Intersection Control Evaluation (ICE)

U.S. Highway (Hwy) 10 and U.S. Hwy 75 (North)

Moorhead, Minnesota
State Project (S.P.): TBD

DRAFT

Minnesota Department of Transportation (MnDOT) – District 4

April 2020

SRF No. 11649

Intersection Control Evaluation (ICE)

U.S. Highway (Hwy) 10 and U.S. Hwy 75
State Project (S.P.): TBD
Proposed Letting Date: TBD

Report Certification:

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Leif A. Garnass	47153
Print Name	Reg. No.
Signature	Date

Approved By:

MnDOT District 4 Traffic Engineer	Date
MnDOT District 4 State Aid Engineer	Date
City of Moorhead Traffic Engineer	Date

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Introduction

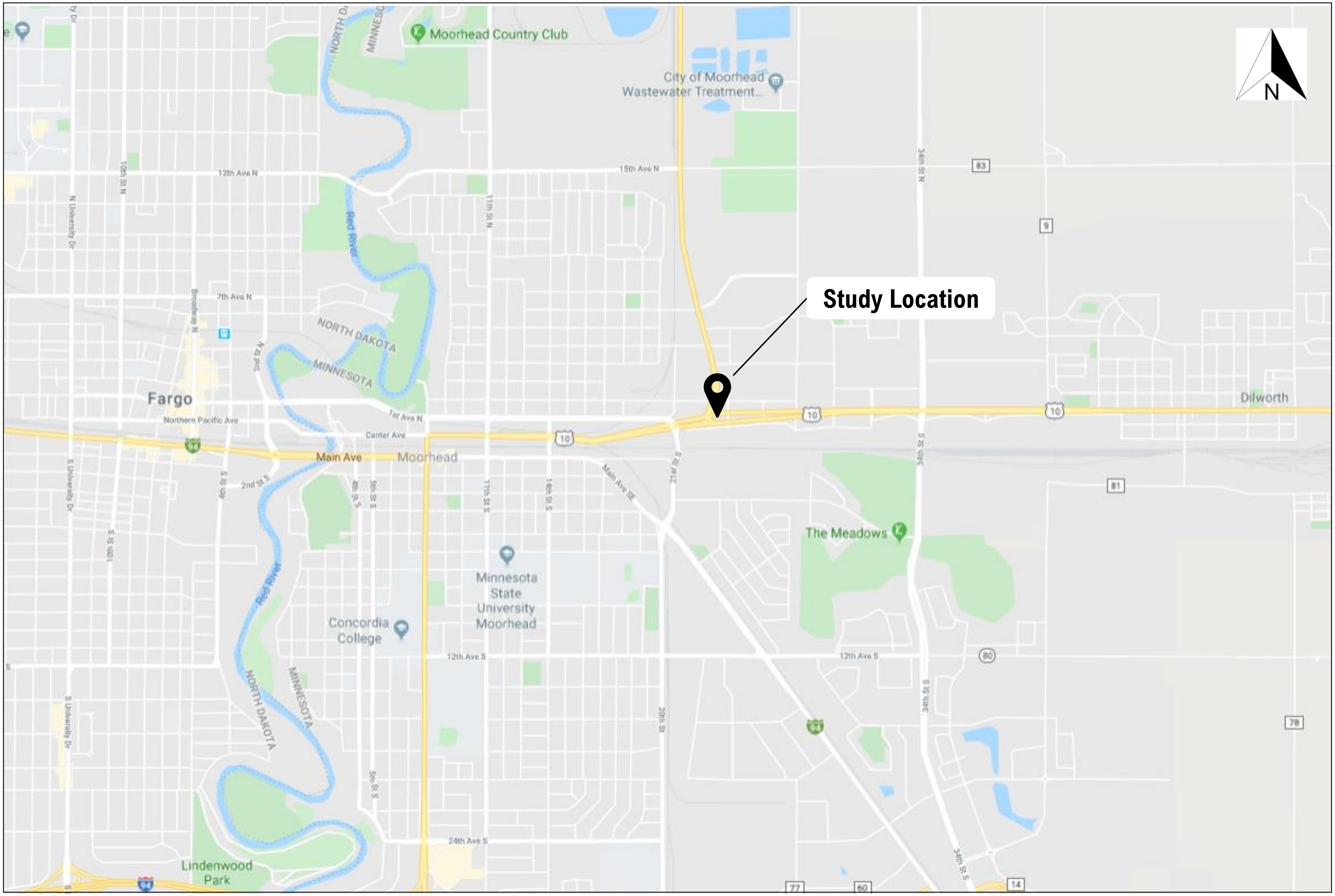
The Fargo-Moorhead Council of Governments (Metro COG) and its partners, the Minnesota Department of Transportation (MnDOT), City of Moorhead, Downtown Moorhead, Inc. and MATBUS completed a study of the U.S. Hwy 10 and U.S. Hwy 75 corridors in Moorhead. The purpose of the study was to develop context-sensitive solutions for the corridors that balance the needs of the City of Moorhead with area stakeholders and users, and ultimately recommend a vision for both corridors to inform the planned reconstruction project in 2025-2026. This report includes the intersection control evaluation results for the U.S. Hwy 10 and U.S. Hwy 75 (North) intersection in the City of Moorhead, Minnesota (see Figure 1). The goal of this evaluation was to identify intersection control for the study intersection which would be constructed in Phase 2 of the overall reconstruction project; therefore, the assumed analysis year is 2027.

The MnDOT Intersection Control Evaluation (ICE) is a process that identifies the most appropriate intersection control type through a comprehensive analysis and documentation of the technical (safety, operational, other) and political issues of viable alternatives. The goal of ICE is to select the optimal control for an intersection based on an objective analysis for the existing conditions and future needs. This ICE report was completed to inform the larger corridor study completed (documented separately). The study was guided by the following overarching goals in which the recommended vision needs to:

1. Provide roadways that fit land use (i.e., appropriate access and design).
2. Accommodate appropriate users (i.e., complete streets).
3. Create an environment to stimulate growth.
4. Provide flexibility for near- and long-term transportation needs.
5. Improve "Gateway" feel for the U.S. Hwy 10 and U.S. Hwy 75 corridors.
6. Develop and executes a project that meets the needs for 30+ years.

Defining the purpose and need explains why an agency or agencies are undertaking a project and the main objectives of the project. The "need" describes the transportation deficiencies or problems to be addressed by the project. The "purpose" is a broad statement of the primary intended transportation result and other related objectives to be achieved by the project. The purpose and need act as measuring sticks for the project alternatives, helping determine to what extent each alternative meets the project's needs. Alternatives that do not address the transportation needs of the project and do not meet the purpose of the project are not studied further. Based on the purpose and need documented in the corridor study, the need for improvements at this study intersection is a result of poor pavement conditions, long side-street delays at adjacent intersections, and crash history along Center Avenue from 21st Street to 34th Street.

Detailed warrants, operations and crash analyses, in combination with engineering judgement, were used to determine recommendations for this ICE.



Study Location

Intersection Control Evaluation
U.S. Hwy 10 at U.S. Hwy 75 (North)
Moorhead, Minnesota

Figure 1

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Intersection Characteristics

Existing Conditions

The U.S. Hwy 10 and U.S. Hwy 75 (North) intersection is a three-way intersection with traffic signal control; however, the eastbound U.S. Hwy 10 movement is not signalized but the existing southbound-to-eastbound left-turn movement is required to "yield" prior to entering U.S. Hwy 10. U.S. Hwy 10 is a four-lane divided highway with a posted speed limit of 45 mph and is functionally classified as a Principal Arterial. U.S. Hwy 75 is a four-lane divided roadway with a posted speed limit of 45 mph and functionally classified as a Minor Arterial. The land adjacent to the intersection includes primarily commercial properties with residential areas located within a half mile of the intersection. Current intersection geometrics are shown in Figure 2.

Crash History

Historical crash data were obtained from MnDOT for a five-year period from 2013 through 2017. Detailed crash data is included in Appendix A. Fourteen crashes were reported during the analysis period resulting in a crash rate of 0.32 crashes per million entering vehicles, which is below the statewide average of 0.70 for a signalized intersection, as well as below the critical crash rate of 1.03. 57 percent of the crashes reported were rear end crashes. A summary of the data is shown below:

- 11 – Property Damage Only (PDO) Crashes
- 2 – Possible Injury (C) Crashes
- 1 – Suspected Minor Injury Crash
- 0 – Suspected Serious Injury Crash
- 0 – Fatality (K) Crash
- Observed Crash Rate – 0.32 (crashes/million entering vehicles)
- Critical Crash Rate – 1.03 (crashes/million entering vehicles)

While the crash history does not indicate a safety concern, input from the community and stakeholders noted this intersection as "confusing" with the wide median an how it's controlled since there is no acceleration lane for drivers making the southbound-to-eastbound left-turn movement, which has to yield in the median to U.S. Hwy 10 traffic.

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Existing Conditions

Intersection Control Evaluation
U.S. Hwy 10 at U.S. Hwy 75
Moorhead, Minnesota

Figure 2

Traffic Volumes

Existing Volumes

During the data collection efforts (September 2018 thru October 2018) there was ongoing construction in the study area that impacted travel patterns and traffic volumes at the study intersection. Construction included:

- 12th Avenue/15th Avenue bridge closed between mid-September and early October 2018
- US 10 (Main Avenue) between 7th Street/8th Street closed early to mid-October 2018
- SE Main Avenue/20th Street/21st Street intersection closed mid-October 2018 to 2021
  - Detour route includes US 10/34th Street/12th Avenue/US 75

Peak periods intersection turning movement counts were collected at the study intersection. The traffic count data was collected from 7:00 to 9:00 a.m. and from 4:00 to 6:00 p.m. All modes collected were grouped by pedestrians, bicyclists, passenger vehicles, transit vehicles/trucks.

The year 2018 traffic count data was supplemented by recently collected traffic volumes (year 2015/2016) provided by the City of Moorhead. Using a combination of the year 2018 and recently collected traffic volumes, an existing a.m. and p.m. peak hour volume set was developed. The peak hour turning movement volumes are summarized in Figure 3.

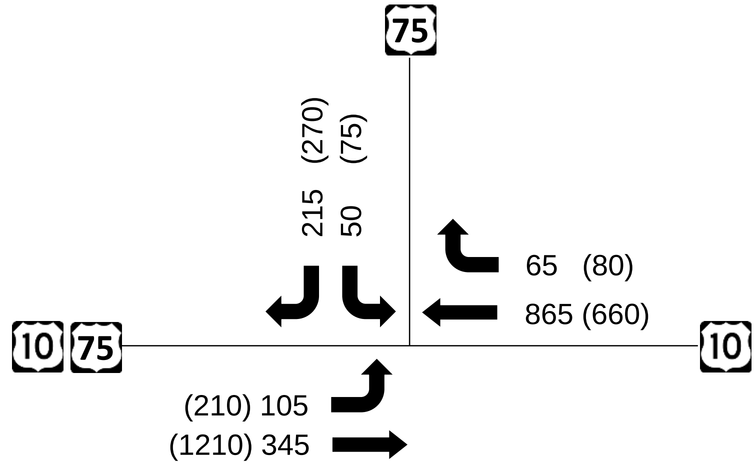
Future Volumes

The Advanced Traffic Analysis Center (ATAC) provided the travel demand model that was used to determine the expected daily traffic forecast volumes along the U.S. Hwy 10 and U.S. Hwy 75 corridors. As part of this study, the year 2045 socio-economic (SE) data in the traffic analysis zones (TAZs) near downtown Moorhead were reviewed and updated based on input provided by the Metro COG and the City of Moorhead to be consistent with current development expectations in the downtown area. Additionally, the external growth rate was modified in the Travel Demand Model from 2.5 percent to 0.25 percent. A growth rate of 0.25 percent is more consistent with the historical traffic volume growth along roadways external to the Fargo-Moorhead area. Results of this analysis indicate that an annual growth rate of approximately one (1) percent is expected; however, historical traffic volumes in Moorhead (see Figure 4) have remained relatively unchanged and data reviewed in downtown Fargo suggests that a mode shift has occurred. Therefore, for this study the 2045 analysis assuming a one (1) percent growth rate was used to assess the risk of the implementation of the alternatives if assumptions were to change. Based on historical data in both downtown Moorhead and Fargo, we do not expect a growth rate of one (1) percent to occur.

Results of this analysis indicate that an annual growth rate of approximately one (1) percent is expected. Projected Opening Day Year 2027 and Projected Design Year 2045 volumes are shown in Figure 3. Further details are included in Appendix B.

