: 10’50”. Rest Period: 13’10”.

Crew 8: Operates Trains A-1940, A-1941, A-1942, A-1943, A-1944 and A-1945.

NOTES:
Crew 7 operates the Northstar Express weekend service on Saturday and Sunday/Holiday. Crew 7 is in addition to Crew 8 which currently operates existing the Northstar Sunday/Holiday commuter service and also provides for extra board capability.

The Rest Period may vary from the time shown depending on the start time of the assignment for this crew on the following day.

8. Alternative Considered and Removed

A “maximum” Service Alternative was initially considered that proposed extending all existing Northstar trains (5 inbound/one outbound in the morning peak and five outbound/one inbound in the afternoon peak) to St. Cloud. All trains originating in Big Lake would have been rescheduled to originate in St. Cloud and all trains originally ending service in Big Lake would have been extended to St. Cloud. To operate this alternative, eight non-revenue (deadhead) movements were scheduled throughout the morning and afternoon peak periods to ensure that train crews would go on and off duty at Big Lake. This schedule would have used 100% of mainline capacity between Big Lake and St. Cloud in the morning and evening peaks, essentially restricting BNSF from operating freight during these periods or would have required significant capacity improvements to accommodate both passenger and freight traffic. Additionally, the “maximum” train schedules encroached into the BNSF midday maintenance window at the end of the morning peak and before the afternoon peak. For these reasons, the alternative was removed from further analysis and was replaced with the Bi-Directional Service Alternative.

Northstar Commuter Rail Extension Feasibility Assessment

Appendix F – Technical Memorandum on Rail Operations Modeling

August 4, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

By

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

The purpose of this document is to outline the modeling methodology and assumptions that were used to evaluate the proposed extension of Northstar service to St. Cloud, MN. To facilitate this analysis, Rail Traffic Controller™ (RTC) computer modeling software was employed. RTC is North America's industry standard railroad planning software. RTC is unique among planning tools because it contains n-logic problem solving technology, allowing the user to simulate countless railroad operating scenarios. Using RTC, impacts to a railroad network's performance, due to changes in the network's traffic or infrastructure, can be quantified.

2. Development of Base Case RTC Model

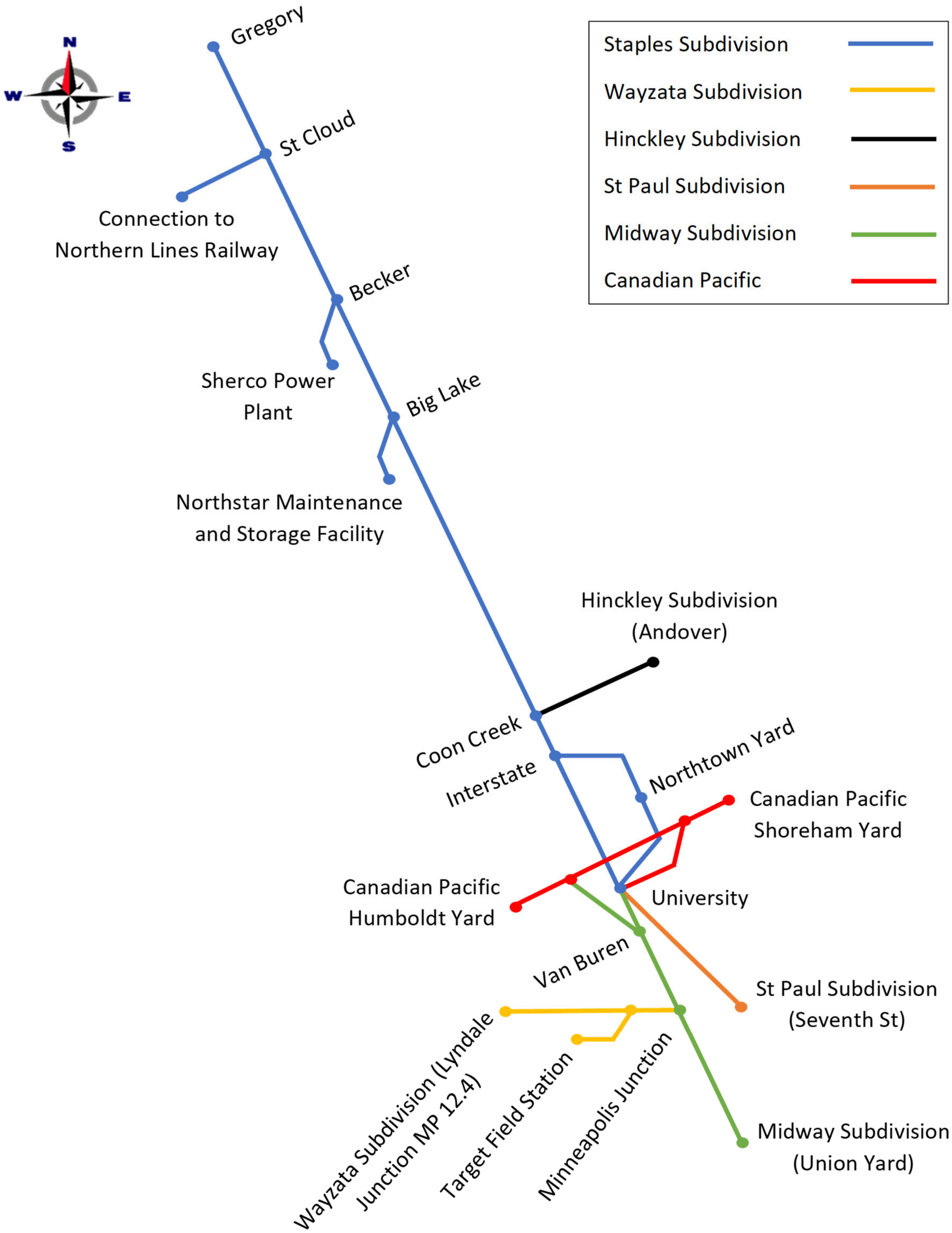
The foundation of this analysis is an RTC model containing the railroad's existing conditions. This RTC model is referred to as the "Base Case" model, which provides a baseline of comparison to operations under 2020 proposed Service Alternative RTC models. In this feasibility assessment, the Base Case model represents 2020 track, signal, and traffic conditions.

2.1. Base Case Network

An RTC network encompasses a railroad's track, signals, and switches and represents the boundary of analysis. Figure 1 depicts the RTC network used to evaluate the extension of Northstar commuter rail service. To achieve meaningful results from the modeling process, the model's network inputs must be as accurate as possible. To ensure the highest level of accuracy, a model provided by BNSF in 2013 was utilized and updated with current track, signals, and switch locations.

The 2020 Base Case RTC network was programmed from Target Field Station (MP 12.5) on the Wayzata Subdivision to Gregory (MP 103.1) on the Staples Subdivision. The network includes the Midway Subdivision, St. Paul Subdivision, Northtown Yard, the junction at Coon Creek, and a connection to the Sherco Coal-Fired Power Plant at Becker (MP 57.2).

Figure 1: RTC Network for Northstar Commuter Rail Service Evaluation



To program the 2020 Base Case, track, signal, and speed limits were gathered from the following files provided by BNSF and input into the 2020 Base Case RTC model:

1. Staples Subdivision Track Chart; 07/30/2019,
2. Midway Subdivision Track Chart; 04/01/2019,
3. Wayzata Subdivision Track Charts; 08/21/2017,
4. Hinckley Subdivision Track Charts; 01/11/2018
5. Twin Cities Division Timetable No. 8; 01/01/2019,
6. System Special Instructions all Subdivisions No. 9; 12/01/2018,
7. Z-Train Transportation Service Plan (TSP) Northtown Dilworth Feb 2020; 02/24/2020

2.1.1. Turnout and Crossover Speeds

To accurately assess trains as they traverse the network, correct speed limits were assigned to the diverging routes of turnouts and crossovers. BNSF publishes each turnout and crossover's speed limits for passenger trains, freight trains over 100 Tons Per Operative Break (TOB), and freight trains under 100 TOB in their timetables. This information was used to program the 2020 Base Case RTC network.

2.1.2. Signals

Movements through much of BNSF's rail network are governed by Centralized Traffic Control (CTC) signals with a Positive Train Control (PTC) overlay. RTC simulates the signal system by defining signal blocks through the network. RTC allows users to program 16 unique signal aspects. Table 1 shows the definition of signal aspects that are programmed into RTC models.

Table 1: Signal Aspects Programmed in RTC

	Signal Imposed Speed Limits (MPH)			
Aspect Name	**Passing**	**Prescribed**	**Target**	**Definition**
Clear	none	none	none	Proceed
Approach Limited	none	none	60	Proceed. Speed passing next signal must not exceed 60 MPH
Advance Approach	none	none	50	Proceed. Speed passing next signal must not exceed 50 MPH
Approach Medium	none	none	40	Proceed. Speed passing next signal must not exceed 40 MPH
Approach Restricting	none	none	15	Proceed. Speed passing next signal at restricted speed
Approach	none	none	40	Proceed. Speed passing next signal must not exceed 40 MPH
Diverging Clear	Turnout Speed	Turnout Speed	Turnou t Speed	Proceed on diverging route not exceeding prescribed speed through turnout
Diverging Approach Diverging	50	50	50	Proceed on diverging route. Speed must not exceed 50 MPH.
Diverging Approach	40	40	40	Proceed on diverging route. Speed must not exceed 40 MPH.
Diverging Approach Medium	35	35	35	Proceed on diverging route. Speed must not exceed 35 MPH.
Restricting	15	15	15	Proceed at restricted speed.
Diverging Lunar	10	10	10	Proceed on diverging route not exceeding 10 MPH through turnout.
Stop and Proceed	0	15	15	Stop before any part of train or engine passes the signal, then proceed at restricted speed.
Stop	0	0	0	Stop before any part of train or engine passes the signal.

Each aspect imposes either a passing, prescribed, or target speed limit. Passing speed limits require trains to operate at, or below, the posted speed limit as the head end of the train passes the signal. Prescribed speed limits instruct the train to begin slowing down to the speed once the head end of the train passes the signal. Target speed limits must be achieved before the head end of the train passes the next signal.

RTC's signal logic is based on a set of trailing aspects which show the cascading sequence of aspects at each signal behind a train as the train proceeds along the railroad. In RTC's logic, and as actually displayed in the field, aspects of signals behind the train ("trailing aspects") become less restrictive as the rear end of the train continues past each signal. The use of trailing aspects enables RTC to accurately simulate the impacts of a train on a railroad's signal system. The trailing aspects prevent a following train from advancing quicker than BNSF's signal system will allow. Table 2 lists the trailing aspects programmed for each signal aspect.

Table 2: Trailing Signal Aspects

Aspect Name	Permissive Trailing Aspect	Absolute Trailing Aspect	Diverging Trailing Aspect
Clear	Clear	Clear	Diverging Clear
Approach Limited	Clear	Clear	Diverging Clear
Advance Approach	Clear	Clear	Diverging Clear
Approach Medium	Clear	Clear	Diverging Clear
Approach Restricting	Clear	Clear	Approach Limited
Approach	Approach Medium	Approach Medium	Diverging Clear
Diverging Clear	Advance Approach	Advance Approach	
Diverging Approach Diverging	Advance Approach	Advance Approach	Diverging Clear
Diverging Approach	Advance Approach	Advance Approach	Diverging Approach Diverging
Diverging Approach Medium	Approach Limited	Approach Limited	Diverging Approach Diverging
Restricting	Approach Restricting	Approach Restricting	Diverging Approach
Diverging Lunar	Advance Approach	Advance Approach	
Stop and Proceed	Approach	Approach	Diverging Approach
Stop	Approach	Approach	Diverging Approach

The trailing signal aspects remained the same throughout all models in this study.

The signal logic described above is the way that RTC software attempts to replicate CTC. The network also contains a PTC system which enforces prescribed safe following distances between trains, penalizes overspeed train movements, and requires compliance with signal, switch, and work zone restrictions. PTC and cab signaling technologies are rapidly improving and advancements in these technologies will increase network capacity in the future. The currently-in-use CTC signal aspects may eventually become obsolete as PTC advances. Because advancements have not yet been fully defined or approved, speed-restricting signal aspects were used in the models.

2.1.2.1. Signal Types and Locations

The railroad's signal locations were provided by BNSF as shown in Table 3 and were verified using track charts, Google Earth imagery, and photos taken during field visits. The 'Name' column indicates whether the signal is a Control Point (CP) or an intermediate location.

Table 3: Location of Signals on BNSF Staples Subdivision

Signal Location Name	BNSF Staples Subdivision Milepost	Signal Location Name	BNSF Staples Subdivision Milepost
University (CP)	11.4 - 11.88	CP 421 (CP)	42.0 - 42.3
35th (CP)	13.6 - 13.8	Intermediate	43.76
44th (CP)	13.7 - 14.0	Intermediate	45.06
Interstate (CP)	15.1 - 15.3	Big Lake Platform (CP)	46.8
16.3 (CP)	16.3	Intermediate	49.5
Intermediate	18.46	Intermediate	50.87
Coon Creek (CP)	20.66 - 21.31	CP 528 (CP)	52.8
Intermediate	23.24	Intermediate	55.2
Coon Rapids Platform (CP)	25.12 - 25.38	***CP 566 Main 2 only***	***56.59***
Anoka Platform (CP)	27.02 - 27.31	Becker (CP)	57.2
Ramsey Platform (CP)	29.17 - 29.42	Intermediate	59.66
CP 321 (CP)	31.06 - 31.42	Intermediate	61.93
Intermediate	33.2	Intermediate	64.01
Intermediate	34.82	MP 66 (CP)	66.1
Elk River Platform (CP)	36.74 - 36.94	Intermediate	68.09
Intermediate	38.46	Intermediate	71.28
Intermediate	40.4	St Cloud (CP)	73.65

BNSF provided a location for proposed CP 566 (shown in red in Table 3) that is proposed to be constructed in the future. Because there is currently no planned construction date, the control point was not included in any of the models.

2.2. Base Case Traffic

An important element of evaluating a railroad's capacity is existing traffic volumes. Traffic volumes for BNSF, Northstar, and Amtrak Empire Builder were programmed for Base Case 2020.

2.2.1. Weekly 2020 Train Counts

As noted in the Section 2.2 introduction paragraph, three types of train traffic operate over BNSF's Staples, Midway, and Wayzata Subdivisions: freight (including BNSF, Canadian Pacific (CPR), and Union Pacific (UP) trains), Northstar commuter rail, and Amtrak intercity passenger rail services. Figure 2 and Figure 3 depict the Northstar and Empire Builder schedules used in the models.

Figure 2: Base Case Northstar Commuter Rail Schedule (February 2020)

Downtown Minneapolis

route number & letter	Target Field Station (7)	Fridley Station (6)	Coon Rapids-Riverdale Station (5)	Anoka Station (4)	Ramsey Station (3)	Elk River Station (2)	Big Lake (1)
AM							
888	6:15	6:29	6:38	6:42	6:47	6:52	7:07
PM							
888	3:57	4:11	4:20	4:24	4:29	4:34	4:49
888	4:27	4:41	4:50	4:54	4:59	5:04	5:19
888	4:57	5:11	5:20	5:24	5:29	5:34	5:49
888	5:30	5:44	5:53	5:57	6:02	6:07	6:22
888	6:15	6:29	6:38	6:42	6:47	6:52	7:07

Downtown Minneapolis

route number & letter	Big Lake Station (1)	Elk River Station (2)	Ramsey Station (3)	Anoka Station (4)	Coon Rapids-Riverdale Station (5)	Fridley Station (6)	Target Field Station (7)
AM							
888	5:00	5:10	5:16	5:21	5:25	5:33	5:52
888	5:48	5:58	6:04	6:09	6:13	6:21	6:40
888	6:18	6:28	6:34	6:39	6:43	6:51	7:10
888	6:48	6:58	7:04	7:09	7:13	7:21	7:40
888	7:18	7:28	7:34	7:39	7:43	7:51	8:10
PM							
888	5:03	5:13	5:19	5:24	5:28	5:36	5:55

Figure 3: Base Case Empire Builder Schedule (April 2018)

7/27		◂ Train Number ▸			8/28
Daily		◂ Normal Days of Operation ▸			Daily
R		◂ On Board Service ▸			R
Read Down	Mile		Symbol		Read Up
10 03P 10 20P	410	Ar Dp	**St. Paul-Minneapolis, MN** Duluth—see page 2 Rochester—see page 2	●	Dp Ar	8 00A 7 43A
12 24A	486		**St. Cloud, MN**	○		5 19A
1 26A	552		**Staples, MN**	○		4 14A

Because BNSF is a private railroad, BNSF's traffic and train type information is not public record. Traffic counts and train types were provided by BNSF as a representation of the traffic typically operating along the Subdivisions. Table 4 describes the train types and quantity that typically operate over the network in a one-week period in existing conditions.

Table 4: Network Train Traffic in 2020

Train Type	Weekly Train Count in 2020
A-Amtrak (Empire Builder)	14
A-Commuter (NorthStar)	72
B-Bare Table Intermodal	6
C-Coal Loads	34
D-Light Engines	2
E-Empty Unit Coal	32
F-Foreign RR Detour (CPR & UP)	46
G-Grain Loads	20
H-Hi Priority Merchandise	44
L-Local	21
M-Merchandise	4
Q-Guaranteed Intermodal	32
S-Stack Train	39
U-Unit ex Coal/Grain	91
V-Vehicle / Parts	43
X-Empty Grain	16
Z-Trains	37

2.2.2. Origin-Destination

The origin and destination points of freight trains are defined in the RTC network to simulate traffic patterns. Figure 4 presents the network's entry/exit points.

Figure 4: Origin and Destination Points in the Network

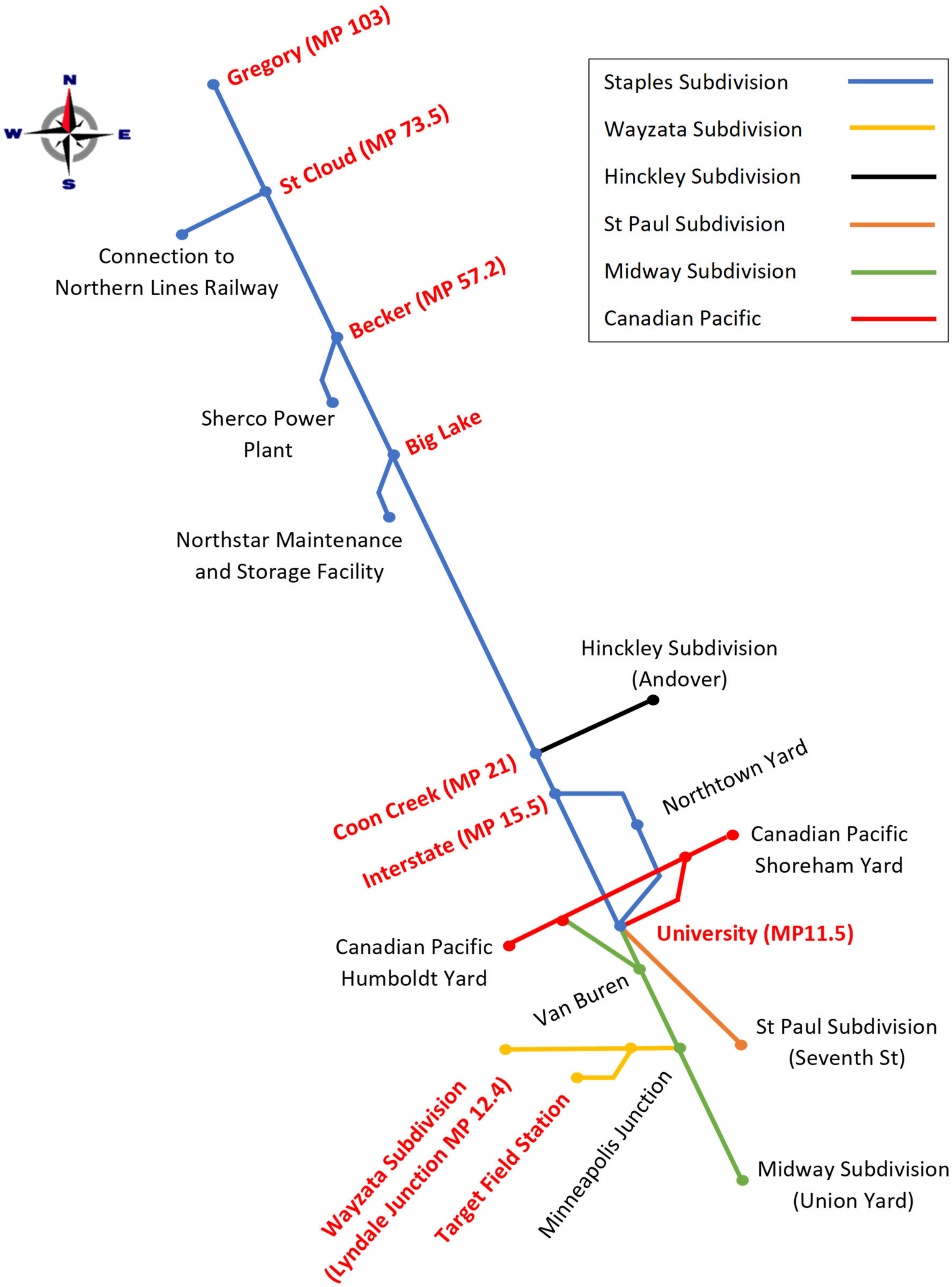


Table 5 lists the number of freight trains operating per week in 2020 by their origin and destination pair.

Table 5: Freight Volumes by Origin and Destination Pair in 2020

Origin-Destination Pair (Subdivision)	Trains per Week (2020)
Gregory - Becker (Staples)	42
Andover (Hinckley) - Northtown Yard (Staples)	2
Andover (Hinckley) - University (Staples)	90
Andover (Hinckley) - Lyndale Junction (Wayzata)	11
Gregory - Northtown Yard (Staples)	44
University - Northtown Yard (Staples)	29
University – CPR Shoreham Yard (CPR Paynesville Sub)	34
Gregory - University (Staples)	186
Gregory (Staples) – Lyndale Junction (Wayzata)	8
Lyndale Junction (Wayzata) – University (Staples)	7

*Local and Passenger trains not included

In addition to the trains listed in Table 5 there are local trains that operate from Northtown and St. Cloud Yards. These trains start and end in the same location (i.e., a train departing from Northtown Yard returns to Northtown Yard). Seven trains per week operate between St. Cloud Yard and Little Falls, MN, seven per week operate between St. Cloud Yard and Northtown Yard, and seven per week operate between Northtown Yard and Hinckley, MN. These local trains were programmed into the RTC models.

2.3. Base Case Train Operations

To achieve a simulated railroad network that closely replicated real-world operations, BNSF's existing operations were reviewed in detail and in coordination with BNSF. Operating and dispatching practices at complex locations in the corridor were refined to more closely match what occurs in the field. Discussions of these issues follow.

2.3.1. Operating and Dispatching Practices

After discussions with BNSF on how trains are dispatched on the Staples Subdivision, the following was programmed into the Base Case:

- Fuel optimizers were added to freight trains (excluding Z-Trains) to limit acceleration to throttle position 5 above 50 MPH
- Freight train minimum stop times were set to five minutes to ensure that freight trains would not operate closer together than BNSF dispatchers allow

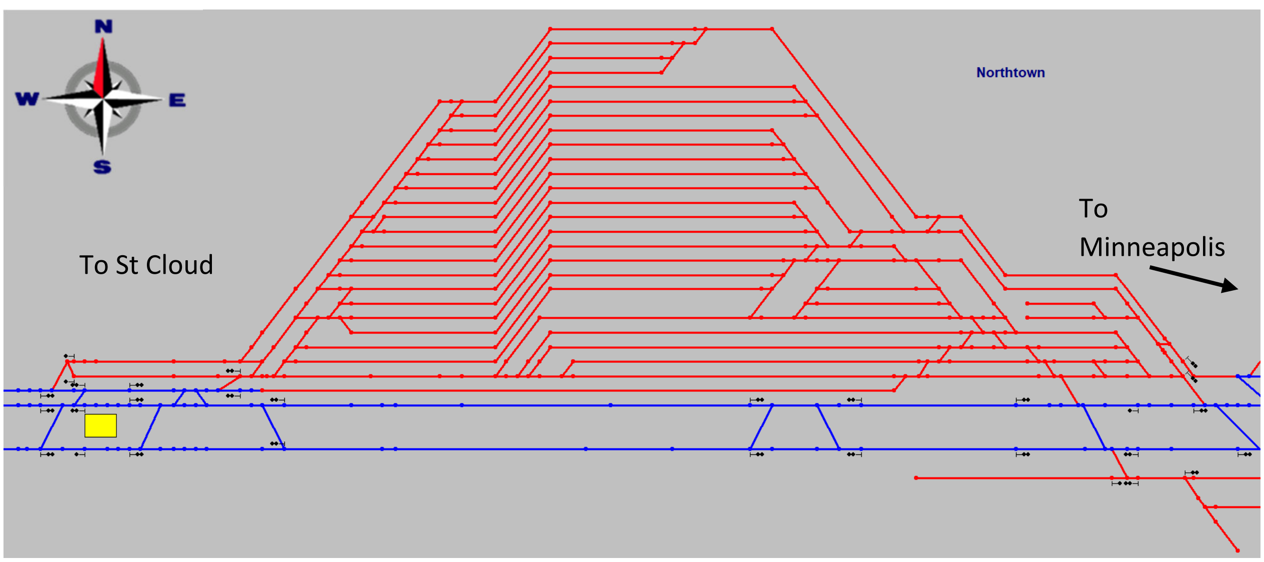
Fuel optimizers limit train acceleration to minimize locomotive fuel consumption and emissions. This has the effect of slowing the train's speed compared to operation at a train's maximum throttle position. The minimum stop time was added to represent the actual time it takes a freight train to restart after it stops. In some cases, the stop may need to be longer to enable trains to properly recharge their air brake system before proceeding. In several instances, freight trains were not permitted to proceed from a stop or waiting point if doing so might have delayed a following passenger train.

2.3.2. Northtown Yard

As discussed in the Technical Memorandum on Existing Constraints (Appendix A), Northtown Yard is located along the Staples Subdivision between railroad control points at University (MP 11.5) and Interstate (MP 15.5). The Yard serves as an origination and termination point for trains moving to and from other major yards on BNSF's network in addition to serving as the origin and terminus of local freight trains and switch runs that service local industries. Northtown Yard also serves as a through-train crew change point and a maintenance point for BNSF locomotives.

A significant number of trains stop and dwell on the main tracks adjacent to Northtown Yard to change crews (see Appendix A for detail). As trains continue to enter, exit, and layover in the Yard, it's entry and exit points become congested, causing a domino effect on the network that results in mainline train delays. The RTC model that BNSF provided in 2013 was pre-programmed with Northtown Yard. For the purposes of this feasibility assessment, it is assumed that the operations were modeled accurately. BNSF confirmed that the Yard is a source of congestion, but no reconfiguration or expansion of the Yard is possible due to its urban location. Figure 5 shows an image of Northtown Yard as it appears in RTC.

Figure 5: RTC Image of Northtown Yard



In addition to congestion within Northtown Yard, BNSF also conducts crew changes on the mainlines paralleling Northtown Yard as described above. Accurately representing these functions in all RTC models is critical to achieving meaningful results.

2.3.3. Passenger Equipment Layover and Storage

Northstar is operated as a commuter rail service with demand southbound to Minneapolis in the morning peak and northbound to the city's suburbs in the afternoon peak. This type of service requires that Northstar trains layover during the midday at Target Field Station in Minneapolis and overnight on storage tracks at the Big Lake Maintenance Facility. To ensure that there would be enough storage tracks available to accommodate the number of trains laying over as proposed in the Service Alternatives, trains were linked in the model. In RTC, trains disappear from the network after completing their programmed trip, making it difficult to assess if there is enough storage capacity. When trains are linked, they do not disappear from the network after finishing their trip; instead they change train numbers to become that trainset's next scheduled trip. By linking the trains, the capacity of Northstar's storage tracks can be assessed.

2.3.4. Operations at Passenger Stations

Northstar serves seven stations along its route between Minneapolis and Big Lake: Target Field, Fridley, Coon Rapids-Riverdale, Anoka, Ramsey, Elk River, and Big Lake. In the RTC models, Northstar trains were programmed to operate on the track corresponding to the platform that passengers use to board and alight their trains. Typical operations at each station are as follows:

- **Target Field** – Passengers board on both sides of the center platform.
- **Fridley** – Because the station platform is located on the west side of the mainlines, existing Northstar trains use the west track (Track 2) to load and unload passengers.
- **Coon Rapids – Riverdale, Anoka, Ramsey, Elk River** – These stations have platforms on the west and east sides of the main tracks that are connected by an overhead pedestrian bridge. Big Lake-bound trains only use the east track (Track 1) and Target Field-bound trains only use the west track (Track 2).
- **Big Lake** – The platform at Big Lake Station is located on a stub track west of the main tracks and all existing trains use the stub track.

3. Development of Proposed Case RTC Models

3.1. Proposed Case Traffic

This feasibility assessment examines the impacts of extending Northstar's passenger train service to serve St. Cloud. The Federal Railroad Administration (FRA) recommends that during the planning of a proposed passenger train service, a study should be conducted to measure the current and future capacity needs of the operation. FRA suggests that passenger and freight train operations be evaluated over a 20-year period to ensure that the services sharing track can coexist without degrading each other's operations. To accomplish this, 2020 freight volumes were projected to 2040 and schedules for extended Northstar service to St. Cloud were developed.

3.1.1. 2040 Freight Traffic

Freight traffic levels were estimated for 2040 using a growth rate of 2% per year compounded, as recommended by FRA in their *"Railroad Corridor Transportation Plans; a Guidance Manual"*. [1] The FRA

[1] https://railroads.dot.gov/elibrary/railroad-corridor-transportation-plans-guidance-manual

guidance manual does not specifically state whether the existing train count, tonnage, or number of rail cars should be increased by 2% per year compounded to determine 2040 traffic levels. BNSF requested that the number of rail cars be increased and that certain types of traffic should be treated differently (i.e., coal train traffic is expected to remain constant whereas grain train traffic fluctuates depending on U.S. trade agreements). For the Northstar Commuter Rail Extension Feasibility Assessment, each train type was designated to either grow or remain constant over the 20-year horizon period, and maximum train lengths were identified for each train type. Table 6 lists the growth assumptions for freight trains by train type.

Table 6: Freight Growth Assumptions by Train Type

Train Type	Maximum Train Length or Number of Cars in 2040	Notes
B-Bare Table Intermodal	75 cars	Length of Trains and Quantity of Trains Expected to Increase
C-Coal Loads		No Increase in Quantity or Length Expected
D-Light Engines		Quantity of Engines Expected to Increase
E-Empty Unit Coal	230 cars	Number of Trailing Cars can grow to over 10,000 feet
F-Foreign RR Detour	130 cars	Length of Trains and Quantity of Trains Expected to Increase
G-Grain Loads	111 cars	Length of Trains and Quantity of Trains Expected to Increase
H-High Priority Merchandise	107 cars	Length and Quantity of Trains Expected to Increase
L-Local Trains		No Increase in Quantity or Length Expected
M-Merchandise	94 cars	Length and Quantity of Trains Expected to Increase
Q-Guaranteed Intermodal	73 cars	Length and Quantity of Trains Expected to Increase
S-Stack Train	83 cars	Length and Quantity of Trains Expected to Increase
U-Unit Excluding Coal/Grain	161 cars (over 10,000 feet)	Length and Quantity of Trains Expected to Increase
V-Vehicle / Parts	145 cars (over 10,000 feet)	Length and Quantity of Trains Expected to Increase
X-Empty Grain	161 cars (over 10,000 feet)	Length and Quantity of Trains Expected to Increase
Z-UPS/Guaranteed Intermodal	74 cars	Length and Quantity of Trains Expected to Increase

The network's existing number of train cars changes as the freight trains pick up and set out cars. To provide a fair estimate of the number of cars in 2040, each train's highest car count was used in the train car inflation calculations.

During a discussion of traffic growth in the kickoff meeting, BNSF stated that their trains could grow to a maximum of 10,000 feet with a 0.8-0.9 HP/ton power-to-weight ratio for loaded trains; lighter consists (empty cars) could grow longer. Generally, the maximum length of a train is limited by the network's infrastructure. For trains to fit into the yards and sidings along their routes and not block critical interlockings or grade crossings, some trains are limited to lengths less than 10,000 feet. During follow-up discussions, BNSF requested that the models consider trains longer than 10,000 feet. This simulates the growing trend of railroads increasing the length of trains to reduce the number of freight trips operating in the network. BNSF noted that longer trains are typically comprised of lighter loads and empty cars.

To determine the number of trains and their lengths in 2040, the number of train cars was increased by 2% compounded per year until the trains reached their maximum length. After the freight trains reached the maximum length, additional trains were added to the network to facilitate the remaining cars. To maintain BNSF's stated power-to-weight ratio, additional locomotives were added to trains as needed.

Using the methodology described above, it was determined that the 2040 traffic would include 48 more freight trains per week than in 2020. Table 7 presents the network traffic by train type over a week of typical operations in 2040.

Table 7: Network Train Traffic in 2040

Train Type	Weekly Train Count in 2040
A-Amtrak (Empire Builder)	14
A-Commuter (Northstar)	Varies by Service Alternative
B-Bare Table Intermodal	8
C-Coal Loads	34
D-Light Engines	3
E-Empty Unit Coal	30
F-Foreign RR Detour	49
G-Grain Loads	26
H-Hi Priority Merchandise	48
L-Local	21
M-Merchandise	5
Q-Guaranteed Intermodal	40
S-Stack Train	47
U-Unit ex Coal/Grain	96
V-Vehicle / Parts	51
X-Empty Grain	17
Z-Trains	40

Table 8 lists the number of freight trains operating between each Origin and Destination pair in 2040.

Table 8: Freight Volumes by Origin and Destination Pair in 2040

Origin and Destination Pairs (Subdivision)	Trains per Week (2040)
Gregory - Becker (Staples)	40
Andover (Hinckley) - Northtown Yard (Staples)	2
Andover (Hinckley) - University (Staples)	94
Andover (Hinckley) - Lyndale Junction (Wayzata)	11
Gregory - Northtown Yard (Staples)	49
University - Northtown Yard (Staples)	27
University (Staples) – CPR Shoreham Yard (CPR Paynesville Sub)	23
Gregory - University (Staples)	224
Gregory (Staples) – Lyndale Junction (Wayzata)	10
Lyndale Junction (Wayzata) – University (Staples)	8

*Local and Passenger trains not included

3.1.2. 2040 Northstar Traffic

Schedules for four Northstar Service Alternatives were defined as part of the feasibility assessment. The schedules are presented in each of the Technical Memoranda on Operating Assumptions (Appendices B, C, D, and E).

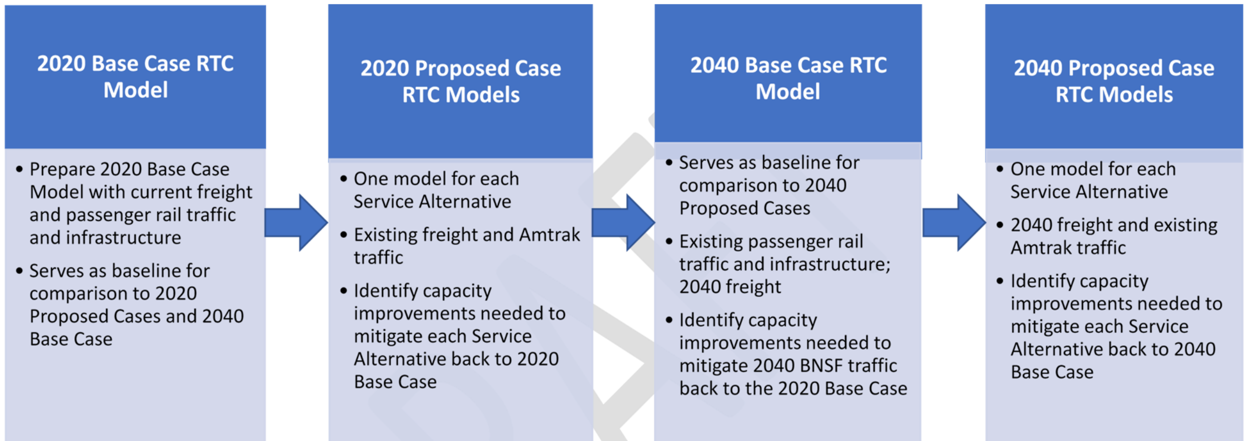
3.1.3. 2040 Amtrak Traffic

The 2040 Empire Builder schedule was assumed to be the same as in the 2020 Base Case.

4. RTC Methodology

A four-part analysis was used to evaluate the impacts of the proposed Northstar Service Alternatives on existing and future BNSF traffic. Using RTC, any significant impact caused by the service expansion was measured and mitigated. Through this process the infrastructure needed to implement the proposed Service Alternatives was identified. Figure 6 presents the methodology.

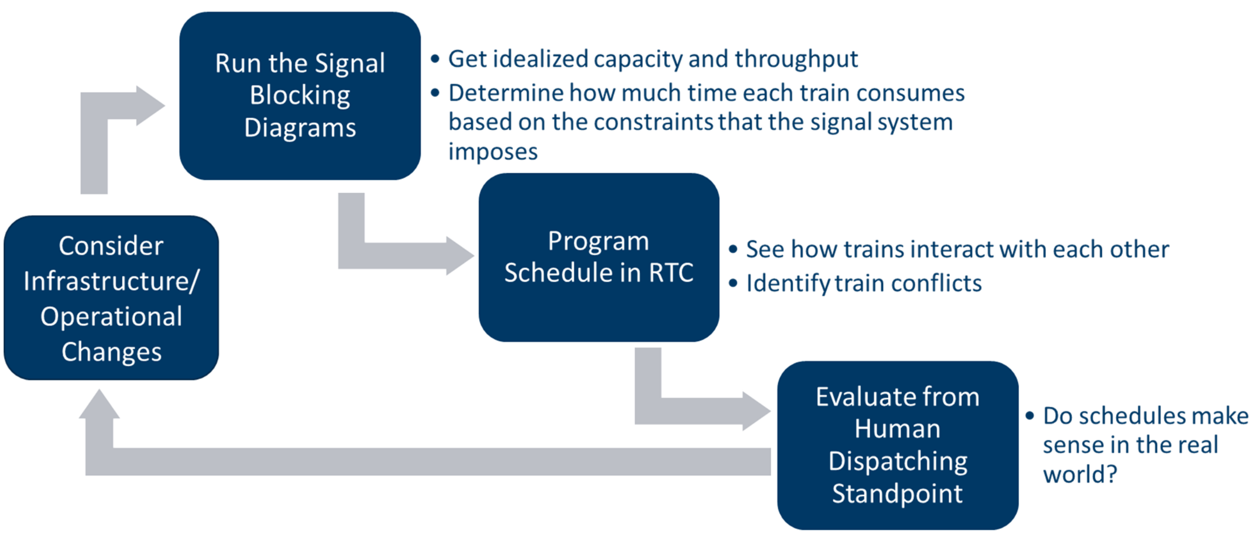
Figure 6: RTC Methodology Diagram



4.1. Signal Blocking Diagrams

Before fully developing the RTC models shown in Figure 6, the capacity of the network was analyzed using a software application that was refined for this Feasibility Assessment. A train's speed, length, and stopping distance, along with physical attributes of the area being traversed and the design of the signal system, were input into the application to produce Signal Blocking Diagrams (SBDs). The SBD charts a train's track occupancy throughout its trip. This information was used to determine the maximum number of trains that could traverse a segment of track in a given time period. The schedule of each Service Alternative was then simulated in RTC to confirm the SBD analysis. The results of the SBD were further vetted by BNSF operations experts. Figure 7 illustrates the process used for evaluating network capacity using SBDs.

Figure 7: Signal Blocking Diagram Analysis Process



SBDs for each of the proposed Service Alternatives are in Attachment 1.

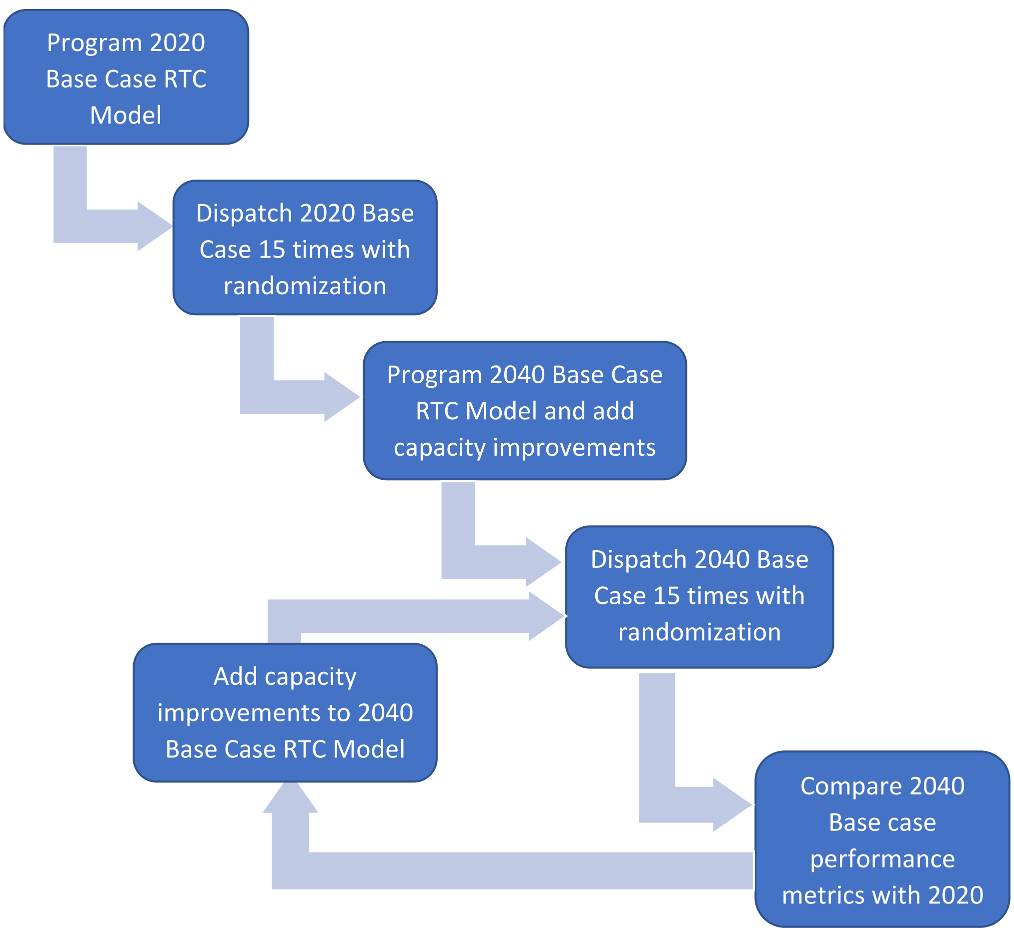
4.2. Evaluations and Metrics

RTC models were prepared for the following cases:

1. Base Case 2020
2. Base Case 2040
3. Proposed Case 2020
    a. Minimum Service Alternative
    b. Minimum Bi-Directional Service Alternative
    c. Northstar Express Service Alternative
    d. Bi-Directional Service Alternative
4. Proposed Case 2040
    a. Minimum Service Alternative
    b. Minimum Bi-Directional Service Alternative
    c. Northstar Express Service Alternative
    d. Bi-Directional Service Alternative

Figure 8 depicts the evaluation methodology used to compare two cases: the 2040 Base Case vs. the 2020 Base Case.

Figure 8: 2040 Base Case Evaluation Methodology



The process illustrated in Figure 8 was completed to compare all other cases. Table 9 shows the pairs of Proposed RTC cases and Base Cases that were compared.

Table 9: RTC Cases for Comparison

RTC Case	Compared to 2020 Base Case	Compared to 2040 Base Case
2020 Minimum Service Alternative	✔	
2020 Minimum Bi-Directional Service Alternative	✔	
2020 Northstar Express Service Alternative	✔	
2020 Bi-Directional Service Alternative	✔	
2040 Base Case	✔	
2040 Minimum Service Alternative		✔
2040 Minimum Bi-Directional Service Alternative		✔
2040 Northstar Express Service Alternative		✔
2040 Bi-Directional Service Alternative		✔

Cases were compared with one another using RTC software outputs. Details of how the models were dispatched, how the data was collected, and how the RTC performance metrics were used are shown in the sections below.

4.2.1. Dispatching

RTC allows users to adjust dispatch logic parameters to emulate the procedures that a railroad dispatcher would use in the real world. Options under RTC's 'Operating Objectives' menus were adjusted until the dispatch results were similar to what was observed in the field. Additional detail on RTC dispatch settings is included in Attachment 2.

All RTC models were dispatched 15 times, collecting 15 data points for evaluation. Results were evaluated using a statistical t-Test. A t-Test is commonly used in statistics to compare two data sets. The t-Test evaluates whether the variation between the data sets represents a significant or non-significant difference in performance. The t-Test provides an understanding of how changes to the model's network or traffic impact train performance metrics.

To better interpret the results of the RTC data, a two tailed t-Test was conducted to compare the Proposed Case and Base Case data. The t-Test process is as follows:

- To conduct the t-Test, each sample's mean (m) and standard deviation (σ) were found.

  m = average (m1, m2, m3….)

$$\sigma = \sqrt{\frac{(m1-m)^2+(m2-m)^2+(m3-m)^2+\cdots\ldots\ldots}{n}}$$ where n = sample size

- Next, the t-value for the data sets was calculated using the formula below (Stone & Ellis, 2016):

$$t = \frac{(m - m')}{\sqrt{\frac{s^2}{n} + \frac{s'^2}{n'}}}$$

  Where m, m' are the means of each data set, n and n' are sample's sizes, and s and s' are the standard deviations.

- A typical t-value was obtained using the standard t-table value for the degree of freedom (DF) = n-1 and based on the level of significance (α) which determined the accuracy of test. The t-value obtained from the data sets was then compared with the standard t-value obtained from the table. If the t-value were less than the t-table value, the two data sets were deemed equal. If the t-value from the data sets were greater than the t-table value, than one data set was deemed to be greater or less than the other.

4.2.2. Randomization

In RTC, trains are programmed to operate at scheduled times. In real-world operations, scheduled freight trains often vary from scheduled departure times, while other types of freight trains operate only when needed. To account for this variability, the time that trains are scheduled to enter the network is programmed with "randomization". Randomization defines a window of time that a train can enter the network, bounded by early and late parameters. Table 10 displays the randomization programmed into the network by train type.

Table 10: BNSF Staples Subdivision Train Traffic Randomization Settings

Train Type	Amount of Time Trains Can Enter Network Before Scheduled Time (hh:mm)	Amount of Time Trains Can Enter Network After Scheduled Time (hh:mm)
A-Amtrak (Empire Builder)	00:00	00:00
A-Commuter (NorthStar)	00:00	00:00
B-Bare Table Intermodal	03:00	03:00
C-Coal Loads	00:30	01:30
D-Light Engines	20:00	20:00
E-Empty Unit Coal	00:30	01:30
F-Foreign RR Detour	03:00	03:00
G-Grain Loads	00:30	01:30
H-Hi Priority Merchandise	00:30	01:30
L-Local	00:30	01:30
M-Merchandise	00:30	01:30
Q-Guaranteed Intermodal	00:00	00:30
S-Stack Train	00:00	00:30
U-Unit ex Coal/Grain	03:00	03:00
V-Vehicle / Parts	00:00	00:30
X-Empty Grain	00:30	01:30
Z-Trains	00:00	00:30

4.2.3. Performance Metrics

RTC outputs nine files detailing a model's set of dispatches. The Summary file is the primary source of results for train performance by type and group. Data contained in the summary files are used for comparing Proposed and Base Cases.

Two RTC performance metrics were used for comparing RTC cases: 1) Average True Delay Minutes per 100 Train Miles (TM), which measures the additional time a train takes to traverse its route over the train's ideal run time, and 2) Average Elapsed Time per train (minutes), which measures the average time it takes a group of trains to traverse the network.

To compare the 2040 Base Case with the 2020 Base Case, the True Delay Minutes per 100 TM metric was used. Because BNSF train counts and train lengths are different in the two cases, the Average Elapsed Time metric was not used. The Average Elapsed Time metric is not recommended for the following reasons:

1. Average Elapsed Time is calculated in RTC from the time the head of a train enters the network to the time the train's rear end exits the network, making trip time directly related to a train's length. This relationship means that, without increasing the speed limit, trains with increased length will always take longer to complete the same route as a shorter train.
2. Lengthening a train changes its power-to-weight ratio, impacting the train's acceleration and deceleration. This impacts a train's elapsed time independent of other changes to the network.

To compare the 2020 and 2040 Proposed Cases with the 2020 and 2040 Base Cases, respectively, the Average Elapsed Time metric is used.

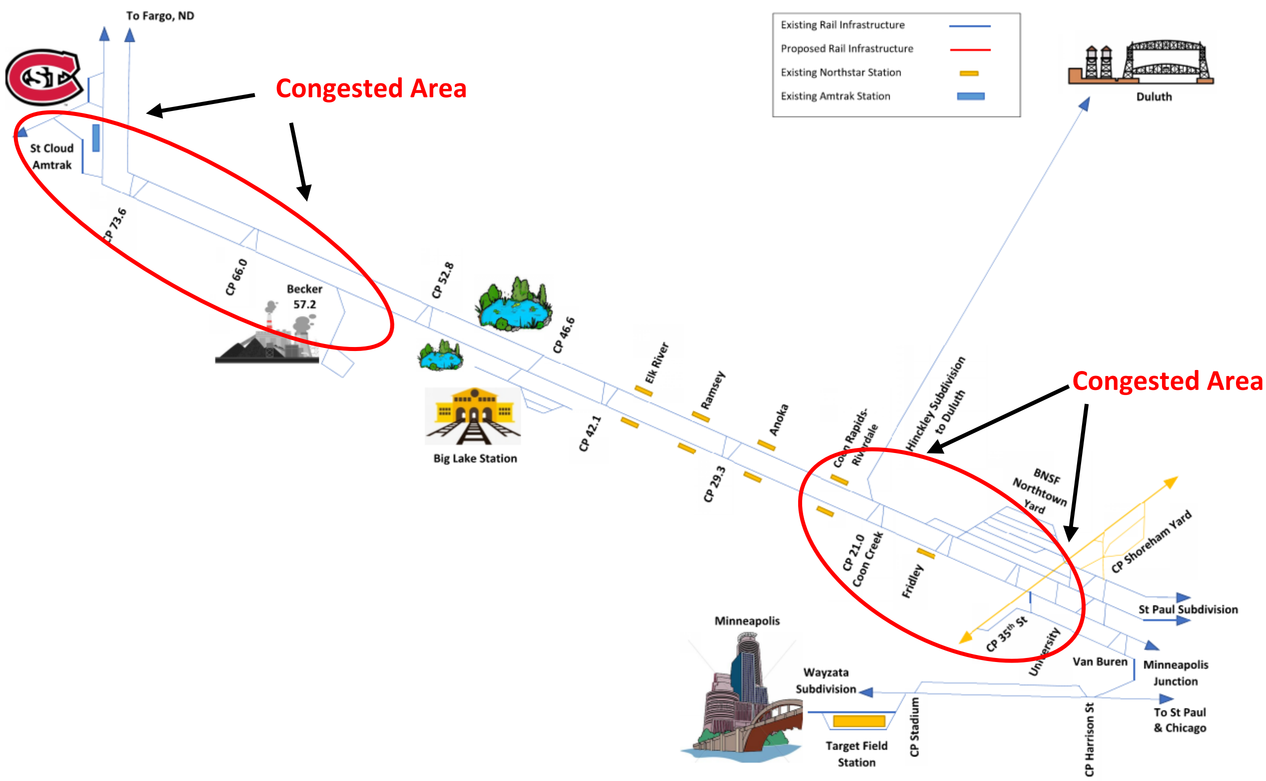
5. Evaluation of Network Capacity

Operation of the Base Case 2020 model, discussed in Section 2, was observed in RTC and "hot spots" of congestion were identified. Similarly, operations were observed for each of the Service Alternatives and 2040 freight traffic. The sections below highlight observations of existing network constraints and the constraints due to increased freight traffic and extended Northstar service.

5.1. 2020 Base Case Network Capacity

Figure 9 presents a graphic of the 2020 network between Minneapolis and St. Cloud with important features and areas of congestion.

Figure 9: 2020 Base Case Network Capacity



Along Northstar's route, trains operate on a single main track between CP Stadium and CP Interstate. Between CP Interstate and St. Cloud, trains operate on a two-track mainline. Within the 2020 Base Case, major points of constraint include:

- Northtown Yard – trains stop to change crews on the main tracks or enter and leave the yard at either end (CP Interstate on the west end and CP University on the east end). Some trains cross several main tracks to enter or leave the yard.
- Becker – loaded and empty unit coal trains arrive at and leave the Sherco power plant. Train crews must stop and operate track switches by hand.
- Minneapolis Junction to CP University – trains of several railroads arrive and depart via several routes in different directions at slow speeds with conflicting routes causing congestion.
- CP 21 at Coon Creek – trains moving via the Hinckley Subdivision (to and from Superior and Duluth) enter or leave the Staples Subdivision where trains to and from Northtown Yard are also changing main tracks.

The Base Case constrained locations are discussed further below.

5.1.1. Northtown Yard

Constraints at Northtown Yard are discussed in Section 2.3.2.

5.1.2. Becker

Operations near Becker (MP 57.2) are complex due to the location of the coal-fired power plant in the area. Trains entering and leaving the power plant at Becker can only operate on Track 2 (west track) between Becker and the next closest control point, CP MP 66 (9 miles west). In addition, two local trains per day stop on Track 1 (east track) at Becker to set off and pick up cars. Because there is no control point or crossovers between Tracks 1 and 2 at Becker, there is limited operating flexibility to pass stopped trains on Tracks 1 or 2.

5.1.3. Minneapolis Junction to CP University

Trains to and from the BNSF Wayzata, Midway, St. Paul, and Staples Subdivisions as well as Union Pacific, Canadian Pacific and short line freight trains, Amtrak intercity trains, and Northstar commuter trains all converge in this segment. Many freight trains are operating at 10 miles per hour moving into or out of yards and/or connecting tracks at junctions. CP University is also the east end of BNSF's busy Northtown Yard. BNSF's Union Yard is a short distance east of Minneapolis Junction. Union Yard is served by the railroad's high-priority intermodal trains (Z-trains) which carry parcels, mail and other time-sensitive commodities. Light engine movements (locomotives without trains) also move through this segment. Northstar commuter trains to and from Target Field Station on the Wayzata Subdivision join the Midway Subdivision at CP Van Buren.

5.1.4. CP 21/Coon Creek

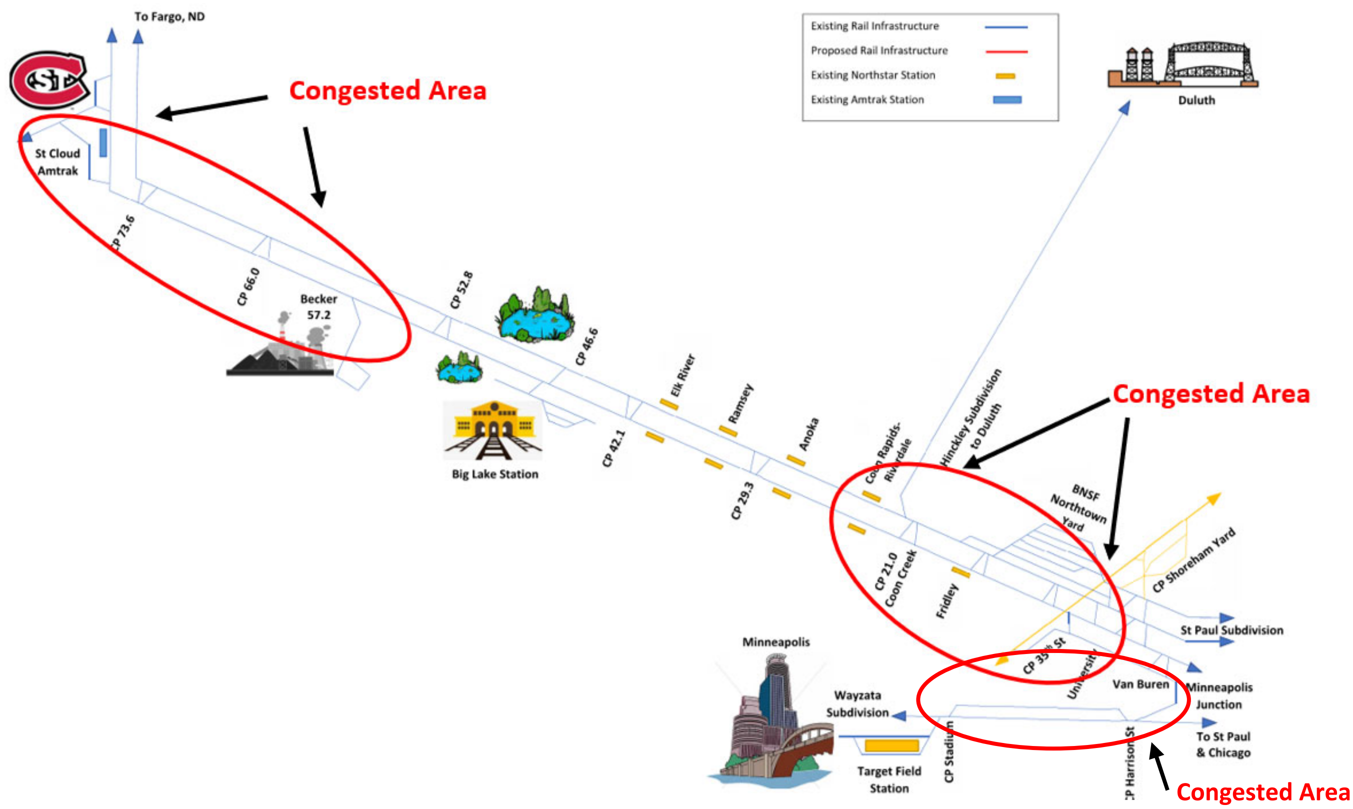
CP 21/Coon Creek connects the single-track Hinckley Subdivision to the double-track Staples Subdivision. This junction links the Twin Cities to the Twin Ports area of Superior, WI and Duluth, MN and links the Twin Cities to St. Cloud and points west. Freight trains often change tracks at CP 21 to facilitate parallel movements into and out of Northtown Yard (approximately 5 miles to the east) and to reduce conflicts near Fridley and CP Interstate. Capacity at the junction is most limited during the morning peak period. During the morning peak, Northstar operates on Main Track 2 at 30-minute intervals, causing westbound freight trains to hold at MP 16.3 while eastbound freight trains and the eastbound Amtrak Empire Builder operate on Main Track 1.

5.2. 2040 Base Case Network Capacity

The 2040 Base Case was modeled with a horizon year level of traffic for freight trains as presented in Table 7. Northstar and Amtrak service levels were assumed to remain unchanged from the 2020 Base Case.

In addition to the congested areas identified in the 2020 Base Case, it was found that, in 2040, the track between CP Van Buren and CP Harrison St. became increasingly congested. This area is depicted in Figure 10.

Figure 10: 2040 Base Case Network Capacity



The single west wye track between CP Van Buren and CP Harrison Street is Northstar's route through Minneapolis Junction. Minneapolis Junction connects BNSF's Wayzata and Midway Subdivisions. Freight trains operating between the Wayzata Sub and Northtown Yard conflict with Northstar trains between Big Lake and Target Field Station in this segment. In 2040, when more freight trains would operate through the network, conflicts would occur more frequently than in 2020 conditions.

5.3. Proposed Case Network Capacity

5.3.1. Description of Service Alternatives

Four Service Alternatives were identified for extending Northstar service to St. Cloud. High-level definitions of the Service Alternatives are as follows:

- **Minimum Service Alternative**: One existing weekday AM peak train to Minneapolis will be extended to begin its trip in St. Cloud and one existing PM peak train will be extended to operate from Minneapolis to St. Cloud.
- **Minimum Bi-Directional Service Alternative**: In the weekday AM peak, one existing train to Minneapolis will be extended to begin its trip in St. Cloud and existing train will be extended to operate from Minneapolis to St. Cloud. In the weekday PM peak, one existing train to Minneapolis will be extended to begin its trip in St. Cloud and one existing train will be extended to operate from Minneapolis to St. Cloud.
- **Express Service Alternative**: One weekday Express train in each direction between Minneapolis and St. Cloud will be added during the AM and PM peak periods.

- **Bi-Directional Service Alternative**: Two existing weekday AM peak trains to Minneapolis will be extended to begin their trips in St. Cloud and one new AM peak train will operate from Minneapolis to St. Cloud. In the PM peak, one existing train to Minneapolis will be extended to begin its trip in St. Cloud and one new train will operate from St. Cloud to Minneapolis. From Minneapolis, two existing trains will be extended to St. Cloud and two new trains will be operated to St. Cloud. One new train will operate from Big Lake to Minneapolis.

On weekdays, all trains in each of the Service Alternatives, except for the Northstar Express Service Alternative, are proposed to stop at all stations. Northstar Express trains will operate non-stop between St Cloud and Minneapolis. On weekends and holidays, each of the four Service Alternatives will add one morning and one afternoon non-stop express train service in each direction between St. Cloud and Minneapolis. The level of weekend/holiday service is the same for all four Service Alternatives. The weekend express trains in all four Service Alternatives are in addition to the existing Northstar local service between Big Lake and Minneapolis.

BNSF requested that Northstar crews from the existing crew base location at Northtown Yard, which go on and off duty at Big Lake, be used to operate any Northstar service extension. Additionally, the crew layover facility will remain in Minneapolis. Continuing to use the Northtown crew base, with crews reporting at Big Lake, will require trains to deadhead 27 miles west to St. Cloud before inbound service begins. For each train operating to or from St Cloud, an additional 54 miles would be traveled.

Detailed information on the Service Alternatives is provided in the Technical Memoranda on Operating Assumptions (Appendices B, C, D, and E).

5.3.2. 2020 and 2040 Proposed Cases

Each of the proposed Service Alternatives was modeled with existing freight and with 2040 freight volumes. Generally, it was observed that congestion under a 2020 Proposed Case became more congested under the associated 2040 Proposed Case (i.e. congested locations for the 2020 Minimum Service Alternative became more congested under the 2040 Minimum Service Alternative). The following sections discuss the observed congestion in the 2020 and 2040 network for each of the Service Alternatives.

5.3.2.1. 2020 and 2040 Minimum Service Alternative

When the Minimum Service Alternative was added to the 2020 Base Case, additional congestion was observed between Big Lake and St. Cloud as a result of the four additional Northstar trains proposed to operate in that segment of track. At St. Cloud, freight train traffic was interrupted by Northstar trains as they access the proposed station by both crossing over from Track 1 to Track 2 and slow down to enter or leave the station track. Congestion also increased at Big Lake. The existing Big Lake Station was designed to function as the terminus of the service, so it is only accessible from the east. The proposed service would require trains to access the station from the west. If the existing track configuration were utilized under the 2020 Minimum Service Alternative, eastbound trains needing to stop at Big Lake Station would have to pull past the Big Lake stub track entrance, change ends, and then make a reverse movement into the stub track. The additional train movements and stopping on the mainline reduced the network's capacity.

In 2040, the Minimum Service Alternative with 2040 freight traffic created additional congestion between St. Cloud and Big Lake, near Northtown Yard, and between CP Van Buren and CP Stadium.

5.3.2.2. 2020 and 2040 Minimum Bi-Directional Service Alternative

When the Minimum Bi-Directional Service Alternative was added to the 2020 Base Case, additional congestion was observed between Big Lake and St. Cloud as a result of the six additional Northstar trains proposed to operate in that segment of track. Similar to the Minimum Service Alternative, Minimum Bi-Directional Service Alternative trains would interfere with freight operations at St. Cloud due to crossover moves and would use up mainline capacity with reverse moves to access Big Lake Station.

In 2040, the Minimum Bi-Directional Service Alternative with 2040 freight traffic created additional congestion between St. Cloud and Big Lake, near Northtown Yard, and between CP Van Buren and CP Stadium.

5.3.2.3. 2020 and 2040 Northstar Express Service Alternative

When the Northstar Express Service Alternative was added to the 2020 Base Case, additional congestion was observed between St. Cloud and Minneapolis as a result of the eight additional Northstar trains proposed to operate between St. Cloud and Big Lake and four additional trains between Big Lake and Minneapolis. Similar to the Minimum Service Alternative, Northstar Express Service Alternative trains would interfere with freight operations at St. Cloud due to crossover moves and would use mainline capacity with reverse moves to access Big Lake Maintenance Facility (BLMF). In addition, the Northstar Express Service Alternative would require time slots to traverse the congested area between CP Coon Creek and CP Interstate, increasing the likelihood of freight trains having to wait to accommodate the proposed trains.

In 2040, the Northstar Express Service Alternative with 2040 freight traffic created additional congestion between St. Cloud and Big Lake and between CP Coon Creek and CP Stadium.

5.3.2.4. 2020 and 2040 Bi-Directional Service Alternative

When the Bi-Directional Service Alternative was added to the 2020 Base Case, additional congestion was observed along the entire route between St. Cloud and Minneapolis as a result of the 16 additional Northstar trains proposed to operate between St. Cloud and Big Lake and six additional trains between Big Lake and Minneapolis. Additionally, the Bi-Directional Service Alternative proposes passenger train meets west of Big Lake, which would require both main tracks to be reserved for passenger operations. This Service Alternative also extends Northstar's hours of operation, causing more interruption to the freight train operations in the network.

In 2040, the Bi-Directional Service Alternative with 2040 freight traffic created additional congestion between St. Cloud and Big Lake and between CP Coon Creek and CP Stadium.

6. RTC Modeling Results

The following sections present the results of the evaluation of proposed Northstar Service Alternatives in 2020 and 2040 using RTC.

6.1. 2020 Results

6.1.1. 2020 Minimum Service Alternative

To mitigate the impact of the 2020 Minimum Service Alternative on the 2020 Base Case, the following capacity improvements are needed:

- Construct station track for Northstar Service at St. Cloud
- Upgrade crossovers east of St. Cloud Station to #24 crossovers
- Construct new CTC control point with #24 universal crossover west of St. Cloud Station
- Extend station track at Big Lake to the west and construct new CTC control point with #24 universal crossover at MP 47.1

In addition, the passenger fare collection system and information system would be upgraded. Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 11 shows the capacity improvements needed for the Minimum Service Alternative in 2020 in red.

Figure 11: 2020 Minimum Service Alternative Capacity Improvements

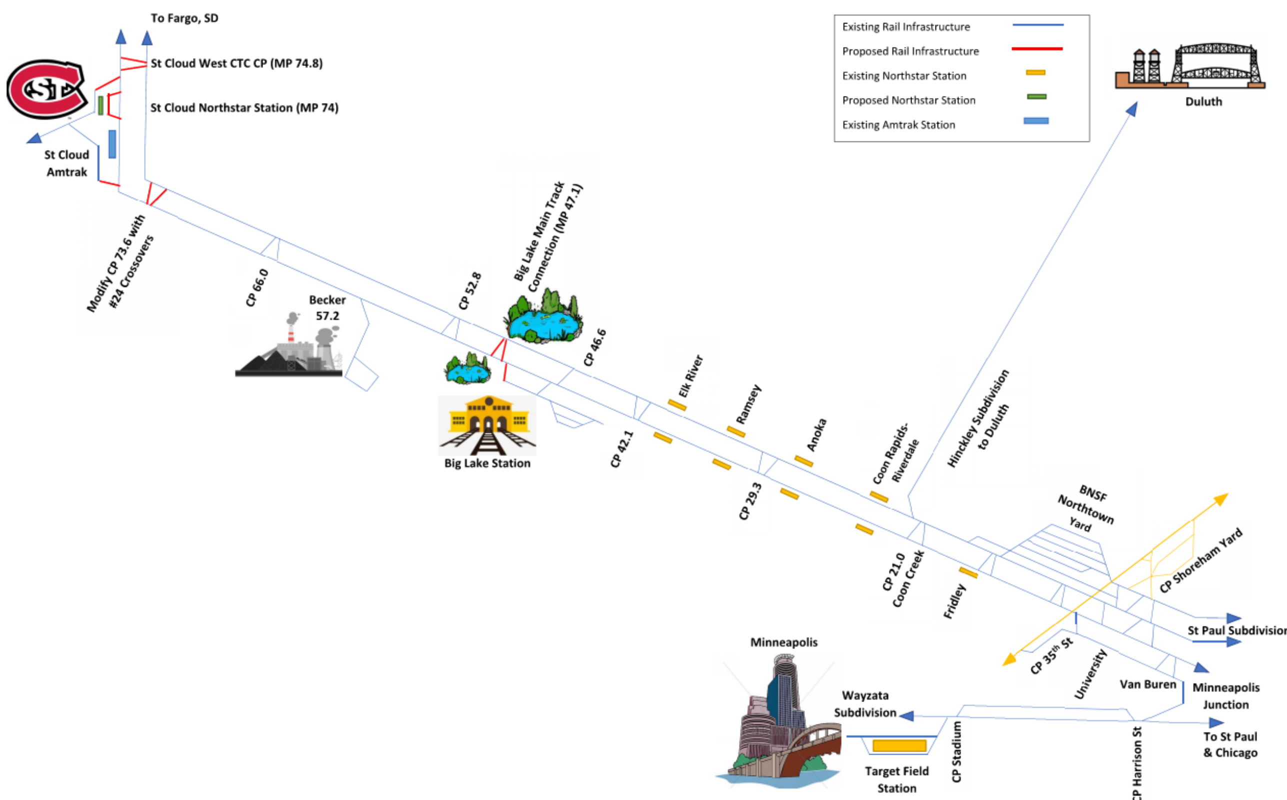


Table 11 presents the results of the RTC analysis and a comparison between the 2020 Base Case and the 2020 Minimum Service Alternative with the capacity improvements shown in Figure 11.

Table 11: 2020 Minimum Service Alternative RTC Results

Service Year and Northstar Service Alternative	Category	Average Elapsed Time per Train (Minutes)
2020 Base Case	BNSF	89.1
2020 Minimum Service	BNSF	88.6

With the proposed capacity improvements in place, the average elapsed time for a BNSF train to traverse the network under the 2020 Minimum Service Alternative would be less than 2020 Base Case levels. The 2020 Minimum Service Alternative would not impact 2020 BNSF operations.

6.1.2. 2020 Minimum Bi-Directional Service Alternative

To mitigate the impact of the 2020 Minimum Bi-Directional Service Alternative on the 2020 Base Case, the following capacity improvements are needed:

- All improvements for the Minimum Service Alternative
- Procurement of one additional Northstar trainset
- Construction of additional capacity at Big Lake Maintenance Facility for storage and maintenance of new trainset
- Construction of center platform at Big Lake Station

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 12 shows the capacity improvements needed for the Minimum Bi-Directional Service Alternative in 2020 in red.

Figure 12: 2020 Minimum Bi-Directional Service Alternative Capacity Improvements

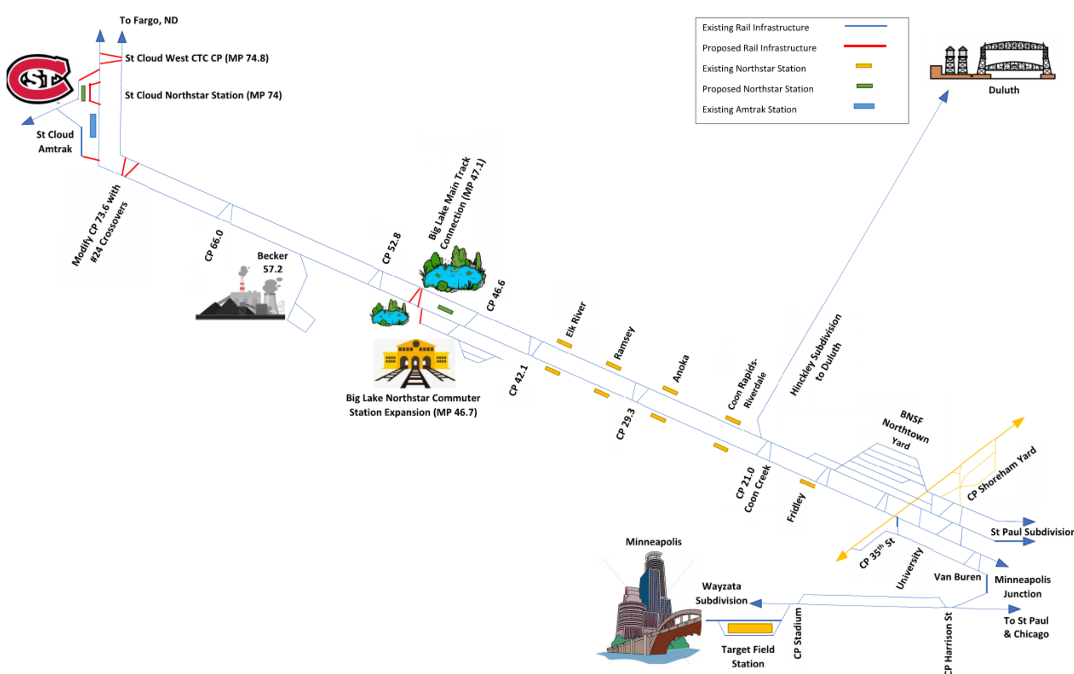


Table 12 presents the results of the RTC analysis and a comparison between the 2020 Base Case and the 2020 Minimum Bi-Directional Service Alternative with the capacity improvements shown in Figure 12.

Table 12: 2020 Minimum Bi-Directional Service Alternative RTC Results

Service Year and Northstar Service Alternative	Category	Average Elapsed Time per Train (Minutes)
2020 Base Case	BNSF	89.1
2020 Minimum Bi-Directional Service	BNSF	88.6

With the proposed capacity improvements in place, the average elapsed time for a BNSF train to traverse the network under the 2020 Minimum Bi-Directional Service Alternative would be less than 2020 Base Case levels. The 2020 Minimum Bi-Directional Service Alternative would not impact 2020 BNSF operations.

6.1.3. 2020 Northstar Express Service Alternative

To mitigate the impact of the 2020 Northstar Express Service Alternative on the 2020 Base Case, the following capacity improvements are needed:

- All improvements for the Minimum Service Alternative
- Procurement of one additional Northstar trainset
- Construction of additional capacity at Big Lake Maintenance Facility for storage and maintenance of new trainset
- Construction of a third main track with additional #24 crossovers and CTC control points between CP Coon Creek and CP Interstate

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 13 shows the capacity improvements needed for the Northstar Express Service Alternative in 2020 in red.

Figure 13: 2020 Northstar Express Service Alternative Capacity Improvement

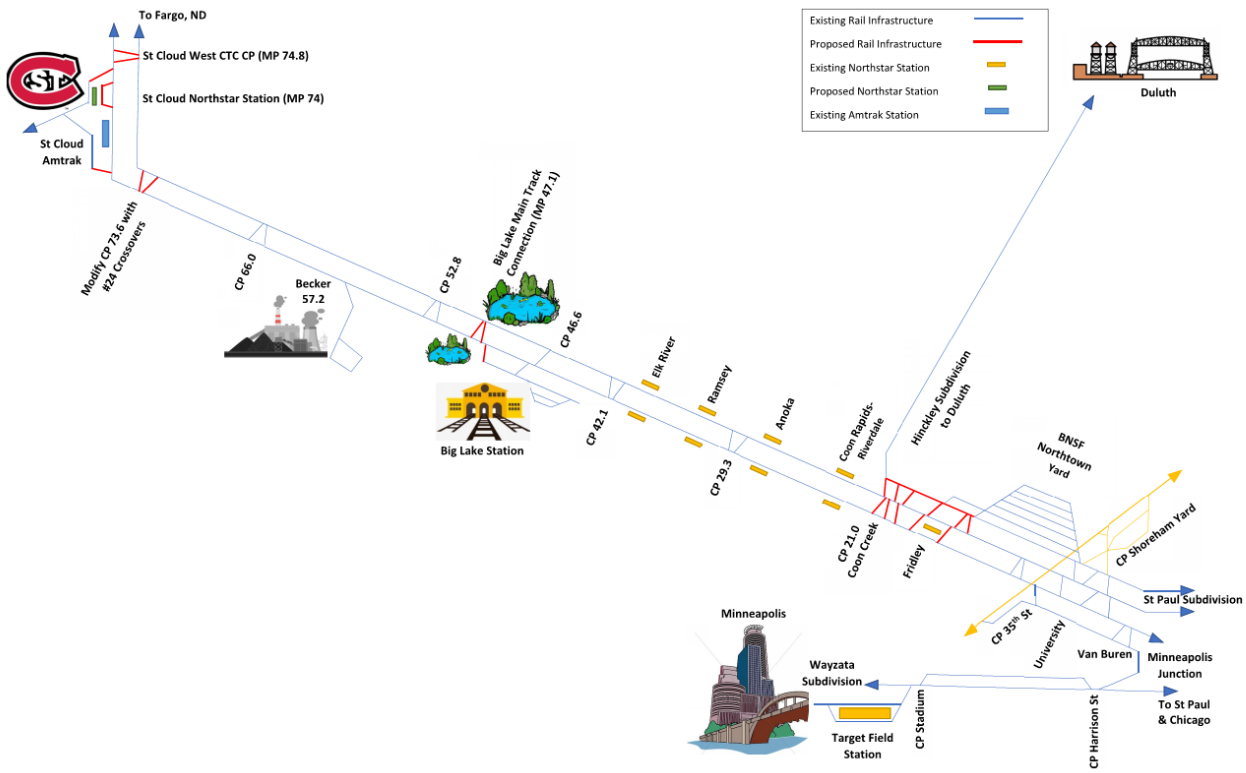


Table 13 presents the results of the RTC analysis and a comparison between the 2020 Base Case and the 2020 Northstar Express Service Alternative with the capacity improvements shown in Figure 13.

Table 13: 2020 Northstar Express Service Alternative RTC Results

Service Year and Northstar Service Alternative	Category	Average Elapsed Time per Train (Minutes)
2020 Base Case	BNSF	89.1
2020 Northstar Express Service	BNSF	88.3

With the proposed capacity improvements in place, the average elapsed time for a BNSF train to traverse the network under the 2020 Northstar Express Service Alternative would be less than 2020 Base Case levels. The 2020 Northstar Express Service Alternative would not impact 2020 BNSF operations.

6.1.4. 2020 Bi-Directional Service Alternative

To mitigate the impact of the 2020 Bi-Directional Service Alternative on the 2020 Base Case, the following capacity improvements are needed:

- All improvements for the Minimum Service Alternative
- Procurement of one additional Northstar trainset
- Upgrade crossovers at MP 66 to #24 crossovers

- Construct new CTC control point at Becker (MP 57.2) with #24 universal crossover
- Construction of additional capacity at Big Lake Maintenance Facility for storage and maintenance of new trainset
- Construction of center platform at Big Lake Station
- Construction of a third main track with additional #24 crossovers and CTC control points between CP 21 at Coon Creek and CP Interstate

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 14 shows the capacity improvements needed for the Bi-Directional Service Alternative in 2020 in red.

Figure 14: 2020 Bi-Directional Service Alternative Capacity Improvements

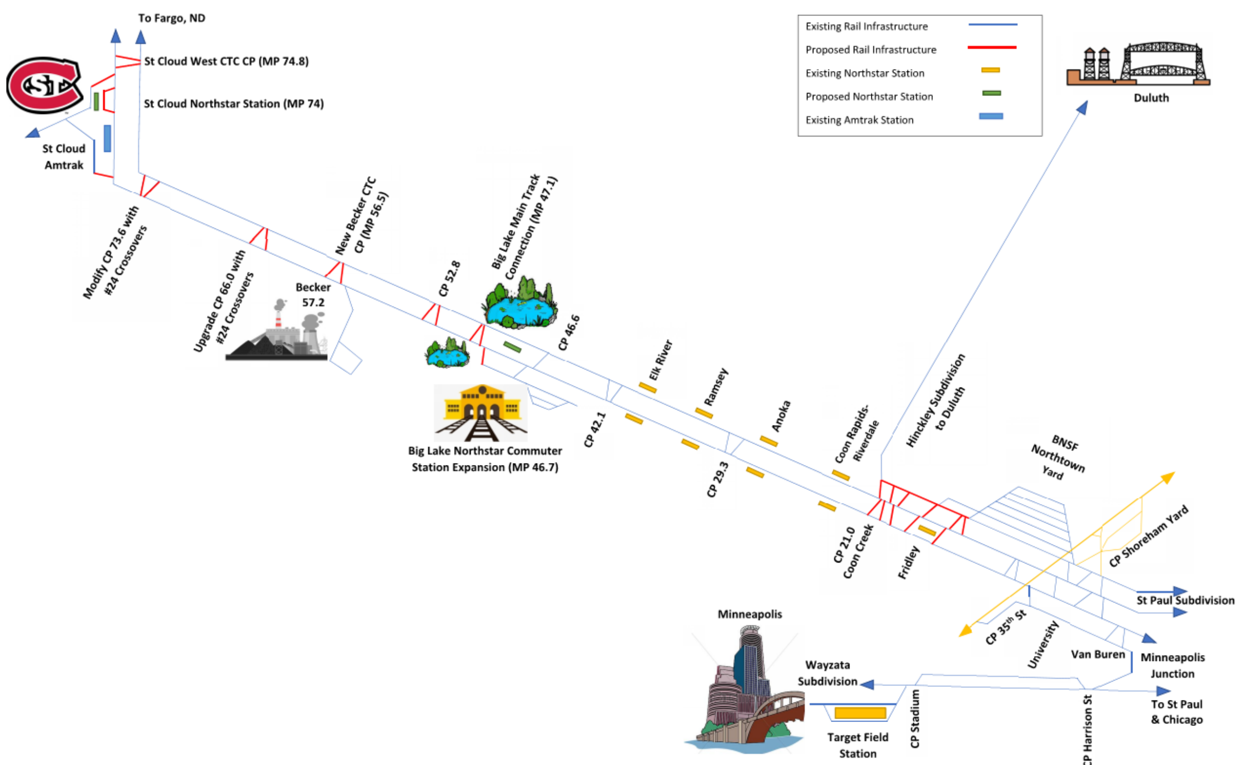


Table 14 presents the results of the RTC analysis and a comparison between the 2020 Base Case and the 2020 Bi-Directional Service Alternative with the capacity improvements shown in Figure 14.

Table 14: 2020 Bi-Directional Service Alternative RTC Results

Service Year and Northstar Service Alternative	Category	Average Elapsed Time per Train (Minutes)
2020 Base Case	BNSF	89.1
2020 Bi-Directional Service	BNSF	88.1

With the proposed capacity improvements in place, the average elapsed time for a BNSF train to traverse the network under the 2020 Bi-Directional Service Alternative would be less than 2020 Base Case levels. The 2020 Bi-Directional Service Alternative would not impact 2020 BNSF operations.

6.2. 2040 Results

6.2.1. 2040 Base Case

To mitigate the impact of the 2040 Base Case (2040 freight traffic) on the 2020 Base Case, the following capacity improvements are needed:

- Construction of a third main track with additional #24 crossovers and CTC control points between CP Coon Creek and CP Interstate
- Construction of a second main track between CP Van Buren and CP Harrison and upgrading the existing auxiliary track and adding crossovers to create a second main track between CP Harrison St. and CP Stadium

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 15 shows the capacity improvements needed to mitigate the 2040 freight traffic in red.

Figure 15: 2040 Base Case Capacity Improvements

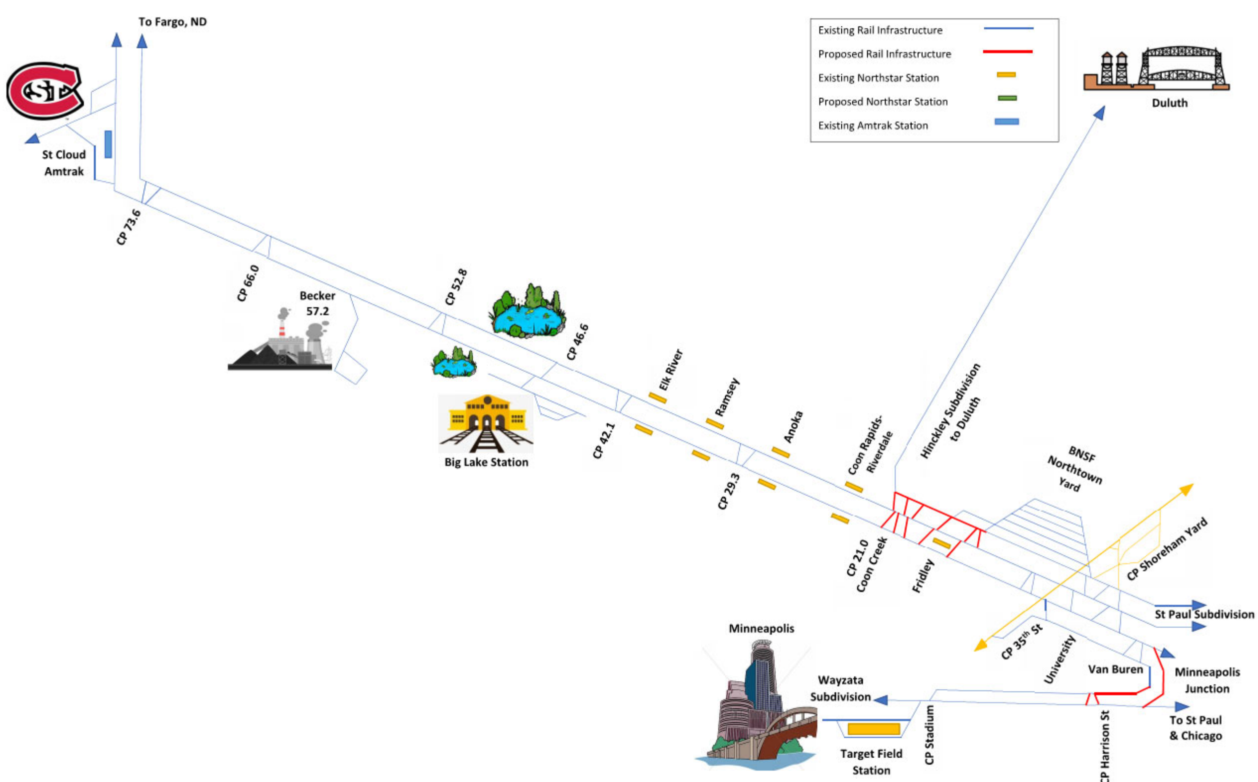


Table 15 presents the results of the RTC analysis and a comparison between the 2020 Base Case and the 2040 Base Case with the capacity improvements shown in Figure 15.

