Intersection Control Evaluation Report

TH 210 (Washington Street) - 4th Avenue NE to 10th Avenue NE

MNT03 152201
S.P. No. 1805-80 |

Brainerd, Minnesota | August 9, 2022

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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.

Graham Johnson, PE (MN), PTOE

Date: _____ License No.: 45429

Approved By:

MnDOT District 3 Traffic Engineer Date

Crow Wing County Engineer Date

City of Brainerd Engineer Date

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TH 210 (Washington Street) - 4th Avenue NE to 10th Avenue NE

Prepared by Short Elliott Hendrickson, Inc. for the Minnesota Department of Transportation (MnDOT) District 3, in cooperation with Crow Wing County and the City of Brainerd.

1 Background and Description

Trunk Highway (TH) 210, also known as Washington Street, is an east-west principal arterial roadway through the City of Brainerd. TH 210 spans across north-central Minnesota and within the project area has daily traffic volumes ranging from 11,800 to 32,500 vehicles per day (vpd).

MnDOT is conducting a corridor planning study along a 3.9-mile segment of TH 210 to identify the future vision for the corridor through Brainerd. Reconstruction of TH 210 between Baxter Drive and Pine Shores Road is anticipated to begin in 2025.

The primary purpose of the corridor study is to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout. The focus of the future improvements is to improve pavement conditions and travel safety, accommodate ADA requirements, and enhance pedestrian and bicyclist accommodations.

This Intersection Control Evaluation (ICE) Report emphasizes the evaluated and proposed improvements along TH 210 between 4th Avenue NE and 10th Avenue NE. The existing conditions, future No Build conditions, and future Build conditions were previously documented for the entire corridor; for more detailed information, see the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

The ICE study intersections include multiple MnDOT State Aid routes for both the County and City; County State Aid Highway (CSAH) 3 is the main study intersection with TH 210, and three of the adjacent study intersections are Municipal State Aid Streets (MSAS).

1.1 Overview

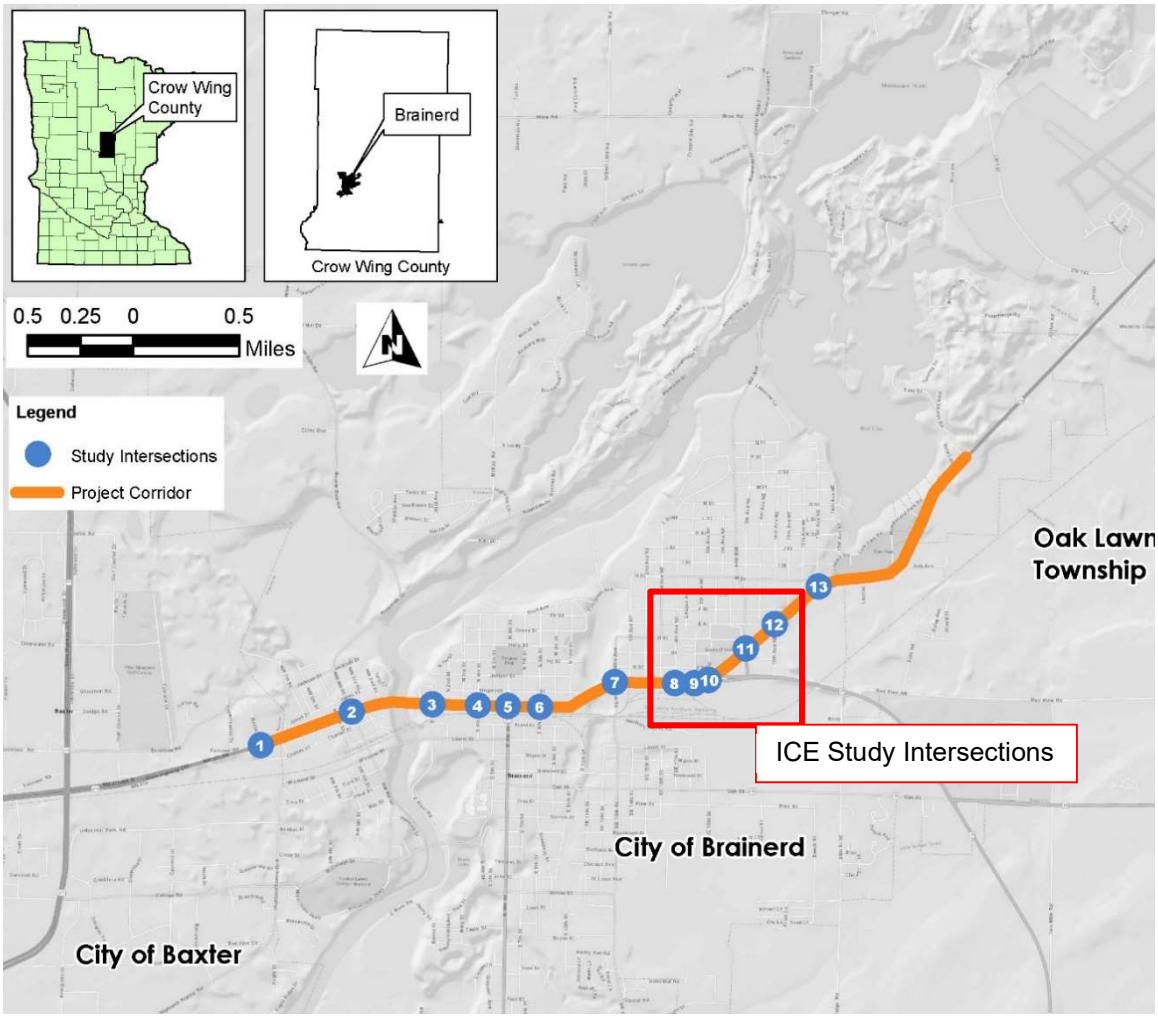
The primary purpose of this report is to determine the optimal alternative and intersection control needed for the study intersections along TH 210 from 4th Avenue NE to 10th Avenue NE.

- TH 210 at 4th Avenue NE (MSAS 118) (traffic signal control)
- TH 210 at 5th Avenue NE (MSAS 141) (3/4-access)
- TH 210 at TH 25 Connections (EB ramp & closed intersection)
- TH 210 at East Brainerd Mall Access (WB Right-in/Right-Out)
- TH 210 at 8th Avenue NE (CSAH 3) (traffic signal control)
- TH 210 at 10th Avenue NE (MSAS 115) (minor stop control)

The MnDOT Intersection Control Evaluation (ICE) is an objective process used to investigate and determine the optimal type of traffic control that should be provided at each intersection to serve the existing conditions and future needs. The investigation includes analyzing traffic operations during the AM and PM peak hours for the existing year (2019) and forecast year (2045) traffic conditions; in addition, a Friday and Summer peak hour were evaluated. The evaluations include assessing traffic control volume warrants, intersection and roadway safety, and traffic operations.

Figure 1 depicts the corridor study intersections and reconstruction area in a location map; the intersections included in this evaluation are highlighted.

Figure 1 – Corridor Study Project Location



Due to the proximity to the East Brainerd Mall on the north side of TH 210, this study area has been named the **East Mall Area**.

2 Existing Conditions

TH 210 is a major east-west principal arterial through the City of Brainerd that connects near-by cities and regional commerce. TH 210 is generally a 4-lane divided roadway through the City of Brainerd. The posted speed limit is 35 miles-per-hour (mph) west of 5th Avenue NE and 45 mph east of 5th Avenue NE.

4th Avenue NE (MSAS 118) is a minor collector providing access to residential land uses north of TH 210. The TH 210 intersection is currently controlled by a traffic signal, with access to the rail yard property to the south.

5th Avenue NE (MSAS 141) is a local roadway providing access to residential land uses to the north as well as to the commercial land uses, including the East Brainerd Mall area. The existing TH 210 intersection is a ¾-access control; minor street can only make a right turn.

8th Avenue NE (CSAH 3) is a minor arterial north of TH 210 providing access to residential land uses along the corridor as well as a regional connection to communities north of the city. The TH 210 intersection is currently controlled by a traffic signal.

TH 25 is a minor arterial providing regional connections to the south and east. The existing connections have been modified in recent years. Currently, eastbound TH 210 has a direct ramp connection to TH 25; all other connections occur at the 8th Avenue NE connection to TH 210.

10th Avenue NE (MSAS 115) major collector between TH 210 and TH 25, and a local roadway north of TH 210. The TH 210 intersection is currently a full access, minor stop control with TH 210 unrestricted.

In addition to the five main study intersections, the East Brainerd Mall has a right-in/right-out (RI/RO) access along westbound TH 210 that was included in the analysis.

2.1 Crash History

Crash data from January 1, 2014 through December 31, 2018 was provided by MnDOT. The type and severity of crashes were reviewed, and crash rates were calculated for each study intersection. There was a total of 75 crashes over the 5 years analyzed at the 5 intersections along TH 210.

The crash rate at each intersection is expressed as a number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be further reviewed.

Crash severity is separated into five categories based on injuries sustained during the crash.

- Fatal – Crash that results in a death
- Severity A – Crash that results in an incapacitating injury or serious injury
- Severity B – Crash that results in a non-incapacitating injury or minor injury
- Severity C – Crash that results in possible injury
- Property Damage – Crash that results in property damage only; with no injuries

Table 1 presents the 5-year crash history; no intersection in the East Mall Area is above the critical rate; however, two are within 15% of the critical rate. **Appendix A** includes additional crash details.

Table 1 – Intersection Crash History (2014-2018)

TH 210 at:	Crash Severity					Crash Rates	
	Fatal & Severity A	Severity B	Severity C	Property Damage	Total Crashes	Int. Rate	Critical Rate
4th Ave NE	0	1	1	20	22	0.47	1.02
5th Ave NE	0	0	2	5	7	0.15	0.32
TH 25 Exit Ramp	0	0	0	2	2	0.06	0.34
TH 25 Entrance Ramp*	1	1	2	8	12	0.36	0.39
8th Ave NE	0	0	8	20	28	0.74	0.75
10th Ave NE	1	0	0	3	4	0.17	0.54
TOTAL	**2**	**2**	**13**	**58**	**75**	n/a	n/a

Note: *Intersection currently closed (2018).

Above Critical Rate

Within 15% of Critical Rate

The following trends are evident from each of the main study intersections along TH 210

- TH 210 at 4th Ave NE (Traffic Signal)
  - 15 of the 22 crashes at this intersection were rear end crashes, likely the result of backups at the intersection, 8 of the rear ends were in the eastbound direction, 6 were in the westbound direction, and 1 crash occurred in the southbound direction, which indicates backups may be similar between the eastbound and westbound direction.
  - There was one bicycle crash at this intersection; a southbound right turning vehicle looking for a gap in traffic did not see a bicycle on the north leg of the intersection (Severity C crash).
- TH 210 at 5th Ave NE (Minor Street Stop)
  - 4 of the 7 crashes at this intersection were right angle/left turn crashes, a majority of which are the result of eastbound left turning vehicles failing to yield to westbound vehicles.
- TH 210 at TH 25 Eastbound Ramp Connection (Exit Ramp)
  - With only 2 crashes over the 5-year analysis period no crash patterns could be identified at this intersection.
- TH 210 at TH 25 Entrance Ramp (Minor Street Stop) – Removed in 2018
  - 7 of the 12 crashes were right angle crashes, a majority of which involved vehicles taking a left off TH 25 failing to yield to TH 210 traffic.
  - 1 Severity A: northbound left turning vehicle failed to yield to an eastbound vehicle.
  - The TH 25 approach to TH 210 was closed in 2018 and westbound TH 25 traffic is now routed through the 8th Avenue NE intersection (approximately 850 feet east), therefore, any safety concerns for this intersection have been removed.

- TH 210 at 8th Ave NE (Traffic Signal)
  - 22 of the 28 crashes at this intersection were rear end crashes, likely the result of backups at the intersection. 10 of the rear ends were in the westbound direction, 7 were in the eastbound direction, 1 northbound and 4 southbound. The crash data indicates that backups are similar between the eastbound and westbound direction.
- TH 210 at 10th Ave NE (Minor Street Stop)
  - All 4 crashes at this intersection were right angle crashes (one of which resulted in a severity A injury), a majority of which were the result of northbound or southbound vehicles turning onto or crossing TH 210 failing to yield to TH 210 vehicles.
  - 1 Severity A: northbound through vehicle failed to yield to an eastbound vehicle.

2.2 Existing Traffic Volumes

MnDOT's Traffic Mapping Application (https://www.dot.state.mn.us/traffic/data/tma.html) was utilized to collect both the most recent and historical Average Annual Daily Traffic (AADT) information for the study area; MnDOT coordinated with all Cities and Counties to keep their roadway information current.

The most current "official" AADT's in the study area are from 2019 along the study roadways; the following **Table 2** presents the current AADT's from the MnDOT application.

Table 2 – 2019 Existing AADTs

Roadway	Description	Year	AADT
TH 210	13th St SE to 4th Ave NE	2019	25,500
	4th Ave NE to TH 25 Exit Ramp	2019	23,600
	TH 25 Exit Ramp to 8th Ave NE	2019	17,100
	8th Ave NE to Pine Shores Rd	2019	11,800
4th Ave NE	North of TH 210	2019	1,200
5th Ave NE	North of TH 210	2019	4,300
8th Ave NE	North of TH 210	2019	8,400
	South of TH 210	2019	4,950
10th Ave NE	South of TH 210	2019	1,400

2.2.1 Intersection Volumes

Existing traffic volumes throughout the TH 210 study corridor were collected from different sources including previous projects and studies, as well as new field information. MnDOT provided intersection counts for the East Mall Area intersections that were captured between October and November of 2019.

The existing corridor wide intersection traffic volumes from the 2018 and 2019 traffic counts were balanced along TH 210 to determine the 2019 existing traffic volumes. From the 2019 existing traffic volumes, the AM peak hour was determined to be 7:30 to 8:30 AM and the PM peak hour was 4:30 to 5:30 PM.

Based on historical traffic counts along TH 210, including weekday and weekend counts from other studies, typically Friday afternoon traffic volumes are higher than normal. A review of the historical data suggests the PM peak hour on a Friday was approximately 5% higher than a typical weekday PM peak. The main difference between the Friday peak period and the PM peak period is the sustained volumes along the corridor. The PM peak period on a typical weekday is contained to approximately a 1 ½ hour period of increased traffic along TH 210. In contrast, the Friday count data shows a relatively constant volume between 1 PM through 5 PM.

Summer peak traffic demands were developed using StreetLight data for the study area; the next section will discuss the data and results. Based on the information from StreetLight data, the summer peak traffic demands are approximately a 10% increase in the PM peak hour volumes.

The balanced existing 2019 vehicle turning movement volumes for the AM, PM, Friday, and summer peak hours as well as the existing roadway geometrics can be found in **Appendix B**; the raw traffic counts are also provided.

2.2.2 Vehicle Origin-Destination Study

To better understand the existing travel patterns along the TH 210 corridor, an origin-destination (OD) study was conducted using StreetLight Data. The platform uses location-based service (LBS) information from connected trucks and cell phones.