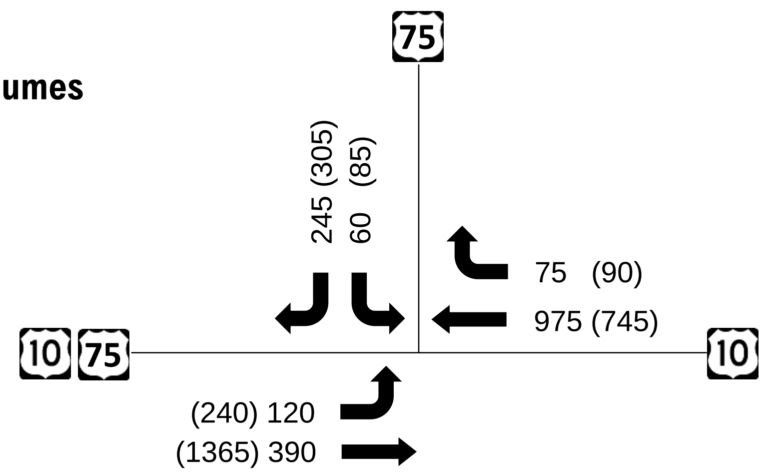
Existing 2018 Traffic Volumes

XX = AM Peak Hour
(XX) = PM Peak Hour



Opening Day Year 2027 Traffic Volumes

XX = AM Peak Hour
(XX) = PM Peak Hour



Year 2045 Traffic Volumes

XX = AM Peak Hour
(XX) = PM Peak Hour

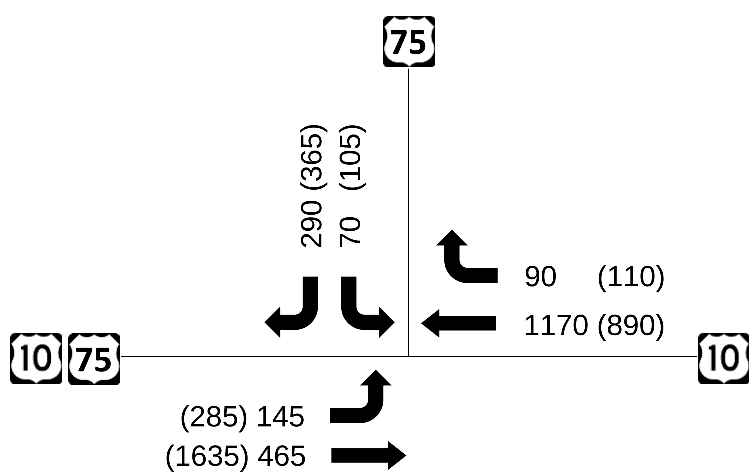
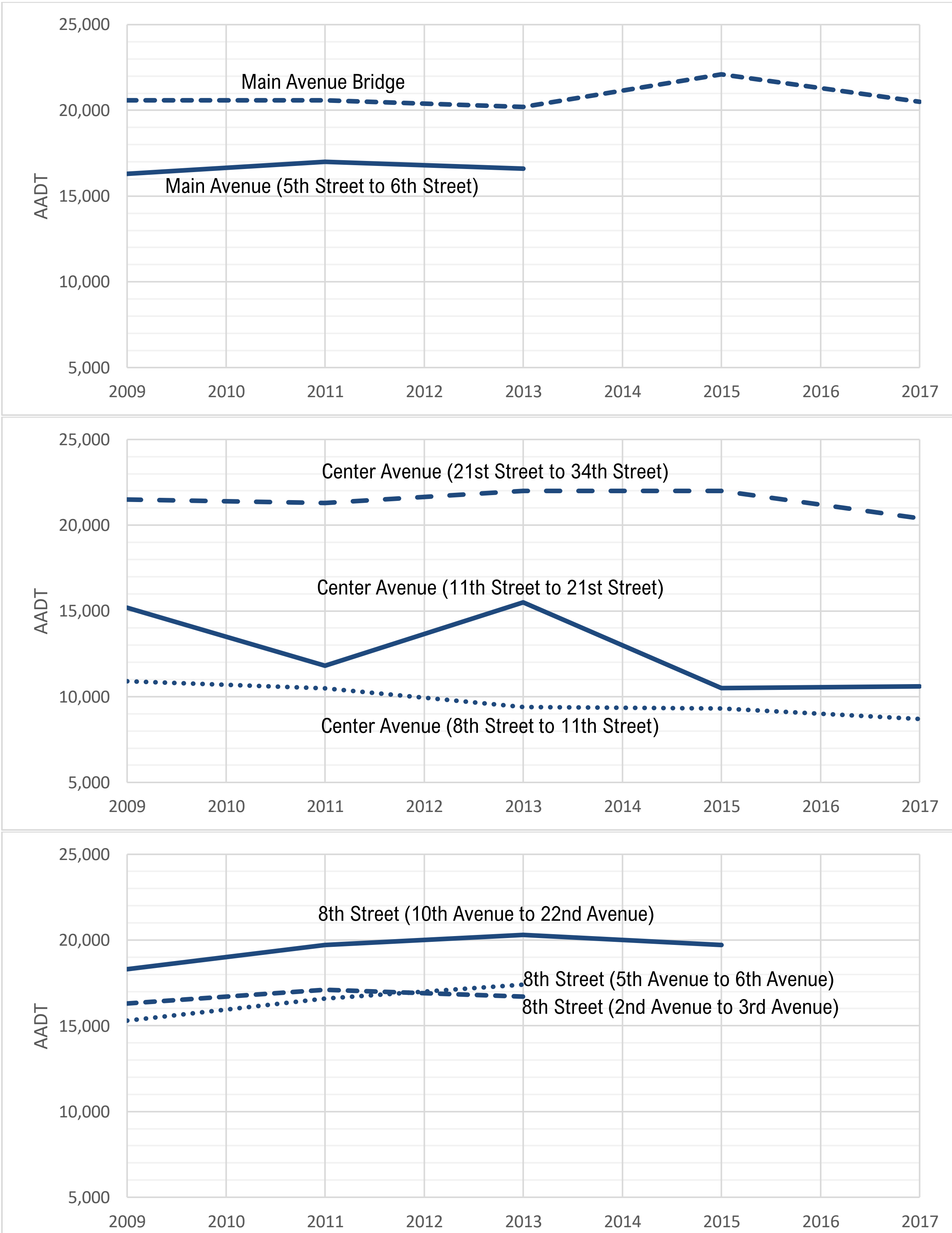


Figure 4. Historical Traffic Volumes



Alternatives

With a solid understanding of the existing issues and deficiencies (including the lack of an eastbound acceleration lane for the southbound-to-eastbound left-turn movement), alternatives were developed. Federal Highway Administration (FHWA) has developed a planning-level tool called CAP-X, which can be used to screen potential alternatives based on traffic volumes. The metric used is the volume-to-capacity (V/C) ratio, which indicates how well the alternative can handle the traffic levels. A V/C approaching or greater than 1.0 indicates the alternative is not sufficient from a traffic perspective. Intersection and corridor constraints (i.e., property impacts) also need to be considered to ensure corridor context is considered when recommending alternatives.

The vision identified for this corridor is to apply access management and reduce the median width to a more standard width to connect the urban character west of the intersection with suburban character east. Further, the analysis for this ICE assumes recommendations included in the corridor study, including: 1) removing the split phasing at 1st Avenue/21st Street; 2) restricting access at the 24th Street and 26th Street intersections to right-in/right-out; 3) restricting access at the 30th Street intersection to a 3/4 access; and 4) signalizing the 28th Street and 32nd Street intersections. Reducing the median width impacts the existing commercial vehicle site in the median. Potential options for a future inspection site are presented later in this report.

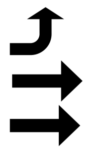
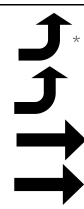
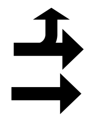
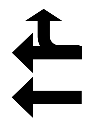
Based on existing (2018) p.m. peak hour volumes, Table 1 summarizes the alternatives considered and justification as to why or why not alternatives were carried forward in this ICE for further evaluation and consideration.

Table 1. Alternatives Considered

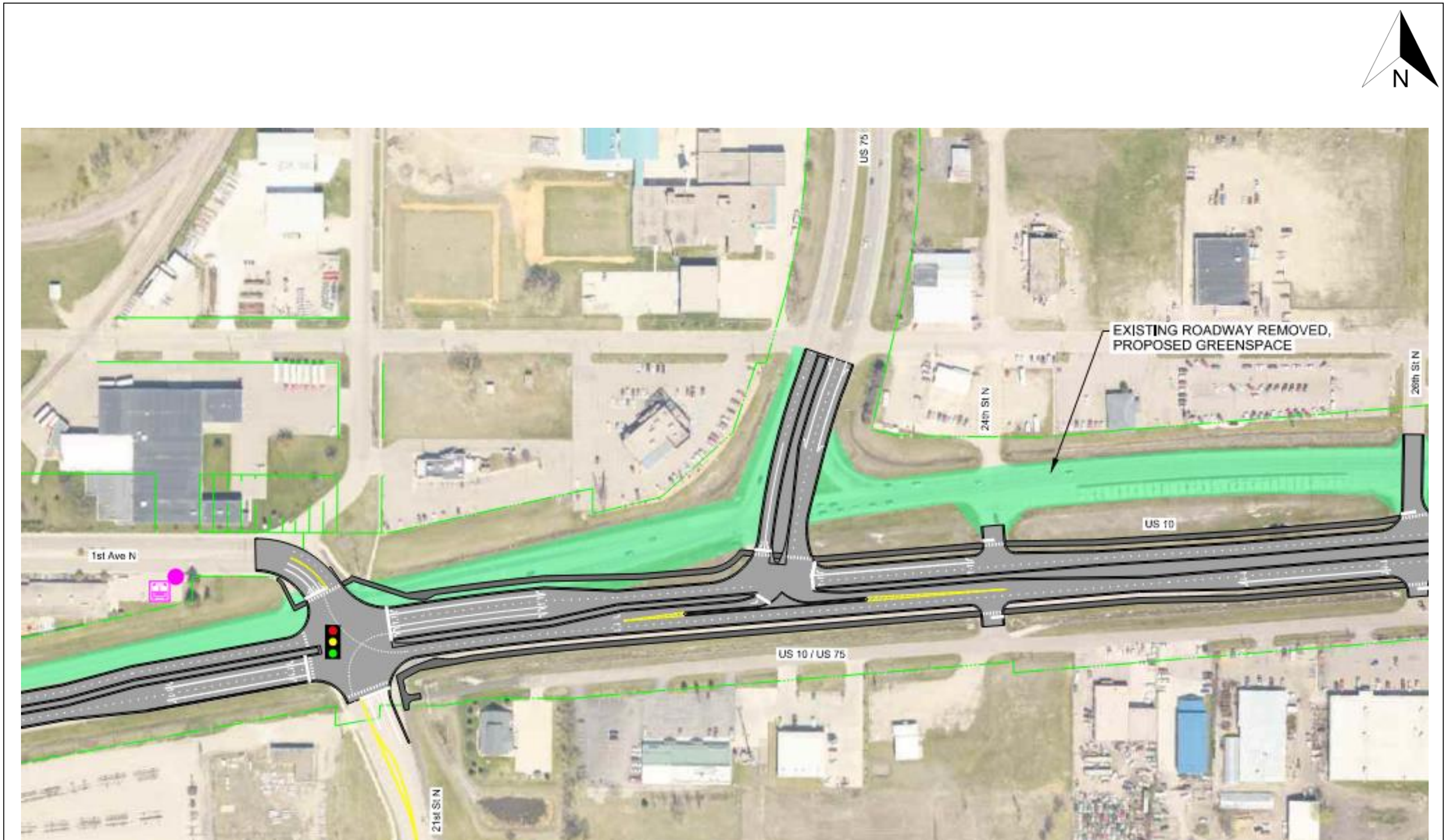
Alternative	V/C	Carried Forward?	Justification
Unsignalized	> 1.0	No	Insuffcent capacity
Traffic Signal Control	< 0.5	**Yes**	Sufficent capacity, consisent with vision
Continuous Green T	< 0.1	**Yes**	Best capacity, consistent with vision
Quadrant Roadway	< 0.8	No	Not consistent with vision
Displaced Left-turns	< 0.5	No	Not consistent with vision
Signalized RCUT	< 0.5	No	Not consistent with vision
Median U-Turn	< 0.8	No	Not consistent with vision
Single-lane Roundabout	> 1.0	No	Insuffcent capacity
Multi-lane Roundabout	< 0.8	**Yes**	Sufficent capacity, consisent with vision

Lane configurations for the continuous green T-intersection, traffic signal control and multi-lane roundabout alternatives were developed to accommodate projected traffic volumes. The assumed lane configurations for the alternatives are shown in Table 2. A concept sketch for the continuous green T, traffic signal control, and multi-lane roundabout is shown in Figures 5-7. While this ICE refers to the alternative as a "multi-lane" roundabout, the southbound approach only needs to be a single-lane approach, but this would require additional reconstruction to the north of the intersection.