Table 15: 2040 Base Case RTC Results

Service Year and Northstar Service Alternative	Category	True Delay Minutes per 100 TM (Minutes)
2020 Base Case	BNSF	10.4
2040 Base Case	BNSF	10.9

With the proposed capacity improvements in place, the average true delay minutes per 100 train miles per train for the 2040 Base Case would be slightly greater than 2020 Base Case levels. A statistical t-test evaluating the 15 dispatches found that the difference in true delay was not significant. The addition of the 2040 Base Case freight traffic would not significantly impact 2020 BNSF operations.

6.2.2. 2040 Minimum Service Alternative

To mitigate the impact of the 2040 Minimum Service Alternative on the 2040 Base Case, the following capacity improvements are needed:

- All improvements for the 2020 Minimum Service Alternative
- Construct new CTC control point at Becker (MP 57.2) with #24 universal crossover
- Construction of a third main track with additional #24 crossovers and CTC control points between CP Coon Creek and CP Interstate
- Construction of a second main track between CP Van Buren and CP Harrison and upgrade of the existing auxiliary track to main track with additional crossovers between CP Harrison and CP Stadium

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 16 shows the capacity improvements needed for the Minimum Service Alternative in 2040 in red.

Figure 16: 2040 Minimum Service Alternative Capacity Improvements

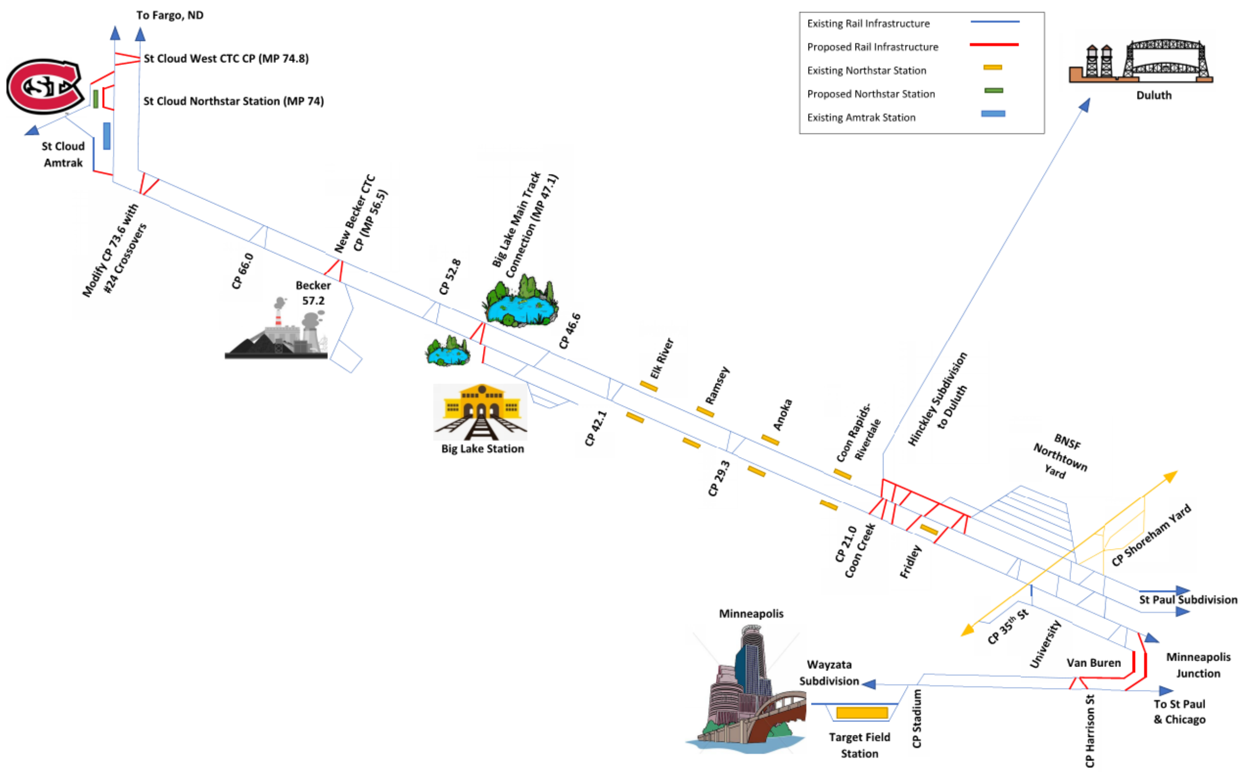


Table 16 presents the results of the RTC analysis and a comparison between the 2040 Base Case and the 2040 Minimum Service Alternative with the capacity improvements shown in Figure 16.

Table 16: 2040 Minimum Service Alternative RTC Results

Service Year and Northstar Service Alternative	Category	Average Elapsed Time per Train (Minutes)
2040 Base Case	BNSF	90.2
2040 Minimum Service	BNSF	90.6

With the proposed capacity improvements in place, the average elapsed time for a BNSF train to traverse the network under the 2040 Minimum Service Alternative, would be slightly greater than 2040 Base Case levels. A statistical t-test evaluating the 15 dispatches found that the difference in average elapsed time between the 2040 Minimum Service Alternative and the 2040 Base Case was not significant. Therefore, the 2040 Minimum Service Alternative would not significantly impact 2040 BNSF operations.

6.2.3. 2040 Minimum Bi-Directional Service Alternative

To mitigate the impact of the 2040 Minimum Bi-Directional Service Alternative on the 2040 Base Case, the following capacity improvements are needed:

- All improvements for the 2020 Minimum Bi-Directional Service Alternative

- Upgrade crossovers at MP 66 to #24 crossovers
- Construct new CTC control point at Becker (MP 57.2) with #24 universal crossover
- Construction of a third main track with additional #24 crossovers and control points between CP Coon Creek and CP Interstate
- Construction of a second main track between CP Van Buren and CP Harrison and upgrade of the existing auxiliary track to main track with additional crossovers between CP Harrison and CP Stadium

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 17 shows the capacity improvements needed for the Minimum Bi-Directional Service Alternative in 2040 in red.

Figure 17: 2040 Minimum Bi-Directional Service Alternative Capacity Improvements

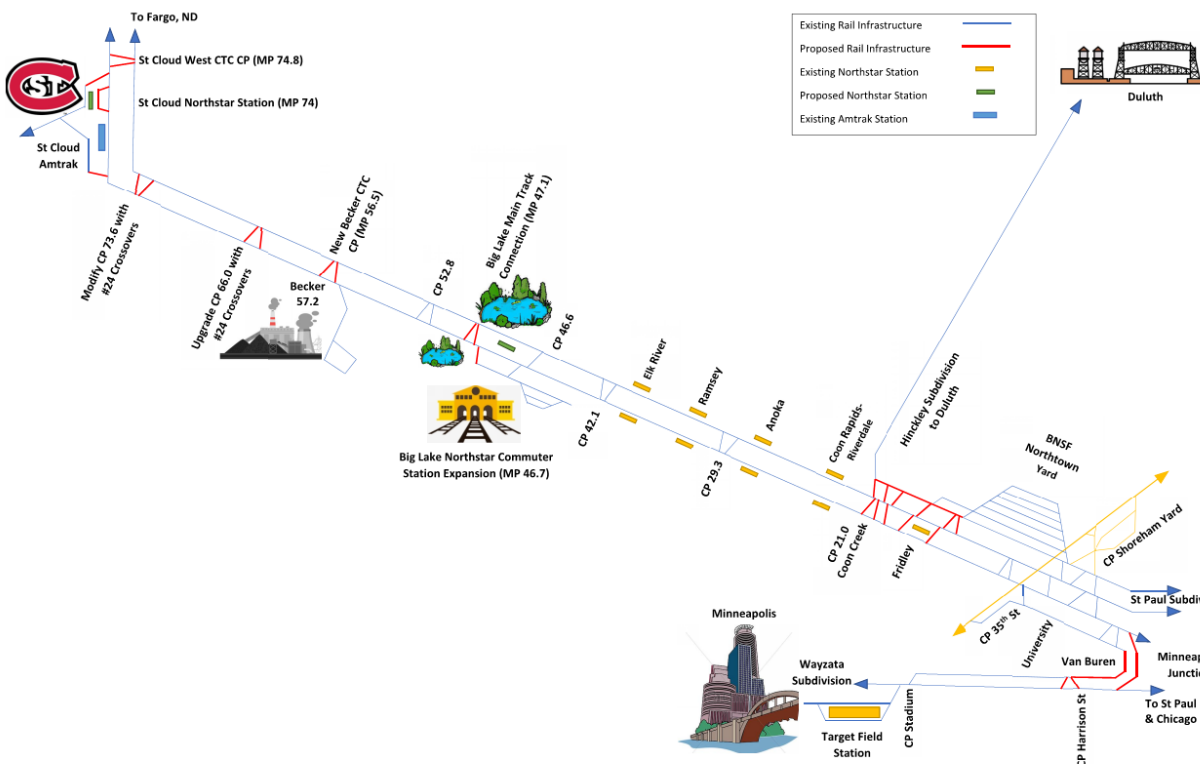


Table 17 presents the results of the RTC analysis and a comparison between the 2040 Base Case and the 2040 Minimum Bi-Directional Service Alternative with the capacity improvements shown in Figure 17.

Table 17: 2040 Minimum Bi-Directional Service Alternative RTC Results

Service Year and Northstar Service Alternative	Category	Average Elapsed Time per Train (Minutes)
2040 Base Case	BNSF	90.2
2040 Minimum Bi-Directional Service	BNSF	90.3

With the proposed capacity improvements in place, the average elapsed time for a BNSF train to traverse the network under the 2040 Minimum Bi-Directional Service Alternative would be slightly greater than 2040 Base Case levels. A statistical t-test evaluating the 15 dispatches found that the difference in average elapsed time between the 2040 Minimum Bi-Directional Service Alternative and the 2040 Base Case was not significant. Therefore, the 2040 Minimum Bi-Directional Service Alternative would not significantly impact 2040 BNSF operations.

6.2.4. 2040 Northstar Express Service Alternative

To mitigate the impact of the 2040 Northstar Express Service Alternative on the 2040 Base Case, the following capacity improvements are needed:

- All improvements for the 2020 Northstar Express Service Alternative
- Upgrade crossovers at MP 66 to #24
- Construct new CTC control point at Becker (MP 57.2) with #24 universal crossover
- Construction of a third main track with additional #24 crossovers between CP Interstate and CP Van Buren
- Construction of a second main track between CP Van Buren and CP Harrison and upgrade of the existing auxiliary track to main track with additional crossovers between CP Harrison and CP Stadium

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 18 shows the capacity improvements needed for the Northstar Express Service Alternative in 2040 in red.

Figure 18: 2040 Northstar Express Service Alternative Capacity Improvements

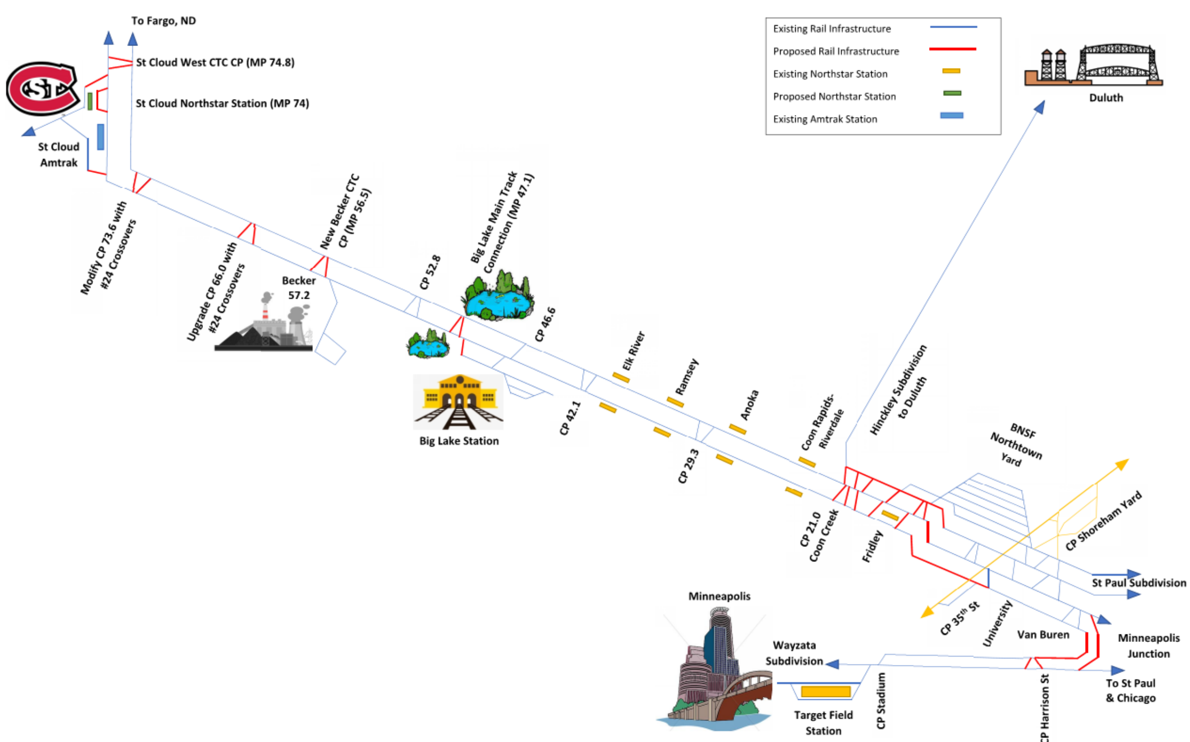


Table 18 presents the results of the RTC analysis and a comparison between the 2040 Base Case and the 2040 Northstar Express Service Alternative with the capacity improvements shown in Figure 18.

Table 18: 2040 Northstar Express Service Alternative RTC Results

Service Year and Northstar Service Alternative	Category	Average Elapsed Time per Train (Minutes)
2040 Base Case	BNSF	90.2
2040 Northstar Express Service	BNSF	90.5

With the proposed capacity improvements in place, the average elapsed time for a BNSF trains to traverse the network under the 2040 Northstar Express Service Alternative would be slightly greater than 2040 Base Case levels. A statistical t-test evaluating the 15 dispatches found that the difference in average elapsed time between the 2040 Northstar Express Service Alternative and the 2040 Base Case was not significant. Therefore, the 2040 Northstar Express Service Alternative would not significantly impact BNSF operations.

6.2.5. 2040 Bi-Directional Service Alternative

To mitigate the impact of the 2040 Bi-Directional Service Alternative on the 2040 Base Case, the following capacity improvements are needed:

- All improvements for the 2040 Bi-Directional Service Alternative
- Construction of a five-mile-long third main track between Big Lake Station and MP 52.8
- Construction of a third main track with additional #24 crossovers between CP Interstate and CP Van Buren
- Construction of a second main track between CP Van Buren and CP Harrison and upgrade of the existing auxiliary track to main track with additional crossovers between CP Harrison and CP Stadium

Concept engineering plans for the capacity improvements are provided in **Appendix G**.

Figure 19 shows the capacity improvements needed for the Bi-Directional Service Alternative in 2040 in red.

Figure 19: 2040 Bi-Directional Service Alternative Capacity Improvement

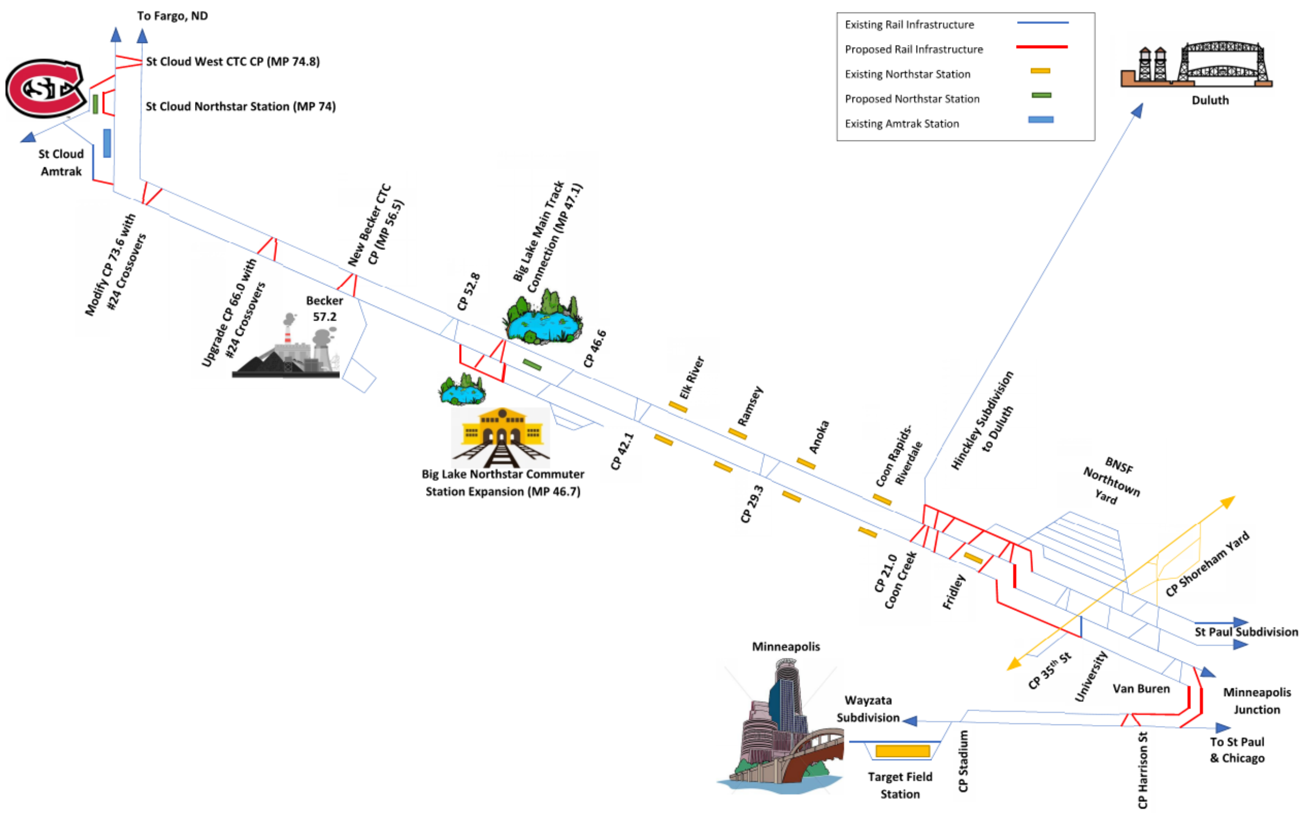


Table 19 presents the results of the RTC analysis and a comparison between the 2040 Base Case and the 2040 Bi-Direct onal Service Alternative with the capac ty mprovements shown in Figure 19.

Table 19: 2040 Bi-Directional Service Alternative RTC Re ult

Service Year and North tar Service Alternative	Category	Average Elap ed Time per Train (Minute)
2040 Base Case	BNSF	90.2
2040 B -Directional Service	BNSF	90.2

With the proposed capacity mprovements in place, the average elapsed t me of a BNSF train to traverse the network under the 2040 Bi-Direct onal Service Alternative would be equal to 2040 Base Case levels. The 2040 Bi-Directional Service Alternat ve would not significantly mpact 2040 BNSF operat ons.

7. Summary of Re ult

The RTC modeling results discussed in Section 6 showed that with the addit on of the capacity improvements, each of the proposed Service Alternat ves could operate without unduly impacting BNSF’s performance in 2020 and 2040. Stringlines for the 2020 Base Case, 2020 Proposed Cases, 2040 Base Case, and 2040 Proposed Cases are available on request to the MnDOT Supervisor of Freight and

Rail Planning.[2] Table 20 summarizes the RTC modeling results for the 2020 Base Case, 2020 Proposed Cases, 2040 Base Case, and 2040 Proposed Cases.

Table 20: Summary of RTC Modeling Re ult

Service Year and North tar Service Alternative	Category	True Delay Minute per 100TM	Elap ed Time per Train (Minute)	Change in Performance from 2020 (Elap ed Time per Train in Minute)	Change in Performance from 2040 (Elap ed Time per Train in Minute)
2020 Base Case	BNSF	10.4	89.1	-	
2020 Min mum Service	BNSF	-	88.6	-0.5	
2020 Min mum B - Directional Service	BNSF	-	88.6	-0.5	
2020 Northstar Express Service	BNSF	-	88.3	-0.8	
2020 B -Directional Service	BNSF	-	88.1	-1.0	
2040 Base Case	BNSF	10.9	90.2	0.9	
2040 Min mum Service	BNSF	-	90.6		0.4
2040 Min mum B - Directional Service	BNSF	-	90.3		0.1
2040 Northstar Express Service	BNSF	-	90.5		0.3
2040 B -Directional Service	BNSF	-	90.2		0.0

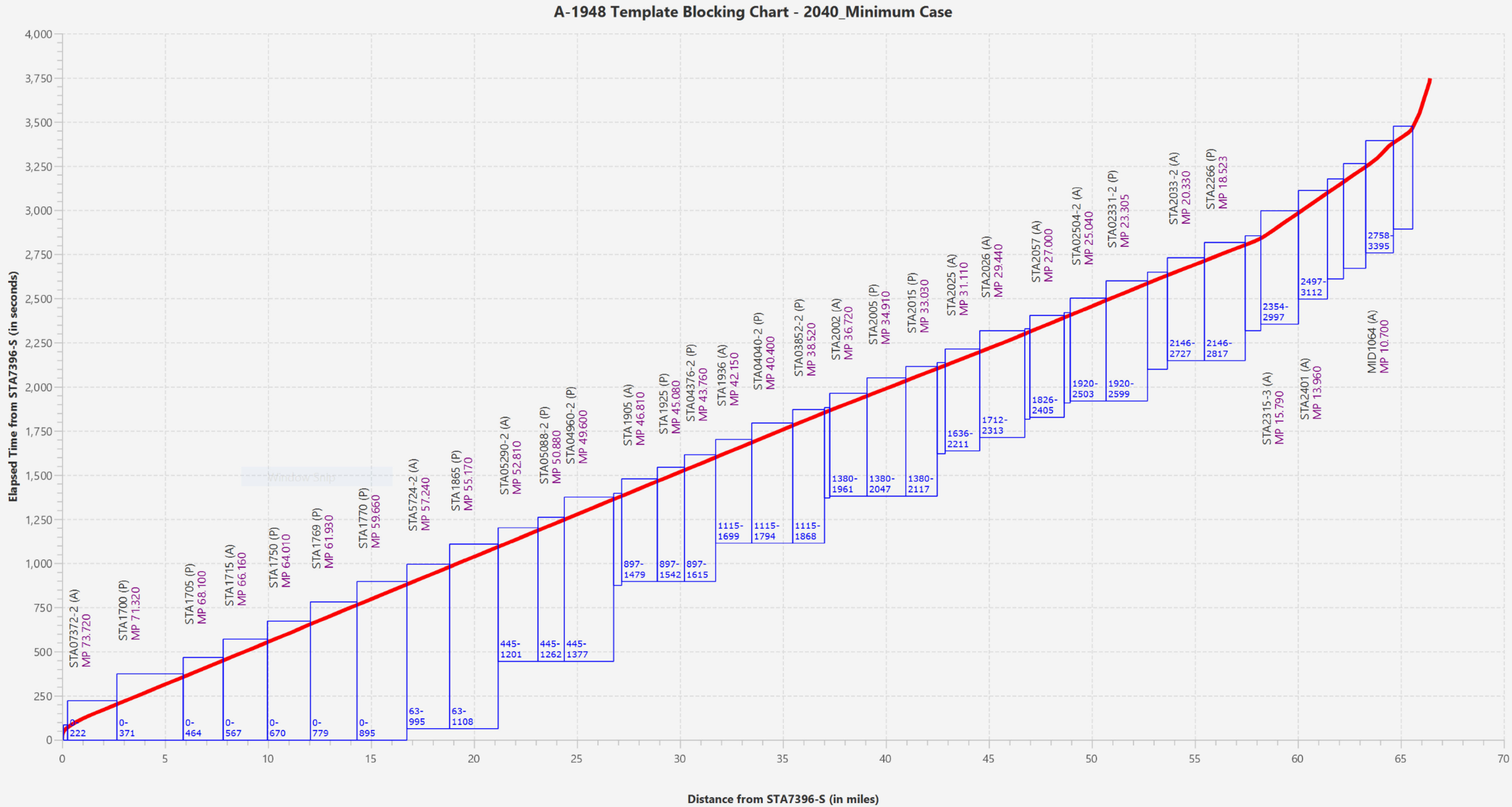
[2] https://www.dot.state.mn.us/ofrw/contacts.html

Attachment 1

Signal Blocking Diagrams

DEPARTMENT OF TRANSPORTATION

Blocking Time Chart



Attributes	Offsets	Graphics	Signal Parameters
☑ Show Blocks	○ Show time and distance from origin	Time the Block is Assigned	Typical Clear Ahead Count (# of absolute signals requested in advance of train): 2
☑ Show Signal IDs	● Show time and distance from first node selected	Signal Node ID (A=Absolute, P=Permissive)	Typical Signal Request Ahead of Train (in seconds): 480
☑ Show Field MPs		Field MP of Signal Node	Signal Release Time (in seconds): 15

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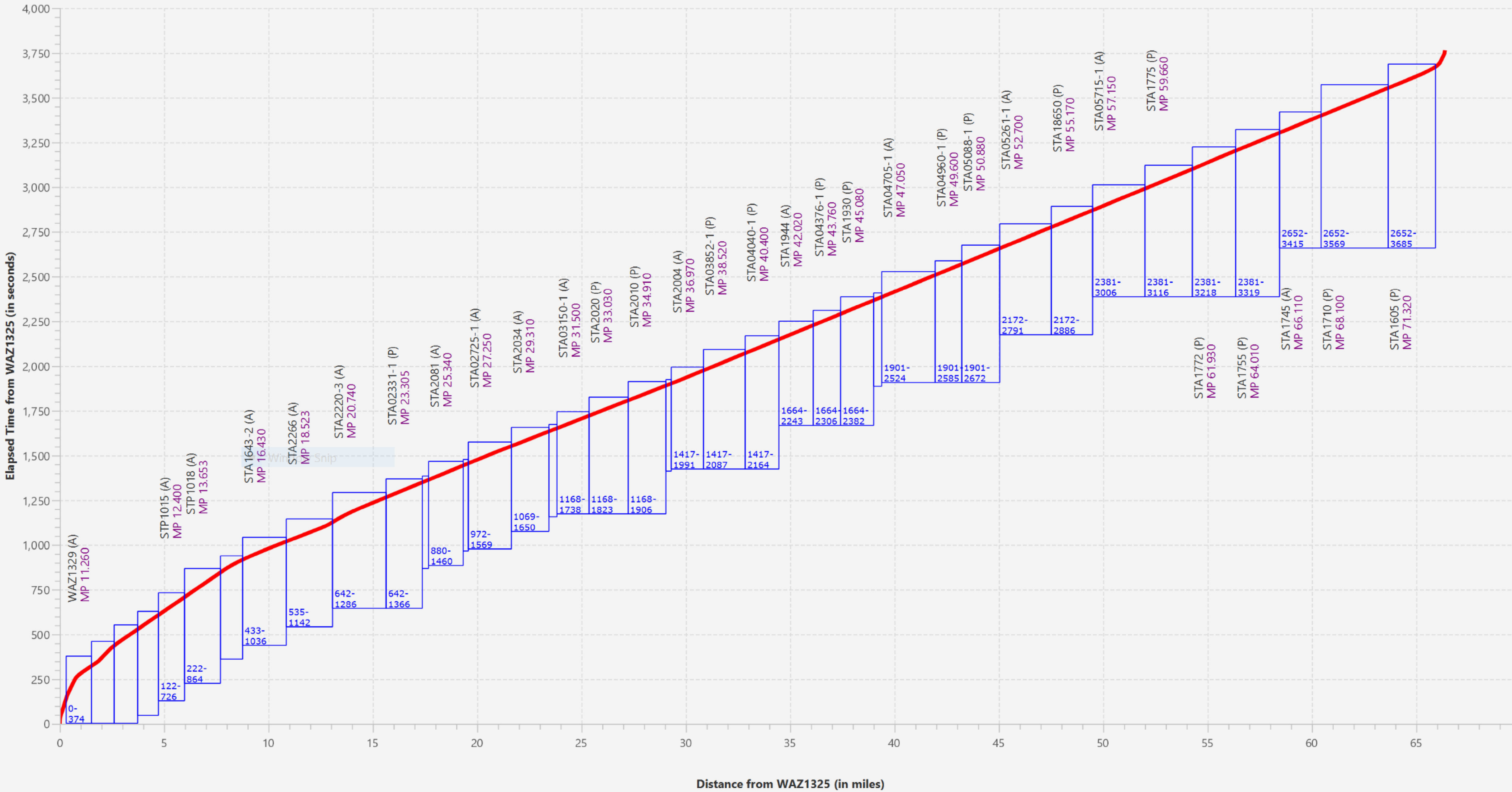
Blocking Time Chart

A-1949 Template Blocking Chart - 2040_Minimum Case



Attributes	Offsets	Graphics	Signal Parameters	
☑ Show Blocks	○ Show time and distance from origin	Time the Block is Assigned	Typical Clear Ahead Count (# of absolute signals requested in advance of train):	2
☑ Show Signal IDs	● Show time and distance from first node selected	Signal Node ID (A=Absolute, P=Permissive)	Typical Signal Request Ahead of Train (in seconds):	480
☑ Show Field MPs		Field MP of Signal Node	Signal Release Time (in seconds):	15

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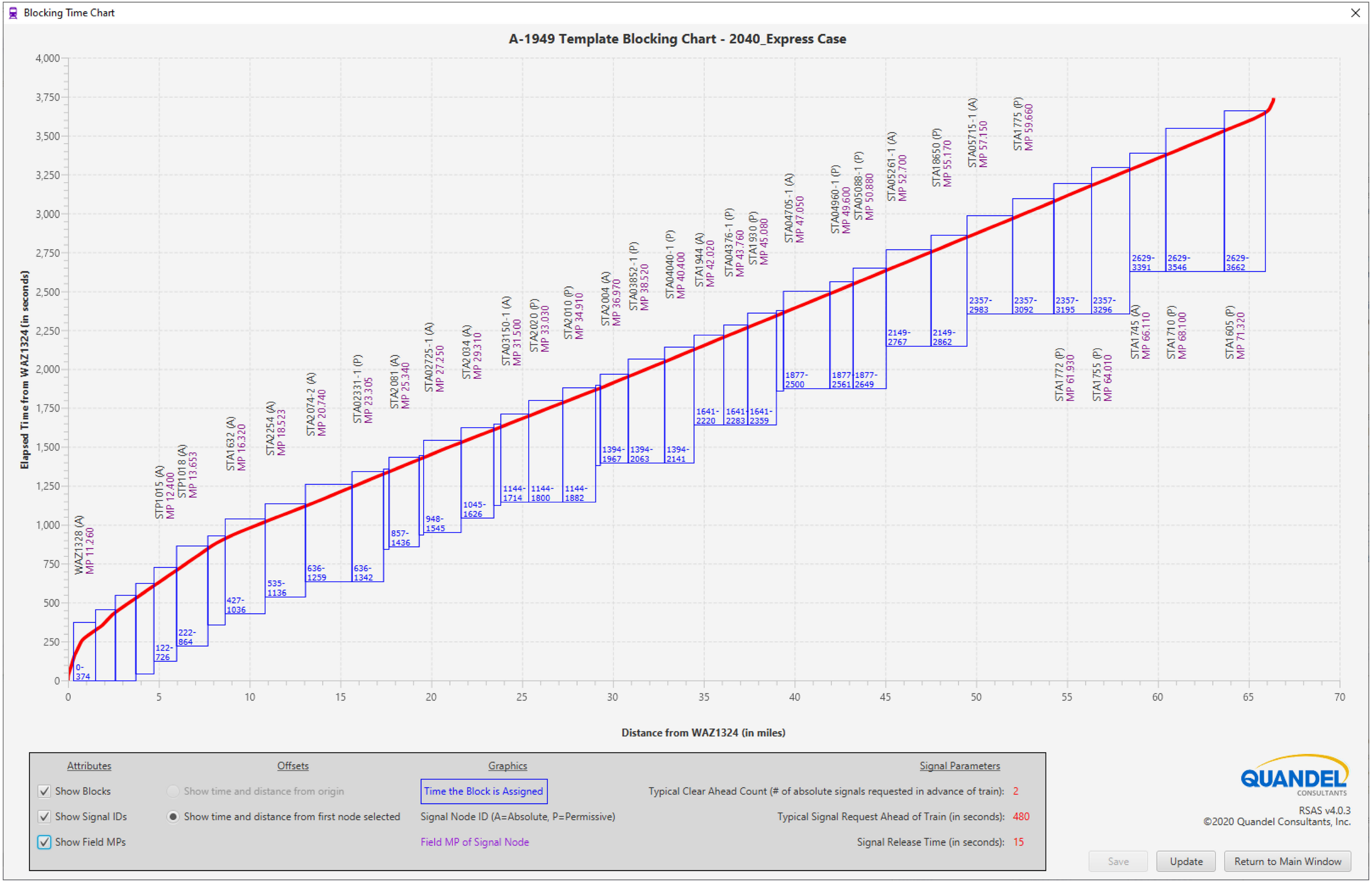
Blocking Time Chart
A-1949 Template Blocking Chart - 2040_Express Case
Elapsed Time from WAZ1324 (in seconds)
Distance from WAZ1324 (in miles)
WAZ1328 (A) MP 11.260
STP1015 (A) MP 12.400
STP1018 (A) MP 13.653
STA1632 (A) MP 16.320
STA2254 (A) MP 18.523
STA2074-2 (A) MP 20.740
STA02331-1 (P) MP 23.305
STA2081 (A) MP 25.340
STA02725-1 (A) MP 27.250
STA2034 (A) MP 29.310
STA03150-1 (A) MP 31.500
STA2020 (P) MP 33.030
STA2010 (P) MP 34.910
STA2004 (A) MP 36.970
STA03852-1 (P) MP 38.520
STA04040-1 (P) MP 40.400
STA1944 (A) MP 42.020
STA04376-1 (P) MP 43.760
STA1930 (P) MP 45.080
STA04705-1 (A) MP 47.050
STA04960-1 (P) MP 49.600
STA05088-1 (P) MP 50.880
STA05261-1 (A) MP 52.700
STA18650 (P) MP 55.170
STA05715-1 (A) MP 57.150
STA1775 (P) MP 59.660
STA1772 (P) MP 61.930
STA1755 (P) MP 64.010
STA1745 (A) MP 66.110
STA1710 (P) MP 68.100
STA1605 (P) MP 71.320
0-374
122-726
222-864
427-1036
535-1136
636-1259
636-1342
857-1436
948-1545
1045-1626
1144-1714
1144-1800
1144-1882
1394-1967
1394-2063
1394-2141
1641-2220
1641-2283
1641-2359
1877-2500
1877-2561
1877-2649
2149-2767
2149-2862
2357-2983
2357-3092
2357-3195
2357-3296
2629-3391
2629-3546
2629-3662
Attributes
Show Blocks
Show Signal IDs
Show Field MPs
Offsets
Show time and distance from origin
Show time and distance from first node selected
Graphics
Time the Block is Assigned
Signal Node ID (A=Absolute, P=Permissive)
Field MP of Signal Node
Signal Parameters
Typical Clear Ahead Count (# of absolute signals requested in advance of train): 2
Typical Signal Request Ahead of Train (in seconds): 480
Signal Release Time (in seconds): 15
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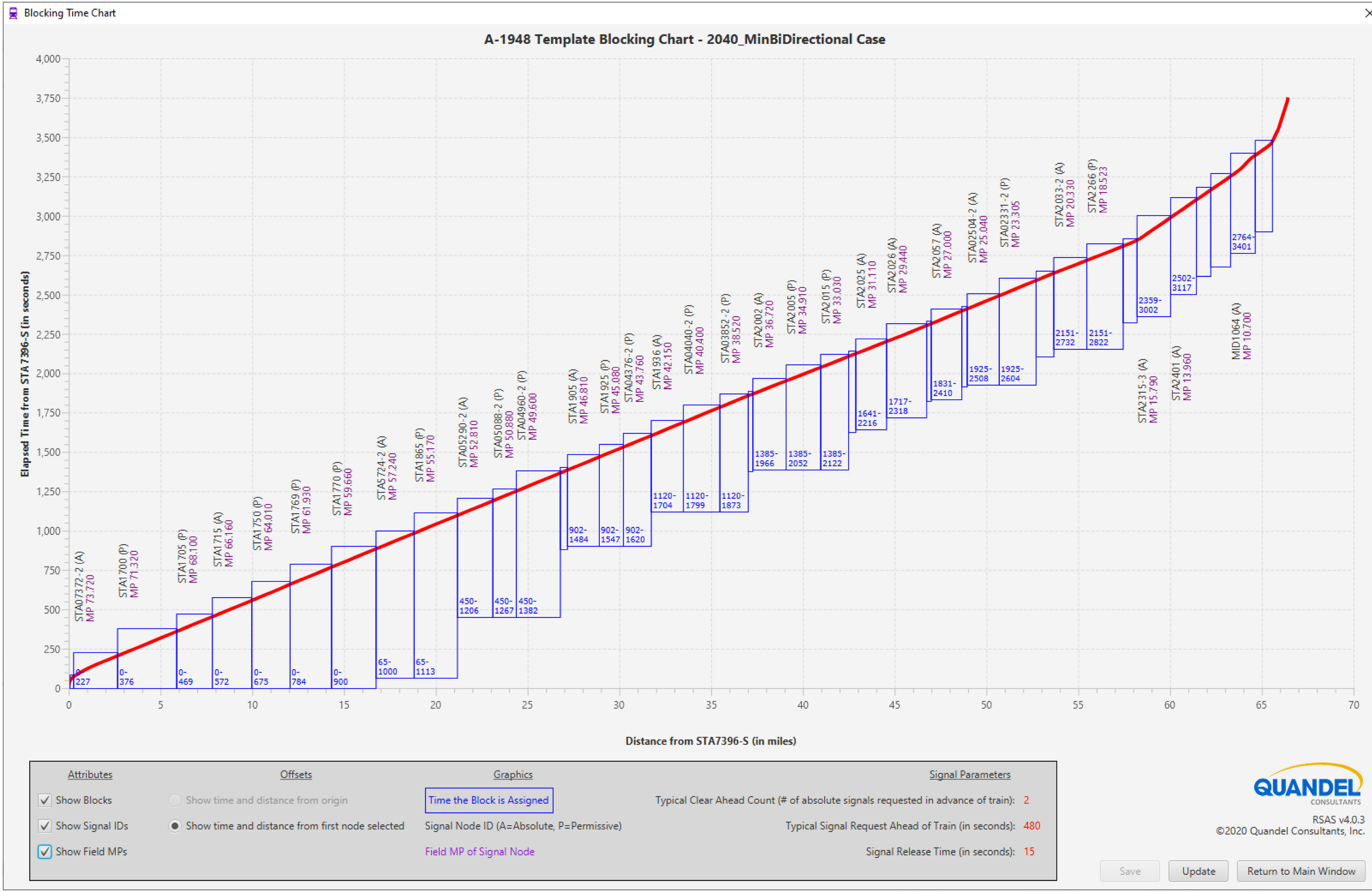
Blocking Time Chart
A-1948 Template Blocking Chart - 2040_MinBiDirectional Case
Elapsed Time from STA7396-S (in seconds)
Distance from STA7396-S (in miles)
Attributes
Show Blocks
Show Signal IDs
Show Field MPs
Offsets
Show time and distance from origin
Show time and distance from first node selected
Graphics
Time the Block is Assigned
Signal Node ID (A=Absolute, P=Permissive)
Field MP of Signal Node
Signal Parameters
Typical Clear Ahead Count (# of absolute signals requested in advance of train): 2
Typical Signal Request Ahead of Train (in seconds): 480
Signal Release Time (in seconds): 15
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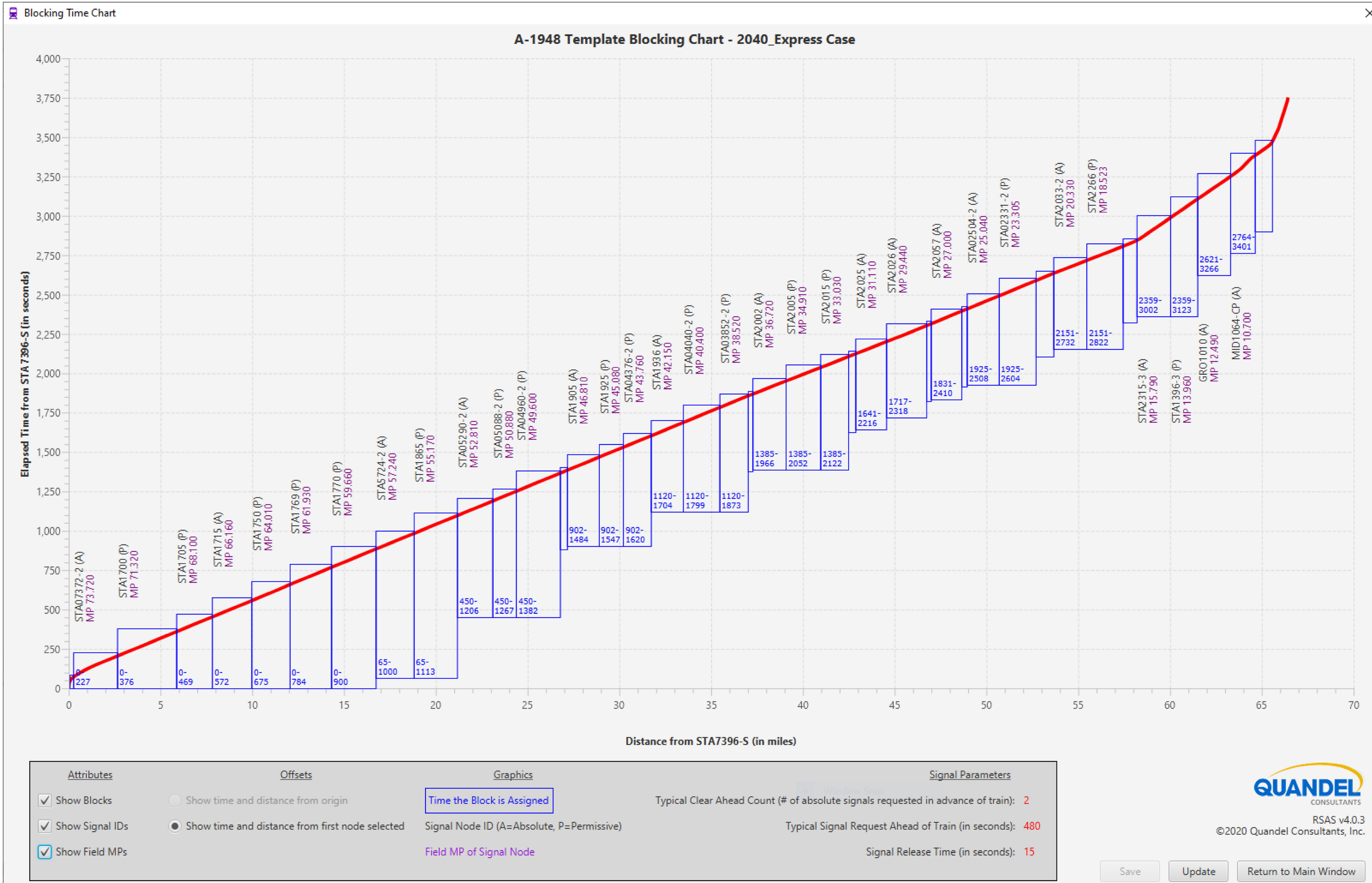
Blocking Time Chart
A-1948 Template Blocking Chart - 2040_Express Case
Elapsed Time from STA7396-S (in seconds)
Distance from STA7396-S (in miles)
STA07372-2 (A) MP 73.720
STA1700 (P) MP 71.320
STA1705 (P) MP 68.100
STA1715 (A) MP 66.160
STA1750 (P) MP 64.010
STA1769 (P) MP 61.930
STA1770 (P) MP 59.660
STA5724-2 (A) MP 57.240
STA1865 (P) MP 55.170
STA05290-2 (A) MP 52.810
STA05088-2 (P) MP 50.880
STA04960-2 (P) MP 49.600
STA1905 (A) MP 46.810
STA1925 (P) MP 45.080
STA04376-2 (P) MP 43.760
STA1936 (A) MP 42.150
STA04040-2 (P) MP 40.400
STA03852-2 (P) MP 38.520
STA2002 (A) MP 36.720
STA2005 (P) MP 34.910
STA2015 (P) MP 33.030
STA2025 (A) MP 31.110
STA2026 (A) MP 29.440
STA2057 (A) MP 27.000
STA02504-2 (A) MP 25.040
STA02331-2 (P) MP 23.305
STA2033-2 (A) MP 20.330
STA2266 (P) MP 18.523
STA2315-3 (A) MP 15.790
STA1396-3 (P) MP 13.960
GRO1010 (A) MP 12.490
MID1064-CP (A) MP 10.700
Attributes
Show Blocks
Show Signal IDs
Show Field MPs
Offsets
Show time and distance from origin
Show time and distance from first node selected
Graphics
Time the Block is Assigned
Signal Node ID (A=Absolute, P=Permissive)
Field MP of Signal Node
Signal Parameters
Typical Clear Ahead Count (# of absolute signals requested in advance of train): 2
Typical Signal Request Ahead of Train (in seconds): 480
Signal Release Time (in seconds): 15
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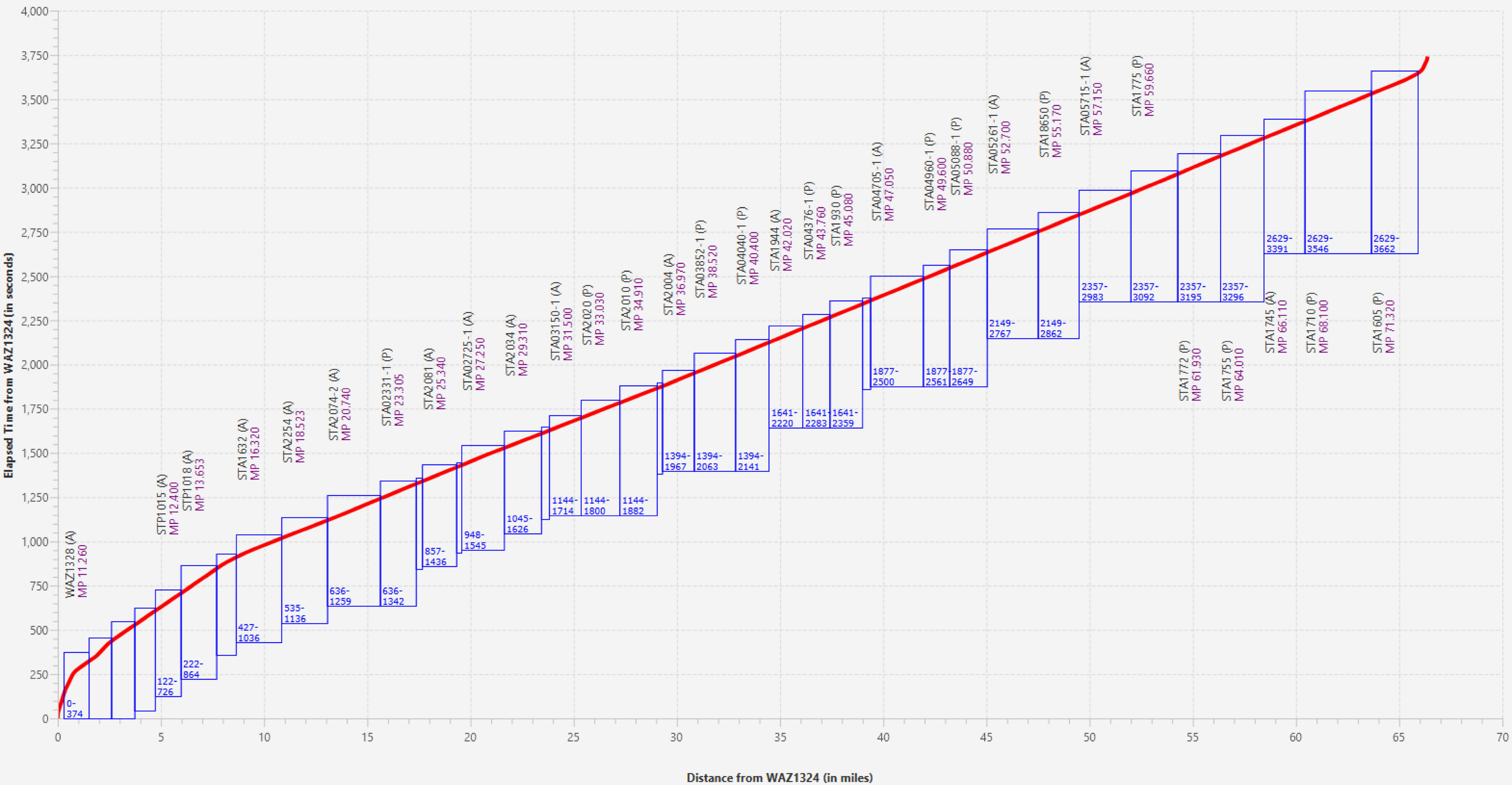
Blocking Time Chart

A-1949 Template Blocking Chart - 2040_Express Case



Attributes	Offsets	Graphics	Signal Parameters
☑ Show Blocks	○ Show time and distance from origin	Time the Block is Assigned	Typical Clear Ahead Count (# of absolute signals requested in advance of train): 2
☑ Show Signal IDs	● Show time and distance from first node selected	Signal Node ID (A=Absolute, P=Permissive)	Typical Signal Request Ahead of Train (in seconds): 480
☑ Show Field MPs		Field MP of Signal Node	Signal Release Time (in seconds): 15

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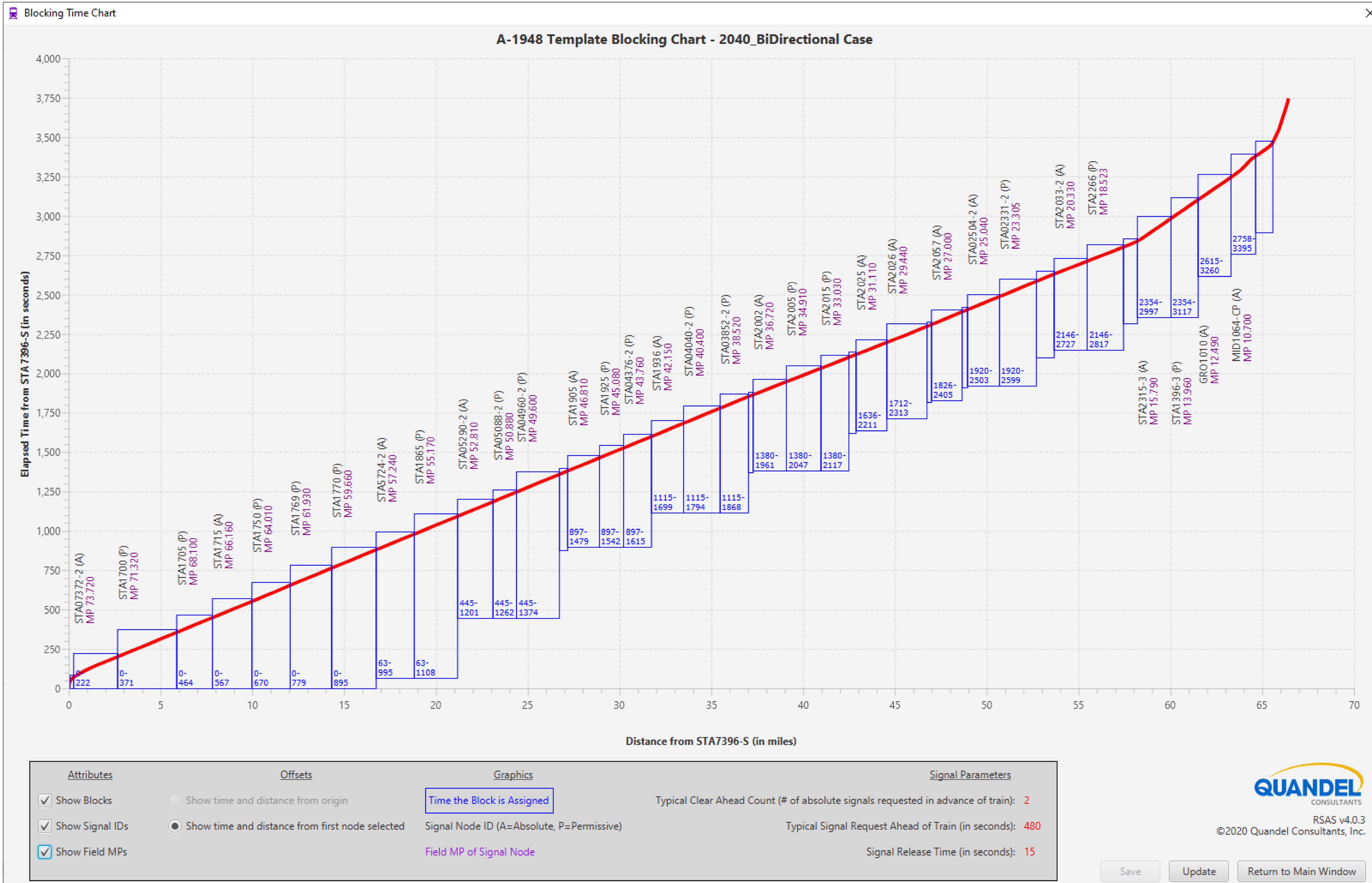

Blocking Time Chart
A-1948 Template Blocking Chart - 2040_BiDirectional Case
Elapsed Time from STA7396-S (in seconds)
Distance from STA7396-S (in miles)
Attributes
Show Blocks
Show Signal IDs
Show Field MPs
Offsets
Show time and distance from origin
Show time and distance from first node selected
Graphics
Time the Block is Assigned
Signal Node ID (A=Absolute, P=Permissive)
Field MP of Signal Node
Signal Parameters
Typical Clear Ahead Count (# of absolute signals requested in advance of train): 2
Typical Signal Request Ahead of Train (in seconds): 480
Signal Release Time (in seconds): 15
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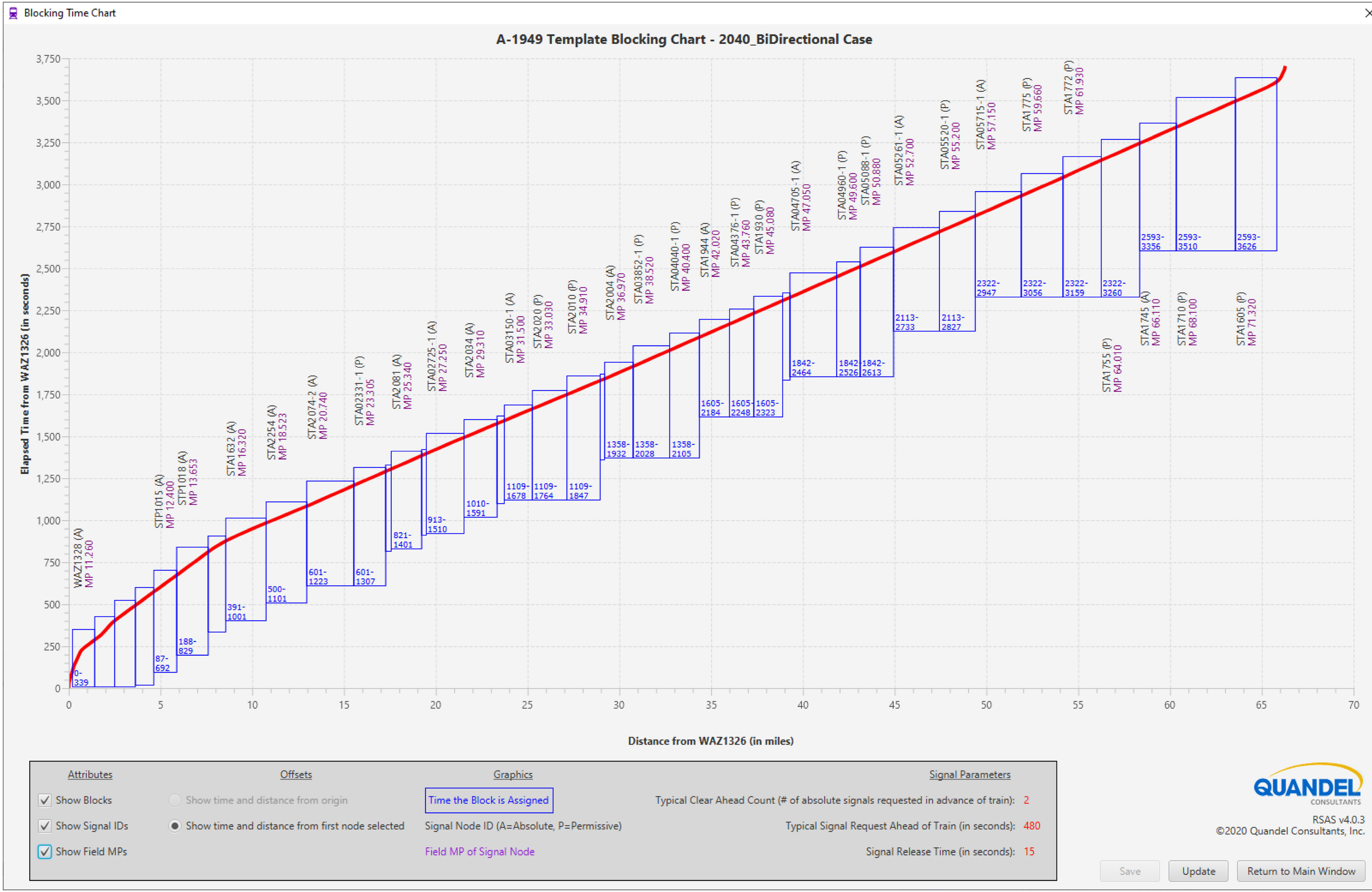
Blocking Time Chart
A-1949 Template Blocking Chart - 2040_BiDirectional Case
Elapsed Time from WAZ1326 (in seconds)
Distance from WAZ1326 (in miles)
3,750
3,500
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
WAZ1328 (A) MP 11.260
STP1015 (A) MP 12.400
STP1018 (A) MP 13.653
STA1632 (A) MP 16.320
STA2254 (A) MP 18.523
STA2074-2 (A) MP 20.740
STA02331-1 (P) MP 23.305
STA2081 (A) MP 25.340
STA02725-1 (A) MP 27.250
STA2034 (A) MP 29.310
STA03150-1 (A) MP 31.500
STA2020 (P) MP 33.030
STA2010 (P) MP 34.910
STA2004 (A) MP 36.970
STA03852-1 (P) MP 38.520
STA04040-1 (P) MP 40.400
STA1944 (A) MP 42.020
STA04376-1 (P) MP 43.760
STA1930 (P) MP 45.080
STA04705-1 (A) MP 47.050
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Show Signal IDs
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Time the Block is Assigned
Signal Node ID (A=Absolute, P=Permissive)
Field MP of Signal Node
Signal Parameters
Typical Clear Ahead Count (# of absolute signals requested in advance of train): 2
Typical Signal Request Ahead of Train (in seconds): 480
Signal Release Time (in seconds): 15
QUANDEL CONSULTANTS
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Attachment 2

RTC Dispatching Details

Technical Documentation on RTC Dispatch Parameters

RTC allows users to adjust dispatch logic parameters to emulate the procedures that a railroad dispatcher would use in the real world. Options under RTC's 'Operating Objectives' menus were adjusted until the dispatch results were similar to what was observed in the field.

As part of the assessment using RTC, the following dispatch objectives were evaluated:

1. Avoid Lateness
2. Minimize Energy Consumption
3. Minimize Crew Expirations
4. Train Rank Dominance
5. Adherence to Train-Type Conflict Delay Caps
6. Maximize Average System Train Speed
7. Maintain Train Order
8. Pacing Preference

Train type operating objectives were also evaluated. These objectives included Dispatch Rank, Dispatch Priority Range, and Target Conflict Delay Cap.

The railroad is double tracked throughout most of the modeling limits and an assortment of trains of varying importance operate on them. Within the model limits, BNSF generally operates trains righthanded and prioritizes passenger traffic and Z-Train traffic. The Z-Train category consists of guaranteed intermodal and mail trains. Although these rules are generally followed, it is important that RTC does not unnecessarily hinder network performance to obey them. Through an iterative process the objectives were adjusted to best replicate operations over the modeling limits.

Dispatch objectives were adjusted to replicate network performance. Maintain Train Order was set as most important; ensuring that trains will not stop on the mainline to allow a trailing, yet more important, train to pass them. Adherence to Train-Type Conflict Delay Caps, Pacing Preference, and Train Rank Dominance were all set at the second most important level; ensuring that train ranking and priority are still factors in dispatching. Avoid Lateness and Maximize Average System Train Speed were set to third most important followed by Minimizing Energy Consumption and Minimizing Crew Expirations.

Train type operating objectives were simplified to maximize the network's output. All freight trains were set with equal train priorities to keep trains operating as they do in the real world. Although train Rank and Priority are the same for all freight trains, the Target Conflict Delay Caps were varied based on each train category's importance. Table 1 summarizes the Target Conflict Delay Caps.

Table 1: Target Conflict Delay Cap Settings

Train Category	Target Conflict Delay Cap (HH:MM)
Bare Table Intermodal, High Priority Merchandise, Intermodal, Guaranteed Intermodal, Stack Train, Vehicle Parts, UPS	1:00
Light Engines, Foreign RR Detour, Local, Merchandise, Empty Grain	2:00
Coal Loads, Grain Loads, Unit Train Excluding Grain or Coal	4:00

The Target Conflict Delay Caps tell the dispatch logic which trains to keep moving and which trains can be stopped to resolve a meet-pass conflict.

Passenger trains were set with the highest priorities and have a Target Conflict Delay Cap of 5 minutes. This ensures trains would not stop along their route. Within the passenger category, Northstar trains were given priority above Amtrak trains because disruptions to Northstar trains can cause network-wide delays.

Northstar Commuter Rail Extension Feasibility Assessment

Appendix G – Technical Memorandum on Conceptual Engineering

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

By

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum provides design documentation for the engineering plans prepared to support the Northstar Commuter Rail Extension Feasibility Assessment. Engineering plans were produced for each proposed capital improvement and are included as Attachment 1 to this Technical Memorandum.

2. Level of Design

Engineering plans were developed at a conceptual level of design. Concept engineering plans are completed at the initial phase of a project to evaluate the feasibility of the project and develop the preliminary costs related to its proposed capital improvements. Concept engineering plans were prepared on scaled orthophoto imagery and show the horizontal alignment and location of design elements including:

- Track
- Turnouts
- Crossovers
- Station Platforms
- Signals
- Highway Rail Grade Crossings
- Fencing

Plans produced for this Feasibility Assessment are for planning purposes only and are not to be used for construction.

3. Base Mapping and Existing Elements

Basemapping and survey are the foundations of civil engineering design. Aerial images were used as basemapping for the Conceptual Level Design Plans. Aerial images were used because they provide enough detail for concept level design. The aerial images were obtained from the National Agriculture Imagery Program and contain geospatial data formatted in the UTM coordinate system using the North American Datum of 1983 (NAD83). The images were used to extract the existing conditions of the railroad. During future project phases, a full ground or LiDAR survey would be needed to create basemapping acceptable for use in final design plans used for construction. Although the locations of features extracted from the aerial images are not exact, they are appropriate for use in assessing the feasibility of the capital improvements and estimating capital costs.

4. Design Standards

Concept Level Design Plans must follow a design standard to ensure their designs are practical and conform with the surrounding rail network. Each railroad has its own design standards that are followed for any construction on their property (right-of-way). BNSF Railway's (BNSF's) standards were used for development of concept level plans.

Concept Level Design Plans present a plan view of the proposed capital improvements. Design standards used for horizontal alignment, horizontal clearances, and turnout sizes are as follows:

- **Horizontal Alignment:** "BNSF Design Criteria for Speed and Curvature – BNSF Engineering Instructions 5 Track Geometry", Appendix A (12/2008) and Appendix B (10/2007)
- **Clearance:** "BNSF Standard Plans – Clearance Requirements by State" (10/1997) & "BNSF Standard Plans – Minimum Clearance Diagram" (10/1997)
- **Turnouts:** "BNSF Standard Plan for No. 11, 15, 20 and 24 Turnouts" (09/2009 & 05/2008)

These standards are included as Attachments 2, 3, and 4.

5. Signal Design

The concept engineering plans show existing and proposed signal locations. Existing signals were located using track charts provided by BNSF, aerial imagery, and information gathered during field visits. The proposed signal design includes removal, relocation, and modification to existing signals and installation of new signals. The final location of signals and signal equipment will be determined by BNSF's signal engineers during PE or final design.

6. Station Design

One station was proposed to be constructed and one station was proposed to be expanded to support implementation of expanded Northstar service. Detailed station designs were not prepared. The concept engineering plans include a general footprint of the proposed St. Cloud Station, Big Lake Station center platform, and associated track and signal work. Site, structural, and architectural elements were not designed. The station designs contain enough to assess their feasibility and complete a high-level cost estimate.

7. Presentation of Concept Engineering Plans

Concept engineering plans are presented in Attachment 1 for the following capital improvements:

- St. Cloud Improvements
- CP MP 66 Upgrade
- New Control Point at Becker
- Big Lake West Siding
- Big Lake Station Track Connection
- Big Lake Station Expansion
- Big Lake Maintenance Facility Expansion
- Third Main Track CP Coon Creek to CP Interstate
- Third Main Track CP Interstate to CP Van Buren
- Two Main Tracks CP Van Buren to CP Stadium

Attachment 1

Conceptual Engineering Plans

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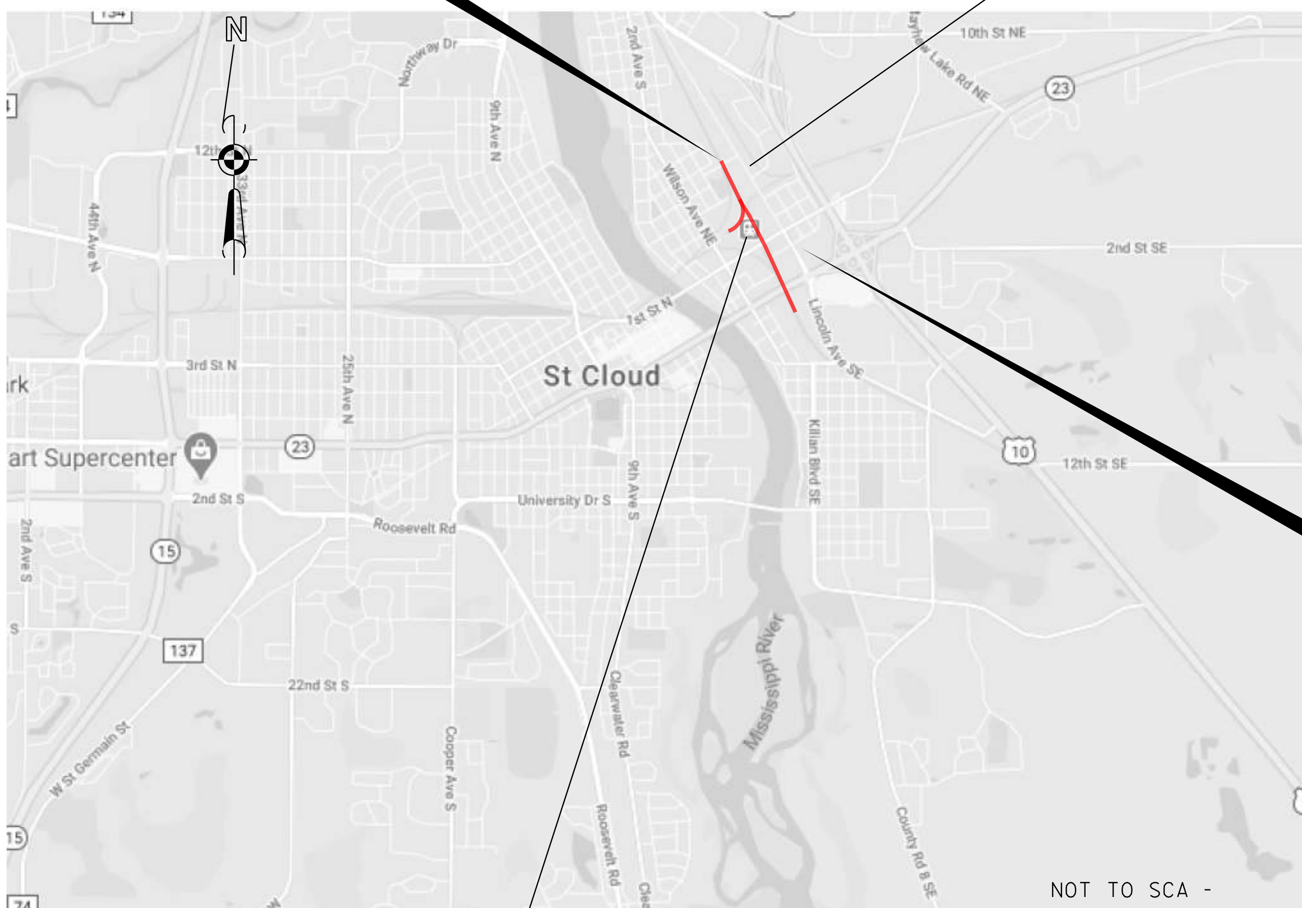

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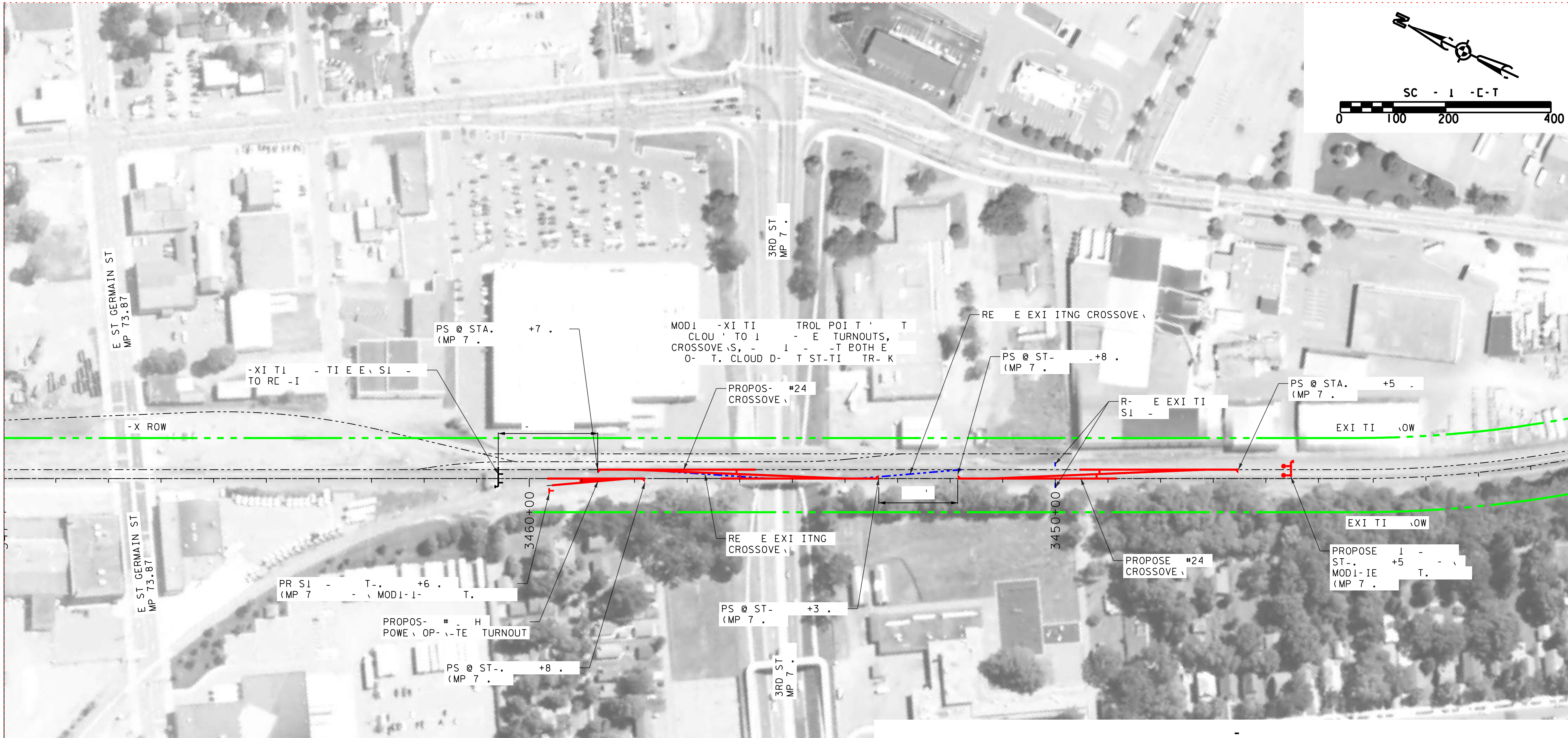

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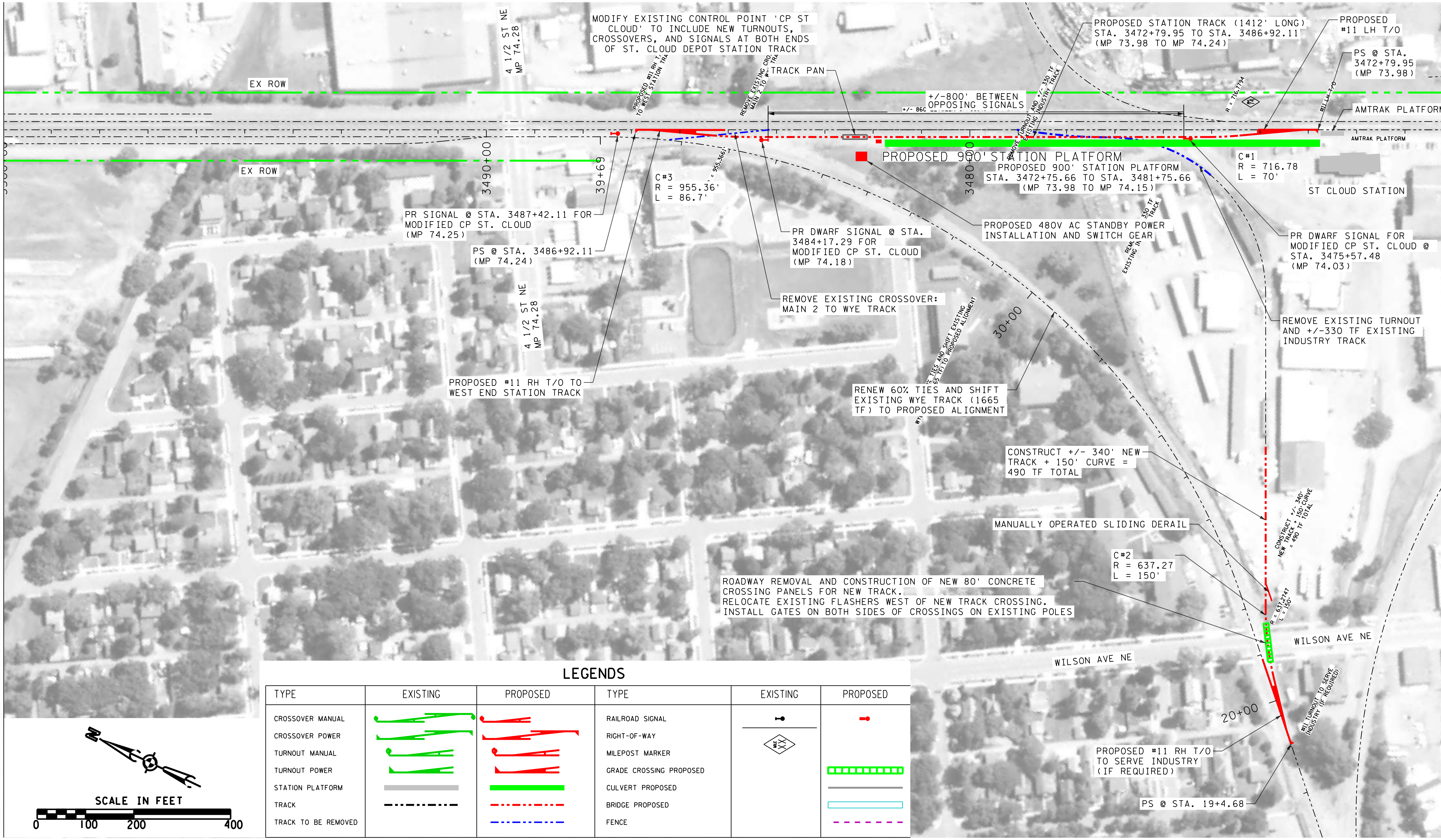

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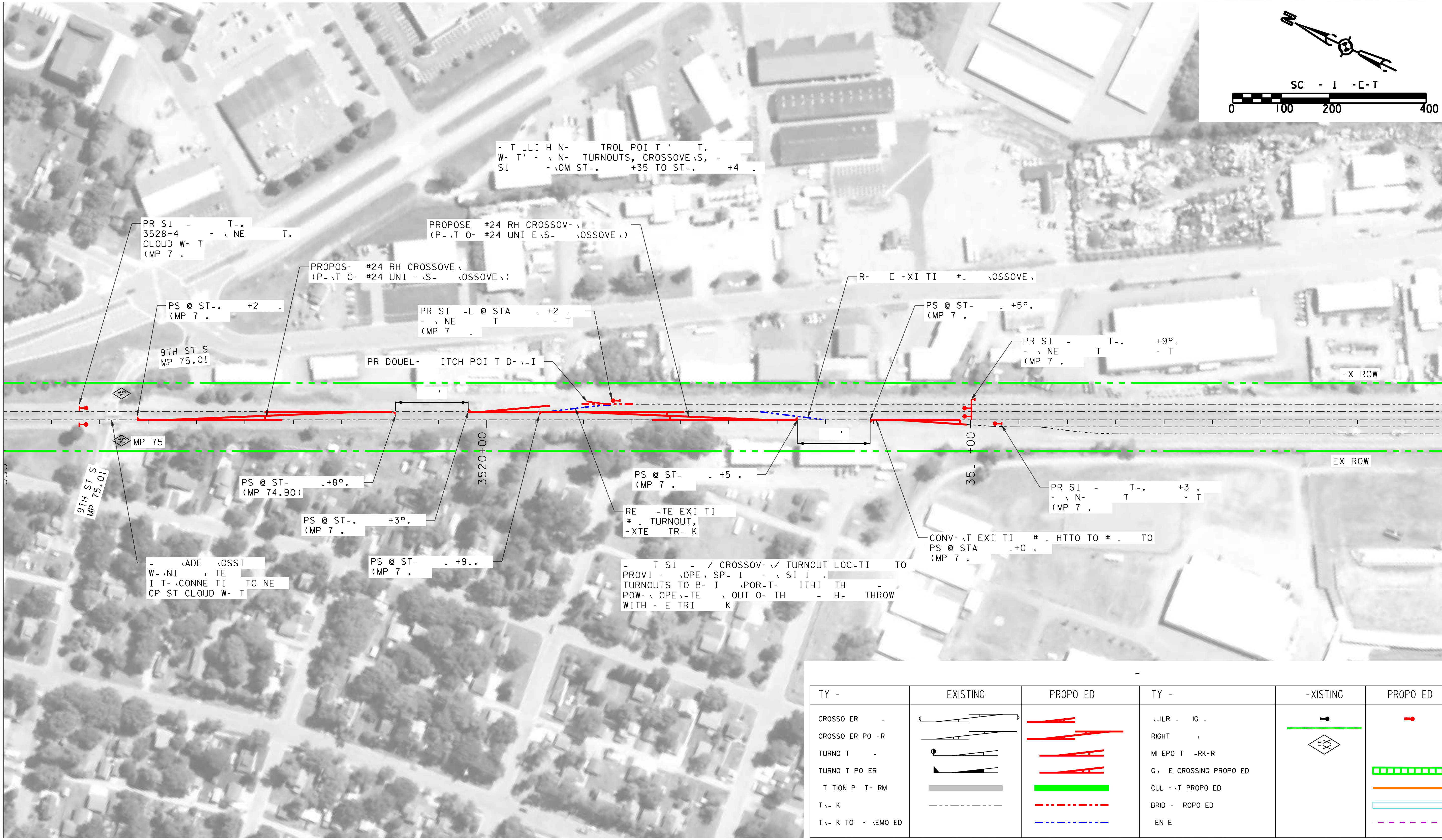

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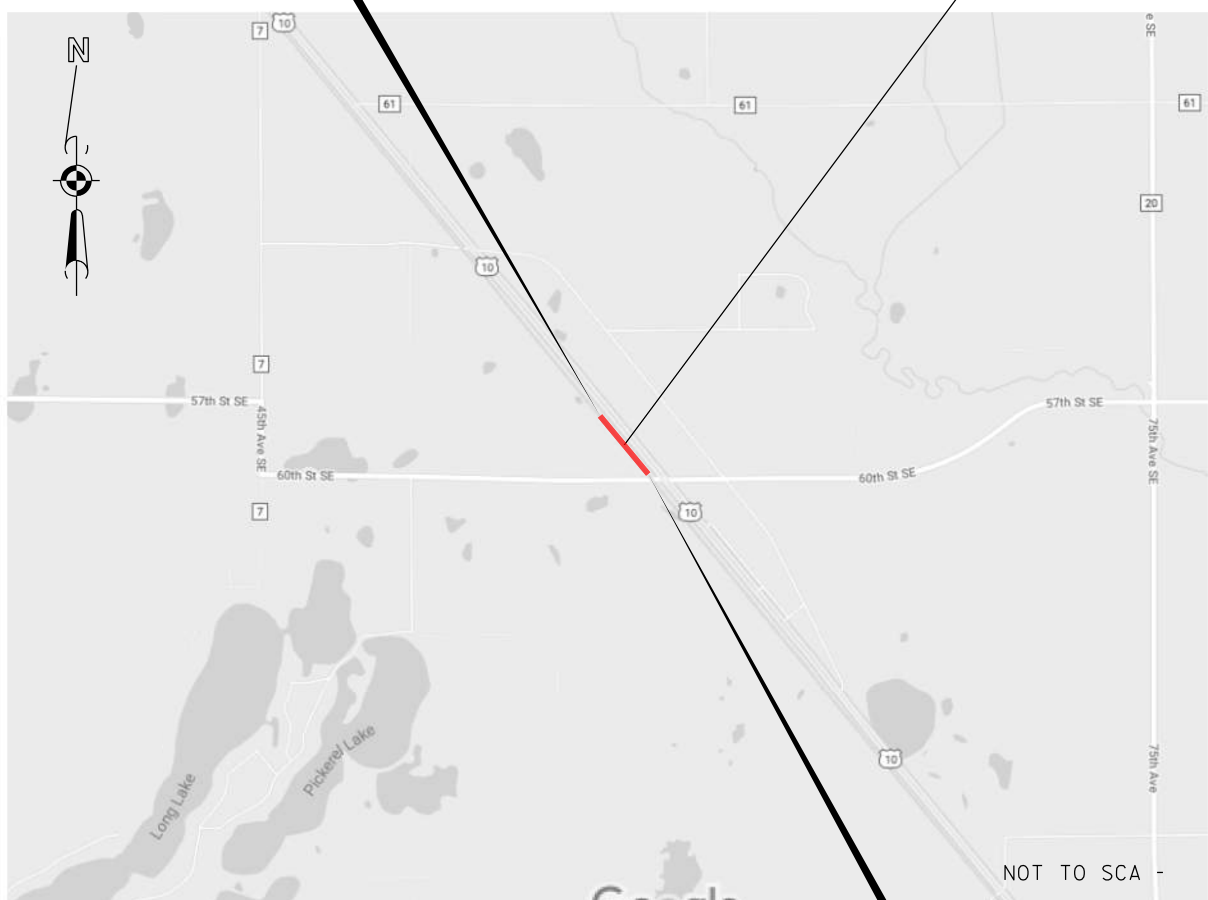