An OD study was conducted along TH 210 in the project study area, results can be found in the *Technical Memorandum - TH 210 Corridor Study - Origin-Destination Study*. All results of the OD study were incorporated into the micro simulation traffic models.

StreetLight was also used to assess different seasonal variations. Combined spring and fall data were collected and compared to summer data from the platform, the summer months had an approximate 25% increase in daily trips along the corridor.

A 3-hour PM peak period had a total increase of 18% between the two seasonal periods. Based on PMT input, a conservative 10% increase in the PM peak hour data was used to account for a “Summer Peak” hour; the additional 8% increase would then be assumed to occur on the two remaining hours of the 3-hour PM peak period.

In addition, a small OD study was conducted for the existing 5th Avenue NE traffic volumes. The analysis resulted in the following:

- From TH 210: Approximately 63% of vehicles from TH 210 enter the East Brainerd Mall commercial area via B Street, C Street, or D Street.
- To TH 210: approximately 59% of the vehicles entering westbound TH 210 are from the commercial area via B Street, C Street, or D Street.
- Approximately 8% of the vehicles on 5th Avenue NE connect to 8th Avenue NE (CSAH 3); meaning they use 5th Avenue NE as a bypass route of the 8th Avenue NE signal.
- The remaining 29% to 33% of trips are local trips not captured in the analysis.

A figure representing the results of the 5th Avenue NE OD analysis can be found in **Appendix B**.

3 Future Conditions

This study includes evaluation of the study area to determine improvements along TH 210 to serve the long-term needs of the corridor and the community. To capture future changes along the corridor, a future year analysis was conducted. Based on the current anticipated project year of 2025, the future design year of 2045 was selected for evaluation.

Traffic forecasts were developed for the entire TH 210 corridor as part of the larger corridor study effort. Future 2045 forecast volumes were developed based on a linear growth rate of 0.5% per year based on historical AADT volumes, population data, and input from the project team.

Table 3 shows the 2019 AADTs, the forecasted 2045 AADTs and corresponding linear growth rate for each project roadway. Mainline TH 210 forecasted 2045 AADTs within the study area range from 13,350 to 28,800

Table 3 – 2045 Future AADTs

Roadway	Description	2019 Existing AADT	2045 Forecast AADT	Linear Growth Rate
TH 210	13th St SE to 4th Ave NE	25,500	28,800	0.5%
	4th Ave NE to TH 25 Exit Ramp	23,600	26,650	0.5%
	TH 25 Exit Ramp to 8th Ave NE	17,100	19,300	0.5%
	8th Ave NE to Pine Shores Rd	11,800	13,350	0.5%
4th Ave NE	North of TH 210	1,200	1,350	0.5%
5th Ave NE	North of TH 210	4,300	4,850	0.5%
8th Ave NE	North of TH 210	8,400	9,500	0.5%
	South of TH 210	4,950	5,600	0.5%
10th Ave NE	South of TH 210	1,400	1,600	0.5%

The forecasted 2045 No Build intersection traffic volumes for the AM, PM, Friday, and summer peak hours can be found in **Appendix B**.

4 Analysis of Alternatives

Intersection control evaluations rely on traffic control warrants to assess the different options available at any intersection. To determine the control options, warrants are evaluated to assess where control changes can be made based on volumes. The results are used to aid in the evaluation of traffic safety and traffic operations at the study intersections.

4.1 Warrant Analysis Guidance

The Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) provides guidance on when it may be appropriate to use all-way stop or 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 signal control may be justified. All-way stop or signal control should not be installed at an intersection unless a MnMUTCD warrant is met. Meeting a warrant at an intersection does not in itself require the installation of a particular control type. The particular control type also requires an engineering analysis of the intersection's design in order for it to be justified.

Under the MnDOT ICE process, roundabouts are considered to be warranted if traffic volumes meet the criteria for either all-way stop or traffic signal control.

All-way stop control warrants were not evaluated as it is not considered a viable control option along TH 210 as an Interregional Corridor (IRC).

4.1.1 Requirements for Installation of a Traffic Signal

For traffic signal installation, MnDOT typically requires volume thresholds for Warrant 1 to be satisfied, which requires 8-hours of combined major approach volumes and the highest minor street approach volume to meet MnMUTCD thresholds. These thresholds vary with the number of approach lanes on the major and minor street. Other warrants may be used as indicators of a need to consider traffic control change; an engineering study that considers factors, including warrants, should be performed to determine the optimum type of control at an intersection.

4.1.2 Requirements for Removal of an Existing Traffic Signal

The MnDOT Traffic Engineering Manual (TEM) provides guidance on volume requirements to remove an existing traffic signal. Based on Chapter 9, section 9-5.02.05 of the TEM, an intersection that meets 80 percent of the volume requirements of Warrant 1 should be considered justified and should not be removed. A signalized intersection that does not meet 60 percent of the volume requirements of Warrant 1, and meets no other Warrant, is an unjustified traffic signal and should be removed.

A signalized intersection that does not meet 80 percent of the volume requirements but does meet 60 percent of the volume requirements of Warrant 1 is in a "gray area" and may be considered for traffic signal removal. Additional studies, findings, engineering judgment and documentation beyond the volume requirements are needed to justify retaining the signal.

4.2 Warrant Analysis Assumptions and Results

MnDOT guidelines suggest that for the purpose of warrant analysis, 100% of right turning traffic from the minor leg should be removed because right turning vehicles are typically able to enter

the traffic stream with minimal delay or conflict; the right turning traffic would not require a traffic signal to reduce delay or improve safety. In certain circumstances (i.e. high right turn volume, minimum mainline gaps, etc.), MnDOT procedures allow for the inclusion of 50% of the minor street right turning traffic in the analysis. The MnDOT guidance states "if right turning volume exceeds 70% of its potential capacity for any hour for each approach, 50% of the right turning volume for all hours should be added back in."

- Based upon MnDOT guidance, the analysis of the five study intersections includes removal of 100% of the right turning traffic on the minor approaches.

MnDOT guidelines suggest that the warrant thresholds may also be reduced based on the roadway speeds and population of the city the intersection is within. If either major approach to the intersection has a posted speed, or 85th percentile speed, that exceeds 40 mph, then a reduction to 70% threshold volumes is allowed. If the population of the city is less than 10,000 people, a reduction to 70% threshold volumes is allowed.

- Based upon MnDOT guidance, the analysis of the 4th Avenue NE intersections does not include reductions based on speeds; however, all other intersections do include a reduction as the posted speed is at 45 mph for at least 1 leg of the intersection.

Traffic warrants were completed for the existing and forecasted 2045 traffic demands.

4.2.1 Warrant Results Summary

Based on the existing and 2045 forecast traffic demands, the study intersection traffic signal warrant analysis is as follows:

- **TH 210 at 4th Avenue NE**: existing traffic signal is not warranted and should be removed.
  - The intersection does not meet the 60% criteria thresholds for Warrant 1 and is therefore justified for removal.
  - Minor stop control may be considered at this intersection.
- **TH 210 at 5th Avenue NE**: traffic signal warrants met.
  - Using the eastbound left turn volumes as the minor street and only the westbound through vehicles for the major, the intersection does meet Warrant 1 criteria.
  - Traffic signal control may be considered at this intersection.
- **TH 210 at TH 25**: no warrants evaluated.
  - Eastbound off ramp cannot meet warrants with no minor approach.
  - Westbound T-intersection is currently closed.
- **TH 210 at 8th Avenue NE**: traffic signal warrants met.
  - Traffic signal control may be considered at this intersection.
- **TH 210 at 10th Avenue NE**: no warrants met, retain minor stop control.
  - Minor stop control may be considered at this intersection.

Table 4 provides the traffic signal warrant summary for the 2019 existing and 2045 future volume conditions. Complete traffic signal warrant analyses can be found in **Appendix C**.

Table 4 – Traffic Signal Warrant Analysis Summary

Intersection	2019 Existing		2045 Future	
TH 210 at: (Existing Control)	Warrant 1 (8 Hr)	Notes	Warrant 1 (8 Hr)	Notes
4th Ave NE (Traffic Signal)	Not Met 0 of 8 hours	60% warrant not met[4]	Not Met 0 of 8 hours	60% warrant not met[4]
5th Ave NE[1] (Minor Street Stop)	**MET 11 of 8 hours**	Warrants 2 & 3 met[2]	**MET 11 of 8 hours**	Warrants 2 & 3 met[2]
8th Ave NE (Traffic Signal)	**MET 12 of 8 hours**	Warrants 2 & 3 met[2]	**MET 12 of 8 hours**	Warrants 2 & 3 met[2]
10th Ave NE (Minor Street Stop)	Not Met 0 of 8 hours	Retain stop control	Not Met 0 of 8 hours	Retain stop control

Notes:

1. The 5th Ave NE traffic signal warrants were analyzed with the eastbound left turn volume as the minor street volume and the westbound volume as the major street volume.
2. Warrant 2 is the 4-hour volume warrant and Warrant 3 is the peak hour volume warrant.
3. Existing signal meets 80% of the volume thresholds for Warrant 1 and is considered justified.
4. 60% of the warrant volume thresholds for Warrant 1 were not met and removal of the existing signal is justified.

4.3 Alternatives

The East Mall Area was considered for potential major design changes to improve the overall corridor performance. Based on the previous information documented in this report, as well as input from the PMT, the following intersection changes were considered.

- **4th Avenue NE** – signal not warranted, remove signal and reduce access.
- **5th Avenue NE** – signal is warranted with high eastbound left turn demands, add traffic signal or reduce access.
- **Eastbound TH 25 Ramp** – high speed exit ramp to TH 25, remove direct ramp.
- **Westbound TH 25** – previously closed access, remain closed.
- **East Brainerd Mall** – RI/RO access or convert to ¾-access.
- **8th Avenue NE** – signal warranted, requires additional capacity at signal or alternative intersection design, including roundabouts.
- **10th Avenue NE** – signal not warranted, reduce access.

Based on intersection safety, traffic volumes, traffic control warrants, non-motorized accommodations, input from the PMT, and other considerations, alternatives were developed for the East Mall Area.

A total of seven design alternatives were developed to address the existing corridor issues within the East Mall Area. After initial screening, three alternatives were carried through the safety and operations analysis.

Refer to the *TH 210 Build Conditions Report* for more information on how the alternatives were developed, including the initially dismissed alternatives.

4.3.1 Alternative 1

The first alternative includes adding traditional intersection capacity to the existing traffic signal, as shown in **Figure 2**, below. Changes to the East Mall Area with this alternative:

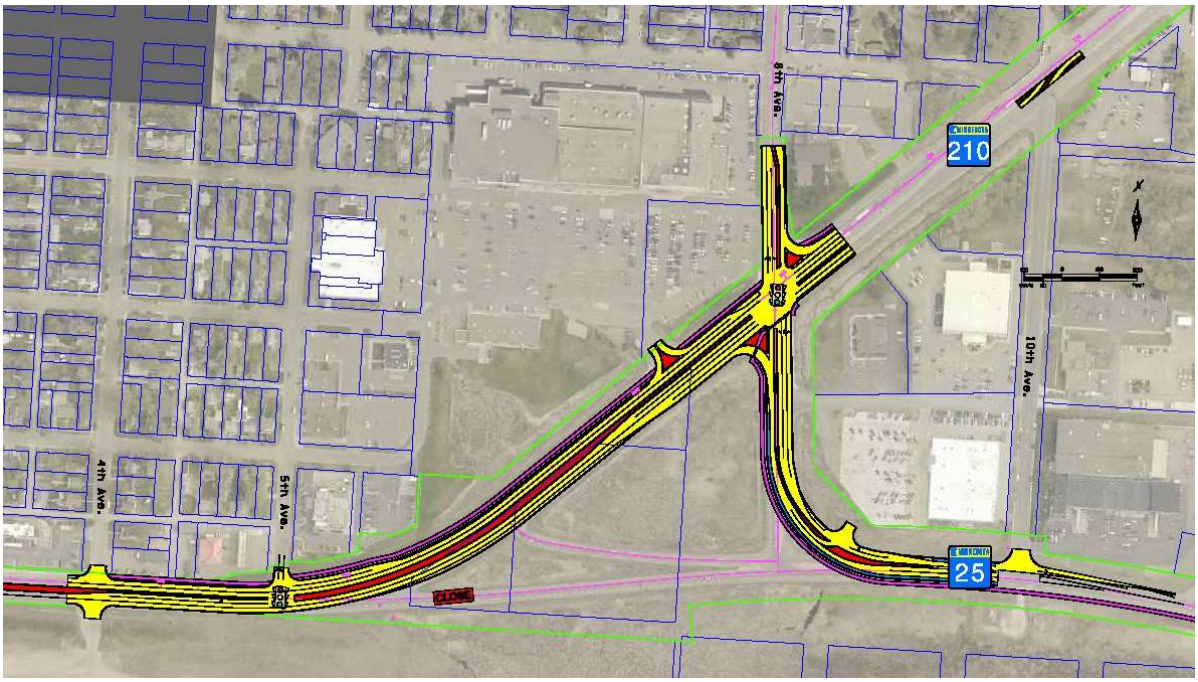
- 4th Avenue NE: remove signal, modify to RI/RO.
- 5th Avenue NE: install traffic signal.
- TH 25 Ramps: remove TH 25 ramp connections.
- Mall Access: retain existing RI/RO.
- 8th Avenue NE: retain existing traffic signal.
  - Add northbound and southbound left turn lanes for both approaches.
  - Separate left, through, and right turn lanes allows removal of the split phasing and the signal timings to operate more efficiently.
- 10th Avenue NE: modify to ¾-access.

This alternative will provide acceptable traffic operations and improve safety over the existing conditions. The standard design includes traffic signal spacing that provides over ¼-mile between signals which is positive for coordination and traffic progression along TH 210.

The new traffic signal at 5th Avenue NE would require an eastbound left turn lane extension for additional storage; this change reduces access at 4th Avenue NE to the railyard south of TH 210. The existing 45-mph posted speed limit through this area would remain.

The preliminary cost estimate for the entire East Mall Area for Alternative 1 is **$7.3 million**.