Table 2. Future Intersection Lane Configurations

Approach	Existing Continuous Green T	Traffic Signal Control	Multi-lane Roundabout
Eastbound U.S. Hwy 10		 *	
Westbound U.S. Hwy 10	 Channelized turn lane	 Channelized turn lane	
Southbound U.S. Hwy 75			

* Note: Dual left-turn lane is not needed from a capacity perspective – it's included because of the geometry/lane continuity of the closely spaced intersection with 1st Avenue/21st Street to the west, which requires dual-left turns for the westbound left-turn.



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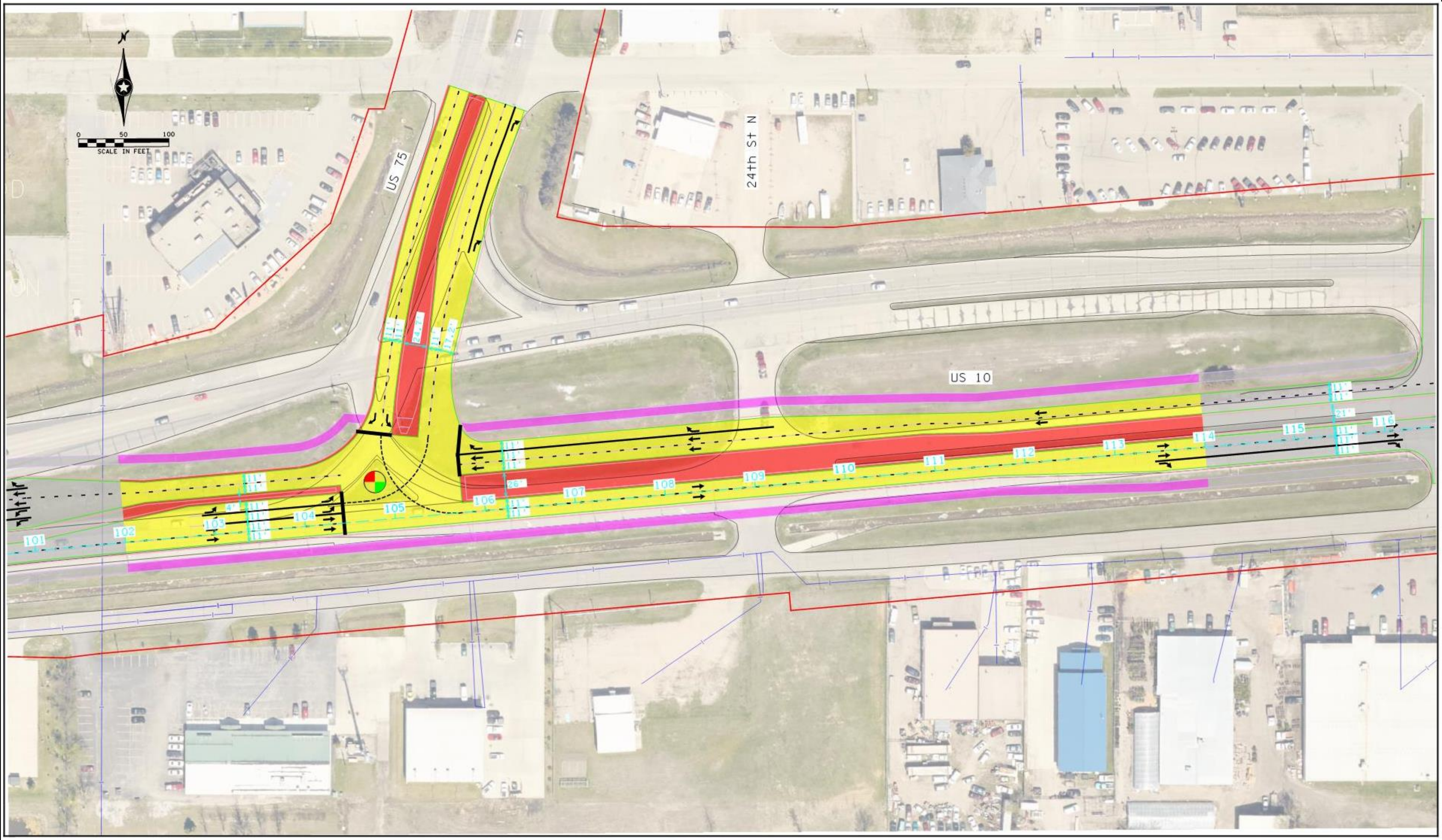
Concept Layout for Continuous Green T-Intersection

Intersection Control Evaluation
U.S. Hwy 10 at U.S. Hwy 75 (North)
Moorhead, Minnesota

Figure 5



Concept Layout for Full Traffic Signal Control

Intersection Control Evaluation
U.S. Hwy 10 at U.S. Hwy 75 (North)
Moorhead, Minnesota

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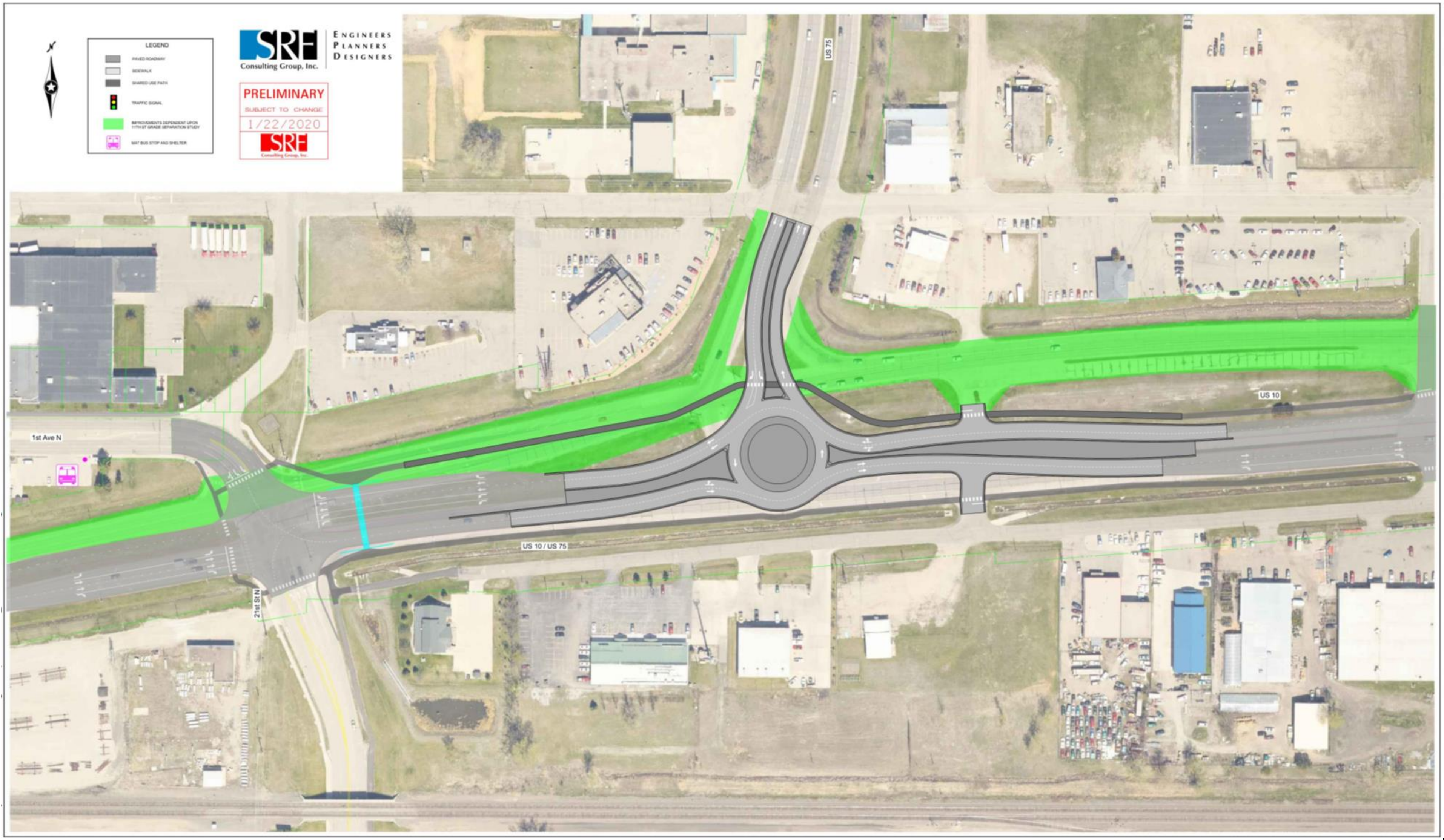
Figure 6



Concept Layout for Multi-Lane Roundabout

Intersection Control Evaluation
U.S. Hwy 10 at U.S. Hwy 75 (North)
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Figure 7

Analysis of Alternatives

Warrants Analysis

The December 2019 *Minnesota Manual on Uniform Traffic Control Devices* (MnMUTCD) provides guidance on when it may appropriate to use all-way stop or traffic signal control at an intersection. This guidance is provided in the form of "warrants", or criteria, and engineering analysis of the intersection's design factors, to determine when all-way stop or traffic signal control may be justified. All-way stop or traffic signal control should not be installed at an intersection unless a MnMUTCD warrant is met but meeting a warrant does not itself require the installation of a control. The control type also needs an engineering analysis of the intersection's design for it to be justified. Under the MnDOT ICE process, roundabouts are warranted if traffic volumes meet the warrant requirements for either all-way stop or traffic signal control.

For this ICE, analysis of signal Warrants 1-3 was conducted for Opening Day Year 2027 and Design Year 2045 volumes. The lane geometry and approach speeds assumed for the warrants analysis are shown in Table 2.

Table 3. Warrants Analysis Assumptions

Approach	Geometry	Speed Limit
Eastbound U.S. Hwy 10	Two or more approach lanes	45 mph
Westbound U.S. Hwy 10	Two or more approach lanes	45 mph
Southbound U.S. Hwy 75	One approach lane	45 mph

For the analysis, right-turn volumes on the minor street approach were excluded because this movement has an exclusive right-turn lane so these turns can be easily made and would not benefit from the addition of a signal. Also, the 70 percent traffic volume factor was used for the warrants analysis as proposed conditions met necessary the criteria specified within the MnMUTCD (i.e., mainline speed limit exceeds 40 mph. Table 4 provides a summary of the warrants analysis results and the detailed volume-based results are included in Appendix C.

Table 4. Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Required	Opening Day Year 2027 Volumes		Year 2040 Volumes	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A: Minimum Vehicular Volume	8	0	No	1	No
Warrant 1B: Interruption of Continuous Traffic	8	8	Yes	10	Yes
Warrant 1C: Combination of Warrants	8	2	No	4	No
Warrant 2: Four-Hour Volume	4	7	Yes	9	Yes
Warrant 3B: Peak Hour Volume	1	3	Yes	6	Yes
Warrants 4-9	Not Evaluated				

The results of the analysis indicate that the intersection meets MnMUTCD signal warrants 1B, 2, and 3B under both Year 2027 and Year 2045 volume conditions. For traffic signal installation, MnDOT typically requires Warrant 1 to be met, which requires 8-hours of combined major approach volumes and the maximum minor approach volume to meet MnMUTCD thresholds. This means if either Warrant 1A or 1B are met, Warrant 1 itself is considered met.

Traffic Operations Analysis

The traffic operations analysis identified a Level of Service (LOS) which indicates how well an intersection is operating based on average delay per vehicle. Delay is calculated based on procedures outlined in the Highway Capacity Manual (HCM). Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are considered acceptable because the intersection would be operating under capacity.

Operational analysis of the continuous green T-intersection alternative was performed using PTV VISSIM (Version 11.00-02). VISSIM can calculate various measures of effectiveness such as control delay, queuing, and total travel time impacts. Operational analysis of the traffic signal control alternative was performed using methods outlined in the 2010 edition of the HCM using Synchro/SimTraffic Version 9.1. Synchro/SimTraffic can calculate various measures of effectiveness such as control delay, queuing, and total travel time impacts. SimTraffic results are reported for the analysis. Operational analysis of the roundabout alternative was performed using RODEL software. RODEL can calculate various measures of effectiveness such as delay and queuing.