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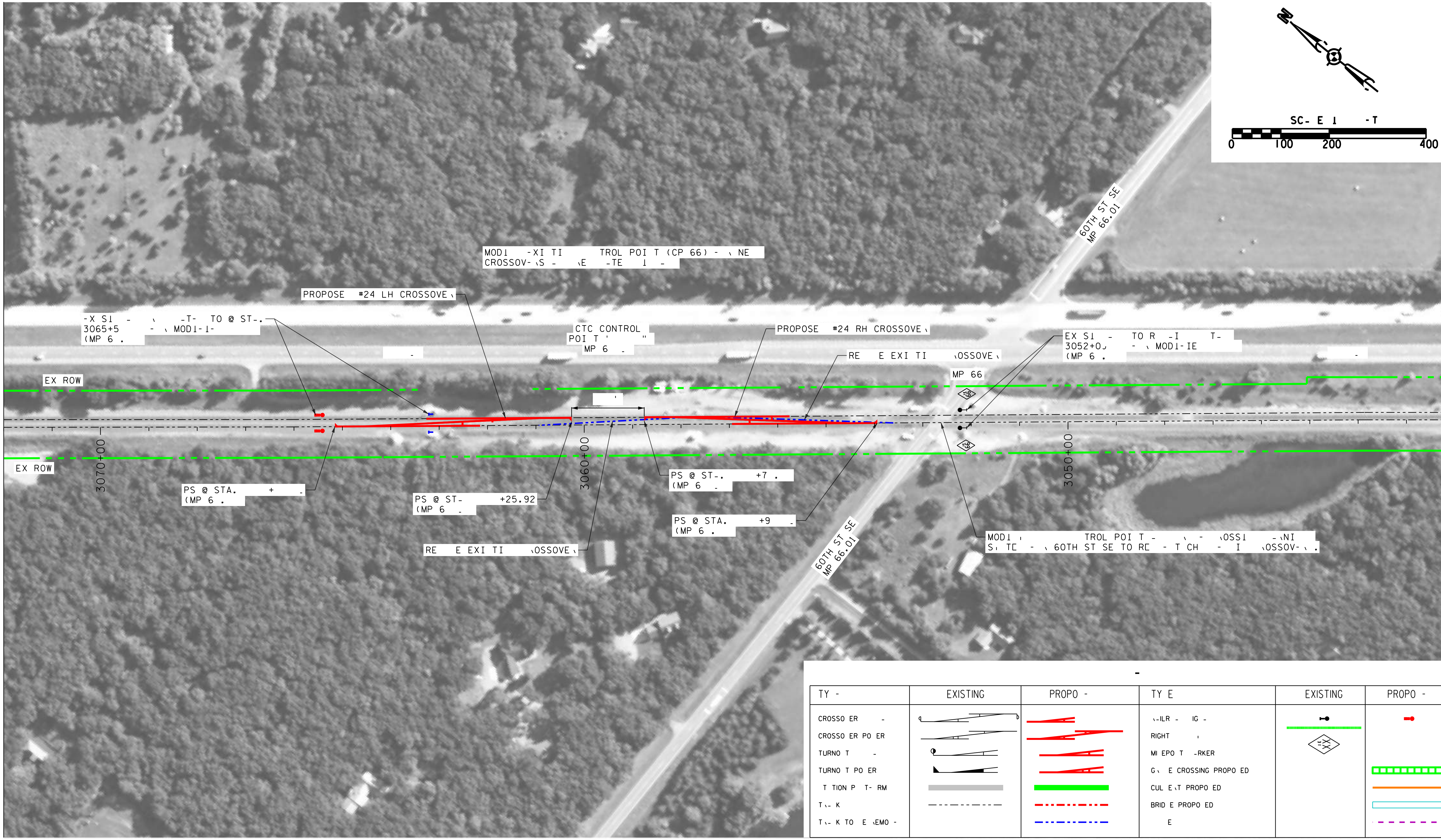

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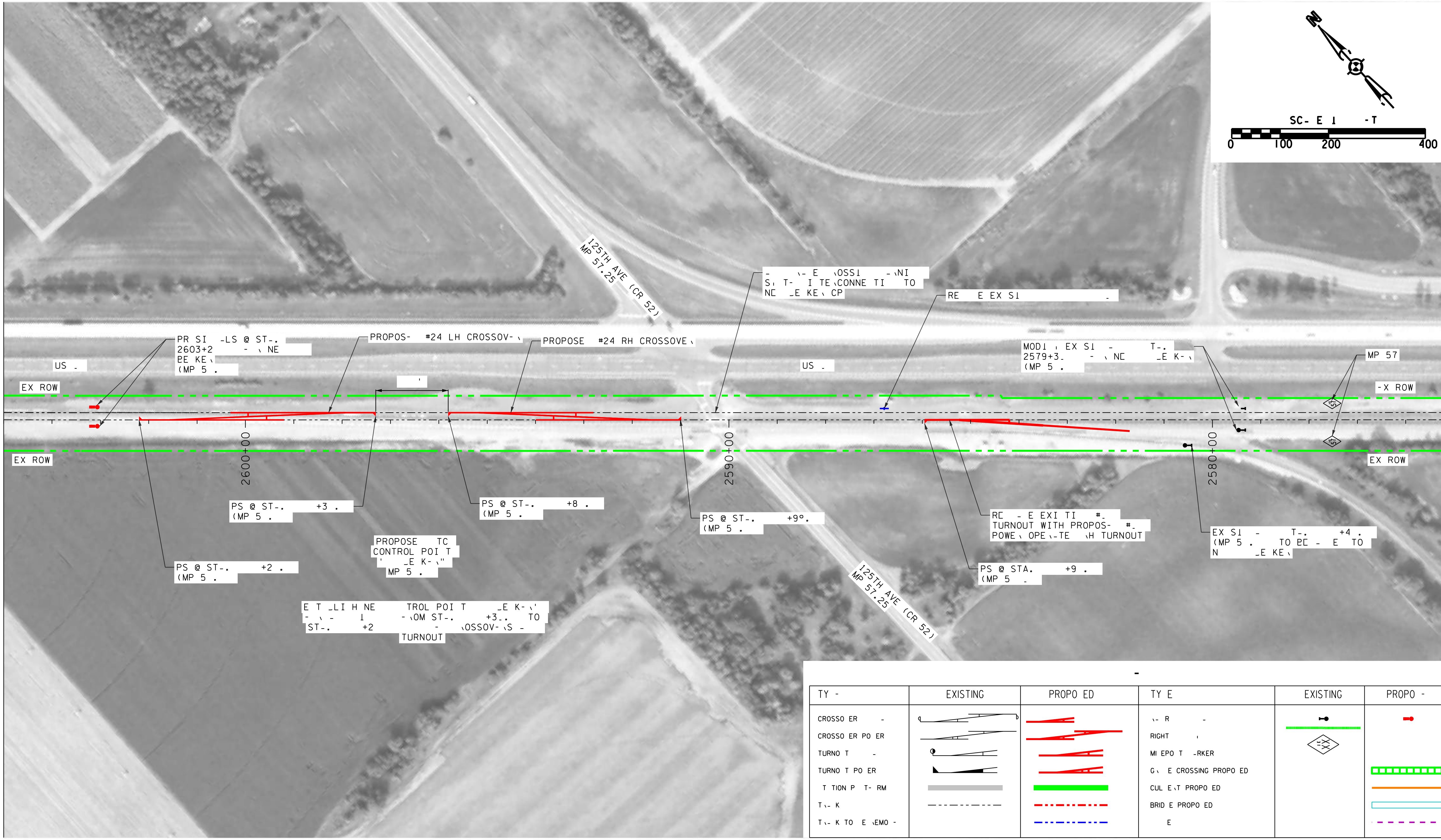

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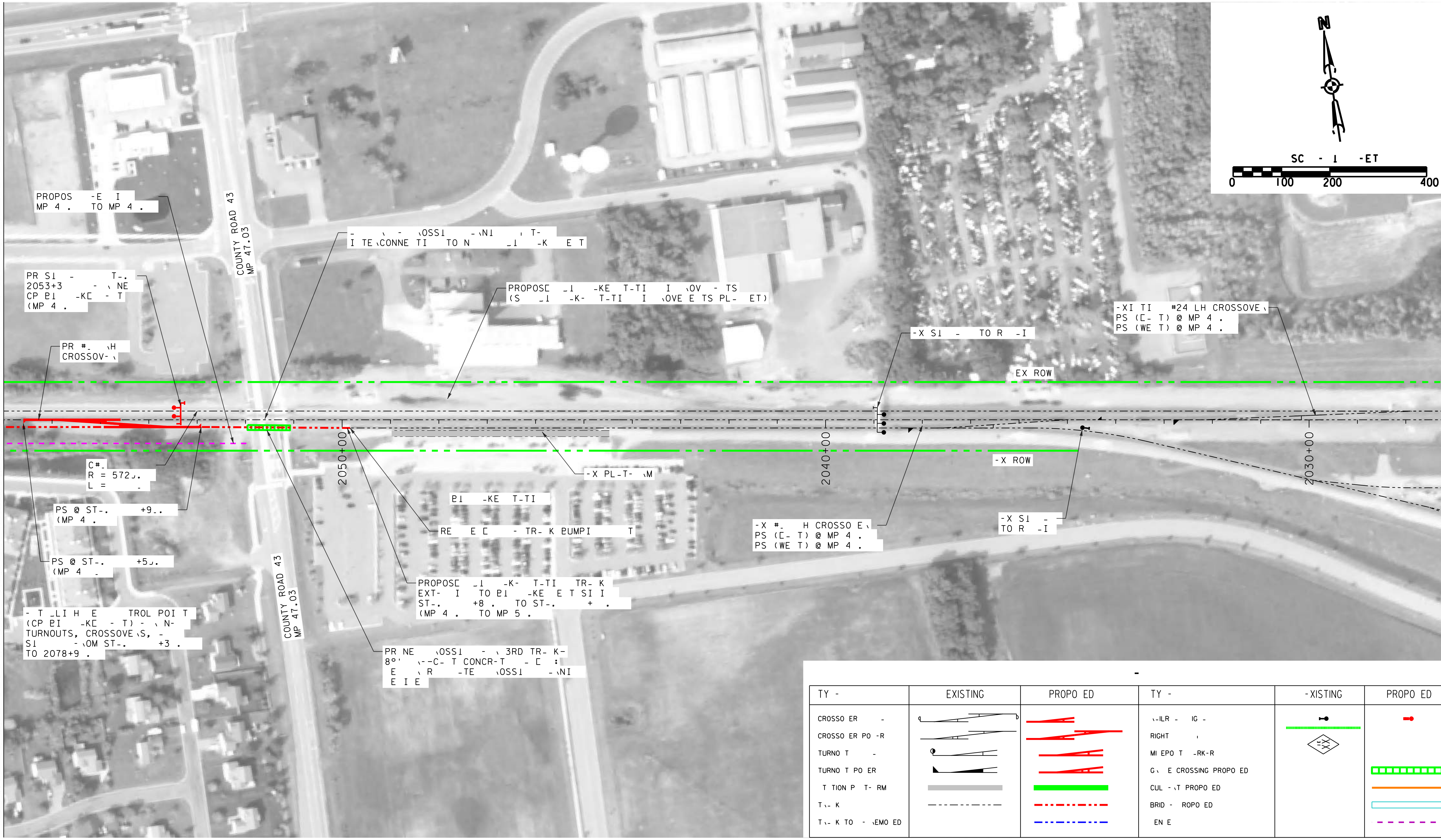

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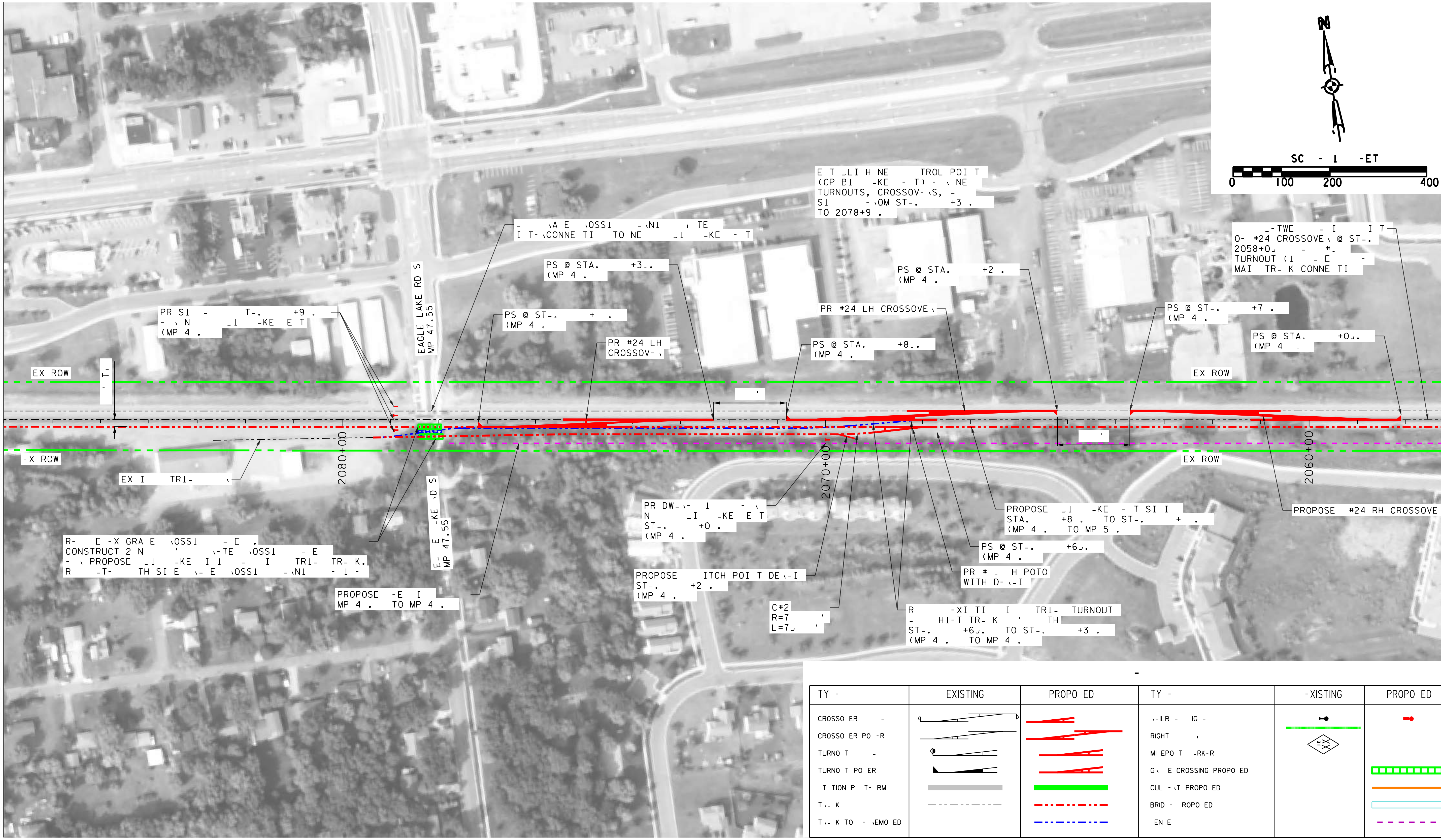

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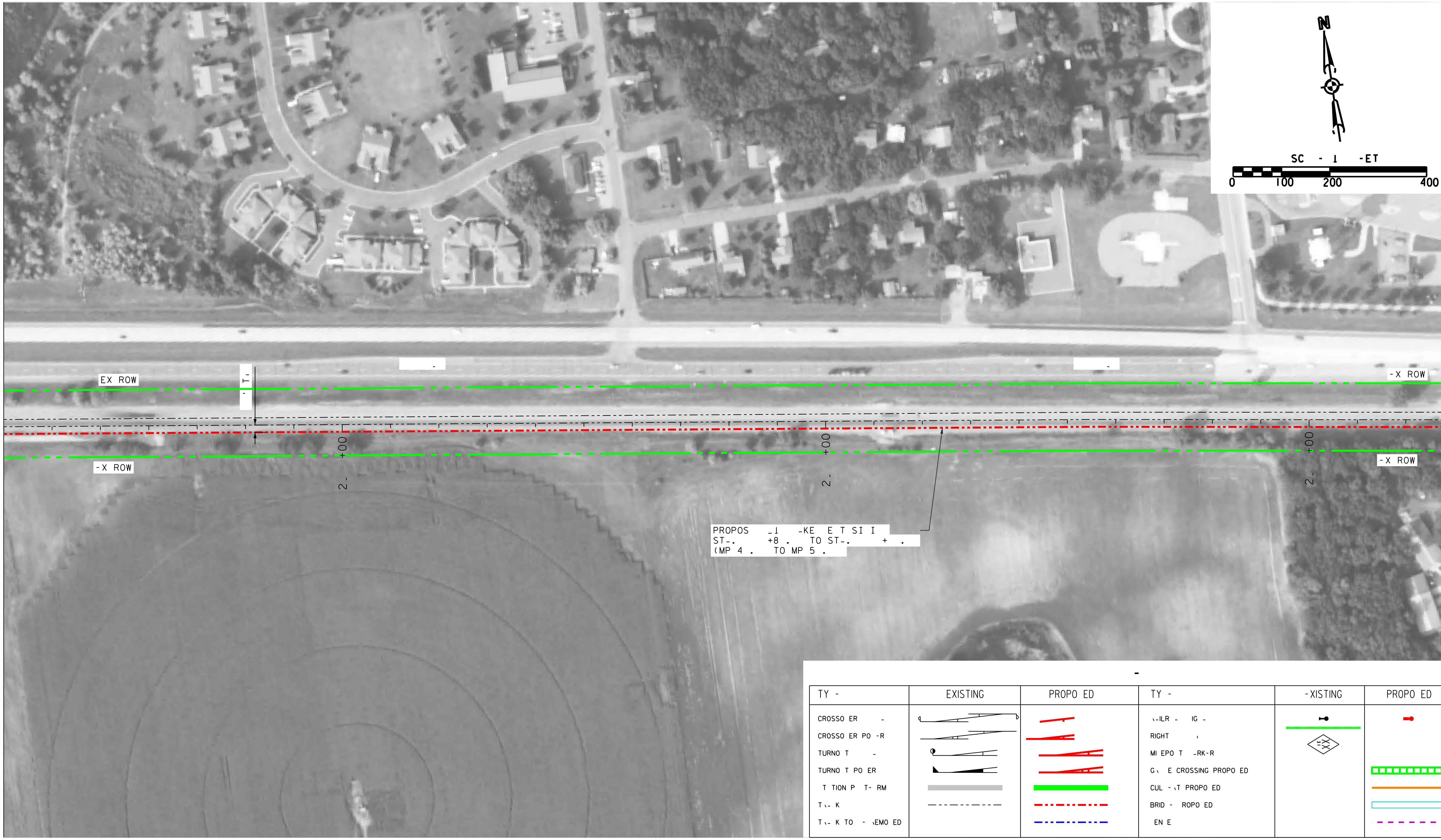

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DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE WEST SIDING
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SHEET N . 5 OF 13

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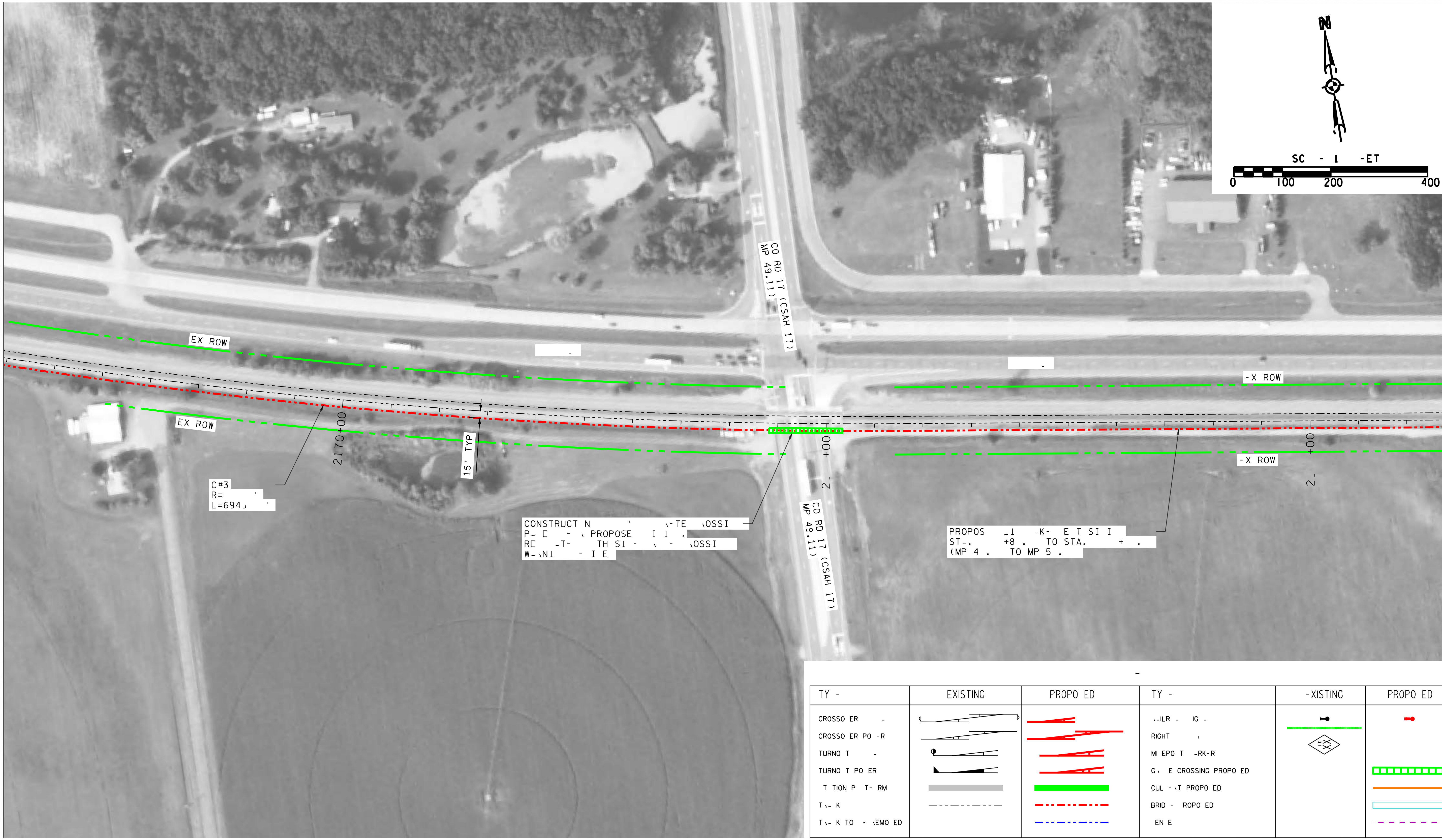

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DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE WEST SIDING
ST .

SHEET N .
6
OF
13

PRO - T: NORTHSTAR COMMUT-R RAI - XPANSION STUDY
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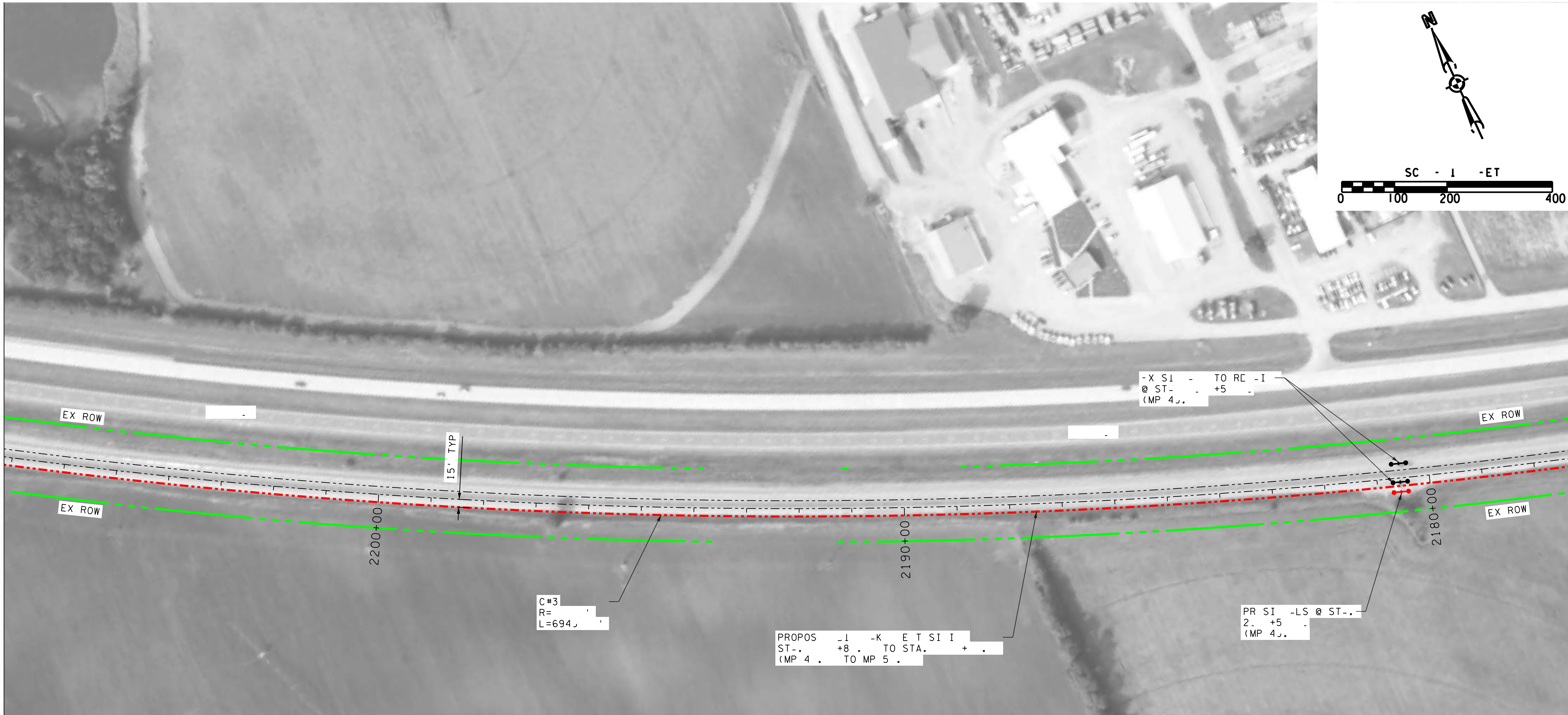

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DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE WEST SIDING
ST .

SHEET N .
7
OF
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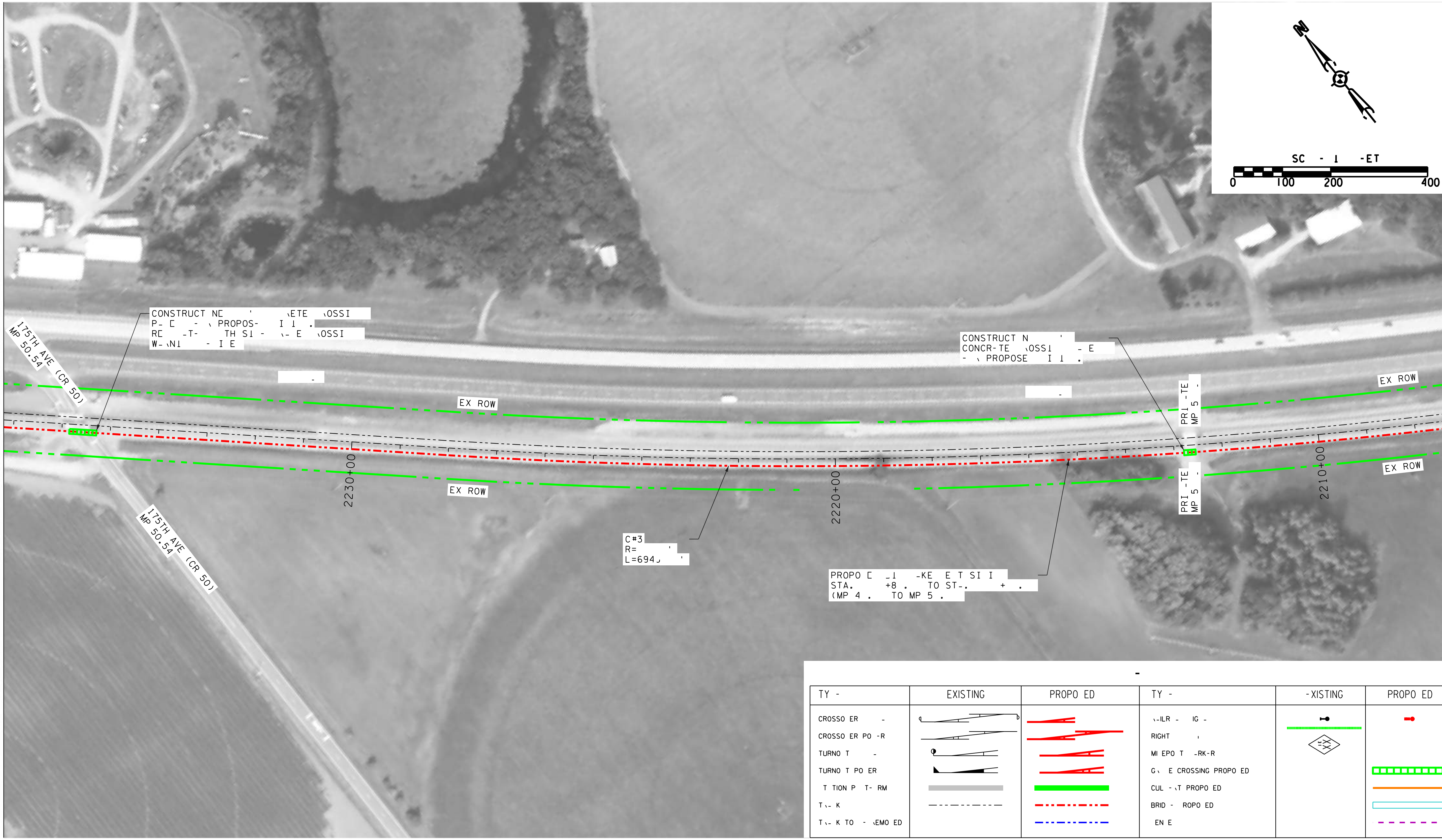

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DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE WEST SIDING
ST .

SHEET N .
8
OF
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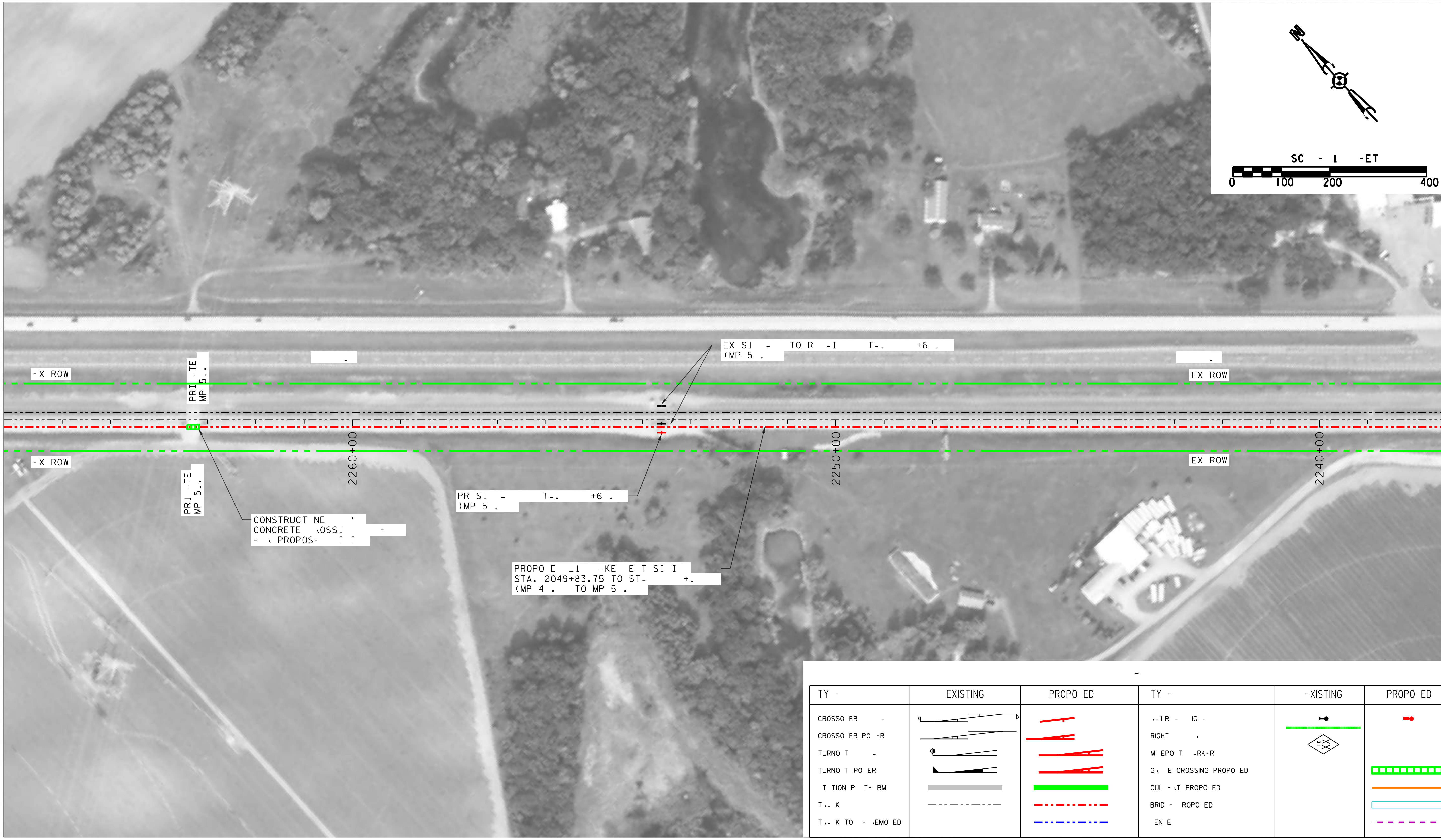

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QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL
EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE WEST SIDING
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9
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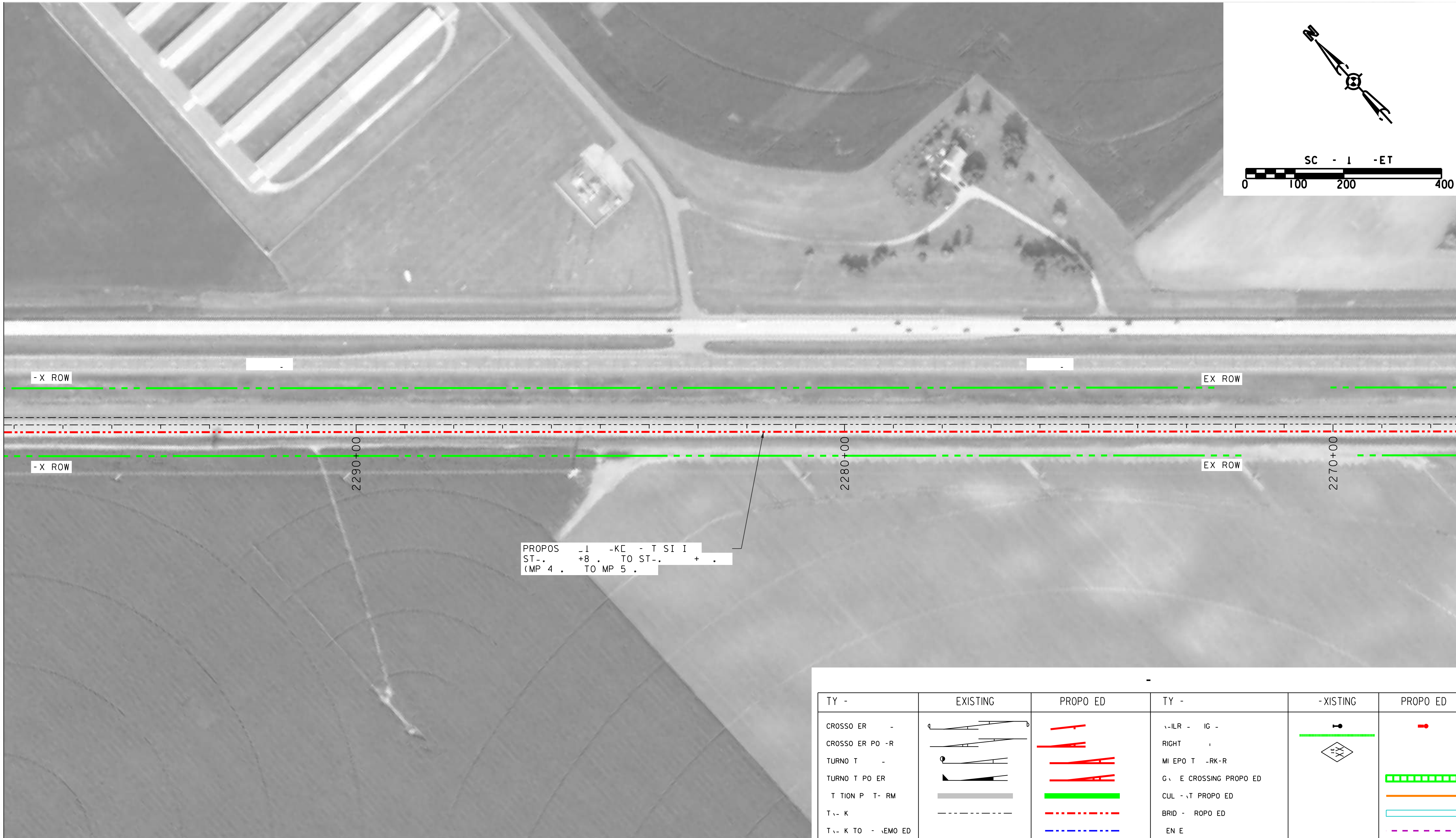

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QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE WEST SIDING
ST .

SHEET N . 10 OF 13

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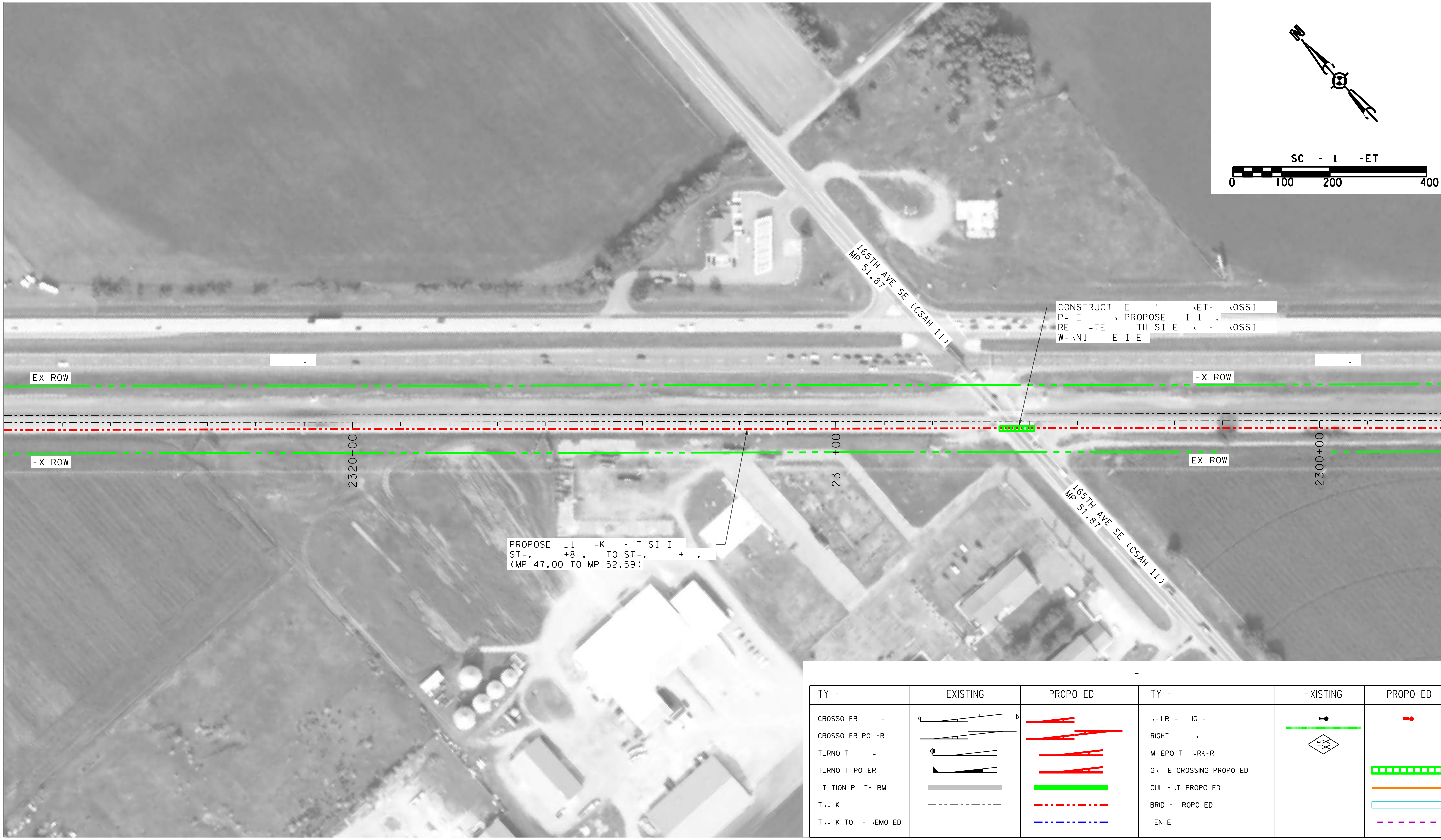

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QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE WEST SIDING
ST .

SHEET N . 11 OF 13

PRO - T: NORTHSTAR COMMUT-R RAI - XPANSION STUDY
PLOT NA - Big Lake We t Siding Plans t
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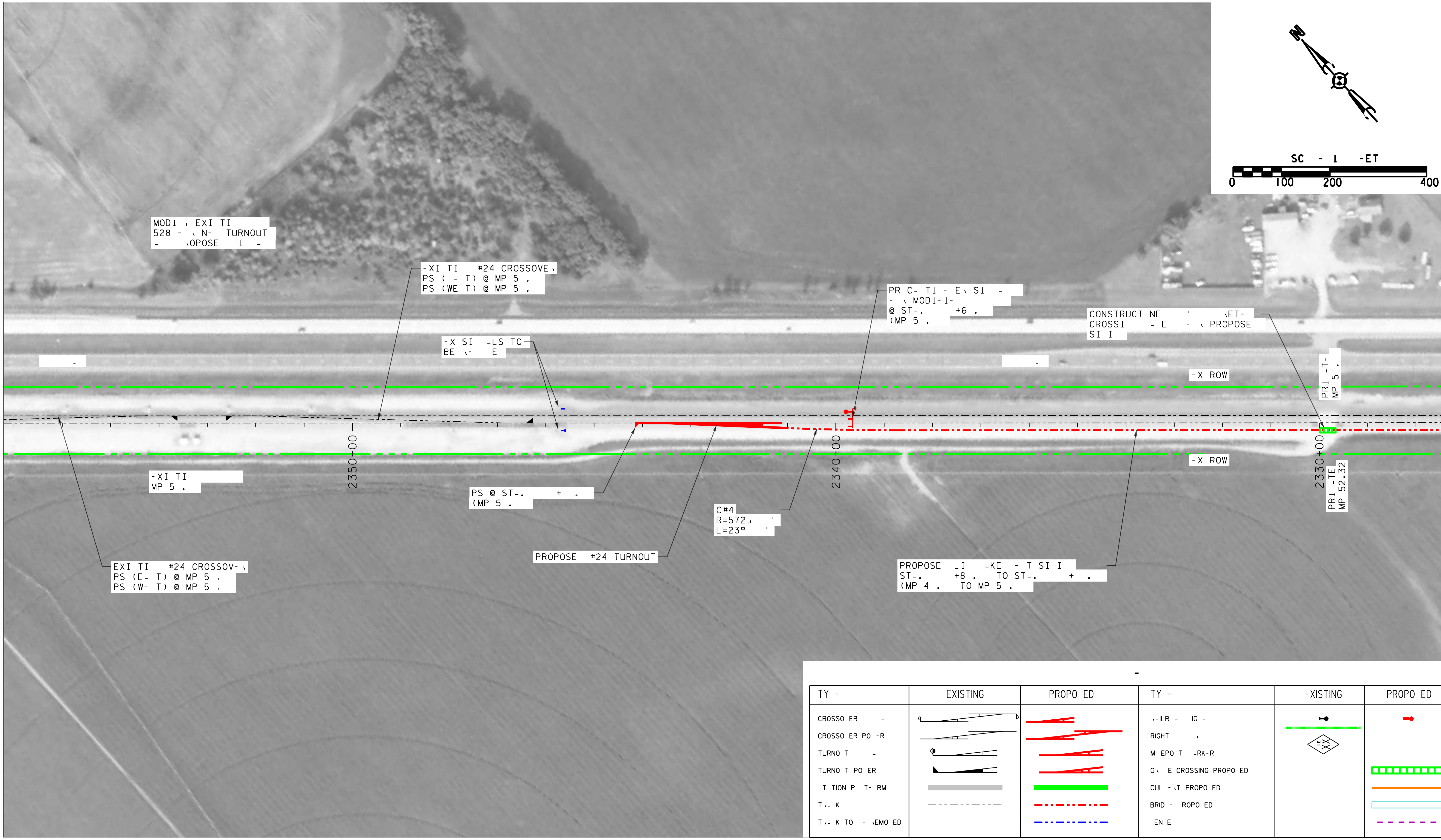

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QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE WEST SIDING

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SHEET N . 12 OF 13

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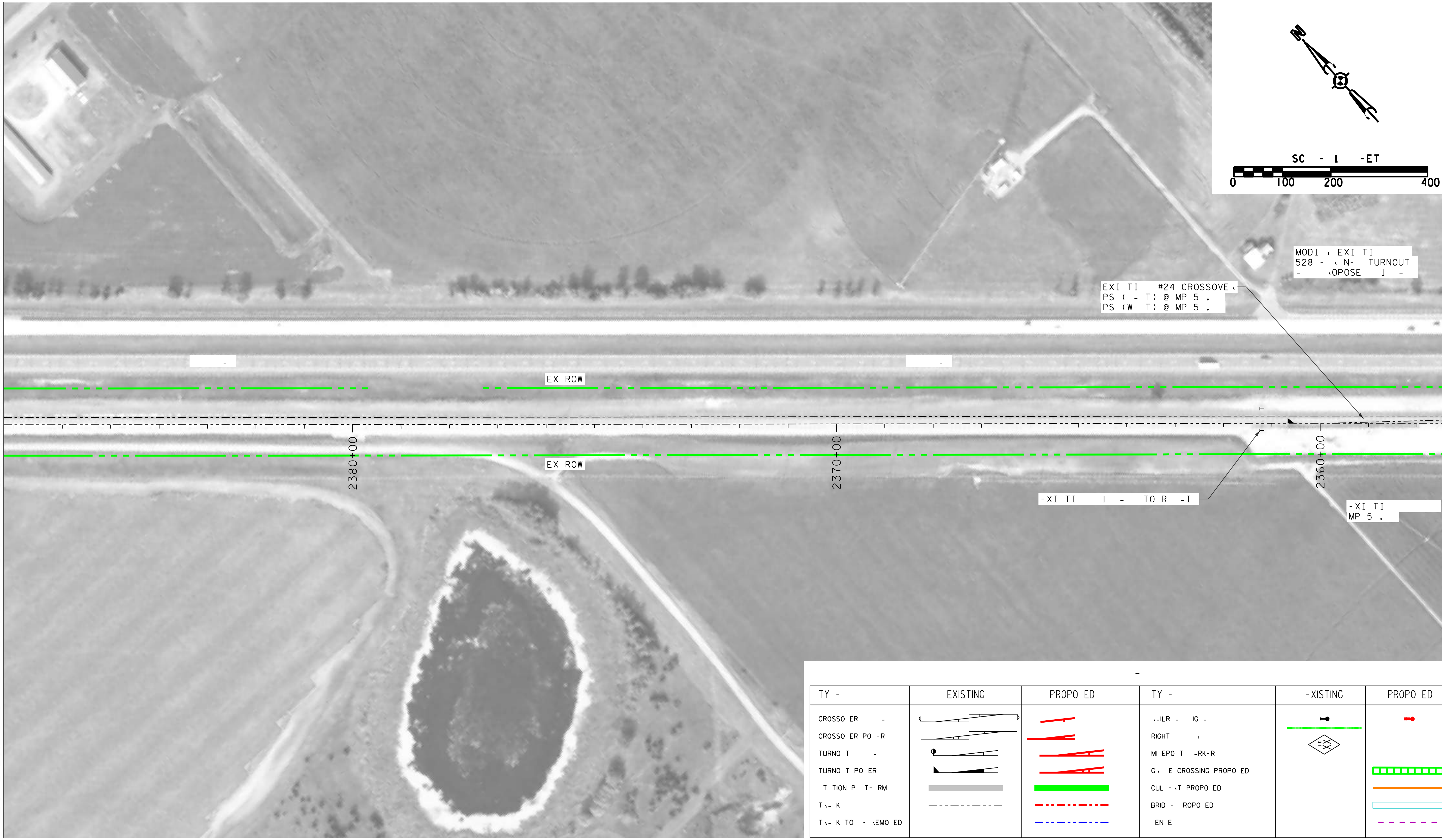

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QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE WEST SIDING

ST .

SHEET N . 13 OF 13

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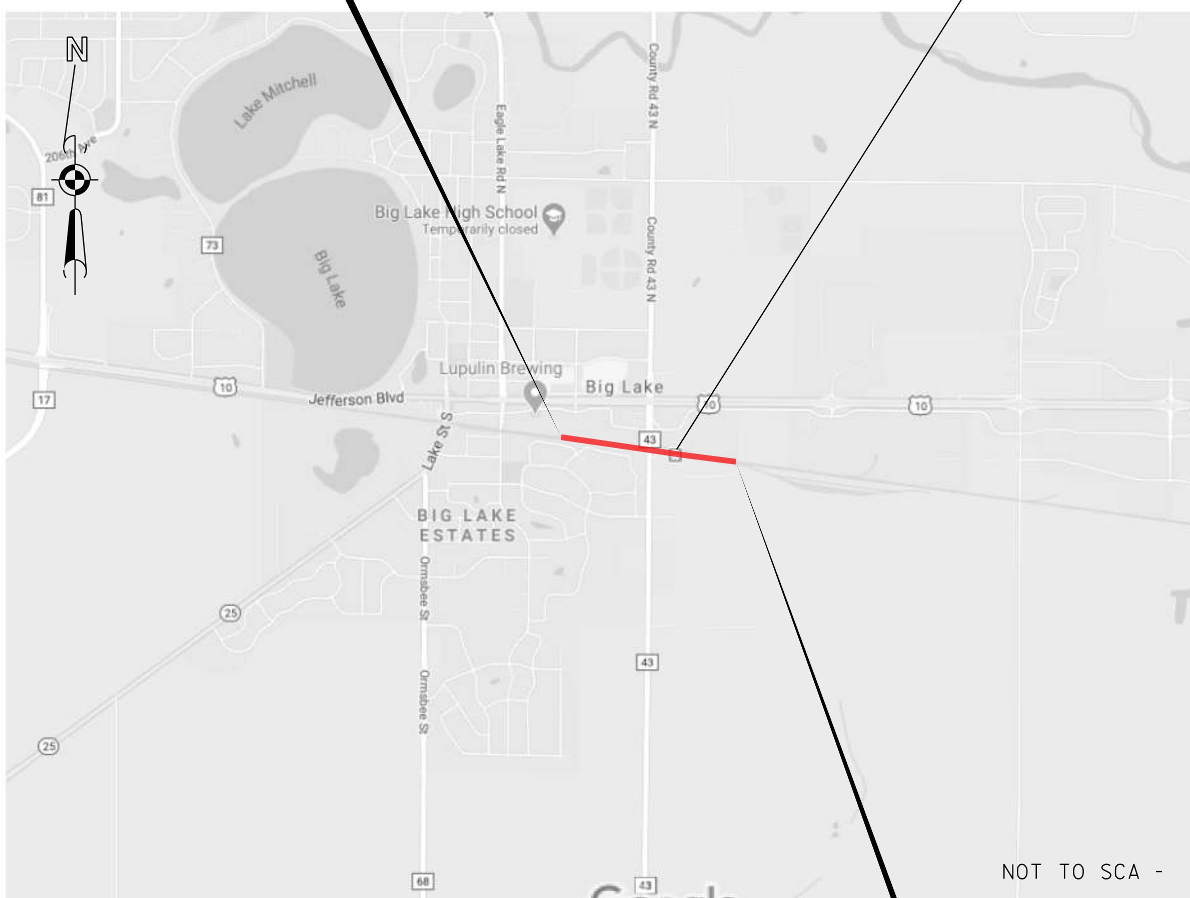

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SHERBURNE COUNTY
BIG LAKE TOWNSHIP

STATE FUNDS

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INDEX

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QUA I
CONSULTANTS

CON - TUAL - I

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DEPARTMENT OF
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TE	SHEET N .	- RO -R
3/16/2020	- HEETS	MKJ
4/14/2020	- HEETS	MKJ

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COUNTY : SH-RBUR -
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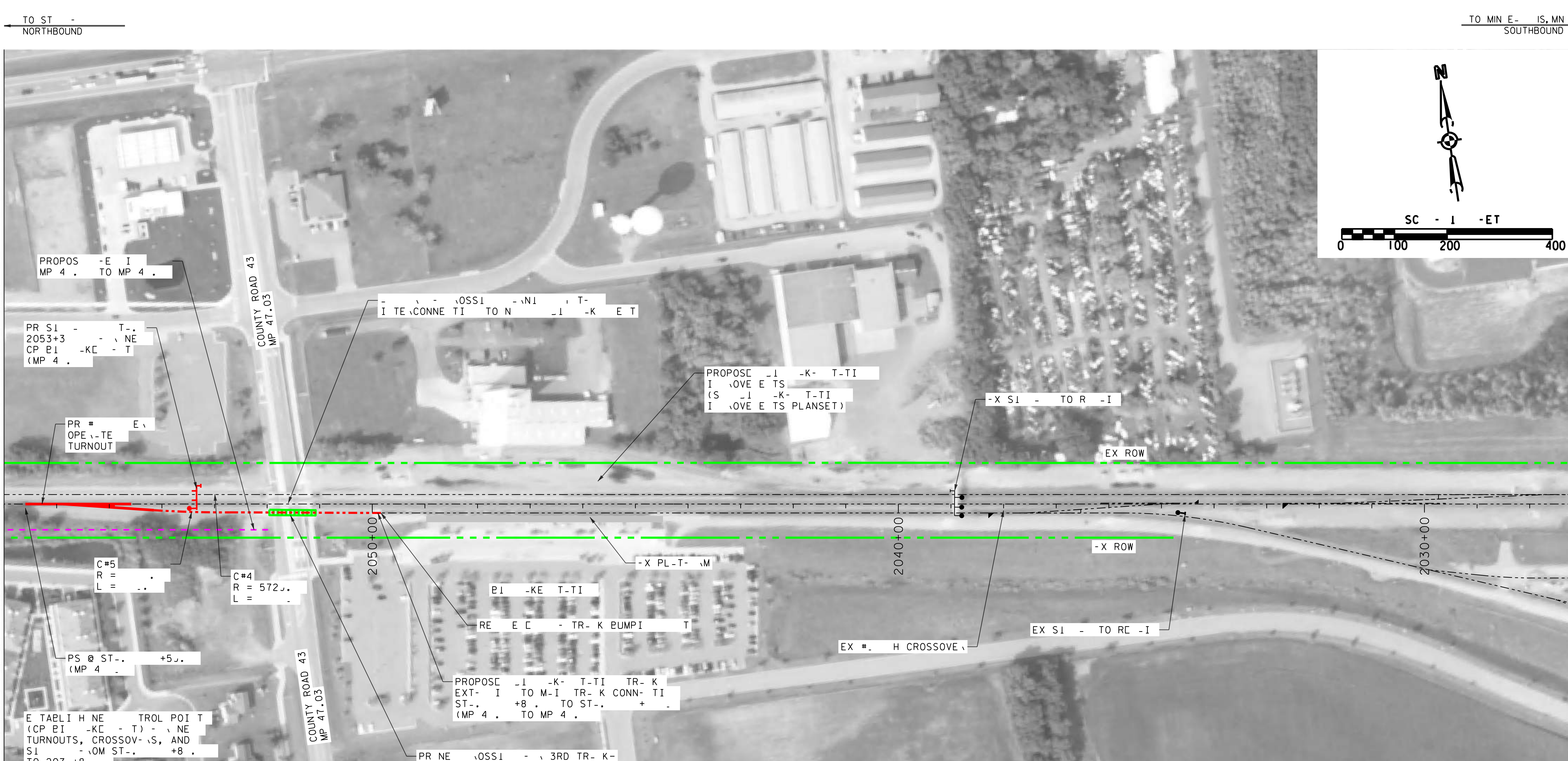

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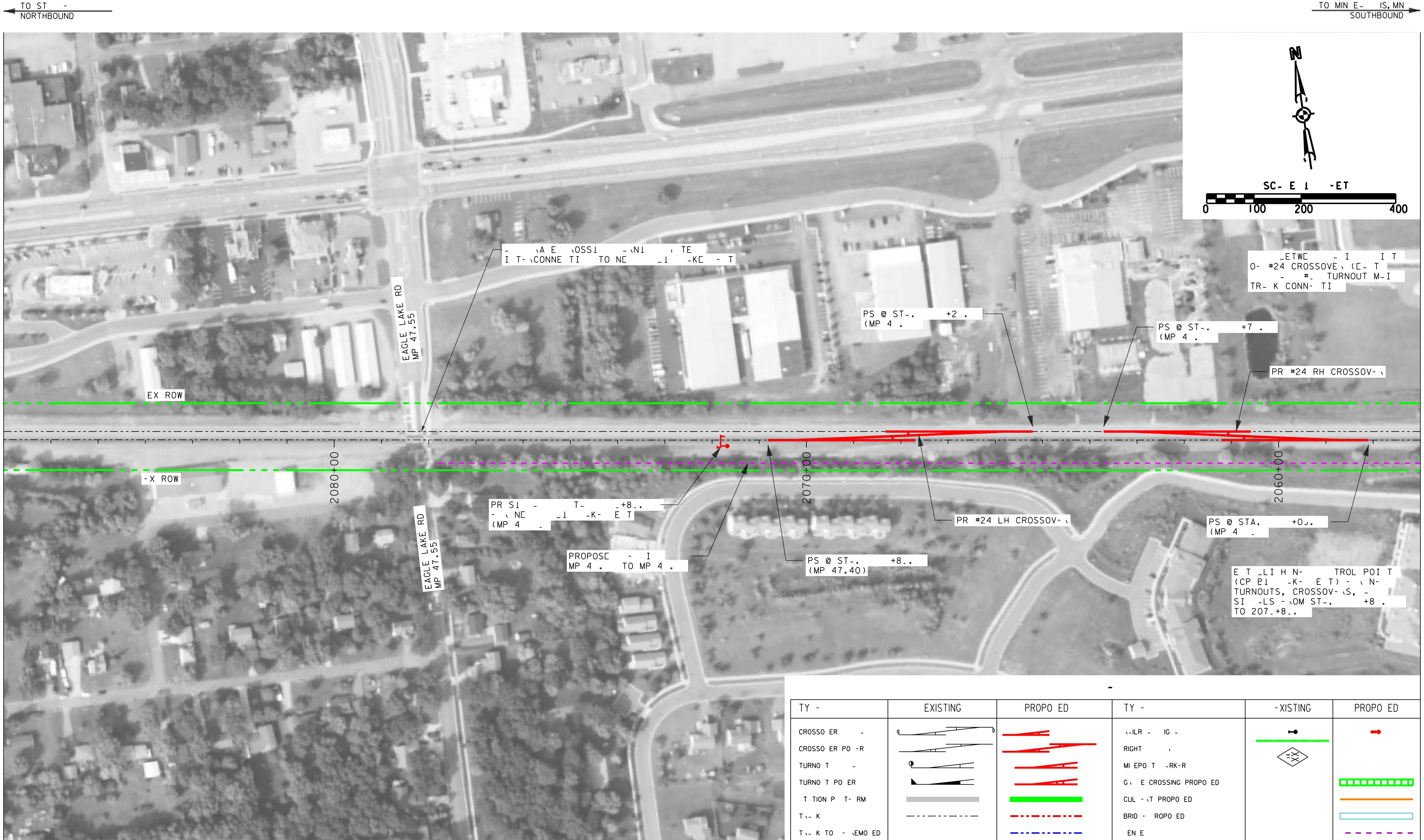
STATE PRO .
QUA I CONSULTANTS
DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE STATION TRACK CONNECTION ST .

SHEET N . 2 OF 3



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2	DR-T 2	SP	SP	4/14/2020

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STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE STATION TRACK CONNECTION ST .

SHEET N . 3 OF 3

PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Big Lake Conne tion Plans t
- IG - I - C:\Users\spadmanabhan\Box\QConsult\Proje ts_Larg -1les\1909_North tar\700 CADD\She ts\Big Lake Conne tion\BL Conne tion Plans t 3.dgn
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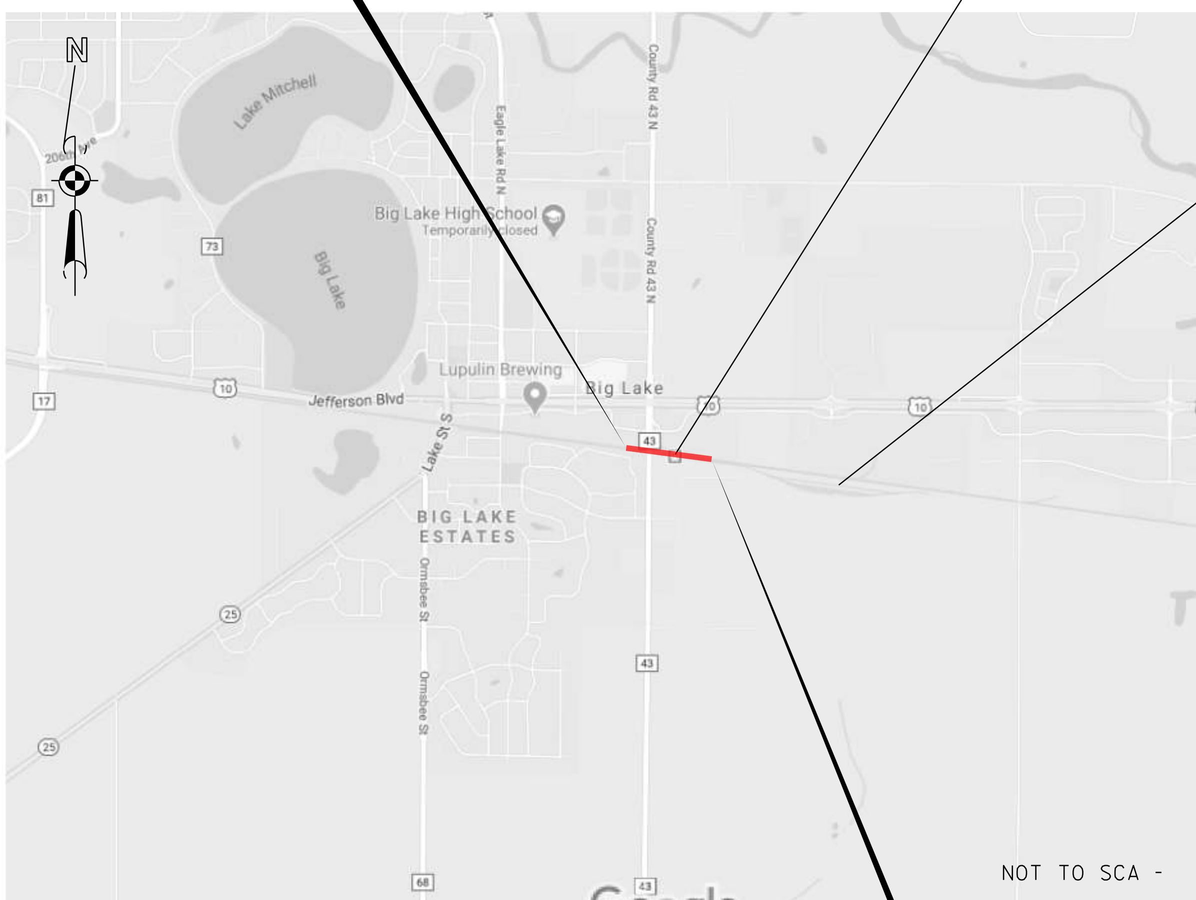

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SHERBURNE COUNTY
BIG LAKE TOWNSHIP

STATE FUNDS

GOVERNING SPECIFICATIONS

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INDEX

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QUA I
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CON - TUAL - I

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STATE PRO .   SHEET N . 1 F 4 SHEETS

PLOTT- / - / - 7/8/2020
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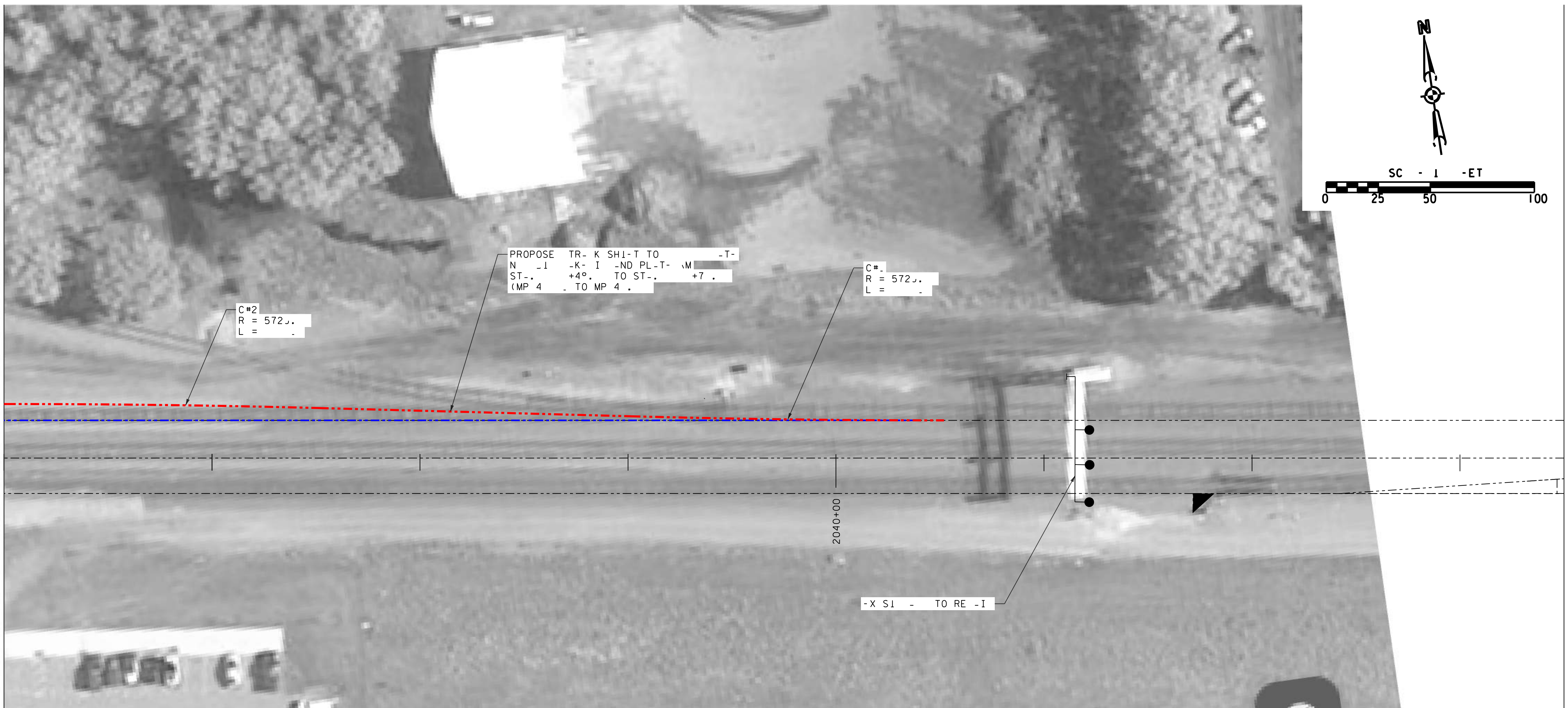

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QUA I CONSULTANTS

mn DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE STATION EXPANSION ST .

SHEET N . 2 OF 4

PRO - T: NORTHSTAR COMMUT-R RAI - XPANSION STUDY
PLOT NA - Big Lake t itlon Plans t
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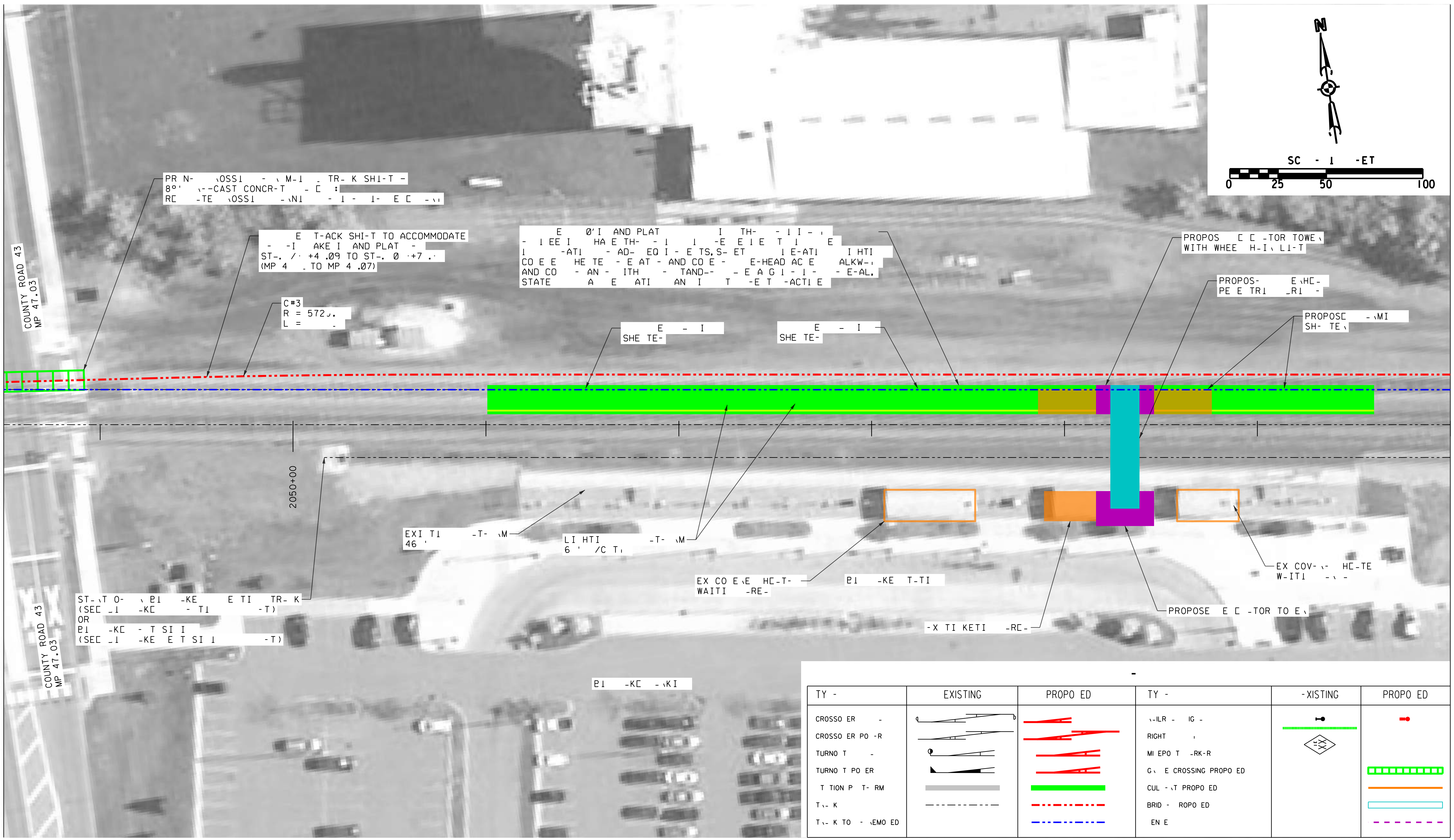

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DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE STATION EXPANSION

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SHEET NO. 3 OF 4

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NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE STATION EXPANSION
ST .

SHEET N . 4 OF 4

MINN- O-A - - -MEN- OF -I -N I -A I N
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LOC-T- -NS T- E -DIVISION - OM MP 4 TO MP 4 .

BIG LAKE MAINTENANC FACILITY
MP 4 .

END TRACK WORK
MP 4 .

NOT TO SCA -

BEGIN TRACK WORK
MP 4 .

SHERBURNE COUNTY
BIG LAKE TOWNSHIP

DEPARTMENT OF TRANSPORTATION

STATE FUNDS

GOVERNING SPECIFICATIONS

THE 201 EDITI - THE MI - T - T T - T - RT TI
- T -RD S - I-I TI - R CONSTRU TI - H ER .

INDEX

H - .	- I TI
1	TIT E SH ET
2 - 3	P ET

THI AN CONTAI 3 H -TS

QUA I CONSULTANTS

CON - TUAL - I

NOT FOR CONSTRUCTION

P - -E I I		
TE	SHEET N .	- RO -R
3/16/2020	- HEETS	MKJ
4/14/2020	- HEETS	MKJ

I EX - NO S E

PRO - T LOCATI
COUNTY : SH-RBUR -
DI TRI T : 3B

- R P TI ITIES EE TECH I -
STATE PRO .
CHAR E I - TI-I-R

STATE PRO .

SHEET N . 1 F 3 SHEETS

PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
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PLOTT - - 7/8/2020

PRO - T: NORTHSTAR COMMUT-R RAI - XPANSION STUDY
PLOT NA - Big Lake Mai tenanc -acility
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PLOTT- /\- I - 7/8/2020

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N .	\EVI I	BY	-	-T-
1	DR--T 1	RWN	SP	3/16/2020
2	DR--T 2	SP	SP	4/14/2020

ESI E : RWN
CH- K :
D\ : RWN
- RO - :

STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
BIG LAKE MAINTENANCE FACILITY EXPANSION
ST .

SHEET N .
2
OF
3

PRO - T: NORTHSTAR COMMUT- R RAI - XPANSION STUDY
PLOT NA - Big Lake Mai tenanc -acility
- IG -I - C:\Users\spadmanabhan\Box\0Consult\Proje ts_Larg -1les\909_North tar\700 CADD\She ts\Big Lake tc Facility\BLM-- lans t 3.dgn
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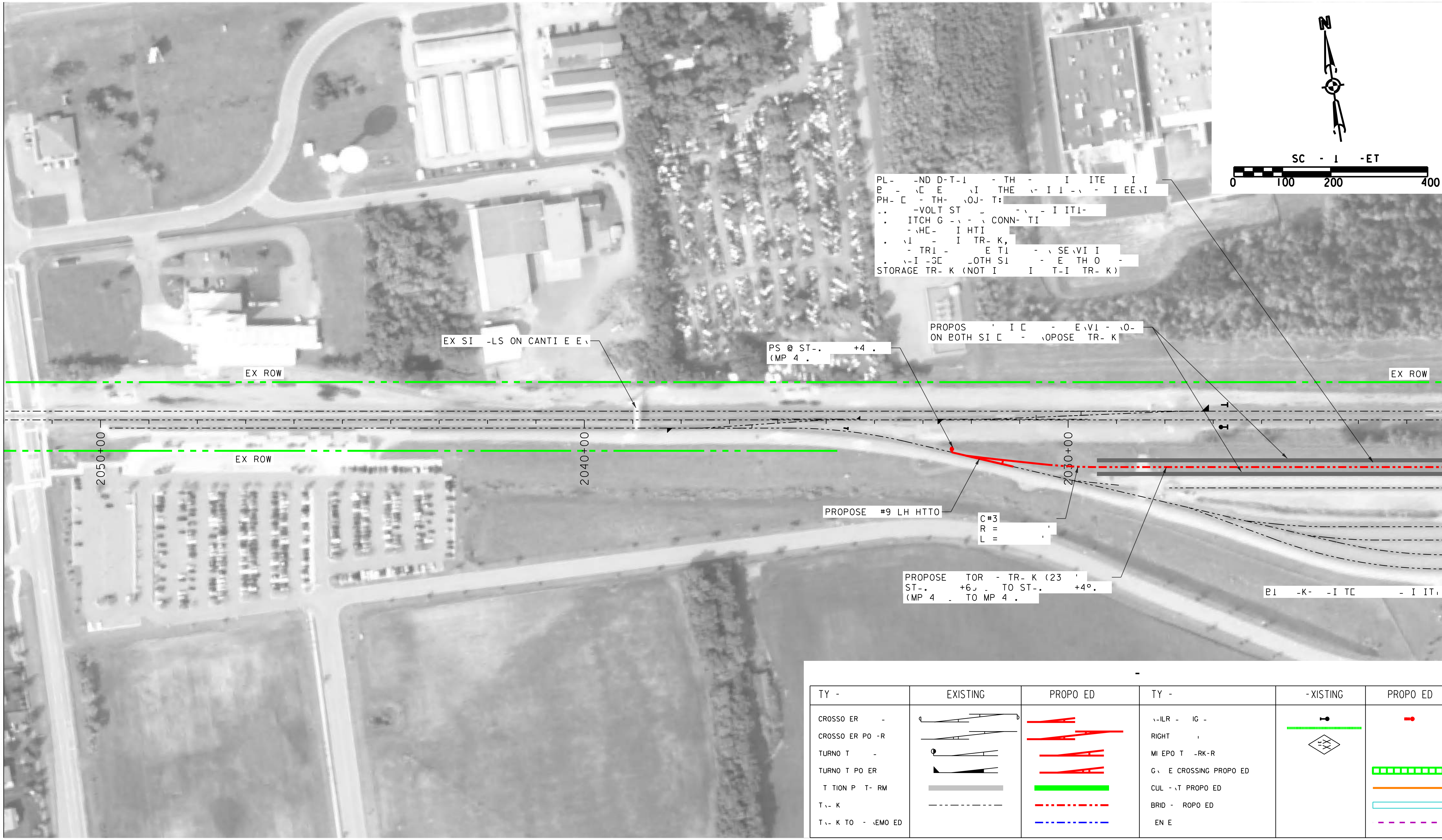

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1	DR--T 1	RWN	SP	3/16/2020	RWN	
2	DR--T 2	SP	SP	4/14/2020	D\ : RWN	- RO - :

STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS BIG LAKE MAINTENANCE FACILITY EXPANSION ST .

SHEET N . 3 OF 3

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LOC-T- PNS T- E DIVISION - OM MP TO MP 21.

STATE FUNDS

GOVERNING SPECIFICATIONS

THE 201 EDITI - THE MI - T T T - T - RT TI
T -RD S - I-I TI - R CONSTRU TI H ER .

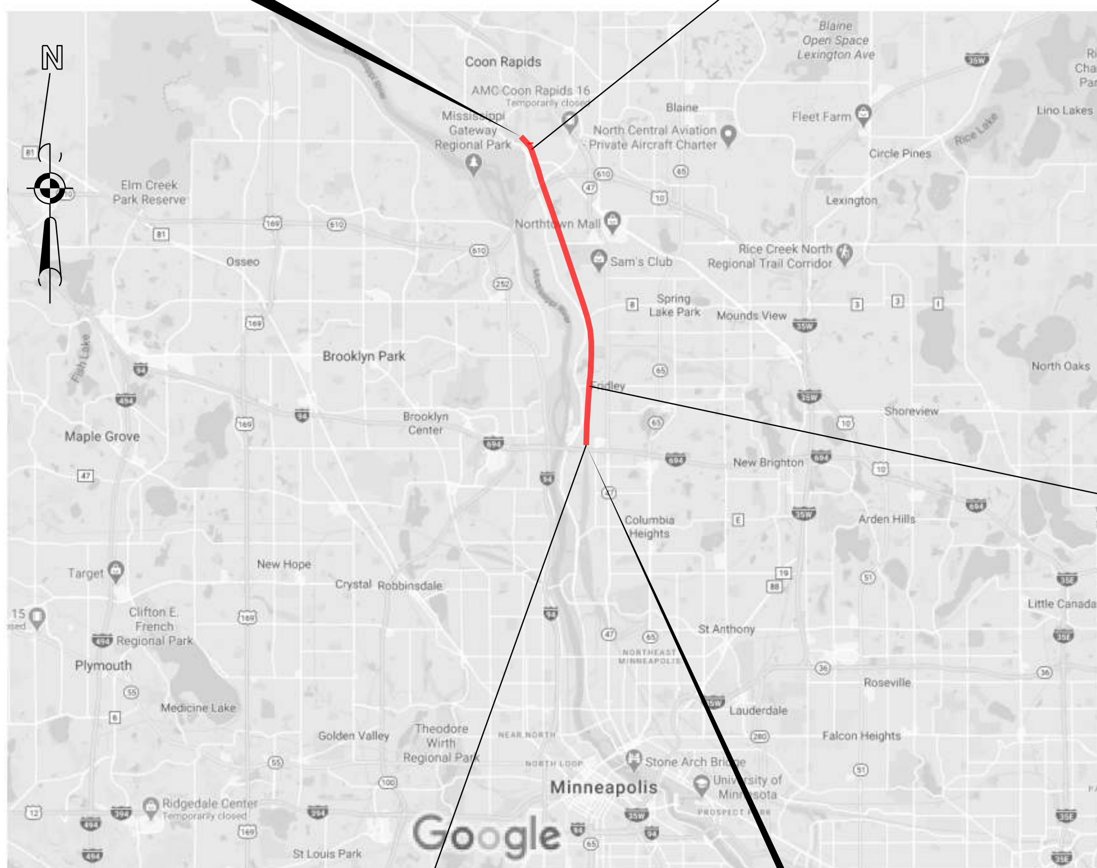
INDEX

H T	TI
1	TIT E SH ET
2 - 12	P ET

THI AN CONTAI 12 H -TS

END TRACK WORK
MP 21.

CP COON CREEK
MP 21.10



FRIDLEY STATION
MP 1 .10

CP INTERSTATE
MP 1 .

BEGIN TRACK WORK
MP 1 .

NOT TO SCA E

ANOKA COUNTY
CITY OF FRIDLEY
CITY OF COON RAPIDS

QUA I CONSULTANTS

CON - TUAL - I
NOT FOR CONSTRUCTION

DEPARTMENT OF TRANSPORTATION

PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main l Plans t
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PLOTT- / - / - 7/8/2020

P - E I I		
TE	SHEET N .	- RO -R
4/17/2020	- HEETS	MKJ

I EX - NO S E

PRO - T LOCATI
COUNTY : ANOKA
DI TRI T : ETRO

- R P TI ITIES EE TECH I -
STATE PRO .
CHAR E I - TI-I-R

STATE PRO .
SHEET N . 1 F 12 SHEETS

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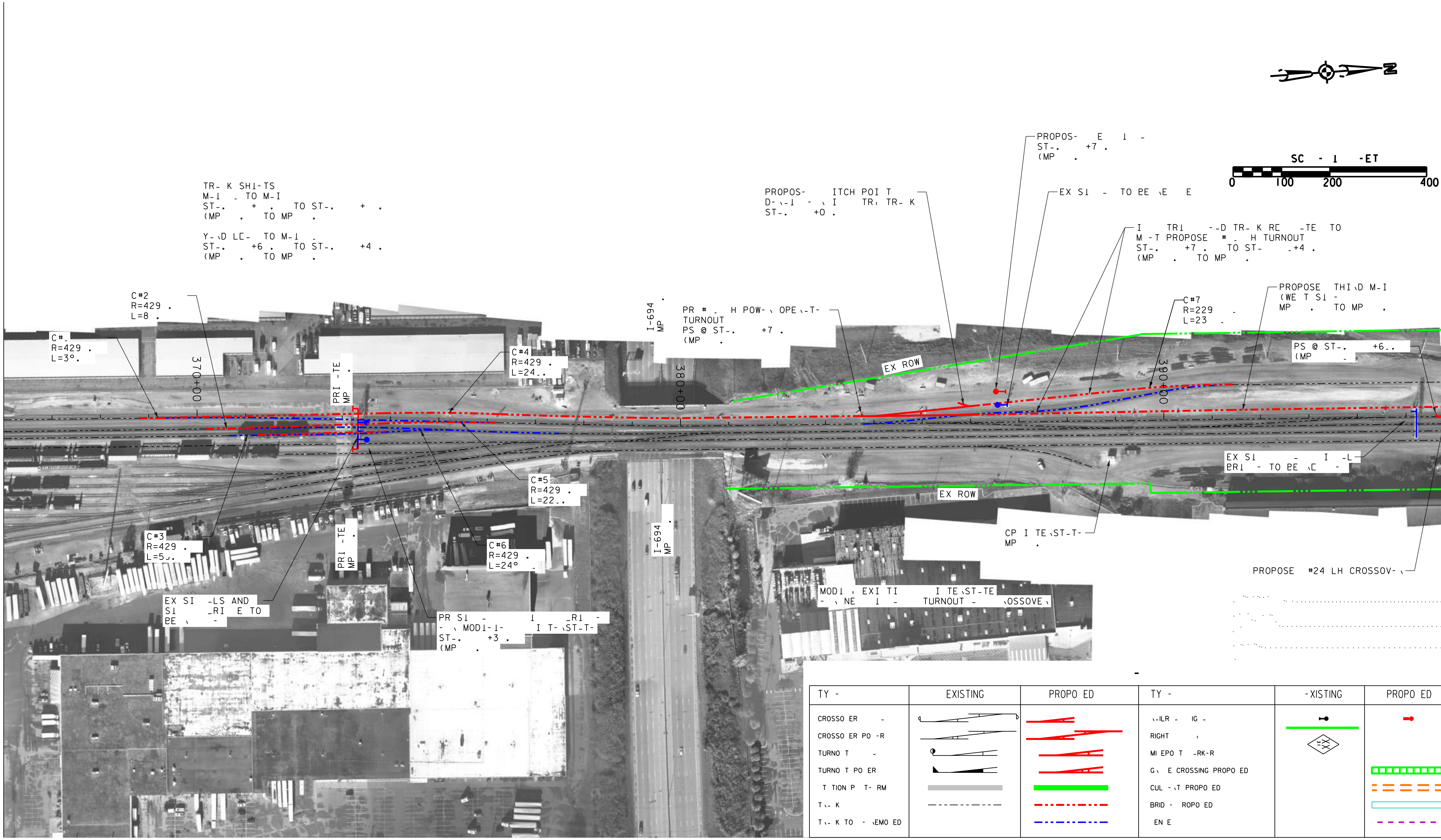
SOUTHBOUND

TO ST ES, MN
NORTHBOUND



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PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main I Plans t
PLOTT- / \- I - . 7/8/2020

N .	\EVI I	BY	-	-T-
1	DR--T 1	RWN	SP	4/17/2020

ESI E : RWN
CH- K :
D\ : RWN
- RO - :
STATE PRO .