Figure 2 – East Mall Area – Alternative 1



4.3.2 Alternative 2

The second alternative replaces the existing 8th Avenue NE traffic signal with roundabout control, as shown in **Figure 3**, below. Changes to the East Mall Area with this alternative include:

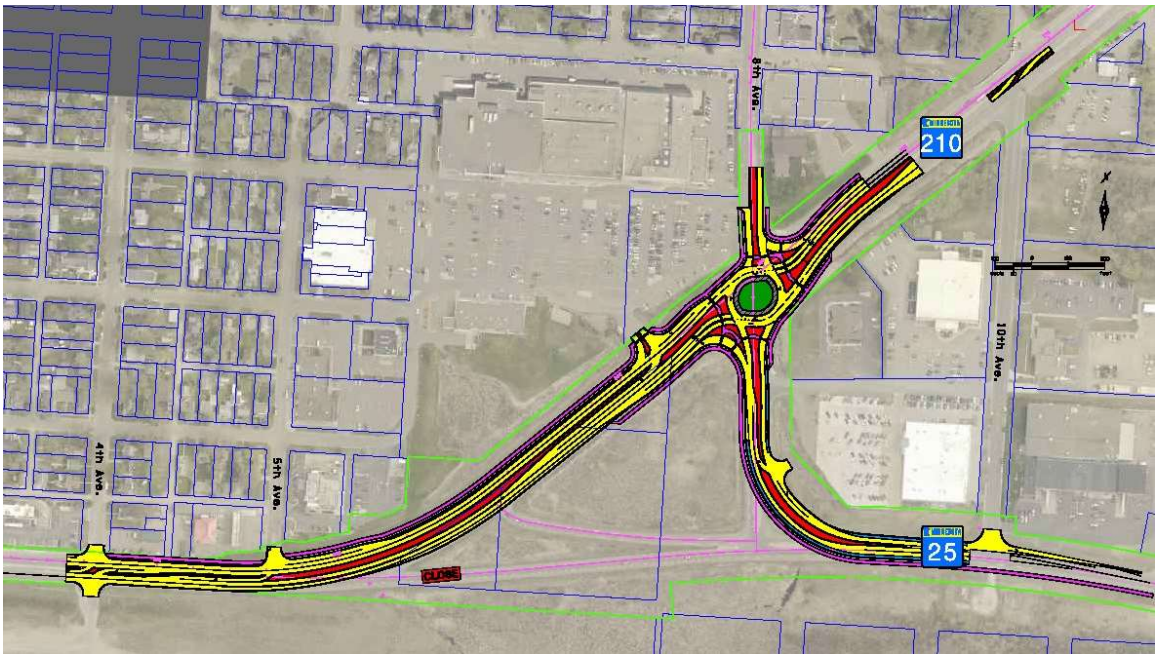
- 4th Avenue NE: remove signal, modify to ¾-access.
- 5th Avenue NE: retain existing ¾-access.
- TH 25 Ramps: remove TH 25 ramp connections.
- Mall Access: convert to ¾-access.
  - The roundabout reduces speeds along TH 210 to allow additional access.
- 8th Avenue NE: convert intersection to roundabout control.
  - Maintain 2-through lanes in each direction along TH 210.
  - 8th Avenue NE and TH 25 have single lane approaches.
- 10th Avenue NE: modify to ¾-access.

This alternative will provide acceptable traffic operations and improve safety over the existing conditions.

The roundabout controlled intersection will reduce all vehicles speeds at the 8th Avenue NE intersection, allowing the 35-mph posted speed limit at 5th Avenue NE to be extended to east of 8th Avenue NE. This reduction in travel speeds allows for the inclusion of additional access at the existing mall access. The 3/4 -access at the East Brainerd Mall and commercial area is expected to reduce the eastbound left turn volumes that currently use 5th Avenue NE to access the commercial area.

The preliminary cost estimate for the entire East Mall Area for Alternative 2 is **$7.25 million**.

Figure 3 – East Mall Area – Alternative 2



4.3.3 Alternative 3

The third alternative replaces the existing 8th Avenue NE traffic signal with two roundabouts, as shown in **Figure 4**, below. Changes to the East Mall Area with this alternative include:

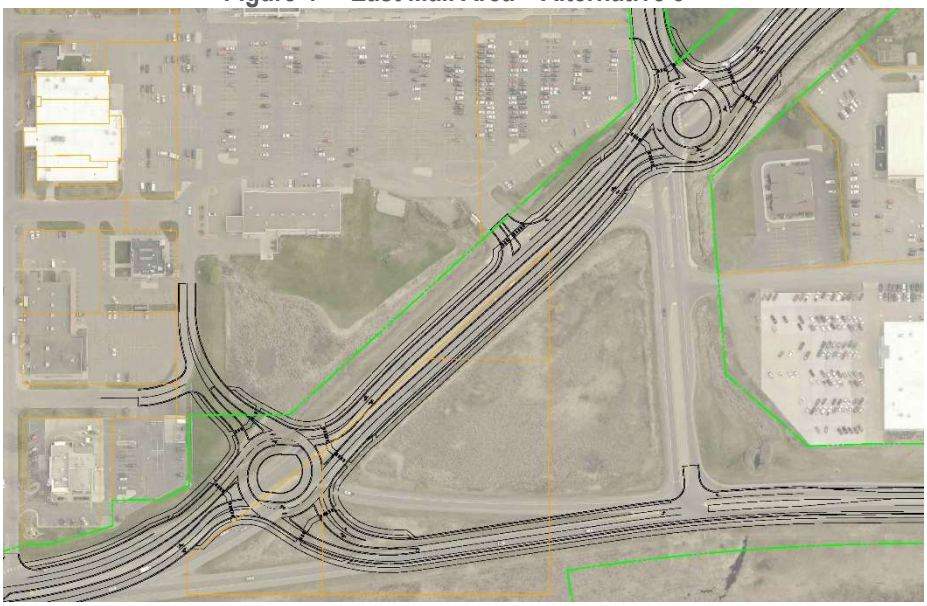
- 4th Avenue NE: remove signal, modify to ¾-access.
- 5th Avenue NE: retain existing ¾-access.
- TH 25 Ramps: connect TH 25 to TH 210 with roundabout control.
  - Maintain 2-through lanes in each direction along TH 210.
  - TH 25 has two approach lanes to accommodate permitted trucks.
  - 4th leg into the retail center for local connections
- Mall Access: retain existing westbound RI/RO.
- 8th Avenue NE: convert intersection to roundabout control.
  - Relocate TH 25, south leg, connection to west.
  - Maintain 2-through lanes in each direction along TH 210.
  - 8th Avenue NE has a single lane approach southbound.
- 10th Avenue NE: modify to ¾-access.

This alternative will provide acceptable traffic operations and improve safety over the existing conditions. Like Alternative 2, the two roundabouts allow for a reduced speed limit along TH 210.

The split intersections allow for simplified movements at each intersection and separates the competing movements at the existing intersection. Northbound TH 25 has a high left turn volume to travel west on TH 210, which is shifted to the west roundabout. Southbound 8th Avenue NE has a high right turn volume to west on TH 210, which no longer competes with TH 25 traffic.

The preliminary cost estimate for the entire East Mall Area for Alternative 3 is **$7.3 million**.

Figure 4 – East Mall Area – Alternative 3



4.4 Safety Review

Future crash estimates were prepared by applying existing and MnDOT statewide average (5-year) crash rates to the 2045 projected traffic volumes for the study intersections in each alternative. In addition, intersection conflict points were compared between the alternatives.

The following crash rates were utilized in this analysis:

- No Build estimates are based on the existing crash rates described in Section 2.
- The MnDOT statewide average crash rate for urban minor street stop-controlled intersections is 0.18 crashes per million entering vehicles (MEV).
- Signalized intersection rates are based on the MnDOT statewide average crash rates for:
  - Low speed (<45 mph), high volume (>15,000 vpd on highest volume leg) signalized intersections; the average crash rate is 0.70 crashes per MEV.
  - High speed (>45 mph), high volume (>15,000 vpd on highest volume leg) signalized intersections; the average crash rate is 0.45 crashes per MEV.
- Roundabout crash estimation was done using MnDOT's *A Study of the Traffic Safety at Roundabouts in Minnesota*; the study concluded the following:
  - Single-lane roundabouts have a crash rate of 0.32 crashes per MEV.
  - Hybrid roundabouts (2x1 design) have a crash rate of 0.76 crashes per MEV.
  - Multi-lane roundabouts (2x2 design) have a crash rate of 2.18 crashes per MEV.
  - The National Cooperative Highway Research Program (NCHRP) Report 672 on roundabouts suggests a 3-leg hybrid roundabout (2x1 design) has an approximate 50% reduction in the crash rate when compared to a 4-leg hybrid roundabout.
- For reduced conflict intersections like ¾ access or right-in/right-out (RI/RO) the MnDOT statewide average crash rate for "other" intersection types was used; the average crash rate is 0.16 crashes per MEV.

4.4.1 Conflict Points

TH 210 is functionally classified as a principal arterial corridor, mobility and safety are a major characteristic of this type of corridor. To improve the safety and mobility of the corridor, some intersections will include reduced access configurations. Reductions of intersection movements can have a significant reduction in vehicle conflict points, which can dramatically improve the safety and operations of the intersection.

A conflict point is any point where vehicles cross, merge, or diverge at an intersection and are the points at which a crash is most likely to occur. Reducing the number of conflict points at an intersection by reducing access can improve vehicle safety.

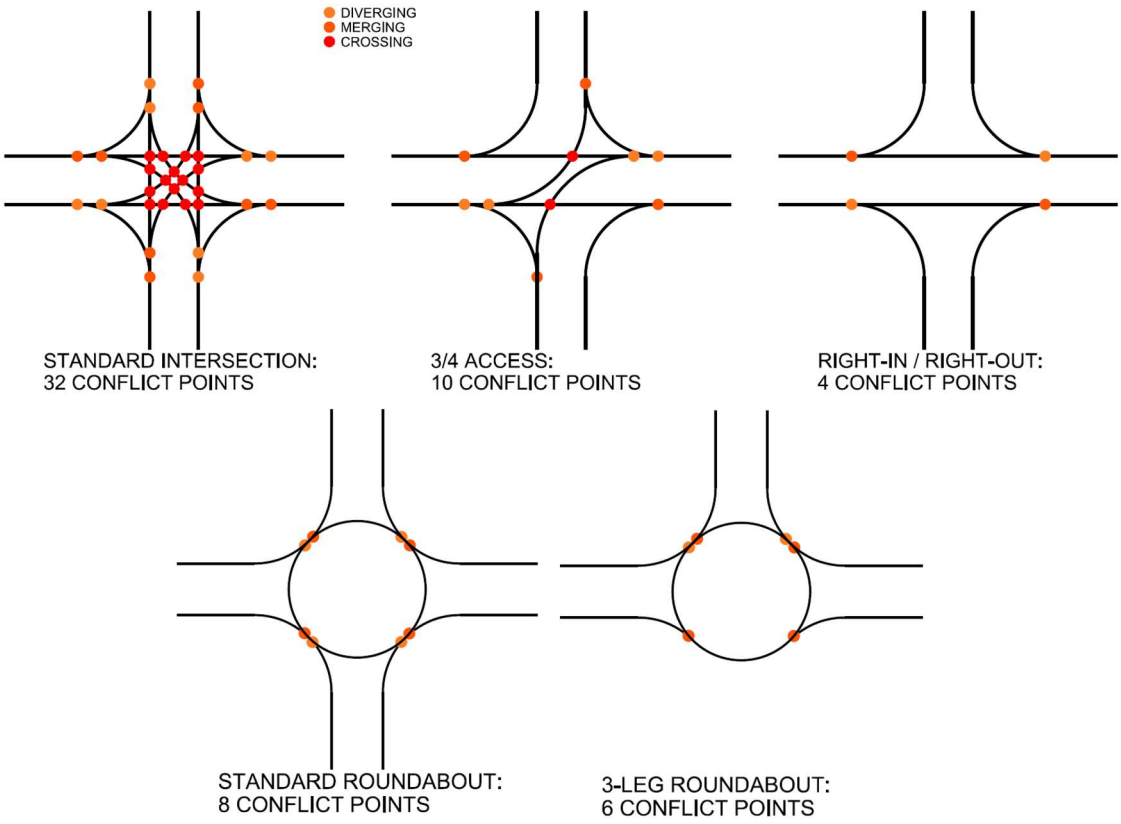
An existing full access, four-leg intersection has a total of 32 conflict points. Reduction in access at an intersection to a ¾ Access or RI/RO configuration has a significant impact on the safety of an intersection.

Figure 5 presents vehicle conflict points at standard intersection configurations.

- A ¾ access intersection has a reduction of almost 70% of the total vehicle conflict points, while only removing some minor street movements.

- A RI/RO access intersection has a reduction of almost 90% of the total vehicle conflict points; this does remove a significant portion of the vehicle turns at an intersection.
- To maintain full access at an intersection, the only way to reduce conflict points is to construct a roundabout. Due to the one-way circulating design, a full movement roundabout has only 8 vehicle conflict points.
  - A 3-legged roundabout intersection has only 6 vehicle conflict points.

Figure 5 – Vehicle Conflict Points



4.4.2 Predicted Crashes

Based on the average crash rates for each intersection type, a comparison of the alternatives was completed to assess the safety impact of each design alternative.

Table 5 presents the crash rates used for each intersection within the East Mall Area, as well as the estimated crashes expected in 2045, and a comparison of the vehicle conflict points at each intersection.

Alternative 1 would have a significant reduction in vehicle conflict points; however, the overall estimation of crashes is similar to the No Build conditions. This is due to the high-volume, high-speed traffic signal proposed at 5th Avenue NE, which has an average MnDOT crash rate that is high.

Alternative 2 has the fewest vehicle conflict points and the fewest total estimated crashes in 2045. The full access, 4-leg, hybrid roundabout design has the highest crash rate of all the control types; however, it should be noted there is a significant reduction in fatal and severe crashes under roundabout control.

Alternative 3 has the 2nd lowest vehicle conflict points and the 2nd lowest estimated crashes in 2045. The 3-leg hybrid roundabouts are estimated to have a crash rate of 0.36. NCHRP 672 suggests a 3-leg roundabout has an approximate 50% reduction in crashes when compared to a similar 4-leg roundabout.

Table 5 – East Mall Area 2045 Crash Estimates

Alternative		East Mall Area Intersections						Total	Change from No Build
		4th Avenue	5th Avenue	TH 25 West	Mall Access	8th Ave/ TH 25 East	10th Avenue		
No Build	Crash Rate[1]	0.47	0.15	0.06	0.05	0.74	0.17	--	--
	Crashes[2]	4.9	1.6	0.5	0	6.3	0.9	14.2	--
	Conflict Points	9	5	1	2	32	32	81	--
Alt 1	Crash Rate[1]	0.16	0.70		0.05	0.45	0.16	--	--
	Crashes[2]	1.7	7.4		1.1	3.8	0.8	14.8	-4%
	Conflict Points	4	9		2	32	10	57	30%
Alt 2	Crash Rate[1]	0.16	0.16		0.16	0.76	0.16	--	--
	Crashes[2]	1.7	1.7		1.1	6.5	0.8	11.8	17%
	Conflict Points	5	5		5	8	10	33	59%
Alt 3	Crash Rate[1]	0.16	0.16	0.76	0.05	0.36[3]	0.16	--	--
	Crashes[2]	1.7	1.7	5.6	0	2.6	0.8	12.4	13%
	Conflict Points	5	5	8	2	6	10	36	56%

1- Crash Rates for No Build condition are existing crashes; MnDOT average rates used for Build Alternatives

2- Estimated crashes in year 2045 based on crash rates and forecast volumes.

3- NCHRP 672 suggests a 3-leg Hybrid Roundabout (2x1) has an approximate 50% reduction in the crash rate compared to a 4-leg Hybrid Roundabout (2x1).

4.5 Traffic Operations

Traffic operations analyses for the existing conditions, future No Build, and three future build alternatives were conducted to determine the level of service (LOS), delay, and queueing information for the AM, PM, Friday, and summer peak hour conditions.