Results of the traffic operations analysis indicate that all alternatives would perform at acceptable levels of service under Year 2027 volumes and proposed lane configurations. Table 5 provides a summary of the Year 2027 traffic operations analysis. The Year 2027 detailed results are included in Appendix D.

Table 5. Opening Day Year 2027 Traffic Operations Analysis Results

Alternative	AM Peak Hour		PM Peak Hour	
	Overall Delay	LOS	Overall Delay	LOS
Continuous Green T-Intersection	8 sec.	A	8 sec.	A
Traffic Signal	11 sec.	B	15 sec.	B
Multi-lane Roundabout	6 sec.	A	9 sec.	A

Table 5 provides a summary of the Year 2045 operations analysis. Results of the traffic operations analysis indicate that all alternatives would continue to operate at acceptable levels of service under Year 2045 volumes and proposed lane configurations. Detailed results can be found in Appendix E.

Table 6. Design Year 2045 Traffic Operations Analysis Results

Alternative	AM Peak Hour		PM Peak Hour	
	Overall Delay	LOS	Overall Delay	LOS
Continuous Green T-Intersection	9 sec.	A	10 sec.	B
Traffic Signal	11 sec.	B	16 sec.	B
Multi-lane Roundabout	7 sec.	A	14 sec.	B

Crash Analysis

A crash analysis was performed to determine the projected crashes per year for each traffic control alternative for the Opening Day Year 2027 and Year 2045 conditions. Since the existing intersection configuration is similar to a green T-intersection (except today drivers making the southbound-to-eastbound left-turn need to yield in the median since there is no acceleration lane) and there is not an identified crash issue today, the existing intersection crash rate was used for the continuous green T-intersection control alternative.

Crash Modification Factors (CMFs) were used to determine predicted crashes for the alternatives. CMFs are estimates of the resulting change in crash rates after a change to an intersection or roadway segment. A CMF of 0.75 indicates that the crash rate after the change is expected to be 75% of the existing crash rate (i.e., a 25% reduction in crashes is expected). For this analysis, CMFs were obtained from the CMF Clearinghouse website. This website is funded by the FHWA and provides a searchable database of CMFs from various studies.

For the Traffic Signal, a CMF of 1.04 for all crashes and 1.15 for injury and fatal crashes was assumed. For the roundabout alternative, a CMF of 1.06 for all crashes and 0.37 for injury crashes was assumed. A summary of the crash analysis is shown in Table 7.

Table 7. Crash Analysis Results

Alternative	Intersection ADT		Crash Modification Factor(s)	Average Crash Rate (1)	Projected Crashes/Year	
	Opening Day Year 2027	Year 2045			Opening Day Year 2027	Forecast Year 2045
Continuous Green T-Intersection	26,500	31,700	N/A	0.32 (2)	3.1	3.7
Traffic Signal			1.04 / 1.15	0.33 (3)	3.2	3.8
Multi-lane Roundabout			1.06 / 0.37	0.34 (3)	3.3	3.9

(1) Per million entering vehicles.
(2) Assumed to match the observed crash rate.
(3) Based on adjusting the observed crash rate with a crash modification factor.

Alternatives Assessment

Right of Way Considerations

Sufficient right of way exists; therefore, right of way is not a differentiator between the alternatives.

Corridor Functionality Considerations

All alternatives are consistent with the corridor vision and can adequately accommodate traffic levels; however, there is risk with the multi-lane roundabout alternative relative to queuing issues between the 1st Avenue/21st Avenue intersection and the US 10/US 75 intersection. From a traffic calming perspective, the multi-lane roundabout slows all traffic down by the nature of its design, which further promotes an urban character connecting the character of the corridor in downtown Moorhead with the character through Dilworth. However, overall average delay per vehicle is less with the continuous green T-intersection compared to the other alternatives.

Further, roundabouts are most appropriate where the traffic flows are balanced on all approaches as roundabouts introduce delay to all movements, essentially treating each movement equally. For the study intersection, over 85 percent of the intersection entering traffic is on U.S. Hwy 10; therefore, a roundabout would cause undue delay to mainline traffic on U.S. Hwy 10. Traffic signals can provide progression along a corridor and can be used to interrupt heavy traffic to allow other traffic, vehicular or pedestrians, to complete their movements. With the green T-intersection there is no delay introduced for eastbound U.S. Hwy 10 traffic but the it still allows traffic the opportunity to easily access the mainline of U.S. Hwy 10 int both directions.

Pedestrian and Bicycle Considerations

All alternatives adequately accommodate pedestrians and bicycles. With traffic signals (even with the continuous green T-intersection), pedestrian phases can be built into the signal timing to allow for protected pedestrian crossings at the designated crosswalks. Bicycles would cross like vehicles unless there is an adjacent shared-use path. However, conflicts exist between turning vehicles and pedestrians/bikes and crashes that involve vehicles that run red lights are severe. Roundabout control benefits pedestrians and bicycles by:

- Making drivers slow down driving through the intersection.
- Reducing the distance pedestrians and bikes need to cross.
- Raised medians provide a refuge for those crossing.
- Pedestrians and bikes only need to look at one direction of traffic at a time.

While the multi-lane roundabout provides additional conflicts for pedestrians/bikes with vehicles (compared to a single-lane roundabout), vehicles are traveling slow through the roundabout so potential crashes tend to be less severe.

Conclusions and Recommendations

Based on the results of this intersection control evaluation, and in support of the overall US 10/ US 75 Corridor Study goals with input from study partners and community, converting the intersection to a continuous green T-intersection is recommended for the intersection of U.S. Hwy 10 and U.S. Hwy 75 (North) intersection in Moorhead. The following supports this recommendation:

Currently, eastbound traffic does not have to stop and would continue to not have to stop with the continuous green T-intersection alternative; both the multi-lane roundabout and traffic signal alternatives introduce undue delay to eastbound U.S. Hwy 10 traffic. Future, the green T-intersection minimizes the potential risk for queuing impacts between the 1st Avenue/21st Street and US 10/75 intersections. Since the existing intersection configuration is similar to a green T-intersection (except today drivers making the southbound-to-eastbound left-turn need to yield in the median since there is no acceleration lane) and there is not an identified crash issue today, the green T-intersection configuration would be low-risk from a safety perspective.

As documented in the overall study, with the continuous green-T intersection recommendation at US 10/75, an inspection site in the westbound direction is not feasible. Input from stakeholders indicates a desire to maintain a future inspection site along U.S. Hwy 10. To address this, several alternatives were developed (see Appendix F) that can be further considered as the project develops.

One option uses the City-owned transfer facility property in the southwest quadrant of the 28th Street intersection. This location would require trucks to exit and re-enter U.S. Hwy 10. Further, the City desires to keep this property for potential redevelopment opportunities if other inspection site locations are feasible. A second option also requires trucks to exit and re-enter U.S. Hwy 10 using the northern frontage road between 26th and 28th Streets.

While State Patrol would prefer the inspection site remains near the US 10/75 intersection where travel speeds are low and commercial vehicles can be captured in both directions, an inspection site on both shoulders of US 10 east of Dilworth between the 12th and 60th Street intersections can be accommodated. This would allow for the inspection of trucks that bypass the I-94 weigh station and access US 10 via Hwy 336.

Findings from this ICE will inform MnDOT's 2025-2026 reconstruction of the corridors. As new traffic date becomes available during preliminary and final design, queue storage and turn lane lengths should be confirmed to ensure turn lanes can accommodate projected traffic.

Appendices

Appendix A: 2013-2017 Crash History

Appendix B: Historical Trends

Appendix C: Opening Day Year 2027 All-way Stop and Traffic Signal Warrants Analysis
Year 2045 All-way Stop and Traffic Signal Warrants Analysis

Appendix D: Opening Day Year 2027 Detailed Traffic Operations Analysis

Appendix E: Year 2045 Detailed Traffic Operations Analysis

Appendix F: Options for Maintaining Commercial Vehicle Inspection Site

Appendix A

2013-2017 Crash History

US 10 / US 75 Corridor Study
Intersection Crash History (2013-2017)

Intersection Name	Traffic Control	Major 1	Major 2	Minor 1	Minor 2	ADT	Expected Crash Rate*	Facility Type	Actual Crash Rate	Critical Crash Rate	Severity Rate	Total Crashes	Total Severe Crashes
I-94 Bus/Main Ave & 4th St	Signalized	22100	16600	3200	1750	21,825	0.70	Signalized High Vol Low Speed	0.35	1.05	0.68	14	1
I-94 Bus/Main Ave & 5th St	Signalized	16600	16600	300	1850	17,675	0.70	Signalized High Vol Low Speed	0.47	1.09	0.59	15	0
I-94 Bus/Main Ave & 6th St	Signalized	16600	16600	1300	1300	17,900	0.70	Signalized High Vol Low Speed	0.28	1.09	0.43	9	0
I-94 Bus/Main Ave & 7th St	Thru Stop	16600	16600	890		17,045	0.18	Urban Thru/Stop	0.13	0.40	0.16	4	0
I-94 Bus/Main Ave & US Hwy 75/8th St	Signalized	16600	10600	16700	10000	26,950	0.70	Signalized High Vol Low Speed	0.57	1.01	0.77	28	0
I-94 Bus/Main Ave & 10th St	Thru Stop	10600	10600	200	200	10,800	0.18	Urban Thru/Stop	0.10	0.46	0.20	2	0
I-94 Bus/Main Ave & 11th St	Signalized	10600	9500	3300	3300	13,350	0.52	Signalized Low Vol Low Speed	0.70	0.91	0.99	17	0
US Hwy 75/8th St & US Hwy 10/Center Ave	Signalized	10000	4700	7000	8700	15,200	0.70	Signalized High Vol Low Speed	0.79	1.12	1.15	22	0
US Hwy 10/Center Ave & 11th St	Signalized	8700	9100	3300	4600	12,850	0.52	Signalized Low Vol Low Speed	0.60	0.92	0.68	14	0
US Hwy 10/Center Ave & 14th St	Signalized	9100	10000	3300	1650	12,025	0.52	Signalized Low Vol Low Speed	0.32	0.93	0.59	7	0
US Hwy 10/Center Ave & 21st St	Signalized	10000	20400	13000	11000	27,200	0.70	Signalized High Vol Low Speed	0.73	1.01	0.97	36	0
US Hwy 10/Center Ave & US Hwy 75	Signalized	20400	20400		7200	24,000	0.70	Signalized High Vol Low Speed	0.32	1.03	0.41	14	0
US Hwy 10 & 24th St	Thru Stop	20400	20400	400	600	20,900	0.18	Urban Thru/Stop	0.16	0.38	0.34	6	0
US Hwy 10 & 26th St	Thru Stop	20400	20400	30	300	20,565	0.18	Urban Thru/Stop	0.03	0.38	0.03	1	0
US Hwy 10 & 28th St	Thru Stop	20400	18400	500	980	20,140	0.18	Urban Thru/Stop	0.30	0.38	0.41	11	0
US Hwy 10 & 30th St	Thru Stop	18400	18400	650	2200	19,825	0.18	Urban Thru/Stop	0.17	0.38	0.25	6	0
US Hwy 10 & 32nd St	Signalized	18400	18400	2700	1500	20,500	0.70	Signalized High Vol Low Speed	0.27	1.06	0.37	10	0
US Hwy 10 & 34th St	Signalized	18400	18400	15600	10200	31,300	0.70	Signalized High Vol Low Speed	1.12	0.99	1.61	64	0
US Hwy 75/8th St & 2nd Ave	Thru Stop	16700	16700	2250	1500	18,575	0.18	Urban Thru/Stop	0.47	0.39	0.47	16	0
US Hwy 75/8th St & 3rd Ave	Thru Stop	16700	16700	850	850	17,550	0.18	Urban Thru/Stop	0.12	0.39	0.22	4	0
US Hwy 75/8th St & 4th Ave	Thru Stop	17400	16700	750	1100	17,975	0.18	Urban Thru/Stop	0.27	0.39	0.30	9	0
US Hwy 75/8th St & 5th Ave	Thru Stop	17400	17400	500	750	18,025	0.18	Urban Thru/Stop	0.00	0.39	0.00	0	0
US Hwy 75/8th St & 6th Ave	Thru Stop	17400	17400	1000	150	17,975	0.18	Urban Thru/Stop	0.15	0.39	0.18	5	0
US Hwy 75/8th St & 7th Ave	Signalized	17400	17400	2200	880	18,940	0.70	Signalized High Vol Low Speed	0.41	1.08	0.49	14	0
US Hwy 75/8th St & 9th Ave (Old Main Bldg)	Thru Stop	17400	17400	100		17,450	0.18	Urban Thru/Stop	0.03	0.39	0.03	1	0
US Hwy 75/8th St & 10th Ave	Signalized Stop	17400	17400	1100		17,950	0.18	Urban Thru/Stop	0.24	0.39	0.34	8	0
US Hwy 75/8th St & 12th Ave	Signalized	19700	17400	3800	6000	23,450	0.70	Signalized High Vol Low Speed	0.51	1.04	0.72	22	0
US Hwy 75/8th St & 14th Ave	Thru Stop	19700	19700	450		19,925	0.18	Urban Thru/Stop	0.08	0.38	0.11	3	0
US Hwy 75/8th St & 16th Ave	Thru Stop	19700	19700	900	100	20,200	0.18	Urban Thru/Stop	0.00	0.38	0.00	0	0
US Hwy 75/8th St & 18th Ave (West)	Thru Stop	19700	19700	500	300	20,100	0.18	Urban Thru/Stop	0.08	0.38	0.08	3	0
US Hwy 75/8th St & 20th Ave	Signalized	33000	19700	710	2100	27,755	0.70	Signalized High Vol Low Speed	0.38	1.01	0.61	19	0