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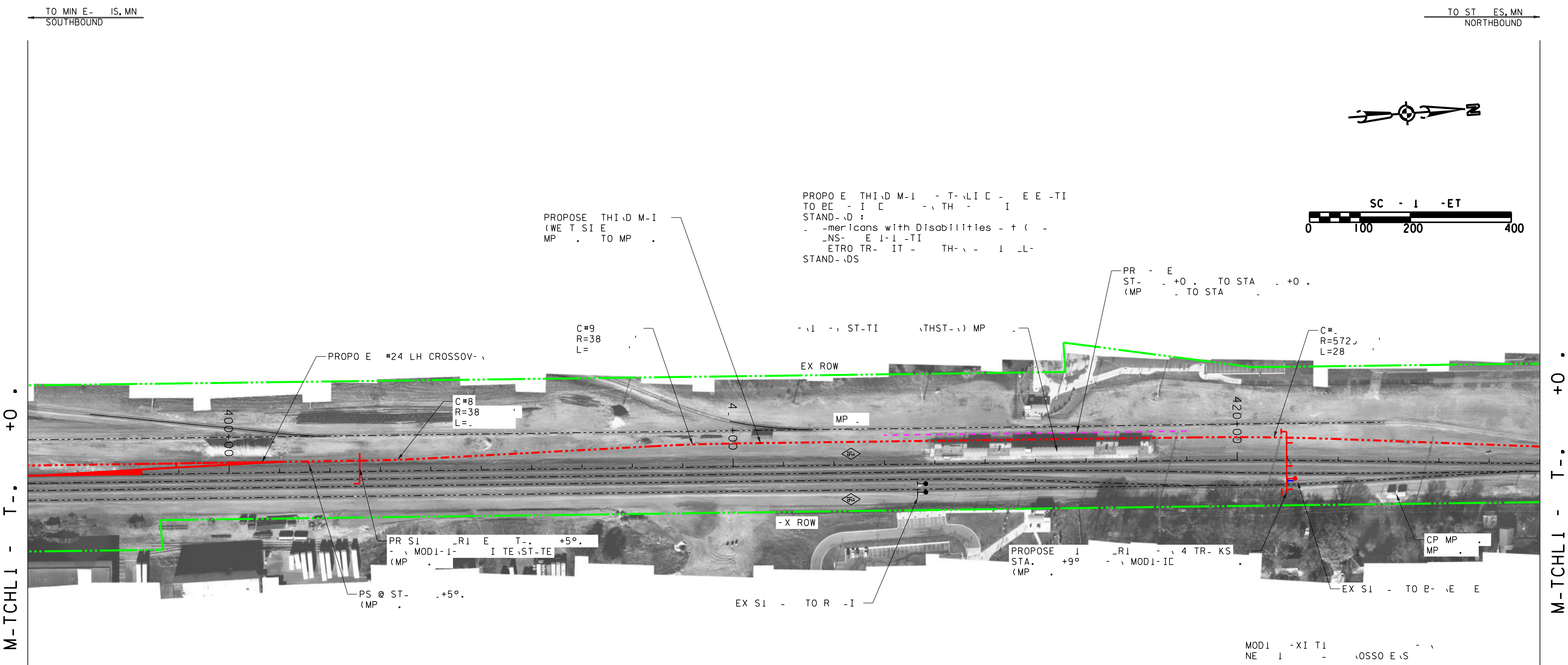
DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST

SHEET N . 2 OF 12



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1	DR--T 1	RWN	SP	4/17/2020	RWN	
					D\ : RWN	- RO - :

STATE PRO .

QUA I CONSULTANTS

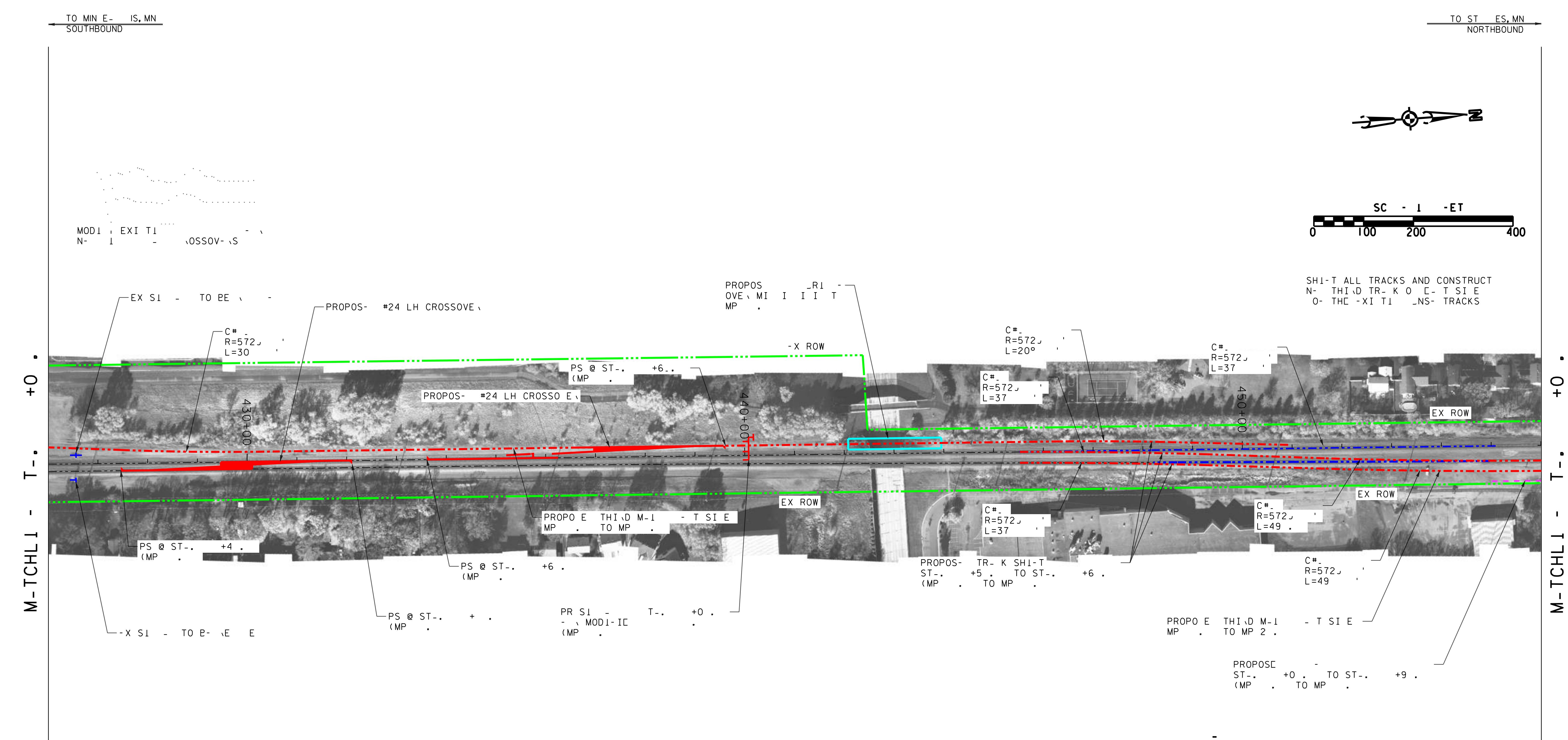
DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST

SHEET N . 3 OF 12

PLOTT- 7/8/2020
PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main l Plans t



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1	DR--T 1	RWN	SP	4/17/2020

ESI E: RWN
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STATE PRO .

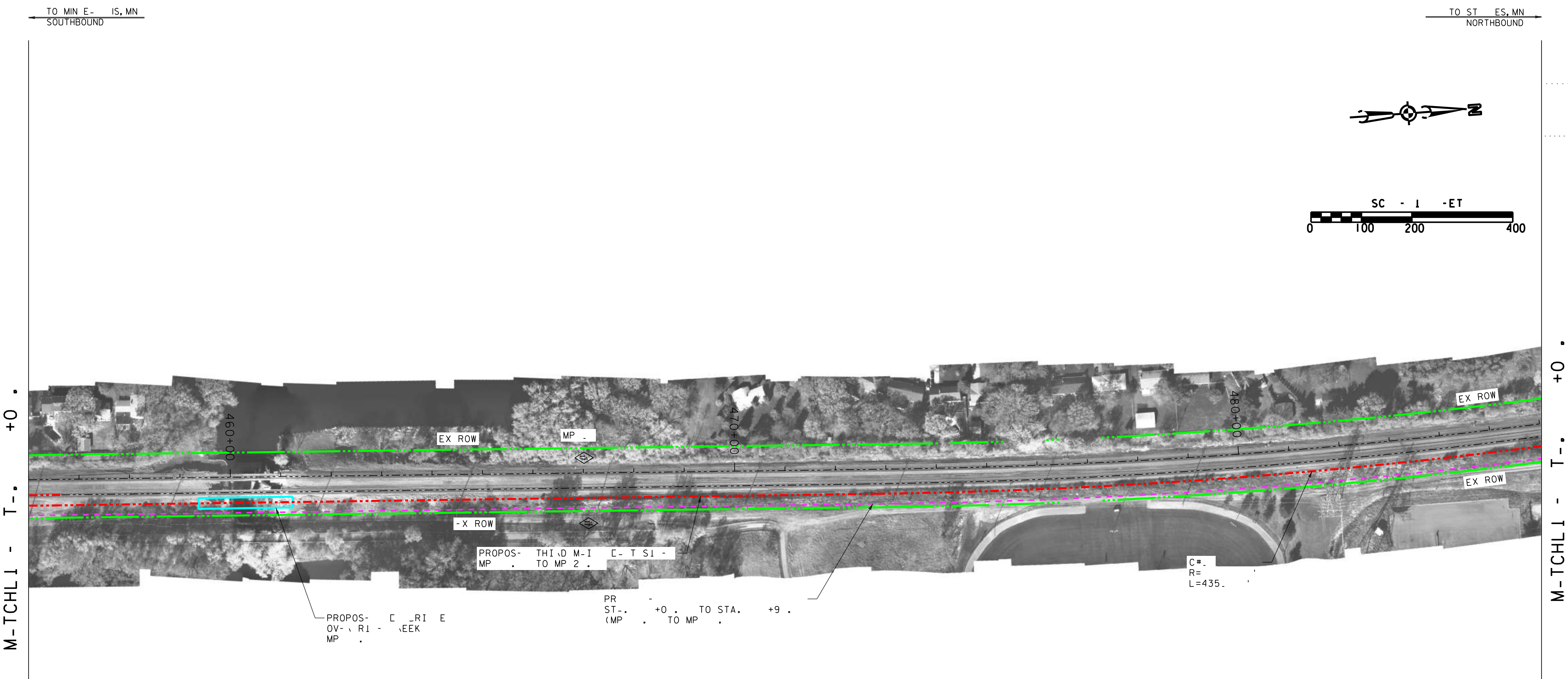
QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST

SHEET N. 4 OF 12



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PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main l Plans t
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PLOTT- / - l - . 7/8/2020

N .	EVI I	BY	-	-T-
1	DR--T 1	RWN	SP	4/17/2020

ESI E: RWN
CH- K:
D : RWN
- RO - :
STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

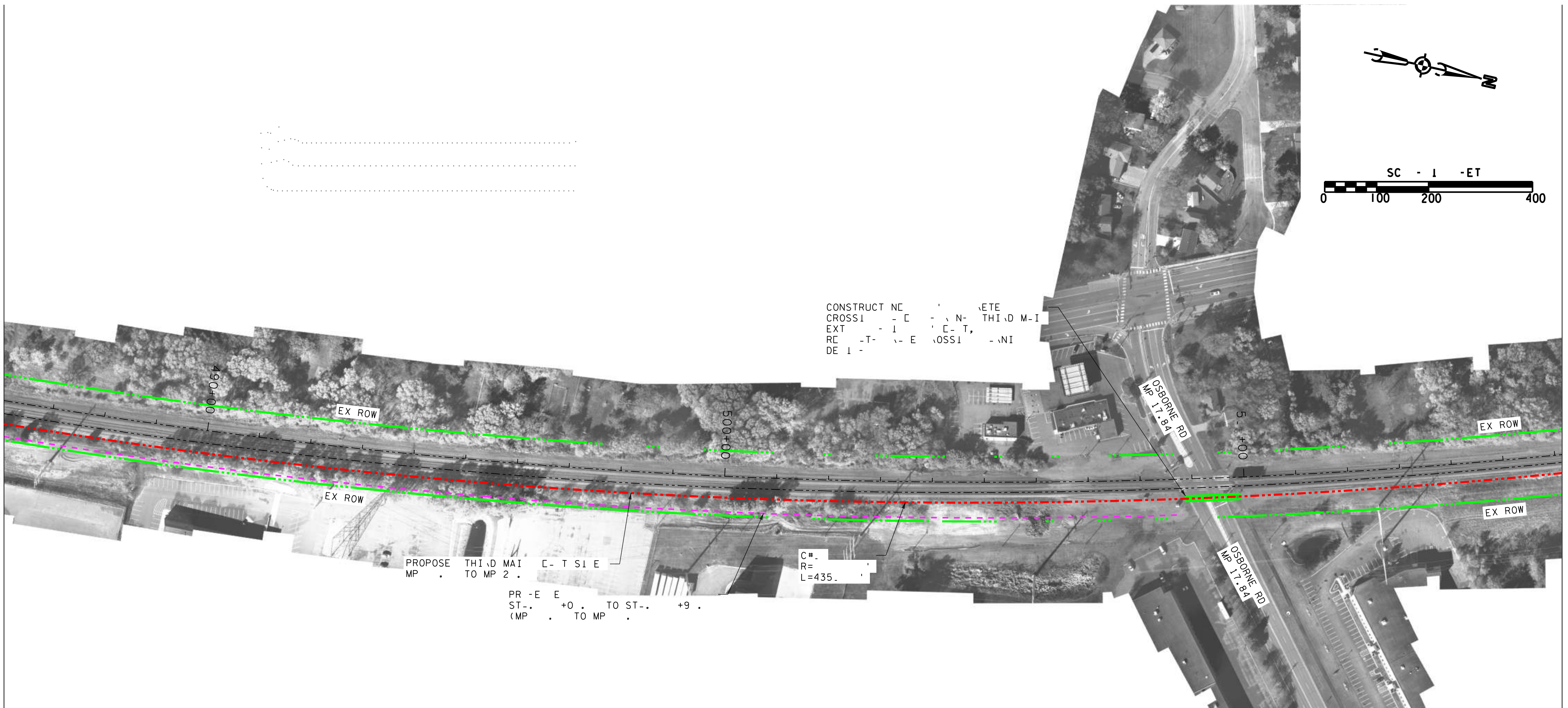
NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST

SHEET N . 5 OF 12

TO MIN E- IS, MN
SOUTHBOUND

TO ST ES, MN
NORTHBOUND



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PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main I Plans t
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PLOTT- / - I - . 7/8/2020

N .	EVI I	BY	-	-T-
1	DR--T 1	RWN	SP	4/17/2020

ESI E : RWN
CH- K :
D : RWN
- RO - :

STATE PRO .

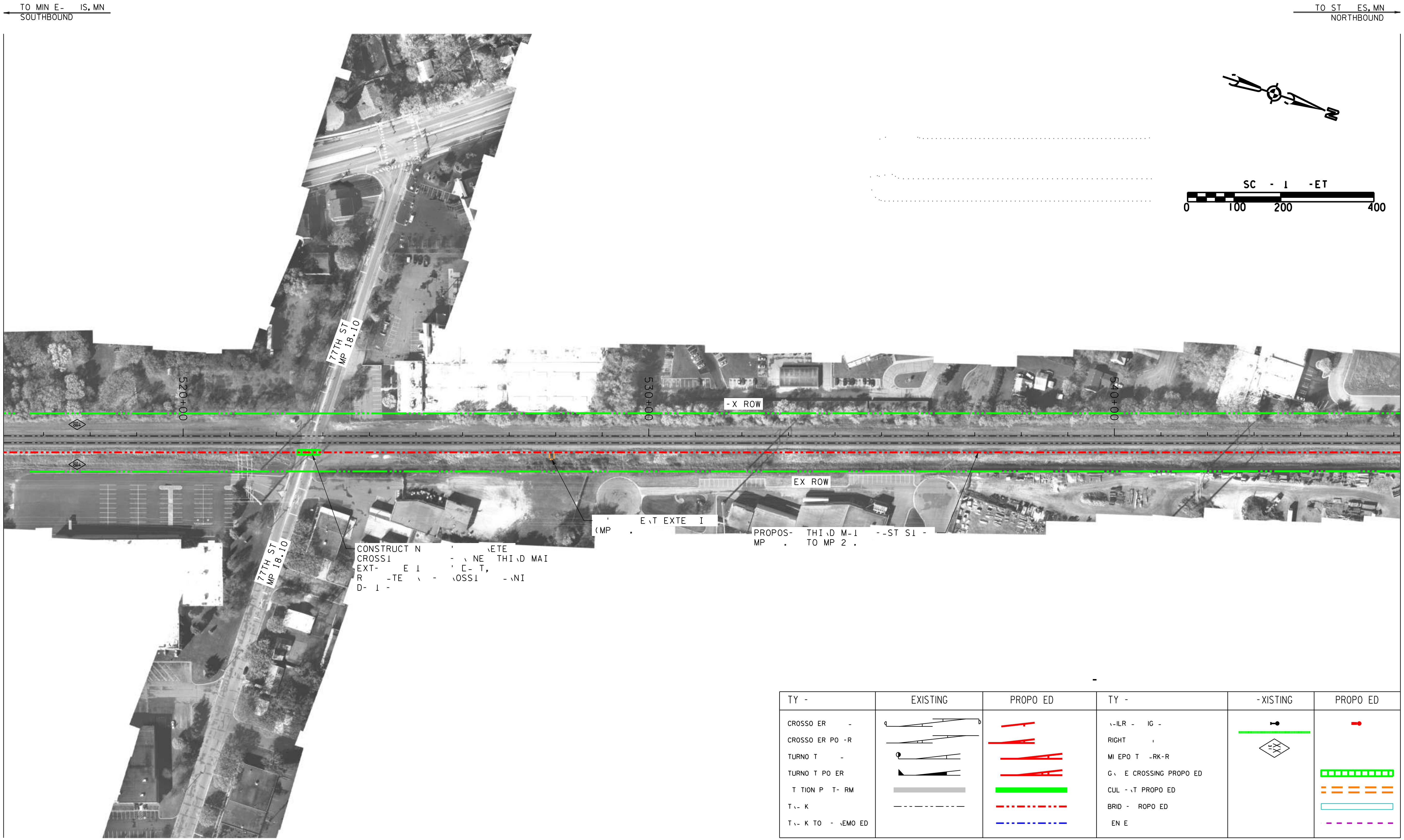
QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST .

SHEET N . 6 OF 12



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1	DR--T 1	RWN	SP	4/17/2020

ESI E : RWN
CH- K :
D\ : RWN
- RO - :

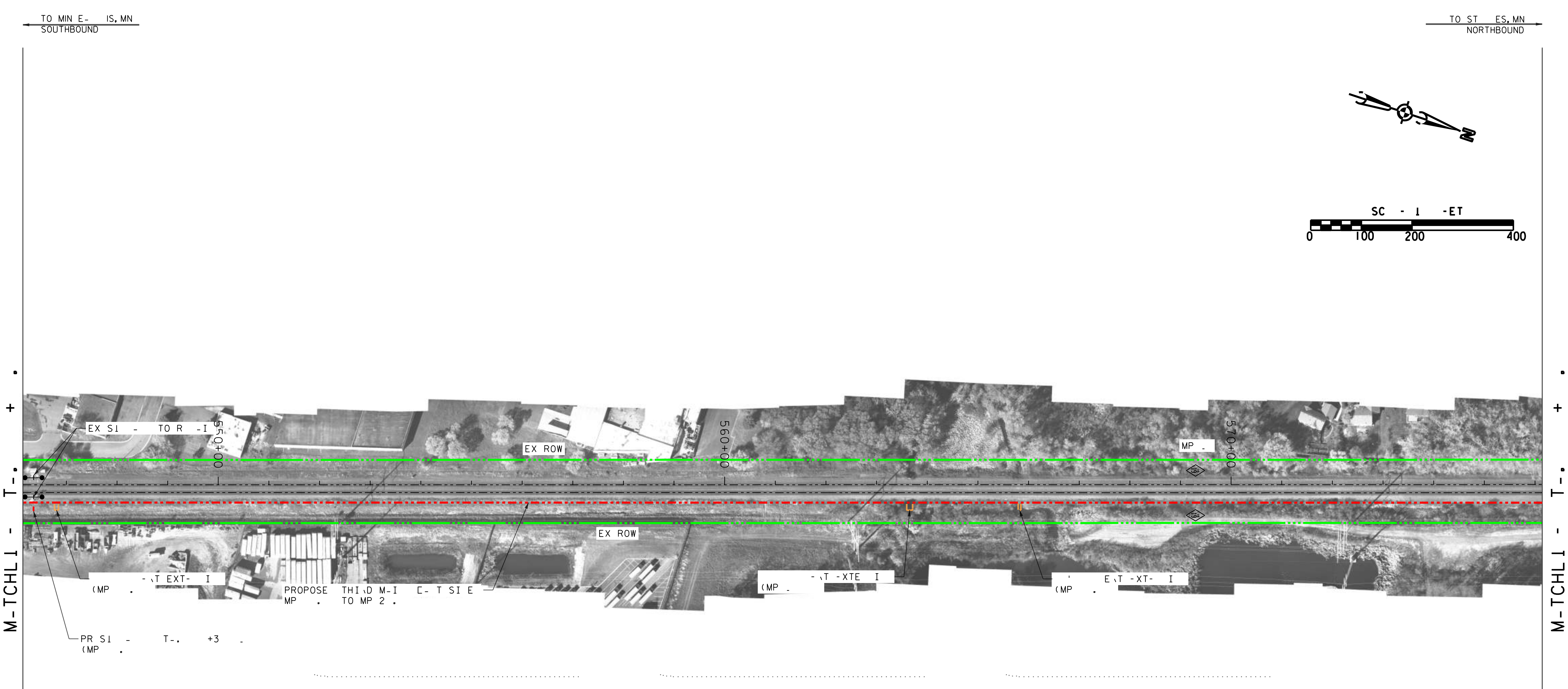
STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST



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1	DR--T 1	RWN	SP	4/17/2020

ESI E: RWN
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STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST

SHEET N. 8 OF 12

PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main I Plans t
- IG -I - C:\Users\spadmanabhan\Box\QConsult\Proje ts_Larg -1les\909_North tar\700 CADD\She ts\Third Main 2\Third - lans t 8.dgn
PLOTT- / - I - . 7/8/2020

PLOTT- / \- I - . 7/8/2020

PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main I Plans t
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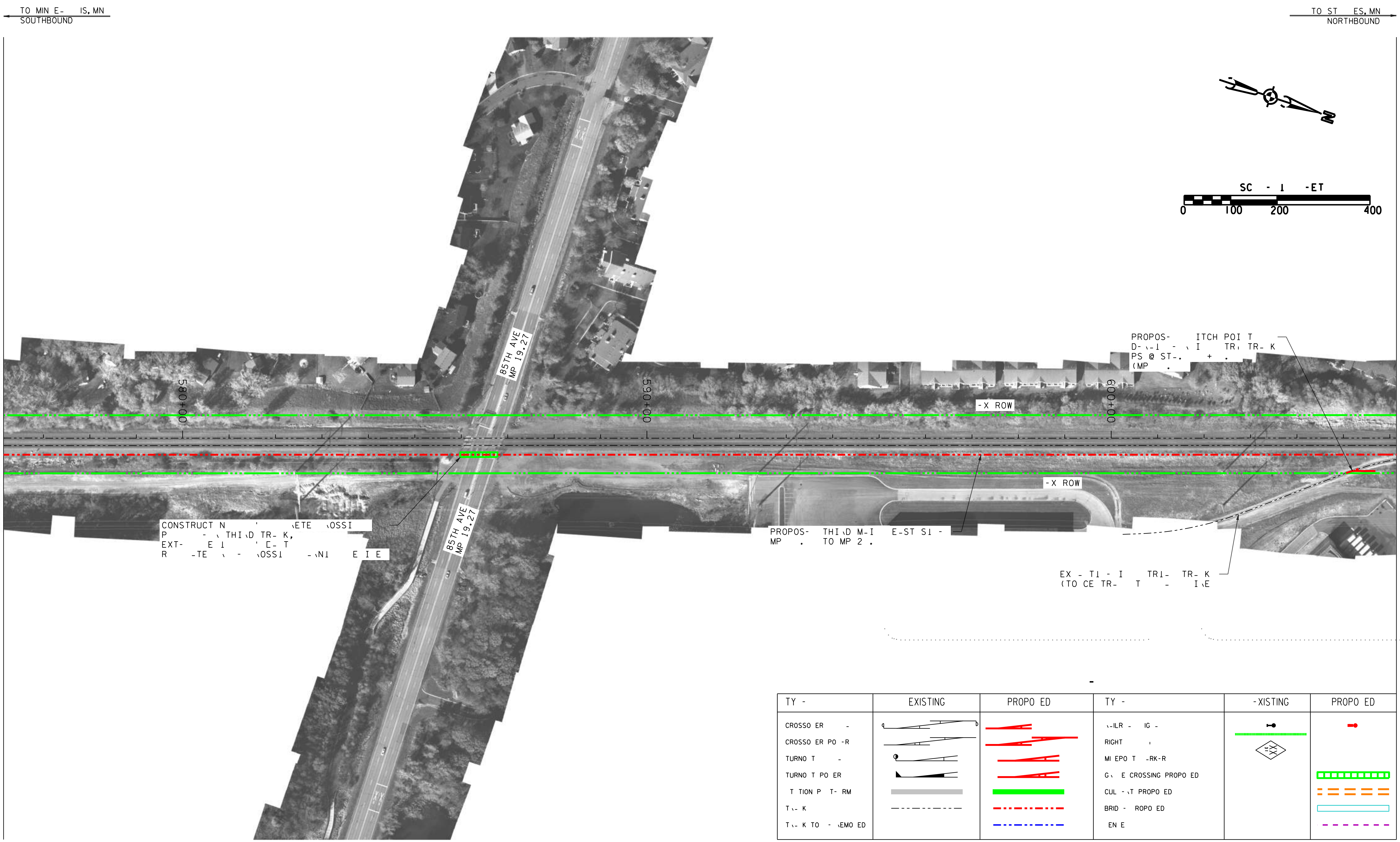

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QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST .

SHEET NO. 9 OF 12

PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
PLOT NA - Third Main I Plans t
- IG -I - C:\Users\spadmanabhan\Box\Consult\Proje ts_Larg -1les\909_North tar\700 CADD\She ts\Third Main 2\Third - lans t l0.dgn
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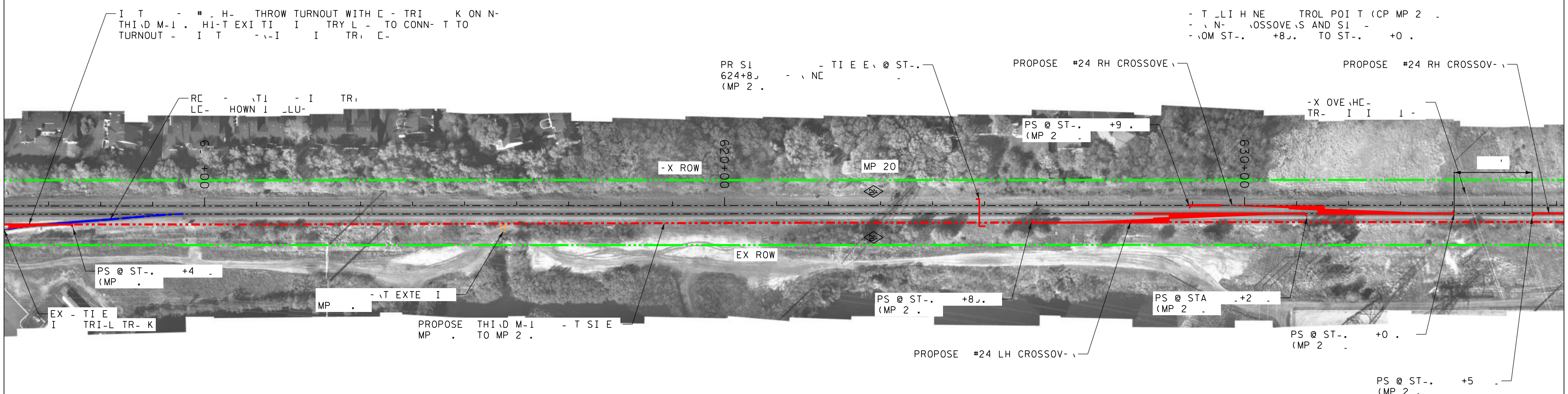

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1	DR--T 1	RWN	SP	4/17/2020

ESI E : RWN
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D : RWN
- RO - :

STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE
ST .

SHEET N . 10 OF 12

PLOTTED/REVISED: 7/8/2020

PROJECT: NORTHSTAR COMMUTER RAIL EXPANSION STUDY
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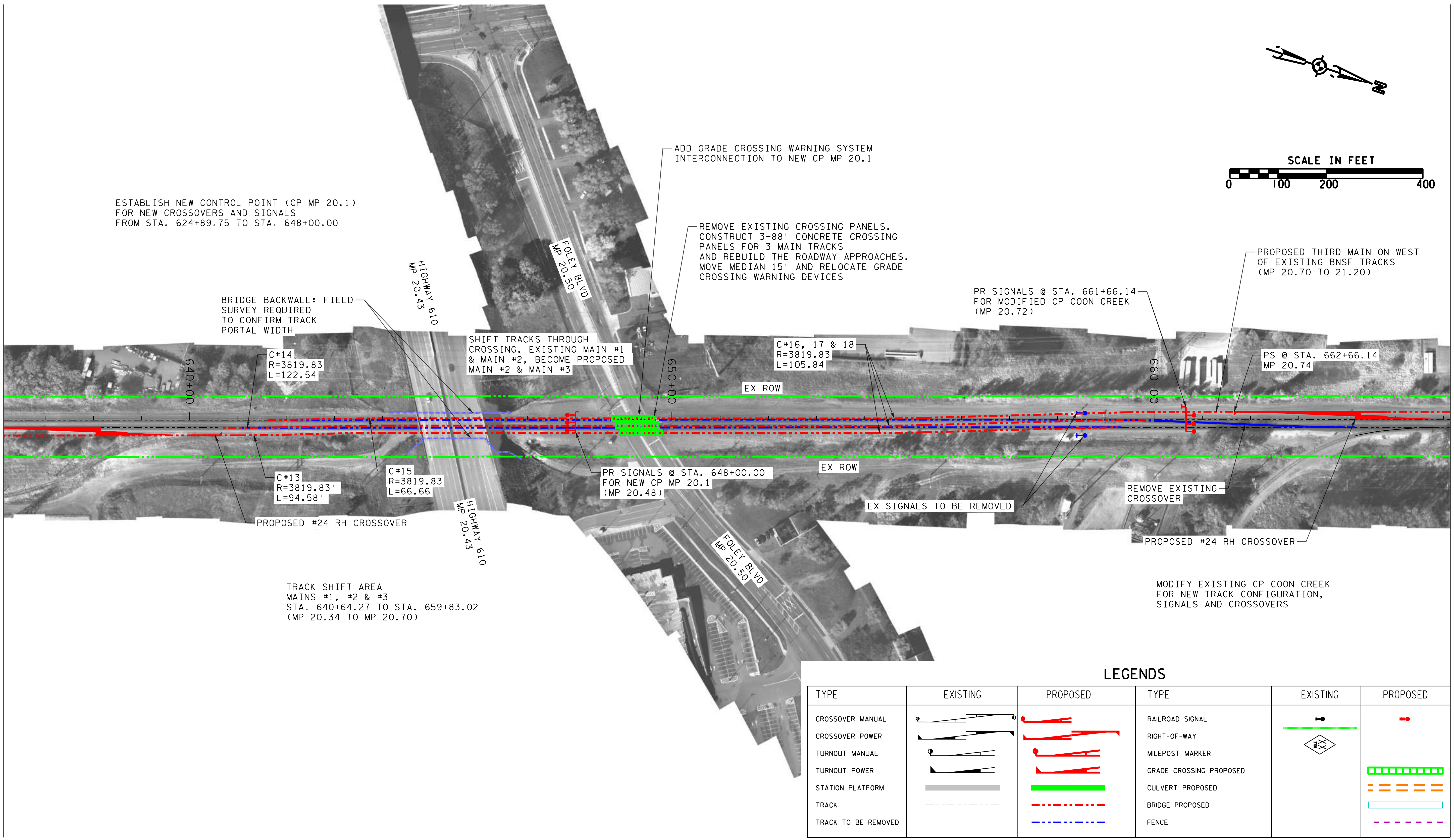

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TURNOUT MANUAL			MILEPOST MARKER		
TURNOUT POWER			GRADE CROSSING PROPOSED		
STATION PLATFORM			CULVERT PROPOSED		
TRACK			BRIDGE PROPOSED		
TRACK TO BE REMOVED			FENCE		

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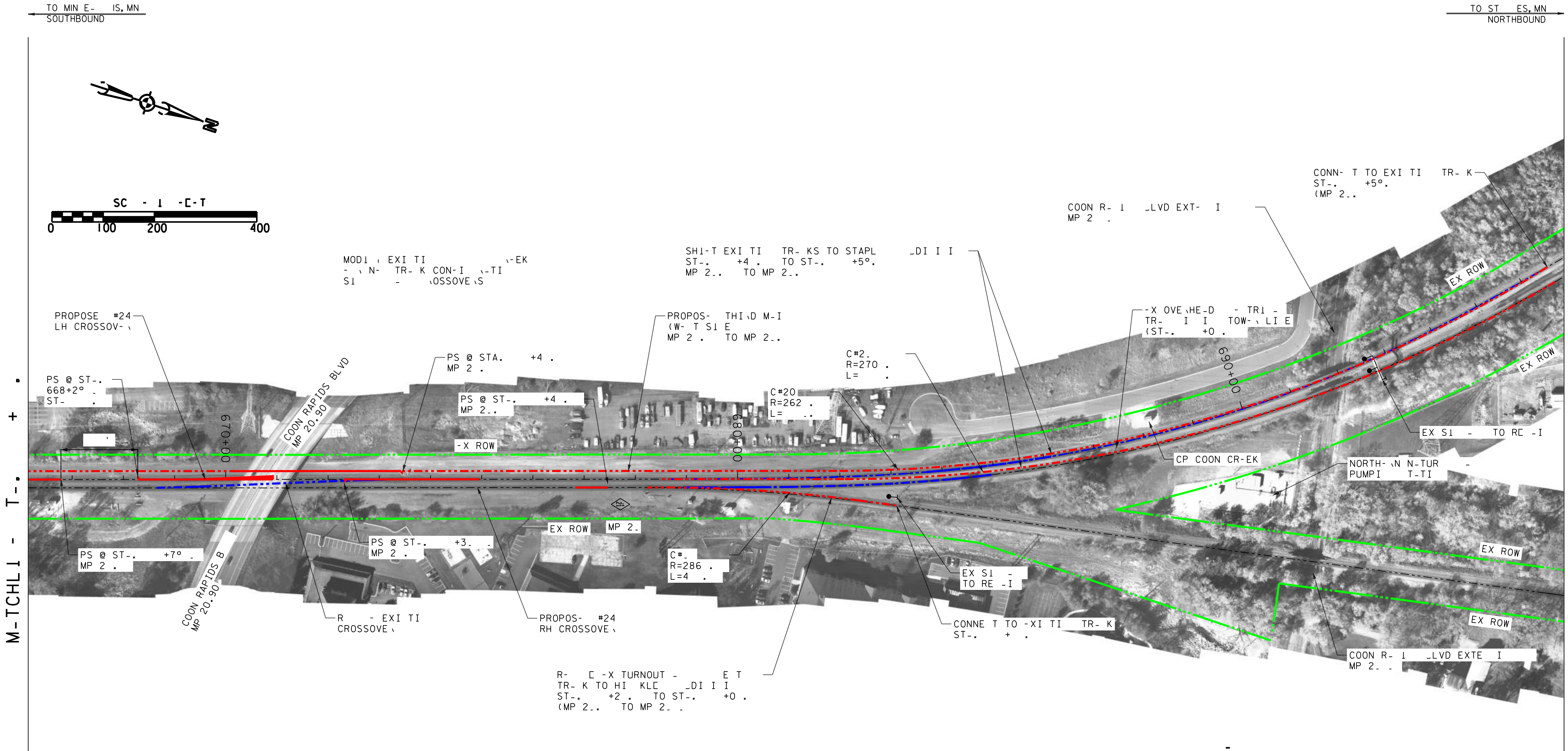
DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE
STA. 636+14.24 TO STA. 666+14.24

SHEET NO. 11 OF 12



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PLOTT- / - I - . 7/8/2020
PRO - T: NORTHSTAR COMMUT-R RAI - XPANSION STUDY
PLOT NA - Third Main I Plans t
- IG - I - C:\Users\spadmanabhan\Box\Consult\Proje ts_Larg - 1les\909_North tar\700 CADD\She ts\Third Main 2\Third - lans t 12.dgn

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1	DR-T 1	RWN	SP	4/17/2020	RWN	
					D : RWN	- RO - :

STATE PRO .

QUA I CONSULTANTS

DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN TRACK CP COON CREEK TO CP INTERSTATE ST .

SHEET N . 12 OF 12

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PR- IMIN- - ET - TR- K WORK, SIGN TROL POI T, GR - OSSINGS
TURNO TS, CROSSOVE S, CULVE T -XT- IONS RIDG-

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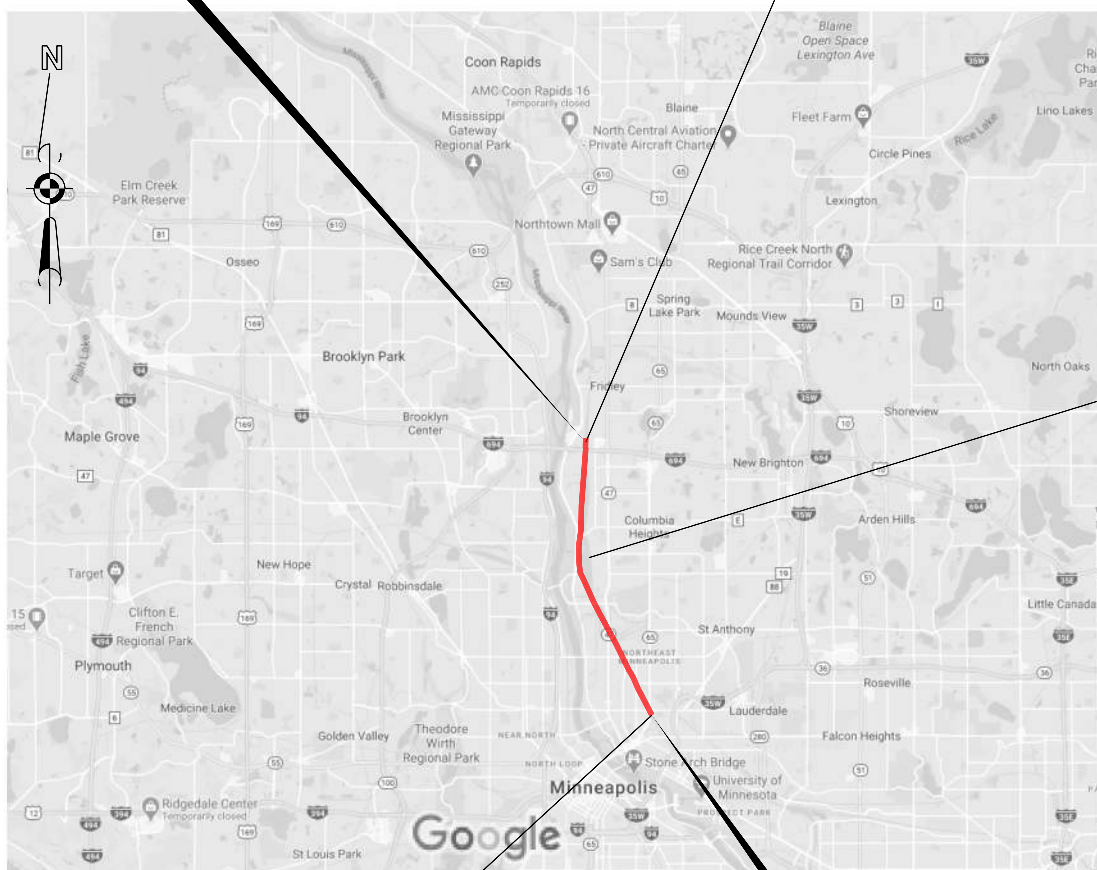
END TRACK WORK
MP 1 .

CP INTERSTATE
MP 1 .



NORTHTOWN YARD
MP 1 .

CP VAN BUREN
MP 1 .

BEGIN TRACK WORK
MP 1 .

NOT TO SCA E

HENNEPIN COUNTY
ANOKA COUNTY
CITY OF MINNEAPOLIS
CITY OF FRIDLEY

STATE FUNDS

GOVERNING SPECIFICATIONS

THE 201 EDITI - THE MI - T - T T - T - RT TI
T -RD S - I-I TI - R CONSTRU TI H ER .

INDEX

H - .	- I TI
1	TIT E SH ET
2 - 10	P ET

THI AN CONTAI 10 H -TS

QUA I CONSULTANTS

CON - TUAL - I

NOT FOR CONSTRUCTION

DEPARTMENT OF TRANSPORTATION

- R P TI ITIES EE TECH I -

STATE PRO . CHAR E I - TI-I-R

PRO - T LOCATI
COUNTY : HEN - I AND ANOKA
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4/14/2020	- HEETS	MKJ

STATE PRO .

SHEET N . 1 F 10 SHEETS

PLOTT - - 7/8/2020

PRO - T: NORTHSTAR COMMUT-R RAI -XPANSION STUDY
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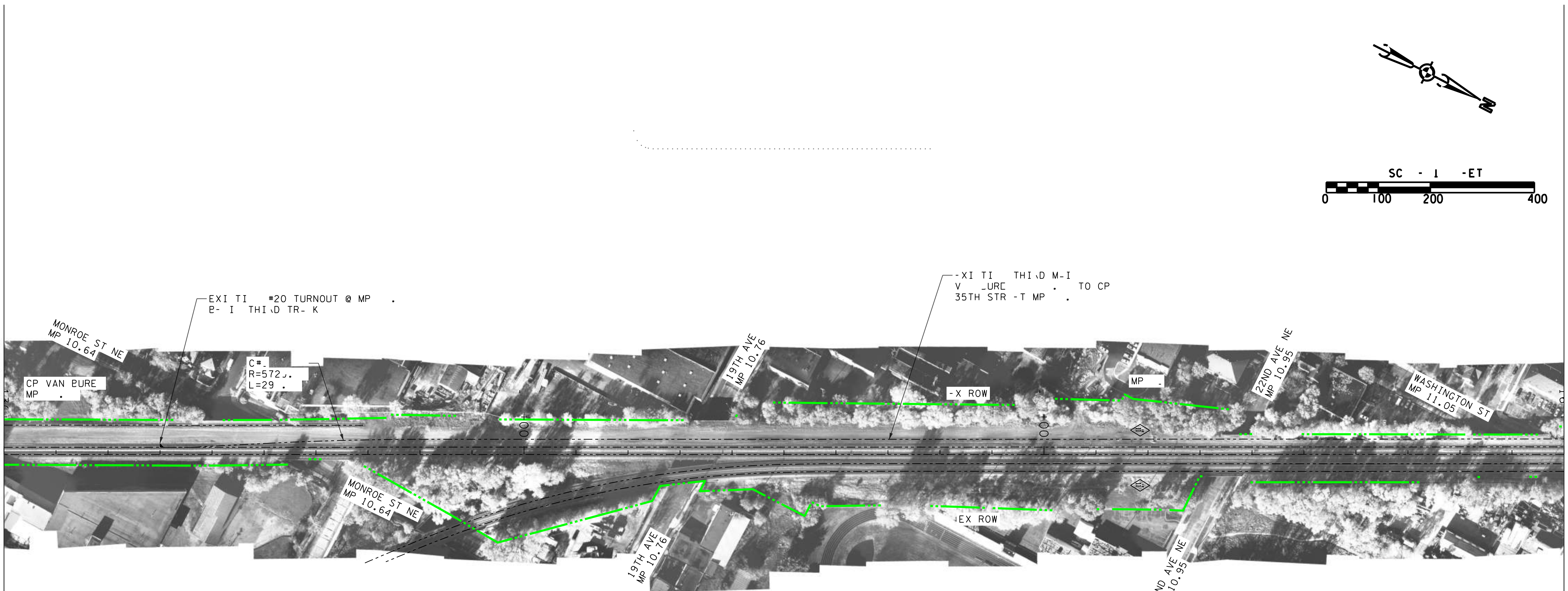

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PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN CP INTERSTATE TO CP VAN BUREN ST

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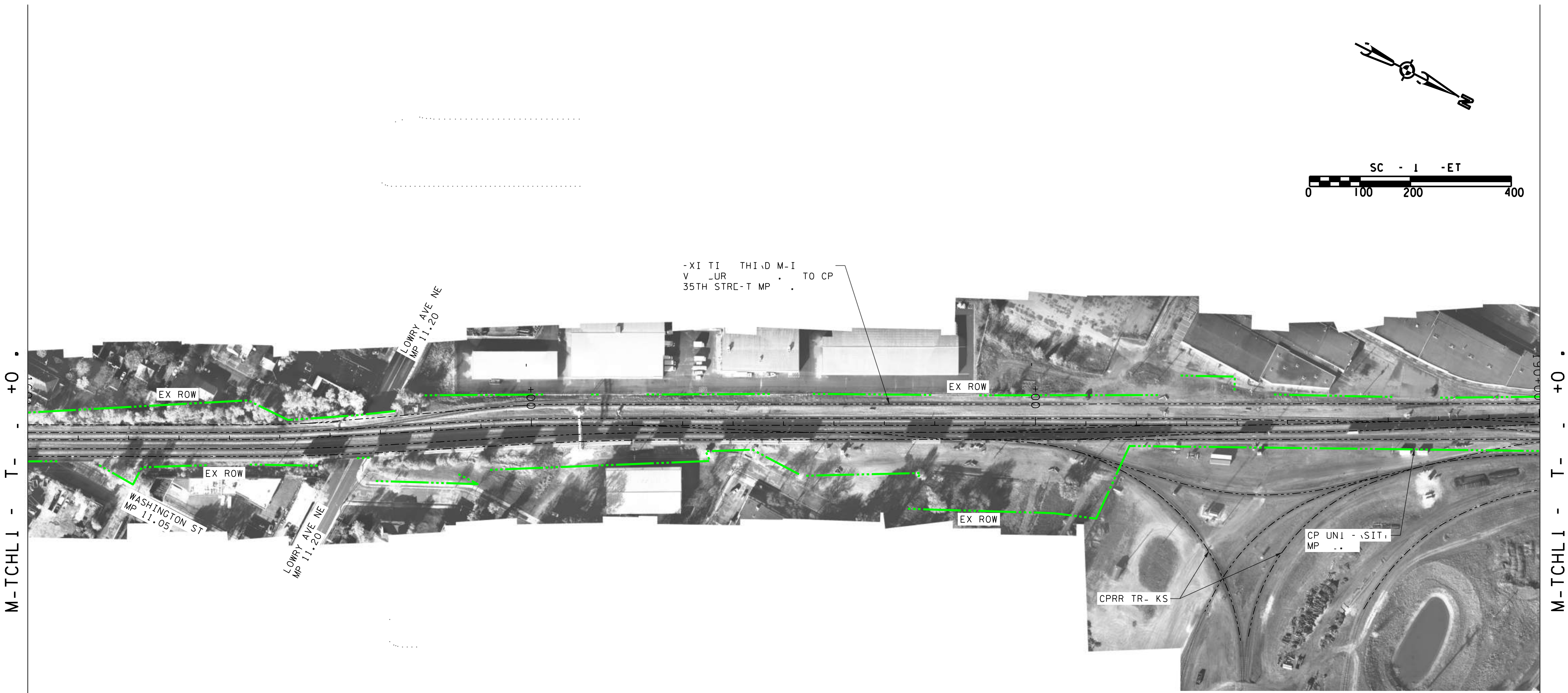

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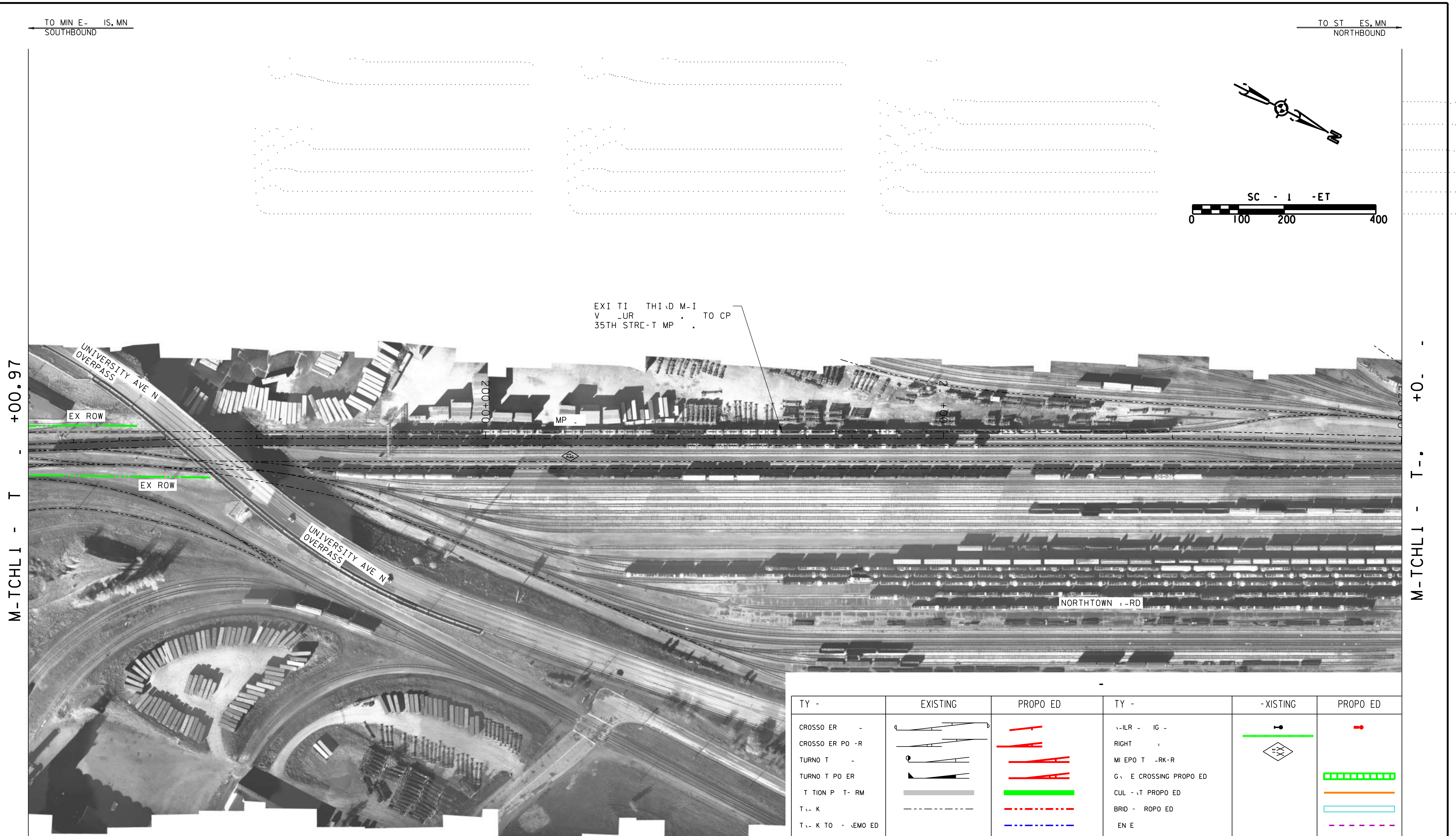

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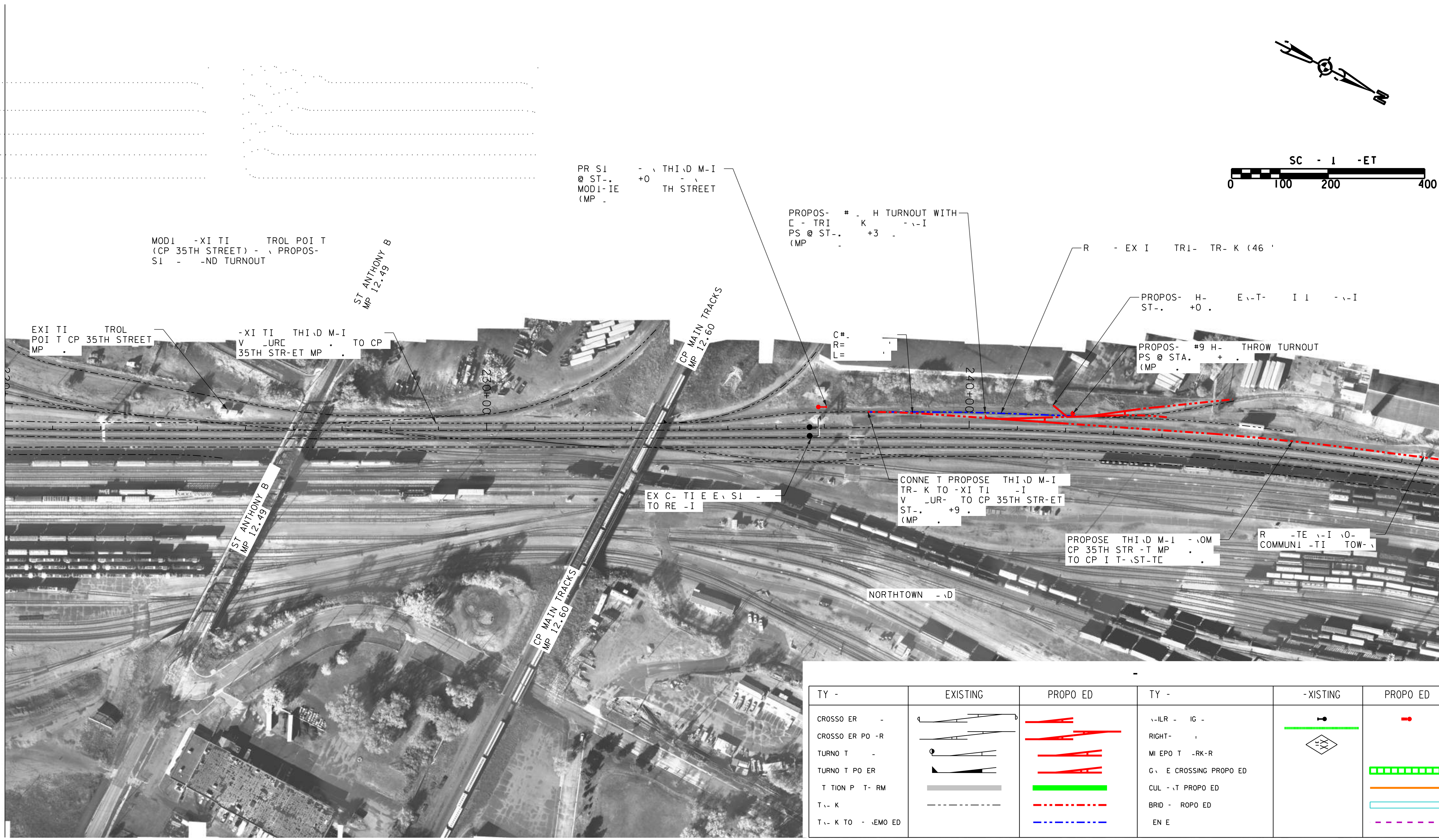

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NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN CP INTERSTATE TO CP VAN BUREN ST .

SHEET N . 5 OF 10

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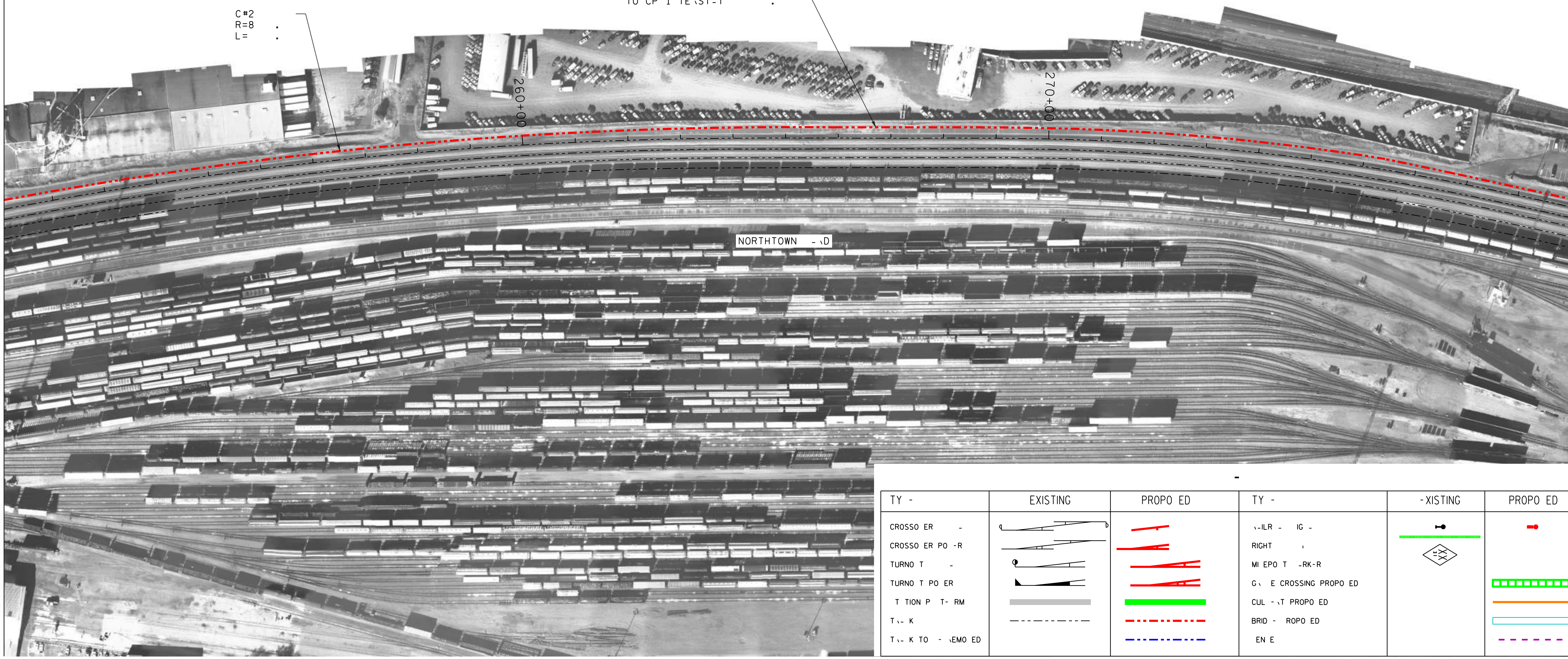

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PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN CP INTERSTATE TO CP VAN BUREN ST

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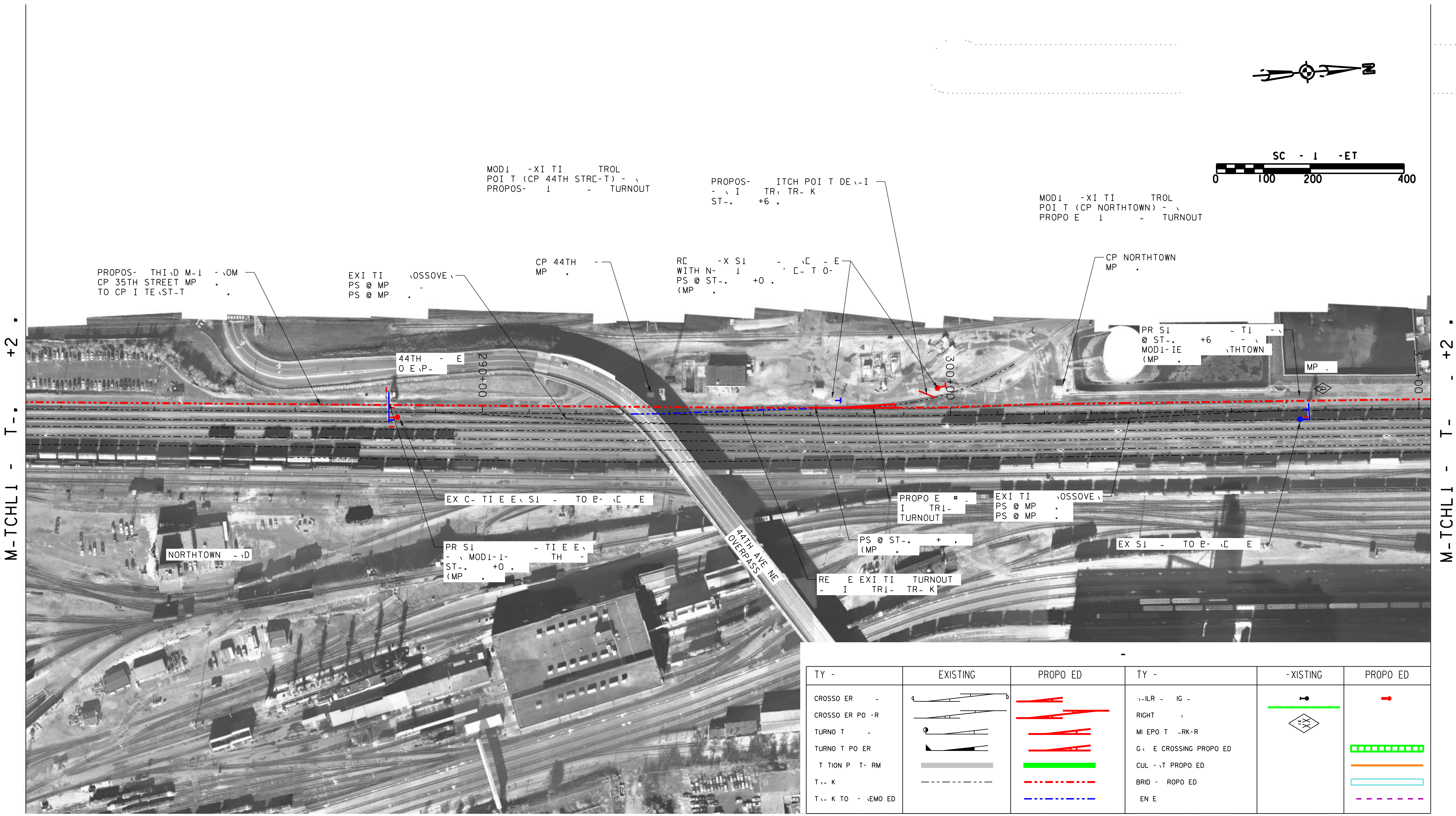

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NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS
THIRD MAIN CP INTERSTATE TO CP VAN BUREN ST .

SHEET N . 7 OF 10

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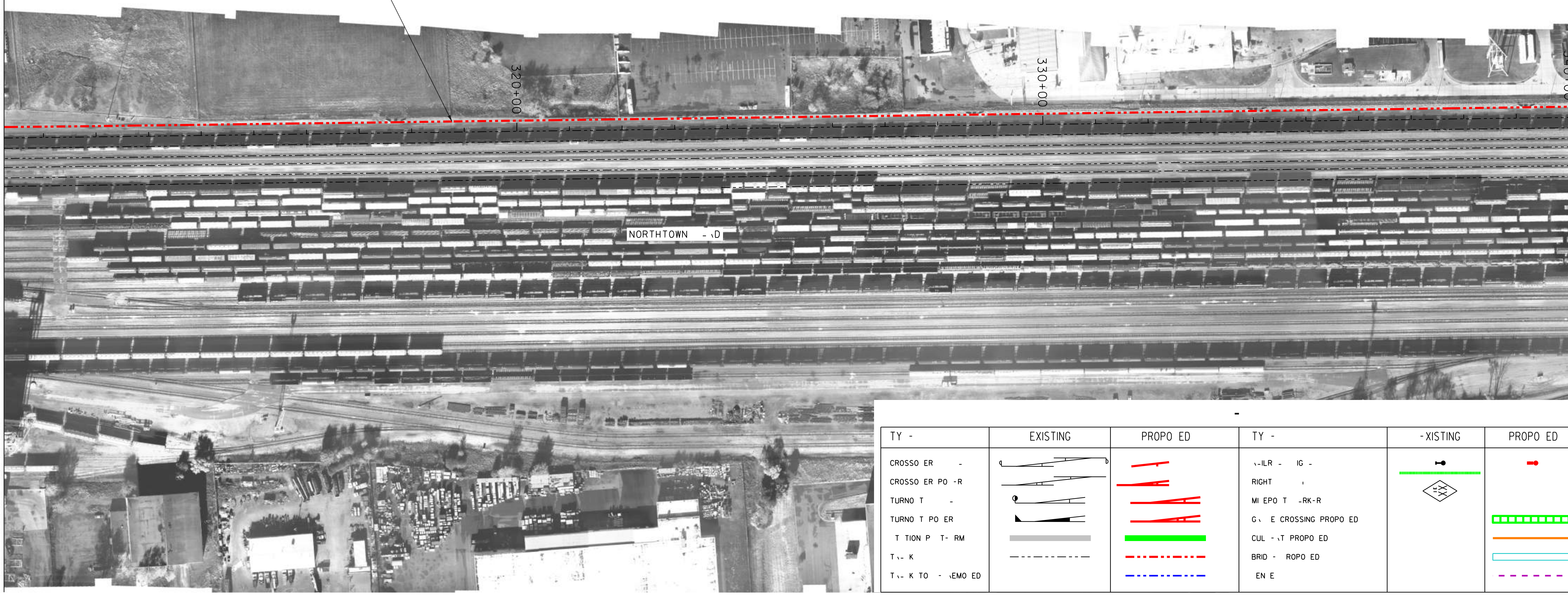

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DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN CP INTERSTATE TO CP VAN BUREN ST .

SHEET N . 8 OF 10

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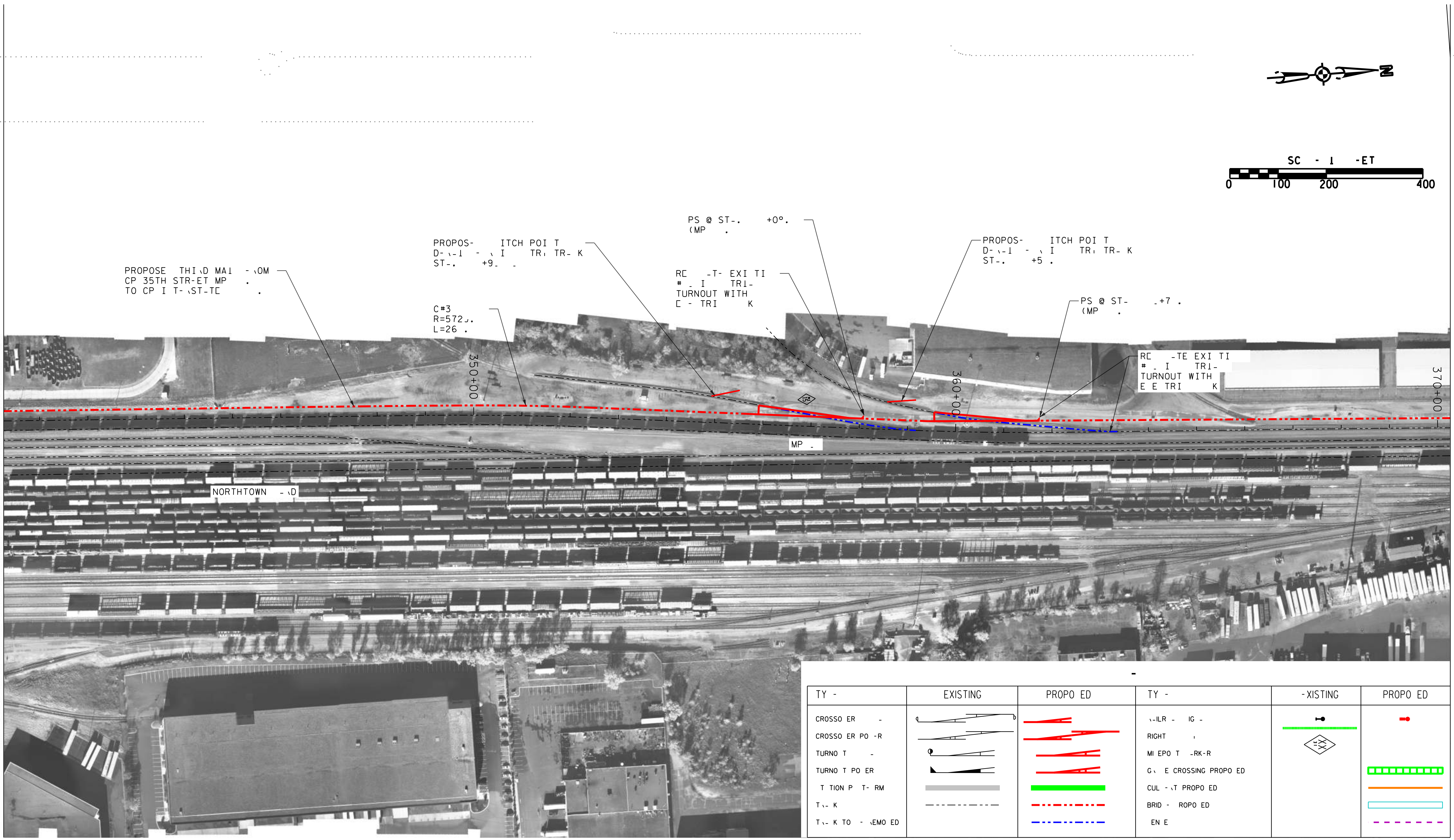

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NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS THIRD MAIN CP INTERSTATE TO CP VAN BUREN ST .

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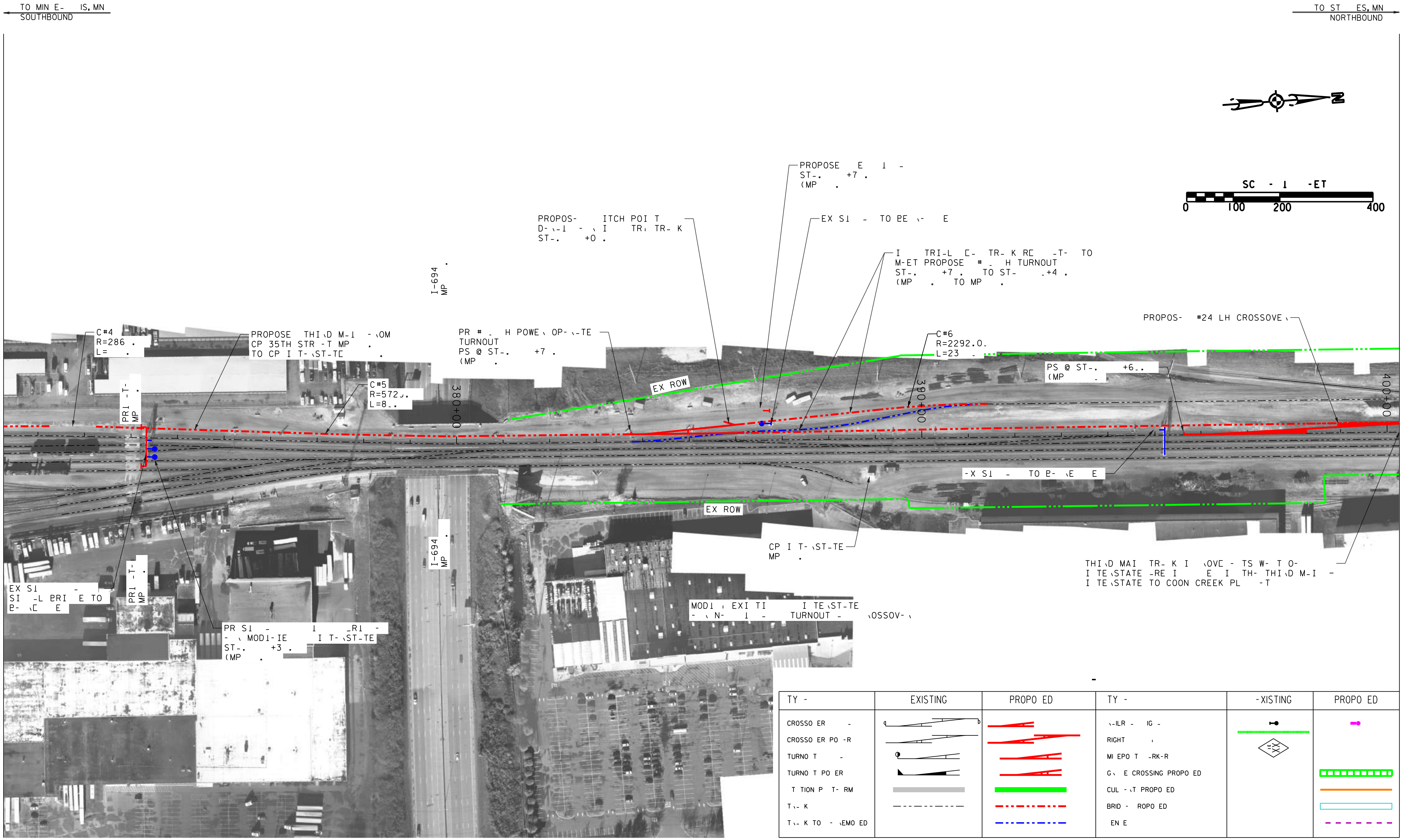

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DEPARTMENT OF TRANSPORTATION

NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

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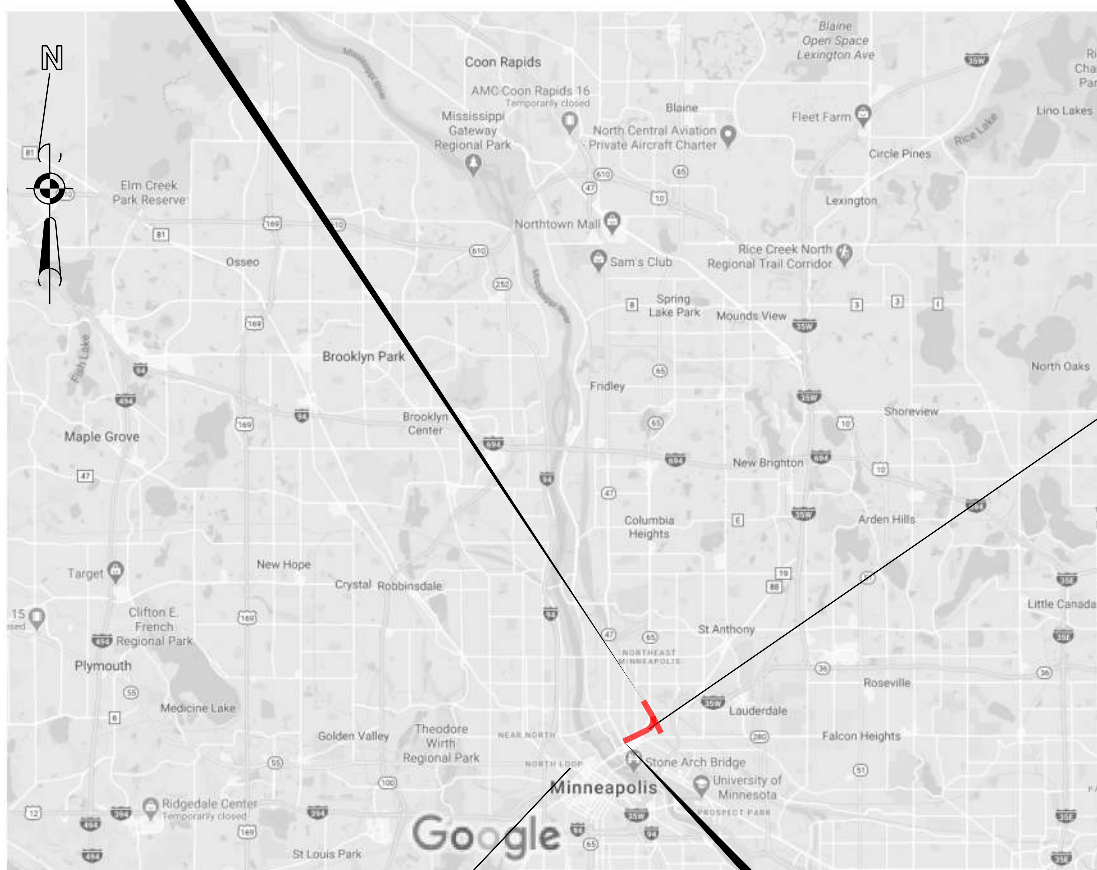

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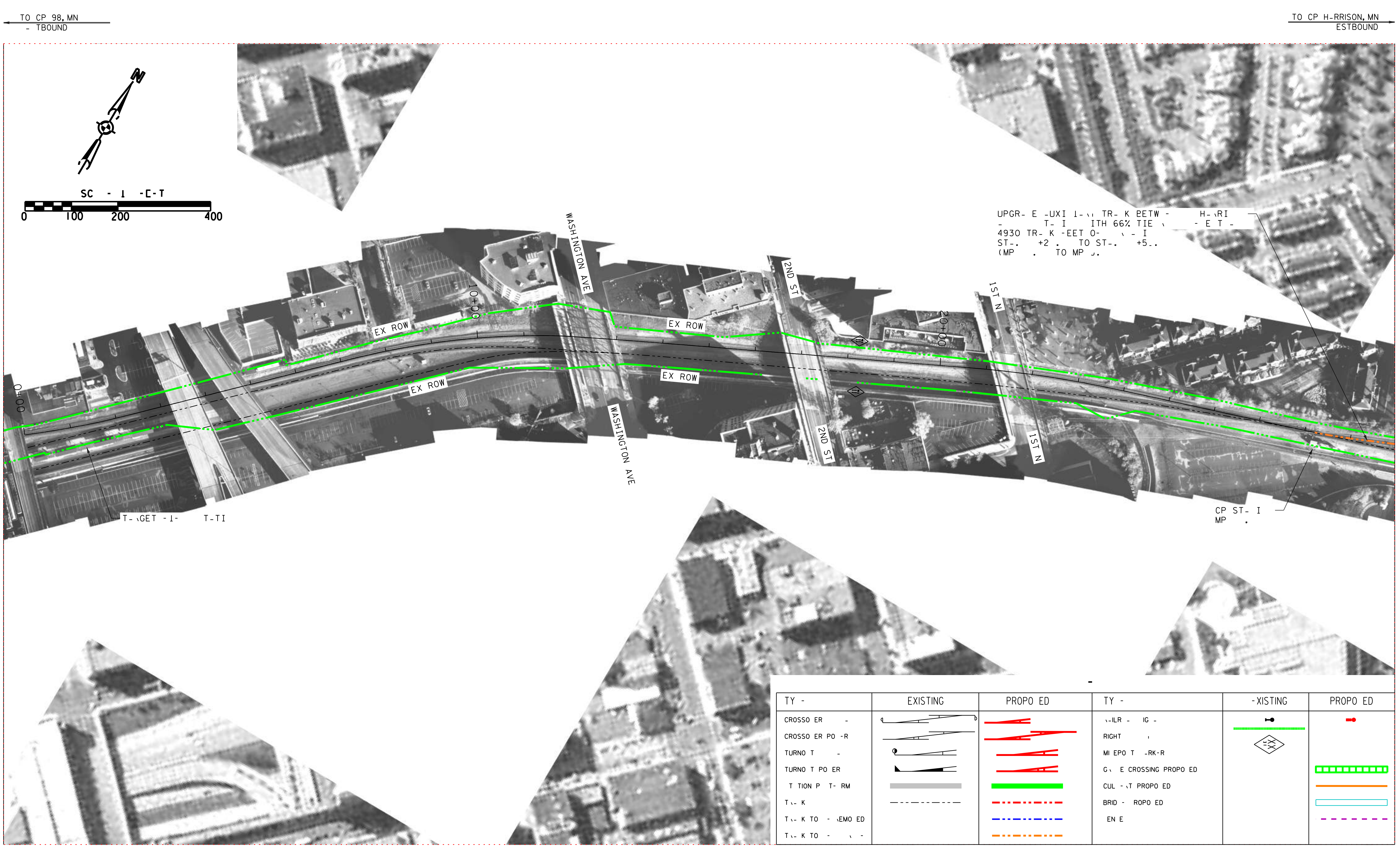

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PROPOSED INFRASTRUCTURE IMPROVEMENTS
TWO MAIN TRACKS CP VAN BUREN TO CP STADIUM
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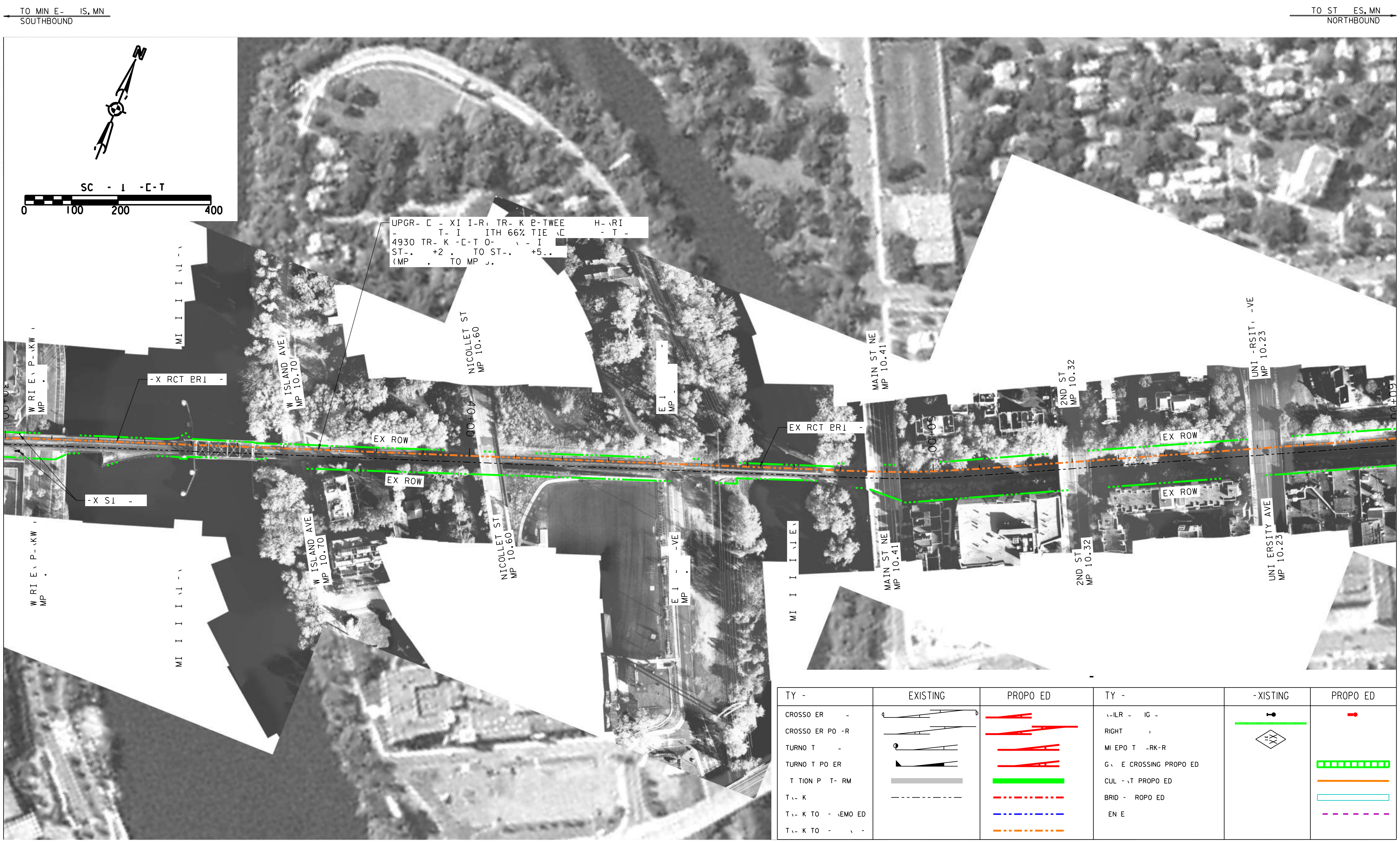

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NORTHSTAR COMMUTER RAIL EXTENSION FEASIBILITY STUDY

PROPOSED INFRASTRUCTURE IMPROVEMENTS TWO MAIN TRACKS CP VAN BUREN TO CP STADIUM ST .