LOS is a qualitative rating system used to describe the efficiency of traffic operations at an intersection. Six LOS levels are defined, designated by letters A through F. LOS A represents the best operating conditions (no congestion), and LOS F represents the worst operating conditions (severe congestion).

LOS for intersections is determined by the average control delay per vehicle. The range of control delay for each LOS is different for signalized and unsignalized intersections (including roundabouts). The expectation is that a signalized intersection is designed to carry higher traffic volumes and will experience greater delays than an unsignalized intersection; driver tolerance for delay is greater at a signal than a stop sign. Therefore, LOS thresholds for each LOS category are lower for unsignalized intersections than for signalized intersections.

Table 6 shows the LOS thresholds for signalized and unsignalized control.

Table 6 – Level of Service Threshold

Level of Service	Average Control Delay (sec/veh)	
	Signalized Intersection	Unsignalized (Stop or Roundabout) Intersection
A	0 to 10	0 to 10
B	> 10 and ≤ 20	> 10 and ≤ 15
C	> 20 and ≤ 35	> 15 and ≤ 25
D	> 35 and ≤ 55	> 25 and ≤ 35
E	> 55 and ≤ 80	> 35 and ≤ 50
F	> 80	> 50

For the entire corridor, it was assumed that a LOS D or better represents acceptable conditions for intersections. However, due to the long cycle lengths along TH 210, some movements may have higher delays, LOS E/F, but are still expected to be served within one signal cycle.

The traffic operations analyses were conducted using the VISSIM (version 2020) software package; an average of 10 simulation runs was used for each modeling result.

Appendix D includes all operational tables and summary for the operations analysis.

4.5.1 Existing Conditions

Many of the existing intersections operate acceptably in all peak hours analyzed. The intersections of TH 210 at 4th Avenue NE, the Mall Access, and 10th Avenue NE all operate acceptably in all peak hours.

The AM peak hour operations are all LOS D or better in the existing conditions. The 8th Avenue NE intersection can have long queues due to the split phase timing, and the eastbound left turn at 5th Avenue NE can extend out of the turn lane and block the through lane.

In the PM, Friday, and Summer peak hours the operations are significantly worse. The two problematic intersections are still the main concern.

At 5th Avenue NE the eastbound left turn volume is one of the highest along the corridor, it is within 5% of the left turn volume at 8th Avenue NE. While the intersection operates at a LOS A, the eastbound left turn must yield to the heavy westbound approach traffic along TH 210. As a platoon of traffic approaches the intersection, the left turns must yield for a longer time and the queue builds and quickly spills out of the storage lane and blocks an eastbound through lane; this is a major safety concern.

The TH 210 at 8th Avenue NE/TH 25 incurs the most delay in the study area. The existing split phase signal timing adds delays for all users as the minor approaches do not have enough capacity to serve the demands. Due to the long cycle length required to serve all of the volumes, there are many movements that operate at a LOS E or LOS F, and the intersection as a whole operates at a LOS E in the PM, Friday, and Summer peaks.

The delays result in long queues at the intersection. The eastbound left turn from TH 210 to 8th Avenue NE extends past the available storage and blocks the through lane. The TH 25 approach operates with the most delay and queues that can extend up to 1,700 feet in the summer peak.

Table 7 presents the existing traffic operations for the AM, PM, Friday, and Summer peak hours.

Table 7 – Existing Conditions – East Mall Area Traffic Operations

Peak	Intersection	Approach Delay (sec/veh / LOS)				Int. Delay (s/veh / LOS)
	TH 210 at:	EB	WB	NB	SB	
AM	4th Avenue NE	1.2 / A	3.9 / A	**43.9 / D**	**37.5 / D**	4.5 / A
	5th Avenue NE	6.4 / A	0.2 / A		10.5 / B	3.3 / A
	Mall Access	0.0 / A	0.9 / A		8.8 / A	
	TH 25/8th Avenue	33.4 / C	**38.7 / D**	**50.5 / D**	27.0 / C	**36.7 / D**
	10th Avenue NE	1.4 / A	0.3 / A	12.5 / B	10.8 / B	2.3 / A
PM	4th Avenue NE	1.3 / A	4.3 / A	**75.1 / E**	**37.4 / D**	4.1 / A
	5th Avenue NE	4.6 / A	0.2 / A		12.7 / B	3.6 / A
	Mall Access	0.0 / A	0.9 / A		9.4 / A	
	TH 25/8th Avenue	**53.0 / D**	**54.2 / D**	**67.3 / E**	**50.0 / D**	**55.6 / E**
	10th Avenue NE	1.2 / A	0.3 / A	15.3 / C	8.8 / A	1.8 / A
Friday	4th Avenue NE	1.5 / A	4.1 / A	**74.9 / E**	**37.7 / D**	4.1 / A
	5th Avenue NE	5.1 / A	0.1 / A		13.7 / B	3.9 / A
	Mall Access	0.0 / A	0.9 / A		9.7 / A	
	TH 25/8th Avenue	**59.1 / E**	**56.6 / E**	**69.8 / E**	**53.9 / D**	**59.6 / E**
	10th Avenue NE	1.3 / A	0.3 / A	16.1 / C	8.4 / A	1.9 / A
Summer	4th Avenue NE	1.2 / A	2.7 / A	**71.7 / E**	**43.5 / D**	3.6 / A
	5th Avenue NE	6.5 / A	0.2 / A		15.0 / C	4.8 / A
	Mall Access	0.0 / A	0.9 / A		10.0 / B	
	TH 25/8th Avenue	**66.9 / E**	**63.2 / E**	**77.9 / E**	**59.3 / E**	**66.6 / E**
	10th Avenue NE	1.3 / A	0.4 / A	23.6 / C	8.3 / A	2.4 / A

4.5.2 2045 Future No Build Conditions

The future No Build condition has increased volumes with added delay and queueing.

The intersections of TH 210 at 4th Avenue NE, the Mall access, and 10th Avenue NE all continue to operate acceptably through the 2045 design year in all peak hours evaluated. The northbound 10th Avenue NE approach will have less gaps in TH 210 traffic and is expected to operate at a LOS E in the summer peak; the southbound approach operates acceptably as most vehicles make a southbound right turn at the intersection.

The eastbound left turn from TH 210 to 5th Avenue NE is expected to continue to have queueing issues in all peak hours that spill out of the available storage lane.

The TH 210 at 8th Avenue NE/TH 25 intersection is expected to have worsening conditions. The existing split phase signal timing and lack of intersection capacity cannot serve the existing and expected traffic volumes. Due to the long cycle length required to serve all of the volumes, there are many movements that operate at a LOS E or LOS F, and the intersection will have failing operations in the PM, Friday, and Summer peaks.

The delays continue to result in long queues at the intersection. The eastbound left turn from TH 210 to 8th Avenue NE extends past the available storage and blocks the through lane at a much higher frequency than the existing conditions. The TH 25 approach operates with high delays and queues that can extend up to 2,800 feet in the summer peak.

Table 8 – 2045 No Build Conditions – East Mall Area Traffic Operations

Peak	Intersection	Approach Delay (sec/veh / LOS)				Int. Delay (s/veh / LOS)
	TH 210 at:	EB	WB	NB	SB	
AM	4th Avenue NE	5.1 / A	4.5 / A	**46.8 / D**	**40.0 / D**	6.7 / A
	5th Avenue NE	11.6 / B	0.2 / A		12.0 / B	5.6 / A
	Mall Access	0.1 / A	0.2 / A		9.0 / A	
	TH 25/8th Avenue	**42.8 / D**	**48.5 / D**	**60.6 / E**	**33.5 / C**	**45.5 / D**
	10th Avenue NE	1.5 / A	0.4 / A	14.9 / B	13.1 / B	2.8 / A
PM	4th Avenue NE	1.9 / A	3.1 / A	**73.2 / E**	**40.6 / D**	4.0 / A
	5th Avenue NE	7.9 / A	0.2 / A		16.3 / C	5.7 / A
	Mall Access	0.3 / A	0.4 / A		10.3 / B	
	TH 25/8th Avenue	**72.6 / E**	**64.8 / E**	**83.5 / F**	**61.6 / E**	**70.6 / E**
	10th Avenue NE	1.4 / A	0.4 / A	25.1 / D	8.1 / A	2.6 / A
Friday	4th Avenue NE	2.6 / A	3.4 / A	**68.7 / E**	**44.0 / D**	4.7 / A
	5th Avenue NE	8.9 / A	0.2 / A		16.5 / C	6.2 / A
	Mall Access	0.5 / A	0.4 / A		11.0 / B	
	TH 25/8th Avenue	**91.4 / F**	**71.7 / E**	**88.4 / F**	**64.8 / E**	**80.1 / F**
	10th Avenue NE	1.3 / A	0.5 / A	29.1 / D	8.8 / A	2.8 / A
Summer	4th Avenue NE	5.4 / A	3.3 / A	**69.7 / E**	**45.0 / D**	6.1 / A
	5th Avenue NE	12.4 / B	0.3 / A		19.6 / C	8.4 / A
	Mall Access	2.5 / A	0.4 / A		11.3 / B	
	TH 25/8th Avenue	**117.4 / F**	**75.2 / E**	**99.4 / F**	**70.0 / E**	**92.6 / F**
	10th Avenue NE	1.2 / A	0.5 / A	**36.4 / E**	9.2 / A	3.3 / A

4.5.3 2045 Alternative 1

Changes to the East Mall Area intersections included with Alternative 1 are as follows:

- 4th Avenue NE: remove signal, modify to RI/RO
- 5th Avenue NE: install traffic signal
- TH 25 Ramps: remove TH 25 ramp connections
- Mall Access: retain existing RI/RO
- 8th Avenue NE: retain existing traffic signal
  - Add northbound and southbound left turn lanes for both approaches.
  - Separate left, through, and right turn lanes allows removal of the split phasing and the signal timings to operate more efficiently
- 10th Avenue NE: modify to ¾-access

To address the TH 210 at 8th Avenue NE intersection, an added lane separates the existing shared left-through lanes and provides the minor approaches with separate left, through, and right turn lanes. This added capacity allows the removal of the existing split phasing and for the signal cycle length to be reduced. The separate left turn lanes allow the minor street approaches to have a protected and permitted left turn phases that run concurrently.

The existing eastbound left turn lane queue issues at 5th Avenue NE will become worse under traffic signal control as the movement is no longer permissive but requires a protected left turn signal phase. The new traffic signal control at TH 210 and 5th Avenue NE would operate at a LOS B in all 2045 peak periods. To contain the eastbound left turn queue so it doesn't impact the through traffic, the left turn lane needs to be extended to approximately 500 feet, which extends through the 4th Avenue NE intersection, converting it to a RI/RO.

The TH 210 at 8th Avenue NE/TH 25 traffic signal will operate at a LOS D or better in all 2045 peak periods. The additional capacity at the traffic signal allows for significantly more efficient operations which results in the overall intersection delay being reduced by more than 50%. The signal does require a long cycle length to effectively process all the volumes on each approach. Three of the four approaches operate at a LOS D, with some of the movements operating at LOS E and F during the PM peak, Friday and summer peak times.

The eastbound approach is the only approach operating at a LOS C, this is due to the long eastbound left turn phase required to serve the major movement. The eastbound left turn volume is at the capacity of a single left turn lane. The expansion to a dual left turn was not considered feasible due to right-of-way constraints along TH 210 and along 8th Avenue NE to accept two northbound lanes. The eastbound left turn lane would need to be extended to approximately 700 feet to contain the maximum queues for this movement; however, this may not fully contain the summer peak queue.

Table 9 presents the proposed 2045 Build Alternative 1 operations for each peak period.

Table 9 – 2045 Build Alternative 1 – East Mall Area Traffic Operations

Peak	Intersection	Approach Delay (sec/veh / LOS)				Int. Delay (s/veh / LOS)
	TH 210 at:	EB	WB	NB	SB	
AM	4th Avenue NE	0.3 / A	0.4 / A	9.7 / A	10.6 / B	0.6 / A
	5th Avenue NE	10.9 / B	13.4 / B		11.4 / B	12.3 / B
	Mall Access	0.0 / A	0.9 / A		8.9 / A	0.9 / A
	TH 25/8th Avenue	25.6 / C	**35.7 / D**	33.8 / C	25.8 / C	29.9 / C
	10th Avenue NE	1.7 / A	0.5 / A	7.0 / A	6.8 / A	1.8 / A
PM	4th Avenue NE	1.1 / A	0.4 / A	12.4 / B	9.9 / A	0.9 / A
	5th Avenue NE	12.0 / B	15.0 / B		15.3 / B	13.4 / B
	Mall Access	0.0 / A	1.0 / A		9.9 / A	2.1 / A
	TH 25/8th Avenue	28.2 / C	**40.4 / D**	**46.3 / D**	**37.3 / D**	**35.9 / D**
	10th Avenue NE	1.3 / A	0.5 / A	8.1 / A	6.4 / A	1.4 / A
Friday	4th Avenue NE	0.7 / A	0.4 / A	12.4 / B	10.2 / B	0.8 / A
	5th Avenue NE	12.2 / B	17.4 / B		16.6 / B	14.6 / B
	Mall Access	0.0 / A	1.0 / A		11.0 / B	2.2 / A
	TH 25/8th Avenue	32.9 / C	**43.4 / D**	**48.3 / D**	**38.8 / D**	**39.1 / D**
	10th Avenue NE	1.3 / A	0.5 / A	8.1 / A	6.6 / A	1.4 / A
Summer	4th Avenue NE	1.1 / A	0.4 / A	13.2 / B	10.1 / B	0.9 / A
	5th Avenue NE	11.1 / B	16.5 / B		18.8 / B	13.8 / B
	Mall Access	0.0 / A	1.0 / A		11.2 / B	2.2 / A
	TH 25/8th Avenue	**35.8 / D**	**47.0 / D**	**54.2 / D**	**43.6 / D**	**43.1 / D**
	10th Avenue NE	1.4 / A	0.5 / A	8.9 / A	6.5 / A	1.5 / A

4.5.4 2045 Alternative 2

Changes to the East Mall Area intersection included with Alternative 2 are as follows:

- 4th Avenue NE: remove signal, modify to ¾-access
- 5th Avenue NE: retain existing ¾-access
- TH 25 Ramps: remove TH 25 ramp connections, all movements to 8th Avenue NE
- Mall Access: convert to ¾-access
  - The roundabout reduces speeds along TH 210 to allow additional access
- 8th Avenue NE: convert intersection to roundabout control
  - Maintain 2-through lanes in each direction along TH 210
  - 8th Avenue NE and TH 25 have single lane approaches
- 10th Avenue NE: modify to ¾-access

The proposed Alternative 2 access and control changes result in all intersections operating at LOS C or better in all time periods for the future 2045 volumes. The combination of restricted access and efficient roundabout control, reduces vehicle speeds and allows all movements to operate acceptably.

From an origin-destination study conducted in the existing conditions, it is understood that over 60% of the eastbound left turns at 5th Avenue NE are destined to the East Brainerd Mall area and most would likely shift to the new ¾ access provided on TH 210 at the mall.