Intersection Name	K	A	B	C	PD	Rear End	Sideswipe Passing	Runoff Road	Angle	Head On	Sideswipe Opposing	Other	Day	Dawn/Dusk	Dark with Streetlights	Dark	Other/ Unknown	Dry	Wet	Snow/Slush	Other	Single Vehicle Crashes	Multi-Vehicle Crashes
I-94 Bus/Main Ave & 4th St	0	1	2	6	5	4	2	1	3	0	3	1	11	0	3	0	0	7	2	5	0	3	11
I-94 Bus/Main Ave & 5th St	0	0	1	2	12	6	2	0	7	0	0	0	15	0	0	0	0	9	0	6	0	0	15
I-94 Bus/Main Ave & 6th St	0	0	1	3	5	3	2	0	2	0	0	2	8	0	1	0	0	5	2	2	0	2	7
I-94 Bus/Main Ave & 7th St	0	0	0	1	3	2	1	0	1	0	0	0	4	0	0	0	0	4	0	0	0	0	4
I-94 Bus/Main Ave & US Hwy 75/8th St	0	0	1	8	19	11	3	0	8	3	0	3	26	1	1	0	0	21	3	4	0	1	27
I-94 Bus/Main Ave & 10th St	0	0	1	0	1	0	0	0	2	0	0	0	2	0	0	0	0	1	0	1	0	0	2
I-94 Bus/Main Ave & 11th St	0	0	1	5	11	3	1	0	12	0	0	1	14	0	3	0	0	12	1	3	1	0	17
US Hwy 75/8th St & US Hwy 10/Center Ave	0	0	3	4	15	5	6	1	9	1	0	0	18	0	4	0	0	12	2	8	0	0	22
US Hwy 10/Center Ave & 11th St	0	0	0	2	12	1	1	1	10	0	0	1	10	0	4	0	0	6	3	5	0	1	13
US Hwy 10/Center Ave & 14th St	0	0	2	2	3	1	1	0	3	1	1	0	6	0	1	0	0	7	0	0	0	1	6
US Hwy 10/Center Ave & 21st St	0	0	2	8	26	13	2	0	10	2	2	7	28	1	7	0	0	25	1	10	0	3	32
US Hwy 10/Center Ave & US Hwy 75	0	0	1	2	11	8	1	0	4	0	0	1	12	0	2	0	0	11	1	2	0	0	14
US Hwy 10 & 24th St	0	0	3	1	2	0	0	0	5	0	1	0	5	0	1	0	0	4	1	1	0	0	6
US Hwy 10 & 26th St	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0
US Hwy 10 & 28th St	0	0	1	2	8	0	0	0	8	0	0	3	10	0	1	0	0	8	1	1	1	2	9
US Hwy 10 & 30th St	0	0	1	1	4	0	0	0	5	0	0	1	6	0	0	0	0	6	0	0	0	1	5
US Hwy 10 & 32nd St	0	0	1	3	5	7	0	1	2	0	0	0	9	0	1	0	0	7	2	1	0	2	9
US Hwy 10 & 34th St	0	0	5	18	41	24	6	0	25	2	3	4	46	2	16	0	0	44	7	11	2	3	61
US Hwy 75/8th St & 2nd Ave	0	0	0	0	16	1	1	0	11	0	0	3	12	0	4	0	0	11	4	0	1	1	15
US Hwy 75/8th St & 3rd Ave	0	0	1	1	2	1	0	0	2	0	0	1	3	0	1	0	0	3	0	1	0	0	4
US Hwy 75/8th St & 4th Ave	0	0	0	1	8	0	1	0	6	0	0	2	7	1	1	0	0	5	0	4	0	1	8
US Hwy 75/8th St & 5th Ave	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US Hwy 75/8th St & 6th Ave	0	0	0	1	4	3	0	0	2	0	0	0	4	0	1	0	0	1	2	2	0	0	5
US Hwy 75/8th St & 7th Ave	0	0	0	3	11	5	1	2	5	1	0	0	12	0	2	0	0	5	4	5	0	3	11
US Hwy 75/8th St & 9th Ave (Old Main Bldg)	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1
US Hwy 75/8th St & 10th Ave	0	0	1	1	6	7	1	0	0	0	0	0	8	0	0	0	0	6	1	1	0	0	7
US Hwy 75/8th St & 12th Ave	0	0	2	5	15	12	1	1	4	2	2	0	19	0	3	0	0	11	1	10	0	0	22
US Hwy 75/8th St & 14th Ave	0	0	0	1	2	1	1	0	1	0	0	0	3	0	0	0	0	2	0	1	0	0	3
US Hwy 75/8th St & 16th Ave	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
US Hwy 75/8th St & 18th Ave (West)	0	0	0	0	3	3	0	0	0	0	0	0	3	0	0	0	0	2	1	0	0	0	3
US Hwy 75/8th St & 20th Ave	0	0	2	8	9	13	0	0	5	1	0	0	16	0	3	0	0	14	3	2	0	0	19
	0%	0%	9%	24%	66%	31%	10%	1%	41%	3%	4%	9%	82%	1%	16%	0%	0%	68%	10%	21%	1%		

Notes:
*Expected rates from MnDOT's 2015 Intersection Green Sheets
MnDOT Traffic Monitoring Products website was used for segment ADT information
Crash Rate < Expected Crash Rate
Expected Crash Rate < Crash Rate < Critical Crash Rate
Crash Rate > Critical Crash Rate
Intersections using 200 ft Radius

Appendix B

Historical Trends

Moorhead

1 US 10 (Main Avenue) Bridge

2009	20600	
2011	20600	
2013	20200	0.32%
2015	22100	
2017	20500	

2 US 10 (Main Avenue) 5th Street to 6th Street

2009	16300	
2011	17000	0.45%
2013	16600	

3 US 10/75 (Center Avenue) 8th Street to 11th

2009	10900	
2011	10500	
2013	9400	-3.22%
2015	9300	
2017	8700	

4 US 10/75 (Center Avenue) 11th Street to 1st

2009	15200	
2011	11800	
2013	15500	-4.95%
2015	10500	
2017	10600	

5 US 10 (Center Avenue) 1st Avenue/21st Street to 34th Street

2009	21500	
2011	21300	
2013	22000	-0.37%
2015	22000	
2017	20400	

6 US 75 (8th Street) 2nd Avenue to 3rd Avenue

2009	16300	
2011	17100	0.60%
2013	16700	

7 US 75 (8th Street) 5th Avenue to 6th Avenue

2009	15300	
2011	16600	3.02%
2013	17400	

8 US 75 (8th Street) 10th Avenue to 22nd Avenue

2009	18300	
2011	19700	1.22%
2013	20300	
2015	19700	

Average Growth Rate $\boxed{-0.37\%}$

Appendix C

Opening Day Year 2027 and Year 2045
All-way Stop and Traffic Signal Warrants Analysis

Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2027

U.S. Hwy 10/U.S. Hwy 75 (North)
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Background Information				Speed (mph)	Lanes	Approach	
	Location :	Moorhead, MN					
	Date:	1/14/2020		45	2 or more	Major Approach 1:	Eastbound U.S. Hwy 10
	Analysis Prepared By:	M.Knight		45	2 or more	Major Approach 3:	Westbound U.S. Hwy 10
	Population Less than 10,000:		No	45	1	Minor Approach 2:	Southbound U.S. Hwy 75
	Seventy Percent Factor Used:		Yes			Minor Approach 4:	

Warrants Analysis: Warrants 1A, 1B and 1C

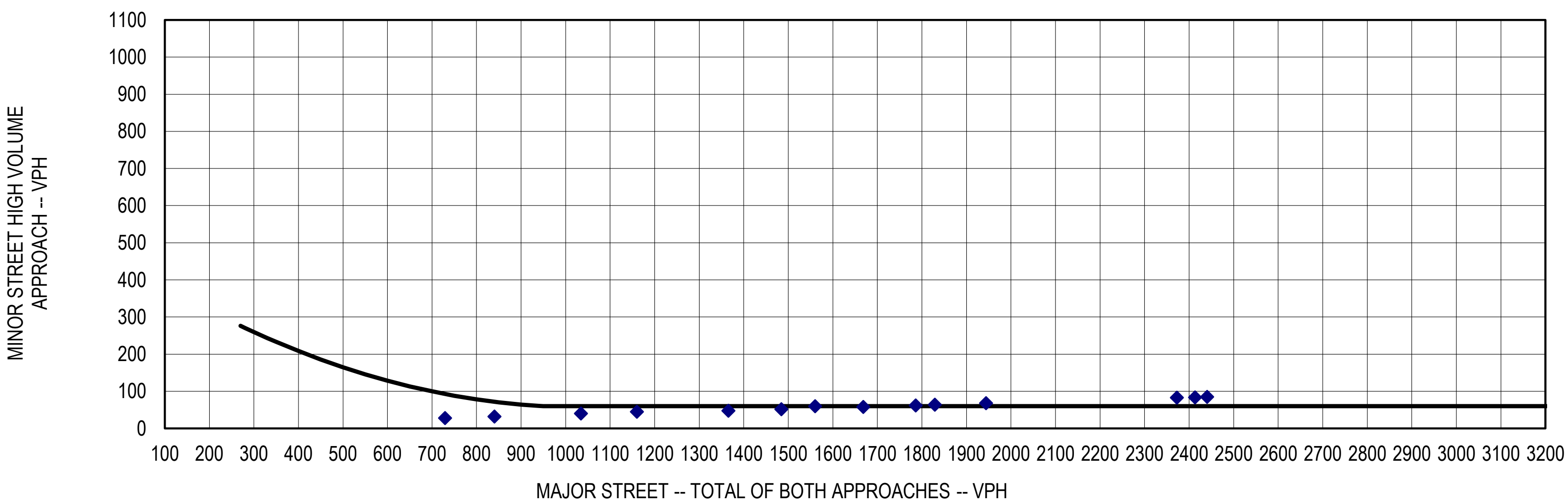
Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	238	491	729	X	X	28	0	28							X	
7 - 8 AM	510	1050	1560	X	X	60	0	60		X		X		X	X	
8 - 9 AM	379	781	1160	X	X	45	0	45						X	X	
9 - 10 AM	275	565	840	X	X	32	0	32							X	
10 - 11 AM	338	696	1034	X	X	40	0	40							X	
11 - 12 AM	976	508	1484	X	X	52	0	52						X	X	
12 - 1 PM	1279	665	1944	X	X	68	0	68		X		X		X	X	
1 - 2 PM	1097	571	1668	X	X	58	0	58		X		X		X	X	
2 - 3 PM	1203	626	1829	X	X	64	0	64		X		X		X	X	
3 - 4 PM	1560	812	2372	X	X	83	0	83		X		X		X	X	
4 - 5 PM	1605	835	2440	X	X	85	0	85		X		X	X	X	X	
5 - 6 PM	1587	826	2413	X	X	84	0	84		X		X	X	X	X	
6 - 7 PM	1175	611	1786	X	X	62	0	62		X		X		X	X	
											0	8	2	11	0	

Warrant Summary

Warrant	Description	Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	8	8	Met - Warrant 1B Satisfied
Warrant 1C:	Combination of Warrants	2	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	7	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	3	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

Warrants Analysis: Warrant 2

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME



Number of Hours Satisfying Requirements:	7

Notes:
1. 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 60 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.
2. INTERSECTION IS EITHER (1) WITHIN A COMMUNITY LESS THAN 10,000 POPULATION OR (2) HAS SPEEDS ABOVE 40 MPH ON MAJOR STREET.