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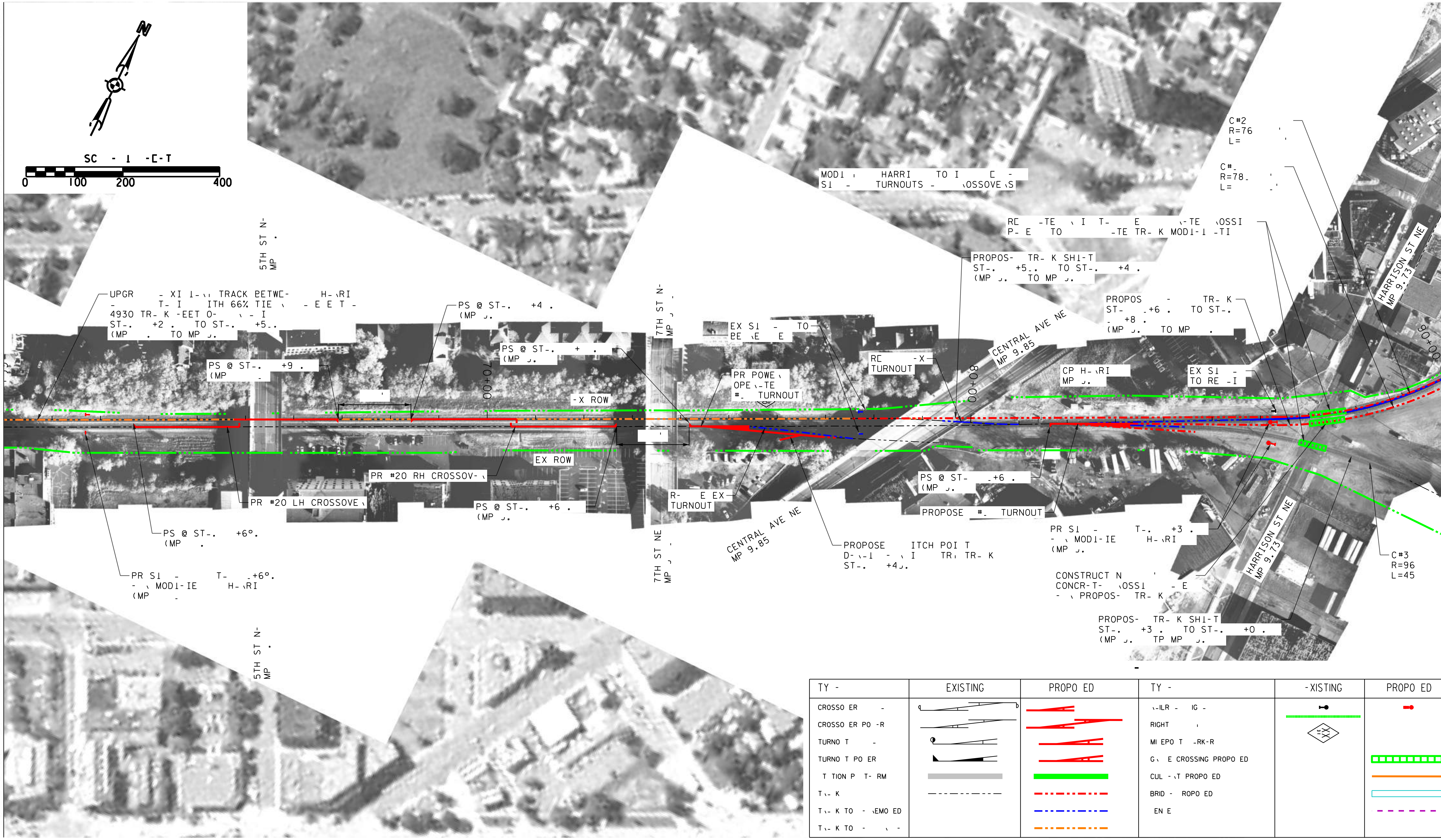

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PROPOSED INFRASTRUCTURE IMPROVEMENTS
TWO MAIN TRACKS CP VAN BUREN TO CP STADIUM ST

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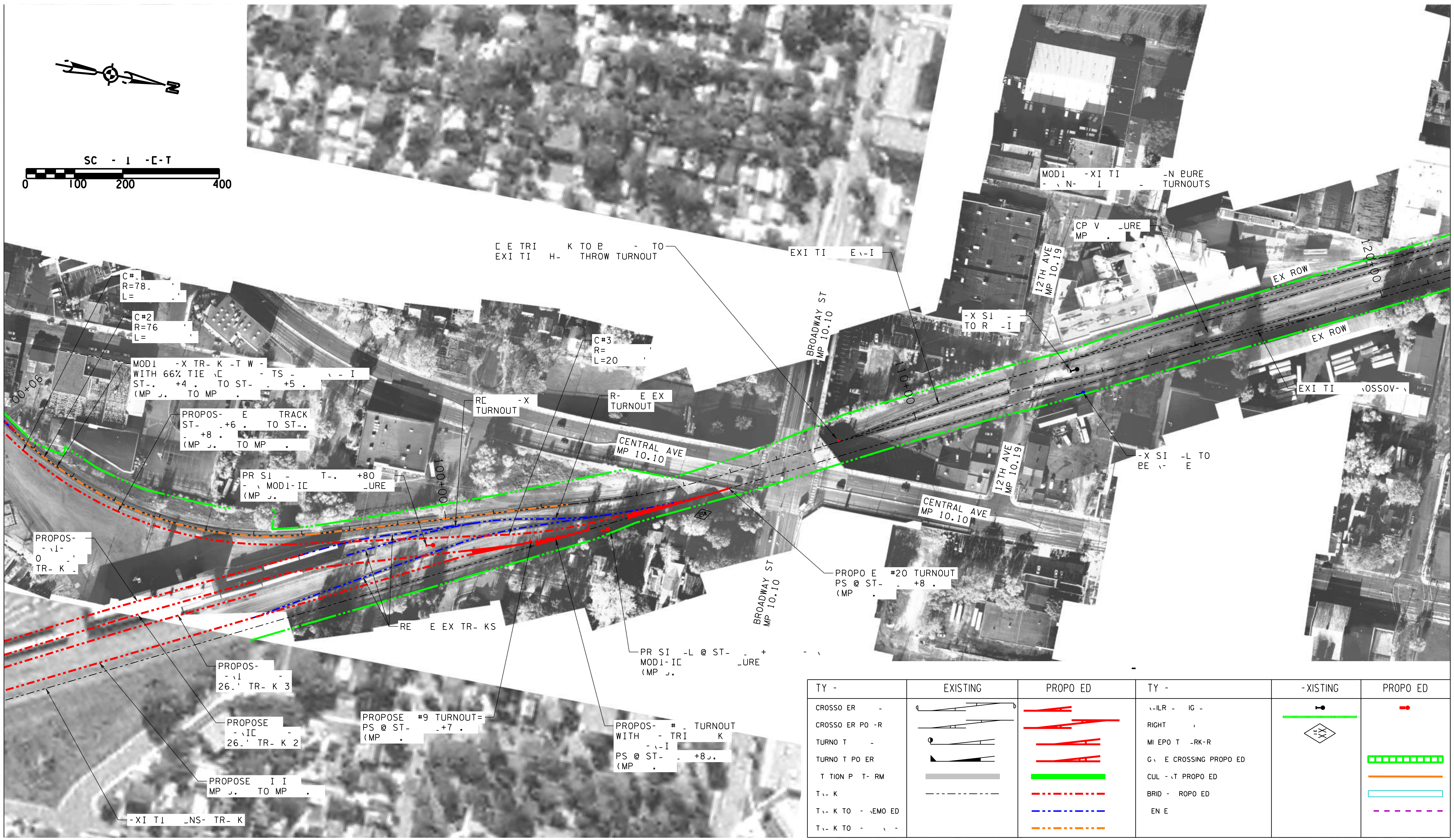

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PROPOSED INFRASTRUCTURE IMPROVEMENTS TWO MAIN TRACKS CP VAN BUREN TO CP STADIUM ST

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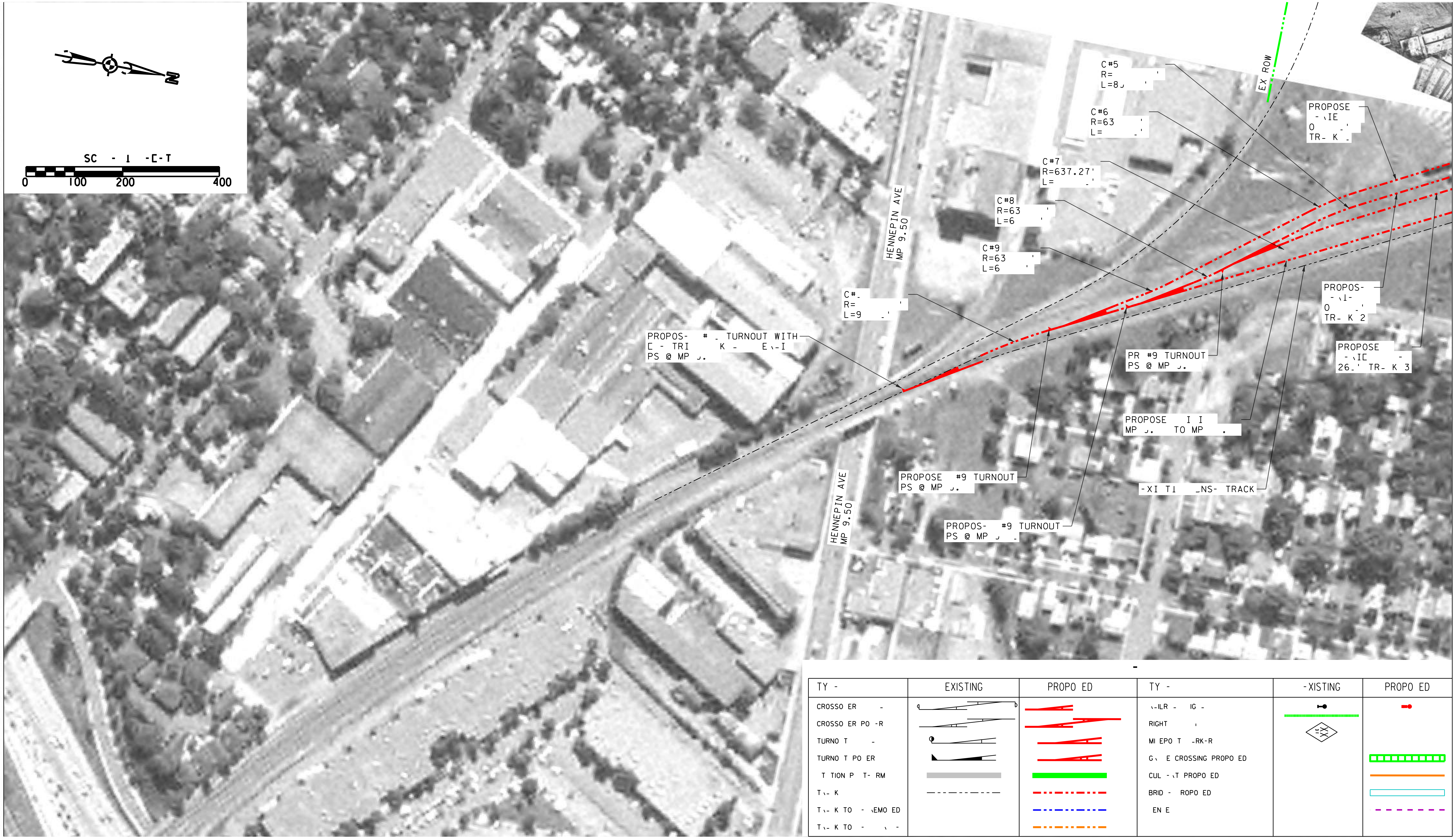

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PROPOSED INFRASTRUCTURE IMPROVEMENTS
TWO MAIN TRACKS CP VAN BUREN TO CP STADIUM
MATCHLINE A-A TO MATCHLINE B-B

SHEET N. 6 OF 6

Attachment 2

BNSF Design Criteria for Speed and Curvature – BNSF Engineering Instructions 5 Track Geometry, Appendix A and Appendix B

Appendix A

Two-Inch Unbalanced Design Superelevation for Freight Trains

Speed

Curvature degrees	Curvature Minutes	20 mph	25 mph	30 mph	35 mph	40 mph	45 Mph	50 mph	55 mph	60 mph	65 mph	70 mph	75 mph	80 mph	85 mph	90 mph
0	30	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 7/8
0	40	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	1 0	1 3/8	1 7/8
0	50	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 7/8	1 3/8	1 3/4	2 1/4	2 3/4
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1	10	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	1 0	1 1/2	2 1/8	2 5/8	3 1/4	4 0	4 5/8
1	20	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 7/8	1 3/8	2 0	2 5/8	3 1/4	4 0	4 3/4	
1	30	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	1 1/4	1 7/8	2 1/2	3 1/4	4 0	4 3/4		
1	40	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	1 0	1 5/8	2 1/4	3 0	3 3/4	4 5/8			
1	50	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	1 1/4	2 0	2 5/8	3 1/2	4 3/8				
2	0	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	0 7/8	1 1/2	2 1/4	3 1/8	4 0	4 7/8				
2	10	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	1 1/8	1 7/8	2 5/8	3 1/2	4 1/2					
2	20	0 3/4	0 3/4	0 3/4	0 3/4	0 3/4	1 3/8	2 1/8	3 0	4 0	5 0					
2	30	0 3/4	0 3/4	0 3/4	0 3/4	0 7/8	1 5/8	2 3/8	3 3/8	4 3/8						
2	40	0 3/4	0 3/4	0 3/4	0 3/4	1 0	1 7/8	2 3/4	3 3/4	4 3/4						
2	50	0 3/4	0 3/4	0 3/4	0 3/4	1 1/4	2 1/8	3 0	4 0							
3	0	0 3/4	0 3/4	0 3/4	0 3/4	1 3/8	2 3/8	3 1/4	4 3/8							
3	10	0 3/4	0 3/4	0 3/4	0 3/4	1 5/8	2 1/2	3 5/8	4 3/4							
3	20	0 3/4	0 3/4	0 3/4	0 7/8	1 3/4	2 3/4	3 7/8								
3	30	0 3/4	0 3/4	0 3/4	1 1/8	2 0	3 0	4 1/8								
3	40	0 3/4	0 3/4	0 3/4	1 1/4	2 1/8	3 1/4	4 1/2								
3	50	0 3/4	0 3/4	0 3/4	1 3/8	2 3/8	3 1/2	4 3/4								
4	0	0 3/4	0 3/4	0 3/4	1 1/2	2 1/2	3 3/4	5 0								
4	10	0 3/4	0 3/4	0 3/4	1 5/8	2 3/4	4 0									
4	20	0 3/4	0 3/4	0 3/4	1 3/4	2 7/8	4 1/4									
4	30	0 3/4	0 3/4	0 7/8	1 7/8	3 1/8	4 1/2									
4	40	0 3/4	0 3/4	1 0	2 1/8	3 1/4	4 5/8									
4	50	0 3/4	0 3/4	1 1/8	2 1/4	3 1/2	4 7/8									
5	0	0 3/4	0 3/4	1 1/4	2 3/8	3 5/8										
5	10	0 3/4	0 3/4	1 3/8	2 1/2	3 7/8										
5	20	0 3/4	0 3/4	1 3/8	2 5/8	4 0										
5	30	0 3/4	0 3/4	1 1/2	2 3/4	4 1/4										
5	40	0 3/4	0 3/4	1 5/8	2 7/8	4 3/8										
5	50	0 3/4	0 3/4	1 3/4	3 1/8	4 5/8										
6	0	0 3/4	0 3/4	1 7/8	3 1/4	4 3/4										
6	10	0 3/4	0 3/4	2 0	3 3/8	5 0										
6	20	0 3/4	0 7/8	2 0	3 1/2											
6	30	0 3/4	0 7/8	2 1/8	3 5/8											
6	40	0 3/4	1 0	2 1/4	3 3/4											
6	50	0 3/4	1 0	2 3/8	3 7/8											
7	0	0 3/4	1 1/8	2 1/2	4 1/8											
7	10	0 3/4	1 1/4	2 5/8	4 1/4											
7	20	0 3/4	1 1/4	2 5/8	4 3/8											
7	30	0 3/4	1 3/8	2 3/4	4 1/2											
7	40	0 3/4	1 3/8	2 7/8	4 5/8											
7	50	0 3/4	1 1/2	3 0	4 3/4											
8	0	0 3/4	1 1/2	3 1/8	4 7/8											
8	10	0 3/4	1 5/8	3 1/4												
8	20	0 3/4	1 3/4	3 1/4												
8	30	0 3/4	1 3/4	3 3/8												
8	40	0 3/4	1 7/8	3 1/2												
8	50	0 3/4	1 7/8	3 5/8												
9	0	0 3/4	2 0	3 3/4												
9	10	0 3/4	2 1/8	3 7/8												
9	20	0 3/4	2 1/8	4 0												
9	30	0 3/4	2 1/4	4 0												
9	40	0 3/4	2 1/4	4 1/8												
9	50	0 7/8	2 3/8	4 1/4												
10	0	0 7/8	2 3/8	4 3/8												
10	10	0 7/8	2 1/2	4 1/2												
10	20	1 0	2 5/8	4 5/8												
10	30	1 0	2 5/8	4 5/8												
10	40	1 0	2 3/4	4 3/4												
10	50	1 1/8	2 3/4	4 7/8												
11	0	1 1/8	2 7/8	5 0												
11	10	1 1/4	3 0													
11	20	1 1/4	3 0													
11	30	1 1/4	3 1/8													
11	40	1 3/8	3 1/8													
11	50	1 3/8	3 1/4													
12	0	1 3/8	3 1/4													

Elevation in Inches

v=square root of ((e+u)/.0007*d)

e=.0007*d*v^2-u

where:

v=velocity in mph

d=degree of curve in decimals

u=unbalanced elevation in inches

Appendix B

Spiral Lengths

Curvature

Elevation inches

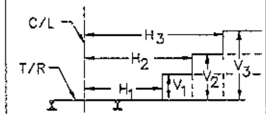
degrees	0	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5
minutes	20	40	0	20	40	0	20	40	0	20	40	0	20	40	0	20	40
0 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0 1/8	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0 1/4	20	10	10	10	10	10	10	0	0	0	0	0	0	0	0	0	0
0 3/8	40	30	20	20	20	10	10	10	10	10	10	10	10	10	10	10	0
0 1/2	50	40	30	30	20	20	20	20	10	10	10	10	10	10	10	10	10
0 5/8	60	50	40	30	30	30	30	20	20	20	20	20	10	10	10	10	10
0 3/4	80	60	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40
0 7/8	90	70	60	50	40	40	40	40	40	40	40	40	40	40	40	40	40
1 0	100	90	70	60	60	50	50	50	50	50	50	50	50	50	50	50	50
1 1/8	120	100	80	70	60	60	50	50	50	50	50	50	50	50	50	50	50
1 1/4	130	120	90	80	70	60	60	60	60	60	60	60	60	60	60	60	60
1 3/8	140	140	100	90	80	70	70	60	60	60	60	60	60	60	60	60	60
1 1/2	160	150	120	100	90	90	80	70	70	70	70	70	70	70	70	70	70
1 5/8	170	160	130	110	100	90	80	70	70	70	70	70	70	70	70	70	70
1 3/4	180	170	140	120	110	100	90	80	80	80	80	80	80	80	80	80	80
1 7/8	200	200	150	130	120	110	100	100	90	90	80	80	80	80	80	80	80
2 0	210	210	180	150	130	120	100	100	90	90	90	90	90	90	90	90	90
2 1/8	220	220	190	160	140	120	120	110	100	100	100	90	90	90	90	90	90
2 1/4	240	240	200	170	160	140	130	120	100	100	100	100	100	100	100	100	100
2 3/8	250	250	210	180	170	150	140	120	120	110	110	100	100	100	100	100	100
2 1/2	270	270	240	190	180	160	150	130	130	120	120	120	110	110	110	110	110
2 5/8	280	280	250	220	180	170	150	140	140	120	120	120	110	110	110	110	110
2 3/4	290	290	260	230	190	180	160	160	140	140	130	130	120	120	120	120	120
2 7/8	310	310	270	240	200	180	170	170	150	150	130	130	130	120	120	120	120
3 0	320	320	280	250	230	190	190	180	160	160	140	140	140	130	130	130	130
3 1/8	330	330	310	260	240	220	200	180	160	160	150	150	150	140	140	140	140
3 1/4	350	350	330	290	250	230	210	190	190	170	170	150	150	150	140	140	140
3 3/8	360	360	340	300	260	240	220	200	200	180	180	160	160	160	150	150	150
3 1/2	370	370	350	310	270	250	230	210	210	180	180	160	160	160	150	150	150
3 5/8	390	390	360	320	280	260	230	210	210	190	190	170	170	170	170	160	160
3 3/4	400	400	400	330	310	270	240	240	220	200	200	200	180	180	180	160	160
3 7/8	410	410	410	340	320	270	250	250	230	230	200	200	180	180	180	170	170
4 0	430	430	430	380	330	310	280	260	240	240	210	210	190	190	190	190	170
4 1/8	440	440	440	390	340	320	290	270	240	240	220	220	190	190	190	190	180
4 1/4	450	450	450	400	350	330	300	280	250	250	220	220	220	200	200	200	180
4 3/8	470	470	470	420	360	340	310	280	280	260	230	230	230	210	210	210	210
4 1/2	480	480	480	430	370	350	320	290	290	270	270	240	240	210	210	210	210
4 5/8	490	490	490	440	410	360	330	300	300	270	270	240	240	240	220	220	220
4 3/4	510	510	510	480	420	370	340	340	310	280	280	250	250	250	220	220	220
4 7/8	520	520	520	490	430	400	350	350	320	290	290	260	260	260	230	230	230
5 0	540	540	540	510	450	420	390	360	330	300	300	300	270	270	240	240	240

Attachment 3

BNSF Standard Plans – Clearance Requirements by State and

BNSF Standard Plans – Minimum Clearance Diagram

			TRACK CENTERS								VERTICAL						HORIZONTAL																			
																							PLATFORMS (H-HORIZONTAL CLEARANCE (MIN) V-VERTICAL CLEARANCE (MAX))						SIGNALS							
																														LOW BETWEEN TRACKS		SWITCH BOXES, ETC.				
STATE	REGULATION REFERENCE	YEAR OF LATEST AMENDMENT	MAIN TRACKS	ANY TWO SUBSIDIARY TRACKS	ADJACENT SUBSIDIARY TRACK TO ANY MAIN TRACKS	LADDER TRACK ADJACENT TO ANY PARALLEL TRACK	TWO ADJACENT PARALLEL LADDER TRACKS	LEAD, REPAIR AND CABOOSE TRACKS	TEAM TRACKS IN PAIRS	UNLOADING TRACKS AT PLATFORMS	GENERAL	THRU BRIDGES	HIGHWAY BRIDGES	TUNNELS	BUILDING DOORS	IN BUILDINGS	GENERAL	THRU BRIDGES	HIGHWAY BRIDGES	TUNNELS	BUILDING DOORS	IN BUILDINGS	V_1	H_1	V_2	H_2	V_3	H_3	HIGH	HEIGHT (MAX)	CLEARANCE	HEIGHT (MAX)	CLEARANCE	POLES	ORE AND COAL DOCKS	CATTLE CHUTES
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
ALABAMA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
ARIZONA	CHPTR. 5, ART. 1	1987	14-0	14-0	15-0	20-0	20-0	NR	13-0	13-6	22-0	22-0	23-0	22-0	18-0[2]	18-0[3]	8-6	8-0	8-6	8-0	7-8[2]	8-6	0-8	4-8			4-6	8-0	8-6	3-0	6-0	0-5	3-0	8-6	8-6	8-6
ARKANSAS	CASE R-1012	1956	14-0	14-0	14-0	17-0	20-0	14-0	13-0	13-0	22-0	22-0	22-0	23-0	17-0[2]	18-0[3]	8-6	8-0	8-6	8-0	7-0[4] [2]	7-0[5]	0-8	5-0	4-0	5-9[6]	4-0	8-0	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
CALIFORNIA	G.O. 26-D	1988	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0	18-0[3]	8-6	8-0	8-6	8-0	8-6	8-6	0-8	4-8	NR	NR	4-0	7-6[8]	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
CANADA	CHPTR. 1189	1983	13-0	13-6	14-0	15-0	18-0	13-6	12-0	12-0	22-6	22-6	22-6	22-6	22-6	22-6	8-4 1/4	8-0	8-4 1/4	8-0	8-4 1/4	8-4 1/4	[12]	[12]	[12]	[12]	4-0	[12]	8-4 1/4	3-0	8-4 1/4	NR	NR	8-4 1/4	8-4 1/4	8-4 1/4
COLORADO	DEC. 55621	1987	14-0	14-0	15-0	17-0	20-0	14-0	13-0	13-6	22-6	22-0	22-6	23-0	17-0[2]	18-0[3]	8-6	8-0	8-6	8-0	7-0	8-0[3]	0-8	5-0	4-0	5-9[6]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
IDAHO	G.O. NO. 158	1980	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	23-6	22-6	22-6	22-6	18-0[2]	18-0[3]	8-6	8-0	8-6	8-0	8-6[2]	8-6[2]	0-8	4-8	4-0	7-3	4-0	8-6[8]	8-0	3-0	6-0	0-4	3-0	8-6	8-6	8-6
ILLINOIS	TITLE 92 I.A.C.	1986	13-6[11]	13-6	15-0	17-0[15]	19-0[16]	NR	13-6	13-6	21-6	21-3	21-6	21-6[1]	H	21-6	8-0	8-0	8-0	8-0[1]	7-0[2]	8-0	0-4	4-6	0-8	5-1[7]	CFH	6-2	8-6	NR	NR	NR	NR	9-0	8-0	8-0
IOWA	NR	1982	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
KANSAS	ART. 5 -RSR	1987	14-0	14-0	14-0	17-0	20-0	14-0	13-0	13-6	22-6	22-6	22-6	23-0	17-0	18-0	8-6	8-6	8-6	8-0	7-0[13]	7-0[14]	0-8	5-0	4-0	6-2[6]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
KENTUCKY	277.240	1942	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	22-0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
MINNESOTA	219.47	1980	14-0	14-0	14-0	17-0	19-0	14-0	14-0	14-0	22-0	22-0	22-0	22-0	22-0[2]	22-0	8-6	8-6	8-6	8-6	8-6[2]	8-6	NR	NR	NR	NR	NR	NR	8-6	NR	NR	NR	NR	8-6	8-6	8-6
MISSISSIPPI	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
MISSOURI	TTL 4 CSR 265-8.060	1987	14-0	14-0	14-0	17-0	19-0	14-0	13-6	14-0	22-0	22-0	22-0	22-0	22-0	22-0	8-6	8-0	8-0	8-6	8-6[2]	8-6	0-4	4-6	0-8	5-1[7]	CFH	8-6	8-6	4-0	5-0 8-0 [10]	0-3	4-2	8-6	8-6	8-6
MONTANA	ADM. RULES	1980	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0[2]	18-0[3]	8-6	8-0	8-6	8-0	8-6[2]	8-6	0-8	4-8	4-0	5-9[6]	4-0	8-6[8]	8-0	3-0	6-0	0-4	3-0	8-6	8-6	8-6
NEBRASKA	ORD 16, CHPT 5, ART 4	1987	14-0	14-0	15-0	17-0	20-0	14-0	13-0	13-6	22-6	22-0	23-0	23-0	17-0[2]	18-0[3]	8-6	8-0	8-6	8-0	7-0[2]	8-6[5]	0-8	5-0	4-0	5-9[5]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
NEW MEXICO	ORDER 2202	1987	14-0	14-0	15-0	17-0	20-0	14-0	13-0	13-6	22-6	22-0	22-6	23-0	17-0[2]	18-0[3]	8-6	8-0	8-6	8-0	7-0[4]	7-0[5]	0-8	4-8	4-0	5-9[5]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
NORTH DAKOTA	SEC.49.10.1-13	1981	NR	NR	NR	NR	NR	NR	NR	NR	21-0	21-0[1]	21-0	21-0[1]	21-0	21-0	8-0[1]	8-0[1]	8-0	8-0[1]	8-0	8-0	NR	NR	NR	NR	4-0	8-0	8-0	NR	NR	NR	NR	8-0	8-0	8-0
OKLAHOMA	ORDER 33847	1987	14-0	14-0	14-0	17-0	20-0	14-0	13-0	13-6	22-0	22-0	22-0	23-0	17-0[2]	18-0[3]	8-6	8-0	8-6	8-0	7-0[2] [4]	7-0[5]	0-8	4-8	4-0	5-9[6]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
OREGON	ORDER 83-313	1983	15-0	14-0	15-0	20-0	20-0	14-0	14-0	13-0	20-9	20-9	20-9	20-9	18-0[2]	18-0[3]	8-6	8-0	8-6	8-0	8-6	8-6	0-8	4-8	NR	NR	4-0	7-3[8]	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
SOUTH DAKOTA	ORDER F2465	1957	NR	NR	NR	NR	NR	NR	NR	NR	22-6	22-6	22-6[1]	22-6	17-0	22-6	8-6	8-0	8-0[1]	8-6	7-0	8-6	0-8	4-8	CFH	5-9[6]	NR	NR	8-0	NR	NR	0-4	3-0	8-6	8-6	8-6
TENNESSEE	RULE 1220-3-1-.12	1970	14-0	13-0	14-0	18-0	18-0	14-0	13-0	13-0	22-0	22-0	22-0	22-0	17-0	17-0[3]	8-0	8-0	8-0	8-0	8-0	8-0	0-8	4-8	4-0	5-9	4-0	7-6	8-0	NR	6-6	0-4	3-0	8-0	8-0	8-0
TEXAS	SEC. 5, CHPT 11	1988	NR	NR	NR	NR	NR	NR	NR	NR	22-0	22-0	22-0	NR	22-0[2]	22-0	8-6	7-6	8-6	NR	8-6[2]	8-6	1-0	4-6	NR	NR	4-0	8-6	8-6	2-6	5-6	0-6	4-0	8-6	8-6	8-6
WASHINGTON	CHPTR. 480-60	1969	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	22-6	22-6	22-6	22-6	18-0[2]	18-0[3]	8-6	8-0	8-6	8-0	8-6[2]	8-6	0-8	4-8	4-0	7-3[6]	4-0	8-6[8]	8-0	3-0	6-0	0-4	3-0	8-6	8-6	8-6
WISCONSIN	CHPTR. TC-3	1982	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0	22-0	22-0[1]	22-0	22-0[1]	22-0	22-0	8-6	E	8-6	8-6[1]	8-6	8-6	0-4 0-8	4-6 5-1	1-9	6-0[7]	5-0	6-4	8-6	E	E	E	E	12-0	8-6	8-6
WYOMING	CHPTR. XIII	1979	14-0	14-0	15-0	17-0	20-0	14-0	13-0	13-0	22-6	22-0	23-6	23-0	17-0[2]	18-0[3]	8-6	8-0	8-6	8-0	7-0[2] [4]	7-0[5]	0-8	5-0	4-0	5-9[6]	4-0	8-6	8-6	3-0	6-0	0-4	3-0	8-6	8-6	8-6
BNSF RY. CO.	[18]	1997	25-0[19]	14-0	25-0	20-0	20-0	14-0	14-0	[20]	23-0	23-0	[21]	23-0	[20]	[20]	8-6[17]	8-6	[21]	8-6	[20]	[20]	[20]	[20]	[20]	[20]	[20]	[20]	8-6	[20]	6-0[17]	[20]	[20]	8-6	8-6	8-6



THIS CHART FOR INFORMATION ONLY - NO LIABILITY CAN BE ASSUMED
ARCHITECTS, CONTRACTORS, ETC., SHOULD CHECK WITH STATE INVOLVED.

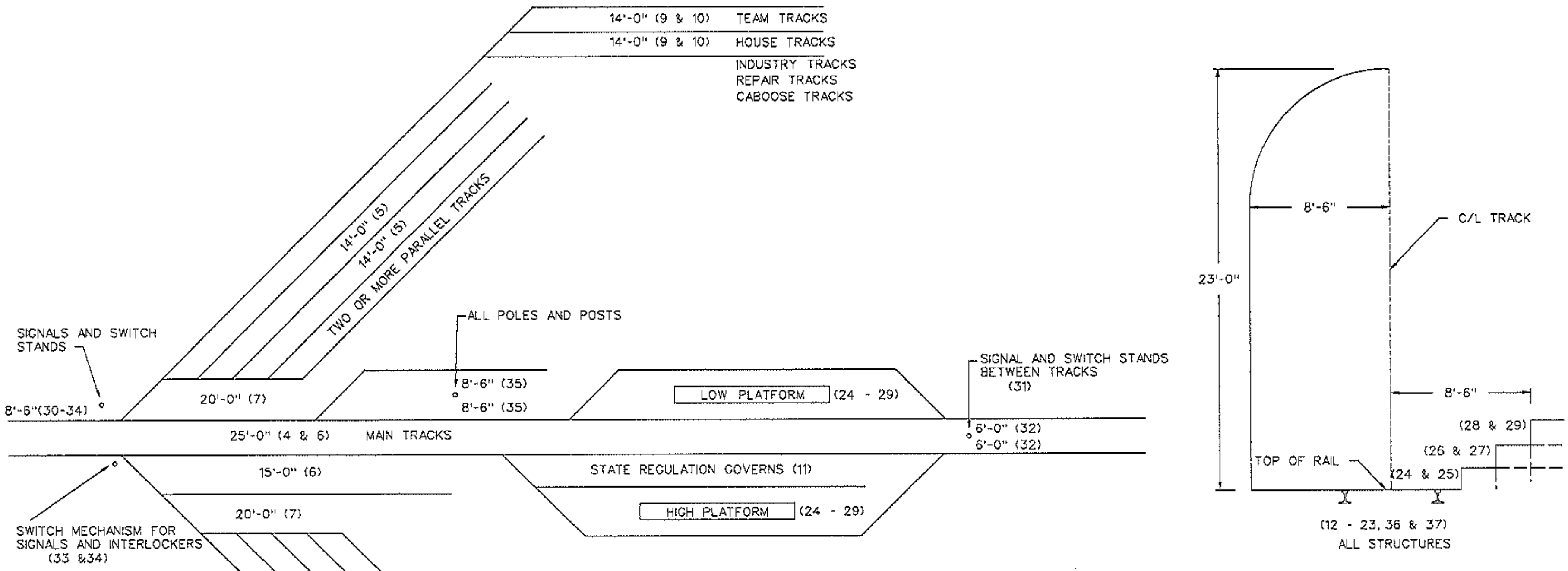
DIMENSIONS:
SHOWN IN FEET AND INCHES.
ARE FOR TANGENT TRACK - MOST LAWS SPECIFY INCREASES FOR CURVED AND SUPERELEVATED TRACK.
VERTICAL - MEASURED FROM TOP OF RAIL. EXCEPT CANADA BASE OF RAIL FOR OTHER THAN PLATFORMS.
HORIZONTAL - MEASURED FROM CENTER LINE OF TRACK.
APPLY TO NEW CONSTRUCTION. SOME RECONSTRUCTION AND SOME EXTENSIONS
SOME CAN BE VARIED UPON APPROVAL OF APPLICATION BY GOVERNING BODY.
ARE BASED ON MAXIMUM CAR SIZE FOR CALIFORNIA, IDAHO, MINNESOTA, MONTANA, NORTH DAKOTA, OREGON AND WASHINGTON.
ALL ARE MINIMUM EXCEPT COLUMNS 24, 26, 28, 31 AND 33 WHICH ARE MAXIMUM.

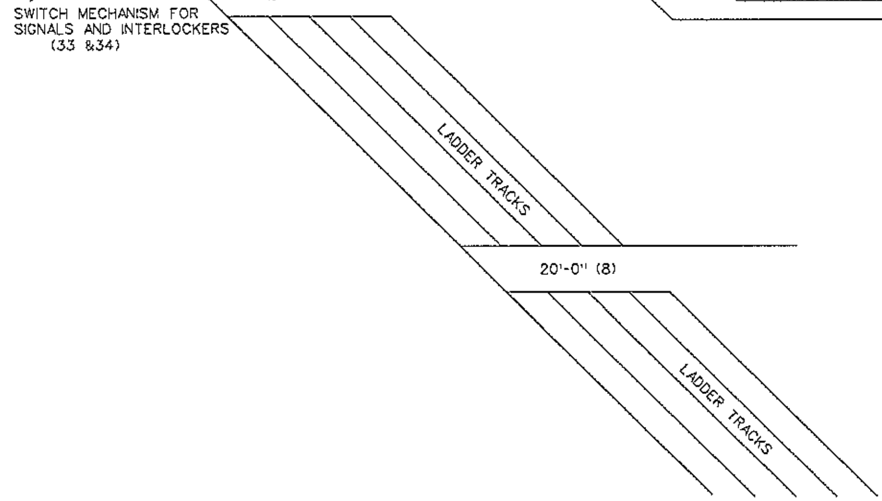
ABBREVIATIONS
CFH - CAR FLOOR HEIGHT
E - EXEMPT
H - HEIGHT OF CAR GOVERNS
NR - NO CURRENT REGULATION TO COVER

COLUMN HEADINGS
2 SHOWS BASIC REGULATION
3 SHOWS EFFECTIVE YEAR OR YEAR OF LATEST AMENDMENT
7 & 8 APPLY TO HAND AND MECHANICALLY OPERATED SWITCHES EXCEPT AS NOTED
12 & 18 PREVAILS FOR ALL ITEMS NOT OTHERWISE PROVIDED FOR
13 & 19 BRIDGES SUPPORTING TRACKS
14 & 20 BRIDGES SPANNING TRACKS
24 & 25 PASSENGER PLATFORMS
26 & 27 PASSENGER/FREIGHT PLATFORMS ON SIDE TRACKS EXCEPT AS NOTED.
28 & 29 FREIGHT PLATFORMS ON SIDE TRACKS
STEPPED PLATFORMS ARE NOT ALLOWED.
35 OTHER THAN TROLLEY CONTACT POLES.
36 TO CENTER OF STAND EXCEPT AS NOTED.
37 APPLIES TO BOTH SUPPORTS AND PLATFORMS EXCEPT AS NOTED.

FOOTNOTES:
1 LESSER CLEARANCES NOT PERMITTED IN QUADRANTS
2 ENGINE HOUSES AND SHOP BUILDINGS EXEMPT OR PERMITTED LESSER DIMENSIONS
3 ONLY IF TRACKS END WITHIN BUILDINGS.
4 MAY BE REDUCED TO 5-9 IF 8-3 (8-6 FOR WY) PROVIDED ON OPPOSITE SIDE
5 MAY BE REDUCED TO 5-9 IF 8-0 (8-6 FOR NE, MO & WY) PROVIDED ON OPPOSITE SIDE
6 ONLY IF 8-0 (7-3 FOR MT & WY; 8-6 FOR WA & SD) PROVIDED ON OPP. SIDE
7 PASSENGER PLATFORMS ONLY.
8 MAY BE 8-0 AT 4-6 FOR REFRIGERATOR CAR PLATFORMS ONLY.
9 TO ENDS OF ARMS IN OPERATING POSITION.
10 FOR PLATFORMS AT CAR EAVE HEIGHT - SUPPORTS TO BE 8-0 (8-6 FOR TEXAS).
11 FOR FREIGHT TRACKS - CAN BE 13-0 FOR PASSENGER TRACKS.
12 REGARDING CANADA - CHECK STANDARD CLEARANCE DIAGRAM APPROVED BY BOARD OF TRANSPORT COMMISSIONERS FOR CANADA FOR RAILWAY INVOLVED.
13 MAY BE REDUCED TO 6-2 IF 8-3 PROVIDED ON OPPOSITE SIDE.
14 MAY BE REDUCED TO 6-2 IF 8-0 PROVIDED ON OPPOSITE SIDE.
15 FOR HAND OPERATED SWITCHES - MAY BE 15-0 FOR MECHNICALLY OPERATED SWITCHES.
16 FOR HAND OPERATED SWITCHES - MAY BE 17-0 FOR MECHANICALLY OPERATED SWITCHES.
17 MUST HAVE ADDITIONAL SIDE CLEARANCE OF 1 1/2 INCH PER DEGREE OF CURVATURE.
18 IF NO FIGURE IS GIVEN USE STATUORY CLEARANCE.
19 NEW CONSTRUCTION 25-0 CENTER TO CENTER MAIN TRACK/CONTROL SIDING.
20 STATE REGULATION GOVERNS.
21 CENTER LINE OF TRACK TO CLOSEST EDGE OF PIER: MAIN LINE-25'0", OTHERS-18'-0".

BURLINGTON NORTHERN SANTA FE STANDARD PLAN ENGINEERING DEPT., FORT WORTH, TEXAS	CLEARANCE REQUIREMENTS BY STATE AND RECOMMENDED BNSF CLEARANCE	DATE: 10/29/97	DWG. NO.	SHEET NO.	REV. NO.
		USE OF THIS DRAWING IS LIMITED TO BURLINGTON NORTHERN SANTA FE AND THE PARTY DESIGNATED ON THE ATTACHED EXHIBIT "A". USE MAY NOT BE MADE BY ANY THIRD PARTY WITHOUT THE WRITTEN CONSENT OF BURLINGTON NORTHERN SANTA FE.	2509	02	01





NOTES:

1. NUMBERS IN PARENTHESIS REPRESENT THE COLUMN NUMBERS FOR DIMENSIONS IN COLUMNS ON DWG. 2509.02.
2. SEE DWGS. 1000.01 AND 1000.02 FOR EXISTING AND NEW CONSTRUCTION TRACK CENTERS.
3. STEPPED PLATFORMS ARE NOT ALLOWED.
4. DIMENSIONS ON THIS PLAN ARE BNSF GENERAL CLEARANCES ONLY. WHERE DIMENSIONS ARE NOT SHOWN, REFER TO DWG. 2509.02 FOR DETAILS. STATE REGULATIONS SUPERSEDE BNSF RECOMMENDED CLEARANCES.

BURLINGTON NORTHERN
SANTA FE
STANDARD PLAN
ENGINEERING DEPT., FORT WORTH, TEXAS

BNSF
MINIMUM CLEARANCES
DIAGRAM

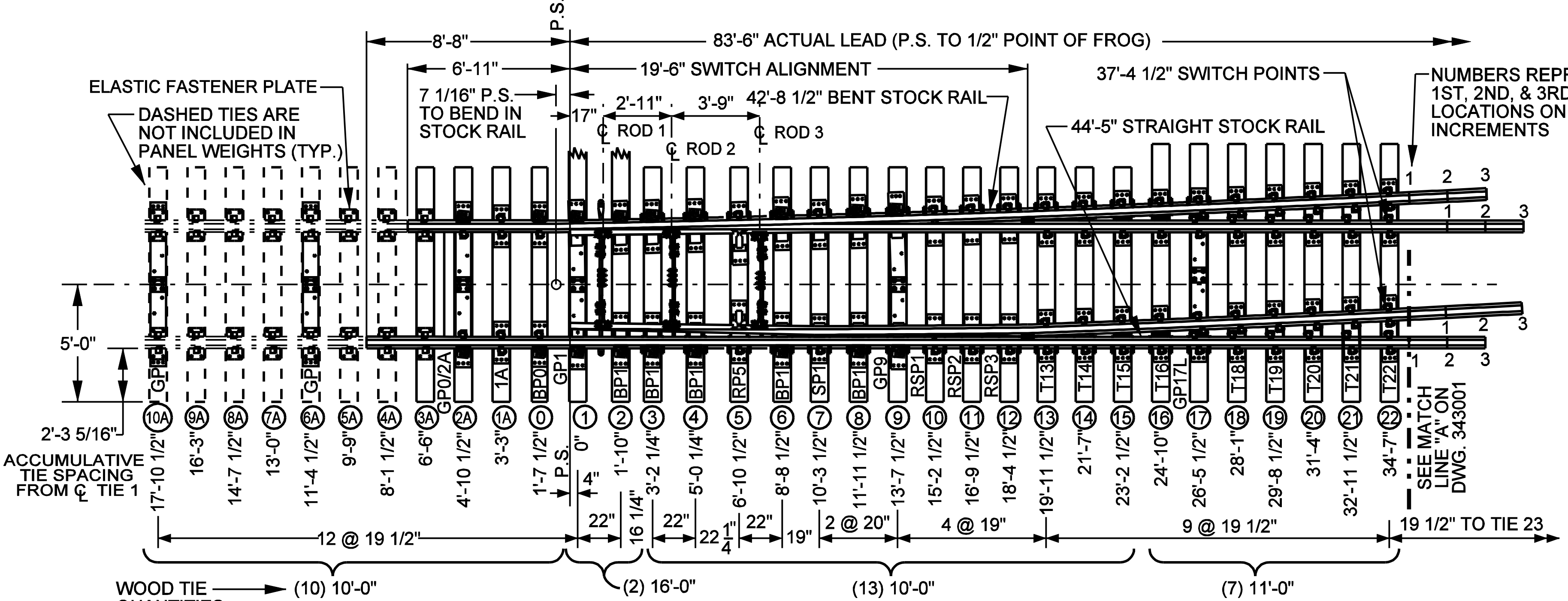
RAIL: NONE

DATE: 10/29/97 | SCALE: NONE

DWG. NO. 2509 | SHEET NO. 01 | REV. NO. 09

Attachment 4

BNSF Standard Plan for No. 11, 15, 20, and 24 Turnouts

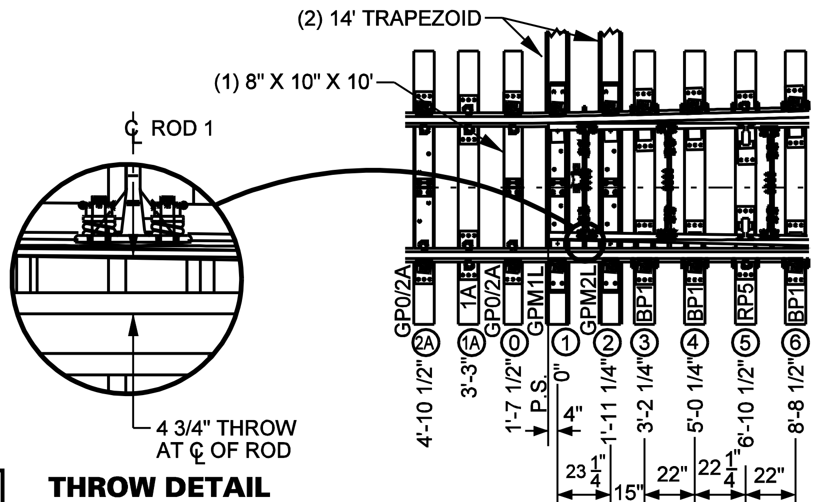


MANUAL OPERATED

PANEL WEIGHT: 20,000 LBS.

NOTES:

1. SEE DWGS 343001 THRU 343005 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 343100 FOR TURNOUT GEOMETRY.
4. SEE DWG 343200 FOR TURNOUT BILL OF MATERIAL.
5. FULLY BOX ANCHOR STOCK RAILS, TIES 3-15 FOR SHIPPING OF PANELS ONLY.
6. APPLY 5" SAFE BOND WIRES ONE CRIB AHEAD OF HEEL OF SWITCH ON STOCK AND SWITCH POINT RAILS.
7. ALL SWITCH POINT AND STOCKRAIL DIMENSIONS ARE TO FIRST INSTALL, SEE PLAN 241500 FOR FULL LENGTH.



THROW DETAIL

POWER OPERATED

PANEL WEIGHT: 20,000 LBS.

	UPRR	BNSF RH	BNSF LH
136LB. POWER	N/A	004734653	004734810
136LB. MANUAL	N/A	004734828	004734836
136LB. MAN. SPR. SW.	N/A	004734869	004734877
141LB. POWER	N/A	005253505	005253497
141LB. MANUAL	N/A	005253521	005253513
141LB. MAN. SPR. SW.	N/A	005253547	005253539

BNSF RAILWAY

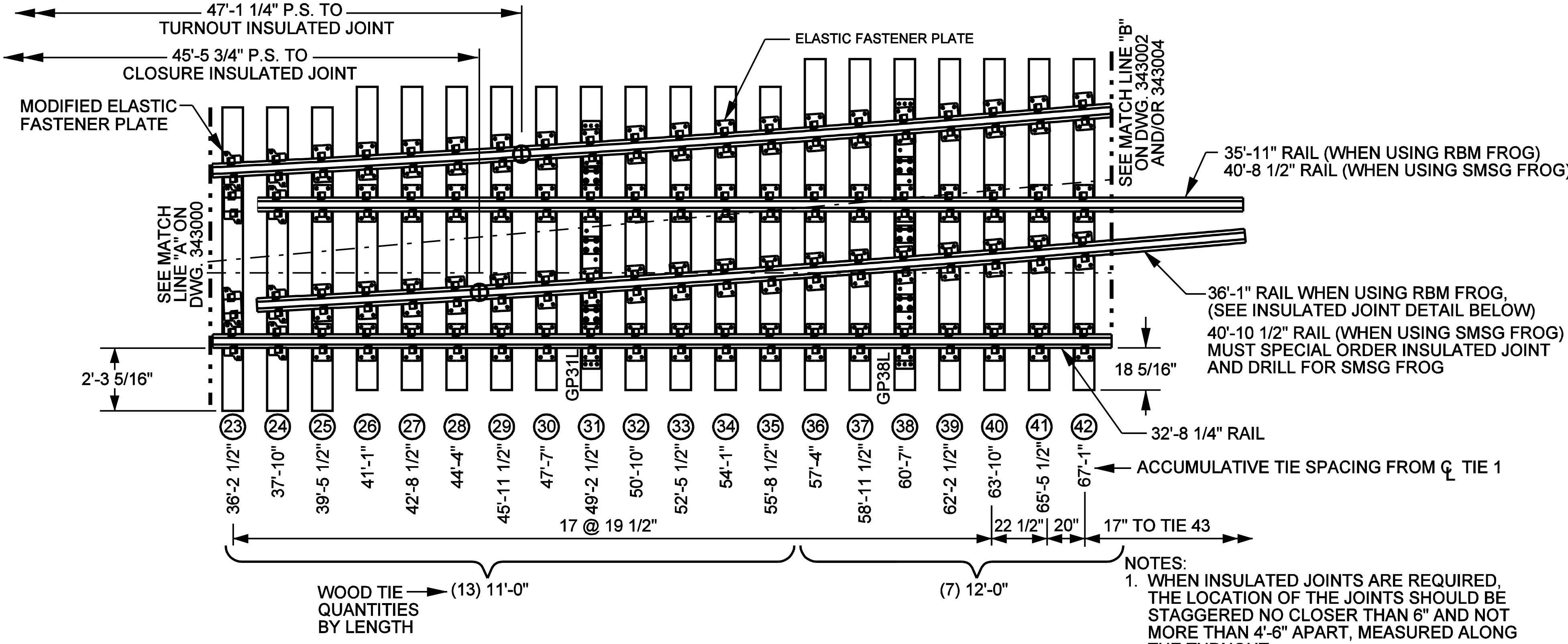
UNION PACIFIC

COMMON STANDARDS

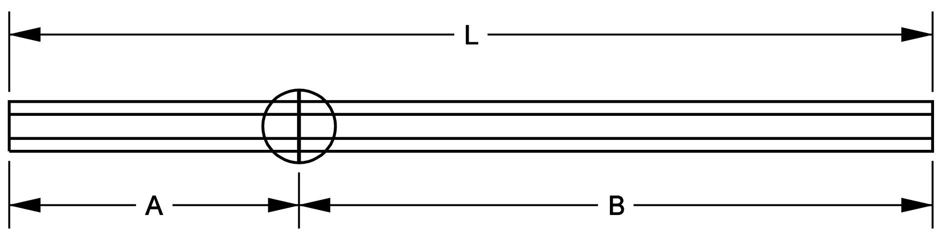
NO. 11 TURNOUT136/141 LB. PANEL NO. 1

FILE OWNER: BNSF | DATE: AUG. 26, 2009

REV. NO.: 5 | DWG NO: 343000



NOTES:
1. WHEN INSULATED JOINTS ARE REQUIRED, THE LOCATION OF THE JOINTS SHOULD BE STAGGERED NO CLOSER THAN 6" AND NOT MORE THAN 4'-6" APART, MEASURED ALONG THE TURNOUT.
2. SEE DWGS 343000, 343002, 343003, 343004, AND 343005 FOR THE BALANCE OF LAYOUT PLANS.
3. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
4. SEE DWG 343100 FOR TURNOUT GEOMETRY.
5. SEE DWG 343200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL WEIGHT = 17,000 LBS.



INSULATED JOINT DETAIL
(FOR USE WITH RBM FROG ONLY)

	A	B	L
TURNOUT INSULATED JOINT RAIL	11'-4"	21'-5"	32'-9"
CLOSURE INSULATED JOINT RAIL	8'-2"	27'-11"	36'-1"

	BNSF STOCK CODE	
	136LB.	141LB.
LH TURNOUT INSULATED JOINT RAIL	005253760	005253554
LH CLOSURE INSULATED JOINT RAIL	005253778	005253562
RH TURNOUT INSULATED JOINT RAIL	005253786	005253570
RH CLOSURE INSULATED JOINT RAIL	005253794	005253588

BNSF RAILWAY

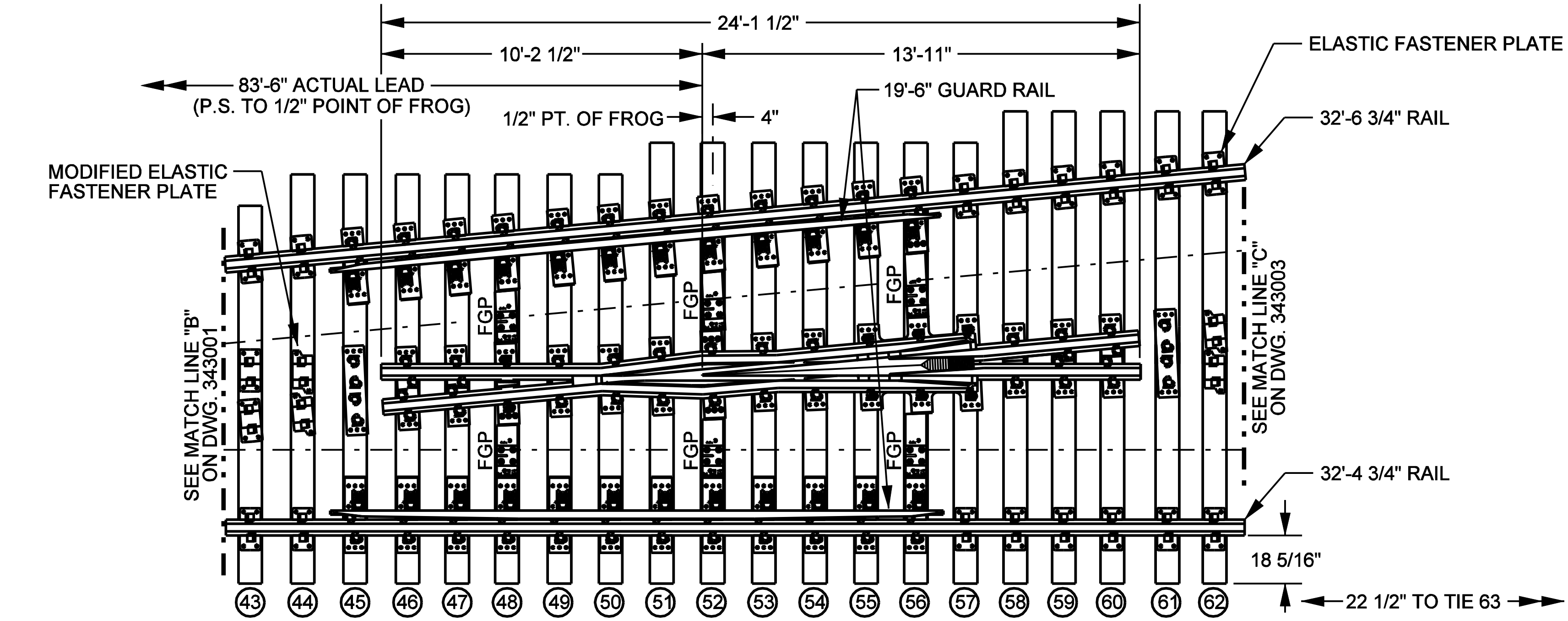
UNION PACIFIC

COMMON STANDARDS

NO. 11 TURNOUT 136/141 LB.
PANEL NO. 2

FILE OWNER: BNSF | DATE: AUG. 26, 2009

REV. NO.: 5 | DWG NO: 343001



NOTES:
1. SEE DWGS 343000, 343001, 343003, 343004, AND 343005 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 343100 FOR TURNOUT GEOMETRY.
4. SEE DWG 343200 FOR TURNOUT BILL OF MATERIAL.
5. APPLY 5" SAFE BOND WIRES ONE CRIB AHEAD OF TOE BLOCK, END OF SOLID WING RAIL, BEHIND END OF WING RAIL ON TAIL RAIL AND ONE CRIB BEHIND HEEL BLOCK OF FROG.
6. PANEL WEIGHT = 22,000 LBS.
7. SEE DWGS 343004 AND 343005 FOR SMSG AND LIFT FROG PANELS.

	UPRR	BNSF RH	BNSF LH
136LB. RBM	N/A	004710299	004710307
136LB. SPR	N/A	004710315	004710323
136LB. SOLID	N/A	004710331	004710349
141LB. RBM	N/A	005252739	005252721
141LB. SPR	N/A	005252754	005252747
141LB. SOLID	N/A	N/A	N/A

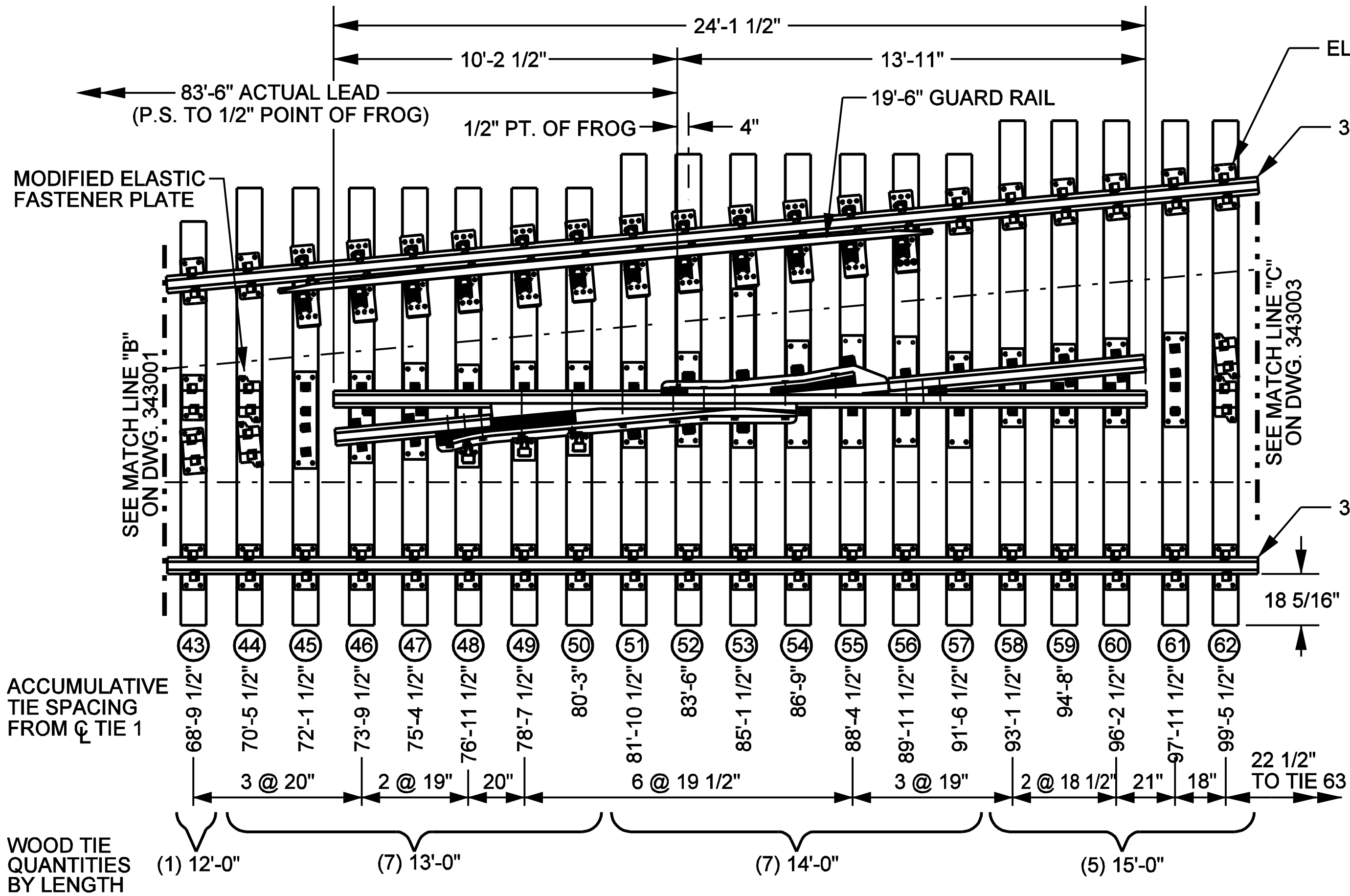
BNSF RAILWAY

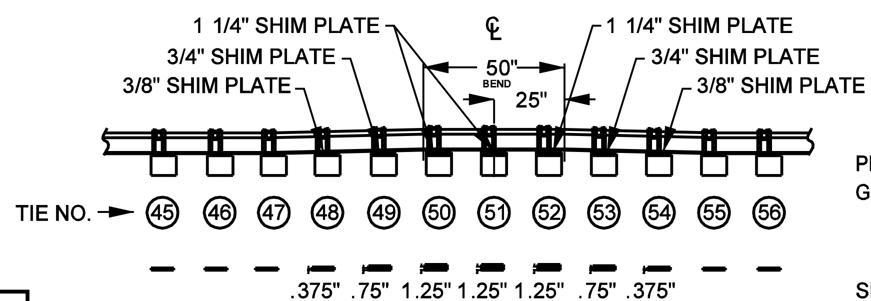
COMMON STANDARDS

NO. 11 TURNOUT 136/141 LB. PANEL NO. 3 WITH OPTIONAL RBM FROG

FILE OWNER: BNSF | DATE: AUG. 26, 2009

REV. NO.: 5 | DWG NO: 343002





PLACE SHIM PLATES UNDER TURNOUT SIDE GUARD RAIL PLATES ON TIES AS SHOWN.

SHIM LOCATION (SIDE VIEW)

NOTES:
1. SEE DWGS 343000, 343001, 343002, 343003, AND 343004 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 343100 FOR TURNOUT GEOMETRY.
4. SEE DWG 343200 FOR TURNOUT BILL OF MATERIAL.
5. APPLY 5" SAFE BOND WIRES ONE CRIB AHEAD OF TOE BLOCK, END OF SOLID WING RAIL, BEHIND END OF WING RAIL ON TAIL RAIL AND ONE CRIB BEHIND HEEL BLOCK OF FROG.
6. PANEL WEIGHT = 22,000 LBS.
7. SEE DWG 343002 AND 343004 FOR SMSG AND RBM FROG PANELS.
8. HY-RAIL VEHICLES MUST USE CAUTION MOVING OVER LIFT FROG.

BNSF RAILWAY

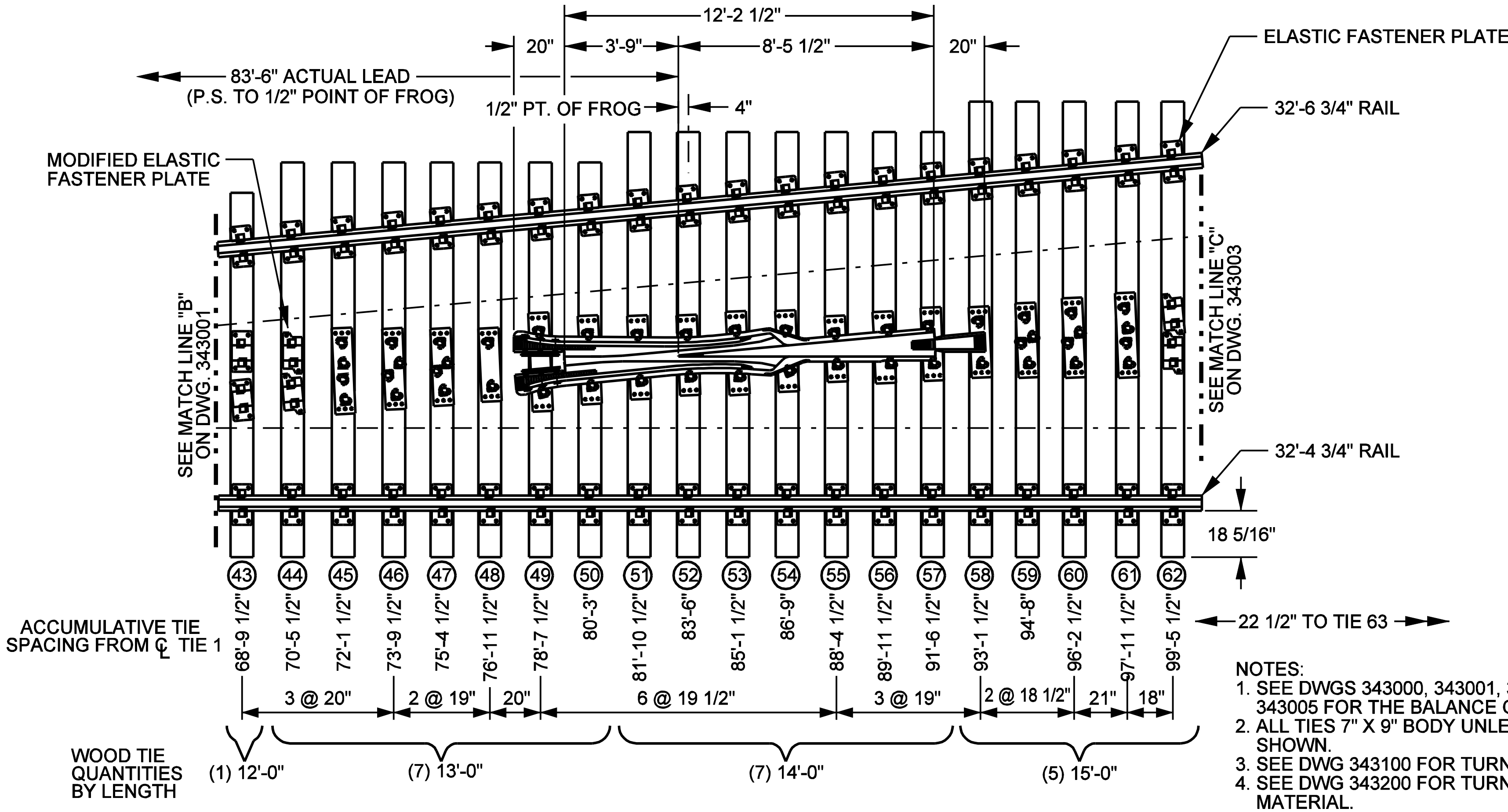
UNION PACIFIC

COMMON STANDARDS

NO. 11 TURNOUT 136/141 LB. PANEL NO. 3 WITH OPTIONAL LIFT FROG

FILE OWNER: BNSF | DATE: AUG. 26, 2009

REV. NO.: 0 | DWG NO: 343005



NOTES:
1. SEE DWGS 343000, 343001, 343002, 343003, AND 343005 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 343100 FOR TURNOUT GEOMETRY.
4. SEE DWG 343200 FOR TURNOUT BILL OF MATERIAL.
5. PANEL WEIGHT = 22,000 LBS.
6. SEE DWGS 343002 AND 343005 FOR RBM AND LIFT FROG PANELS.

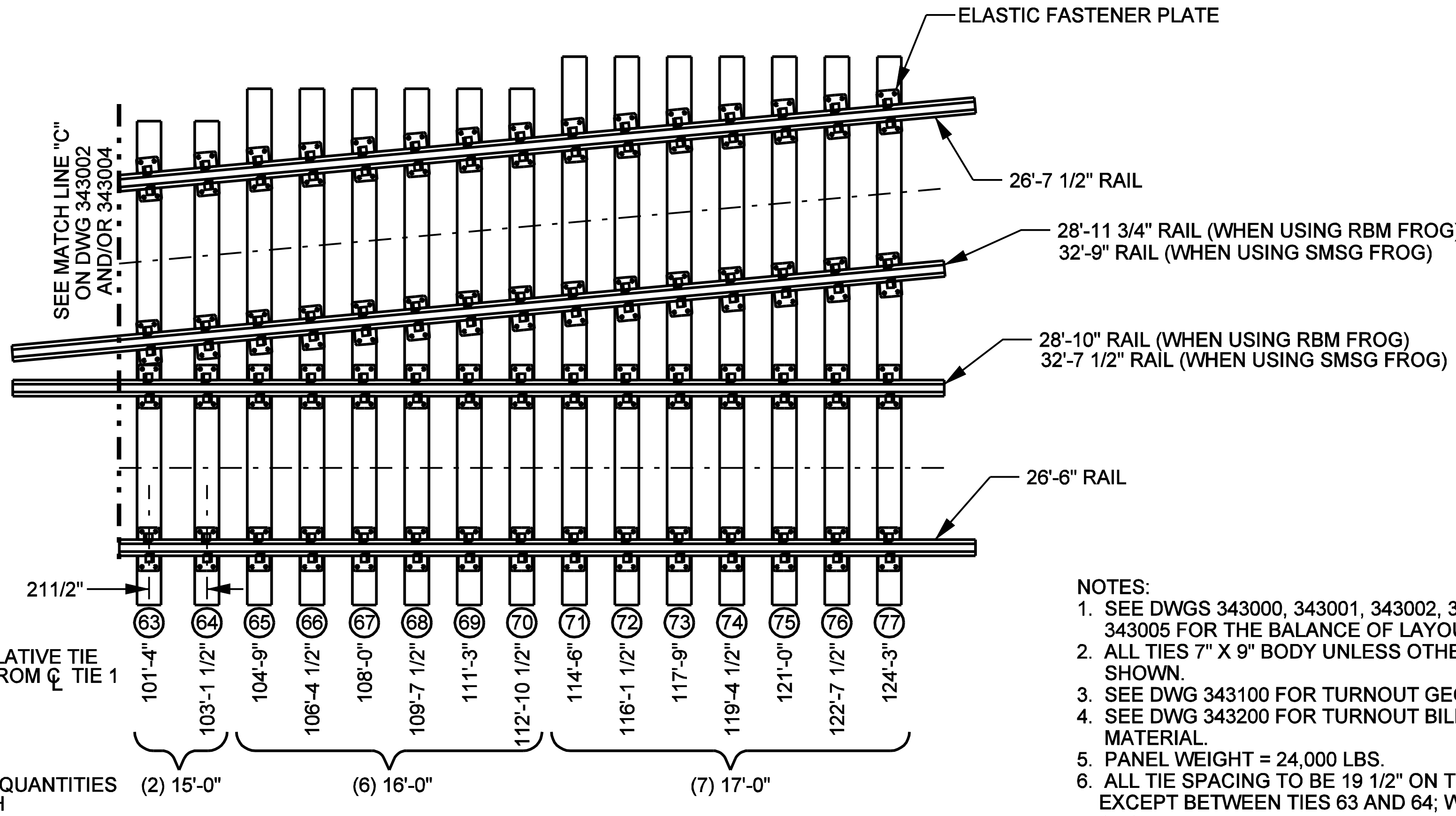
	UPRR	BNSF RH	BNSF LH
136LB. RBM	N/A	004710299	004710307
136LB. SPR	N/A	004710315	004710323
136LB. SOLID	N/A	004710331	004710349
141LB. RBM	N/A	005252739	005252721
141LB. SPR	N/A	005252754	005252747
141LB. SOLID	N/A	N/A	N/A

BNSF RAILWAY

COMMON STANDARDS

NO. 11 TURNOUT 136/141 LB. PANEL NO. 3 WITH OPTIONAL SMSG FROG

FILE OWNER: BNSF	DATE: AUG. 26, 2009
REV. NO.: 2	DWG NO: 343004



NOTES:

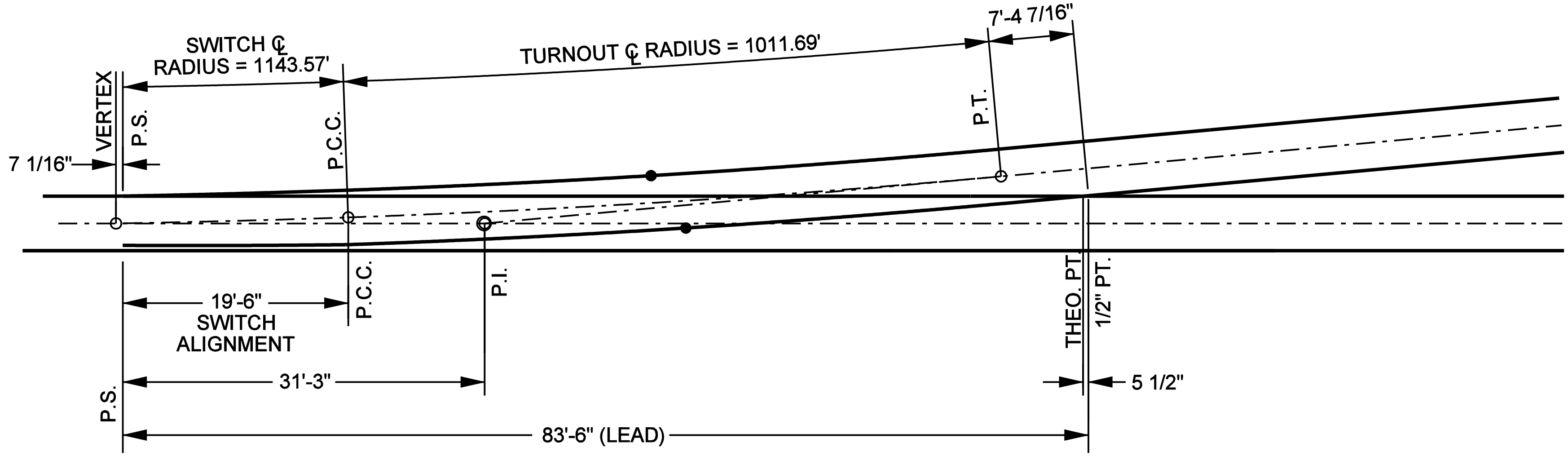
1. SEE DWGS 343000, 343001, 343002, 343004, AND 343005 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 343100 FOR TURNOUT GEOMETRY.
4. SEE DWG 343200 FOR TURNOUT BILL OF MATERIAL.
5. PANEL WEIGHT = 24,000 LBS.
6. ALL TIE SPACING TO BE 19 1/2" ON THIS DWG. EXCEPT BETWEEN TIES 63 AND 64; WHICH ARE SHOWN AT 21 1/2".

BNSF RAILWAY — UNION PACIFIC

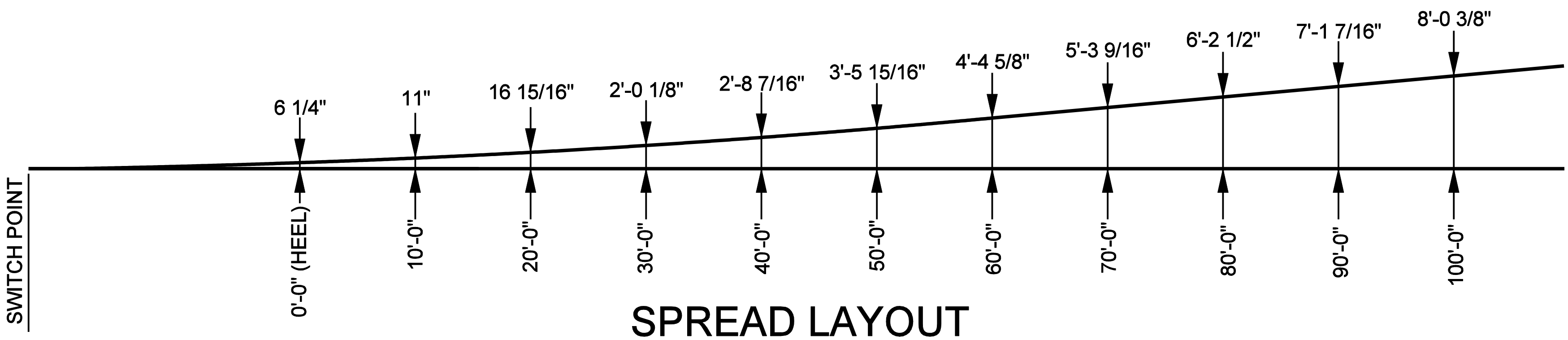
COMMON STANDARDS

NO. 11 TURNOUT 136/141 LB.
PANEL NO. 4

FILE OWNER: BNSF	DATE: AUG. 26, 2009
REV. NO.: 3	DWG NO: 343003



GENERAL LAYOUT



SPREAD LAYOUT

	SWITCH DATA	
	SWITCH LENGTH	19'-6"
	HEEL SPREAD	6 1/4"
	HEEL ANGLE	1°-59'-16"
	SWITCH ANGLE	1°-00'-40"
	THROW AT ROD #1	4 3/4"
	RADIUS (CENTER LINE)	1143.57'
	T =	9.69'
	CENTRAL ANGLE - CLOSURE CURVE	0°58'16"
	DEGREE OF CURVE	5°00'06"
TURNOUT POINT	THICKNESS AT POINT	1/8"
TURNOUT POINT	RADIUS (CLOSURE CURVE)	1145.92'
TURNOUT POINT	VERTEX DISTANCE	7 1/16"

FROG DATA	
ANGLE	5°-12'-18"
LENGTH	VARIES

TURNOUT DATA	
RADIUS OF CENTER LINE	1011.69'
T =	28.35'
CENTRAL ANGLE - CLOSURE CURVE	3°13'02"
DEGREE OF CURVE	5°40'44"

NOTES:

COMMON STANDARDS

NO. 11 TURNOUT 19'-6" CURVED SWITCH TURNOUT GEOMETRY

FILE OWNER: BNSF	DATE: JAN. 9, 2003
REV. NO.: 0	DWG NO: 343100

ITEMS SPECIAL TO MANUAL OR POWER AND A CHOICE OF FROGS

QTY.	REQUIRED FOR MANUAL	DRW #	BNSF STOCK CODE	UPRR ITEM #
2	"BP0" PLATE FOR TIE 0	241306	004721361	N/A
1	"GP1" ADJUSTABLE BRACE GAGE PLATE FOR TIE 1	241300	SEE DRG	SEE DRG
2	"BP1" ADJUSTABLE BRACE SLIDE PLATE FOR TIE 2	241306	004721338	557-2638
1	7' X 9" X 10' - 0" TIE (TIE 0)	N/A	004929436	502-1000
2	7' X 9" X 16' - 0" TIE (TIES 1 AND 2)	N/A	004929550	502-1600
1	SWITCH ROD NO. 1	241600	SEE DRG	557-5587
QTY.	REQUIRED FOR POWER	DRW #	BNSF ITEM #	UPRR ITEM #
1	"GP0/2A" ADJUSTABLE BRACE GAGE PLATE FOR TIE 0	241301	004721056	N/A
1	"GPM1L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE 1	241302	SEE DRG	SEE DRG
1	"GPM2L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE 2	241303	SEE DRG	SEE DRG
1	8" (TOP) X 10" X 10'-0" TIE (TIE 0)	250000	004930145	502-4300
2	7" X 10' X 14'-0" TRAPEZOID TIE (TIES # 1 AND # 2)	250000	004930186	502-4899
1	SWITCH ROD NO. 1 WITH BASKET (ADJUSTER)	241601	SEE DRG	557-5585
QTY.	FROGS	DRW #	BNSF ITEM #	UPRR ITEM #
1	RBM WITH PLATES	153100	SEE DRG	SEE DRG
1	SOLID SELF GUARDED FROG WITH PLATES	153200	SEE DRG	SEE DRG
1	SPRING FROG WITH PLATES	153300	SEE DRG	SEE DRG
6	"FGP" FROG GAGE PLATE	156000	004720983	555-6806
QTY.	GUARD RAIL (REQUIRED FOR RBM, SPRING AND JUMP FROGS)	DRW #	BNSF ITEM #	UPRR ITEM #
2	19' - 6" BOLTLESS ADJUSTABLE GUARD BAR	160100	004729257	556-5260

MANUAL OPERATED ITEM NUMBERS	BNSF L.H.		BNSF R.H.		BNSF L.H.	BNSF R.H.	UPRR L.H.		UPRR R.H.		UPRR L.H.	UPRR R.H.
USE OF SPRING SWITCH 1 1/4" REINF. IN TURNOUTS					WITH	WITH					WITH	WITH
USE OF BONDED JOINT IN TURNOUS	WITHOUT	WITH	WITHOUT	WITH	WITH	WITH	WITHOUT	WITH	WITHOUT	WITH	WITH	WITH
136 LB - #11 TURNOUT W/ RBM FROG, PANEL (COMPLETE)	004737243	004737235	004737227	004737219	004737573	004737581	N/A	N/A	N/A	N/A	N/A	N/A
136 LB - #11 TURNOUT W/ SPRING FROG, PANEL	004737326	004737318	004737300	004737292	004737607	004737615	N/A	N/A	N/A	N/A	N/A	N/A
136 LB - #11 TURNOUT W/ SMSG FROG, PANEL (COMPLETE)	004737284	004737276	004737268	004737250	004737623	004737631	N/A	N/A	N/A	N/A	N/A	N/A
136 LB - #11 TURNOUT W/ RBM FROG, PPTO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	557-8058	N/A	557-8059	557-8034	557-8082
136 LB - #11 TURNOUT W/ SPRING FROG, PPTO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	557-8083	N/A	557-8084	557-8079	557-8080
136 LB - #11 TURNOUT W/ SMSG FROG, PPTO	N/A	N/A	N/A	N/A	N/A	N/A	557-8089	N/A	557-8090	N/A	N/A	N/A
136 LB - #11 TURNOUT W/ JUMP FROG, PPTO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	557-8098	N/A	557-8099	N/A	N/A

POWER OPERATED ITEM NUMBERS	BNSF L.H.		BNSF R.H.		UPRR L.H.		UPRR R.H.	
UES OF BONDED JOINT IN TURNOUTS	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH	WITHOUT	WITH
136 LB #11 W/ RBM FROG, PANEL	004737367	004737359	004737342	004737334	N/A	N/A	N/A	N/A
136 LB #11 TURNOUT W/ SPRING FROG, PANEL	004737441	004737433	004737425	004737417	N/A	N/A	N/A	N/A
136 LB #11 TURNOUT W/ SMSG FROG, PANEL	004737409	004737391	004737383	004737375	N/A	N/A	N/A	N/A
136 LB #11 TURNOUT W/ RBM FROG, PPTO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
136 LB #11 TURNOUT W/ SPRING FROG, PPTO	N/A	N/A	N/A	N/A	N/A	557-8077	N/A	557-8078
136 LB #11 TURNOUT W/ SMSG FROG, PPTO	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

141 LB ITEM NUMBERS

DESCRIPTION	BNSF STOCK CODE
141 LB RH SPRING MANUAL W O/ INSULATED JOINTS	BNSF PART # 004738274
141 LB LH SPRING MANUAL W O/ INSULATED JOINTS	BNSF PART # 004738290
141 LB RH SPRING POWER W O/ INSULATED JOINTS	BNSF PART # 004738316
141 LB LH SPRING POWER W O/ INSULATED JOINTS	BNSF PART # 004738332
141 LB RH SPRING MANUAL TURNOUT W/ INSULATED JOINTS	BNSF PART # 004738266
141 LB LH SPRING MANUAL TURNOUT W/ INSULATED JOINTS	BNSF PART # 004738282
141 LB RH SPRING POWER TURNOUT W/ INSULATED JOINTS	BNSF PART # 004738308
141 LB LH SPRING POWER TURNOUT W/ INSULATED JOINTS	BNSF PART # 004738324
DESCRIPTION	UPRR ITEM #
141 LB LH TURNOUT W/ RBM FROG, SS, PPTO	UPRR PART # 557-8521
141 LB RH TURNOUT W/ RBM FROG, SS, PPTO	UPRR PART # 557-8522
141 LB LH TURNOUT W/ SPRING FROG, HT, PPTO	UPRR PART # 557-8523
141 LB RH TURNOUT W/ SPRING FROG, HT, PPTO	UPRR PART # 557-8524
141 LB LH TURNOUT W/ RBM FROG, HT, PPTO	UPRR PART # 557-8527
141 LB RH TURNOUT W/ RBM FROG, HT, PPTO	UPRR PART # 557-8528
141 LB LH TURNOUT W/ SPRING FROG, PO, PPTO	UPRR PART # 557-8529
141 LB RH TURNOUT W/ SPRING FROG, PO, PPTO	UPRR PART # 557-8530
141 LB LH TURNOUT W/ SPRING FROG, SS, PPTO	UPRR PART # 557-8531
141 LB RH TURNOUT W/ SPRING FROG, SS, PPTO	UPRR PART # 557-8532
141 LB LH TURNOUT W/ JUMP FROG, HT, PPTO	UPRR PART # 557-8441
141 LB RH TURNOUT W/ JUMP FROG, HT, PPTO	UPRR PART # 557-8442

TIES USED IN ALL # 11 TURNOUTS

QTY	SIZE	TIE NUMBER
10	7" X 9" X 10'-0"	TIES 1A THRU 10A
13	7" X 9" X 10'-0"	TIES 3 THRU 15
20	7" X 9" X 11'-0"	TIES 16 THRU 35
8	7" X 9" X 12'-0"	TIES 36 THRU 43
7	7" X 9" X 13'-0"	TIES 44 THRU 50
7	7" X 9" X 14'-0"	TIES 51 THRU 57
7	7" X 9" X 15'-0"	TIES 58 THRU 64
6	7" X 9" X 16'-0"	TIES 65 THRU 70
7	7" X 9" X 17'-0"	TIES 71 THRU 77

ITEMS USED IN ALL # 11 TURNOUTS

QTY.	COMPONENT DESCRIPTION	DWG #	BNSF STOCK CODE	UPRR ITEM #
1	19'-6" (EXT. 35'-9") STRT SAMSON SWITCH POINT (NO TIP)	243100	SEE DWG	SEE DWG
1	19'-6" (EXT. 35'-9") CURVED SAMSON SWITCH POINT (W/TIP)	243100	SEE DWG	SEE DWG
1	37'-11" STRAIGHT SAMSON STOCK RAIL	241500	SEE DWG	SEE DWG
1	36'-2" BENT / CURVED SAMSON STOCK RAIL	241500	SEE DWG	SEE DWG
1	EA. SWITCH RODS NO. 2, AND 3	241600	SEE DWG	SEE DWG
2	"GP" GAGE PLATE FOR TIES 6A & 10A AHEAD OF POINT	241304	004721270	N/A
1	"GP0/2A" ADJUSTABLE BRACE GAGE PLATE FOR TIE 2A	241301	004721031	N/A
2	"1A" PLATE FOR TIE 1A	241307	004721403	N/A
1	"GP9" ADJUSTABLE BRACE GAGE PLATE FOR TIE 9	241305	004721312	N/A
2	"RP5" ROLLER RISER PLATE	241309	004721551	N/A
2	ROLLER BEARING ASSEMBLY FOR "PR5" PLATE	241309	516650007	N/A
8	"BP1" ADJUSTABLE BRACE SLIDE PLATE	241306	004721338	557-2960
4	"SP1" SIDE PLATE	241306	004721346	557-2961
2	EA. "RSP1", "RSP2", AND "RSP3" RISER SLIDE PLATES FOR TIP 10-12	243309	SEE DWG	N/A
2	TURNOUT PLATES T13 THUR T22	243307	SEE DWG	SEE DWG
1	"GP17" GAGE PLATE FOR TIE 17	243311	SEE DWG	SEE DWG
1	"GP31" GAGE PLATE FOR TIE 31	243312	SEE DWG	SEE DWG
1	"GP38" GAGE PLATE FOR TIE 38	243313	SEE DWG	SEE DWG
1	36'-1" CLOSURE INSULATED JOINT RAIL	343001	004741385	N/A
1	32'-9" INSULATED JOINT TURNOUT RAIL	343001	004741377	N/A
1	36'-1" CLOUSRE RAIL (ONLY IN NON-INSULATED TU)	343001	N/A	N/A
1	32'-9" JOINT TURNOUT RAIL (ONLY IN NON-INSULATED TURNOUT)	343001	N/A	N/A
253	136 OR 141 LB. RAIL (IN LINEAR FEET)	N/A	N/A	N/A
152	PANDROL TIE PLATE	263000	004743175	503-9020
12	MODIFIED PANDROL TIE PLATE	263001	N/A	N/A
518	PANDROL ECLIP E-2055 (SUBTRACT 8 FOR INSULATED TURNOUT)	132500	004740866	503-6100
8	INSULATED JOINT CLIP ASSEMBLY (ONLY IN INSULATED TURNOUT)	132800	SEE DWG	SEE DWG
1254	15/16" DIA. 6 1/2' LG. "RAILROAD APPROVED" SCREW SPIKES	130800	004744066	503-8620
2208	RAIL ANCHORS FOR BNSF	135010	004738647	N/A
520	RAIL ANCHORS FOR UPRR	135010	N/A	550-1650

NOTES FOR MANUFACTURERS

1. ALL MATERIAL TO MEET OR EXCEED RAILROADS RELATED SPECIFICATIONS.
2. SIGNAL DEPARTMENT TO FURNISH DAP PLATING FOR MACHINE MOUNTING.
3. TRAPEZOID HEAD BLOCK TIES ARE DAPPED PER DWG DB0046.00.