While the single roundabout control at 8th Avenue NE/TH 25 operates with overall LOS C or better, with all movements at one single intersection, the minor single lane approaches have more delay with longer queues.

In the AM peak hour, the southbound approach will operate at a LOS D. The single lane southbound approach will have an average queue of approximately 200 feet, but the maximum queue is approaching 1,000 feet, which will extend through the upstream E Street intersection and impact the F Street intersection.

During the PM peak hour, the southbound approach operates at a LOS C with a maximum queue of 650 feet; this would just extend through the E Street intersection. In the Summer peak the approach will operate at a LOS E, with an average and maximum queue similar to the AM peak hour.

Table 10 presents the proposed 2045 Build Alternative 2 operations for each peak period.

Table 10 – 2045 Build Alternative 2 – East Mall Area Traffic Operations

Peak	Intersection	Approach Delay (sec/veh / LOS)				Int. Delay (s/veh / LOS)
	TH 210 at:	EB	WB	NB	SB	
AM	4th Avenue NE	1.3 / A	0.3 / A	10.9 / B	11.8 / B	1.3 / A
	5th Avenue NE	2.5 / A	0.2 / A		10.4 / B	1.7 / A
	Mall Access	7.6 / A	0.3 / A		2.3 / A	2.5 / A
	TH 25/8th Avenue	1.9 / A	4.8 / A	4.3 / A	**34.0 / D**	11.3 / B
	10th Avenue NE	1.4 / A	0.5 / A	6.7 / A	6.6 / A	1.7 / A
PM	4th Avenue NE	2.6 / A	0.3 / A	13.2 / B	12.2 / B	2.0 / A
	5th Avenue NE	1.9 / A	0.2 / A		13.4 / B	2.1 / A
	Mall Access	3.1 / A	0.3 / A		2.3 / A	1.7 / A
	TH 25/8th Avenue	3.4 / A	10.4 / B	16.6 / C	15.1 / C	9.6 / A
	10th Avenue NE	1.1 / A	0.5 / A	7.6 / A	6.1 / A	1.3 / A
Friday	4th Avenue NE	2.7 / A	0.3 / A	13.4 / B	12.2 / B	2.0 / A
	5th Avenue NE	2.3 / A	0.2 / A		14.0 / B	2.4 / A
	Mall Access	3.8 / A	0.3 / A		2.6 / A	2.1 / A
	TH 25/8th Avenue	3.6 / A	13.6 / B	19.0 / C	24.3 / C	12.6 / B
	10th Avenue NE	1.1 / A	0.6 / A	7.7 / A	6.3 / A	1.4 / A
Summer	4th Avenue NE	3.2 / A	0.3 / A	14.5 / B	13.4 / B	2.3 / A
	5th Avenue NE	2.7 / A	0.2 / A		16.0 / C	2.8 / A
	Mall Access	4.4 / A	0.3 / A		2.5 / A	2.4 / A
	TH 25/8th Avenue	4.3 / A	14.8 / B	**26.7 / D**	**33.8 / D**	16.4 / C
	10th Avenue NE	1.2 / A	0.5 / A	8.1 / A	6.1 / A	1.4 / A

4.5.5 2045 Alternative 3

Changes to the existing East Mall Area intersections included with Alternative 3 are as follows:

- 4th Avenue NE: remove traffic signal and modify to ¾-access
- 5th Avenue NE: retain existing ¾-access
- TH 25 Ramps: connect TH 25 to TH 210 with roundabout control
  - Maintain 2-through lanes in each direction along TH 210
  - TH 25 has two approach lanes to accommodate permitted trucks
  - 4th leg into the retail center for local connections
- Mall Access: retain existing westbound RI/RO
- 8th Avenue NE: convert intersection to roundabout control
  - Relocate TH 25, south leg, connection to west
  - Maintain 2-through lanes in each direction along TH 210
  - 8th Avenue NE has a single lane approach southbound
- 10th Avenue NE: modify to ¾-access

The proposed Alternative 3 access and control changes result in all intersections operating at LOS A in all time periods for the future 2045 volumes. The combination of restricted access and roundabout control, reduces vehicle speeds and allows all movements to operate acceptably.

From an origin-destination study conducted in the existing conditions, it is understood that over 60% of the eastbound left turns at 5th Avenue NE are destined to the East Brainerd Mall area and most would likely shift to the new Th 25 roundabout with the 4th leg provided to the mall area.

Providing the two separate roundabout intersection design for TH 25 and 8th Avenue NE provides two simplified intersections with less turning traffic at each intersection, resulting in more efficient operations.

The roundabout control is an efficient design that operates with a LOS A in all peak hours. In the AM peak hour, the eastern roundabout at 8th Street NE will have an average queue of less than 50 feet, but a maximum queue that can reach 400 feet; this will just reach the E Street intersection. Queues at the western TH 25 intersection are all 200 feet or less.

In the PM peak hour, all average queues at both intersections are less than 50 feet, and all maximum queues are approximately 400 feet or less.

In the summer peak, the eastbound approach to the western TH 25 roundabout has an average queue of less than 50 feet and a maximum queue of just under 550 feet; this queue would not reach the 5th Avenue NE intersection.

Table 11 presents the proposed 2045 Build Alternative 3 operations for each peak period.

Table 11 – 2045 Build Alternative 3 – East Mall Area Traffic Operations

Peak	Intersection	Approach Delay (sec/veh / LOS)				Int. Delay (s/veh / LOS)
	TH 210 at:	EB	WB	NB	SB	
AM	4th Avenue NE	0.2 / A	0.1 / A	11.8 / B	10.5 / B	0.4 / A
	5th Avenue NE	3.8 / A	0.4 / A		12.5 / B	2.3 / A
	TH 25	3.1 / A	3.7 / A	3.9 / A	22.4 / C	3.5 / A
	Mall Access	0.2 / A	0.2 / A		4.2 / A	0.2 / A
	8th Avenue NE	0.7 / A	2.9 / A		4.5 / A	2.7 / A
	10th Avenue NE	1.3 / A	0.5 / A	6.7 / A	6.7 / A	1.6 / A
PM	4th Avenue NE	0.4 / A	0.2 / A	15.6 / B	10.3 / B	0.5 / A
	5th Avenue NE	2.8 / A	0.4 / A		15.0 / C	2.6 / A
	TH 25	7.7 / A	3.7 / A	11.2 / B	18.0 / C	5.3 / A
	Mall Access	0.4 / A	0.2 / A		3.1 / A	0.5 / A
	8th Avenue NE	1.4 / A	7.4 / A		3.0 / A	3.4 / A
	10th Avenue NE	1.1 / A	0.6 / A	7.6 / A	6.4 / A	1.4 / A
Friday	4th Avenue NE	0.4 / A	0.2 / A	17.2 / B	11.0 / B	0.5 / A
	5th Avenue NE	3.7 / A	0.4 / A		16.5 / C	3.1 / A
	TH 25	8.8 / A	4.2 / A	11.6 / B	19.2 / C	6.0 / A
	Mall Access	0.4 / A	0.2 / A		3.1 / A	0.5 / A
	8th Avenue NE	1.5 / A	8.4 / A		3.1 / A	3.8 / A
	10th Avenue NE	1.2 / A	0.6 / A	7.9 / A	6.9 / A	1.4 / A
Summer	4th Avenue NE	0.9 / A	0.2 / A	21.8 / C	11.1 / B	0.8 / A
	5th Avenue NE	4.7 / A	0.4 / A		18.3 / C	3.8 / A
	TH 25	9.6 / A	5.0 / A	14.5 / B	22.7 / C	6.8 / A
	Mall Access	0.6 / A	0.2 / A		3.6 / A	0.6 / A
	8th Avenue NE	1.9 / A	10.6 / B		3.6 / A	4.7 / A
	10th Avenue NE	1.2 / A	0.6 / A	8.1 / A	6.4 / A	1.4 / A

4.6 Comparison of Alternatives

All three East Mall Area alternatives provide acceptable safety and operations. To assess the impacts of the East Mall Area changes on the entire TH 210 corridor, network wide Measures of Effectiveness (MOE's) were pulled from each modeled alternative.

Network wide statistics for the entire TH 210 corridor include average vehicle delay, vehicle miles traveled (VMT), vehicle hours traveled (VHT), and average vehicle speeds.

- The VMT has negligible differences between alternatives and was not considered further.
- Alternative 2 and 3 both reduce the posted speed limit for just under ½ mile of TH 210, resulting in slightly lower average speeds.

Table 12 presents the network wide average vehicle delay for each alternative, the existing MOE's are also shown for comparison.

Table 12 – Network Wide MOE – Average Delay (seconds/vehicle)

Peak	Existing	No Build	Alternative 1	Alternative 2	Alternative 3
AM	136.8	141.8	70.7	58.6	56.5
PM	72.8	157.0	82.0	69.6	68.1
Friday	77.2	171.4	90.7	77.6	75.3
Summer	144.3	181.4	102.6	90.6	90.1
Weighted Average	**106.8**	**164.6**	**87.7**	**75.4**	**73.7**
Reduction From No Build			**47%**	**54%**	**55%**

Table 13 presents the network wide VHT for each alternative, the existing MOE's are also shown for comparison. VHT includes both the delay time and general travel time for all vehicles in the network.

Table 13 – Network Wide MOE – VHT

Peak	Existing	No Build	Alternative 1	Alternative 2	Alternative 3
AM	476.4	561.2	442.8	424.8	427.6
PM	467.2	724.8	563.7	542.2	548.3
Friday	499.5	792.9	612.0	588.1	590.3
Summer	669.0	845.9	670.2	649.0	654.5
Weighted Average	**534.1**	**743.5**	**581.6**	**560.4**	**564.5**
Reduction From No Build			**22%**	**25%**	**24%**

From these two metrics, each alternative has a significant improvement compared to the No Build conditions. Alternative 1 has the least improvement, and Alternatives 2 and 3 have similar results between the two.

These results are similar to the predicted crashes for each alternative in Section 4.4.

5 Findings and Conclusions

MnDOT is planning to reconstruct TH 210/Washington Street between Baxter Drive and Pine Shores Road beginning in 2025. MnDOT is currently studying the corridor to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout.

This document provides information for the alternatives analysis and control options for the East Mall Area. The main topics evaluated for the intersections consist of intersection safety and operations.

The existing traffic control and intersection designs will continue to have operational and safety issues as traffic grows.

- The 4th Avenue NE traffic signal does not meet signal warrants and should be removed.
- The 5th Avenue NE intersection has a high eastbound left turn volume that creates a safety concern as the queue blocks the through lane; the left turn volume does meet the traffic signal warrants. Many of these left turns are destined to the Brainerd Mall retail area; over 60% based on Origin-Destination study.
- The eastbound TH 25 exit ramp design promotes high speeds along TH 210.
- The Mall access is currently RI/RO and has limited use due to the limited movements allowed.
- The TH 210 at 8th Avenue NE/TH 25 has a high volume of traffic entering the intersection, the limited capacity and signal timing issues result in long delays and extensively long queues at the intersection.
- The 10th Avenue NE intersection will begin to have fewer gaps along TH 210 as traffic increases, and the intersection design has safety concerns due to the high speeds.

To improve the operations in the East Mall Area, seven concepts were initially developed. Some of these concepts were screened out, and the remaining three were evaluated in this document.

Alterative 1 includes converting 4th Avenue NE to a RI/RO, adding a traffic signal at 5th Avenue NE, removing the TH 25 direct connections, no change to the Mall access, providing additional capacity at 8th Avenue/TH 25, and converting 10th Avenue NE to a ¾-access.

The design of this alternative reduces the vehicle conflict points to a total of 57, a 30% reduction compared to the No Build conditions. The predicted crashes within the East Mall Area for this alternative is estimated to be 14.8 crashes in 2045, a nominal increase from the No Build.

All intersections would operate acceptably with LOS D or better under this alternative. The intersection of 8th Avenue NE would operate with three of the four approaches operate at a LOS D and with some of the individual movements operating at LOS E and F during the PM peak, Friday and summer peak times.

This alternative has a preliminary cost estimate of $7.3 million.

Alternative 2 includes converting 4th Avenue NE to a ¾-access, converting 5th Avenue NE to a ¾-access, removing the TH 25 direct connections, converting the Mall access to ¾-access, providing a hybrid roundabout at 8th Avenue NE/TH 25, and converting 10th Avenue NE to a ¾-access.

The design of this alternative reduces the vehicle conflict points to a total of 33, a 59% reduction compared to the No Build conditions. The predicted crashes within the East Mall Area for this alternative is estimated to be 11.8 crashes in 2045, a 17% reduction from the No Build.

All intersections would operate with LOS C or better under this alternative. The roundabout intersection at 8th Avenue NE would have long queues on the single lane, minor street approaches that can reach 1,000 feet.

This alternative has a preliminary cost estimate of $7.25 million.

Alternative 3 includes converting 4th Avenue NE to a ¾-access, converting 5th Avenue NE to a ¾-access, providing a hybrid roundabout at the new TH 25 intersection with a connection into the retail area, retaining the Mall access RI/RO, providing a hybrid roundabout at 8th Avenue NE, and converting 10th Avenue NE to a ¾-access.

The design of this alternative reduces the vehicle conflict points to a total of 36, a 56% reduction compared to the No Build conditions. The predicted crashes within the East Mall Area for this alternative is estimated to be 12.4 crashes in 2045, a 13% reduction from the No Build.

All intersections would operate with a LOS A under this alternative, with the worst approach operating at a LOS C. The two separate 3-legged roundabouts not only reduce the delays, but the maximum queues are also reduced to under 600 feet on any approach.

This alternative has a preliminary cost estimate of $7.3 million.

5.1 Recommendations

Based on the analysis documented in this report, and input from the Project Management Team, Alternative 3 is recommended for the East Mall Area for the following reasons:

- Provides the best overall traffic operations at all intersections in the East Mall Area.
- Provides the 2nd lowest number of expected crashes in the 2045 design year.
  - Roundabouts also reduce severe and fatal crashes by over 85%.
- Reduces vehicle speeds through the East Mall Area under roundabout control, allowing the posted speed limit to be reduced between 5th Avenue NE and 8th Avenue NE.
- All three alternatives have similar costs.