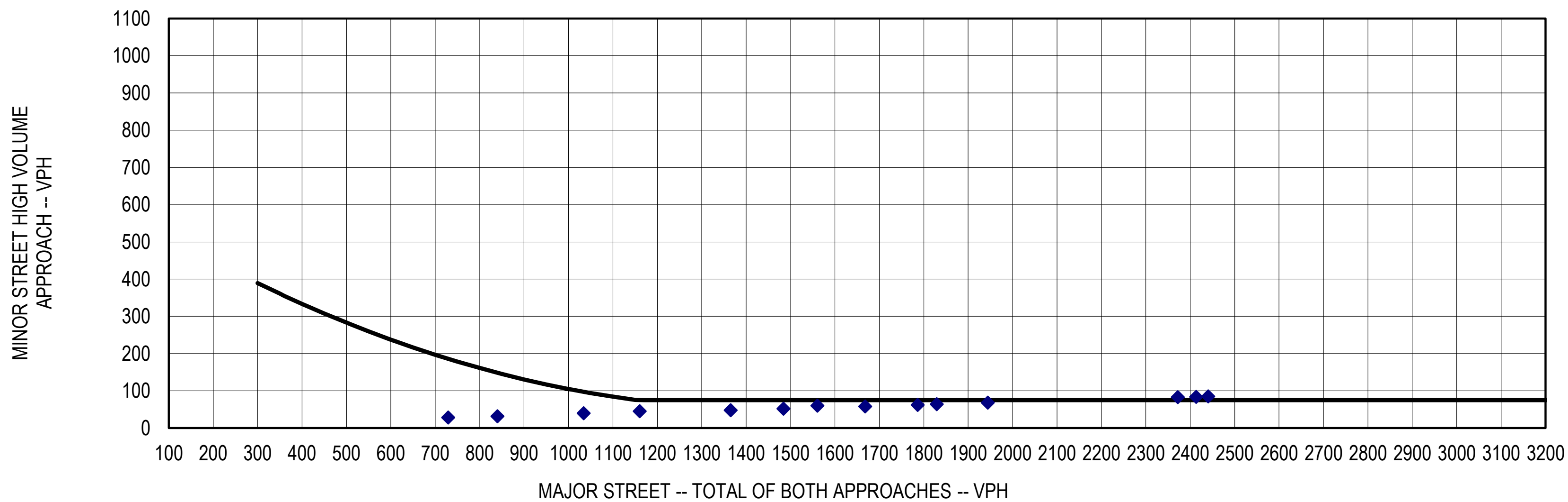
WARRANTS ANALYSIS

Year 2027

U.S. Hwy 10/U.S. Hwy 75 (North)
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Warrants Analysis: Warrant 3

WARRANT 3 - PEAK HOUR



Number of Hours Satisfying Requirements:	3

Notes:
1. 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 75 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.
2. INTERSECTION IS EITHER (1) WITHIN A COMMUNITY LESS THAN 10,000 POPULATION OR (2) HAS SPEEDS ABOVE 40 MPH ON MAJOR STREET.

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2045

U.S. Hwy 10/U.S. Hwy 75 (North)
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Background Information			Speed (mph)	Lanes	Approach	
Location :	Moorhead, MN					
Date:	12/30/2019		45	2 or more	Major Approach 1:	Eastbound U.S. Hwy 10
Analysis Prepared By:	M.Knight		45	2 or more	Major Approach 3:	Westbound U.S. Hwy 10
Population Less than 10,000:		No	45	1	Minor Approach 2:	Southbound U.S. Hwy 75
Seventy Percent Factor Used:		Yes			Minor Approach 4:	

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met		Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met		Met Same Hours		Combination		MWSA (C)	
				420	630				105	53	Condition A	Condition B	A	B	210	140
6 - 7 AM	285	589	874	X	X	33	0	33							X	
7 - 8 AM	610	1260	1870	X	X	70	0	70		X		X		X	X	
8 - 9 AM	454	937	1391	X	X	52	0	52						X	X	
9 - 10 AM	328	678	1006	X	X	38	0	38							X	
10 - 11 AM	404	835	1239	X	X	46	0	46						X	X	
11 - 12 AM	1167	608	1775	X	X	64	0	64		X		X		X	X	
12 - 1 PM	1530	797	2327	X	X	84	0	84		X		X	X	X	X	
1 - 2 PM	1313	684	1997	X	X	72	0	72		X		X		X	X	
2 - 3 PM	1439	750	2189	X	X	79	0	79		X		X		X	X	
3 - 4 PM	1866	972	2838	X	X	102	0	102		X		X	X	X	X	
4 - 5 PM	1920	1000	2920	X	X	105	0	105	X	X	X	X	X	X	X	
5 - 6 PM	1899	989	2888	X	X	104	0	104		X		X	X	X	X	
6 - 7 PM	1405	732	2137	X	X	77	0	77		X		X		X	X	
											1	10	4	12	0	

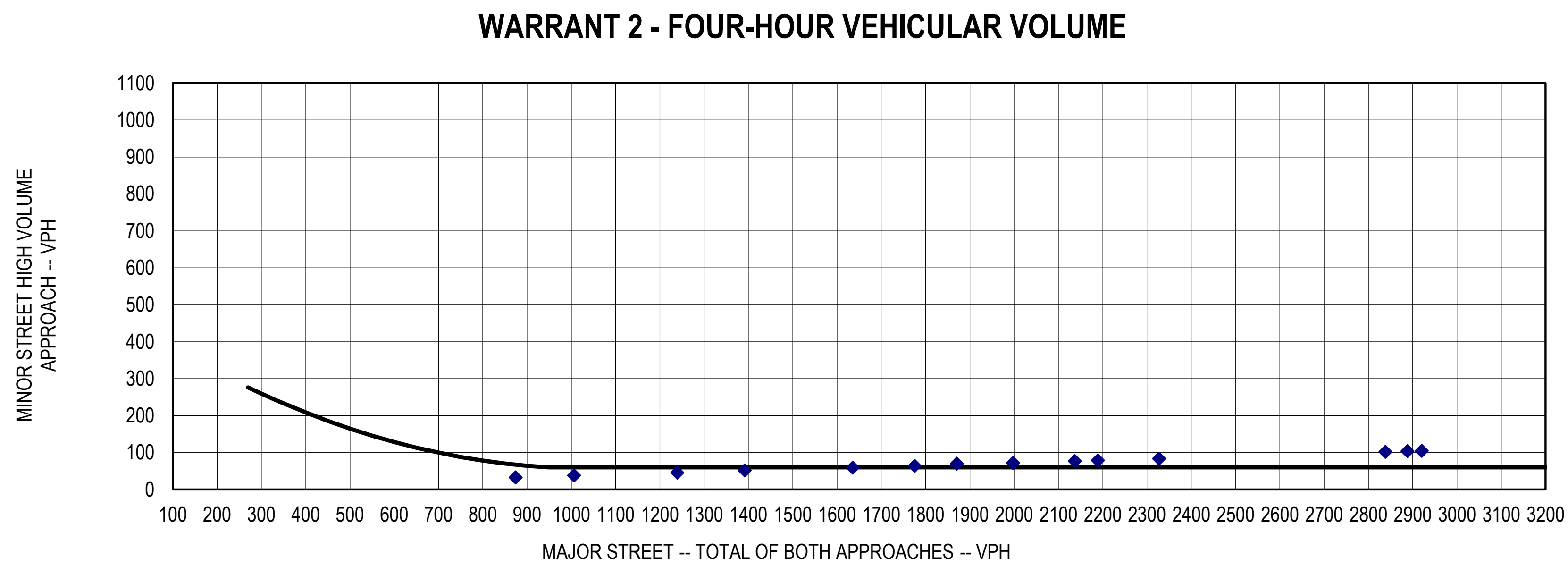
Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	1	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	10	8	Met - Warrant 1B Satisfied
Warrant 1C:	Combination of Warrants	4	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	9	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	6	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

WARRANTS ANALYSIS **Year 2045**

U.S. Hwy 10/U.S. Hwy 75 (North)
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

Warrants Analysis: Warrant 2



Number of Hours Satisfying Requirements:	9

Notes:
1. 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 60 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.
2. INTERSECTION IS EITHER (1) WITHIN A COMMUNITY LESS THAN 10,000 POPULATION OR (2) HAS SPEEDS ABOVE 40 MPH ON MAJOR STREET.

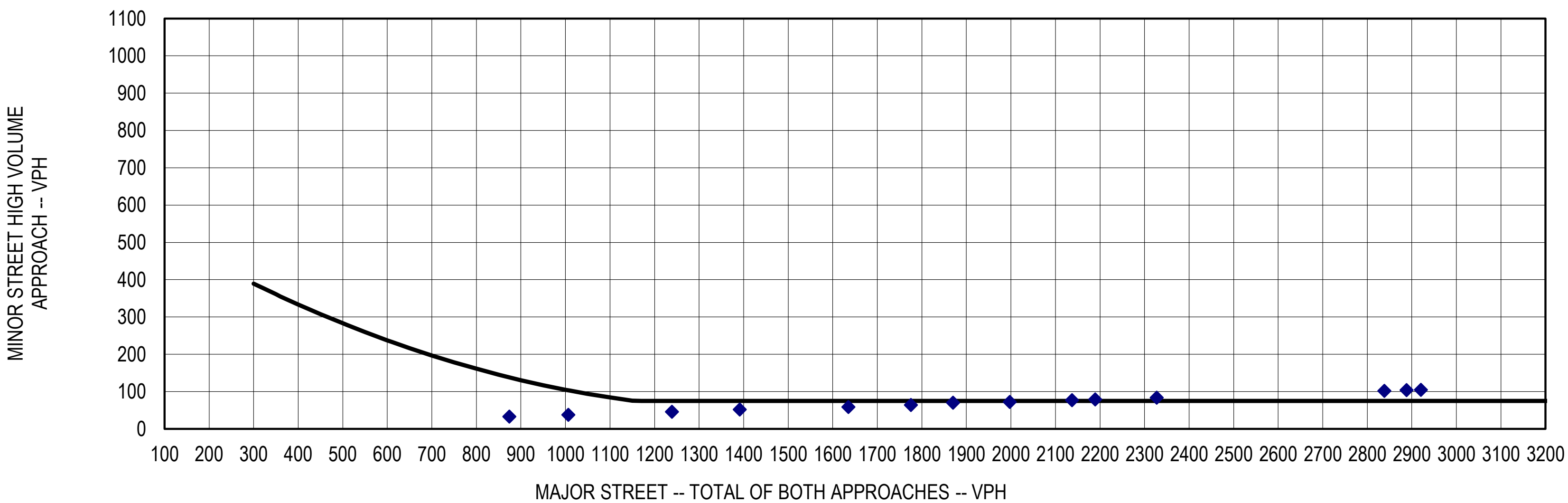
Warrants Analysis: Warrant 3

WARRANTS ANALYSIS

Year 2045

U.S. Hwy 10/U.S. Hwy 75 (North)
US Hwy 10/US Hwy 75 Corridor Study
Moorhead, MN

WARRANT 3 - PEAK HOUR



Number of Hours Satisfying Requirements:	6

Notes:
1. 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 75 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.
2. INTERSECTION IS EITHER (1) WITHIN A COMMUNITY LESS THAN 10,000 POPULATION OR (2) HAS SPEEDS ABOVE 40 MPH ON MAJOR STREET.