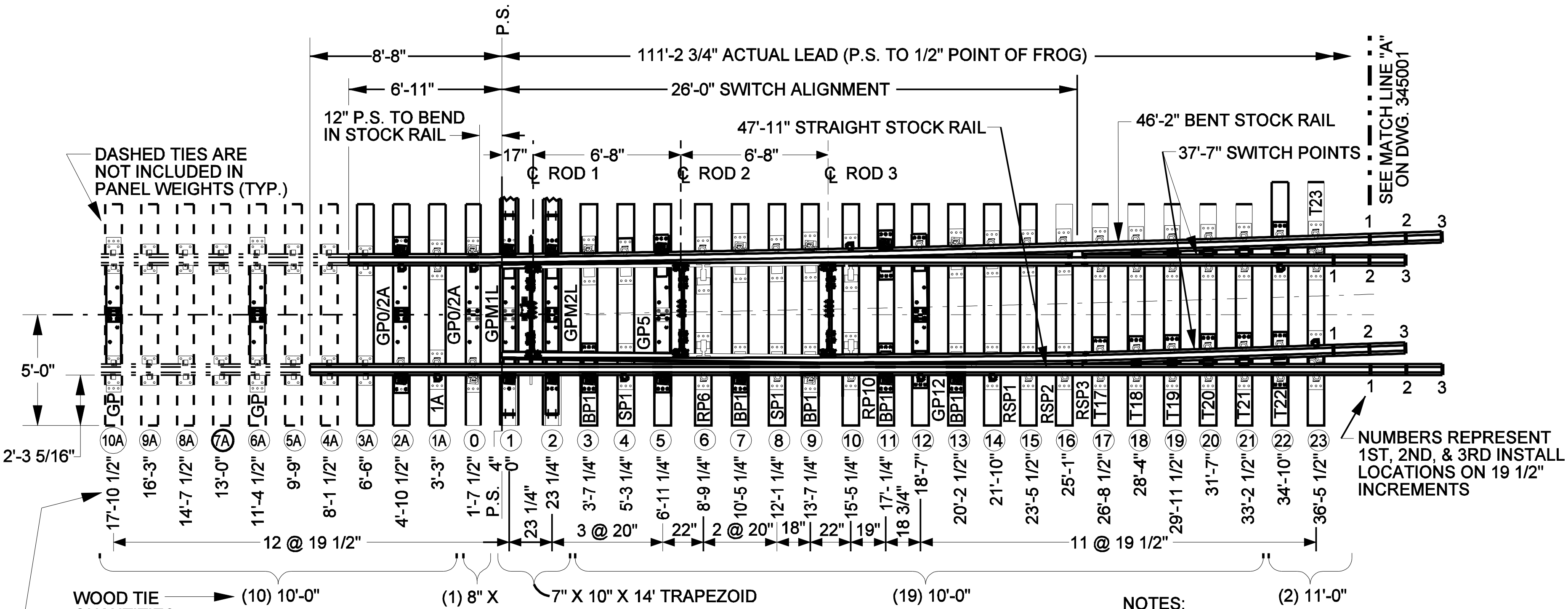
BNSF RAILWAY

UNION PACIFIC

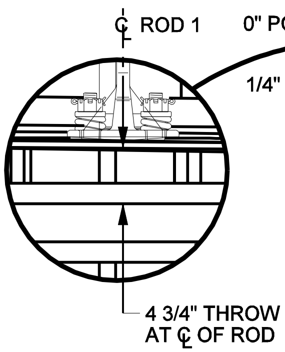
COMMON STANDARDS

NO. 11 TURNOUT WITH RBM, SMSG, LIFT AND SPRING FROGS BILL OF MATERIALS

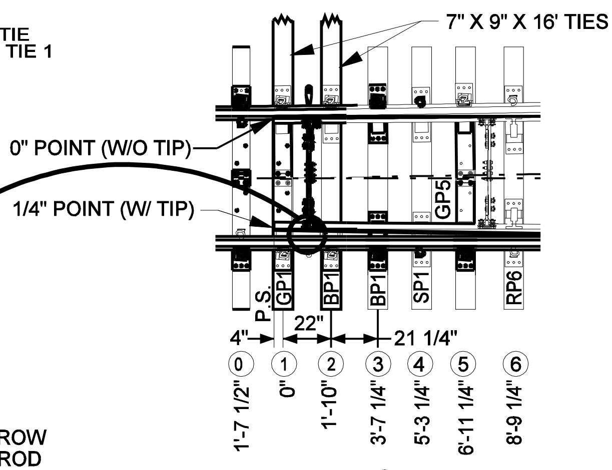
FILE OWNER: BNSF	DATE: AUG. 26, 2009
REV. NO.: 8	DWG NO: 343200



POWER OPERATED



THROW DETAIL



MANUAL OPERATED

NOTES:
1. SEE DWGS 345001, 345002, AND 345003 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING 19 1/2" EXCEPT WHERE NOTED.
3. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
4. SEE DWG 345100 FOR TURNOUT GEOMETRY.
5. SEE DWG 345200 FOR TURNOUT BILL OF MATERIAL.
6. APPLY 5" SAFE BOND WIRES ONE CRIB AHEAD OF HEEL OF SWITCH ON STOCK AND SWITCH POINT RAILS.
7. BNSF MANUAL AND MANUAL SPRING SWITCHES WILL BE SUPPLIED WITH UHMWPE PADS ON TIES 1 THROUGH 14.
8. PANEL WEIGHT = APPROXIMATELY 20,900 LBS.

	UPRR	BNSF LH	BNSF RH
136LB. POWER	N/A	518030091	518030065
136LB. MANUAL	N/A	518030093	518030092
136LB. MAN. SPRG.	N/A	518030095	518030094
141LB. POWER	N/A	518030134	518030135
141LB. MANUAL	N/A	518030136	518030137
141LB. MAN. SPRG.	N/A	518030138	518030139

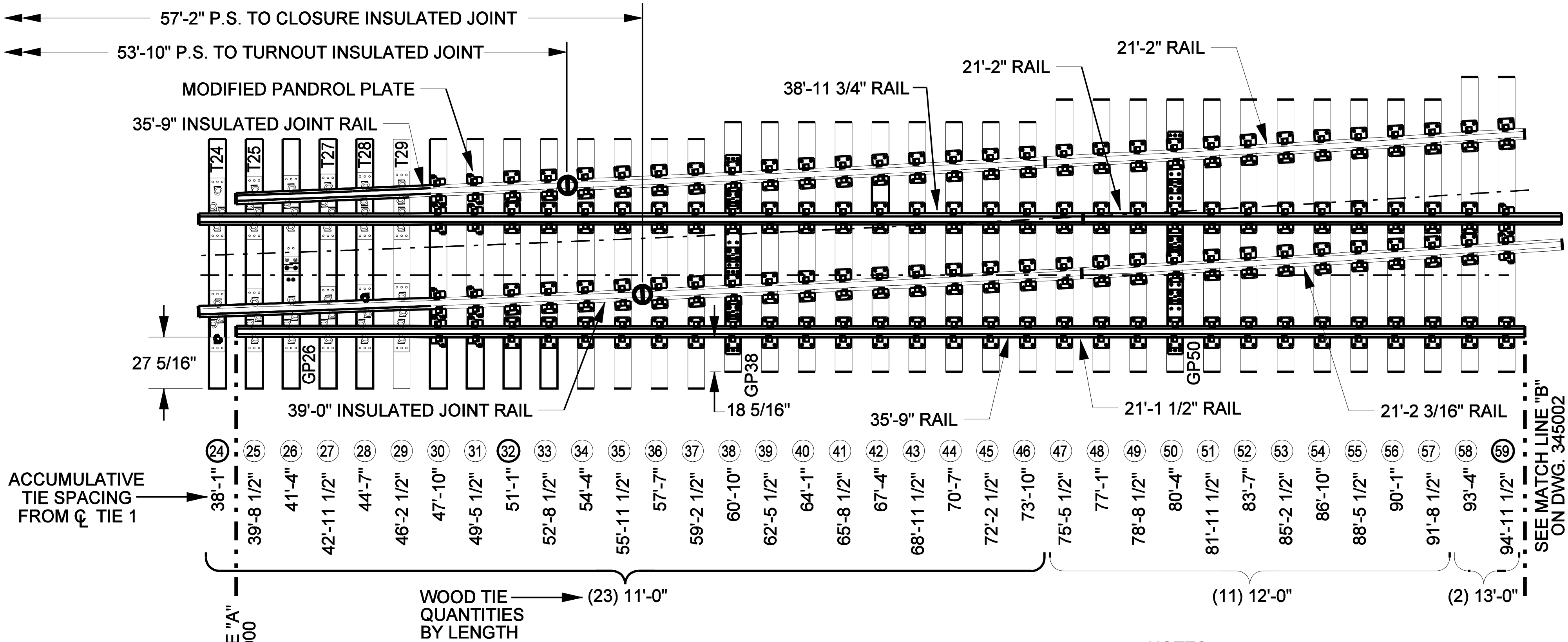
BNSF RAILWAY

UNION PACIFIC

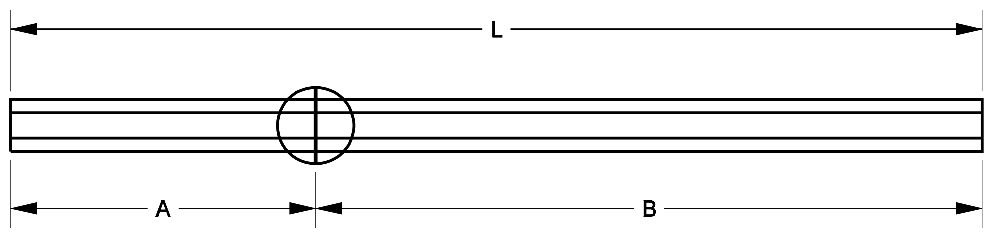
COMMON STANDARDS

NO. 15 TURNOUT 136/141 LB. PANEL NO. 1

FILE OWNER: UPRR | DATE: MAY 16, 2008
REV. NO.: 4 | DWG NO: 345000



NOTES:
1. SEE DWGS 345000, 345002, AND 345003 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING IS 19 1/2" ON THIS PANEL.
3. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
4. SEE DWG 345100 FOR TURNOUT GEOMETRY.
5. SEE DWG 345200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL WEIGHTS = APPROXIMATELY 19,500 LBS. AND 11,800 LBS.



	A	B	L
TURNOUT INSULATED JOINT RAIL	14'-8"	21'-1"	35'-9"
CLOSURE INSULATED JOINT RAIL	19'-7"	19'-5"	39'-0"

	BNSF ITEM NUMBER	
	136LB.	141LB.
LH TURNOUT INSULATED JOINT RAIL	518030155	518030140
LH CLOSURE INSULATED JOINT RAIL	518030156	518030141
RH TURNOUT INSULATED JOINT RAIL	518030157	518030142
RH CLOSURE INSULATED JOINT RAIL	518030158	518030143

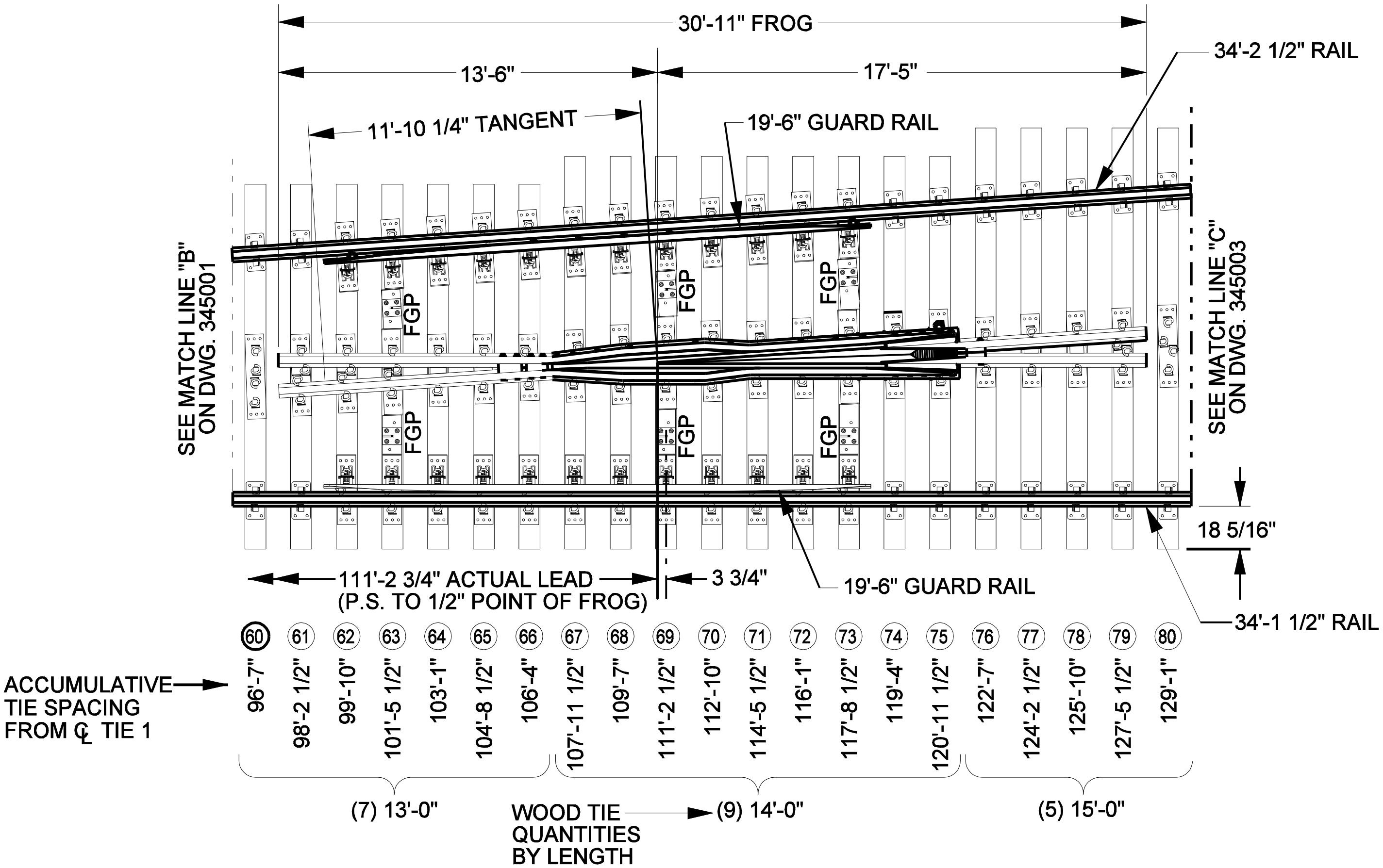
BNSF RAILWAY

UNION PACIFIC

COMMON STANDARDS

NO. 15 TURNOUT 136/141 LB. PANELS NO. 2 AND NO. 3

FILE OWNER: UPRR	DATE: MAY 19, 2008
REV. NO.: 3	DWG NO: 345001



NOTES:
1. SEE DWGS 345000, 345001, AND 345003 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING IS 19 1/2" ON THIS PANEL.
3. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
4. SEE DWG 345100 FOR TURNOUT GEOMETRY.
5. SEE DWG 345200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL WEIGHT = APPROXIMATELY 28,800 LBS.

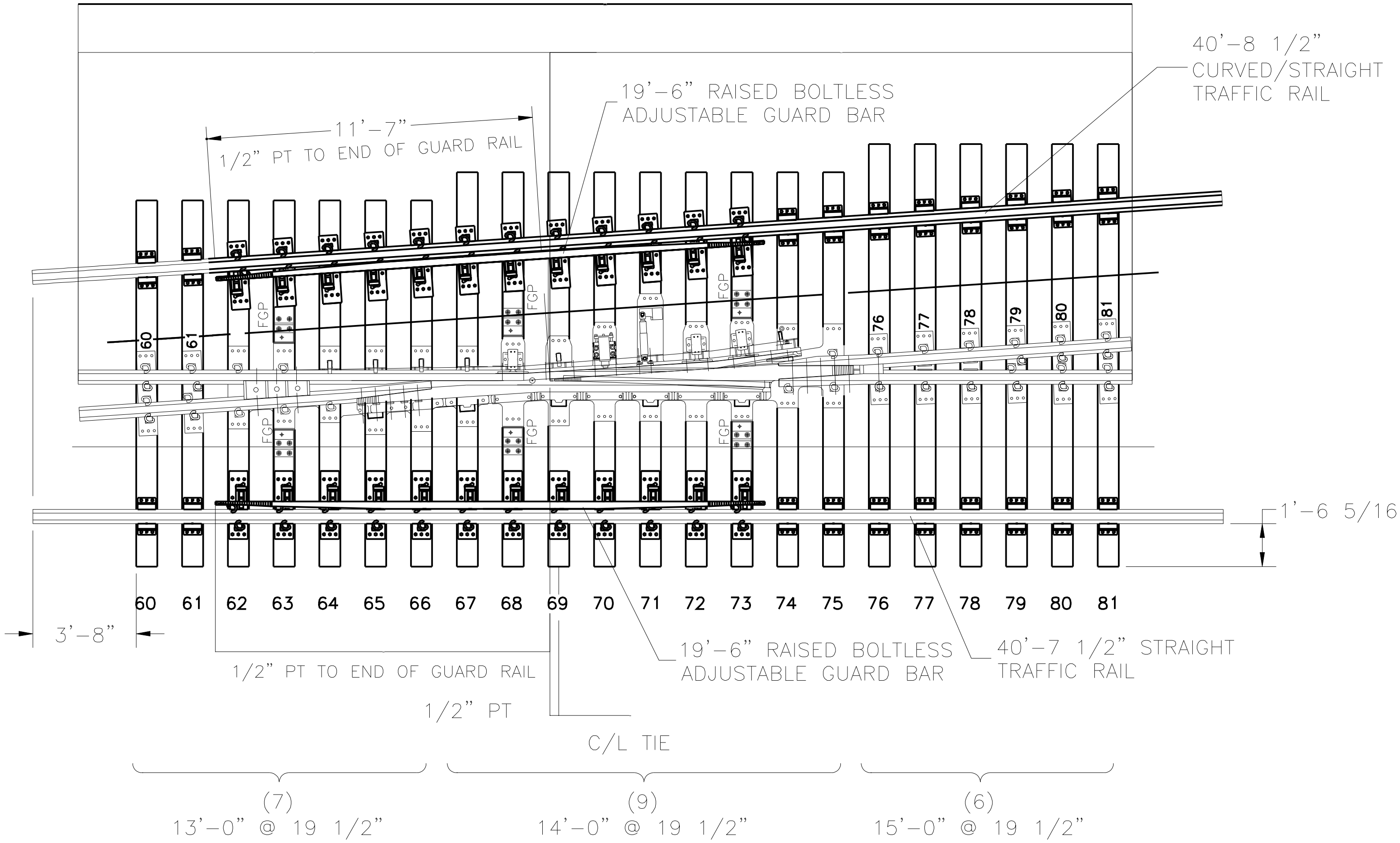
BNSF RAILWAY — UNION PACIFIC

COMMON STANDARDS

NO. 15 TURNOUT 136/141 LB. PANEL NO. 4

	UPRR	BNSF LH	BNSF RH
136LB. RBM	N/A	513450060	513450059
136 LB. SPRING	N/A	513450063	513450061
141 LB. RBM	N/A	513450232	513450233
141 LB. SPRING	N/A	513450234	513450235

FILE OWNER: UPRR | DATE: MAY 16, 2008
REV. NO.: 3 | DWG NO: 345002



LEFT HAND FROG PANEL (SHOWN)
RIGHT HAND FROG PANEL (OPPOSITE)

MAINTENANCE LENGTH SHOWN

#15 SPRING FROG PANEL	BNSF PART NUMBER
LEFT HAND	513450063
RIGHT HAND	513450061

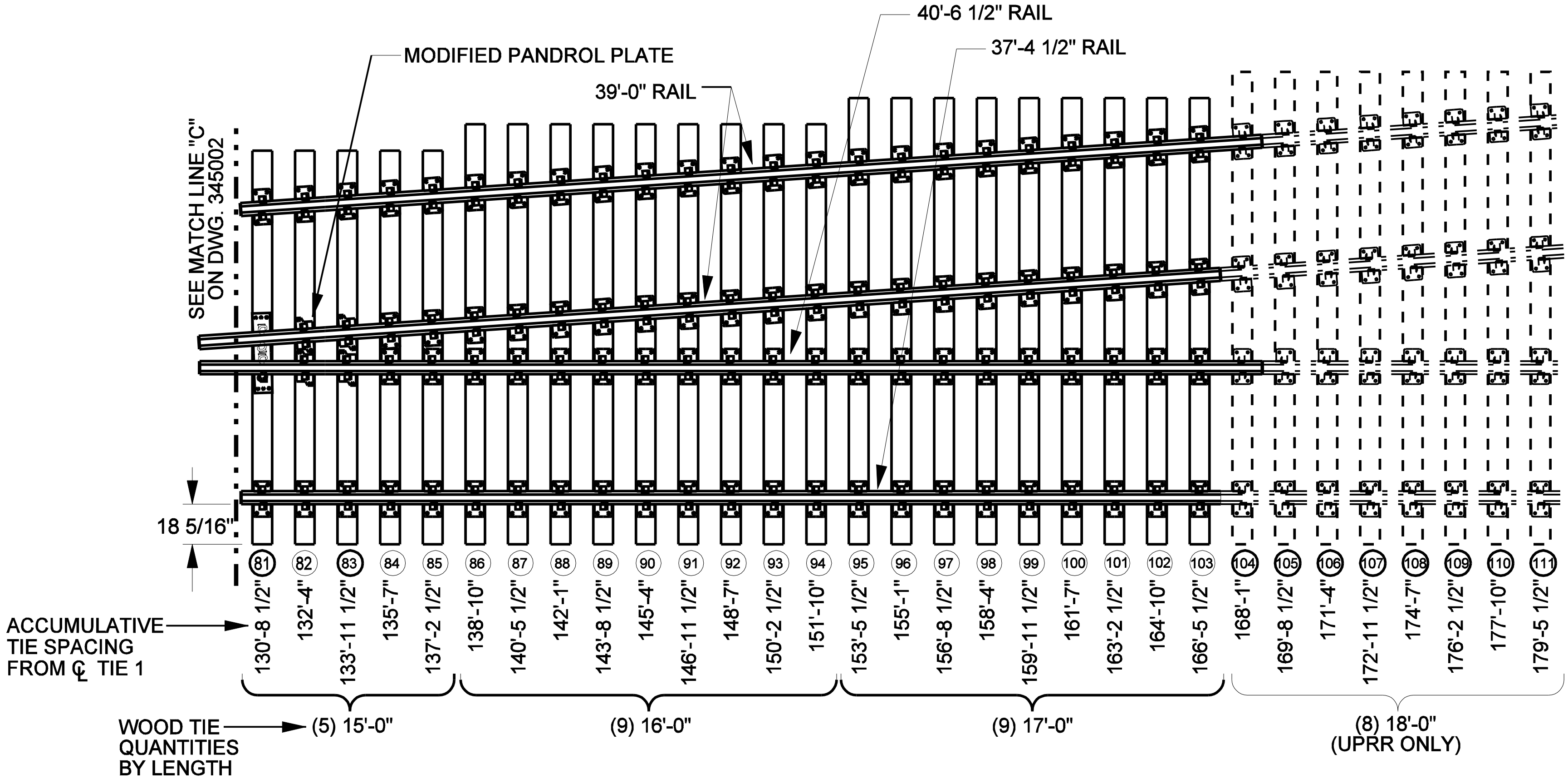
BNSF RAILWAY

STANDARD PLAN

#15 SPRING FROG 136 LB. PANEL NO. 4

SCALE: NONE	FILE OWNER BNSF	DATE: JUNE 8, 2007
	REV. NO.: 00	DWG. 345010

22-15A



NOTES:
1. SEE DWGS 345000, 345001, AND 345002 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING IS 19 1/2" ON THIS PANEL.
3. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
4. SEE DWG 345100 FOR TURNOUT GEOMETRY.
5. SEE DWG 345200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL WEIGHT = APPROXIMATELY 23,650 LBS.

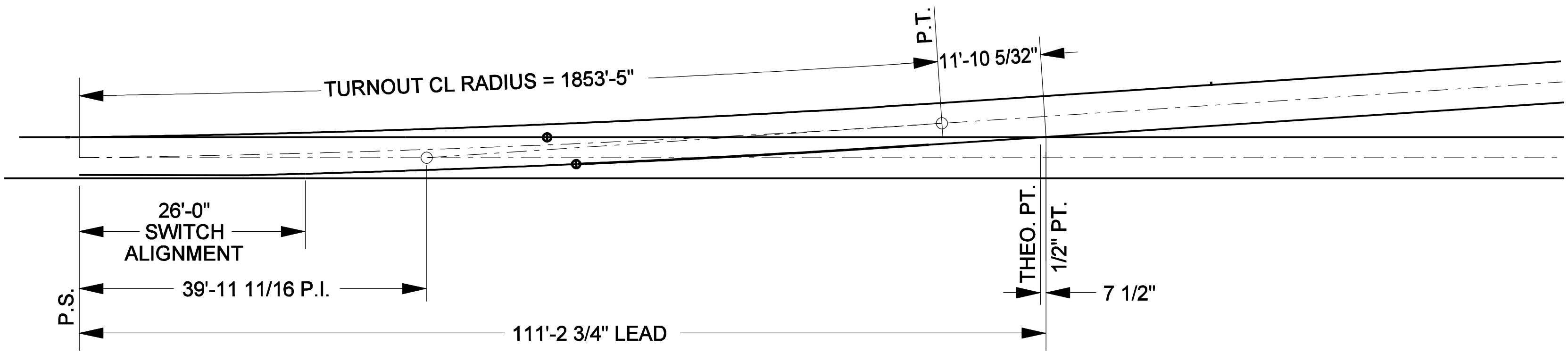
BNSF RAILWAY

UNION PACIFIC

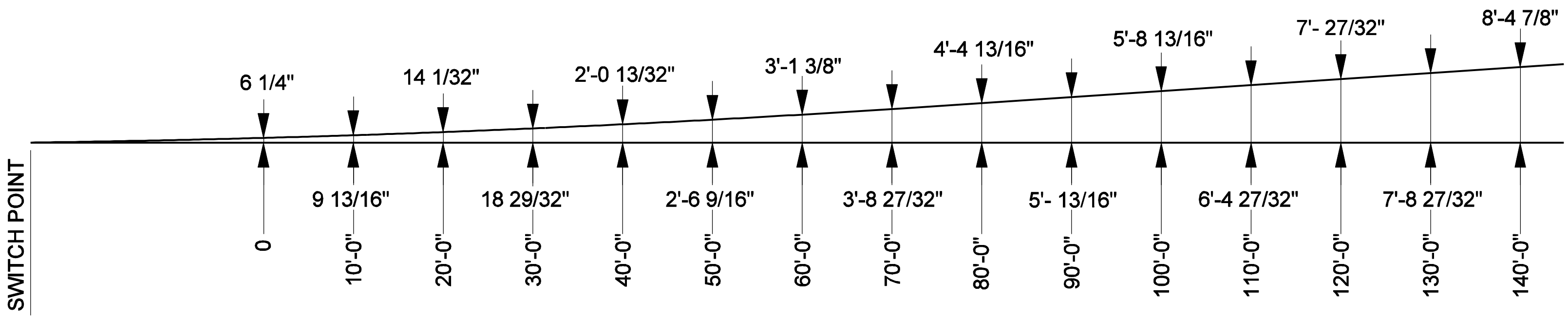
COMMON STANDARDS

NO. 15 TURNOUT 136/141 LB. PANEL NO. 5

FILE OWNER: UPRR	DATE: MAY 2, 2008
REV. NO.: 1	DWG NO: 345003



GENERAL LAYOUT



SPREAD LAYOUT

SWITCH DATA

	SWITCH LENGTH	26'-0"
	HEEL SPREAD	6 1/4"
	HEEL ANGLE	1°-33'-2"
	SWITCH ANGLE	0°-44'-47"
	THROW AT ROD #1	4 3/4"
	RADIUS (CENTER LINE)	1853.42'
	T =	49.68'
	CENTRAL ANGLE - CLOSURE CURVE	3°-04'-16"
	DEGREE OF CURVE	3°-05'-30"
TURNOUT POINT	THICKNESS AT POINT	1/4"
TURNOUT POINT	RADIUS (CLOSURE CURVE)	1855.77'
TURNOUT POINT	VERTEX DISTANCE	0"

FROG DATA

ANGLE	3°-49'-06"
LENGTH	VARIES

TURNOUT DATA

RADIUS OF CENTER LINE	1853.42'
T =	49.68'
CENTRAL ANGLE - CLOSURE CURVE	3°-04'-16"
DEGREE OF CURVE	3°-05'-30"

NOTES:

COMMON STANDARDS

NO. 15 TURNOUT 26'-0" CURVED SWITCH, TURNOUT GEOMETRY

FILE OWNER: UPRR	DATE: JAN. 14, 2003
REV. NO.: 0	DWG NO: 345100

345100

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ITEMS USED IN ALL NO. 15 TURNOUTS

QTY.	COMPONENT DESCRIPTION	DWG NO.	BNSF ITEM NO.	UPRR ITEM NO.
1	26-0" (EXT. 37'-7") STRT SAMSON SWITCH POINT (NO TIP)	245100	SEE DWG	SEE DWG
1	26-0" (EXT. 37'-7") CURVED SAMSON SWITCH POINT (W/TIP)	245100	SEE DWG	SEE DWG
1	47'-11" STRAIGHT SAMSON STOCK RAIL	241500	SEE DWG	SEE DWG
1	46'-2" BENT/CURVED SAMSON STOCK RAIL	241500	SEE DWG	SEE DWG
1 EA.	SWITCH RODS NO. 2 AND 3	241600	516620171	557-5586
2	"GP" GAGE PLATE FOR TIES 6A & 10A AHEAD OF POINT	241304	515821526	N/A
2	"1A" PLATE FOR TIE 1A AHEAD OF POINT	241306	515821540	N/A
2	"GP0/2A" ADJUSTABLE BRACE GAGE PLATE FOR TIES 0 & 2A	241301	515821003	N/A
1	"GP5" ADJUSTABLE BRACE GAGE PLATE FOR TIE 5	245305	515910639	N/A
1	"GP12" GAGE PLATE FOR TIE 12	245300	515910640	N/A
2	"RP6" ROLLER RISER PLATE	241309	515821555	SEE DWG
2	"RP10" ROLLER RISER PLATE	241309	515821556	SEE DWG
4	ROLLER ASSEMBLY	241309	516650007	SEE DWG
10	"BP1" ADJUSTABLE BRACE SLIDE PLATE	241306	515821014	557-2638
4	"SP1" SLIDE PLATE	241306	515821069	557-2849
2	RISER SLIDE PLATES - RSP1, RSP2, AND RSP3	243309	SEE DWG	SEE DWG
2	TURNOUT PLATES T17 THRU T29	245307	SEE DWG	557-8991
1	"GP26" GAGE PLATE FOR TIE 26	245310	SEE DWG	SEE DWG
1	"GP38" GAGE PLATE FOR TIE 38	245311	SEE DWG	SEE DWG
1	"GP50" GAGE PLATE FOR TIE 50	245312	SEE DWG	SEE DWG
2	19'-6" BOLTLESS ADJUSTABLE GUARD RAIL	160100	516240059	556-5260
6	"FGP" FROG GAGE PLATE	156000	515821497	555-6806
1	39'-0" CLOSURE INSULATED JOINT RAIL	345001	524400035	N/A
1	35'-9" INSULATED JOINT TURNOUT RAIL	345001	524400034	N/A
384	136 OR 141 LB. RAIL (IN LINEAR FEET)	176000	SEE DWG	SEE DWG
218	PANDROL TIE PLATE	263000	525820956	503-9020
14	MODIFIED PANDROL TIE PLATE	263001	N/A	N/A
720	PANDROL CLIP E-2055	132500	521710020	503-6100
8	PANDROL INSULATED JOINT CLIP ASSEMBLY	132800	521710020	503-5580
1424	15/16" DIA. x 6 1/2" LG. "RAILROAD APPROVED" SCREW SPIKES	130800	527570012	503-8620
2208	RAIL ANCHORS FOR BNSF	135010	520130012	N/A
610	RAIL ANCHORS FOR UPRR	135010	N/A	550-1650

ITEMS SPECIAL TO MANUAL OR POWER AND A CHOICE OF FROGS

QTY.	REQUIRED FOR MANUAL	DWG #	BNSF ITEM #	UPRR ITEM #
1	"GP1" ADJUSTABLE BRACE GAGE PLATE FOR TIE 1	241300	SEE DWG	SEE DWG
2	"BP1" ADJUSTABLE BRACE SLIDE PLATE FOR TIE 2	245306	515821014	557-2638
1	7" X 9" X 10'-0" TIE (TIE 0)	N/A	N/A	502-1000
2	7" X 9" X 16'-0" TIE (TIES 1 AND 2)	N/A	N/A	502-1600
1	SWITCH ROD NO. 1	241600	SEE DWG	557-5587
QTY.	**REQUIRED FOR POWER**	**DWG #**	**BNSF ITEM #**	**UPRR ITEM #**
1	SWITCH ROD NO. 1 WITH BASKET (ADJUSTER)	241601	SEE DWG	557-5585
1	"GPM1L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE 1	241302	SEE DWG	SEE DWG
1	"GPM2L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE 2	241303	SEE DWG	SEE DWG
1	8" (TOP) X 10" X 10'-0" TIE (TIE 0)	N/A	SEE DWG	502-4300
2	7" X 10" X 14'-0" TRAPEZOID TIE (TIES 1 AND 2)	250000	SEE DWG	502-4899
QTY.	**REQUIRED FOR POWER**	**DWG #**	**BNSF ITEM #**	**UPRR ITEM #**
1	30'-11" RBM WITH PLATES	157100	SEE DWG	SEE DWG
1	30'-11" SOLID MANGANESE SPRING FROG WITH PLATES	157200	SEE DWG	SEE DWG

TIES USED IN ALL #15 TURNOUTS

QTY.	SIZE	TIE NUMBER
10	7" X 9" X 10'-0"	TIES 1A THRU 10A
19	7" X 9" X 10'-0"	TIES 3 THRU 21
25	7" X 9" X 11'-0"	TIES 22 THRU 46
11	7" X 9" X 12'-0"	TIES 47 THRU 57
9	7" X 9" X 13'-0"	TIES 58 THRU 66
9	7" X 9" X 14'-0"	TIES 67 THRU 75
10	7" X 9" X 15'-0"	TIES 76 THRU 85
9	7" X 9" X 16'-0"	TIES 86 THRU 94
9	7" X 9" X 17'-0"	TIES 95 THRU 103

MANUAL OPERATED ITEM NUMBERS	BNSF L.H.	BNSF R.H.	UPRR L.H.	UPRR R.H.
136 LB - #15 TURNOUT W/ SPRING SWITCH AND RBM FROG, PANEL (COMPLETE)	518789148	518789149	N/A	N/A
136 LB - #15 TURNOUT W/ SPRING SWITCH AND SPRING FROG, PANEL (COMPLETE)	518789150	518789151	N/A	N/A
136 LB - #15 TURNOUT W/ RBM FROG, PREPLATED TIES	N/A	N/A	557-8289	557-8290
136 LB - #15 TURNOUT W/ SPRING FROG, PREPLATED TIES	N/A	N/A	557-8295	557-8296
136 LB - #15 TURNOUT W/ SPRING SWITCH AND RBM FROG, PREPLATED TIES	N/A	N/A	557-8287	557-8288
136 LB - #15 TURNOUT W/ SPRING SWITCH AND SPRING FROG, PREPLATED TIES	N/A	N/A	557-8293	557-8294
141 LB - #15 TURNOUT W/ SPRING SWITCH AND RBM FROG, PANEL (COMPLETE)	XXXXXXXXX	XXXXXXXXX	N/A	N/A
141 LB - #15 TURNOUT W/ SPRING SWITCH AND SPRING FROG, PANEL (COMPLETE)	XXXXXXXXX	XXXXXXXXX	N/A	N/A
141 LB - #15 TURNOUT W/ RBM FROG, PREPLATED TIES	N/A	N/A	557-8545	557-8546
141 LB - #15 TURNOUT W/ SPRING FROG, PREPLATED TIES	N/A	N/A	557-8541	557-8542
141 LB - #15 TURNOUT W/ SPRING SWITCH AND RBM FROG, PREPLATED TIES	N/A	N/A	557-8543	557-8544
141 LB - #15 TURNOUT W/ SPRING SWITCH AND SPRING FROG, PREPLATED TIES	N/A	N/A	557-8547	557-8548

POWER OPERATED ITEM NUMBERS	BNSF L.H.	BNSF R.H.	UPRR L.H.	UPRR R.H.
136 LB - #15 TURNOUT W/ RBM FROG, PANEL (COMPLETE)	518789130	518789129	N/A	N/A
136 LB - #15 TURNOUT W/ SPRING FROG, PANEL (COMPLETE)	5187889132	518789131	N/A	N/A
136 LB - #15 TURNOUT W/ RBM FROG, PREPLATED TIES	N/A	N/A	557-8245	557-8246
136 LB - #15 TURNOUT W/ SPRING FROG, PREPLATED TIES	N/A	N/A	557-8240	557-8241
141 LB - #15 TURNOUT W/ RBM FROG, PANEL (COMPLETE)	518789226	518789227	N/A	N/A
141 LB - #15 TURNOUT W/ SPRING FROG, PANEL (COMPLETE)	518789232	518789233	N/A	N/A
141 LB - #15 TURNOUT W/ RBM FROG, PREPLATED TIES	N/A	N/A	557-8553	557-8554
141 LB - #15 TURNOUT W/ SPRING FROG, PREPLATED TIES	N/A	N/A	557-8551	557-8552

NOTES FOR MANUFACTURERS

1. ALL MATERIAL TO MEET OR EXCEED RAILROADS RELATED SPECIFICATIONS.
2. SIGNAL DEPARTMENT TO FURNISH #1 ROD BASKET ADJUSTER AND DAP PLATING FOR MACHINE MOUNTING.
3. TRAPEZOID HEAD BLOCK TIES ARE DAPPED PER DWG 250000.

BNSF RAILWAY

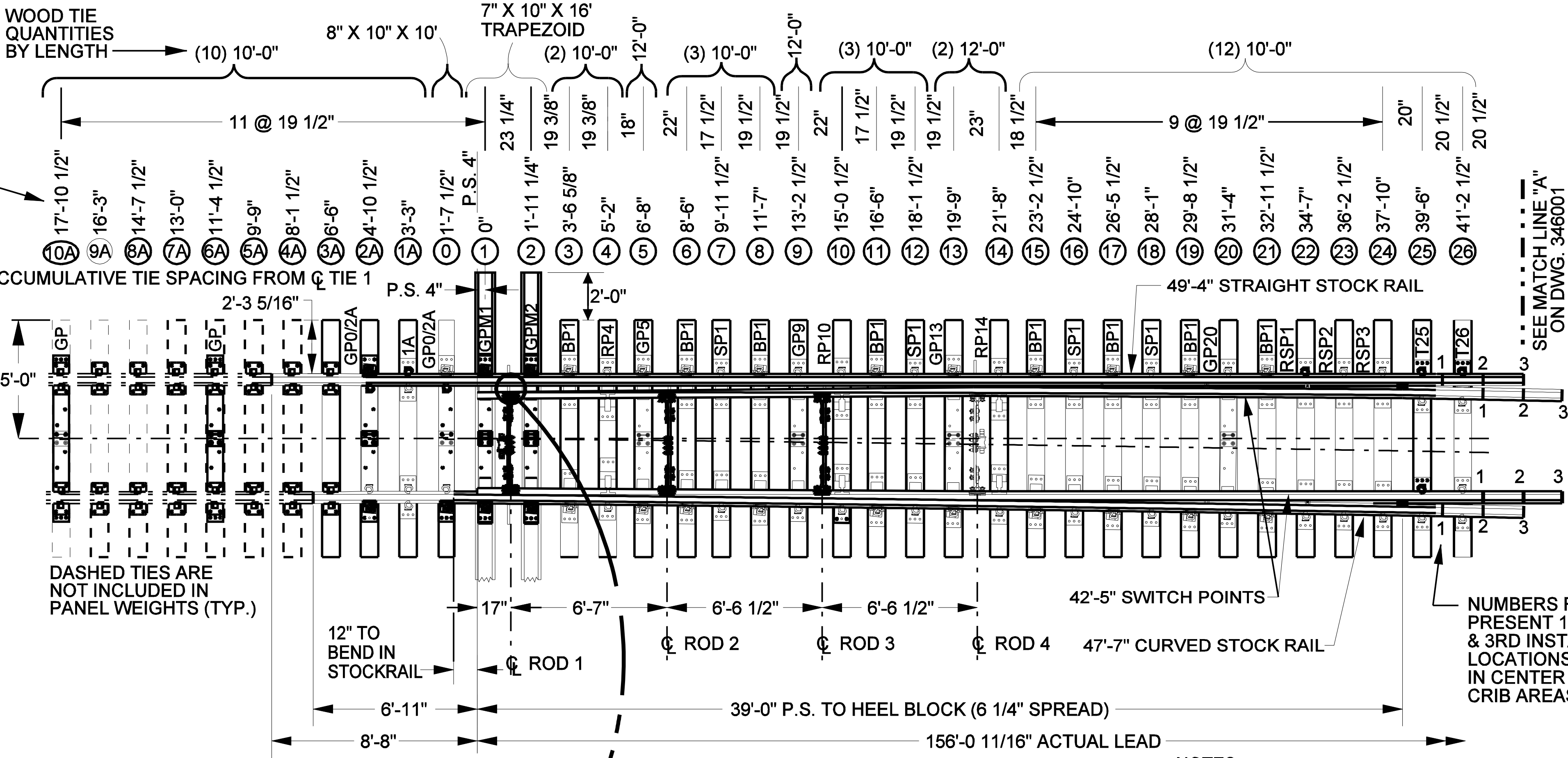
UNION PACIFIC

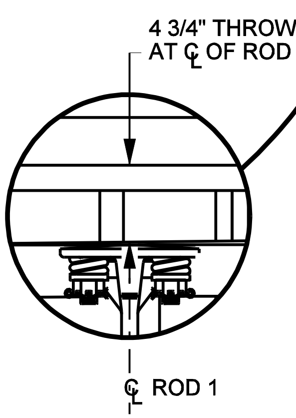
COMMON STANDARDS

NO. 15 TURNOUT 136/141 LB. WITH RBM AND SPRING FROGS, BILL OF MATERIALS

FILE OWNER: UPRR | DATE: MAY 2, 2008

REV. NO.: 5 | DWG NO: 345200





THROW DETAIL

NOTES:
1. SEE DWGS 346001, 346002, 346003, AND 346004 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 346100 FOR TURNOUT GEOMETRY.
4. SEE DWG 346200 FOR TURNOUT BILL OF MATERIAL.
5. APPLY 5" SAFE BOND WIRES ONE CRIB AHEAD OF HEEL OF SWITCH ON STOCK AND SWITCH POINT RAILS.
6. PANEL WEIGHT = APPROXIMATELY 24,500 LBS.

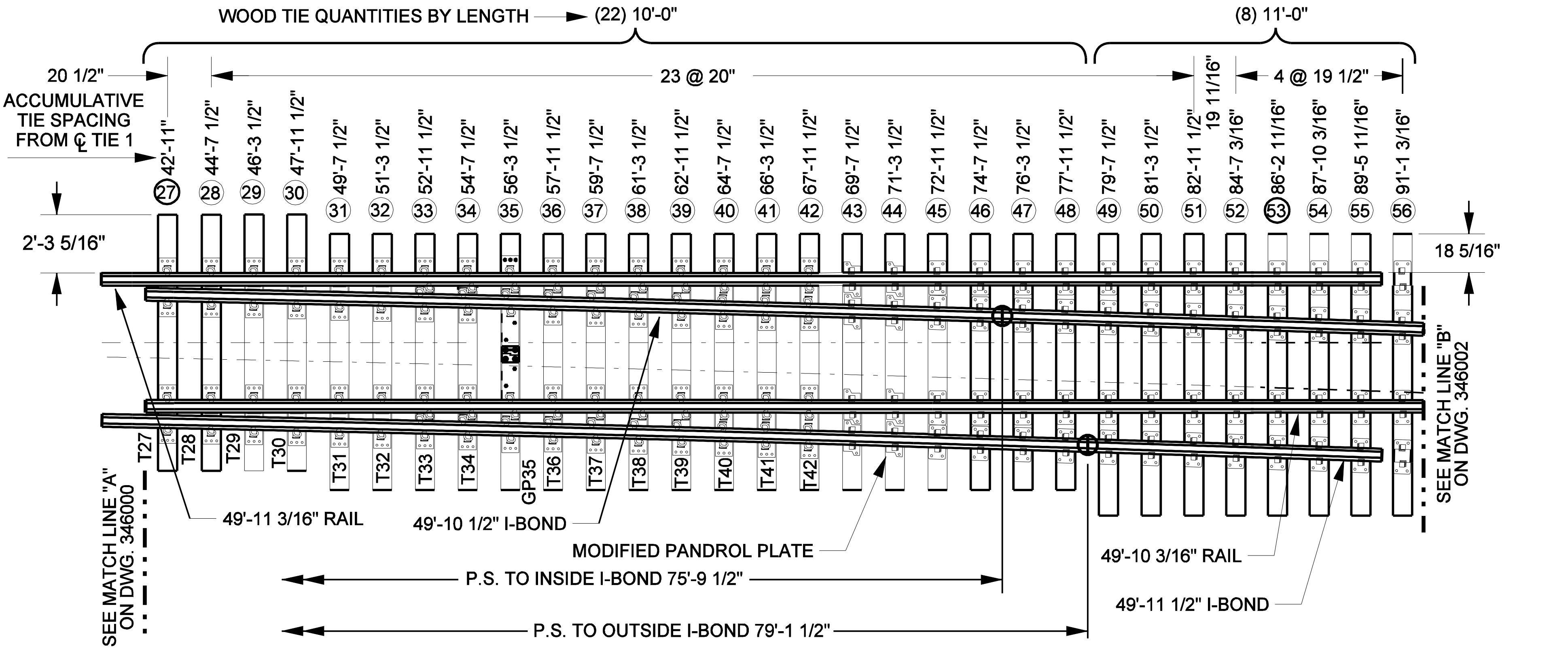
	UPRR	BNSF LH	BNSF RH
136LB. POWER	N/A	518030099	518030067
136LB. MAN. SPRG.	N/A	518030101	518030100
141LB. POWER	N/A	518030144	518030145
141LB. MAN. SPRG.	N/A	518030146	518030147

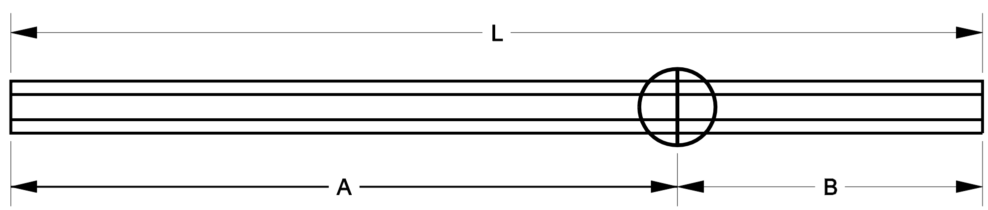
BNSF RAILWAY

UNION PACIFIC

NO. 20 TURNOUT 136/141 LB.
PANEL NO. 1

FILE OWNER: UPRR	DATE: MAY 16, 2008
REV. NO.: 2	DWG NO: 346000





NOTES:
1. SEE DWGS 346000, 346002, 346003, AND 346004 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY ON THIS DWG.
3. SEE DWG 346100 FOR TURNOUT GEOMETRY.
4. SEE DWG 346200 FOR TURNOUT BILL OF MATERIAL.
5. PANEL WEIGHT = APPROXIMATELY 24,000 LBS.

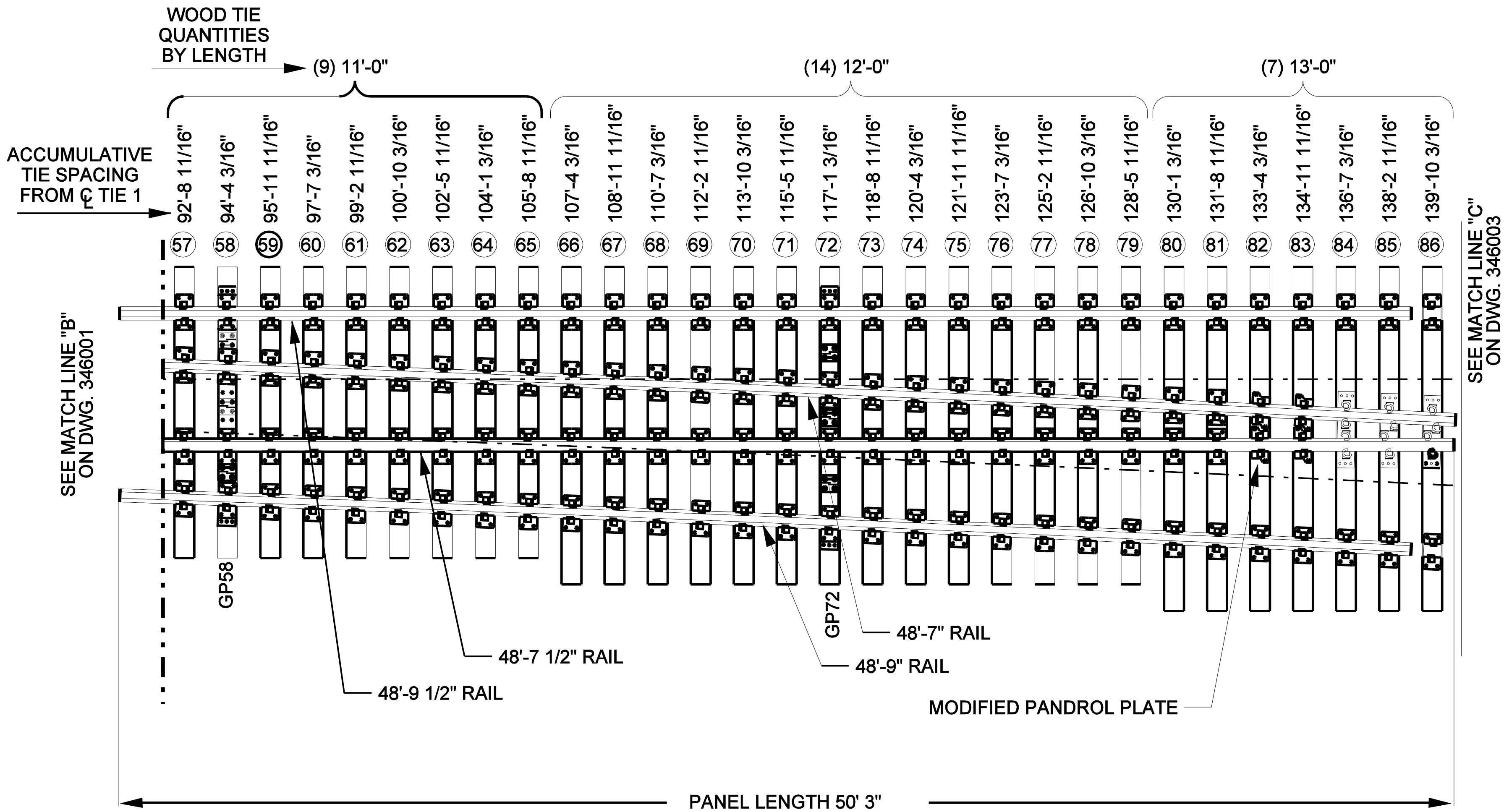
	A	B	L	136 LB. BNSF ITEM NO.	141 LB. BNSF ITEM NO.
CLOSURE INSULATED JOINT RAIL	33'-5"	16'-5 1/2"	49'-10 1/2"	524400038	524400074
TURNOUT INSULATED JOINT RAIL	38'-5 1/2"	11'-6"	49'-11 1/2"	524400036	524400075

BNSF RAILWAY

UNION PACIFIC

NO. 20 TURNOUT 136/141 LB. PANEL NO. 2

FILE OWNER: UPRR	DATE: MAY 7, 2008
REV. NO.: 3	DWG NO: 346001

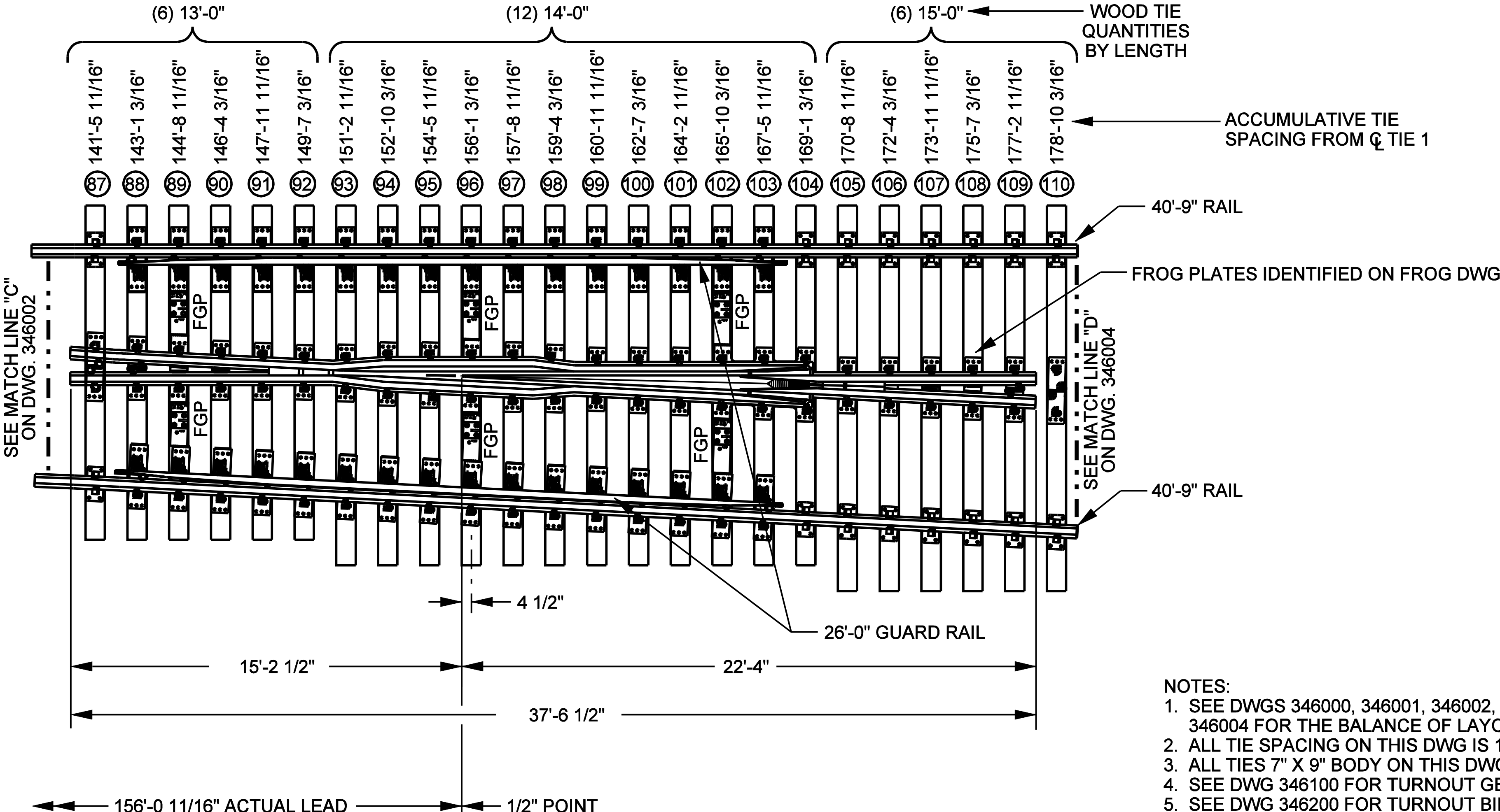


NOTES:
1. SEE DWGS 346000, 346001, 346003, AND 346004 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING ON THIS DWG IS 19 1/2".
3. ALL TIES 7" X 9" BODY ON THIS DWG.
4. SEE DWG 346100 FOR TURNOUT GEOMETRY.
5. SEE DWG 346200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL WEIGHT = APPROXIMATELY 26,500 LBS.

BNSF RAILWAY

NO. 20 TURNOUT 136/141 LB. PANEL NO. 3

FILE OWNER: UPRR	DATE: MAY 7, 2008
REV. NO.: 4	DWG NO: 346102



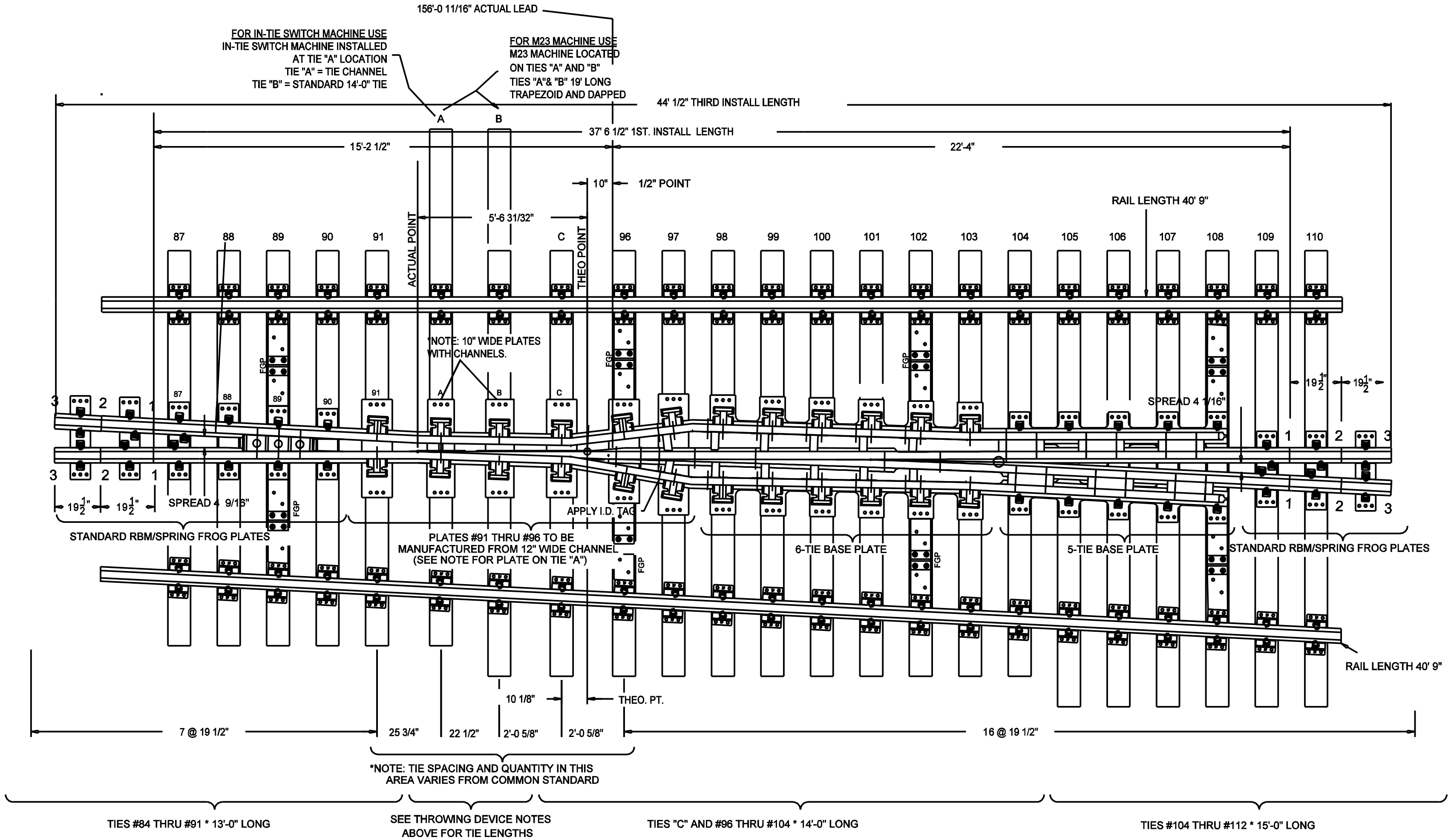
NOTES:
1. SEE DWGS 346000, 346001, 346002, AND 346004 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING ON THIS DWG IS 19 1/2".
3. ALL TIES 7" X 9" BODY ON THIS DWG.
4. SEE DWG 346100 FOR TURNOUT GEOMETRY.
5. SEE DWG 346200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL WEIGHT = APPROXIMATELY 31,000 LBS.

	136 LB.		141 LB.	
	BNSF RH	BNSF LH	BNSF RH	BNSF LH
RBM	004710422	004710414	005252853	005252846
SPRING	004710422	004710430	005252879	005252861

BNSF RAILWAY

NO. 20 TURNOUT 136/141 LB.
PANEL NO. 4

FILE OWNER: BNSF | DATE: MAY 7, 2008
REV. NO.: 5 | DWG NO: 346103



NOTES:

1) BODY BOLTS TO BE GRADE 8, 1 3/8" DIAMETER, HEX HEAD W/ FLAT WASHER AND LOCK NUT. FINAL BOLT TORQUE TO BE 2200 FT./LBS. LUBRICATED USING "NEVER SEIZE" ON THE BOLT THREADS, WASHER AND NUT FACE. TORQUE DEVICE MAY BE MANUAL, PNEUMATIC OR HYDRAULIC.
2) PANEL SHIPPING WEIGHT TO BE STENCILED ON RAIL HEAD WITH WHITE PAINT.
3) ID TAGS TO BE ATTACHED AS NEAR THE POINT AS POSSIBLE WHERE THEY CAN BE CLEARLY READ.
4) RAIL ENDS BLANK.
5) TIES FOR SWITCH MACHINE WILL BE DAPPED AND TRAPEZOID. REMAINING SWITCH TIES ARE 10" WIDE.
6) PROVIDE A SLOT WITH EASEMENT THAT ALLOWS FOR A 5/8"x 1 1/4" OPENING FOR A CALROD HEATER IN WING/ FROG AREA.
7) FOR NEW APPLICATION, CUT TO 1st. LENGTH, MAINTENANCE LENGTH IS 3rd INSTALL.
8) LOCATION OF 1/2" POINT OF FROG WILL BE MARKED ON BOTH WING RAILS.
9) 1ST INSTALL LENGHT IS LONGER COMPARED TO RBM/SPRING FROG PANEL DUE TO SHORTER BASE TO BASE CLEARANCE ON THE TOE AND HEEL END.

RH FROG SHOWN

PANEL WEIGHT 31,294 LBS

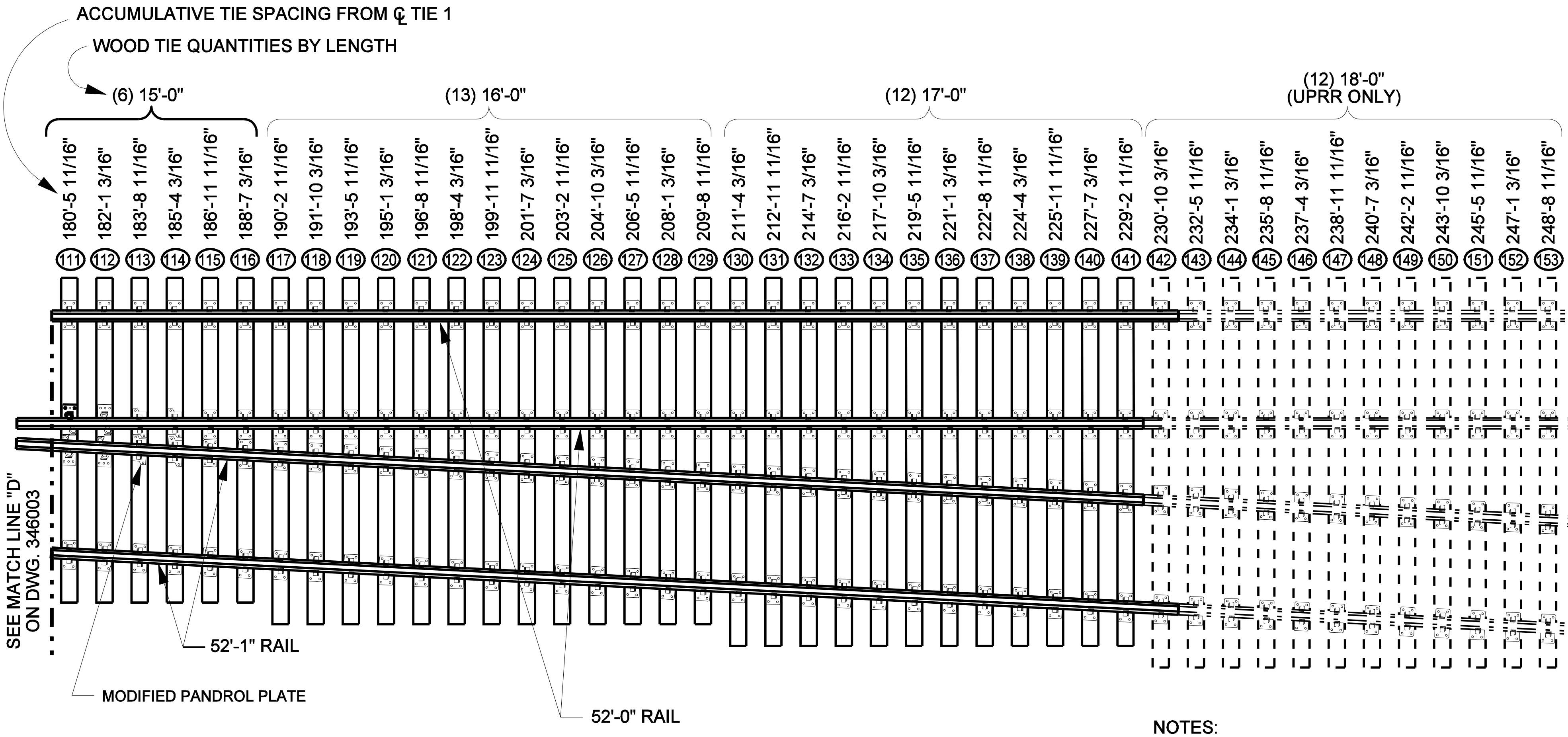
	STOCK CODE
# 20 MPF 141LB RH POWER TURNOUT W/ INSULATED JOINTS	004738340
# 20 MPF 141LB LH POWER TURNOUT W/ INSULATED JOINTS	004738357

BNSF RAILWAY

BNSF STANDARD PLAN

NO. 20 MOVABLE POINT FROG 141 & 136 LB. PANEL NO. 4

FILE OWNER: BNSF | DATE: MAY 7, 2009
REV. NO. 07 | DWG NO: 346210



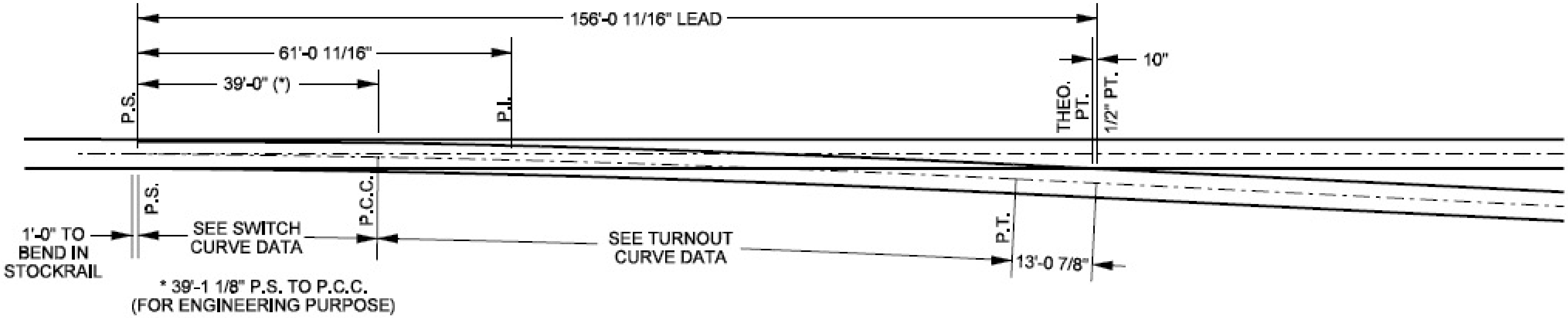
NOTES:

1. SEE DWGS 346000, 346001, 346002, AND 346003 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING ON THIS DWG IS 19 1/2".
3. ALL TIES 7" X 9" BODY ON THIS DWG.
4. SEE DWG 346100 FOR TURNOUT GEOMETRY.
5. SEE DWG 346200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL WEIGHT = APPROXIMATELY 31,750 LBS.

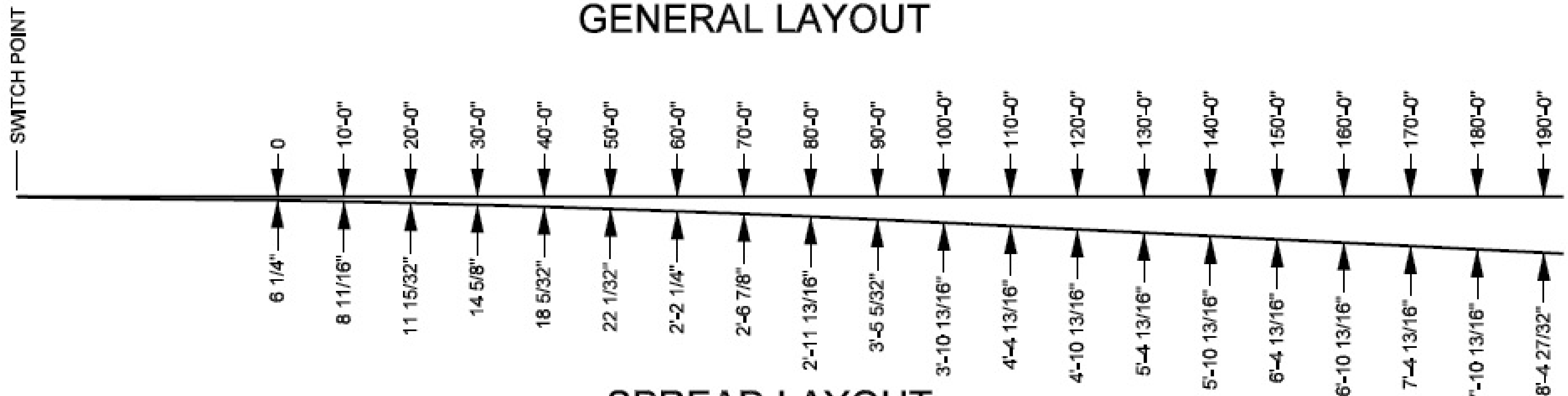
BNSF RAILWAY — UNION PACIFIC

NO. 20 TURNOUT 136/141 LB. PANEL NO. 5

FILE OWNER: UPRR	DATE: MAY 7, 2008
REV. NO.: 1	DWG NO: 346004



GENERAL LAYOUT



SPREAD LAYOUT

	SWITCH DATA	
	SWITCH LENGTH	39'-0"
	HEEL SPREAD	6 1/4"
	HEEL ANGLE	0°-59'-02"
	SWITCH ANGLE	0°-32'-45"
	THROW AT ROD #1	4 3/4"
	RADIUS (CENTER LINE)	5103.26'
	T =	19.5'
	CENTRAL ANGLE - CLOSURE CURVE	0°-26'-16"
	DEGREE OF CURVE	1°-07'-22"
TURNOUT POINT	THICKNESS AT POINT	1/4"
TURNOUT POINT	RADIUS (CLOSURE CURVE)	5105.62'
TURNOUT POINT	VERTEX DISTANCE	12"

FROG DATA	
ANGLE	2°-51'-51"
LENGTH	VARIES

TURNOUT DATA	
RADIUS OF CENTER LINE	3329.66'
T =	51.99'
CENTRAL ANGLE - CLOSURE CURVE	1°-47'-21"
DEGREE OF CURVE	1°-43'-15"

NOTES:

COMMON STANDARDS

NO. 20 TURNOUT WITH 39'-0" CURVED SWITCH, TURNOUT GEOMETRY

FILE OWNER: UPRR	DATE: JAN. 14, 2003	
REV. NO.: 0	DWG NO: 346100	

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QTY.	COMPONENT DESCRIPTION	DWG. NO.	BNSF ITEM NO.	UPRR ITEM NO.
1	39'-0" (EXT. 42'-5") STRT SAMSON SWITCH POINT (NO TIP)	246100	SEE DWG	SEE DWG
1	39'-0" (EXT. 42'-5") CURVED SAMSON SWITCH POINT (W/TIP)	246100	SEE DWG	SEE DWG
1 EA.	49'-4" STRAIGHT & 47'-7" BENT/CURVED SAMSON STOCK RAIL	241500	SEE DWG	SEE DWG
1	SWITCH ROD NO. 1 W/ BASKET	241601	516620011	557-5585
1 EA.	SWITCH RODS NO. 2 AND 3	241600	SEE DWG	557-5586
1	SWITCH ROD NO. 4 W/ BASKET	241601	516620013	557-5588
2	"GP" GAGE PLATE FOR TIES 6A & 10A AHEAD OF POINT	241304	515821526	N/A
2	"1A" PLATE FOR TIE #1A AHEAD OF POINT	241307	515821539	N/A
2	"GP0/2A" ADJUSTABLE BRACE GAGE PLATE FOR TIES #0 & 2A	241301	515821504	N/A
1	"GPM1L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE #1	241302	SEE DWG	SEE DWG
1	"GPM2L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE #2	241303	SEE DWG	SEE DWG
16	"BP1" ADJUSTABLE BRACE SLIDE PLATE	241306	515821532	557-2960
8	"SP1" SLIDE PLATE	241306	515821533	557-2961
2	"RP4" ROLLER RISER PLATE	241309	515821557	SEE DWG
2	"RP10" ROLLER RISER PLATE	241309	515821558	SEE DWG
2	"RP14" ROLLER RISER PLATE	241309	515821559	SEE DWG
6	ROLLER ASSEMBLY	241309	516650007	SEE DWG
1	"GP5" & "GP13" GAGE PLATES FOR TIES #5 & #13	246300	SEE DWG	N/A
1	"GP9" & "GP20" GAGE PLATE FOR TIES #9 & #20	246301	SEE DWG	N/A
2	"RSP1", "RSP2", AND "RSP3" RISER SLIDE PLATES	243309	SEE DWG	N/A
2	TURNOUT PLATES T25 THRU T42	246307	515861711	557-8995
1	"GP35" GAGE PLATE FOR TIE 35	246311	SEE DWG	SEE DWG
1	"GP58" GAGE PLATE FOR TIE 58	246312	SEE DWG	SEE DWG
1	"GP72" GAGE PLATE FOR TIE 72	246313	SEE DWG	SEE DWG
*1	35'-11" RBM FROG WITH PLATES (*RBM OR SPRING PER OPTION)	158100/200	SEE DWG	SEE DWG
6	"FGP" FROG GAGE PLATE	156000	515821497	555-6806
2	26'-0" BOLTLESS ADJUSTABLE GUARD RAIL	160100	516240058	556-6021
242	STANDARD ROLLED STEEL PANDROL PLATES	263000	525820956	503-9020
16	MODIFIED PANDROL TIE PLATE	263001	N/A	N/A
902	PANDROL CLIP E-2055	132500	521710020	503-6100
8	PANDROL INSULATED JOINT CLIP ASSEMBLY	132800	SEE DWG	SEE DWG
1	CLOSURE INSULATED JOINT RAIL 49'-10 1/2"	346001	524400038	N/A
1	TURNOUT INSULATED JOINT RAIL 49'-11 1/2"	346001	524400036	N/A
1804	15/16" DIA. x 6 1/2" LG. "RAILROAD APPROVED" SCREW SPIKES	130800	527570012	503-8620
2208	RAIL ANCHORS FOR BNSF	135010	520130012	N/A
616	RAIL ANCHORS FOR UPRR	135010	N/A	550-1650
587	136 OR 141 LB. RAIL (IN LINEAR FT.)	176000	N/A	N/A

BILL OF TIES

QTY.	SIZE	TIE NUMBER
10	7" X 9" X 10'-0"	1A THRU 10A
1	8" X 10" X 10'-0"	0
2	7" X 10" X 16'-0" TRAPEZOID TIES	1 & 2
46	7" X 9" X 10'-0"	3 THRU 48
17	7" X 9" X 11'-0"	49 THRU 65
14	7" X 9" X 12'-0"	66 THRU 79
13	7" X 9" X 13'-0"	80 THRU 92
12	7" X 9" X 14'-0"	93 THRU 104
12	7" X 9" X 15'-0"	105 THRU 116
13	7" X 9" X 16'-0"	117 THRU 129
12	7" X 9" X 17'-0"	130 THRU 141
152 TOTAL		

ITEM NUMBERS	BNSF LH	BNSF RH	UPRR LH	UPRR RH
136 LB - #20TURNOUT W/ RBM FROG, PANEL (COMPLETE)	518789134	518789133	N/A	N/A
136 LB - #20 TURNOUT W/ SPRING FROG, PANEL (COMPLETE)	518789136	518789135	N/A	N/A
136 LB - #20TURNOUT W/ RBM FROG, PANEL (COMPLETE) WITH MANUAL THROW SPRING SWITCHES	518789152	518789153	N/A	N/A
136 LB - #20 TURNOUT W/ SPRING FROG, PANEL (COMPLETE) WITH MANUAL THROW SPRING SWITCHES	518789154	518789155	N/A	N/A
136 LB - #20 TURNOUT W/ RBM FROG, PO, PPTO	N/A	N/A	557-8407	557-8408
136 LB - #20 TURNOUT W/ SPRING FROG, PO, PPTO	N/A	N/A	557-8409	557-8410
141 LB - #20 TURNOUT W/ RBM FROG, PO, PPTO	N/A	N/A	557-8563	557-8564
141 LB - #20 TURNOUT W/ SPRING FROG, PO, PPTO	N/A	N/A	557-8565	557-8566

NOTES FOR MANUFACTURERS

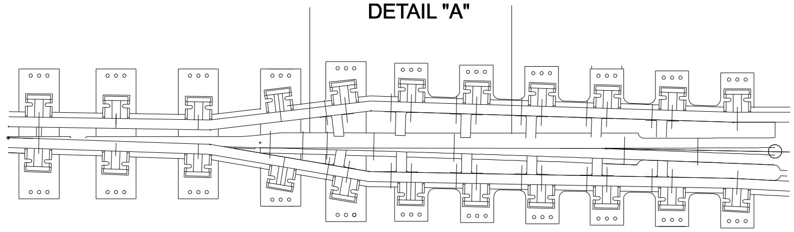
1. ALL MATERIAL TO MEET OR EXCEED RAILROADS RELATED SPECIFICATIONS.
2. SIGNAL DEPARTMENT TO FURNISH ROD BASKETS, ADJUSTER, AUXILARY THROWING DEVICE, AND DAP PLATING FOR MACHINE MOUNTING WHEN REQUIRED.
3. TRAPEZOID HEAD BLOCK TIES ARE DAPPED PER STD DWG 250000.