All three alternative layouts can be found in **Appendix E.**

Appendix A

Crash Information

Intersection Safety Screening

Intersection: TH 210 at 4th Avenue NE

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	1
Possible Injury	1
Property Damage	20
Total Crashes	22

Intersection Characteristics	
Entering Volume	25,400
Traffic Control	Signals
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $81,000

Statewide Comparison

Signals: high volume, low speed

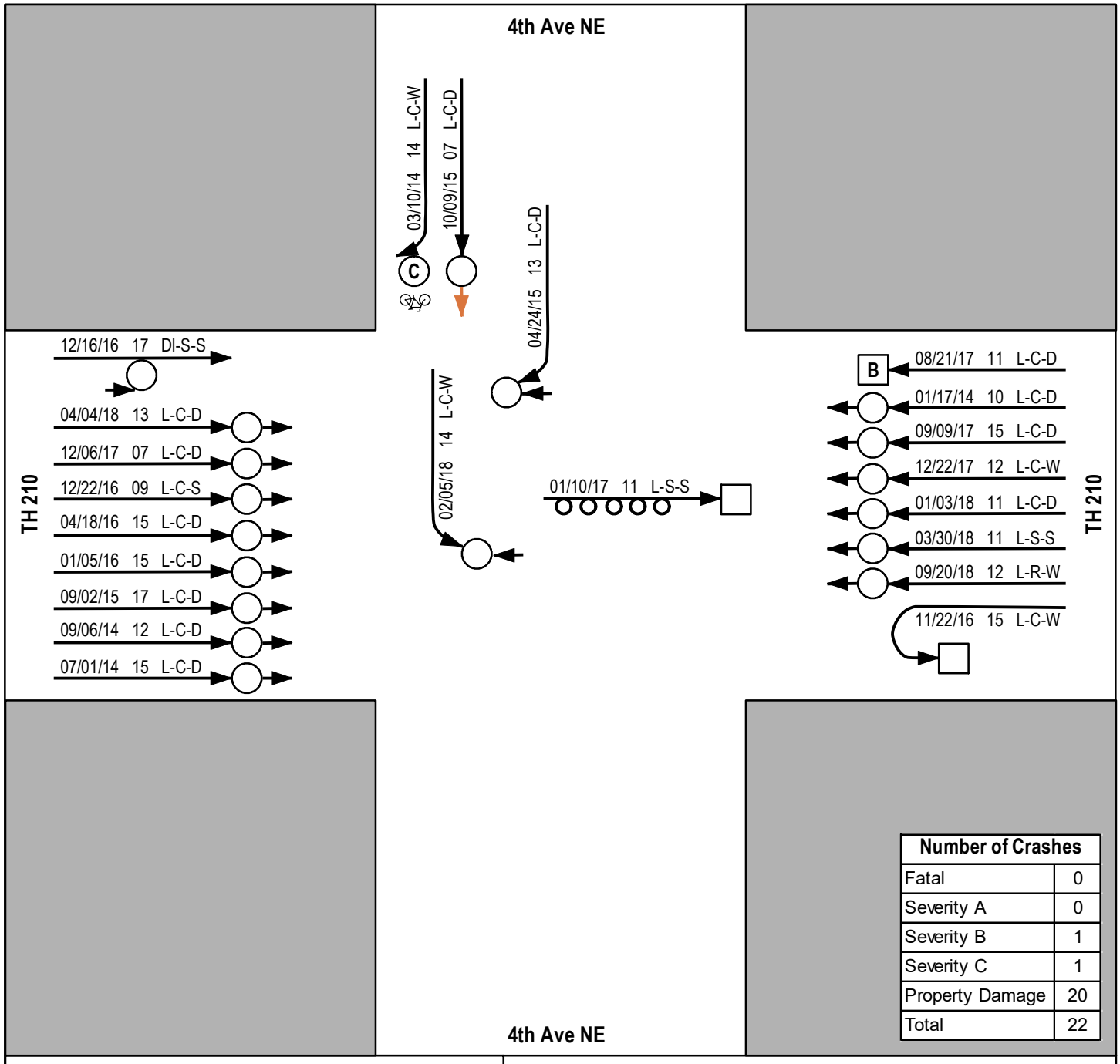
Total Crash Rate	
Observed	0.47
Statewide Average	0.70
Critical Rate	1.02
Critical Index	**0.46**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	3.49
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.47 per MEV; this is 54% below the critical rate. Based on similar statewide intersections, an additional 26 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	1
Severity C	1
Property Damage	20
Total	22

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
A Severity A
B Severity B
C Severity C
Property Damage Only
Vehicle Out of Control

Notes:

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

DEPARTMENT OF TRANSPORTATION

Project: MNT03 152201
Print Date: 3/15/2022

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at 4th Ave NE
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A1

Path: S:\KO\M\Mnt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A9_TH 210 at 4th Ave NE_Crash Diagram.mxd

Intersection Safety Screening

Intersection: TH 210 at 5th Avenue NE

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	2
Property Damage	5
Total Crashes	7

Intersection Characteristics	
Entering Volume	25,750
Traffic Control	Other
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $40,800

Statewide Comparison *Other Unsignalized*

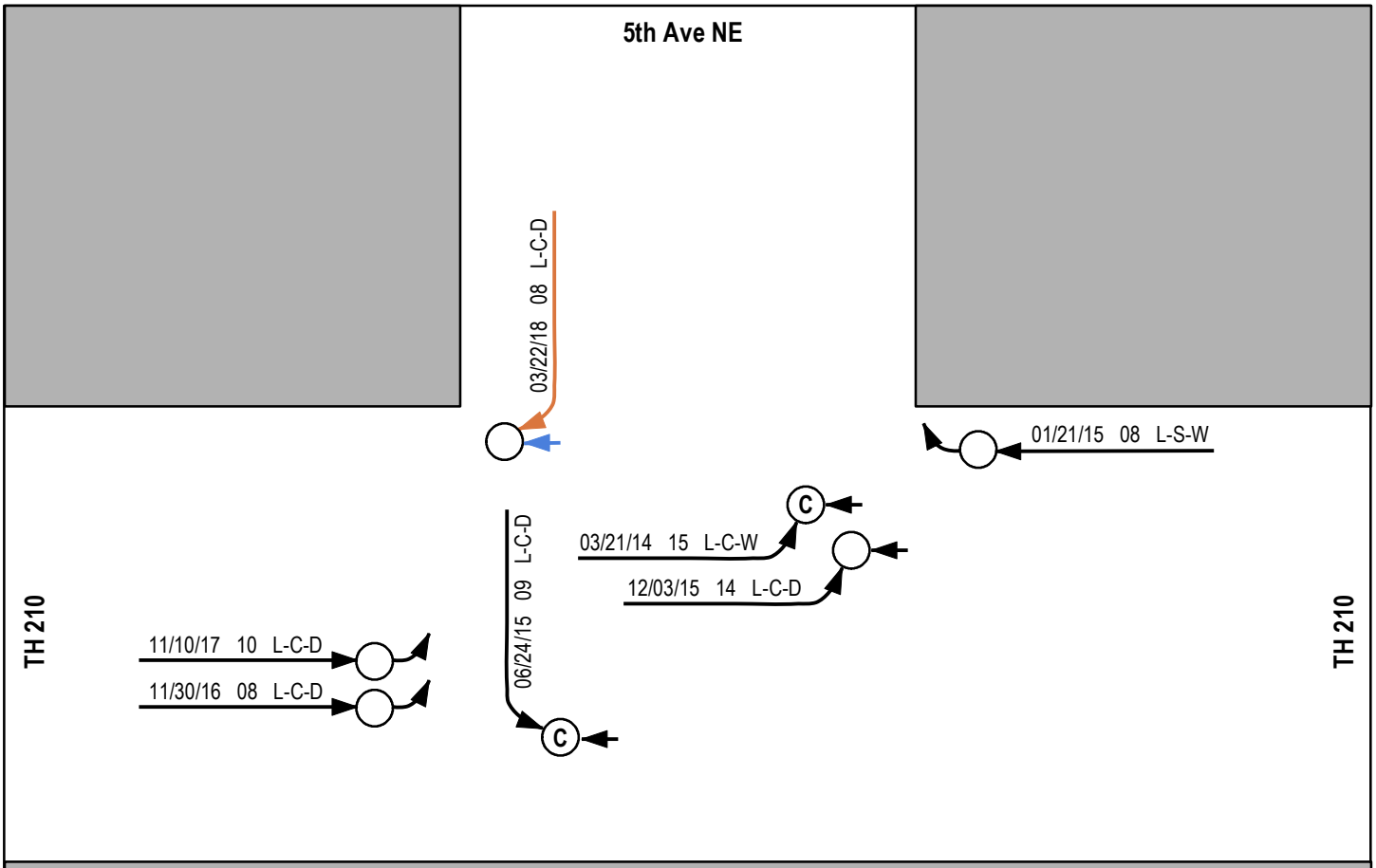
Total Crash Rate	
Observed	0.15
Statewide Average	0.16
Critical Rate	0.32
Critical Index	**0.47**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.17
Critical Rate	2.00
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.15 per MEV; this is 53% below the critical rate. Based on similar statewide intersections, an additional 9 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	0
Severity C	2
Property Damage	5
Total	7

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
A Severity A
B Severity B
C Severity C
Property Damage Only
Vehicle Out of Control

Notes:

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → (Injury Type) → Other Vehicle(s)

DEPARTMENT OF TRANSPORTATION

Project: MNT03 152201
Print Date: 3/15/2022

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at 5th Ave NE
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A2

Path: S:\KO\M\Mnt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A10_TH 210 at 5th Ave NE_Crash Diagram.mxd

Intersection Safety Screening

Intersection: TH 210 at TH 25 EB Off Ramp

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	0
Property Damage	2
Total Crashes	2

Intersection Characteristics	
Entering Volume	19,900
Traffic Control	Other
Environment	Urban
Speed Limit	45 mph

Annual crash cost = $3,040

Statewide Comparison *Other Unsignalized*

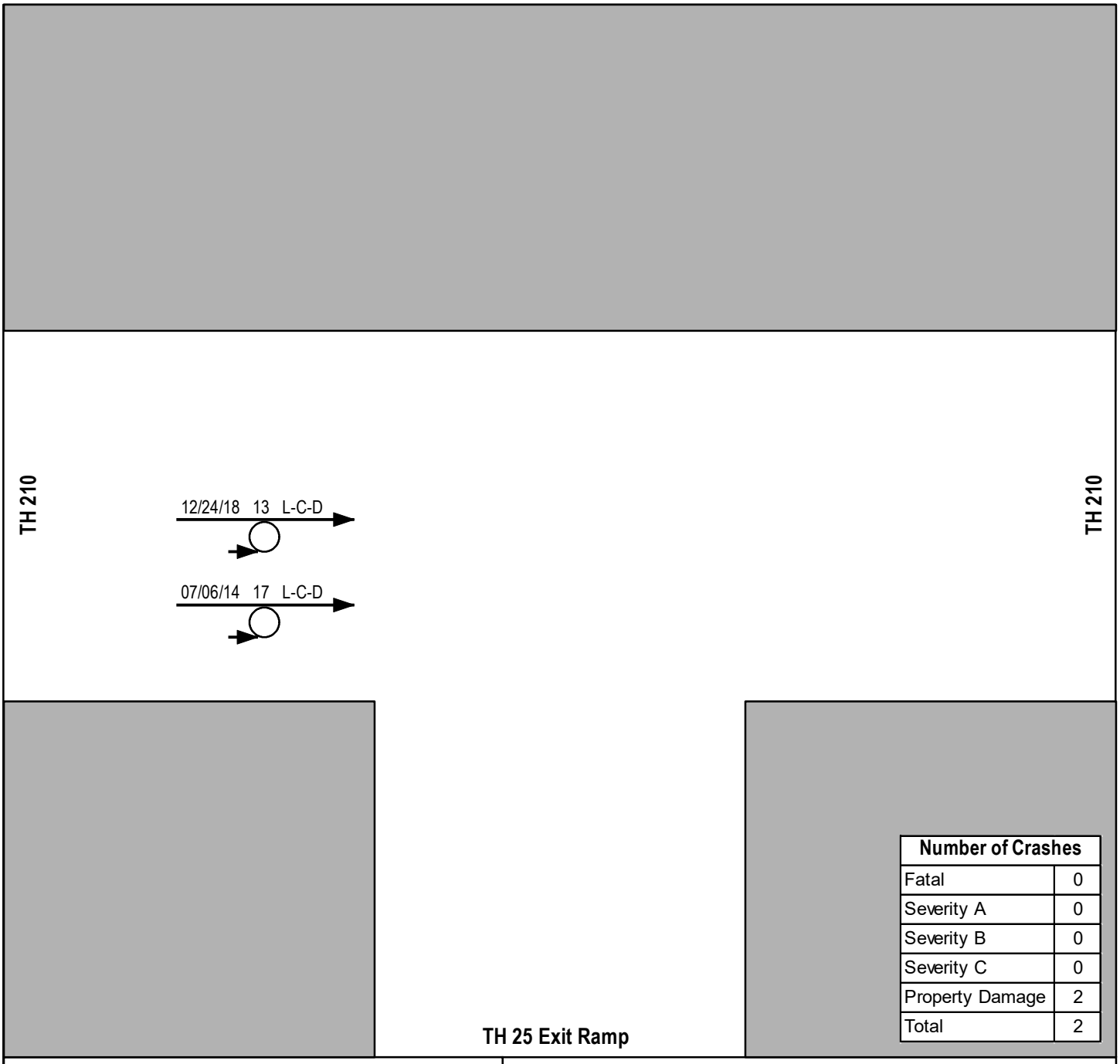
Total Crash Rate	
Observed	0.06
Statewide Average	0.16
Critical Rate	0.34
Critical Index	**0.18**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.17
Critical Rate	2.42
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.06 per MEV; this is 82% below the critical rate. Based on similar statewide intersections, an additional 11 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	0
Severity C	0
Property Damage	2
Total	2

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Notes:

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

DEPARTMENT OF TRANSPORTATION

Project: MNT03 152201
Print Date: 3/15/2022

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at TH 25 Exit Ramp
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A3

Path: S:\KO\M\Mnt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A11_TH 210 at TH 25 Exit Ramp_Crash Diagram.mxd

Intersection Safety Screening

Intersection: TH 210 at TH 25 T-Intersection

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	1
Non-incapacitating Injury	1
Possible Injury	2
Property Damage	8
Total Crashes	12

Intersection Characteristics	
Entering Volume	18,200
Traffic Control	Thru / stop
Environment	Urban
Speed Limit	45 mph