Appendix D

Opening Day Year 2027 Detailed Traffic Operations Analysis

2027 AM No Build
US 10/US 75 VISSIM Analysis
MOE Results

Center Ave/TH 75 — **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Southbound	Left	55	18	98	46.8	D	17.4	B	8.3	A
	Right	239	34	128	10.6	B				
Eastbound	Left	114	21	109	40.8	D	9.7	A		
	Thru	380	0	0	0.4	A				
Westbound	Thru	982	12	166	5.4	A	5.1	A		
	Right	72	0	9	1.1	A				

2027 No Build PM
US 10/US 75 VISSIM Analysis
MOE Results

Center Ave/TH 75 **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Southbound	Left	85	27	131	50.8	D	18.5	B	8.3	A
	Right	298	46	161	9.3	A				
Eastbound	Left	233	40	193	40.1	D	6.3	A		
	Thru	1,347	0	0	0.5	A				
Westbound	Thru	759	12	152	7.9	A	7.4	A		
	Right	89	0	12	3.2	A				

110: Center Ave/Center Ave (TH 10) Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.0	0.0	0.2	0.0
Total Del/Veh (s)	12.4	9.2	12.9	10.7

Intersection: 110: Center Ave/Center Ave (TH 10)

Movement	EB	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	L	T	T	T	T	L	R
Maximum Queue (ft)	53	72	32	63	160	165	63	107
Average Queue (ft)	24	51	14	29	98	107	41	65
95th Queue (ft)	66	80	45	67	177	190	80	121
Link Distance (ft)			691	691	329	329	744	744
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	175	175						
Storage Blk Time (%)								
Queuing Penalty (veh)								

110: Center Ave/Center Ave (TH 10) Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.0	0.0	0.3	0.0
Total Del/Veh (s)	16.6	8.8	20.7	14.9

Intersection: 110: Center Ave/Center Ave (TH 10)

Movement	EB	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	L	T	T	T	T	L	R
Maximum Queue (ft)	141	159	221	224	208	200	150	166
Average Queue (ft)	68	90	90	94	98	82	65	75
95th Queue (ft)	119	138	179	187	183	159	121	135
Link Distance (ft)			700	700	321	321	748	748
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	175	175						
Storage Blk Time (%)	0	0	0					
Queuing Penalty (veh)	0	0	1					

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	SB US 75	0	0	12.00	1	14.00	1	35.00	100.00	40.00
2	EB US 75/US 10	90	0	24.00	2	28.00	2	35.00	100.00	40.00
3	WB US 10	270	0	24.00	2	28.00	2	35.00	100.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	SB US 75	180.00	32.00	2	18.00	1	24.00	2
2	EB US 75/US 10	180.00	20.00	1	30.00	2	24.00	2
3	WB US 10	180.00	20.00	1	30.00	2	24.00	2

Bypass Geometry

Bypass Approach Geometry (ft)

Leg	Leg Names	Bypass Type	Bypass Flows	V	nv	Vb	nvb	Vt	nvt
1	SB US 75	Yield	245	12	1	12	1	24	2

Bypass Entry and Exit Geometry (ft)

Leg	Leg Names	Entry Geometry						Leg	Leg Names	Exit Lanes	
		Eb	neb	Lb	Lt	Rb	Phib			nex	Nmx
1	SB US 75	14	1	35	35	100.0000 992	40	2	EB US 75/US 10	2	2

Operational Results

2027 AM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	SB US 75	Yield	5.21	8.29	7.68	0.23	1.24	A	A	A
2	EB US 75/US 10	None	4.69		4.69	1.08		A		A
3	WB US 10	None	6.52		6.52	2.83		A		A

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	SB US 75	0	0	12.00	1	14.00	1	35.00	100.00	40.00
2	EB US 75/US 10	90	0	24.00	2	28.00	2	35.00	100.00	40.00
3	WB US 10	270	0	24.00	2	28.00	2	35.00	100.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	SB US 75	180.00	32.00	2	18.00	1	24.00	2
2	EB US 75/US 10	180.00	20.00	1	30.00	2	24.00	2
3	WB US 10	180.00	20.00	1	30.00	2	24.00	2

Bypass Geometry

Bypass Approach Geometry (ft)

Leg	Leg Names	Bypass Type	Bypass Flows	V	nv	Vb	nvb	Vt	nvt
1	SB US 75	Yield	305	12	1	12	1	24	2

Bypass Entry and Exit Geometry (ft)

Leg	Leg Names	Entry Geometry						Leg	Leg Names	Exit Lanes	
		Eb	neb	Lb	Lt	Rb	Phib			nex	Nmx
1	SB US 75	14	1	35	35	100.0001056	40	2	EB US 75/US 10	2	2

Operational Results

2027 PM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	SB US 75	Yield	5.26	8.52	7.80	0.30	1.53	A	A	A
2	EB US 75/US 10	None	11.18		11.18	9.54		B		B
3	WB US 10	None	6.18		6.18	2.24		A		A

Appendix E

Year 2045 Detailed Traffic Operations Analysis

2045 AM Build - Split Phase Removed
US 10/US 75 VISSIM Analysis
MOE Results

Center Ave/1st Ave/21st St — **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Northbound	Left	72	15	125	41	D	27.5	C	27.2	C
	Thru	476	55	238	32.4	C				
	Right	246	15	148	13.9	B				
Southbound	Left	120	20	91	38.2	D	35.8	D		
	Thru	239	53	230	35.0	D				
	Right	8	50	231	23.3	C				
Eastbound	Left	15	4	34	47.6	D	23.6	C		
	Thru	226	19	116	25.4	C				
	Right	49	3	93	7.9	A				
Westbound	Left	464	61	216	41.0	D	25.5	C		
	Thru	545	27	173	16.4	B				
	Right	428	44	297	20.4	C				

Center Ave/TH 75 — **Roundabout**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Southbound	Left	67	17	152	7.5	A	10.7	B	5.7	A
	Right	286	17	152	11.5	B				
Eastbound	Left	138	0	24	2.6	A	2.0	A		
	Thru	453	0	24	1.8	A				
Westbound	Thru	1,153	5	178	6.1	A	6.1	A		
	Right	84	4	178	5.9	A				

2045 Build PM - Split Phase Removed
US 10/US 75 VISSIM Analysis
MOE Results

Center Ave/1st Ave/21st St — **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Northbound	Left	25	6	57	46	D	28.5	C	33.3	C
	Thru	343	50	256	37.0	D				
	Right	573	79	347	22.6	C				
Southbound	Left	398	98	293	62.0	E	51.1	D		
	Thru	235	53	230	33.5	C				
	Right	8	51	232	25.2	C				
Eastbound	Left	24	6	54	49.3	D	37.1	D		
	Thru	904	127	456	39.3	D				
	Right	87	5	107	11.0	B				
Westbound	Left	519	60	214	37.0	D	24.5	C		
	Thru	470	21	135	14.9	B				
	Right	246	18	160	16.3	B				

Center Ave/TH 75 — **Roundabout**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Southbound	Left	102	13	147	5.3	A	7.2	A	7.1	A
	Right	358	13	147	7.8	A				
Eastbound	Left	284	7	223	7.4	A	6.4	A		
	Thru	1,588	7	223	6.2	A				
Westbound	Thru	881	5	151	8.5	A	8.4	A		
	Right	104	5	150	7.2	A				

2045 AM No Build
US 10/US 75 VISSIM Analysis
MOE Results

Center Ave/TH 75 **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Southbound	Left	68	23	124	45.8	D	18.4	B	8.8	A
	Right	285	40	155	11.9	B				
Eastbound	Left	138	24	137	38.8	D	9.3	A		
	Thru	453	0	0	0.4	A				
Westbound	Thru	1,166	17	201	6.1	A	5.8	A		
	Right	86	0	10	1.1	A				

2040 No Build
US 10/US 75 VISSIM Analysis
MOE Results

Center Ave/TH 75 **Signal**

Approach	Movement	Volume (vph)	Average Queue (ft)	Maximum Queue (ft)	Movement Delay (sec/veh)	Movement LOS	Approach Delay (sec/veh)	Approach LOS	Overall Delay (sec/veh)	Overall LOS
Southbound	Left	103	36	168	53.2	**D**	20.9	C	9.7	A
	Right	358	56	198	11.5	B				
Eastbound	Left	276	45	207	39.1	**D**	6.3	A		
	Thru	1,587	0	0	0.6	A				
Westbound	Thru	889	19	203	11.7	B	11.0	B		
	Right	106	0	17	5.3	A				

110: Center Ave/Center Ave (TH 10) Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.0	0.0	0.3	0.0
Total Del/Veh (s)	12.3	8.4	19.0	11.3

Intersection: 110: Center Ave/Center Ave (TH 10)

Movement	EB	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	L	T	T	T	T	L	R
Maximum Queue (ft)	54	84	84	94	178	178	66	136
Average Queue (ft)	31	59	45	63	127	124	38	100
95th Queue (ft)	66	87	99	110	213	213	72	164
Link Distance (ft)			691	691	329	329	744	744
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	175	175						
Storage Blk Time (%)								
Queuing Penalty (veh)								

110: Center Ave/Center Ave (TH 10) Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.0	0.0	0.3	0.0
Total Del/Veh (s)	17.8	9.7	24.5	16.4

Intersection: 110: Center Ave/Center Ave (TH 10)

Movement	EB	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	L	T	T	T	T	L	R
Maximum Queue (ft)	170	174	238	107	238	200	172	234
Average Queue (ft)	84	103	45	47	116	86	79	112
95th Queue (ft)	142	156	110	95	208	163	142	199
Link Distance (ft)			700	700	321	321	748	748
Upstream Blk Time (%)			0					
Queuing Penalty (veh)			0					
Storage Bay Dist (ft)	175	175						
Storage Blk Time (%)	0	1	0					
Queuing Penalty (veh)	1	4	0					

Appendix F

Options for Maintaining Commercial Vehicle Inspection Site

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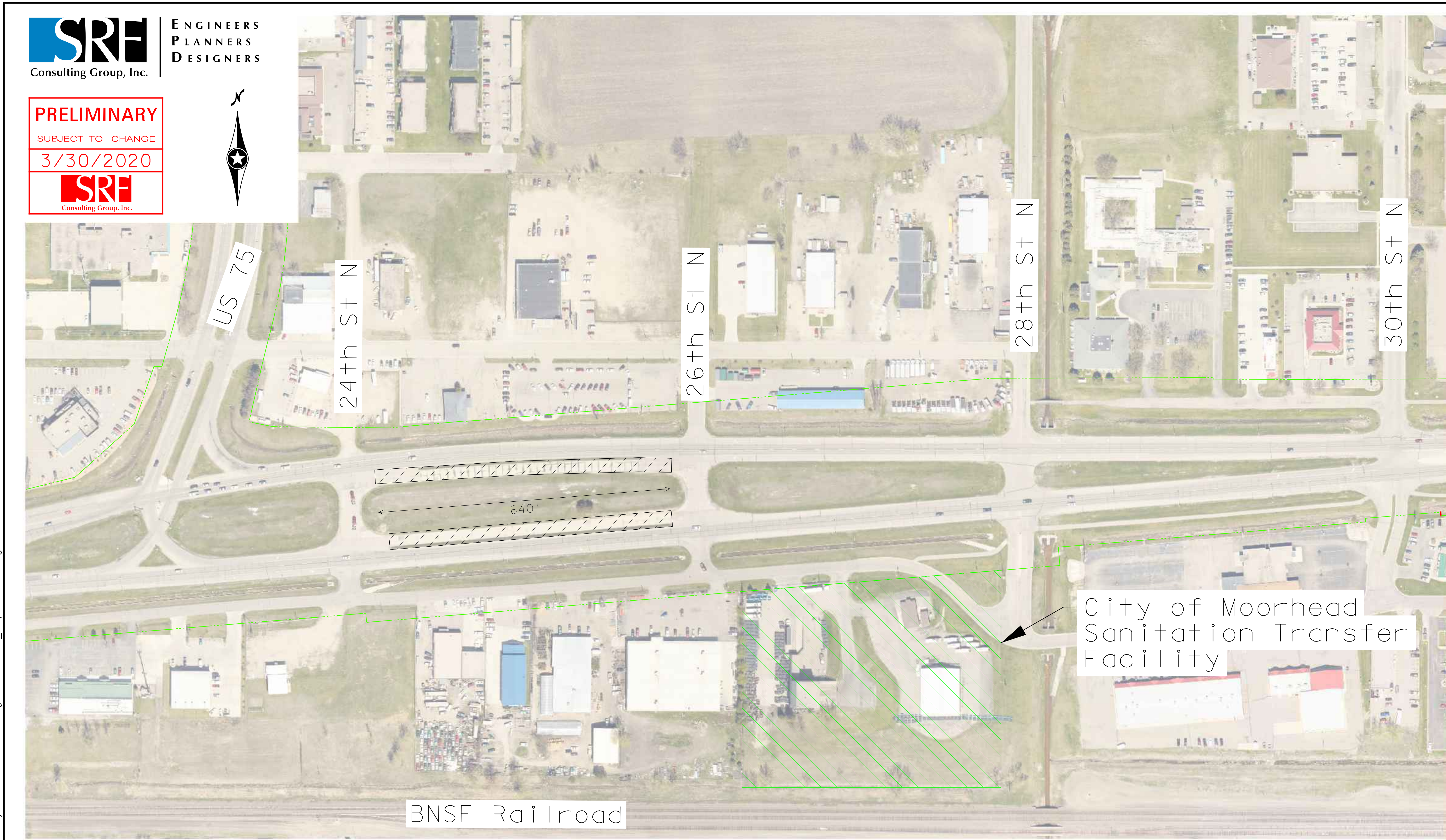
Potential Truck Inspection Site East of Dilworth