BNSF RAILWAY

UNION PACIFIC

NO. 20 TURNOUT WITH RBM AND SPRING FROGS 136/141 LB. BILL OF MATERIALS

FILE OWNER: UPRR	DATE: JUNE 25, 2008
REV. NO.: 4	DWG NO: 346200



PROGRESS RAIL FROGS

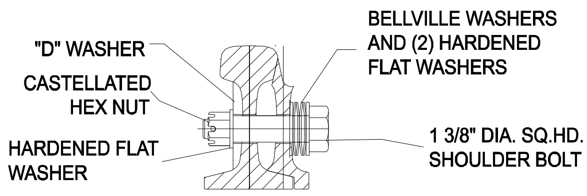
NORTRAK FROGS

POINT ASSEMBLY BOLT SCHEDULE

BOLT TO BE 1" SQ.HD x DRILLED @ "L"
* COMPLETE W/ BELLVILLE WASHERS,
4 HARDENED FLAT WASHERS, AND
CASTELLATED HEX NUT & COTTER PIN

BOLT#	"L"	BNSF PART NUM.
#1	4 1/8"	510282029
#2	4 1/4"	510282030
#3	4 3/8"	510282031
#4	4 3/8"	510282031
#5	4 3/4"	510282032
#6	4 3/4"	510282032
#7	5"	510282033
#8	5 1/4"	510282034
#9	5 3/4"	510282035
#10	6 3/4"	510282036

FOR OLD STYLE FROGS ON ORIN
SUB FROM MP 39
TO MP 56 AND MARIETTA, SD



POINT ASSEMBLY BOLT SCHEDULE

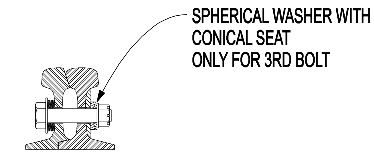
SHOULDER BOLTS TO BE 1 3/8" SQ.HD
* COMPLETE W/ BELLVILLE WASHERS,
(3) HARDENED FLAT WASHERS, AND
CASTELLATED HEX NUT & COTTER PIN

BOLT#	"A"	"B"	PART No.
#1	3 3/4"	4 5/8"	
#2	4"	4 7/8"	
#3	4 3/4"	5 5/8	

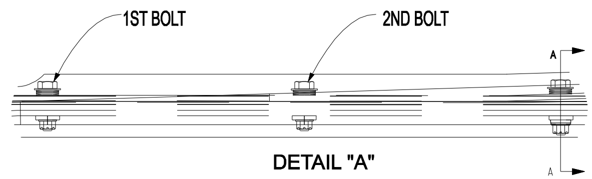
BOLT#	"L"
#4	5 3/4"
#5	6 3/4"

BOLT TO BE 1" SQ.HD x DRILLED @ "L"
* COMPLETE W/ BELLVILLE WASHERS,
4 HARDENED FLAT WASHERS, AND
CASTELLATED HEX NUT & COTTER PIN

FOR FROGS MADE AFTER JULY 2006



SECTION A-A



DETAIL "A"

BOLT LOCATION	SPACER BOLT SIZE	BNSF PART NUM.
BOLT #1 & #2	1 3/8"X 5 9/16"	510282027
BOLT #3	1 3/8" X 6"	510282028

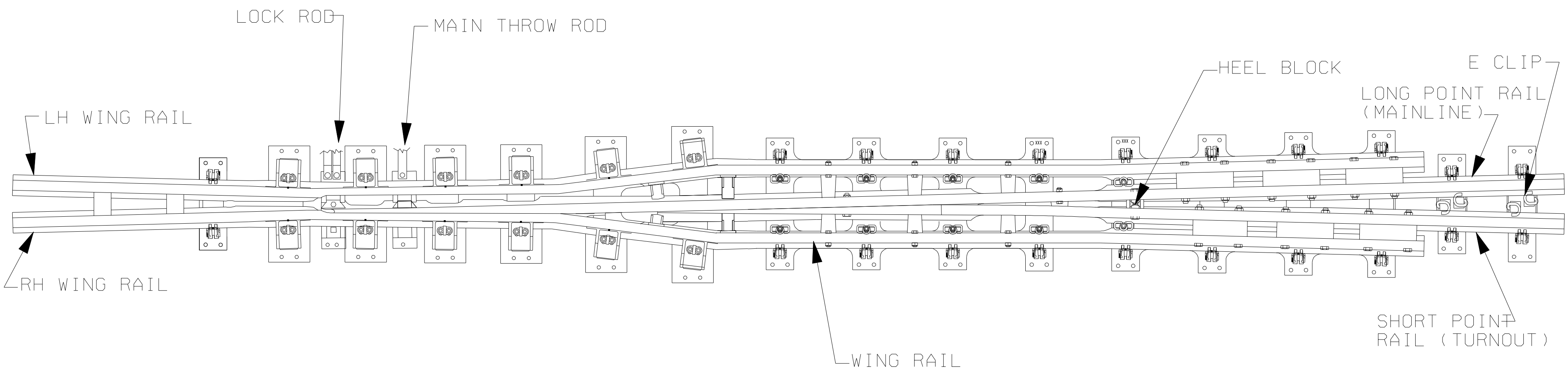
BNSF RAILWAY

STANDARD PLAN

SHORT AND LONG POINT ASSEMBLEY #20 SWING NOSE FROG

FILE OWNER: BNSF | DATE: JULY 17, 2006
REV. NO. 1 | DWG NO: 346215

NOTES
FROG INSPECTION MUST INCLUDE BOLTS AS SHOWN ON DRAWING.
BROKEN OR BENT BOLTS MUST BE REPLACED IMMEDIATLELY.



ITEM DESCRIPTION	MAINTENANCE LENGTH	BNSF PART NUMBER
LONG POINT RAIL LH	25'-7" HEEL	516241007
LONG POINT RAIL RH	25'-7" HEEL	516241008
SHORT POINT RAIL LH	25'-7" HEEL	516241009
SHORT POINT RAIL RH	25'-7" HEEL	516241010
WING RAIL LH	16' 10" TOE	516241011
WING RAIL RH	16' 10" TOE	516241012

WEIGHTS

LONG POINT	1418 LBS
SHORT POINT	1058 LBS
WING RAIL	1632 LBS

BNSF RAILWAY

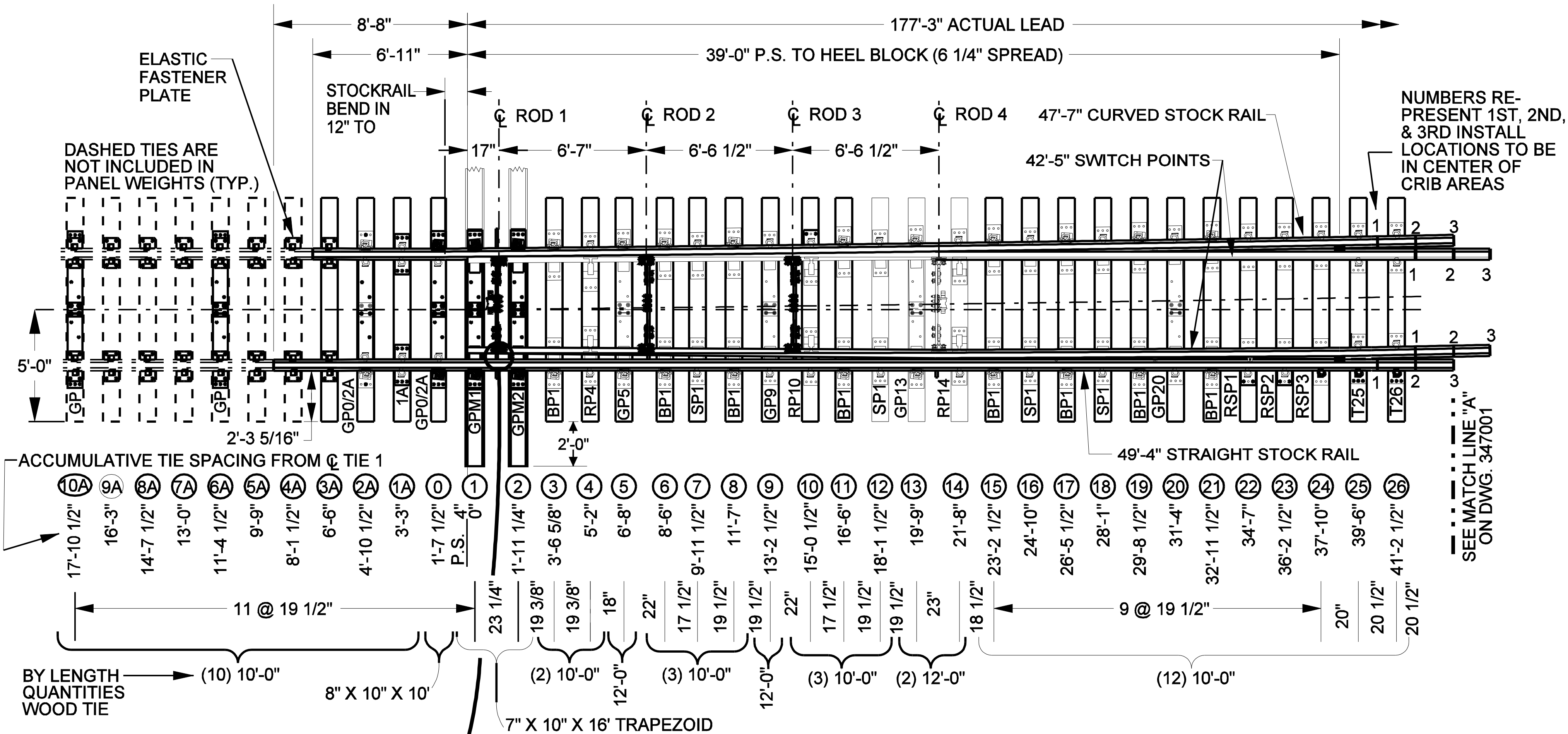
STANDARD PLAN

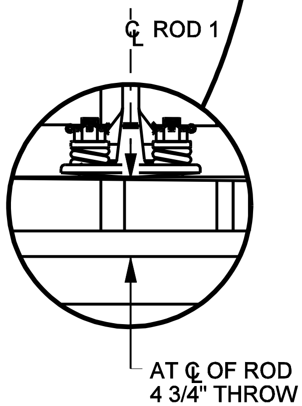
POINT AND WING RAILS
FOR #20 SWING NOSE FROG
NORTRAK DESIGN 141LB

REV. NO.: 0 | SHEET NO. 0 | DATE: 11/13/ 06

DWG NO: 346216

22-25C





THROW DETAIL

NOTES:
1. SEE DWGS 347001 THROUGH 347006 FOR THE BALANCE OF LAYOUT PLANS. 347006 IS ONLY USED BY UPRR.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 347100 FOR TURNOUT GEOMETRY.
4. SEE DWG 347200 FOR TURNOUT BILL OF MATERIAL.
5. APPLY 5" SAFE BOND WIRES ONE CRIB AHEAD OF HEEL OF SWITCH ON STOCK AND SWITCH POINT RAILS.
6. PANEL WEIGHT = APPROXIMATELY 24,500 LBS.

	UPRR	BNSF LH	BNSF RH
136LB. POWER	N/A	518030070	518030148
141LB. POWER	N/A	518030149	518030150

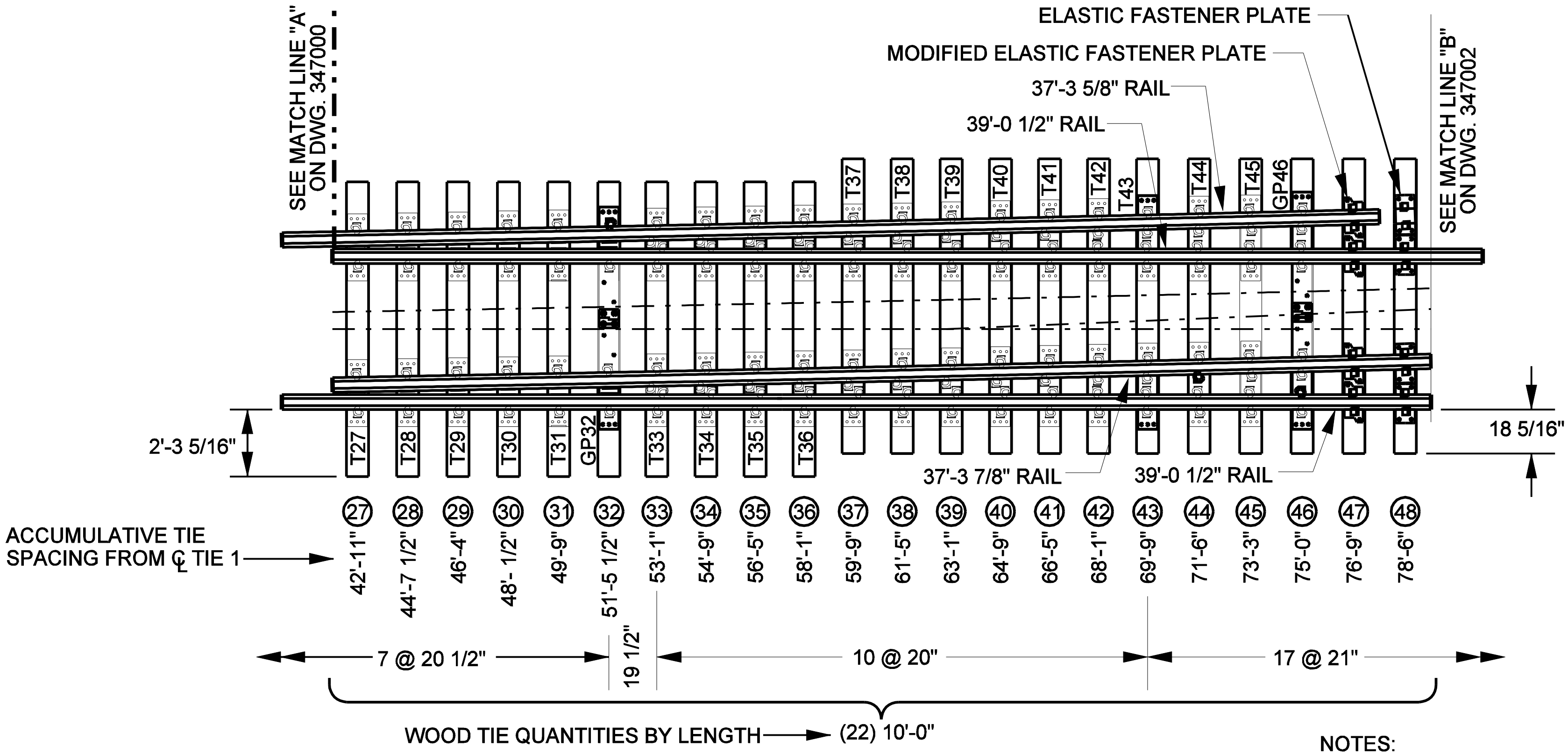
BNSF RAILWAY

UNION PACIFIC

COMMON STANDARDS

NO. 24 TURNOUT 136/141 LB. PANEL NO. 1

FILE OWNER: UPRR	DATE: MAY 16, 2008
REV. NO.: 2	DWG NO: 347000



NOTES:
1. SEE DWGS 347000 AND 347002 THROUGH 347006 FOR THE BALANCE OF LAYOUT PLANS. 347006 IS ONLY USED BY UPRR.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 347100 FOR TURNOUT GEOMETRY.
4. SEE DWG 347200 FOR TURNOUT BILL OF MATERIAL.
5. PANEL WEIGHT = APPROXIMATELY 16,600 LBS.

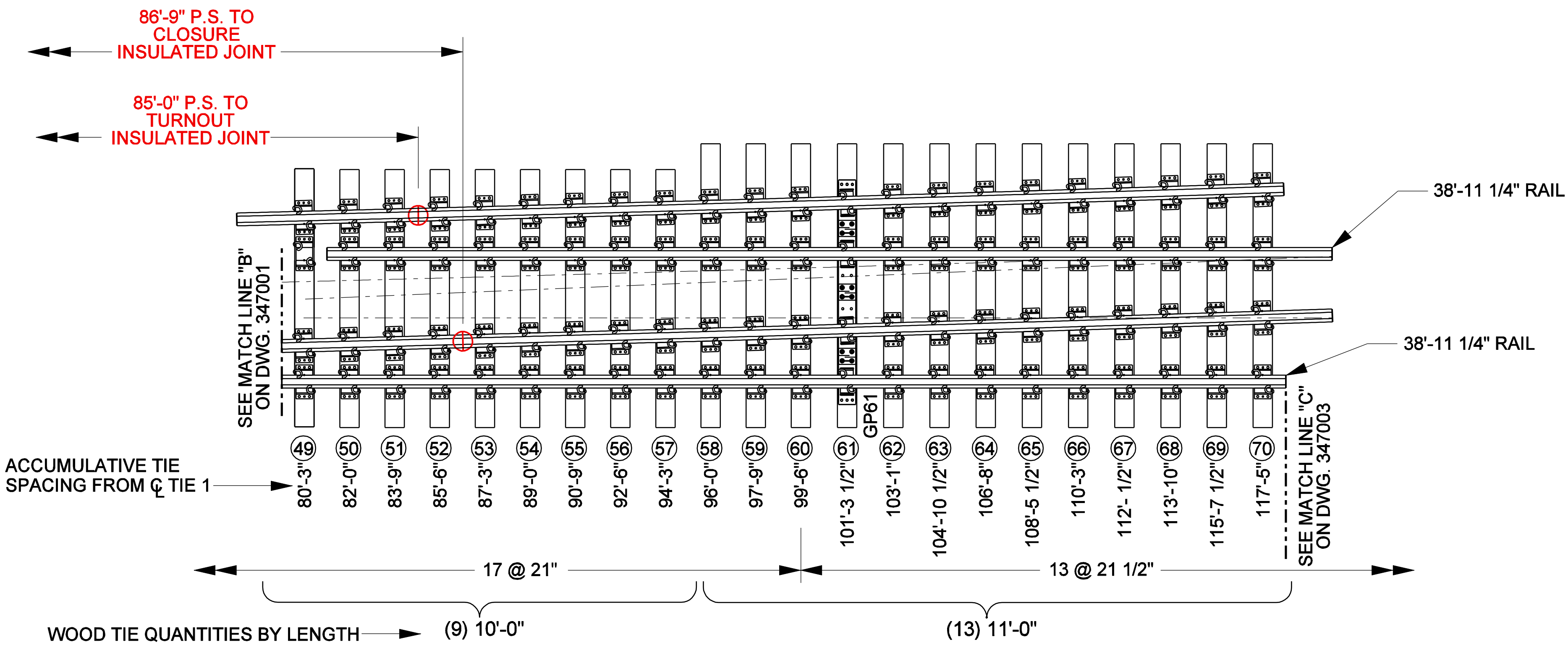
BNSF RAILWAY

UNION PACIFIC

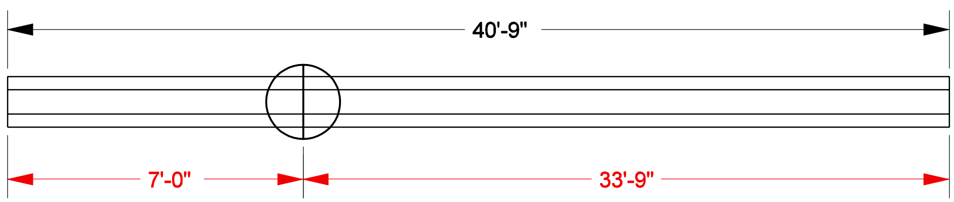
COMMON STANDARDS

NO. 24 TURNOUT 136/141 LB.
PANEL NO. 2

FILE OWNER: UPRR	DATE: MAY 8, 2008
REV. NO.: 1	DWG NO: 347001



NOTES:
1. SEE DWGS 347000, 347001, 347003, 347004, 347005, AND 347006 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 347100 FOR TURNOUT GEOMETRY.
4. SEE DWG 347200 FOR TURNOUT BILL OF MATERIAL.
5. PANEL WEIGHT = APPROXIMATELY 18,450 LBS.



TURNOUT AND CLOSURE INSULATED JOINT RAIL

(BNSF ITEM NO. 524400040)

COMMON STANDARDS

NO. 24 TURNOUT 136 LB. PANEL NO. 3

FILE OWNER: UPRR	DATE: FEB. 11, 2004
REV. NO.: 2	DWG NO: 347002

347002

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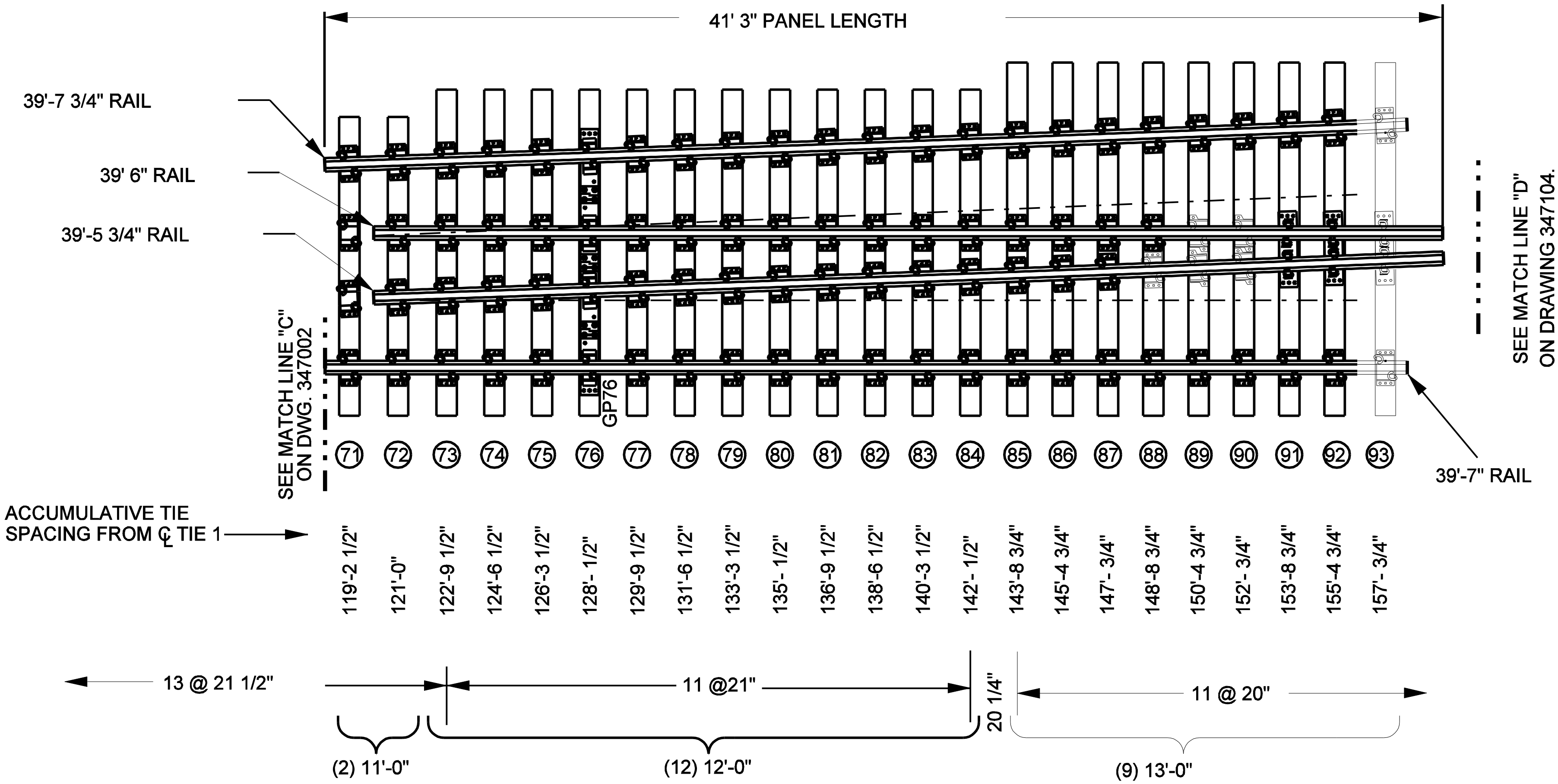


NOTES:

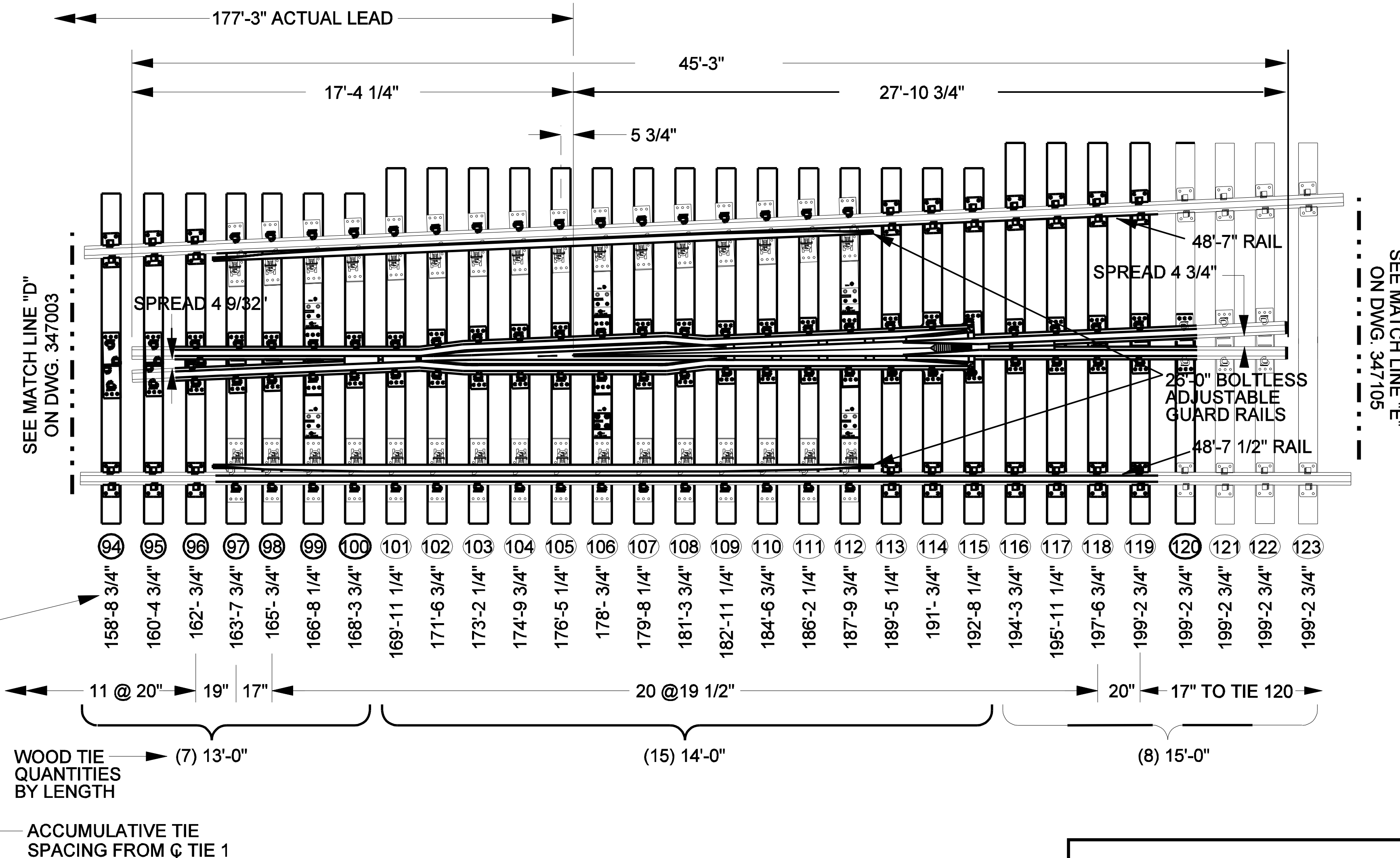
1. SEE DWGS 347000, 347001, 347002, 347104, 347105, AND 347006 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 347100 FOR TURNOUT GEOMETRY.
4. SEE DWG 347200 FOR TURNOUT BILL OF MATERIAL.
5. PANEL WEIGHT = APPROXIMATELY 18,750 LBS.

BNSF RAILWAY

STANDARD PLAN

NO. 24 TURNOUT 136/141 LB.
PANEL NO. 4

SCALE: NONE	FILE OWNER BNSF	DATE: MAR 8, 2007
	REV. NO.: 04	DWG NO: 347103



NOTES:
1. SEE DWGS 347000 THROUGH 347003, 347005, AND 347006 FOR THE BALANCE OF LAYOUT PLANS. 347006 IS ONLY USED BY UPRR.
2. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
3. SEE DWG 347100 FOR TURNOUT GEOMETRY.
4. SEE DWG 347200 FOR TURNOUT BILL OF MATERIAL.
5. PANEL WEIGHT = APPROXIMATELY 24,650 LBS.

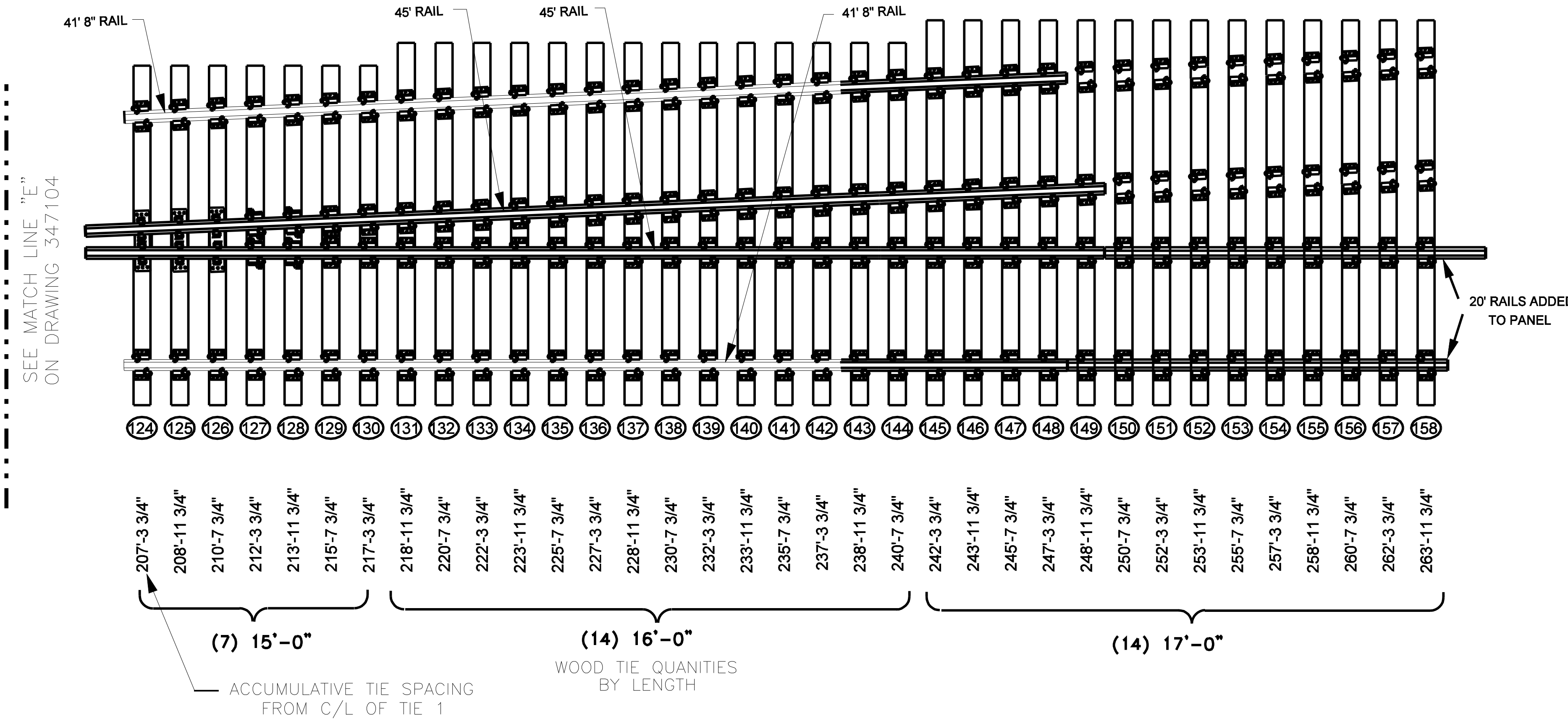
	136 LB.	141 LB.
	BNSF ITEM NO.	BNSF ITEM NO.
RH	513450068	513450241
LH	513450069	513450240

BNSF RAILWAY

STANDARD PLAN

NO. 24 TURNOUT 136/141 LB. PANEL NO. 5

FILE OWNER: BNSF	DATE: JULY 10, 2008
REV. NO.: 1	DWG NO: 347104



NOTES:

1. SEE DWGS 347000, 347001, 347002, 347103, 347104, AND 347006 FOR THE BALANCE OF LAYOUT PLANS.
2. ALL TIE SPACING 20" UNLESS OTHERWISE SHOWN.
3. ALL TIES 7" X 9" BODY UNLESS OTHERWISE SHOWN.
4. SEE DWG 347100 FOR TURNOUT GEOMETRY.
5. SEE DWG 347200 FOR TURNOUT BILL OF MATERIAL.
6. PANEL SHIPPED PREPLATED.

22-31

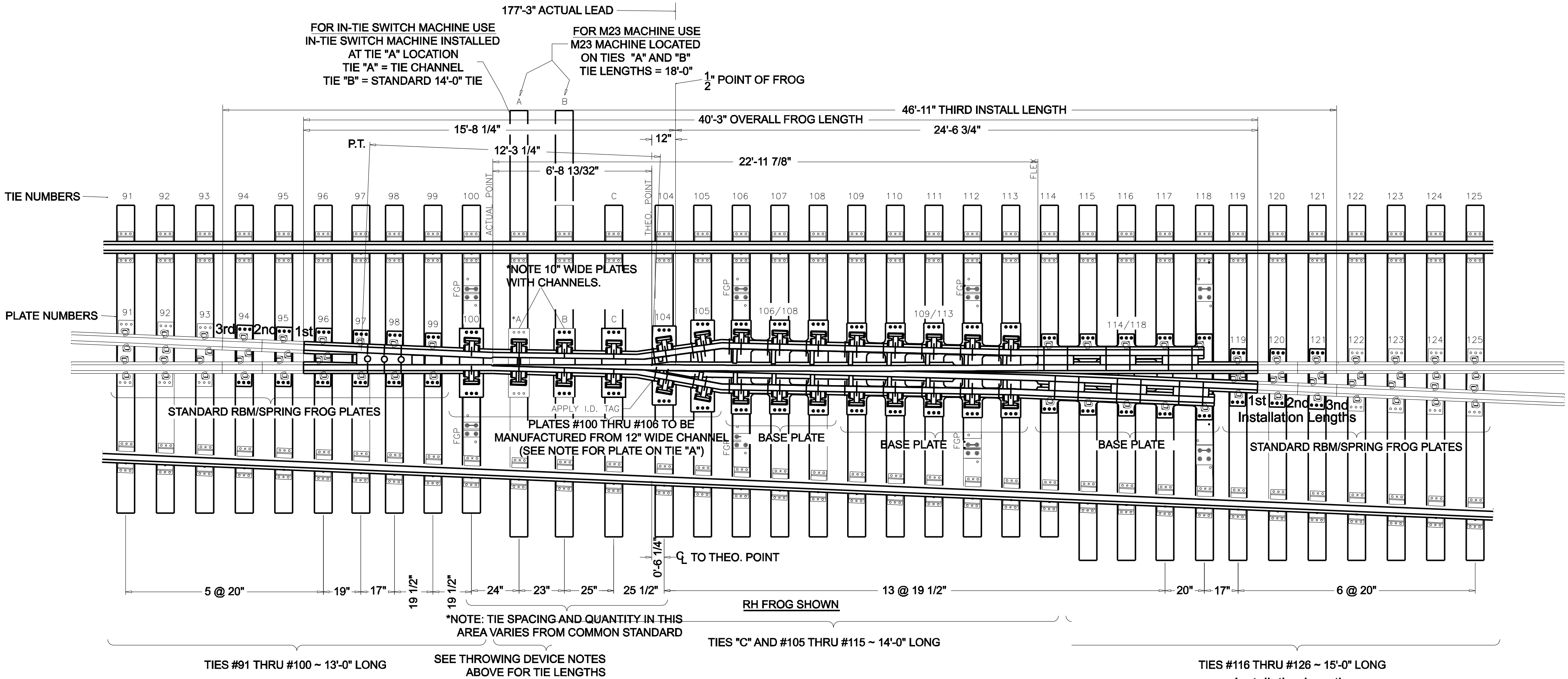
PANEL WEIGHT 32,500 LBS

BNSF RAILWAY

STANDARD PLAN

NO. 24 TURNOUT 136/141 LB.
PANEL NO. 6

SCALE: NONE	FILE OWNER BNSF	DATE: JUNE 19, 2008
	REV. NO.: 04	DWG NO: 347105



Installation Lengths

1st install	40' 3"
2nd install	43' 7"
3rd install	46' 11"

NOTES:

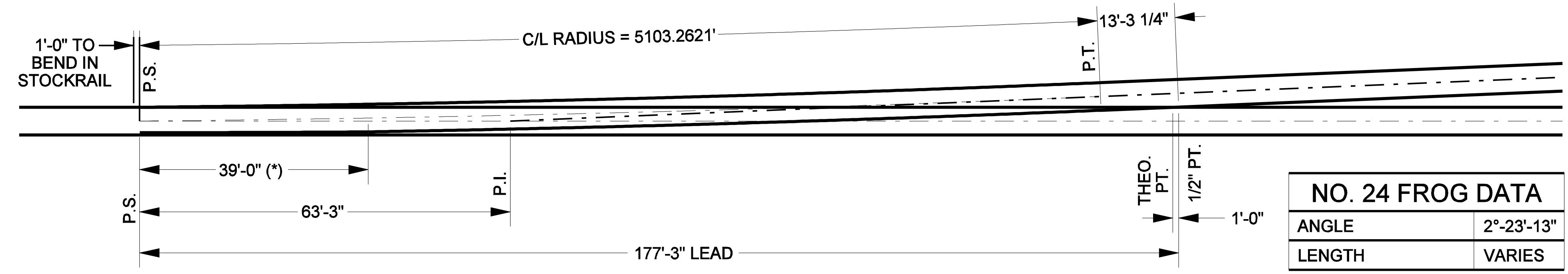
1) BODY BOLTS TO BE GRADE 8, 1 3/8" DIAMETER, HEX HEAD W/ FLAT WASHER AND LOCK NUT. FINAL BOLT TORQUE TO BE 2200 FT./LBS. LUBRICATED USING "NEVER SEIZE" ON THE BOLT THREADS, WASHER AND NUT FACE. TORQUE DEVICE MAY BE MANUAL, PNEUMATIC OR HYDRAULIC.
2) PANEL SHIPPING WEIGHT TO BE STENCILED ON RAIL HEAD WITH WHITE PAINT.
3) ID TAGS TO BE ATTACHED AS NEAR THE POINT AS POSSIBLE WHERE THEY CAN BE CLEARLY READ.
4) RAIL ENDS BLANK.
5) TIES FOR SWITCH MACHINE WILL BE DAPPED AND TRAPIZOID.
6) PROVIDE A SLOT WITH EASEMENT THAT ALLOWS FOR A 5/8"x 1 1/4" OPENING FOR A CALROD HEATER IN WING/ FROG AREA.
7) FOR NEW APPLICATION, CUT TO 1st. LENGTH, MAINTANENCE LENGTH IS 3rd INSTALL.
8) LOCATION OF 1/2" POINT OF FROG WILL BE MARKED ON BOTH WING RAILS.

BNSF RAILWAY

BNSF STANDARD PLAN

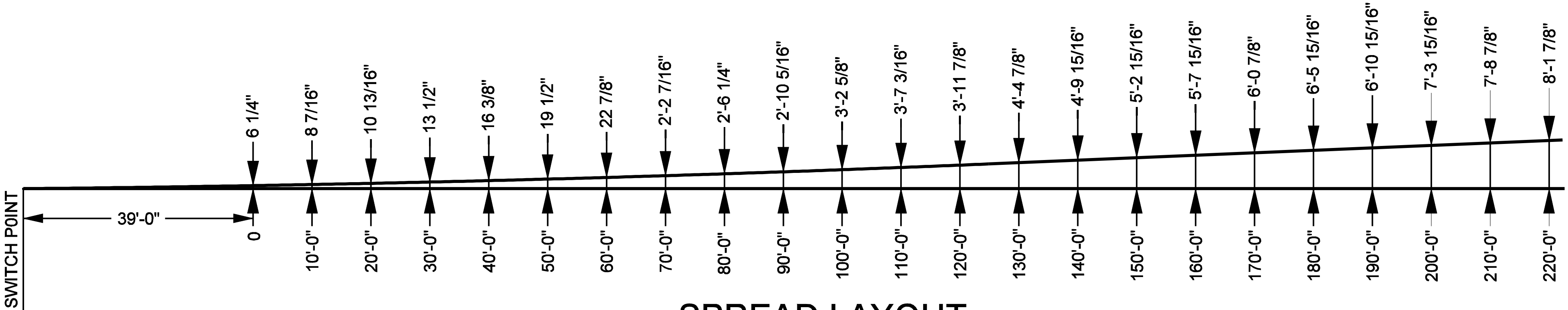
NO. 24 MOVABLE POINT FROG 141 & 136 LB. PANEL NO. 5

FILE OWNER: BNSF	DATE: DEC. 6, 2006
REV. NO. 07	DWG NO: 347010



NO. 24 FROG DATA	
ANGLE	2°-23'-13"
LENGTH	VARIES

GENERAL LAYOUT



SPREAD LAYOUT

	SWITCH DATA	
	SWITCH LENGTH	39'-0"
	HEEL SPREAD	6 1/4"
	HEEL ANGLE	0°-59'-02"
	SWITCH ANGLE	0°-32'-45"
	THROW AT ROD #1	4 3/4"
	RADIUS (CENTER LINE)	5103.26'
	T =	81.99'
	CENTRAL ANGLE - CLOSURE CURVE	1°-50'-27"
	DEGREE OF CURVE	1°-07'-22"
TURNOUT POINT	THICKNESS AT POINT	1/4"
	RADIUS (CLOSURE CURVE)	5105.62'
	VERTEX DISTANCE	12"

FROG DATA	
ANGLE	2°-23'-13"
LENGTH	VARIES

TURNOUT DATA	
RADIUS OF CENTER LINE	5103.26'
T =	81.99'
CENTRAL ANGLE - CLOSURE CURVE	1°-50'-27"
DEGREE OF CURVE	1°-07'-22"

BNSF RAILWAY

UNION PACIFIC

COMMON STANDARDS

NO. 24 TURNOUT 39'-0" CURVED SWITCH, TURNOUT GEOMETRY

FILE OWNER: UPRR	DATE: OCT. 12, 2005
REV. NO.: 1	DWG NO: 347100

QTY.	COMPONENT DESCRIPTION	DWG. NO.	BNSF ITEM NO.	UPRR ITEM NO.
1	39'-0" (EXT. 42'-5") STRT SAMSON SWITCH POINT (NO TIP)	246100	SEE DWG	SEE DWG
1	39'-0" (EXT. 42'-5") CURVED SAMSON SWITCH POINT (W/TIP)	246100	SEE DWG	SEE DWG
1 EA.	49'-4" STRAIGHT & 47'-7" BENT/CURVED SAMSON STOCK RAIL	241500	SEE DWG	SEE DWG
1	SWITCH ROD NO. 1 W/ BASKET	241601	516620011	557-5585
1 EA.	SWITCH RODS NO. 2 AND 3	241600	SEE DWG	557-5586
1	SWITCH ROD NO. 4 W/ BASKET	241601	516620013	557-5588
2	"GP" GAGE PLATE FOR TIES 6A & 10A AHEAD OF POINT	241304	515821526	N/A
2	"1A" PLATE FOR TIE #1A AHEAD OF POINT	241307	515821539	N/A
2	"GP0/2A" ADJUSTABLE BRACE GAGE PLATE FOR TIES #0 & 2A	241301	515821504	N/A
1	"GPM1L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE #1	241302	SEE DWG	SEE DWG
1	"GPM2L/R" ADJUSTABLE BRACE MACHINE GAGE PLATE FOR TIE #2	241303	SEE DWG	SEE DWG
16	"BP1" ADJUSTABLE BRACE SLIDE PLATE	241306	515821532	557-2960
8	"SP1" SLIDE PLATE	241306	515821533	557-2961
2	"RP4" ROLLER RISER PLATE	241309	515821557	SEE DWG
2	"RP10" ROLLER RISER PLATE	241309	515821558	SEE DWG
2	"RP14" ROLLER RISER PLATE	241309	515821559	SEE DWG
6	ROLLER ASSEMBLY	241309	516650007	SEE DWG
1	"GP5" & "GP13" GAGE PLATES FOR TIES #5 & #13	246300	SEE DWG	N/A
1	"GP9" & "GP20" GAGE PLATE FOR TIES #9 & #20	246301	SEE DWG	N/A
2	"RSP1", "RSP2", AND "RSP3" RISER SLIDE PLATES	243309	SEE DWG	N/A
2	TURNOUT PLATES T25 THRU T45	247307	SEE DWG	557-8999
1	"GP32" GAGE PLATE FOR TIE 32	247310	SEE DWG	SEE DWG
1	"GP46" GAGE PLATE FOR TIE 46	247311	SEE DWG	SEE DWG
1	"GP61" GAGE PLATE FOR TIE 61	247312	SEE DWG	SEE DWG
1	"GP76" GAGE PLATE FOR TIE 76	247313	SEE DWG	SEE DWG
*1	46'-11" RBM FROG WITH PLATES (*RBM OR SPRING PER OPTION)	159100/200	SEE DWG	SEE DWG
6	"FGP" FROG GAGE PLATE	156000	515821497	555-6806
2	26'-0" BOLTLESS ADJUSTABLE GUARD RAIL	160101	516240058	556-6021
328	STANDARD ROLLED STEEL PANDROL PLATES	263000	525820956	503-9020
12	MODIFIED PANDROL TIE PLATE	263001	N/A	N/A
1040	PANDROL CLIP E-2055	132500	521710020	503-6100
8	PANDROL INSULATED JOINT CLIP ASSEMBLY	132800	SEE DWG	SEE DWG
2	40'-9" CLOSURE AND TURNOUT INSULATED JOINT RAIL	347002	524400040	SEE DWG
2092	15/16" DIA. x 6 1/2" LG. "RAILROAD APPROVED" SCREW SPIKES	130800	527570012	503-8620
2208	RAIL ANCHORS FOR BNSF	135010	520130012	N/A
944	RAIL ANCHORS FOR UPRR	135010	N/A	550-1650
636	136 OR 141 LB. RAIL (IN LINEAR FT.)	176000	N/A	N/A

BILL OF TIES

QTY.	SIZE	TIE NUMBER
10	7" X 9" X 10'-0"	1A THRU 10A
1	8" X 10" X 10'-0"	0
2	7" X 10" X 16'-0" TRAPEZOID TIES	1 & 2
55	7" X 9" X 10'-0"	3 THRU 57
15	7" X 9" X 11'-0"	58 THRU 72
12	7" X 9" X 12'-0"	73 THRU 84
16	7" X 9" X 13'-0"	85 THRU 100
15	7" X 9" X 14'-0"	101 THRU 115
15	7" X 9" X 15'-0"	116 THRU 130
14	7" X 9" X 16'-0"	131 THRU 144
14	7" X 9" X 17'-0"	145 THRU 158
169 TOTAL		

NOTES FOR MANUFACTURERS

1. ALL MATERIAL TO MEET OR EXCEED RAILROADS RELATED SPECIFICATIONS.
2. SIGNAL DEPARTMENT TO FURNISH ROD BASKETS, ADJUSTER, AUXILARY THROWING DEVICE, AND DAP PLATING FOR MACHINE MOUNTING WHEN REQUIRED.
3. TRAPEZOID HEAD BLOCK TIES ARE DAPPED PER STD DWG 250000.

ITEM NUMBERS	BNSF LH	BNSF RH	UPRR LH	UPRR RH
136 LB - #24TURNOUT W/ RBM FROG, PANEL (COMPLETE)	004737540	004737532	N/A	N/A
136 LB - #24 TURNOUT W/ SPRING FROG, PANEL (COMPLETE)	004737565	004737557	N/A	N/A
136 LB - #24 TURNOUT W/ RBM FROG, PREPLATED TIES	N/A	N/A	557-8449	557-8450
136 LB - #24 TURNOUT W/ SPRING FROG, PREPLATED TIES	N/A	N/A	557-8451	557-8452
141 LB - #24TURNOUT W/ RBM FROG, PANEL (COMPLETE)	005254057	005254065	N/A	N/A
141 LB - #24 TURNOUT W/ SPRING FROG, PANEL (COMPLETE)	005254115	005254123	N/A	N/A
141 LB - #24 TURNOUT W/ RBM FROG, PREPLATED TIES			557-8596	557-8597
141 LB - #24 TURNOUT W/ SPRING FROG, PREPLATED TIES			557-8598	557-8599

BNSF RAILWAY

UNION PACIFIC

NO. 24 TURNOUT WITH RBM AND SPRING FROGS 136/141 LB., BILL OF MATERIALS

FILE OWNER: UPRR	DATE: APRIL 16, 2010
REV. NO.: 5	DWG NO: 347200

Northstar Commuter Rail Extension Feasibility Assessment

Appendix H – Technical Memorandum on Capital Cost Estimates

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

by

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum documents the assumptions used to estimate the costs for capital improvements to support the proposed Northstar Service Alternatives.

2. Capital Cost Methodology

2.1. Standard Cost Categories and Unit Costs

Capital costs were estimated for the Northstar Commuter Rail Extension Feasibility Assessment following the Federal Railroad Administration's (FRA's) Standard Cost Categories, presented in Table 1. Capital costs were based on a quantification of the infrastructure improvements necessary to accommodate the expanded Northstar service on the existing BNSF rail corridor.

Table 1: FRA Standard Cost Categories

FRA Standard Cost Categories
10 Guideway & Track Elements
20 Stations, Stops, Terminals, Intermodals
30 Support Facilities: Yards, Shops, Admin. Bldgs
40 Sitework & Special Conditions
50 Systems
60 ROW, Land, Existing Improvements
70 Vehicles
80 Professional Services
90 Unallocated Contingency
100 Finance Charges

The costs were estimated using the Technical Memorandum on Capital Cost Estimating Methodology prepared for this project. The Methodology is presented in Appendix I. Unit costs for all Northstar-specific pay items were estimated in 2020 dollars. Overall costs were increased to 2025 dollars using an inflation factor.

2.2. Assumptions for Proposed Capital Improvements

Berkeley Simulation Software, Inc. Rail Traffic Controller™ (RTC) software was used to identify the improvements needed to accommodate expanded Northstar commuter rail service with existing and future traffic levels. RTC simulations concluded in April 2020 and informed the capital cost estimating process.

The primary capital improvements needed to maintain the level of projected freight service, as identified in the RTC model, consist of:

- Installing new higher-speed turnouts and crossovers
- Adding new main track, station track, and maintenance facility track
- Upgrading or relocating existing auxiliary tracks and industry track connections
- Constructing new bridges to support proposed new track
- Reconfiguring and expanding existing Centralized Traffic Control (CTC) control points
- Adding new CTC control points
- Adding CTC and Positive Train Control (PTC) to new or extended tracks (which also includes the installation of power-operated derails at several locations)
- Construction of new grade crossing warning devices or modification of existing grade crossing devices

The sub-sections below discuss the assumptions for the general types of capital improvements needed to accommodate expanded Northstar service that are associated with the FRA Standard Cost Categories listed in Table 1.

2.2.1. Guideway & Track Elements

New main track is assumed to be constructed at several locations with 136# continuous welded rail (CWR) with timber ties in accordance with BNSF track standards, with mainline track built to FRA Class 5 standards. Where locations for new track are identified as part of the needed capital improvements, the type and extent of work needed to prepare the existing track right-of-way, including clearing, sub-grade preparation, and embankment widening, was estimated by analyzing the existing field conditions using a combination of online maps, Google Earth, and field visits to the site locations.

Main track tie replacement and surfacing work is not included for the corridor between Minneapolis and St. Cloud because BNSF track is already able to accommodate the Northstar commuter train and Amtrak maximum train speeds of 79 MPH in the corridor. Lower maximum train speeds exist in some locations due to the characteristics of the railroad and are not proposed to be increased. The one exception is the proposed upgrade of the auxiliary track on the Wayzata Subdivision between CP Stadium and CP Harrison Street with 66% tie replacement and surfacing to increase train speeds to 40 MPH. New turnouts and crossovers are assumed to be constructed with timber ties, with the size and location of new turnouts and crossovers determined using the RTC model and other operating characteristics that affect maximum permissible or achievable train speed. Where turnouts or segments of track are required to be removed or relocated, the costs for those activities are included.

Costs for extending existing culverts under main tracks to accommodate a new third main track are included where appropriate. Costs for new track structures are included where a proposed new main track parallel to other main tracks crosses over a roadway or stream. Two new structures are included on the Staples Subdivision; one over Rice Creek and one over Mississippi Street, both located between Northtown Yard and Coon Creek. No other new structures are required because the lengths, track centers, and locations of new tracks were adjusted to avoid the need for new structures.

As a safety measure for pedestrians, fencing will be installed in two locations, one of which is near a CTC control point in a residential area between two grade crossings, and one of which is at a commuter station to be expanded. Decorative fencing will be used near the commuter station. Six-foot-high chain link fencing will be used near the CTC control point.

2.2.2. Stations, Stops, Terminals, Intermodals

The proposed extension of Northstar commuter train service to St. Cloud involves four categories of station improvements:

- At Big Lake Station, a new center platform is proposed for certain Service Alternatives where Northstar trains operating between St. Cloud and Minneapolis make stops at Big Lake. The new center platform will conform with Americans with Disabilities Act, BNSF, Metro Transit and other applicable standards. The center platform will be constructed between Staples Subdivision Main Tracks 1 and 2 and will be connected to the existing Big Lake Station platform with an enclosed overhead walkway between a new elevator/stairway tower on the center platform and a new elevator/stairway tower on the existing station platform. No changes to existing driveways, parking, or access roadways are anticipated.
- At. St. Cloud station, a new station track with power-operated turnouts and signals at both ends, 480-Volt AC standby power facility and connections, and a new platform conforming to Americans with Disabilities Act, BNSF, Metro Transit and other applicable standards will be constructed and connected to the existing Amtrak station area.
- At all Northstar stations, existing electronic signage and passenger information systems will be updated to reflect all the changes associated with the proposed extension of Northstar service to St. Cloud. No other changes are anticipated at those stations.
- At the existing Northstar Fridley commuter station, a new third main track will be constructed along the south side of the existing station platform for certain Service Alternatives. Northstar trains will use the third main track to board and alight passengers and the track will be constructed to required horizontal and vertical levels to achieve accessible boarding and alighting at Fridley.

Each of the proposed Service Alternatives considered train frequency and scheduling so that the number of trainsets and train crews at Target Field Station at any one time would not exceed the available space. Therefore, no storage track or station platform extensions are required and no expansion of the existing train crew facility at Target Field Station is needed. The proposed train schedules for each of the Service Alternatives does not require a trainset or train crew to lay overnight at Target Field Station or at St. Cloud Station. However, 480-Volt AC standby power was proposed at the St. Cloud station to allow a train to layover with its locomotive shut down during the midday if necessary.

2.2.3. Support Facilities: Yards, Shops, Admin. Bldgs

Metro Transit operates the Big Lake Maintenance Facility (BLMF), also known as the Vehicle Maintenance Facility (VMF), where Northstar commuter trains are based and serviced. Almost all the servicing and light-to-medium maintenance required for the Northstar fleet is performed at BLMF. The exception is wheel truing of Northstar locomotives, which is performed by BNSF forces at the BNSF Northtown locomotive maintenance facility. An expansion of the BLMF, including the construction of an additional stub track inside the shop building, was underway at the time of a visit during the study. The installation of a new drop table to facilitate the changeout of passenger car wheel sets had recently been completed.

The Northstar fleet currently includes four operational 4-car train sets plus spare equipment. Several of the Service Alternatives would require one additional Northstar trainset to be procured. BLMF does not have enough trackage to accommodate the additional train set. Therefore, for those Service Alternatives that require the additional train set, a double-ended storage and servicing track was proposed to be added to the existing track configuration, as well as an extension of the east lead track to enable east-end train movements between the new track and the maintenance buildings.

The proposed storage/servicing track incudes:

- Paved access roadway on both sides of the track
- 480-Volt AC standby power facilities and connections
- Compressed air connections
- Locomotive drip pans
- Exterior lighting
- Electrical connections
- Track, and platform area drainage
- Derails to facilitate the use of FRA Blue Signal Protection for Workers requirements

2.2.4. Sitework & Special Conditions

Sitework includes removal of existing turnouts, crossovers, and track, clearing and grubbing at the St. Cloud Station, and removal of a bumping post at the Big Lake Station.

2.2.5. Systems

The cost estimate recognizes that full-corridor CTC and PTC are fully operational between Minneapolis and St. Cloud. All Northstar locomotives and cab control passenger cars are equipped with operational PTC equipment.

Communications and signaling improvements include new CTC control points at certain locations and enlarged, upgraded, or reconfigured CTC control points at other locations. CTC and PTC are proposed for all segments of new main track, as well as the signal and communications work necessary to modify the CTC and PTC systems to accommodate all other proposed improvements. Certain signals, signal bridges, and cantilevers are proposed to be removed and signals are proposed to be replaced or added as needed to accommodate the additional main track or extended CTC control points. All the changes are required to maintain or increase operating capacity and connectivity, increase the operating flexibility available to train dispatchers, and to ensure the continued dependability of Northstar, Amtrak, and BNSF freight train operations in the corridor.

Communications and signaling work at grade crossings are also included in this category. Most of the existing grade crossings are currently signaled and some have FRA-approved Quiet Zones. Proposed grade crossing work includes upgrades to accommodate a third main track through the crossings that currently have two main tracks. In several locations, grade crossings are included within the limits of a new or expanded CTC control point with multiple main tracks. Signal work has been included to incorporate coordinated signal functionality at these locations.

Upgrades to roadway approaches and grade crossings to accommodate new tracks through crossings include new precast crossing panels, rubber flange and timber or concrete panel crossing surfaces at private crossings, removal and extension of median barriers to accommodate additional or shifted tracks, modifications to drainage ditches and culverts, and roadway re-profiling of approach grades to meet MnDOT and AREMA standards. Costs for precast concrete panels are included at public crossings where panels do not currently exist.

2.2.6. ROW, Land, Existing Improvements

Based on conceptual designs, no land acquisition is needed in locations where new track is to be constructed. However, two existing easements near the Rice Creek Bridge will likely need to be modified to enable the construction of the proposed new third main track and the continuation of existing recreational facilities. Changes to the property and track lease to a private party at Minneapolis Junction will need to be revised to accommodate the new second west leg of the wye at that location. With these exceptions, it is assumed that new track will be built within the existing right-of-way.

2.2.7. Vehicles and Equipment

Costs for one additional locomotive, two additional bi-level passenger coaches, and two additional bi-level cab control passenger cars were included. Currently, MnDOT's preference is to acquire and upgrade, modify, equip, and paint (or wrap) compatible used commuter rail equipment from other agencies, where available, to supplement the Northstar fleet so that all commuter equipment is interchangeable, has the same functionality and appearance, and uses the same spare parts inventory as the existing Northstar fleet. The modifications and upgrades specifically include the necessary compatible PTC equipment, HVAC, operating control systems, and passenger information systems. The purchase of new locomotives and commuter cars is also an option, depending on market conditions and availability at the time of the acquisition. The cost of the rolling stock acquisitions also included the cost of on-site testing and qualification by BNSF and Metro Transit personnel of the on-board PTC equipment on the acquired locomotives and cab control passenger cars.

If, at the time of procurement, Metro Transit opts to acquire locomotives and passenger cars that are not the same as the existing Northstar fleet, then the purchase of a spare parts inventory with sufficient quantities of critical and long-lead time components will be required to support the acquired equipment. If the spare parts and components are foreign made and stocked, then sufficient inventory must be purchased and maintained by the agency to compensate for the long lead time needed for the transportation time for overseas replenishment. Failure to maintain an adequate spare parts inventory could result in the rolling stock being unavailable for service due to the inability of maintenance forces to replace critical components when required. In addition to the spare parts inventory, an analysis would be required to identify any special tooling and/or shop equipment, not already on hand at the Big Lake Maintenance Facility, that would be needed to service the acquired rolling stock.

2.2.8. Professional Services

Professional services fees are included to cover design costs, program management costs, construction management and oversight costs, and integration, testing and commissioning costs. These costs are included in the estimate as a percentage of construction cost. Table 2 presents the assumptions used to calculate Professional Services costs.

Table 2: Professional Services Costs

Professional Services	Cost as a Percentage of Construction Cost
Design Engineering (Categories 10, 40, 50, 60)	5%
Design Engineering for Stations and Facilities (Categories 20 AND 30)	10%
Program Management	2%
Construction Management & Inspection	6%
Engineering Services During Construction	1%
Integration, Testing, Commissioning	1%

2.2.9. Contingency

Contingency costs are calculated as a percentage of the total capital cost for each FRA Standard Cost Category. Contingency percentages vary depending on the level of design completed for the work elements included in a particular category. An unallocated contingency of 5% is added to categories 10 through 80. Table 3 presents the assumptions used to calculate Contingency Costs.

Table 3: Contingency Cost Percentages

FRA Standard Cost Category	Contingency Cost as a Percentage of Total Capital Cost
10 Guideway & Track Elements	20%
20 Stations, Stops, Terminals, Intermodals	30%
30 Support Facilities: Yards, Shops, Admin. Bldgs	30%
40 Sitework & Special Conditions	20%
50 Systems	20%
60 ROW, Land, Existing Improvements	Not Applicable
70 Vehicles	20%
80 Professional Services	0%
90 Unallocated Contingency	5% of All Category 10-80 Costs
100 Finance Charges	Not Applicable

2.2.10. Finance Charges

Finance charges are not calculated for the Northstar Commuter Rail Extension project.

3. Description of Capital Improvements

Capital improvements are discussed in the following sub-sections with the justification for the improvement. Concept plans for the capital improvements are in Appendix G.

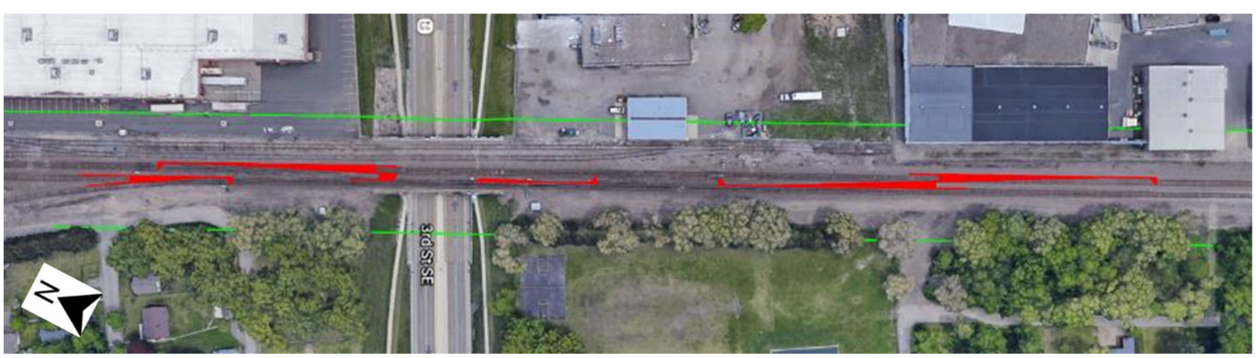
3.1. St. Cloud Improvements

The St. Cloud improvements would provide additional operating capacity and improved operating flexibility between MP 75.2 and MP 73.2 to accommodate Northstar trains clear of Main Track 2 at St. Cloud station, enable improved utilization of both main tracks at St. Cloud by both Amtrak and freight trains, and improve the flow of freight train traffic on the Staples Subdivision. Figure 1, Figure 2, and Figure 3 depict the three capital improvements in St. Cloud.

Figure 1: New St. Cloud West Control Point

Figure 2: St. Cloud Station Track

Figure 3: Upgrade St. Cloud Control Point



Proposed improvements include:

- Construct new CTC control point at MP 75.0 West St. Cloud including:
  - New universal #24 power-operated crossover between Main Tracks 1 and 2 to replace existing hand throw crossover
  - New powered west wye turnout to replace existing hand throw turnout to enable trains to enter and leave west wye without stopping
  - Upgraded industry track connections
  - Signal/PTC changes to accommodate the proposed new track work
- Construct new station track and platform off Main Track 2 west of Amtrak platform at St. Cloud station for Northstar commuter trains including related improvements:
  - New powered turnouts and signals on both ends as part of extending existing CP St. Cloud to include the station track
  - 480-Volt AC standby power connection and drip pan at west end of station track
  - Elimination of industry track turnout on Main Track 2 west of station and reconnect industry track from other end from west leg of the wye
  - Grade crossing and warning system improvements for industry track
  - Elimination of hand throw turnout connection between west wye and Main Track 2 just west of St. Cloud station
  - Signal/PTC changes to accommodate the proposed new track work
- Upgrade Existing CP St. Cloud at MP 73.6 including:
  - Replace existing crossovers with new #24 universal crossover
  - Other track and turnout changes due to using #24 universal crossover
  - Extend existing CTC control point to include turnouts and signals at both ends of proposed station track off Main Track 2 west of Amtrak station
  - Signal/PTC changes to accommodate the proposed new track work

3.2. CP MP 66 Upgrade

Upgrading the universal crossover at MP 66 to #24 would reduce the time required to make diverging route movements at CP 66 by increasing diverging route speeds for both passenger and freight trains through the universal crossover. Increasing speeds would improve the flow of train traffic on the Staples Subdivision. The improvement would be needed because of additional train traffic between St. Cloud and Big Lake. Figure 4 depicts the capital improvements at MP 66.

Figure 4: CP MP 66 Upgrade

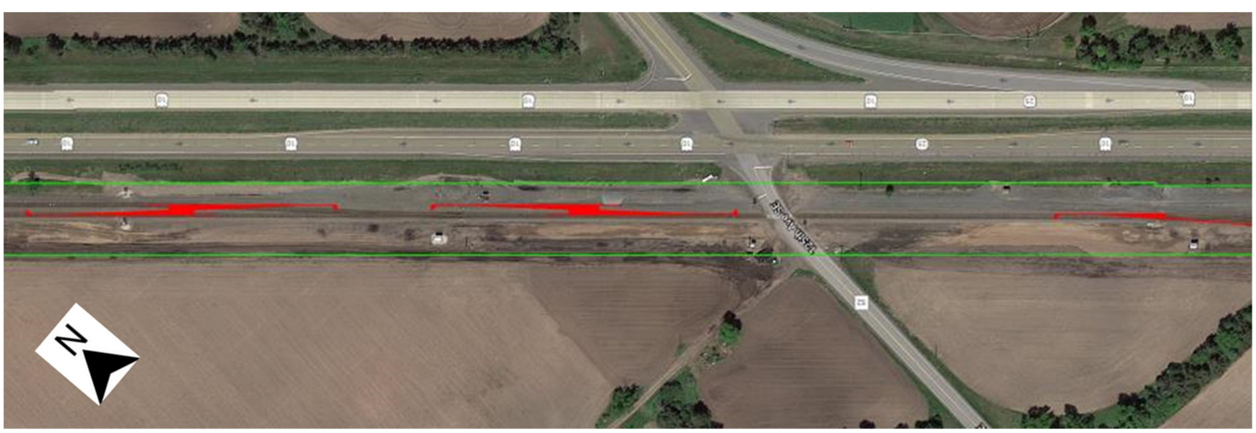
Proposed Improvements:

- Construct new universal #24 power-operated crossover between Main Tracks 1 and 2 to replace existing #20 universal crossover
- Signal/PTC changes to accommodate the proposed new track work

3.3. New Control Point at Becker

Constructing a new CTC control point at Becker would provide additional operating capacity and improved operating flexibility between the existing CTC control points at MP 66 and MP 52.8, improving the flow of train traffic on the Staples Subdivision. The new control point would reduce congestion caused by loaded and empty coal trains moving to and from Becker. The improvement is needed because of additional train traffic between St. Cloud and Big Lake. Figure 5 presents the capital improvements at Becker.

Figure 5: New Control Point at Becker



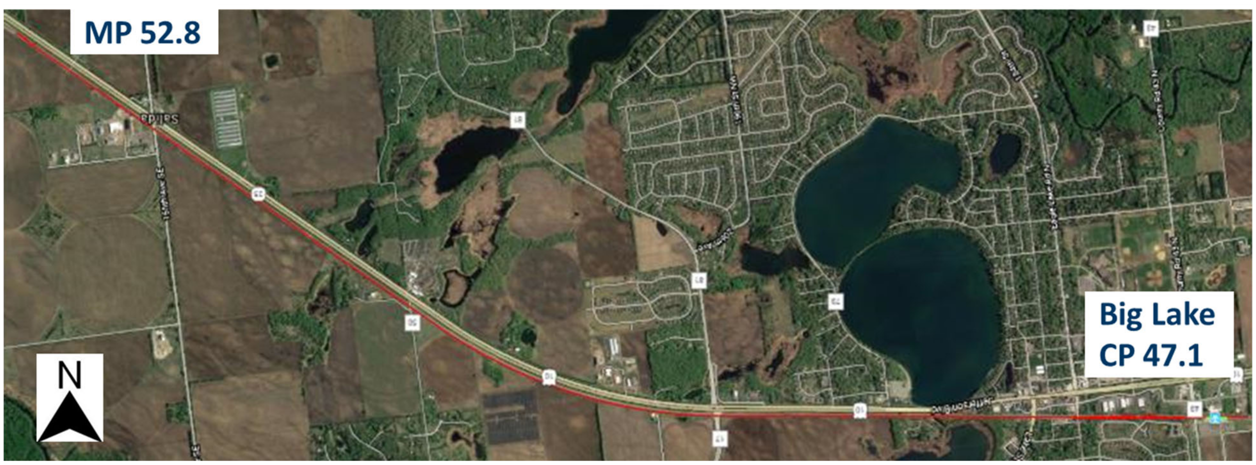
Proposed improvements include:

- Construct new #24 universal crossover between Main Tracks 1 and 2, west of the existing turnout to expedite the movement of trains that serve the coal-fired electrical generating station. This also expedites the movements of the St. Cloud-Northtown Yard local which works at the Becker siding off Main Track 1 twice each day.
- Replace existing hand throw turnout to generating station spur with new power-operated turnout to reduce the time needed for loaded and empty coal trains to enter and leave the main track at Becker. Configuration also enables westbound empty coal trains to utilize Main Track 1 from Becker instead of using Main Track 2 to MP 66 and then crossing over to Main Track 1.
- Signal/PTC changes to accommodate the proposed new track work.

3.4. Big Lake West Siding

The Big Lake West Siding would provide additional operating capacity and improved operating flexibility between the existing CTC control point at MP 52.8 and the Big Lake Station over a new connection to the station track. The five-mile-long siding would be needed to accommodate meets between opposing Northstar revenue and deadhead trains moving between Big Lake and St. Cloud that would occur in this segment under certain Service Alternatives. Figure 6 depicts the capital improvements for the Big Lake West Siding.

Figure 6: Big Lake West Siding



Proposed Improvements include:

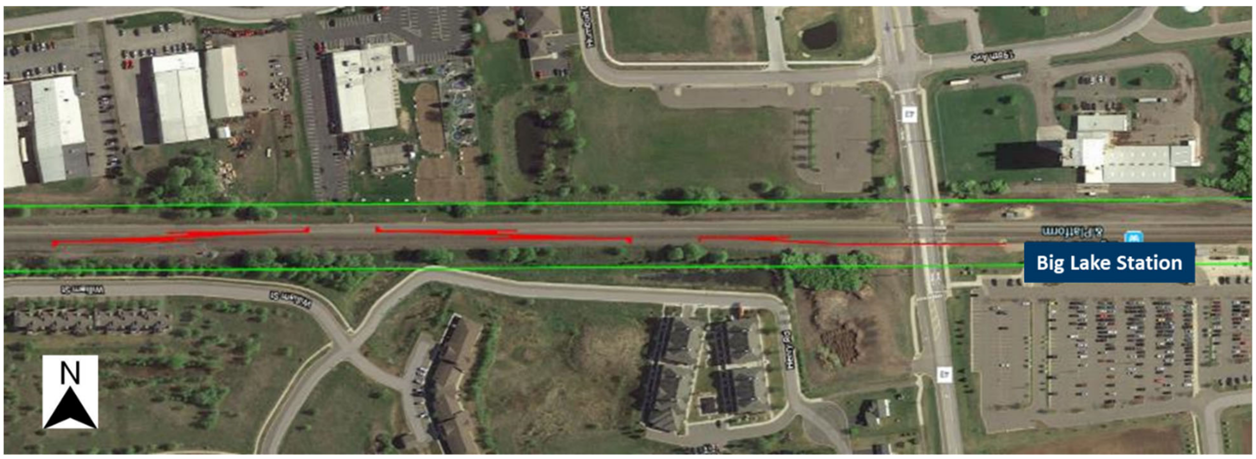
- Construct new Big Lake West Siding (a third main track in CTC territory) between the existing CTC control point at MP 52.8 and the proposed new CTC control point at MP 47.1, with a new track connection to the Big Lake Station
- Construct new #24 power-operated turnout at CP 528 for west end of new main track
- Construct new #24 power-operated turnout at CP 47.1 for east end of new main track
- Construct new grade crossing and warning system improvements to accommodate new main track through existing rail-highway grade crossings between MP 46.9 and MP 52.8
- Industry track changes at MP 47.1 to accommodate new CTC control point.

- Signal/PTC changes to accommodate the proposed new track work.

3.5. Big Lake Station Track Connection

The Big Lake Station track connection would provide a direct connection for trains moving between BLMF and St. Cloud. The improvement would be needed to avoid a reverse movement for each Northstar commuter train that would be caused by the current 'east-end only' stub track configuration at Big Lake Station. The improvement would be necessary to enable all the proposed Service Alternatives to operate efficiently and avoid the consumption of main track capacity that would occur without this improvement. Figure 7 depicts the Big Lake Station Track Connection improvements.

Figure 7: Big Lake Station Track Connection



Proposed Improvements include:

- Construct new CTC control point with #24 universal crossover between Main Tracks 1 and 2 at MP 47.1
- Extend the west end of the Big Lake Station stub track to connect with new CTC control point at MP 47.1 east of the proposed new universal crossover enabling direct connection between the Big Lake Maintenance Facility and St. Cloud without the need for a reverse movement over the existing control point at Big Lake (MP 46.6)
- Construct grade crossing and signal improvements to add third track through the County 43 grade crossing
- Signal/PTC changes to accommodate the proposed new track work

3.6. Big Lake Station Expansion

The Big Lake Station Expansion would include construction of a center platform at Big Lake Station that would mitigate train movement conflicts, congestion, and lost corridor capacity caused by crossover movements made by Northstar commuter trains operating between St. Cloud and Minneapolis. With the proposed center platform station, each Northstar commuter train to or from St. Cloud that had a schedule stop at Big Lake would use the main tracks to serve Big Lake commuters. Figure 8 illustrates the improvements that are proposed for the Big Lake Station Expansion.

Figure 8: Big Lake Station Expansion

Proposed improvements include:

- Shift Main Track 1 to north between west end of CP Big Lake (MP 46.6) and west end of County 43 grade crossing to accommodate new Northstar commuter station platform between Main Tracks 1 and 2.
- Construct new accessible Northstar commuter station platform with Northstar amenities between Main Tracks 1 and 2 to enable Northstar commuter trains operating between St. Cloud and Target Field Station to remain on their same main track for the station stop.
- Construct new enclosed pedestrian overhead walkway between a new elevator tower on the center platform and a new elevator tower on the existing Big Lake station platform to provide access between the existing Big Lake Northstar station and its parking facilities and the proposed new center platform facility.
- Signal/PTC changes to accommodate the proposed new trackwork

3.7. Big Lake Maintenance Facility Expansion

The BLMF expansion is needed for the service alternatives that require an additional trainset for the Northstar commuter train fleet. The existing maintenance facility does not have enough track room to store and service the added trainset. Figure 9 presents the improvements proposed for the BLMF Expansion.

Figure 9: Big Lake Maintenance Facility Expansion

Proposed improvements include:

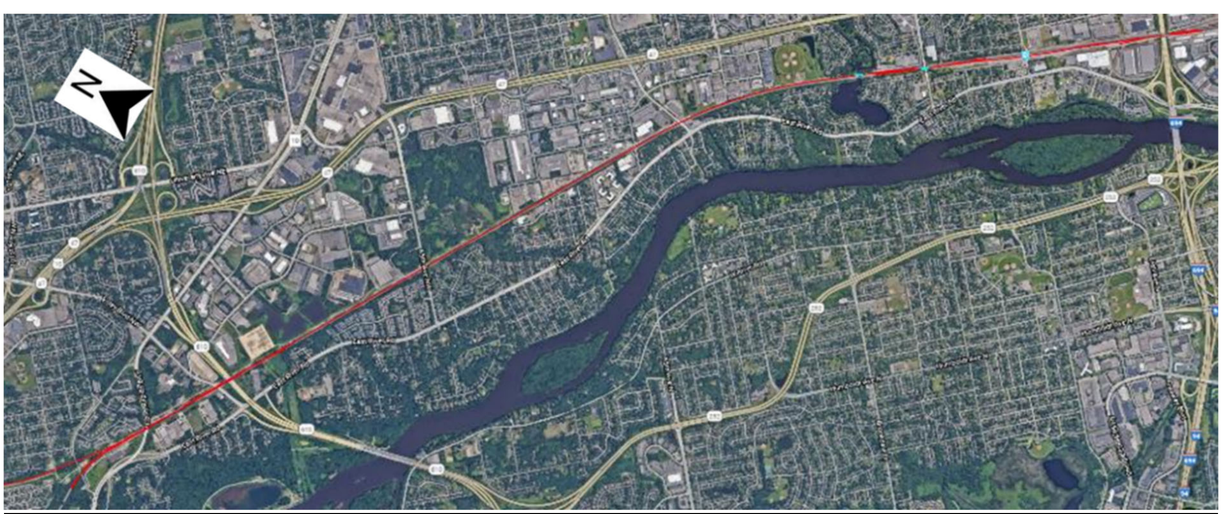
- Construct a new storage/service track north of the existing tracks within the Big Lake Maintenance Facility where there is presently room to construct up to three more tracks.
- Connect both ends of the new track to the lead tracks on each end and extend the east lead stub track to provide head room for a train set to enter and leave the track from the east end.
- Construct service roads, overhead lighting, drip pans, 480-Volt AC standby power connections, compressed air connections, electrical service drop outlets, and drainage for the new track.

3.8. Third Main Track CP Coon Creek to CP Interstate

The third main track would be needed to maintain dependable and/or expanded Northstar commuter train operations, improve the capability to prioritize the movement of additional freight trains through the highly congested main track corridor west of and around BNSF's Northtown Yard, and increase the capacity to enable freight trains to depart from and enter the west end of Northtown Yard simultaneously. Freight trains enter and leave the yard at several locations at very slow (5-10 mph) speeds from both ends of the Yard. Through-freight-trains that do not need to enter Northtown Yard stop on the two main tracks at Northtown to change crews. All these movements create congestion that affects the performance and schedules of BNSF freight trains, Amtrak intercity trains, and Northstar commuter trains. Adding a third main track would provide an additional route that would also serve the west side platform at the Fridley Northstar commuter station, enabling Northstar commuter trains in both directions to serve Fridley Station simultaneously.

Two adjacent control points are proposed at Coon Creek to provide universality from all three main tracks east of Coon Creek to both main tracks of the Staples Subdivision and the single-track Hinckley Subdivision main track west of Coon Creek. The configuration would also enable the construction of a new passenger station west of Foley Boulevard grade crossing on the north side to serve NLX intercity passenger trains between Minneapolis and Superior-Duluth should NLX service be established in the future. Figure 10 presents the third main track improvements between CP Coon Creek and CP Interstate.

Figure 10: Third Main Track CP Coon Creek to CP Interstate



Proposed improvements include:

- Reconfigure the existing CTC control point at Coon Creek to accommodate the proposed new third main track, utilizing all new #24 crossovers to increase the speed of diverging movements at this busy junction between the BNSF Staples and Hinckley Subdivisions approximately five miles west of Northtown Yard
- Construct a new CTC control point adjacent to and immediately east of Coon Creek in the vicinity of and through the existing opening at the MN 610 overhead highway bridge, utilizing new #24 crossovers to connect the new third main track with Main Tracks 1 and 2
- Construction of a new third main track in CTC territory with several track shifts, changes to several grade crossings, several culvert extensions, a new bridge over Rice Creek, and a new bridge over Mississippi Street between CP Coon Creek and CP Interstate
- Expansion of the existing CTC control point at MP 16.3 to accommodate the proposed new third main track as well as new #24 crossovers between main tracks
- Expansion of the existing CTC control point at CP Interstate to accommodate the new third main track including new #24 crossovers connecting main tracks at the west end of Northtown Yard
- Industry track changes to accommodate the new third main track between CP Coon Creek and CP Interstate
- Removal of existing signals and construction of new signals at several locations and other signal/PTC changes to accommodate the proposed new track work.

3.9. Third Main Track CP Interstate to CP Van Buren

The third main track from CP Interstate to CP Van Buren would be needed to maintain dependable and/or expanded Northstar commuter train operations through the highly congested main track corridor around and east of BNSF's Northtown Yard. When connected to the CP Coon Creek to CP Interstate segment, this third main track would extend from CP Coon Creek, through CP Interstate, past Northtown Yard, through CP 35th Street to CP Van Buren, without a connection to the congested control point at Mississippi Street. The east half of this third main track segment is currently in use by trains moving to and from the Canadian Pacific Railroad's main tracks that cross over Northtown Yard on an elevated right-of-way. Figure 11 presents the third main track improvements between CP Interstate and CP Van Buren.

Figure 11: Third Main Track CP Interstate to CP Van Buren

Proposed improvements include:

- Construct new turnout in CP Interstate to connect the western segment of the third main track to the Interstate-Van Buren segment.
- Conduct right-of-way preparation and construct a new third main track in CTC territory between CP Interstate and CP 35th Street and join the recently constructed BNSF-CP connecting track that extends from CP 35th Street to CP Van Buren to complete a third main track between approximately MP 16.3 and MP 10.5.
- Remove and replace industry track turnouts and shift industry tracks as necessary to enable construction of proposed new third main track and maintain industry track functionality.
- Construct new signals, remove some existing signals, and make other signal/PTC changes required to accommodate the proposed new track work.
- Relocate communications facilities to accommodate the new third main track

3.10. Two Main Tracks CP Van Buren to CP Stadium

Constructing a second track between CP Harrison and CP Van Buren and upgrading the auxiliary track to main track between CP Stadium and CP Harrison would provide additional track and signal capacity and operating flexibility (effectively two main tracks) between CP Stadium and CP Van Buren. The two main tracks would enable simultaneous passenger and freight train movements and increase freight train operating speeds in this bottleneck segment immediately outside Target Field Station. The added capacity and additional flexibility would support service dependability for Northstar commuter trains and reduce delays and transit time for freight trains. Figure 12 presents the improvements.

Figure 12: Two Main Tracks CP Van Buren to CP Stadium

Proposed improvements include:

- Construction of a new second west wye track between CP Van Buren and CP Harrison Street with minor track shifts of the existing leg of the wye between the two points
- Extension of CP Van Buren east to accommodate the new second west wye track including adding and removing several signals for this control point
- Reconfiguration of the siding on the Midway Subdivision between CP Van Buren and the Wayzata Subdivision connection to enable major track changes to the tracks within the "Friends of the 261" facility inside the wye at Minneapolis Junction. The proposed track changes were required to accommodate the new second leg of the wye between CP Van Buren and CP Harrison Street
- Reconfiguration of CP Harrison Street to provide parallel connections between the Wayzata Subdivision main track, the Wayzata Subdivision auxiliary track east of Harrison Street, and the

two legs of the west wye between Harrison Street and CP Van Buren. The reconfiguration provides two parallel tracks between CP Stadium and CP Van Buren

- Reconfiguration of the east wye connection (Wayzata Sub. main track) and the industry track near Central Avenue at CP Harrison Street to accommodate the west wye changes
- Construction of new #20 power-operated universal crossover on the east end of CP Harrison Street to enable trains using either of the two Wayzata Subdivision tracks to reach any of the three wye tracks (2 west and 1 east) at Harrison Street (Minneapolis Junction)
- Upgrade of the auxiliary track between CP Harrison Street and CP Stadium with 66% tie replacement and surfacing to increase train speeds on that track segment
- Grade crossing improvements and signal/PTC changes (including the removal of several existing signals and construction of several new signals and other signal/PTC changes) to accommodate the proposed new track work

4. Presentation of Capital Costs by Service Alternative

Table 4 provides an overview of the capital improvements needed for each Service Alternative. Cells in blue indicate improvements needed for initial operation and orange cells indicate improvements needed by 2040.

Table 4: Capital Improvements by Service Alternative

Improvements Needed for Initial Operation Improvements Needed by 2040	Minimum Service Alternative	Minimum Bi directional Alternative	Northstar Express Alternative	Bi Directional Alternative
Overhead and Equipment Costs				
Upgrade Fare Collection Systems				
Acquire one additional Northstar trainset				
Expand Big Lake Maintenance Facility				
Station Improvements				
Extend and connect Big Lake Station spur track to the north				
Build station siding at St Cloud Station				
Construct center through platform at Big Lake Station				
Control Points, Crossovers and Sidings				
Upgrade existing universal crossover east of St Cloud station				
Install new CTC Control Point and universal crossover west of St Cloud station				
New CTC Control Point at Becker				
Upgrade Universal Crossover in CTC Control Point MP 66				
Big Lake West Siding				
Additional Mainline Track				
Third Main track CP Coon Creek to CP Interstate				
Third Main Track CP Interstate to CP Van Buren				
Second Main Track CP Van Buren to CP Stadium				

The subsections below present the capital costs by Service Alternative for initial operation and by 2040. All costs are shown in 2025 dollars.