Annual crash cost = $193,360

Statewide Comparison *Urban Thru / Stop*

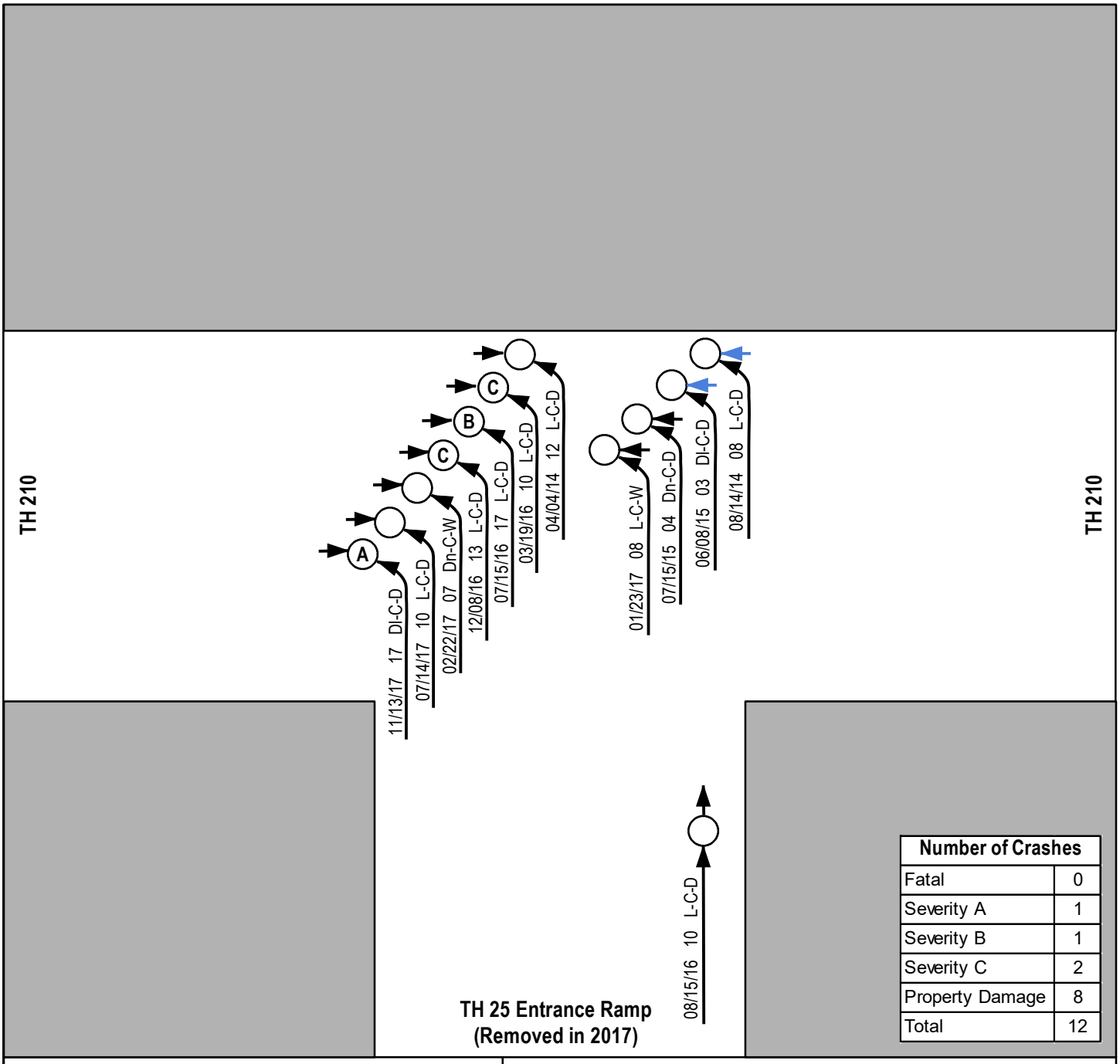
Total Crash Rate	
Observed	0.36
Statewide Average	0.18
Critical Rate	0.39
Critical Index	**0.92**

Fatal & Serious Injury Crash Rate	
Observed	3.01
Statewide Average	0.33
Critical Rate	3.10
Critical Index	**0.97**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.36 per MEV; this is 8% below the critical rate. Based on similar statewide intersections, an additional 1 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 3.01 per 100 MEV; this is 3% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	1
Severity B	1
Severity C	2
Property Damage	8
Total	12

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:
The TH 25 entrance ramp was closed in 2017

DEPARTMENT OF TRANSPORTATION

Project: MNT03 152201
Print Date: 3/15/2022

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at TH 25 Entrance Ramp

TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A4

Path: S:\KO\M\Mnt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A12_TH 210 at TH 25 Entrance Ramp_Crash Diagram.mxd

Intersection Safety Screening

Intersection: TH 210 at 8th Avenue (CSAH 3)/TH 25

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	8
Property Damage	20
Total Crashes	28

Intersection Characteristics	
Entering Volume	20,680
Traffic Control	Signals
Environment	Urban
Speed Limit	50 mph

Annual crash cost = $163,200

Statewide Comparison

Signals: high volume, high speed

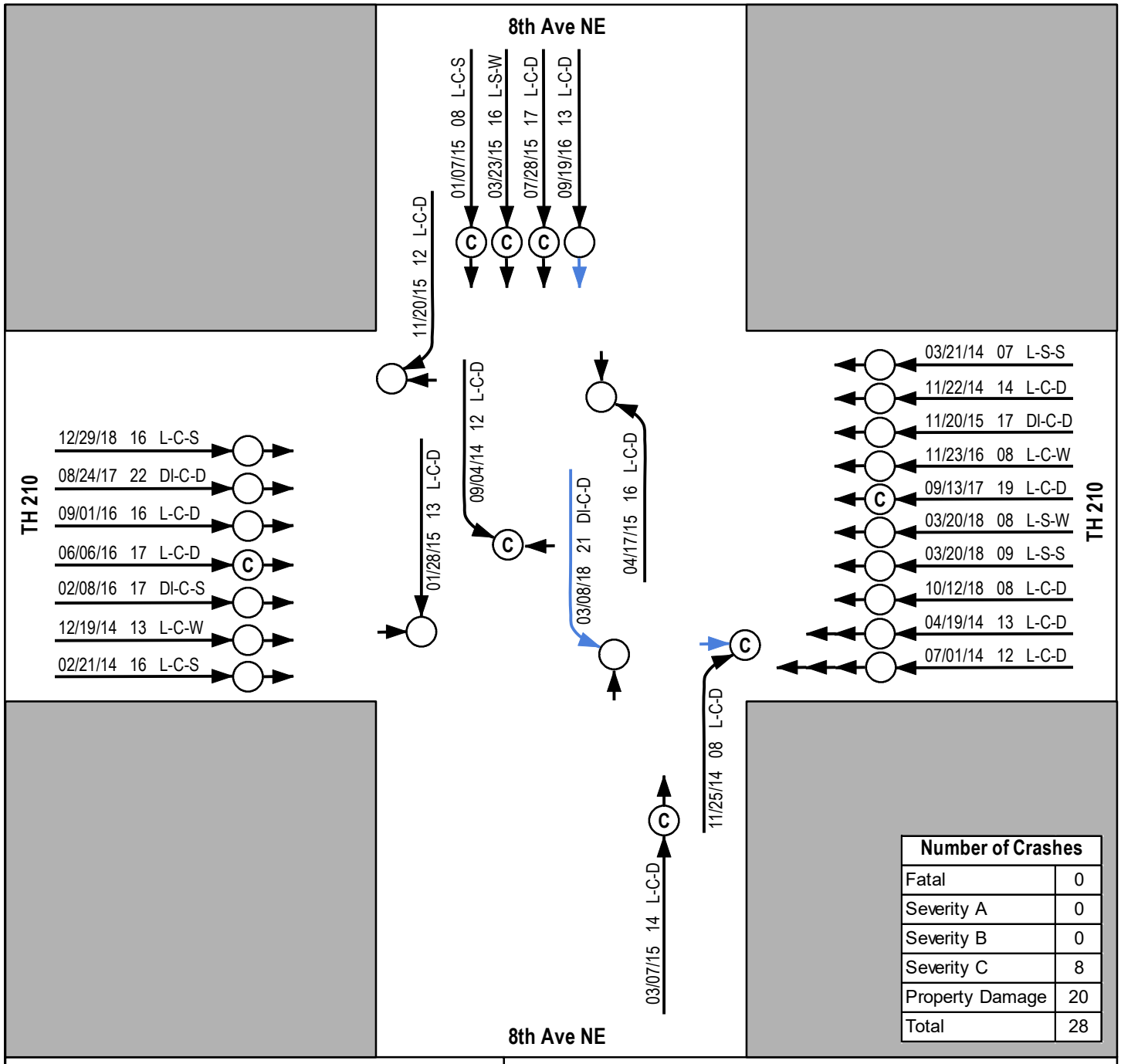
Total Crash Rate	
Observed	0.74
Statewide Average	0.45
Critical Rate	0.75
Critical Index	**0.99**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.48
Critical Rate	3.24
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.74 per MEV; this is 1% below the critical rate. Based on similar statewide intersections, an additional 1 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	0
Severity C	8
Property Damage	20
Total	28

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:

DEPARTMENT OF TRANSPORTATION

Project: MNT03 152201
Print Date: 3/15/2022

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at 8th Ave NE
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A5

Path: S:\KO\M\Mnt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A13_TH 210 at 8th Ave NE_Crash Diagram.mxd

Intersection Safety Screening

Intersection: TH 210 at 10th Avenue NE

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	1
Non-incapacitating Injury	0
Possible Injury	0
Property Damage	3
Total Crashes	4

Intersection Characteristics	
Entering Volume	12,750
Traffic Control	Thru / stop
Environment	Rural
Speed Limit	45 mph

Annual crash cost = $118,560

Statewide Comparison *Rural Thru / Stop*

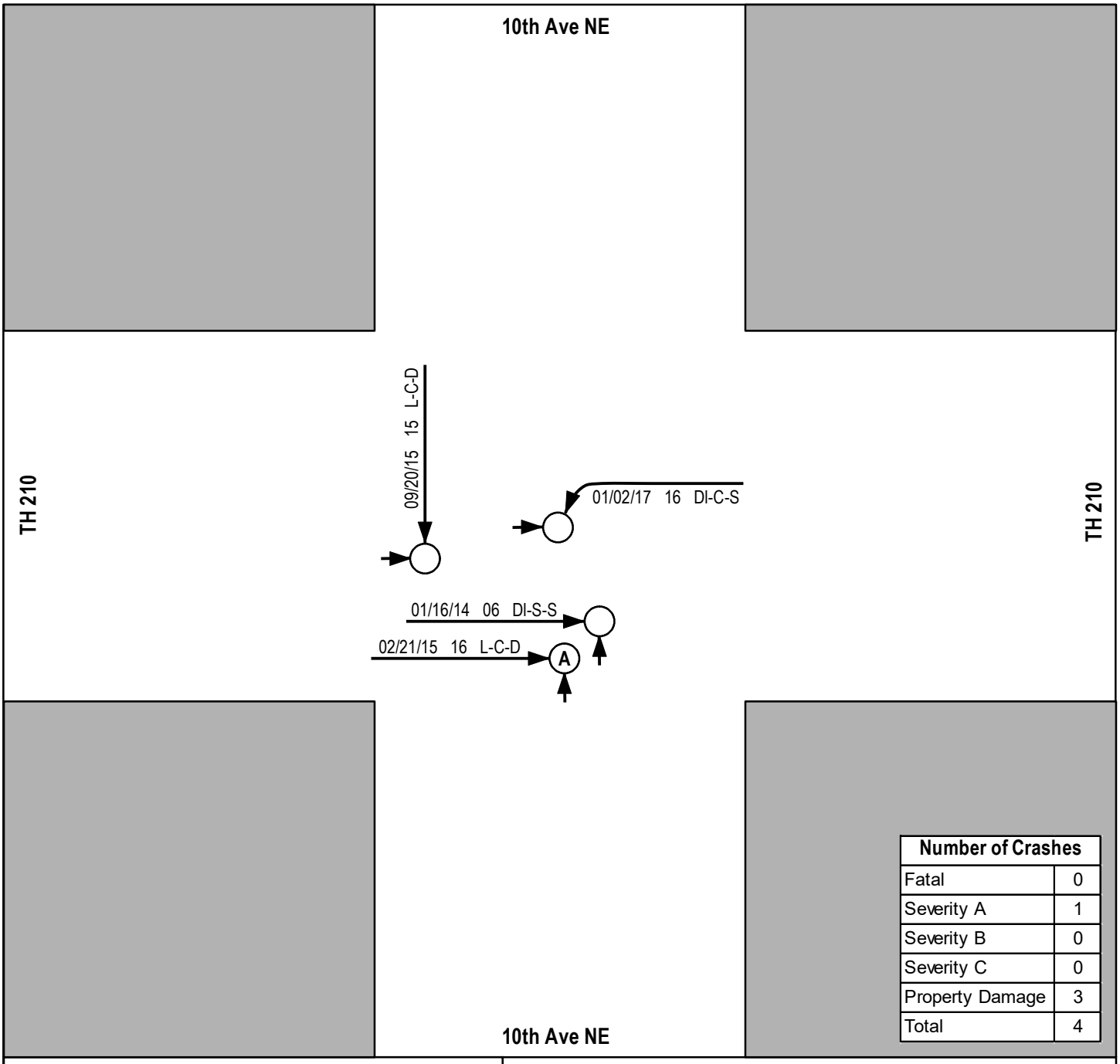
Total Crash Rate	
Observed	0.17
Statewide Average	0.25
Critical Rate	0.54
Critical Index	**0.31**

Fatal & Serious Injury Crash Rate	
Observed	4.30
Statewide Average	1.05
Critical Rate	5.92
Critical Index	**0.73**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.17 per MEV; this is 69% below the critical rate. Based on similar statewide intersections, an additional 9 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 4.30 per 100 MEV; this is 27% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	1
Severity B	0
Severity C	0
Property Damage	3
Total	4

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Notes:

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

DEPARTMENT OF TRANSPORTATION

Project: MNT03 152201
Print Date: 3/15/2022

Map by: jdanibas
Projection:
Source:

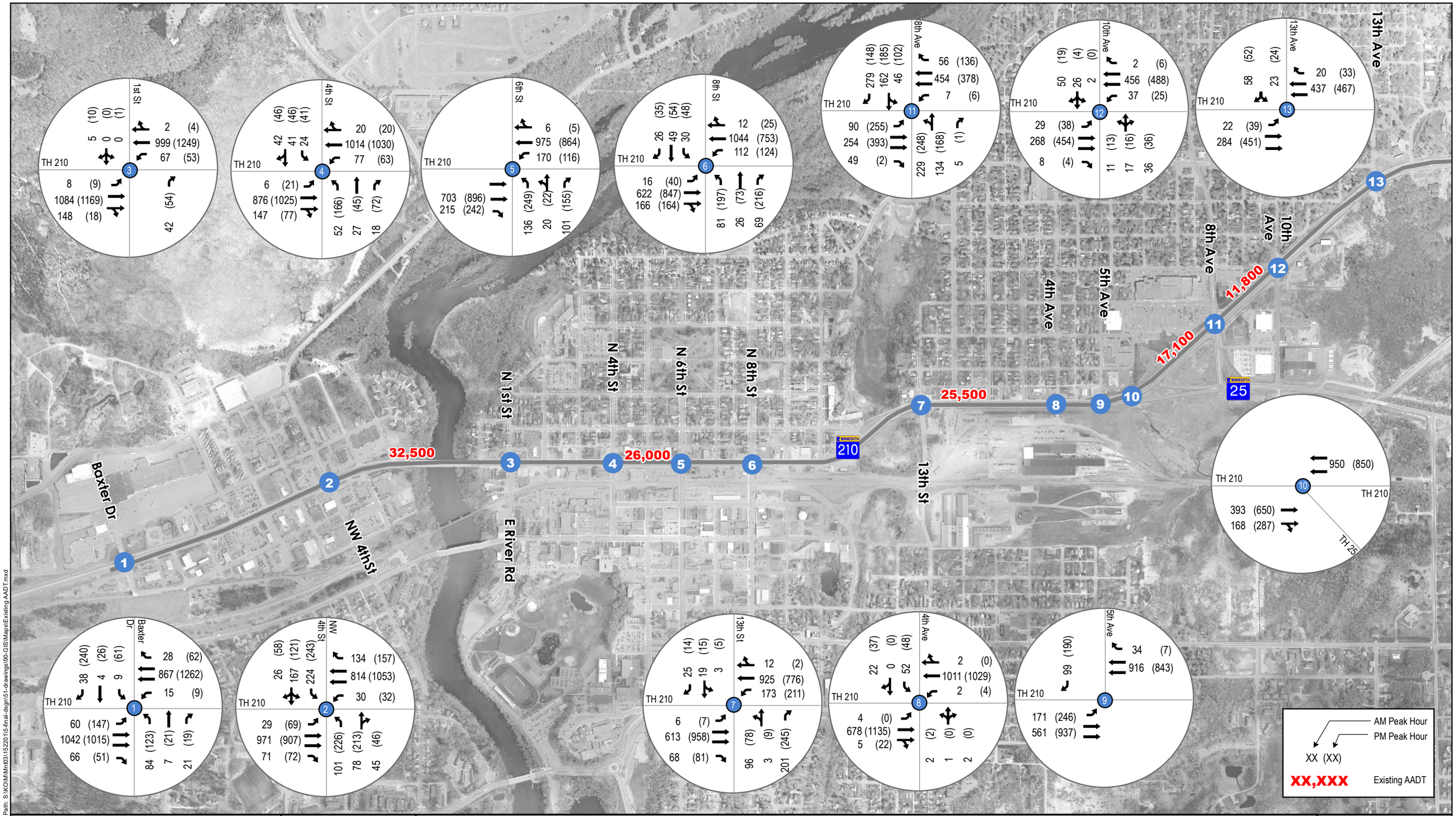
Crash Diagrams (2014-2018)
TH 210 at 10th Ave NE
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A6