US 10 / US 75 Corridor Study

Moorhead, Minnesota

Job # 11648
3/30/2020



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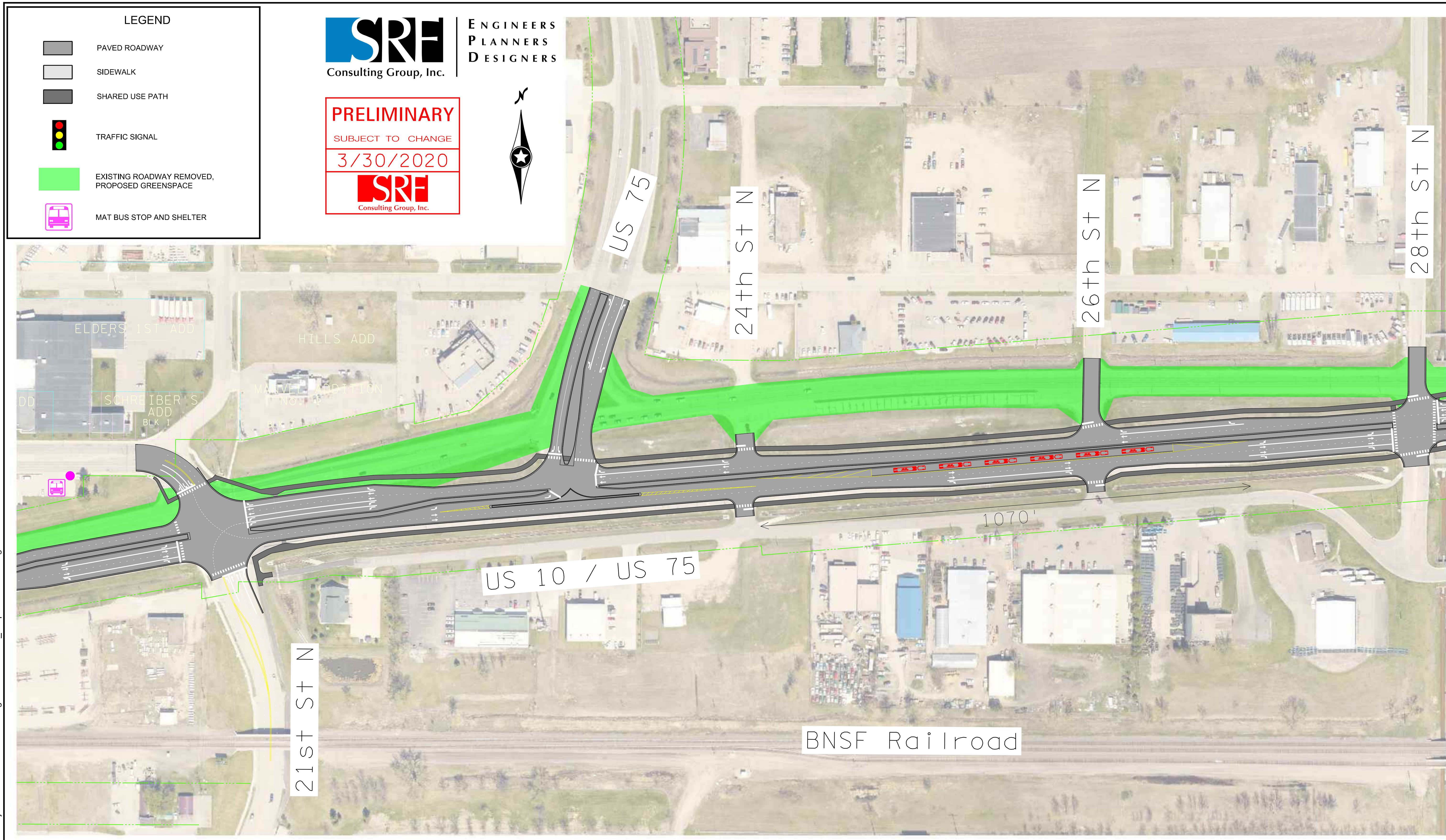
Existing Truck Inspection Site & Proposed City Transfer Site

US 10 / US 75 Corridor Study

Moorhead, Minnesota

Job # 11648
3/30/2020



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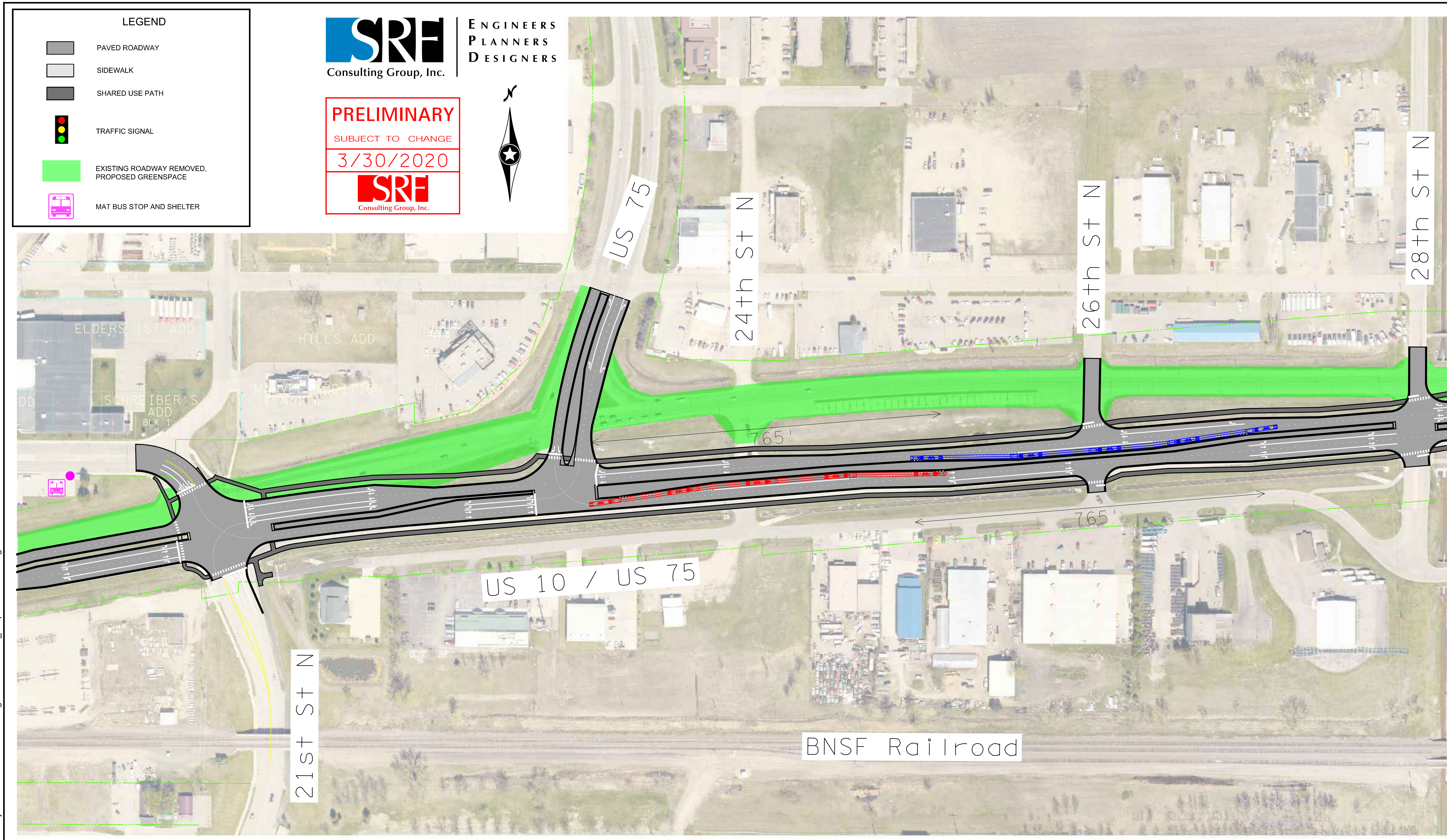
Potential Eastbound Inspection Site with Green Tee Intersection

US 10 / US 75 Corridor Study

Moorhead, Minnesota

Job # 11648
3/30/2020



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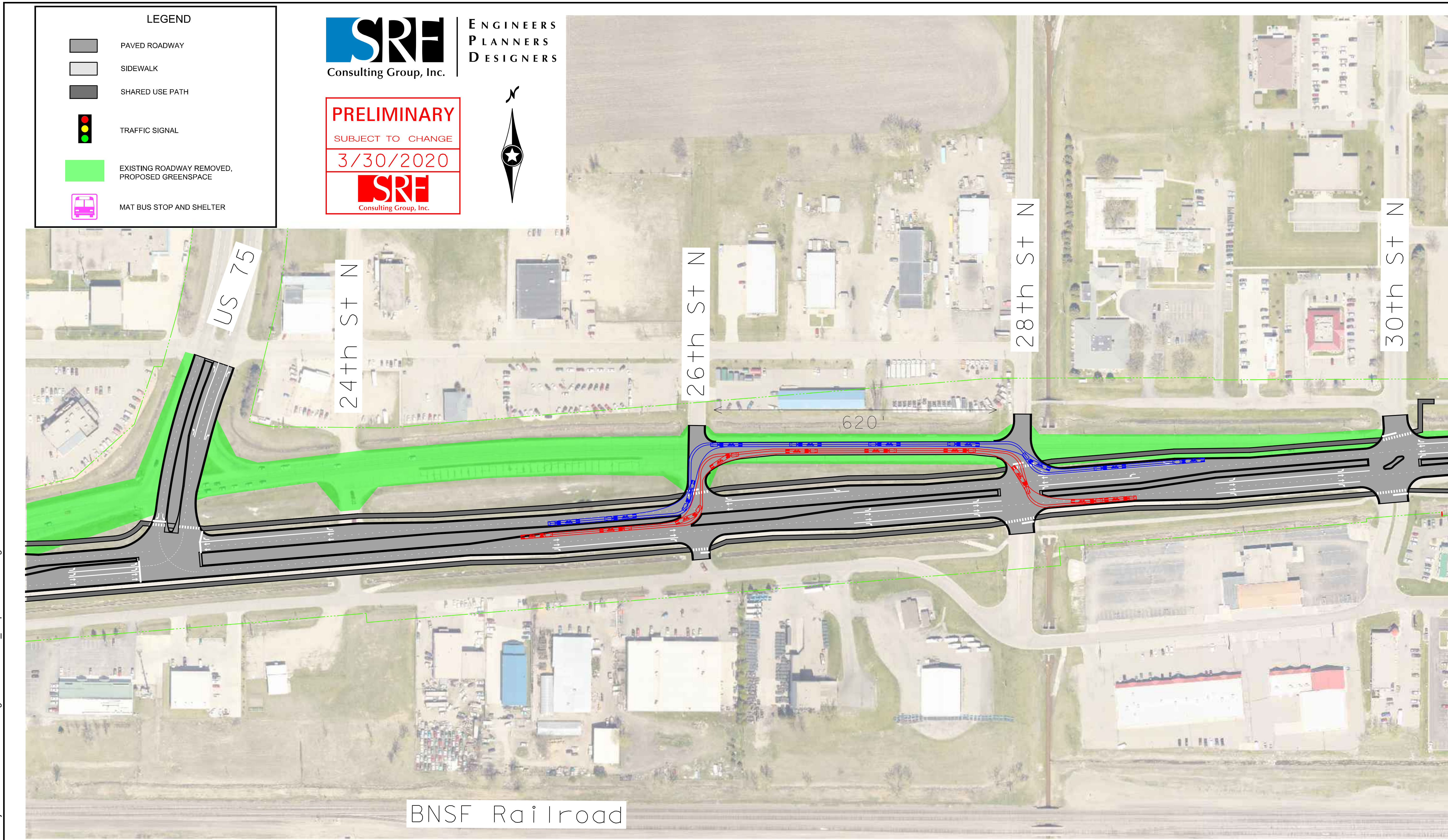
Potential Median Truck Inspection Site

US 10 / US 75 Corridor Study

Moorhead, Minnesota

Job # 11648
3/30/2020



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Potential Pull Off Truck Inspection Site

US 10 / US 75 Corridor Study

Moorhead, Minnesota

Job # 11648
3/30/2020