4.1. Minimum Service Alternative

Table 5 presents the capital improvements needed for the Minimum Service Alternative for initial operation and by 2040.

Table 5: Capital Costs for Minimum Service Alternative

Capital Improvements	Cost for Improvements Needed for Initial Operation (2025$)	Cost for Improvements Needed by 2040 (2025$)
St. Cloud Improvements	$25.9 million	$25.9 million
New Becker CTC Control Point		$7.8 million
Big Lake Station Track Connection	$9.6 million	$9.6 million
Third Main Track CP Coon Creek to CP Interstate		$76.5 million
Two Main Tracks CP Van Buren to CP Stadium		$19.2 million
Total	**$35.6 million**	**$139.0 million**

4.2. Minimum Bi-Directional Service Alternative

Table 6 presents the capital improvements needed for the Minimum Bi-Directional Service Alternative for initial operation and by 2040.

Table 6: Capital Costs for Minimum Bi-Directional Service Alternative

Capital Improvements	Cost for Improvements Needed for Initial Operation (2025$)	Cost for Improvements Needed by 2040 (2025$)
St. Cloud Improvements	$25.9 million	$25.9 million
Upgrade Universal Crossovers at CP MP 66		$7.6 million
New Becker CTC Control Point		$7.8 million
Big Lake Station Track Connection	$9.6 million	$9.6 million
Big Lake Station Expansion	$31.1 million	$31.1 million
Big Lake Maintenance Facility Expansion	$8.0 million	$8.0 million
Third Main Track CP Coon Creek to CP Interstate		$76.5 million
Two Main Tracks CP Van Buren to CP Stadium		$19.2 million
Equipment Procurement	$21.0 million	$21.0 million
Total	**$95.6 million**	**$206.7 million**

4.3. Northstar Express Service Alternative

Table 7 presents the capital improvements needed for the Northstar Express Service Alternative for initial operation and by 2040.

Table 7: Capital Costs for Northstar Express Service Alternative

Capital Improvements	Cost for Improvements Needed for Initial Operation (2025$)	Cost for Improvements Needed by 2040 (2025$)
St. Cloud Improvements	$25.9 million	$25.9 million
Upgrade Universal Crossovers at CP MP 66		$7.6 million
New Becker CTC Control Point		$7.8 million
Big Lake Station Track Connection	$9.6 million	$9.6 million
Big Lake Maintenance Facility Expansion	$8.0 million	$8.0 million
Third Main Track CP Coon Creek to CP Interstate	$76.5 million	$76.5 million
Third Main Track CP Interstate to CP Van Buren		$14.0 million
Two Main Tracks CP Van Buren to CP Stadium		$19.2 million
Equipment Procurement	$21.0 million	$21.0 million
Total	**$141.0 million**	**$189.6 million**

4.4. Bi-Directional Service Alternative

Table 8 presents the capital improvements needed for the Bi-Directional Service Alternative for initial operation and by 2040.

Table 8: Capital Costs for Bi-Directional Service Alternative

Capital Improvements	Cost for Improvements Needed for Initial Operation (2025$)	Cost for Improvements Needed by 2040 (2025$)
St. Cloud Improvements	$25.9 million	$25.9 million
Upgrade Universal Crossovers at CP MP 66	$7.6 million	$7.6 million
New Becker CTC Control Point	$7.8 million	$7.8 million
Big Lake West Siding		$36.2 million
Big Lake Track Connection	$9.6 million	$9.6 million
Big Lake Station Expansion	$31.1 million	$31.1 million
Big Lake Maintenance Facility Expansion	$8.0 million	$8.0 million
Third Main Track CP Coon Creek to CP Interstate	$76.5 million	$76.5 million
Third Main Track CP Interstate to CP Van Buren		$14.0 million
Two Main Tracks CP Van Buren to CP Stadium		$19.2 million
Equipment Procurement	$21.0 million	$21.0 million
Total	**$187.5 million**	**$256.8 million**

Northstar Commuter Rail Extension Feasibility Assessment

Appendix I – Technical Memorandum on Capital Cost Estimating Methodology

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

by

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This document provides a written methodology for establishing unit costs for pay items related to the proposed extension of the Northstar commuter rail corridor. This methodology serves as a basis for the formulation of conceptual cost estimates for the proposed Service Alternatives.

The cost estimates were developed at a conceptual level based on limited information regarding overall track, signal, Positive Train Control (PTC), and infrastructure conditions; railroad operations; and input from the owning railroad. The validity of the capital cost estimates rests on the assumptions and information gained from available railroad track charts and timetables; aerial mapping; input from BNSF, Minnesota Department of Transportation, and Metro Transit; and visual observations of the railroad made from publicly accessible locations. The methodology serves as a starting point for the continuing development of costs associated with the proposed extension of Northstar commuter rail service to St. Cloud.

2. Development of Unit Costs

The unit costs used to estimate capital costs for the Northstar Commuter Rail Extension Feasibility Assessment were developed over time from detailed breakdowns of the units into their basic elements. The costs related to material, labor, equipment and overhead for these elements were accumulated and rolled up to provide an inclusive unit cost for the various components required to develop a passenger rail system. Initially, the unit costs were developed for planned construction in the Midwest as part of the Midwest Regional Rail Initiative. Later, the costs were applied to capital cost estimates for high-speed rail in Florida, Ohio, Minnesota, and Colorado. The unit costs have been refreshed and refined periodically to update for inflation and changes in the approach to infrastructure development and technology. The unit costs were updated and modified for the proposed extension of Northstar commuter rail service to St. Cloud.

For this cost methodology, the unit costs were updated to 2020 dollars using an inflation factor of 1.09 obtained from the Bureau of Economic Analysis's Table 1.1.9. Implicit Price Deflators for Gross Domestic Product from 2014 to 2020[1]. The overall cost of the capital improvements was presented in both 2020 and 2025 dollars, the latter of which was calculated using Federal Railroad Administration's (FRA's) Standard Cost Category and inflation worksheet[2].

Unit costs presented in this methodology include allocated contingencies but exclude professional services fees and unallocated contingencies. Once the cost for each capital improvement is calculated, the professional services fees and unallocated contingencies are added.

The revised base set of unit costs addresses typical passenger rail infrastructure construction elements expected to be found within the proposed Northstar corridor including roadbed and trackwork, signal and PTC systems, facilities, structures, and grade crossings. The unit costs are reasonable for developing

[1] https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=3&isuri=1&nipa_table_list=13
[2] https://railroads.dot.gov/elibrary/mp-33-scc-worksheets

the capital costs under either normal contractor bidding procedures or under railroad force account agreements for construction.

3. Cost Categories

3.1. Trackwork

Currently, Northstar commuter rail service, Amtrak intercity passenger rail service, and BNSF freight operations occur over track complying with FRA Classes I through 4, allowing maximum speeds of 60 MPH for freight and 79 MPH for passenger trains. Other freight carriers also operate over several segments of BNSF track in the corridor. No changes in the maximum authorized speeds for trains operating in the corridor are included as part of the proposed extension of Northstar commuter service to St. Cloud. In some segments of the corridor, trains operate at lower speeds due to design or operating characteristics. Increased track speeds through certain turnouts and crossovers, achievable by upgrading the trackwork to higher speed configurations within the existing track standards, is proposed for several locations to increase corridor capacity. New track and special trackwork, as well as upgraded track, are proposed as part of the Northstar extension to increase corridor capacity and improve operating flexibility.

3.1.1. Design Considerations

- Maximum speed for all service alternatives is 79 mph for passenger trains and 60 mph for freight trains (FRA Class 4).
- Additional main track, new or upgraded existing tracks, new or upgraded CTC/PTC control points, and other improvements are proposed where shown to be necessary by Rail Traffic Controller™ (RTC) operations analysis to accommodate additional freight trains as well as extended and/or an additional number of Northstar commuter trains.
- Fencing will be provided at certain locations along the length of the route.
- For existing private crossings, no change is anticipated in the crossing warning devices.
- Public crossings, where an additional track will be constructed through the crossing, will have the existing grade crossing warning equipment on the affected side(s) relocated and, where applicable, the median removed and extended to accommodate the additional track. Widening, approach gradient surface modifications, and the extension of culverts are also included.

Where new track will be constructed, the primary unit of cost will be “New Track”. This unit is based on BNSF typical sections and is composed of the following:

- New 136 or 141 lb. Continuous Welded Rail
- 7” x 9” x 8’6” timber crossties spaced at 19.5” C-C, which results in 3249 per mile
- Two-13” double shouldered tie plates, four rail anchors, and eight track spikes (or corresponding rail seats and elastomeric fasteners) per tie.
- 12” of Granite ballast (AREMA #4) placed to support the proper vertical and horizontal track alignment. Depth of ballast is measured at the center of the tie. Additional ballast will be placed to fill the cribs between the ties and provide a ballast shoulder on the outside of each tie per the typical section required by the owning railroad.

3.1.2. Track on Existing Roadbed

Track on Existing Roadbed addresses the installation of a new track on an existing roadbed within an existing railroad right of way where track(s) has been removed. If there is an existing track present in the right of way, the new track will be built at an appropriate distance from it, generally using the same track centers as had been used before the historic second track had been removed. The track center to center distance is typically 14'. If there is no track in place, the new track will generally be centered in the right of way per the operating railroads typical track section. The work consists of leveling the roadbed, maintaining existing drainage, and placing a 6" ballast pad prior to track construction. Track will be constructed on this base and the remaining 6" required ballast will be installed to allow final alignment and surfacing of the new track. The unit cost for this item is $1,563,200 per mile.

3.1.3. Track on New Roadbed

This unit was used for proposed track on an existing embankment where the roadbed is replaced. The work consists of removing the existing roadbed and placing 12" of sub-ballast. Track will then be constructed on this base. The unit cost for this item is $1,847,600 per mile.

3.1.4. Track on New Roadbed & New Embankment

This unit was used for proposed track where no track or railroad right of way is present, or when the required track center distance to an existing freight operation places the proposed new track outside the limits of the existing roadbed and/or right of way limits. The work consists of site clearing the full width of additional roadbed or right of way (a minimum of 25 feet in width for single track and 50 feet in width for double track), preparing the subgrade (up to 5 feet above the surrounding ground elevation), establishing drainage patterns or maintaining existing drainage, and placing 12" of sub-ballast. Track will then be constructed on this base. The unit cost for this item is $2,114,900 per mile.

3.2. Turnouts & Crossovers

This work includes:

- Removal and reclamation of the existing standard track or turnout/crossover section where the new turnout or crossover will be placed.
- Leveling of the roadbed and removing & stockpiling excess ballast for re-use.
- Installation of a switch panel (or assembly and installation of a switch package) which includes all rods, plates, anchors, fasteners, 136/141 lb rail, switch points, stock rails, frog and wood or concrete ties and field welds to place the turnout into operation.
- Ballast – placed to ensure 12" under the ties.
- Filter fabric for the footprint of the turnout to be installed.
- Track surfacing to ensure proper vertical and horizontal alignment of the turnout or crossover and the track that it is connected to.
- Provision of a measure to protect the operating components of the turnout from freezing due to snow and ice: these include but are not limited to hot or cold air blowers and electric cal-rod heaters.
- Crossovers will include a section of track (after the frogs of each turnout) with special timbers used until the track separates enough to allow standard "New Track" to be constructed

completing the connection between the opposite ends of the crossover. The length of the "New Track" will depend on the distance between the centerlines of the tracks to be connected.

The various types of turnouts to be used are:

- #24 Turnout - Timber Ties – The unit cost for this item is $637,900 each.
- #20 Turnout – Timber Ties – The unit cost for this item is $229,400 each.
- #15 Turnout – Timber Ties – The unit cost for this item is $184,900 each.
- #11 Turnout – Timber Ties – The unit cost for this item is $161,300 each.
- #9 Turnout – Timber Ties – The unit cost for this item is $146,100 each.
- 16'6" Double Switch Point Derail – Timber Ties – The unit cost for this item is $73,000 each.
- Hand-Operated Sliding Derail – Timber Ties – The unit cost for this item is $1,500 each
- Switch Point Derail – The unit cost for this item is $36,500 each.
- #24 Crossover – The unit cost for this item is $1,329,700 each.
- #20 Crossover – The unit cost for this item is $1,006,600 each.
- #15 Crossover – The unit cost for this item is $463,100 each.

3.3. Track Improvements

Based on the above discussion, several categories of track improvements and types of track construction have been developed. Track improvements include:

3.3.1. Track Shift

This work consists of lining and relocating the track as indicated in the concept plans. Work includes adjusting the horizontal and vertical alignments. The unit cost for this item is $153,300 per mile.

3.3.2. Tie & Surface w/ 66% Tie Replacement

This work consists of removing 2/3 of the ties and replacing them with new ties. Additionally, 600 tons of ballast per mile will be placed in the work area to support the tie renewal. Assuming 19.5" tie spacing and 3,249 ties per mile, this would result in the renewal of 2,166 ties per mile. The unit cost for this item is $469,200 per mile.

3.4. Site Work Related to Track Construction

3.4.1. Fencing, 6 ft Chain Link (both sides of the railroad right of way)

This work includes the installation of 6 ft galvanized steel chain link right-of-way fencing. Included in the cost are the fencing and post materials, clearing and grubbing of the area at the right-of-way line, and installation costs. The unit cost for this item is $149,900 per mile.

3.4.2. Drainage Improvements (cross country)

This work includes the installation of drainage pipe, assumed to be a maximum of 30" in diameter, at locations where new track or track sidings will be installed and/or embankment widened. It is assumed that 2 drainage pipes per mile of improvements will be installed. The unit cost for this item is $81,400 per mile.

3.4.3. Remove Existing Turnout or Crossover

Work consists of removal of complete turnout or crossover from head block ties to last long tie at locations where existing turnout or crossover is to be returned to straight track. Restoration of the parent track is not included in this pay item and is accounted for as "New Track" at the appropriate unit cost per mile. The unit cost for Remove Existing Turnout is $8,700 each and Remove Existing Crossover is $17,400 each.

3.4.4. Clearing and Grubbing

Clearing consists of removing and disposing of all obstructions such as fences, walls, foundations, buildings, accumulations of rubbish of whatever nature, and existing structures. The cost also includes removal of all logs, shrubs, bushes, saplings, grass, weeds, other vegetation, and stumps of a diameter less than 6 inches. The unit cost also includes tree removal, which consists of cutting, grubbing, removal, and disposal of trees and stumps. The unit cost for this item is $2,100 per acre.

3.4.5. Removal of Track on Existing Roadbed

This work consists of removing and disassembling existing track and stockpiling of removed rail and other track material. The cost includes all costs for handling, loading, hauling, and stockpiling of the scrap rail and track material and blading the remaining roadbed so that its surface is smooth and sloped to drain surface water. The unit cost for this item is $12 per track-foot.

3.4.6. Removal of Bumping Post

This work consists of removing a steel bumping post from the rails at the end of the track at Big Lake Station. The unit cost for this item is $1,000 each.

4. Structures

Structures expected for the extension of Northstar commuter rail service include bridges that carry the railroad over a river; these bridges are categorized as “undergrade”. Bridges that carry an environmental feature over a railroad, for instance, a two-lane highway, are categorized as “overhead”. Additionally, other structures such as structural culverts and retaining walls are included in this section. The type size and location of these structures will be determined during Preliminary Engineering; for these conceptual cost estimates, general categories of structures, and their unit costs have been developed based on their function and an estimate of required cross section and approximate cost per square foot and are listed below. These costs are for the structures and their typical components only; the cost of any track features is priced separately.

4.1. Design Considerations

General design considerations have been established to guide conceptual planning and are listed below.

- Bridges generally include superstructure, substructure, appropriate wing walls and embankment retention systems, and approach treatments in both directions from the bridge
- In areas where the proposed service will travel under existing bridges carrying highway, railroad or pedestrian traffic over the alignment, the addition of a new track at various track centers may be infeasible due to insufficient portal opening to accommodate the new track. In these instances, the overhead bridge will be replaced to accommodate the proposed alignment.

   - In some cases, it may be possible to modify the piers, abutments and other structural features of the existing overhead bridge to accommodate the new track. However, the extent to which this will be possible requires more a more detailed engineering study which is not conducted at the conceptual level. Since that is the case, a conservative assumption is made that unless there is a clear indication that the existing portals will allow the construction of a new track or tracks, the overhead structure will be replaced.
- In areas where the proposed alignment prevents the use of existing bridges or where there are no existing bridges, new bridges will be built as needed.

4.2. Bridges – Undergrade

This group of unit costs is intended to capture the level of effort required to allow the addition of a new track parallel and adjacent to an existing track as it passes over a variety of obstacles in the environment. Generally, the work will include provision of new abutments or abutment extensions, necessary grading and earth retention system to control the embankment at the abutments, any new piers or pier modification necessary and the placement of a new superstructure and track on the substructure at these locations.

- <u>Four Lane Urban Expressway</u> - The unit cost for this item is $6,853,600 each.
- <u>Minor River</u> – generally, this bridge type is less than 100’ between abutments with relatively short span lengths. The unit cost for this item is $1,148,200 each.

4.3. Other Structures

4.3.1. Culvert Extensions

This work includes the installation of a culvert extension in locations where a new track will be built parallel and adjacent to an existing track. The culvert extension consists of a new pipe starting at the end of the existing culvert and extending to the edge of the embankment that the new track will be built upon. The cost includes connection to the existing pipe, associated grading, headwall and embankment retention associated with the culvert. It is assumed that the extension will consist of a maximum size of 36” reinforced concrete pipe. In some segments, the number of existing culverts is known. In those segments, the actual number of culverts will be estimated. In others, one culvert extension will be installed per mile of improvements on average. The unit cost for this item is $72,700 per mile.

5. Systems

In all instances where a new track and/or Control Point (CP) are proposed on the mainline, a Centralized Traffic Control (CTC) signal system and PTC signal system must be installed. The CTC and PTC systems will be designed by BNSF during Preliminary Engineering.

5.1. Design Considerations

General design considerations have been established to guide conceptual planning and are listed below.

- All signal elements include hardware and software to design, procure, install and operate the element under consideration. This includes “signals”, “communications” & “dispatch” components which together make up the interactive remote-controlled signal system.

- At all locations where a train can change from one track to another or divert from the main track to a siding, yard, or railroad using remote-controlled switches, a CP must be established. The CP links the track infrastructure and circuitry to a communications network allowing the dispatcher to maintain or change the route of a given train, as well as allow it to proceed or cause it to stop. Significant components are the remote-controlled powered switch machine, cable connecting it to logical and relays and microprocessor-based control and communication equipment housed in a wayside building, a communications link between the control point and the remote dispatcher, signals to provide a train approaching from any direction with visual indications governing its movement, and a provision of commercial electrical power and backup to operate the various elements.
- At locations where a connection to a rail-served industry is required outside of a CP, protection must be provided so that a freight or passenger train cannot be unintentionally diverted into the industry track and also so that a railcar or other vehicle occupying the siding cannot access the main track without permission from the dispatcher controlling the main line railroad. Typically, at these locations, a switch is installed and "electric lock" protection is provided at the switch. Along the siding, a derail is placed as a measure to prevent an uncontrolled movement from the siding to the main or vice versa. The electric lock prevents opening the switch without the knowledge of and direct permission from the dispatcher in charge of the railroad. When the switch is opened, the track circuitry "notifies" the dispatcher and wayside signals in either direction.

5.2. Assumptions

It is assumed that BNSF uses Wabtec's Electronic Train Management System (ETMS) PTC technology throughout the Northstar corridor. ETMS uses Global Positioning Systems (GPS), in tandem with digital radio, to monitor train speeds and locations. This system was designed to prevent train collisions, restrict trains from operating above allowable speed limits, and avoid speed related derailments. To maintain BNSF's operational safety and abide by FRA's PTC requirements, ETMS was included in capital infrastructure estimates produced for the Northstar Commuter Rail Extension Feasibility Assessment.

Unit costs were developed specifically for this Feasibility Assessment using estimated PTC costs from an intercity passenger rail program whose system was designed to be compatible with BNSF's ETMS PTC technology. The Northstar estimate was prepared with enough detail in the unit cost build-up to enable railroad stakeholders to understand the proposed PTC elements. Generally, each unit cost includes the price of materials and installation, costs for the railroad to complete wayside engineering and detailed location design, and costs to update the Subdivision file, ITCM communications, and dispatch office. A complexity factor was assigned to each cost element to account for the increased labor required to update the Subdivision file, ITCM communications, and dispatch office. Attachment 1 provides the breakdown of PTC/CTC unit costs.

5.3. Systems Categories

5.3.1. New PTC/CTC Control Point

New PTC/CTC CPs are established where new crossovers or turnouts are proposed outside of an existing CP. The unit cost includes all communications and central dispatch equipment, track circuitry, and wayside signaling to control the flow of rail traffic. Wayside signaling includes signals, signal masts/cantilevers/bridges, power-operated switch machines, hardware, software, controllers, wiring/cabling, hot air blowers, cabinets, housings, and commercial power. The unit cost also includes costs for PTC system design and location design (back-office work) by the railroad. New PTC/CTC CPs are proposed at the following locations:

- CP West St. Cloud (MP 75.0) – unit cost is $1,827,700 Lump Sum.
- CP Becker (MP 57.2) – unit cost is $1,336,000 Lump Sum.
- CP Big Lake West for Big Lake Track Connection (MP 47.1) – unit cost is $1,550,800 Lump Sum.
- CP MP 20.1 – unit cost is $1,659,700 Lump Sum.

5.3.2. *Modified PTC/CTC Control Point*

Modifications occur to PTC/CTC CPs when new crossovers or turnouts are added to an existing CP. A CP can also be modified for the addition of a signal, relocation or replacement of a signal, or addition of an electric lock or derail. In general, the unit cost includes new wayside signaling (described under Section 5.3.1) for the signal elements proposed for each CP. Where significant modifications are made to the existing CP, new wayside equipment (housing, cables, utility poles, utility service, PTC antenna, equipment racks, batteries, vital and non-vital relays, etc.) is included in the cost. PTC/CTC CPs are proposed to be modified at the following locations:

- CP St. Cloud (MP 73.6) – new wayside equipment, signal work for two new crossovers and 3 new turnouts, one electric lock and derail with track circuit, four new signals, and one two-track signal cantilever – unit cost is $2,162,800 Lump Sum.

- CP MP 66 – new wayside equipment, signal work for two new crossovers, and two new signals – unit cost is $1,094,200 Lump Sum.

- CP MP 52.8 – signal work for one new turnout and one three-track signal bridge – unit cost is $435,600 Lump Sum.

- CP Big Lake West for Big Lake West Siding (assumes Big Lake Station Track Connection has been constructed) – signal work for two new crossovers and one turnout, one derail, and four new signals – unit cost is $1,117,700 Lump Sum.

- CP Coon Creek (MP 21.1) – new wayside equipment, signal work for three crossovers, new three-track signal bridge – unit cost is $1,532,500 Lump Sum.

- CP MP 16.3 – new wayside equipment, signal work for two new crossovers, and one three-track and one four-track signal bridge – unit cost is $1,434,700 Lump Sum.

- CP Interstate – new wayside equipment, signal work for one new crossover and one new turnout, one new derail, one new signal, and two four-track signal bridges – unit cost is $1,470,200 Lump Sum.

- CP Interstate for Third Main CP Interstate to CP Van Buren (assumes third main from CP Coon Creek to CP Interstate has been constructed) – two new electric locks and derails with track circuit – unit cost is $243,000 Lump Sum.

- CP 44th Avenue – signal work for one new turnout, one new derail, one new signal, and two new three-track signal bridges – unit cost is $693,200 Lump Sum.
- CP 35th Avenue – one new electric lock and derail with track circuit, one new signal, and one new three-track signal bridge – unit cost is $358,700 Lump Sum.
- CP Van Buren – one new turnout, one new electric lock and derail with track circuit, and two new signals – unit cost is $483,000 Lump Sum.
- CP Harrison St. – new wayside equipment, signal work for two new crossovers and two new turnouts, one new derail, and four new signals – unit cost is $1,751,200 Lump Sum.

5.3.3. Modified Intermediate Signal with PTC/CTC

Where a proposed third track is constructed through an existing intermediate signal location, modifications occur to the signal location to accommodate the new track. Modifications include installation of an additional signal to govern the new track and installation of a new bungalow and antenna, if necessary. Modifications are proposed for the following intermediate signal locations:

- MP 50.8 – unit cost is $58,400 Lump Sum.
- MP 49.5 – unit cost is $195,800 Lump Sum.
- MP 18.4 – unit cost is $58,400 Lump Sum.

5.3.4. Industry Turnout (Signal Work)

In several locations, existing track is proposed to be realigned at industry turnouts. When this occurs, the industry turnout is relocated and new electric locks with derails are installed. This unit cost includes costs for the electric lock and layout, the wayside case, foundation, and components within the case, commercial power and power connection materials, track connections, the derail, battery, battery box, and all wire connections. Additionally, the work includes intermediate signal modifications and track circuit modifications to tie the new Electric Lock Switch location into the existing signal system. Industry turnout signal work is proposed at the following locations:

- MP 19.64 – unit cost is $122,500 Lump Sum.
- On BNSF Midway Sub – unit cost is $239,600 Lump Sum.

6. Grade Crossings

The treatment and design of improved safety and warning devices will need further development to identify specifications and various approaches that may be advanced as part of an integrated program.

6.1. Design Considerations

For the purpose of establishing a reasonable cost estimate at the conceptual design stage, the following design parameters are proposed:

- Train warning systems will be upgraded to standard two quadrant gates and flashers with constant warning time for public at-grade crossings
- Precast crossing surface panels will be installed at all public crossings on existing track at locations where trackwork related to passenger service takes place

- Precast crossing surface panels will be installed on both new and existing tracks and the roadway will be re-profiled where new track is constructed through the crossing

6.2. Crossing Improvement Categories

6.2.1. Conventional Gates/single mainline track

6.2.2. Conventional Gates/double mainline track

6.2.3. Conventional Gates/triple mainline track

Work to install conventional gates for a single, double, or triple mainline track includes all hardware, software, wiring, communication equipment and commercial power with battery backup to operate the warning system. Where grade crossing warning devices are proposed to be relocated due to a track shift at a two-track crossing, the existing grade crossing warning devices are replaced with Conventional Gates/double mainline track. Where a third track is proposed to cross an existing two-track crossing, the existing grade crossing warning devices are replaced with Conventional Gates/triple mainline track. Additional measures include the installation of <u>Manual on Uniform Traffic Control Devices</u> (MUCTD) -approved signs that specify "2 TRACKS" or "3 TRACKS" located on the same post as the crossbucks. Pedestrian gates are not included in this unit cost and are accounted for as "Pedestrian Gates" at the appropriate unit cost per gate. The unit costs for conventional gates are $213,600 each for single track, $290,800 each for double track, and $305,400 each for triple track.

6.2.4. Install Median

Where a third track is proposed to cross an existing two-track crossing with medians along the approach roadway, the existing median is removed, and a new 100-foot concrete median installed. The unit cost is $13,100 each to install a median.

6.2.5. Precast Panels

This work includes installing prefabricated concrete and steel crossing surface panels at a grade crossing. The crossing panels are placed within the track structure at the crossing to form a smooth running surface for vehicular traffic. The top surface of the panel will be level with the top of rail. The width of the crossing treatment will include and extend beyond associated sidewalks if present. At a minimum, the crossing panels will extend 2' beyond the paved roadway surface or sidewalk. The unit costs for this item is $112,800 each.

6.2.6. Minor Roadway Improvements at Grade Crossing

Roadway crown and superelevation in the approach pavement will be eliminated at or tapered into the crossing to match the grade and profile of the track. Additionally, the elevation of the approach pavement will be reconstructed to equal the top of rail for a minimum of 2 ft beyond the outer rail of the outermost track in each direction. Finally, the roadway surface must be within +/- 3" of the top of rail at a distance of 30' from the outermost rail unless track superelevation dictates otherwise. The unit cost for this item is $27,300 each.

6.2.7. Pedestrian Gate

Pedestrian gates are proposed where existing sidewalks approach a public track crossing. The unit cost includes a pedestrian gate, flashing lights, the hardware, software and wiring needed to connect the gate to the grade crossing warning device system. These items would be installed as a supplement to the "Conventional Gates/single mainline track", "Conventional Gates/double mainline track", or "Conventional gates/triple mainline track". The unit cost for this item is $70,900 each.

7. Allocations for Special Elements (Placeholders)

The methodology includes placeholders as conservative estimates for large and/or complex engineering projects that have not been estimated on the basis of unit costs and quantities. Placeholders are used where detailed engineering requirements are not fully known and provide lump sum budget approximations based on expert opinion rather than on an engineering estimate. These approximations will require close attention as the project moves through further phases of development.

The following list highlights some of the key Special Elements that are assumed in this analysis.

7.1. Special Elements

7.1.1. Big Lake Maintenance Facility

The Big Lake Maintenance Facility currently accommodates the existing Northstar fleet of locomotives and commuter passenger cars on its tracks, some of which are inside shop buildings. The facility is currently completing an expansion of track and facilities inside the main shop building to increase its ability to handle repairs and maintenance. The improvements include the installation of a drop table facility that enables shop forces to replace the wheel sets on commuter passenger cars.

Three of the four service alternatives require an additional Northstar trainset consisting of one locomotive and four commuter passenger cars, but the facility does not have adequate track space to accommodate this additional trainset. Therefore, a new outside storage and servicing track is required to accommodate this trainset. The improvement would be constructed on improved land within the limits of the facility that was originally designed to accommodate a future expansion. The new track includes a turnout connected to the shop lead tracks on each end and an extension of the east lead track to provide the capability for one complete trainset to move to and from the new track on the east lead track and other tracks in the facility.

The following utilities and components enable the track to be used to service and store trains during their layovers:

- Paved roadways on both sides of the track to enable employees and service vehicles to access both sides of the train for inspection, maintenance and servicing;
- 480-volt AC standby power connections to provide electrical power to the locomotive and cars when the locomotive is shut down so that employees can service the train;
- Compressed air connections to supply the parked train with compressed air to maintain air brake pressure and auxiliary train functions that depend on air when the locomotive is shut down;
- Drip pan facilities in the track at the location where the locomotive will stand when parked;
- Electrical drop connections to enable the use of power tools and electrical equipment as needed;
- Overhead lighting to both sides of the track since most work on the trains will be done at night;
- Water connections and drainage facilities to keep the track and paved surfaces free of standing water; and
- Derails and blue signal equipment at each end of the track required to protect workers when trains are being serviced.

The unit cost for the Big Lake Maintenance Facility only includes the elements in the list above. The total cost for the BLMF expansion includes track work and turnouts, which are captured under unit items for “New Track” and “Turnout”. Since a detailed engineering estimate of these improvements was not made in the field, cost estimates for the various construction elements for the storage track were based on costs recently experienced for similar improvements planned or constructed at other railroad facilities.

The unit cost for this item is $2,589,100 Lump Sum.

7.1.2. Big Lake Station Expansion

The Big Lake Station Expansion consists of a single new center platform to be constructed between BNSF Main Tracks 1 and 2 adjacent to the existing Northstar station platform which is located on the station stub track at Big Lake. The new platform would be constructed in a manner consistent with other Northstar station facilities including specifically:

- Platform shelter with lighting, heated areas, Northstar signage and ticketing machines;
- A stairway/elevator tower from the new platform to reach an enclosed, heated and lighted overhead pedestrian walkway to reach the existing Big Lake Northstar station platform;
- A stairway/elevator tower on the existing platform connecting to the overhead walkway;
- Compliance with Americans with Disabilities Act (ADA), BNSF, Metro Transit and other applicable standards;

The unit cost for the Big Lake Station Expansion only includes the elements in the list above. The total cost for the station expansion includes track work, turnouts, and grade crossing work, which are captured under unit items for “New Track”, “Conventional Gates”, “Install Median”, “Precast Panels”, and “Minor Roadway Improvements”. A lump sum estimate from the recent construction of the new Northstar station at Ramsey was provided by BNSF and was used to estimate the approximate cost of the platform, stairway/elevator towers, overhead walkway, and other amenities for the station expansion itself.

The unit cost for the Big Lake Station Expansion is $15,000,000 Lump Sum.

7.1.3. St. Cloud Station Improvements

The St. Cloud Station improvements to accommodate Northstar trains originating and terminating at St. Cloud are needed to enable arriving westbound Northstar trains to clear the main track at St. Cloud to detrain passengers, change ends, make the required pre-departure tests for the eastbound trip, board passengers and/or layover until the eastbound train's departure time. The improvement frees up BNSF main tracks 1 and 2 at St. Cloud for the operation of freight trains and allows Amtrak trains in both directions to move to and from the Amtrak platform on Track 2 directly in front of the existing St. Cloud depot. The improvement, when used in combination with a new control point proposed at West St. Cloud, and the upgrading of the existing control point east of the St. Cloud station, are critical features needed to keep train traffic fluid on the Staples Subdivision while accommodating the Northstar service extension to St. Cloud.

The St. Cloud Station improvements include:

- Construction of a new station track south of BNSF Main Track 2 immediately west of the existing Amtrak platform at the depot. The track would be long enough to accommodate a Northstar commuter train;
- Power-operated turnouts and associated signals governing movements to and from the new station track and modifications to the existing control point at St. Cloud to accommodate the new track and signals;
- New station platform along the new station track compliant with ADA, BNSF, Metro Transit and other applicable standards;
- New commercial power drop, electrical substation, 480-volt AC standby power connections and drip pan at the west end of the station track to enable Northstar trains with longer layovers to shut down the locomotive during the layover;
- Platform connection to the existing St. Cloud depot;
- Removal of industry track turnout on BNSF Main Track 2 and removal of connection to west wye track west of the station to enable construction of the station track; and
- Construction of a new turnout and grade crossing improvements on the new industry track connection from the west wye track to serve the industry track from the other end.

Unit costs were used to estimate the cost of track, platform, and grade crossing improvements. A detailed engineering estimate of these improvements was not made in the field. Cost estimates for the various construction elements for the St. Cloud station track platform and associated improvements were based on costs recently experienced for similar improvements planned or constructed at other railroad facilities.

The unit cost for the St. Cloud Station Improvements is $1,699,000 Lump Sum.

7.1.4. Equipment Acquisition

Metro Transit and BNSF have both stated that there are important advantages in acquiring an additional trainset that is compatible with, has the same appearance and amenities and uses the same spare parts inventory as the existing fleet. To achieve these objectives, minimize costs, and reduce the time period required for acquisition, the assumption was made that one used locomotive, two used commuter coaches, and two used cab control commuter coaches like Northstar equipment would be acquired rather than new equipment. The equipment would be acquired, then rebuilt and upgraded to Northstar standards including the installation and testing of Positive Train Control (PTC) equipment, Northstar livery, interiors, information systems, and operational controls.

Because the Northstar Extension to St. Cloud is a feasibility study, no solicitation of proposals was made to potential owners or vendors of similar equipment. Rather, a cursory review of recent industry announcements was used to estimate the approximate cost of acquiring and rebuilding and upgrading used equipment. FRA has regulations that define the acquisition values of equipment if one agency is acquiring used equipment from another agency and FTA originally paid for the equipment. In addition, the COVID-19 pandemic has drastically altered commuting patterns and reduced ridership on all commuter railroads, including Northstar. These factors make estimating the cost of equipment acquisition very difficult and subject to fluctuation.

Another important factor in fleet planning is the timing of the extension to St. Cloud, should the decision be made to do so. The Northstar fleet will soon be approaching the time when it will be due for its mid-life rebuild and updating. To accomplish that work, Metro Transit may need to acquire an additional trainset just to be able to release one trainset for rebuild while still maintaining its published schedules. The additional trainset required by three of the four service alternatives could be acquired early, rebuilt and upgraded to Northstar standards, and then used as the trainset needed to release others for rebuild over a period of one or two years. Following that process, the same added trainset would then be available to augment the Northstar fleet to serve the St. Cloud Extension.

The following assumptions were used to estimate the cost of acquiring the additional transit needed for three of the four service alternatives for the St. Cloud extension:

- Approximate Cost of New PTC-Equipped Passenger Locomotive: $5,000,000.
- Approximate Cost of New PTC-Equipped Bi-Level Cab Control Passenger Car: $2,500,000.
- Approximate Cost of New Bi-Level Passenger Car (Non-Cab): $2,000,000

If the equipment were purchased new, the Rough Order of Magnitude Cost Estimate for the additional trainset would be approximately $14,000,000. This number is used in the estimate as a conservative placeholder. If the Northstar order could be added on to a larger Northstar fleet replacement order or added on to another agency's larger order for the same type equipment at the same time, pricing discounts may be able to be negotiated with the vendor and reduce the cost estimate shown above.

If surplus used equipment were able to be obtained from another commuter agency, and if FTA price controls were applicable, then the additional trainset may be able to be acquired, rebuilt, upgraded, and placed in service for substantially less than new pricing depending on condition of the equipment and the level of rebuilding that would be required.

The unit cost for the equipment procurement is $14,000,000.

8. Contingency & Soft Costs

Contingencies are an allowance for unexpected costs added to the estimated construction costs based on past experience for projects in early stages of definition. Their purpose is to account for items and conditions that cannot be identified with certainty during the conceptual design phase of the project. Contingency costs are added as an overall percentage of the total construction cost. The allocated contingency for this level of detail is set at 20% of the estimated direct construction cost elements for all cost categories except stations and support facilities. The allocated contingency for stations and support facilities is 30%. The allocated contingency percentage is expected to be reduced as the project advances into more detailed engineering and conceptual uncertainties are investigated and resolved. Contingencies should not be considered as potential savings. The allocated contingency amount is expected to be expended within the project; typically, as the project develops, contingency amounts are transferred to construction cost as project details are investigated during continued design. In effect, project uncertainties become known project elements as the project matures.

Soft Costs are associated with the planning, design and coordination of the project. These include design engineering, insurance and bonding, program management, construction management and inspection, and engineering services during construction. The percentage for each project element is as follows:

Design Engineering	10%
Insurance and Bonding	2%
Program Management	4%
Construction Management & Inspection	6%
Engineering Services During Construction	2%
Total Soft Costs	24%

Attachment 1

PTC/CTC Cost Breakdown

Technical Documentation on PTC/CTC Cost Breakdown

The following tables present the units and unit costs that were employed to build PTC/CTC costs. Generally, each PTC/CTC element is comprised of a wayside signal cost and, if applicable, costs for the railroad to complete wayside engineering and detailed location design and update the Subdivision file, ITCM communications, and dispatch office.

Table 1: Establish New Control Point (No signals or switches)

		For a CP	
	Estimated Unit Cost (2017)	*Assumed Quantity*	*Total - Cost*
Install Phasing Equipment	$ 3,744.00	1	$ 3,744
Insulated Bondstrand	$ 5.84	375	$ 2,190
Cable, 3C #6 W/#6 Gnd. Power	$ 10.77	100	$ 1,077
Install Wayside House w/Pier, 10' X 14'	$ 43,736.00	1	$ 43,736
Install Instrument House Grounding Grid	$ 6,401.00	1	$ 6,401
Utility Pole	$ 2,760.00	1	$ 2,760
AC Meter Service	$ 2,748.00	1	$ 2,748
Tilt Down Antenna Mast with ATCS/PTC Antenna	$ 11,248.00	1	$ 11,248
Conduit, 4 inch, PVC SCH 80	$ 40.20	160	$ 6,432
Emer. Generator, Power Xfer and Distribution	$ 35,748.00	1	$ 35,748
Regulators	$ 304.45	2	$ 609
House Equipment			
Factory Wiring - Equipment Racks	$ 40.30	1400	$ 56,420
Entrance Racks	$ 1,223.48	1	$ 1,223
Batteries 240 AH	$ 454.00	25	$ 11,350
Rectifiers	$ 2,017.00	3	$ 6,051
Relays Vital	$ 1,773.60	6	$ 10,642
Relays Non-vital	$ 246.00	2	$ 492
Vital Microprocessor w/rack	$ 43,040.00	1	$ 43,040
Local Control Panel (LCP)	$ 9,919.18	1	$ 9,919
ATCS Package	$ 5,704.00	1	$ 5,704
PTC Package	$ 8,480.00	1	$ 8,480
Misc./Spare Material	6%		$ 16,201
Material Handeling	3%		$ 8,586
	Wayside Total (2017)		***$ 294,801***
	Wayside Total (2020) 5% Inflation		***$ 310,425***
		For a CP	
Wayside Engineering	***$/Hr***	***Hours***	***Cost***
Location Detailed - House placement Track & Cable Plan 30%/100%			$ -
Design	$ 130.00	10	$ 1,300.00
Check	$ 130.00	5	$ 650.00
CAD/Drafting	$ 87.50	7	$ 612.50
SYSTEM DESIGN TOTALS		***190***	***$ 24,170.00***
DETAILED LOCATION DESIGN TOTAL	**$/Hr**		
Location Plans			
Design	$ 130.00	10	$ 1,300.00
IN/OUT Drawings	$ 130.00	4	$ 520.00
Check	$ 130.00	5	$ 650.00
CAD/Drafting	$ 87.50	10	$ 875.00
As Builts	$ 130.00		
CAD As Builts	$ 87.50		
Cutover Support	$ 130.00	11	$ 1,430.00
Material			
Submitals	$ 130.00	12	$ 1,560.00
Material List	$ 130.00		
Application Logic			
Design	$ 130.00		
Test Forms	$ 130.00		
Test	$ 130.00		
Verity	$ 87.50		
DETAILED LOCATION DESIGN TOTAL		***88***	***$ 13,503.75***
GRAND TOTAL WAYSIDE ENGINEERING			***$ 37,673.75***
		For a CP	
Total Wayside Estimate			***$ 348,099.22***

Table 2: Addition of a Turnout to a Control Point

	Estimated Unit Cost (2017)	Addition of a Turnout to a Control Point	
		Assumed Quantity	*Total - Cost*
Cable, 7C#14 Snow Mltr	$ 6.87	200	$ 1,373.20
Cable, 5C #6; 5C #14; 7C #14 Switch	$ 19.62	200	$ 3,923.20
Cable, 7C #6 Signal	$ 11.03	2500	$ 27,565.00
Cable, 12C #14 Snow Mltr	$ 8.11	200	$ 1,621.20
Cable, 5C #9 Snow Mltr	$ 11.85	200	$ 2,370.00
Track Bootlegs & Connections	$ 367.88	12	$ 4,414.50
Switch Bonding	$ 3,768.23	1	$ 3,768.23
Dual Control Power Switch Machine & Layout	$ 36,120.00	1	$ 36,120.00
Insulated Joints	$ 2,748.00	8	$ 21,984.00
1" Gas Pipe	$ 4.98	100	$ 497.60
1-1/4" Gas Pipe	$ 5.05	100	$ 504.60
1-1/2" Gas Pipe	$ 5.11	100	$ 510.60
2" Gas Pipe	$ 5.55	200	$ 1,109.20
Trenching	$ 8.20	1000	$ 8,200.00
Pressure Boosters	$ 504.45	1	$ 504.45
Propane Tank Filled	$ 57,020.00	1	$ 57,020.00
Switch Snow Blower	$ 11,872.00	1	$ 11,872.00
House Equipment			
Relay/Equipment Racks	$ 955.25	1	$ 955.25
Transformers	$ 1,424.60	1	$ 1,424.60
Batteries 240 AH	$ 454.00	1	$ 454.00
Batteries 160 AH	$ 245.00	6	$ 1,470.00
Track Rectifiers	$ 1,689.00	1	$ 1,689.00
Relays Vital	$ 1,773.60	2	$ 3,547.20
Relays Non-vital	$ 246.00	2	$ 492.00
Misc./Spare Material	6%		$ 11,603.39
			$ -
Material Handling	3%		$ 6,149.80
	Wayside Total (2017)		***$ 211,143.01***
	Wayside Total (2020) 5% Inflation		***$ 222,333.59***
		Addition of a Turnout to a Control	
Wayside Engineering	***$/Hr***	***Hours***	***Cost***
Location Detailed - House placement Track & Cable Plan 30%/100%			
Design	$ 130.00	4	$ 520.00
Check	$ 130.00	2	$ 260.00
CAD/Drafting	$ 87.50	4	$ 350.00
SYSTEM DESIGN TOTALS		***10***	***$ 1,130.00***
DETAILED LOCATION DESIGN TOTAL	**$/Hr**		
Location Plans			
Design	$ 130.00	12	$ 1,560.00
Check	$ 130.00	5	$ 650.00
CAD/Drafting	$ 87.50	10	$ 875.00
As Builts	$ 130.00	5	$ 650.00
CAD As Builts	$ 87.50	8	$ 700.00
Material			
Material List	$ 130.00	8	$ 1,040.00
Application Logic			
Design	$ 130.00	32	$ 4,160.00
Test Forms	$ 130.00	8	$ 1,040.00
Test	$ 130.00	32	$ 4,160.00
Verity	$ 87.50	8	$ 700.00
DETAILED LOCATION DESIGN TOTAL		***128***	***$ 15,535.00***
GRAND TOTAL WAYSIDE ENGINEERING			***$ 16,665.00***
		Addition of a Turnout to a Control Point	
Total Wayside Estimate			***$ 238,998.59***

Table 3: Addition of a Crossover to a Control Point

		Addition of Crossover to Control Point	
	Estimated Unit Cost (2017)	Assumed Quantity	Total - Cost
Cable, 7C#14 Snow Mltr	$ 6.87	400	$ 2,746
Cable, 5C #6; 5C #14; 7C #14 Switch	$ 19.62	800	$ 15,693
Cable, 5C #6 Signal	$ 9.52	400	$ 3,806
Cable, 7C #6 Signal	$ 11.03	1500	$ 16,539
Cable, 12C #14 Snow Mltr	$ 8.11	150	$ 1,216
Cable, 5C #9 Snow Mltr	$ 11.85	150	$ 1,778
Track Bootlegs & Connections	$ 367.88	12	$ 4,415
Switch Bonding	$ 3,768.23	2	$ 7,536
Dual Control Power Switch Machine & Layout	$ 36,120.00	2	$ 72,240
Conduit, 4 inch, GRS	$ 77.40	50	$ 3,870
Insulated Joints	$ 2,748.00	8	$ 21,984
1" Gas Pipe	$ 4.98	200	$ 995
1-1/4" Gas Pipe	$ 5.05	200	$ 1,009
1-1/2" Gas Pipe	$ 5.11	200	$ 1,021
2" Gas Pipe	$ 5.55	1000	$ 5,546
Trenching	$ 8.20	1000	$ 8,200
Pressure Boosters	$ 504.45	1	$ 504
Propane Tank Filled	$ 57,020.00	1	$ 57,020
Switch Snow Blower	$ 11,872.00	2	$ 23,744
House Equipment			
Relay/Equipment Racks	$ 955.25	1	$ 955
Transformers	$ 1,424.60	1	$ 1,425
Batteries 240 AH	$ 454.00	2	$ 908
Batteries 160 AH	$ 245.00	6	$ 1,470
Track Rectifiers	$ 1,689.00	1	$ 1,689
Relays Vital	$ 1,773.60	4	$ 7,094
Relays Non-vital	$ 246.00	2	$ 492
Misc./Spare Material	6%		$ 15,834
Material Handeling	3%		$ 8,392
	Wayside Total (2017)		***$ 288,122***
	Wayside Total (2020) 5% Inflation		***$ 303,392***

		Addition of Crossover to Control Point	
Wayside Engineering	***$/Hr***	***Hours***	***Cost***
Location Detailed - House placement Track & Cable Plan 30%/100%			
Design	$ 130.00	8	$ 1,040.00
Check	$ 130.00	4	$ 520.00
CAD/Drafting	$ 87.50	6	$ 525.00
SYSTEM DESIGN TOTALS		***18***	***$ 2,085.00***
DETAILED LOCATION DESIGN TOTAL	**$/Hr**		
Location Plans			
Design	$ 130.00	12	$ 1,560.00
Check	$ 130.00	5	$ 650.00
CAD/Drafting	$ 87.50	10	$ 875.00
As Builts	$ 130.00	5	$ 650.00
CAD As Builts	$ 87.50	6	$ 525.00
Material			
Material List	$ 130.00	6	$ 780.00
Application Logic			
Design	$ 130.00	24	$ 3,120.00
Test Forms	$ 130.00	6	$ 780.00
Test	$ 130.00	24	$ 3,120.00
Verity	$ 87.50	8	$ 700.00
DETAILED LOCATION DESIGN TOTAL		***106***	***$ 12,760.00***
GRAND TOTAL WAYSIDE ENGINEERING			***$ 14,845.00***
		Addition of Crossover to Control Point	
Total Wayside Estimate			***$ 318,237.39***

Table 4: Addition of a Single Signal Mast to a Control Point

	Estimated Unit Cost (2017)	*Addition of a Single Signal Mast to a Control Point*	
		Assumed Quantity	*Total - Cost*
Cable, 2 - 1C #6 Tw. Track	$ 6.17	3400	$ 20,964
High Signal Heads (3 Aspect, LED, Typ)	$ 3,797.00	3	$ 11,391
Signal Mast/Ladder/Base/Fdn.	$ 5,895.98	1	$ 5,896
House Equipment			
Misc./Spare Material	6%		$ 2,295
Material Handling	3%		$ 1,216
	Wayside Total (2017)		***$ 41,763***
	Wayside Total (2020) 5% Inflation		***$ 43,976***
		Addition of a Single Signal Mast to a Control Point	
Wayside Engineering	***$/Hr***	***Hours***	***Cost***
SYSTEM DESIGN TOTALS		***0***	***0***
DETAILED LOCATION DESIGN TOTAL	**$/Hr**		
DETAILED LOCATION DESIGN TOTAL		***0***	***$ -***
GRAND TOTAL WAYSIDE ENGINEERING			***$ -***
		Addition of a Single Signal Mast to a Control Point	
Total Wayside Estimate			***$ 43,976.29***

Table 5: Addition of a Two-Track Signal Cantilever to a Control Point

	Estimated Unit Cost (2017)	*Addition of a Two-Track Signal Cantilever to a Control Point*	
		Assumed Quantity	*Total - Cost*
Cable, 2 - 1C #6 Tw. Track	$ 6.17	3400	$ 20,964
34' Signal Cantilever with 4 position lights	$ 79,349.70	1	$ 79,350
House Equipment			
Misc./Spare Material	6%		$ 6,019
Material Handling	3%		$ 3,190
	Wayside Total (2017)		***$ 109,523***
	Wayside Total (2020) 5% Inflation		***$ 115,328***
		Addition of a Two-Track Signal Cantilever to a Control Point	
Wayside Engineering	***$/Hr***	***Hours***	***Cost***
SYSTEM DESIGN TOTALS		***0***	***$ -***
DETAILED LOCATION DESIGN TOTAL	**$/Hr**		
DETAILED LOCATION DESIGN TOTAL		***0***	***$ -***
GRAND TOTAL WAYSIDE ENGINEERING			***$ -***
		Addition of a Two-Track Signal Cantilever to a Control Point	
Total Wayside Estimate			***$ 115,327.65***

Table 6: Addition of a Three-Track Signal Bridge to a Control Point

		Addition of a Three-Track Signal Bridge to a Control Point	
	Estimated Unit Cost (2017)	*Assumed Quantity*	*Total - Cost*
Cable, 2 - 1C #6 Tw. Track	$ 6.17	3400	$ 20,964
62' Signal Bridge with 6 Position Lights	$ 138,874.80	1	$ 138,875
House Equipment			
Misc./Spare Material	6%		$ 9,590
Material Handling	3%		$ 5,083
	Wayside Total (2017)		***$ 174,512***
	Wayside Total (2020) 5% Inflation		***$ 183,762***
		Addition of a Three-Track Signal Bridge to a Control Point	
Wayside Engineering	***$/Hr***	***Hours***	***Cost***
SYSTEM DESIGN TOTALS		***0***	***$ -***
DETAILED LOCATION DESIGN TOTAL	**$/Hr**		
DETAILED LOCATION DESIGN TOTAL		***0***	***$ -***
GRAND TOTAL WAYSIDE ENGINEERING			***$ -***
		Addition of a Three-Track Signal Bridge to a Control Point	
Total Wayside Estimate			***$ 183,761.60***

Table 7: Addition of a Four-Track Signal Bridge to a Control Point

		Addition of a Four-Track Signal Bridge to a Control Point	
	Estimated Unit Cost (2017)	*Assumed Quantity*	*Total - Cost*
Cable, 2 - 1C #6 Tw. Track	$ 6.17	3400	$ 20,964
82.5' Signal Bridge with 8 Position Lights	$ 178,086.05	1	$ 178,086
House Equipment			
Misc./Spare Material	6%		$ 11,943
Material Handling	3%		$ 6,330
	Wayside Total (2017)		***$ 217,323***
	Wayside Total (2020) 5% Inflation		***$ 228,841***
		Addition of a Four-Track Signal Bridge to a Control Point	
Wayside Engineering	***$/Hr***	***Hours***	***Cost***
SYSTEM DESIGN TOTALS		***0***	***$ -***
DETAILED LOCATION DESIGN TOTAL	**$/Hr**		
DETAILED LOCATION DESIGN TOTAL		***0***	***$ -***
GRAND TOTAL WAYSIDE ENGINEERING			***$ -***
		Addition of a Four-Track Signal Bridge to a Control Point	
Total Wayside Estimate			***$ 228,841.42***

Table 8: Addition of an Electric Lock and Derail to a Control Point

	Estimated Unit Cost (2017)	Addition of an Electric Lock and Derail to a Control Point	
		Assumed Quantity	Total - Cost
Insulated Bondstrand	$ 5.84	50	$ 292.00
Track Bootleg & Connections	$ 367.90	2	$ 735.80
Install Electric Lock and Rods	$ 10,808.00	1	$ 10,808.00
Install Derail, Circuit Controller and Rods	$ 10,623.00	1	$ 10,623.00
Instrument Case & Grounding Grid	$ 7,561.00	1	$ 7,561.00
Field Wiring	$ 8.99	500	$ 4,495.00
Cable, 3C #6 Pwr. Power	$ 10.77	1700	$ 18,302.20
Cable, 7C#14 Switch	$ 6.87	200	$ 1,373.20
Cable, 2-1C #6 Tw. Track	$ 6.17	450	$ 2,774.70
Conduit, 4 inch, PVC	$ 40.20	100	$ 4,020.00
Cable, 12C #14	$ 8.92	1700	$ 15,157.20
House Equipment			
Factory Wiring	$ 4.03	1000	$ 4,030.00
Epic III Track Circuit	$ 1,561.00	1	$ 1,561.00
AC Power Circuit Breaker Box	$ 664.00	1	$ 664.00
AC Power Lightning/Surge Prot.	$ 387.00	1	$ 387.00
Battery Charger 12VDC (40A)	$ 2,017.00	1	$ 2,017.00
Batteries 265 AH	$ 454.00	6	$ 2,724.00
Relays Vital	$ 1,773.60	2	$ 3,547.20
			$ -
Miscellaneous Material	6.00%		$ 5,464.34
			$ -
Material Handling	3.00%		$ 2,896.10
Wayside Total (2017)			***$ 99,433***
Wayside Total (2020) 5% Inflation			***$ 104,404***

Table 9: Electric Lock and Derail on Separate Track Circuit

	Estimated Unit Cost (2017)	Electric Lock and Derail on Separate Track Circuit	
		Assumed Quantity	Total- Cost
Insulated Bondstrand	$ 5.84	50	$ 292.00
Track Bootleg & Connections	$ 367.90	2	$ 735.80
Install Electric Lock and Rods	$ 10,808.00	1	$ 10,808.00
Install Derail, Circuit Controller and Rods	$ 10,623.00	1	$ 10,623.00
Field Wiring	$ 8.99	2000	$ 17,980.00
Cable, 7C#14 Switch	$ 6.87	200	$ 1,373.20
Cable, 2-1C #6 Tw. Track	$ 6.17	450	$ 2,774.70
Conduit, 4 inch, PVC	$ 40.20	100	$ 4,020.00
House Equipment			
Epic III Track Circuit	$ 1,561.00	1	$ 1,561.00
Battery Charger 12VDC (40A)	$ 2,017.00	1	$ 2,017.00
Batteries 265 AH	$ 454.00	6	$ 2,724.00
Relays Vital	$ 1,773.60	4	$ 7,094.40
Miscellaneous Material	6.00%		$ 6,028.03
Material Handling	3.00%		$ 3,194.85
	Wayside Total (2017)		***$ 109,690***
	Wayside Total (2020) 5% Inflation		***$ 115,174***

Table 10: Install Derail on Power-Operated Switch

	Estimated Unit Cost (2017)	Install Derail on Power-Operated Switch	
		Assumed Quantity	Total- Cost
Install Derail, Circuit Controller and Rods	$ 10,623.00	1	$ 10,623.00
Field Wiring	$ 8.99	500	$ 4,495.00
Cable, 7C#14 Switch	$ 6.87	200	$ 1,373.20
Conduit, 4 inch, PVC	$ 40.20	100	$ 4,020.00
House Equipment			
Epic III Track Circuit	$ 1,561.00	1	$ 1,561.00
Miscellaneous Material	6.00%		$ 1,324.33
Material Handling	3.00%		$ 701.90
	Wayside Total (2017)		***$ 24,098***
	Wayside Total (2020) 5% Inflation		***$ 25,303***

Table 11: Install Single Mast for Intermediate Signal

	Estimated Unit Cost (2017)	Install Single Mast for Intermediate Signal	
		Assumed Quantity	***Total - Cost***
Insulated Bondstrand	$ 5.84	50	$ 292.00
Track Bootlegs & Connections	$ 367.90	4	$ 1,471.60
Install Instrument House Grounding Grid	$ 6,401.00	1	$ 6,401.00
High Signal Heads (3 aspect, LED, typ)	$ 3,797.00	3	$ 11,391.00
Signal Mast/Ladder/Base/Fdn.	$ 5,895.98	1	$ 5,895.98
Insulated Joints	$ 2,748.00	2	$ 5,496.00
Cable, 7C #6 Temp. Signal	$ 11.03	400	$ 4,410.40
Cable, 2-1C #6 Tw. Track	$ 6.17	400	$ 2,466.40
Conduit, 4 inch, PVC	$ 40.20	100	$ 4,020.00
Field Wiring	$ 7.23	500	$ 3,615.00
Misc./Spare Material 10%	6%		$ 2,727.56
Material Handling 5%	3%		$ 1,445.61
Wayside Total (2017)			$ 49,632.55
Wayside Total (2020) 5% Inflation			$ 52,114.18

Table 12: Install Two-Track Signal Cantilever for Intermediate Signal

	Estimated Unit Cost (2017)	Install Two-Track Signal Cantilever for Intermediate Signal	
		Assumed Quantity	***Total - Cost***
Insulated Bondstrand	$ 5.84	50	$ 292.00
Track Bootlegs & Connections	$ 367.90	4	$ 1,471.60
Install Instrument House Grounding Grid	$ 6,401.00	1	$ 6,401.00
High Signal Heads (3 aspect, LED, typ)	$ 3,797.00	6	$ 22,782.00
34' Signal Cantilever with 4 position lights	$ 79,349.70	1	$ 79,349.70
Insulated Joints	$ 2,748.00	2	$ 5,496.00
Cable, 7C #6 Temp. Signal	$ 11.03	400	$ 4,410.40
Cable, 2-1C #6 Tw. Track	$ 6.17	800	$ 4,932.80
Conduit, 4 inch, PVC	$ 40.20	100	$ 4,020.00
Field Wiring	$ 7.23	500	$ 3,615.00
Misc./Spare Material 10%	6%		$ 7,966.23
Material Handling 5%	3%		$ 4,222.10
Wayside Total (2017)			$ 144,958.83
Wayside Total (2020) 5% Inflation			$ 152,206.77

Table 13: Install Three-Track Signal Cantilever for Intermediate Signal

	Estimated Unit Cost (2017)	Install Three-Track Signal Cantilever for Intermediate Signal	
		Assumed Quantity	Total - Cost
Insulated Bondstrand	$ 5.84	50	$ 292.00
Track Bootlegs & Connections	$ 367.90	4	$ 1,471.60
Install Instrument House Grounding Grid	$ 6,401.00	1	$ 6,401.00
62' Signal Bridge wirh 6 Position Lights	$ 138,874.80	1	$ 138,874.80
Insulated Joints	$ 2,748.00	2	$ 5,496.00
Cable, 7C #6 Temp. Signal	$ 11.03	400	$ 4,410.40
Cable, 2-1C #6 Tw. Track	$ 6.17	1200	$ 7,399.20
Conduit, 4 inch, PVC	$ 40.20	100	$ 4,020.00
Field Wiring	$ 7.23	500	$ 3,615.00
Misc./Spare Material 10%	6%		$ 10,318.80
Material Handling 5%	3%		$ 5,468.96
Wayside Total (2017)			$ 187,767.76
Wayside Total (2020) 5% Inflation			$ 197,156.15

Table 14: Install New Intermediate Signal Box and Antenna

	Estimated Unit Cost (2017)	Install New Intermediate Signal Box and Antenna	
		Assumed Quantity	Total - Cost
Install 8' X 10' Instrument House W/FDN	$ 33,589.00	1	$ 33,589.00
AC Meter Service	$ 2,748.00	1	$ 2,748.00
Cable, 3C #6 W/#6 Gnd. Power	$ 10.77	100	$ 1,076.60
Tilt Down Antenna Mast with PTC Antenna	$ 10,748.00	1	$ 10,748.00
HOUSE EQUIPMENT			
Factory Wiring	$ 4.03	2000	$ 8,060.00
Electronic Coded Track Circuit	$ 32,968.00	1	$ 32,968.00
Track Interface Panel	$ 1,268.00	1	$ 1,268.00
Relay/Equipment Racks	$ 955.26	1	$ 955.26
Entrance Racks	$ 1,223.48	1	$ 1,223.48
PTC Package	$ 8,480.00	1	$ 8,480.00
AC Power Circuit Breaker Box	$ 664.00	1	$ 664.00
AC Power Lightning/Surge Prot.	$ 347.00	1	$ 347.00
Battery Charger 12VDC (40A)	$ 2,017.00	3	$ 6,051.00
Batteries 265 AH	$ 454.00	18	$ 8,172.00
Relays Vital	$ 1,773.60	2	$ 3,547.20
Misc./Spare Material 10%	6%		$ 7,193.85
			.
Material Handling 5%	3%		$ 3,812.74
Wayside Total (2017)			$130,904.13
Wayside Total (2020) 5% Inflation			$137,449.34

Northstar Commuter Rail Extension Feasibility Assessment

Appendix J – Technical Memorandum on Operating and Maintenance Costs

July 31, 2020

Prepared for

DEPARTMENT OF TRANSPORTATION

by

QUANDEL CONSULTANTS

Table of Contents

1. Introduction

This Technical Memorandum describes the main drivers of Northstar's operating and maintenance (O&M) costs and the methodology used to calculate the O&M costs for four proposed Service Alternatives under consideration.

2. Assumptions

The following four Service Alternatives are proposed to expand Northstar Service to St. Cloud, MN:

- Minimum Service Alternative
    - One peak direction trip – morning and afternoon peak periods
- Minimum Bi-Directional Service Alternative,
    - One peak direction, one off-peak direction – morning and afternoon peak periods
- Northstar Express Service Alternative
    - One peak direction Express, one off-peak direction Express – morning peak period
    - One peak direction Express, one off-peak direction Express – afternoon peak period
- Bi-Directional Service Alternative
    - Two peak direction, one off-peak direction – morning peak period
    - Three peak direction, two off-peak direction – afternoon peak period
        - One additional SB train from Big Lake to Minneapolis
    - One late evening NB trip from Minneapolis to St Cloud

To facilitate providing midday service between Minneapolis and St. Cloud, a Northstar Midday Shuttle Bus option was identified that could be included in any of the four proposed Service Alternatives. An express bus operated by St. Cloud Metro Bus would run on weekdays, departing St. Cloud mid-morning, operating non-stop to Minneapolis and returning to St. Cloud mid-afternoon. The Northstar Midday Shuttle has two important advantages: It provides the midday service in both directions that was requested at public meetings and it also avoids operating Northstar commuter trains during the BNSF's midday maintenance window.

Detailed information on the operating assumptions and schedules for each Service Alternative are included in Appendices B, C, D, and E.

To estimate the O&M costs for each alternative, the following assumptions were made:

1. Service to St. Cloud would be provided within the existing Northstar commuter rail service framework currently provided by BNSF and Metro Transit.

2. The O&M costs will be substantially different for each Service Alternative due to differences in train operations, train sets, train crews, and number of stations in each alternative.

3. Each alternative's Scheduled Miles (annual revenue and deadhead trip miles operated under the normal weekly schedule) were calculated based on the proposed schedules and crew sheets developed for regular weekly service. Crew sheets show both the scheduled revenue and deadhead trips proposed for each alternative.

4. The Scheduled Miles for each alternative were used to calculate the following:
    a. Locomotive fuel consumption and cost.
    b. Locomotive and passenger car maintenance expenses based on miles of usage per year and the FRA time-based inspections for each piece of equipment regardless of number of miles operated. (Example: 92-Day Inspection, etc.).
    c. Other costs that are driven by miles including BNSF ROW maintenance and liability insurance costs for train operations.
5. BNSF Train Crew Labor (and costs that are calculated based on train crew labor such as health and welfare, insurance, crew service expense, etc.) were calculated for each alternative based on the proposed train schedules and crew sheets. The proposed St. Cloud extension requires that some existing long crew days (currently around 19 hours daily compensation per crew) be broken into two separate crews of minimum 8-hour days because of the Federal Railroad Administration (FRA) Hours of Service limitations. In addition to time, train crews also have mileage components in their compensation rates that affect when overtime is paid. Conductors and locomotive engineers are paid at different rates and may have different overtime requirements. To simplify calculations, BNSF crews were considered a single unit containing one engineer and one conductor. The actual compensation for some crews may decrease even if the number of crews on Northstar increases.
6. An option that can be considered for each Service Alternative is a “Northstar Midday Shuttle Bus” that would operate round trip between St. Cloud and Minneapolis. Operating cost data was developed for Midday Shuttle Bus through discussions with St. Cloud’s Metro Bus service.
7. The crew van expense is for transporting train crews between St. Cloud and Big Lake Maintenance Facility for the Service Alternative that proposes a midday layover for one train in St. Cloud.
8. The electricity utility cost for 480VAC standby power will increase to accommodate additional trains connecting to standby power. There will also be additional utility costs related to the new station at St. Cloud and the center platform Big Lake station.
9. Snow plowing expenses will increase for alternatives requiring the addition of a new storage/servicing track at the Big Lake Maintenance Facility and new station platforms at St. Cloud and Big Lake.
10. It is understood that expensed maintenance costs incurred by BNSF will increase once proposed infrastructure needed to support extended Northstar service is constructed. Due to the nature of the cost sharing structure between BNSF and Metro Transit, the increase in O&M costs will be negotiated at a later date and is not included in the O&M costs for any Service Alternative.

O&M costs were calculated using the assumptions described above.

3. O&M Cost Calculations

O&M costs were developed in partnership with Metro Transit. Metro Transit provided their 2020 Northstar O&M budget and an estimation of O&M costs for each Service Alternative based on Scheduled Miles. The following sections document the information received from Metro Transit and the methodology used for estimating each Service Alternative's O&M costs.

3.1. O&M Cost Criteria

O&M costs are based directly on the operating characteristics of a service. Northstar's operating characteristics were identified and used to develop O&M unit cost criteria that could be applied to the proposed Service Alternatives to calculate O&M costs. The identified operating characteristics are listed below:

1. Number of Stations
2. Maintenance and Storage Facility
3. Operating Train Sets
4. Locomotives
5. Train Cars
6. Staffing
7. BNSF Train Crews
8. Weekly Crew Van Trips
9. Scheduled Miles

Table 1 summarizes the operating characteristics for existing Northstar service and proposed Service Alternatives.

Table 1: Operating Characteristics for Existing Service and Proposed Service Alternatives

	Existing Northstar Service	Minimum Service Alternative	Minimum Bi-Directional Service Alternative	Northstar Express Service Alternative	Bi-Directional Service Alternative
Number of Stations	6	8	8	7	8
Number of Maintenance and Storage Facilities	1	1	1	1	1
Number of Operating Train Sets	4	4	5	5	5
Number of Locomotives	6	6	7	7	7
Number of Train Cars	19	19	23	23	23
Staffing Levels (Mechanical, Administrative, Clerical)	36	36	40	40	40
Number of BNSF Train Crews	6	6	8	8	8
Scheduled Miles	148,795	210,558	224,939	280,628	356,761

3.2. O&M Cost Categories

Northstar O&M costs were broken down into the following categories:

1. Labor and Benefits
2. Contracted Services
3. Materials, Parts & Supplies
4. Other Expenses
5. Allocated Expenses

The methodologies for estimating O&M costs for each of the cost categories are included in the following sub-sections.

3.2.1. Labor and Benefits

The Labor and Benefits portion of O&M costs is dependent on the number of people working to operate and maintain Northstar's maintenance and storage facility, locomotives, train cars, and stations. Metro Transit provided three employee designations in their O&M costs: Mechanic, Administrative, and Clerical. Metro Transit currently employs 26 mechanics, 6 administrative employees, and 4 clerical employees to operate and maintain Northstar service.

For the Service Alternatives requiring an additional trainset to be added to the Northstar fleet, the following employees will be added to the Labor and Benefits budget:

- 2 additional mechanics
- 1 additional administrative employee
- 1 additional clerical employee

The estimated overtime budgets for mechanics, administrative employees, and clerical employees for each Service Alternative were calculated by increasing the 2020 budget proportionally by the number of new employees.

It is assumed that new employees will be full time and have the accompanying benefits packages. Metro Transit benefits include vacation days, sick days, holidays, pension, FICA, insurance, workers' compensation, post-retirement, and tool allowance. The overall benefits budget for each Service Alternative were estimated by increasing the 2020 budget proportionally by the number of new employees. The percentage of budget allocated to each sub-benefit for 2020 was carried forward for each Service Alternative.

The proposed labor staffing for existing service and proposed Northstar Service Alternatives are presented in Table 2.

Table 2: Proposed Labor Staffing for Existing Service and Proposed Service Alternatives

	Existing Northstar Service	Minimum Service Alternative	Minimum Bi-Directional Service Alternative	Northstar Express Service Alternative	Bi-Directional Service Alternative
Number of Mechanics	26	26	28	28	28
Number of Administrative Employees	6	6	7	7	7
Number of Clerical Employees	4	4	5	5	5
Total Labor Staff	**36**	**36**	**38**	**38**	**38**

3.2.2. Contracted Services

Metro Transit contracts some services needed to operate and maintain Northstar service. Contracted services were broken down into the five categories below:

1. Security
2. BNSF Administrative Services
3. BNSF Running Roadway
4. BNSF Commuter Train Operations
5. Other Maintenance

In addition to the above, contracted services also include costs for crew van transportation and an option for midday bus service. Costs of contracted services were estimated for each of the Service Alternatives based on the 2020 budgets for the five categories shown above.

Security and Other Maintenance costs were calculated based on the number of stations in the corridor; as the number of stations increase, Security and Other Maintenance costs will increase proportionally. Because Target Field Station serves multiple transportation modes in addition to Northstar, Metro Transit indicated that the 2020 Northstar Contracted Services budget does not include costs for Target Field Station. A per station cost was calculated for Security and Other Maintenance based on 6 stations in the corridor. For each new station proposed by a Service Alternative, the Security and Other Maintenance costs were increased proportionally.

The BNSF Administrative Services category includes the cost of the local BNSF Northstar commuter rail service management team, as well as Northstar's share of the train dispatching and system passenger management costs. Northstar's share of the costs are calculated per train mile for the total passenger, commuter, and freight train miles operated in the Northstar corridor. For each of the four Service Alternatives, the BNSF Administrative Services cost was increased based on the additional Northstar Scheduled Miles proposed.

The BNSF Running Roadway cost is calculated by BNSF based on the Scheduled Miles and the amount of physical plant (track, structures, signals, etc.) in the Northstar corridor. This category includes the cost of maintaining existing track, structures, Centralized Traffic Control (CTC) control points, signals, Positive Train Control (PTC) equipment, grade crossings, drainage facilities, and other right-of-way maintenance items. Each of the four Service Alternatives increases both the number of Northstar trains and the amount of infrastructure needed to maintain fluid corridor operations. The level of detail available was not sufficient to accurately calculate the changes in expensed maintenance costs for infrastructure needed to accommodate the four Service Alternatives. BNSF Running Roadway costs were estimated by increasing the 2020 Running Roadway costs proportionally by the proposed Scheduled Miles for each Service Alternative.

BNSF Commuter Train Operations costs include labor and related costs for BNSF train crews that operate Northstar service and were calculated using detailed information on current operations provided by BNSF. Proposed schedules and crew sheets were developed for each of the four Service Alternatives. The crew sheets detail the starting and ending duty times of individual trips, trip miles, layover times, and the compensated hours of service, for each crew and each alternative. To compute the annual BNSF Commuter Train Operations cost per alternative, an average cost per BNSF crew was developed for the 2020 budget and multiplied by the number of BNSF crews that were needed to operate each of the four Service Alternatives.

Included in Contracted Services is an Easement (or access) Fee charged by BNSF for Northstar's use of the corridor. This fee is calculated by BNSF based on system capacity and revenue considerations. The information provided was insufficient to calculate this expense for each of the four Service Alternatives. The Easement Fee and BNSF Running Roadway Expense are both items that are subject to negotiation with BNSF.

3.2.3. Materials, Parts & Supplies

The Materials, Parts, and Supplies budget includes fuel, locomotive and passenger car parts, system repair parts, office supplies, and small equipment. This category is dependent on the amount of equipment and the miles traveled by the equipment. Although maintenance cycles are not solely dependent on miles traveled (some are time-based), it is assumed that this additional cost is covered in other areas of the operating cost such as "Labor and Benefits" because the maintenance will be completed by the additional employees. Materials, Parts, and Supplies costs for each Service Alternative were calculated using the proposed number of Scheduled Miles estimated for that alternative. See Table 1 for the scheduled miles for existing Northstar service and proposed Service Alternatives.

3.2.4. Other Expenses

The Other Expenses category includes costs for the station and maintenance facility utilities, insurance, and small equipment rentals. Station utility costs were estimated for each Service Alternative based on the total number of stations. Utilities for the Big Lake Maintenance facility were increased by the number of locomotives and train cars in service under each Service Alternative. Insurance and small equipment rentals were increased based on Scheduled Miles for each Service Alternative. See Table 1 for the number of locomotives and train cars for existing service and proposed Northstar Service Alternatives.

3.2.5. Allocated Expenses

Allocated Expenses include Modal, A-87 Support Service, and Met Council categories. According to Metro Transit, the only category expected to change under any of the proposed Service Alternatives is

A-87 Support Service. The cost for A-87 Support Service for each of the Service Alternatives was calculated as 25.4% of the total Labor cost. Modal and Met Council costs remained equal to 2020 values for each Service Alternative.

4. Presentation of Annual O&M Costs

Table 3 presents the estimated annual O&M costs in 2025 dollars for existing Northstar service and the four Service Alternatives.

Table 3: Annual O&M Costs for Existing Northstar and Proposed Service Alternatives (2025$)

	Existing Northstar Service (millions)	Minimum Service Alternative (millions)	Minimum Bi-Directional Service Alternative (millions)	Northstar Express Service Alternative (millions)	Bi-Directional Service Alternative (millions)
Labor and Benefits	$5.9	$5.9	$6.6	$6.6	$6.6
Contracted Services	$9.5	$11.7	$13.3	$13.6	$15.2
Materials, Parts & Supplies	$2.8	$4.0	$4.3	$5.3	$6.8
Other Expenses	$3.8	$5.1	$5.5	$6.6	$8.2
Allocated Expenses	$3.0	$3.0	$3.0	$3.0	$3.0
Total O&M Costs	**$25.0**	**$29.7**	**$32.7**	**$35.1**	**$39.7**

Note:

1. O&M costs do not include access fees or expensed maintenance costs for proposed infrastructure projects

5. Summary

Using the assumptions and methodology described above, O&M costs for the proposed Northstar Service Alternatives were estimated in coordination with Metro Transit and BNSF. Attachment 1 presents the detailed O&M costs.

Attachment 1

Detailed Operating and Maintenance Costs

Northstar Commuter Rail Extension Operating and Maintenance Cost Budget

	2020 Northstar Budget	2020 Unit Cost	Units	Basis	Minimum Service Alternative Budget	Minimum Bi-Directional Service Alternative Budget	Northstar Express Service Alternative Budget	Bi-Directional Service Alternative Budget
SECTION 1.0 LABOR AND BENEFITS								
Labor								
Mechanics Budget	$1,702,253	$65,471	$/Mechanic	Number of Mechanics	$1,702,253	$1,833,195	$1,833,195	$1,833,195
Overtime	$232,727	$8,951	$/Mechanic	Number of Mechanics	$232,727	$250,630	$250,630	$250,630
Administrative	$810,970	$135,162	$/Administrative Staff	Number of Admin Staff	$810,970	$946,132	$946,132	$946,132
Overtime	$12,267	$2,045	$/Administrative Staff	Number of Admin Staff	$12,267	$14,312	$14,312	$14,312
Clerical	$154,510	$38,627	$/Clerical Staff	Number of Clerical Staff	$154,510	$193,137	$193,137	$193,137
Overtime	$22,708	$5,677	$/Clerical Staff	Number of Clerical Staff	$22,708	$28,385	$28,385	$28,385
Subtotal Labor	***$2,935,436***				***$2,935,436***	***$3,265,791***	***$3,265,791***	***$3,265,791***
Benefits								
Vac / Sick / Holiday	$435,840	15%	% of labor	Total Labor Budget	$435,840	$484,889	$484,889	$484,889
Pension	$209,358	7%	% of labor	Total Labor Budget	$209,358	$232,919	$232,919	$232,919
FICA	$250,043	9%	% of labor	Total Labor Budget	$250,043	$278,183	$278,183	$278,183
Insurance	$943,830	32%	% of labor	Total Labor Budget	$943,830	$1,050,050	$1,050,050	$1,050,050
Workers Comp	$200,000	7%	% of labor	Total Labor Budget	$200,000	$222,508	$222,508	$222,508
Post Retirement		0%	% of labor	Total Labor Budget	$0	$0	$0	$0
Tool Allowance	$16,450	1%	% of labor	Total Labor Budget	$16,450	$18,301	$18,301	$18,301
Subtotal Benefits	***$2,055,521***				***$2,055,521***	***$2,286,850***	***$2,286,850***	***$2,286,850***
Subtotal Labor and Benefits (2020$)	***$4,990,957***				***$4,990,957***	***$5,552,641***	***$5,552,641***	***$5,552,641***
Subtotal Labor and Benefits (2025$)	***$5,927,691***				***$5,927,691***	***$6,594,796***	***$6,594,796***	***$6,594,796***
SECTION 2.0 CONTRACTED SERVICES								
Security	$4,213	$602	$/Station&Facility	Number of Stations/Facilities	$5,417	$5,417	$4,815	$5,417
BNSF Administrative services	$567,563	$4	$/Mile	Annual Scheduled Miles	$803,153	$858,008	$1,070,426	$1,360,831
BNSF Running Roadway	$1,249,501	$8	$/Mile	Annual Scheduled Miles	$1,768,156	$1,888,920	$2,356,563	$2,995,894
BNSF Commuter Train Operations	$3,536,132	$589,355	$/Train Crew	Number of BNSF Train Crews	$3,536,132	$4,714,843	$4,714,843	$4,714,843
Crew Van Trips*		$80	$/Trip	Annual Number of Crew Van Trips	$41,714	$41,714	$41,714	$41,714
Midday Bus Option**		$629	$/Round-Trip Bus Service	Annual Number of Midday Bus Round-Trips	$163,537	$163,537	$163,537	$163,537
Other Maint	$2,658,368	$443,061	$/Station	Number of Stations	$3,544,491	$3,544,491	$3,101,429	$3,544,491
Total Contracted Services (2020$)	***$8,015,778***				***$9,862,600***	***$11,216,930***	***$11,453,329***	***$12,826,728***
Total Contracted Services (2025$)	***$9,520,229***				***$11,713,675***	***$13,322,194***	***$13,602,962***	***$15,234,129***
SECTION 3.0 MATERIALS, PARTS & SUPPLIES								
Fuel	$1,424,615	$10	$/Mile	Annual Scheduled Miles	$2,015,958	$2,153,647	$2,686,829	$3,415,761
Repair parts - Locomotives/Cars	$671,033	$5	$/Mile	Annual Scheduled Miles	$949,572	$1,014,427	$1,265,571	$1,608,918
Repair parts - systems	$270,555	$2	$/Mile	Annual Scheduled Miles	$382,860	$409,009	$510,268	$648,702
Office & Shop Supplies / small equipment	$17,783	$0	$/Mile	Annual Scheduled Miles	$25,165	$26,884	$33,539	$42,638
Total Materials, Parts & Supplies (2020$)	***$2,383,986***				***$3,373,554***	***$3,603,966***	***$4,496,207***	***$5,716,020***
Total Materials, Parts & Supplies (2025$)	***$2,831,428***				***$4,006,724***	***$4,280,381***	***$5,340,083***	***$6,788,838***
SECTION 4.0 OTHER EXPENSES								
Utilities								
Stations								
Electric	$245,504	$40,917	$/Station	Number of Stations	$327,339	$327,339	$286,421	$327,339
Gas	$18,836	$3,139	$/Station	Number of Stations	$25,115	$25,115	$21,976	$25,115
Water	$16,536	$2,756	$/Station	Number of Stations	$22,048	$22,048	$19,292	$22,048
Big Lake Maintenance Facility								
Electric	$303,417	$12,137	$/Cars and Locomotives	Number of cars and locomotives	$303,417	$364,101	$364,101	$364,101
Gas	$28,403	$1,136	$/Cars and Locomotives	Number of cars and locomotives	$28,403	$34,083	$34,083	$34,083
Water	$16,306	$652	$/Cars and Locomotives	Number of cars and locomotives	$16,306	$19,567	$19,567	$19,567
Refuse	$1,866	$75	$/Cars and Locomotives	Number of cars and locomotives	$1,866	$2,239	$2,239	$2,239
Telephone	$0	$0		N/A	$0	$0	$0	$0
Insurance								
Insurance - liability	$2,486,898	$17	$/Mile	Annual Scheduled Miles	$3,519,184	$3,759,542	$4,690,299	$5,962,768
Insurance - Retention		$0		N/A	$0	$0	$0	$0
Leases and Rentals								
Leases and Rentals - small equip	$49,726	$0.33	$/Mile	Annual Scheduled Miles	$70,367	$75,173	$93,783	$119,227
Total Other Expenses (2020$)	***$3,167,492***				***$4,314,044***	***$4,629,207***	***$5,531,762***	***$6,876,487***
Total Other Expenses (2025$)	***$3,761,987***				***$5,123,731***	***$5,498,046***	***$6,569,997***	***$8,167,110***
SECTION 5.0 ALLOCATED EXPENSES								
Modal	$1,623,307	0.0%	% of Increased Labor	Direct Labor Cost	$1,623,307	$1,623,307	$1,623,307	$1,623,307
A-87 Support Service	$311,151	25.4%	% of Increased Labor	Direct Labor Cost	$311,151	$311,151	$311,151	$311,151
Met Council	$558,148	0.0%	% of Increased Labor	Direct Labor Cost	$558,148	$558,148	$558,148	$558,148
Total Allocated Expenses (2020$)	***$2,492,606***				***$2,492,606***	***$2,492,606***	***$2,492,606***	***$2,492,606***
Total Allocated Expenses (2025$)	***$2,960,434***				***$2,960,434***	***$2,960,434***	***$2,960,434***	***$2,960,434***
Total Operating Expenses (2020$)	**$21,050,819**				**$25,033,762**	**$27,495,351**	**$29,526,544**	**$33,464,482**
Total Operating Expenses (2025$)	**$25,001,769**				**$29,732,256**	**$32,655,852**	**$35,068,272**	**$39,745,307**
Incremental Increase over 2020 (2025$)	**-**				**$4,730,487**	**$7,654,082**	**$10,066,503**	**$14,743,538**

* Crew Van service is not separated out for 2020 Northstar budget; per trip cost was provided by Passenger Transportation Inc.

**Midday Bus Service is an option for all Service Alternatives; per round-trip cost was provided by the St. Cloud Metropolitan Transit Commission

Metro Transit Labor Calculations	2020 Northstar Service	2020 Units	Unit Description	Basis	Minimum Service Alternative Budget	Minimum Bi-Directional Service Alternative Budget	Northstar Express Service Alternative Budget	Bi-Directional Service Alternative Budget
Number of Mechanics	26	2	Crew/Operating Trainset	Assumed 2 more per additional train set	26	28	28	28
Number of Administrative Staff	6	1	Admin/Operating Trainset	Assumed 1 more per additional train set	6	7	7	7
Number of Clerical Staff	4	1	Cleric/Operating Trainset	Assumed 1 more per additional train set	4	5	5	5

Operating Components	2020 Northstar Service	Minimum Service Alternative	Minimum Bi-Directional Service Alternative	Northstar Express Service Alternative	Bi-Directional Service Alternative
Number of Stations	6	8	8	7	8
Number of Maintenance Facilities	1	1	1	1	1
Number of Daily Midday Bus Round-Trips**	0	1	1	1	1
Number of Operating Trainsets	4	4	5	5	5
Number of Locomotives	6	6	7	7	7
Number of Cars	19	19	23	23	23
Total Number of Metro Transit Staff	36	0	0	0	0
Number of BNSF Train Crews	6	6	8	8	8
Number of Daily Crew Van Trips*	0	2	2	2	2
Annual Scheduled Miles	148,795	210,558	224,939	280,628	356,761

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