Path: S:\KO\M\Mnt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A14_TH 210 at 10th Ave NE_Crash Diagram.mxd

Appendix B

Traffic Volumes



Path: S:\IKOM\Mnt01\152201\5-final-dsgn\51-drawings\90-GIS\Maps\Existing AADT.mxd

DEPARTMENT OF TRANSPORTATION

0 250 500 1,000 Feet

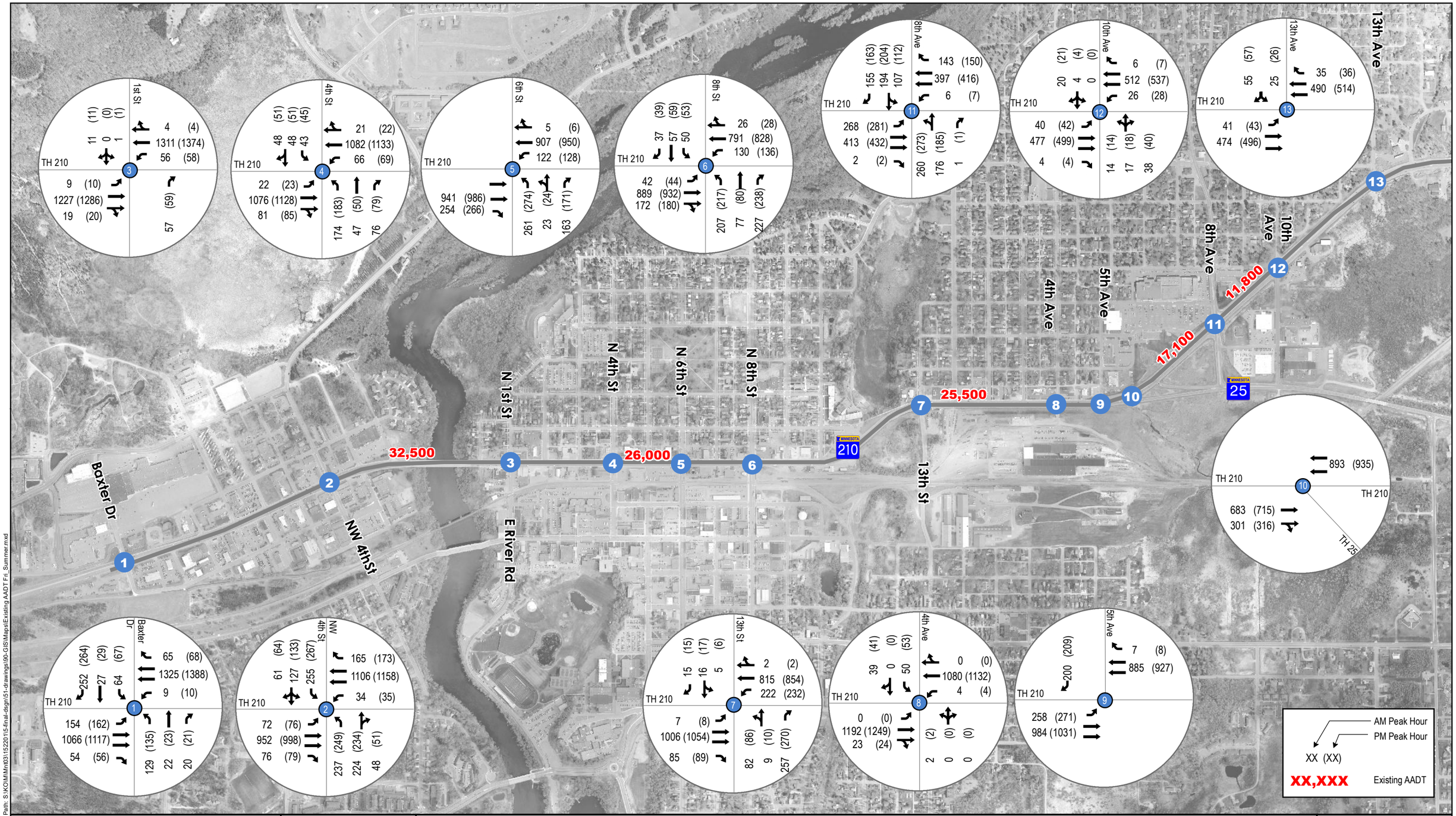
Project: MNT01 152201
Print Date: 3/15/2022

User Name: jdanibas
Projection: Crow Wing County Coords.
Source:

2019 Existing Conditions - AM / PM Weekday

TH 210/Washington Street Corridor Study
Brainerd, Minnesota

Figure B1



Path: S:\IKOM\Mnt01\152201\5-final-dsgn\51-drawings\90-GIS\Maps\Existing AADT Fri_Summer.mxd

DEPARTMENT OF TRANSPORTATION

0 250 500 1,000 Feet

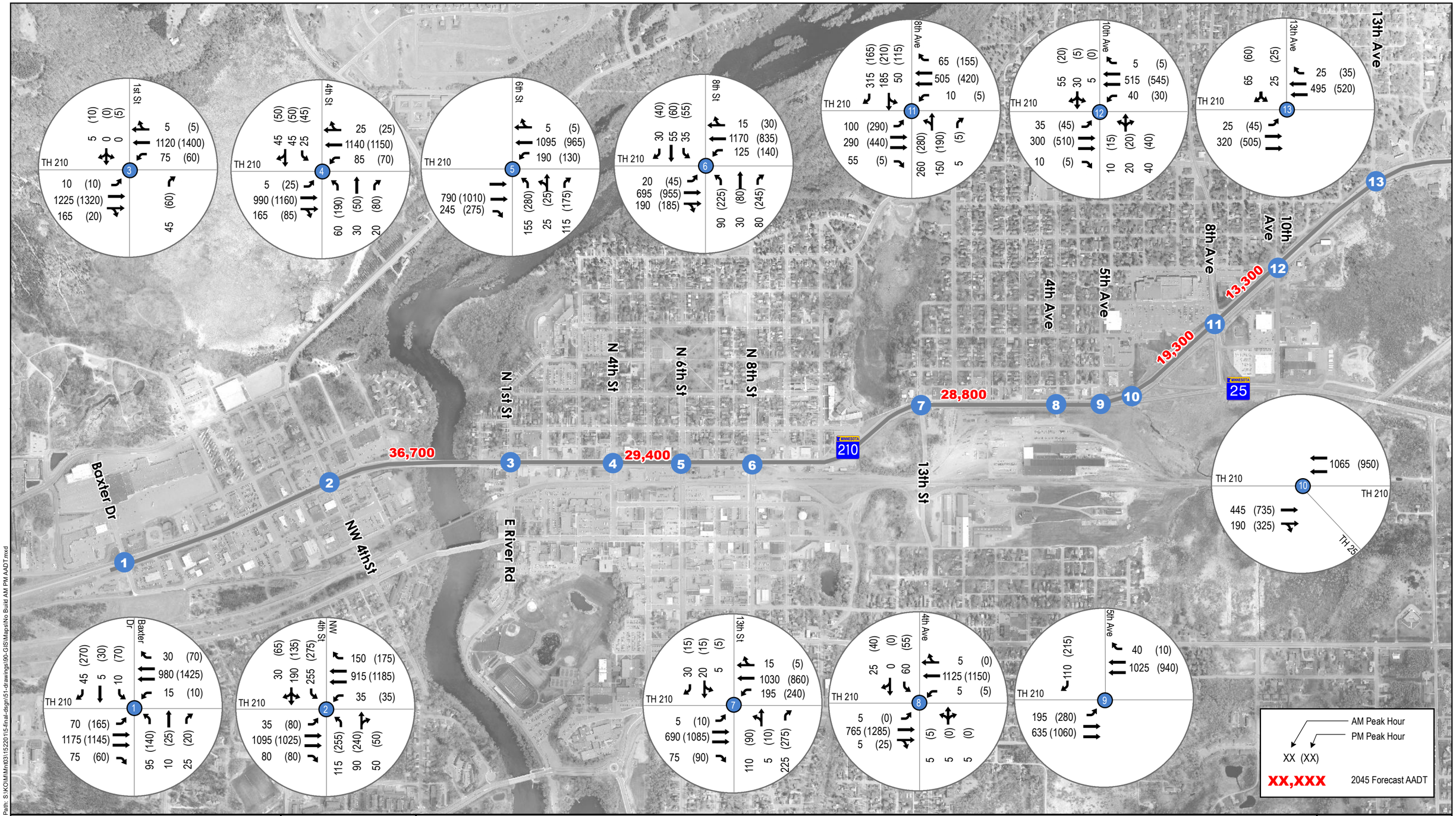
Project: MNT01 152201
Print Date: 3/15/2022

User Name: jdanibas
Projection: Crow Wing County Coords.
Source:

2019 Existing Conditions - Friday and Summer

TH 210/Washington Street Corridor Study
Brainerd, Minnesota

Figure B2



Path: S:\KOM\Mnt01\152201\5-final-dsgn\51-drawings\90-GIS\Maps\No Build AM PM AADT.mxd

DEPARTMENT OF TRANSPORTATION

0 250 500 1,000 Feet

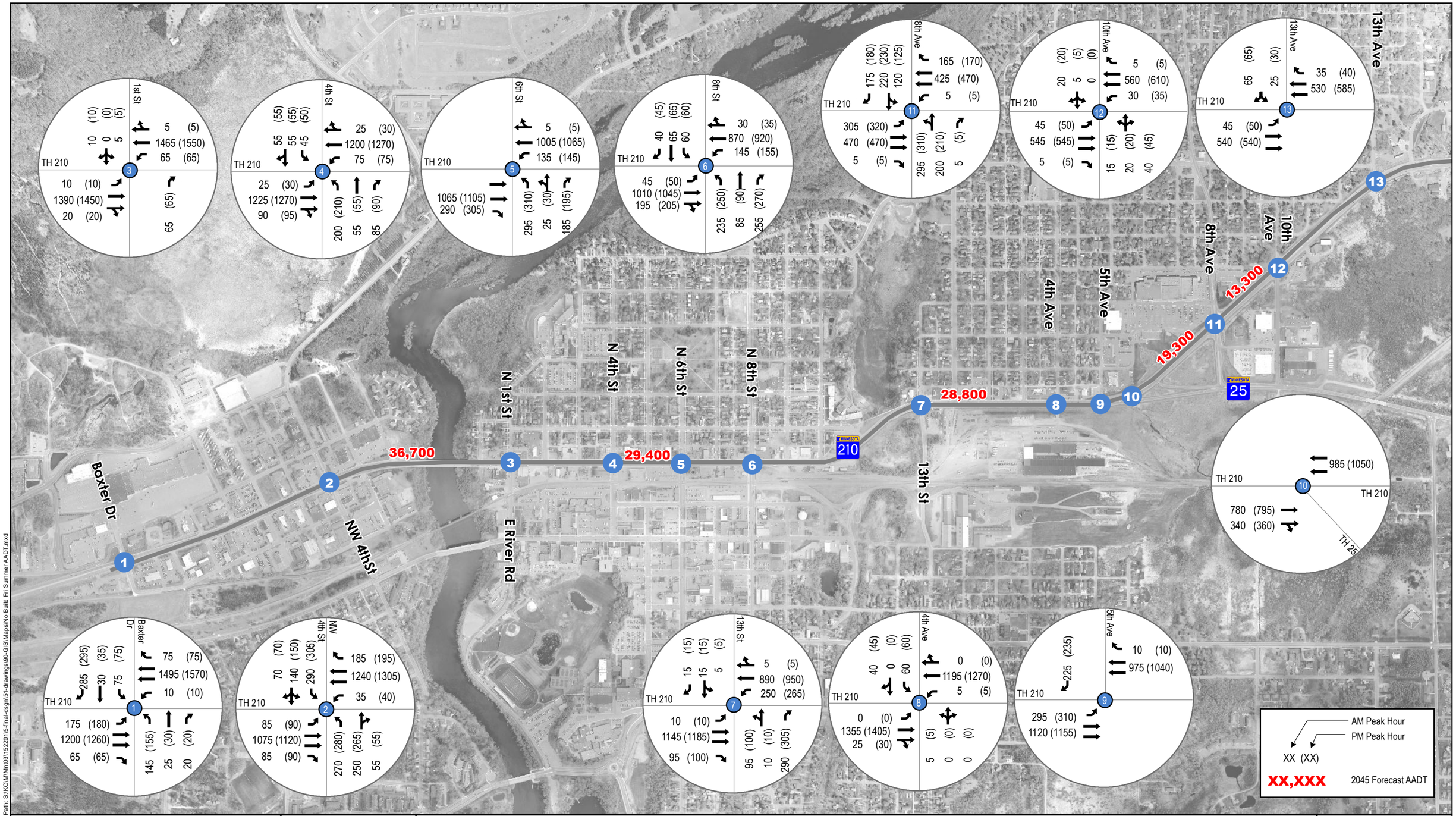
Project: MNT01 152201
Print Date: 3/15/2022

User Name: jdanibas
Projection: Crow Wing County Coords.
Source:

2045 No Build Conditions - AM / PM Weekday

TH 210/Washington Street Corridor Study
Brainerd, Minnesota

Figure B3



Path: S:\IKO\MNt01\152201\5-final-dsgn\51-drawings\90-GIS\Maps\No Build Fri Summer AADT.mxd

DEPARTMENT OF TRANSPORTATION

0 250 500 1,000 Feet

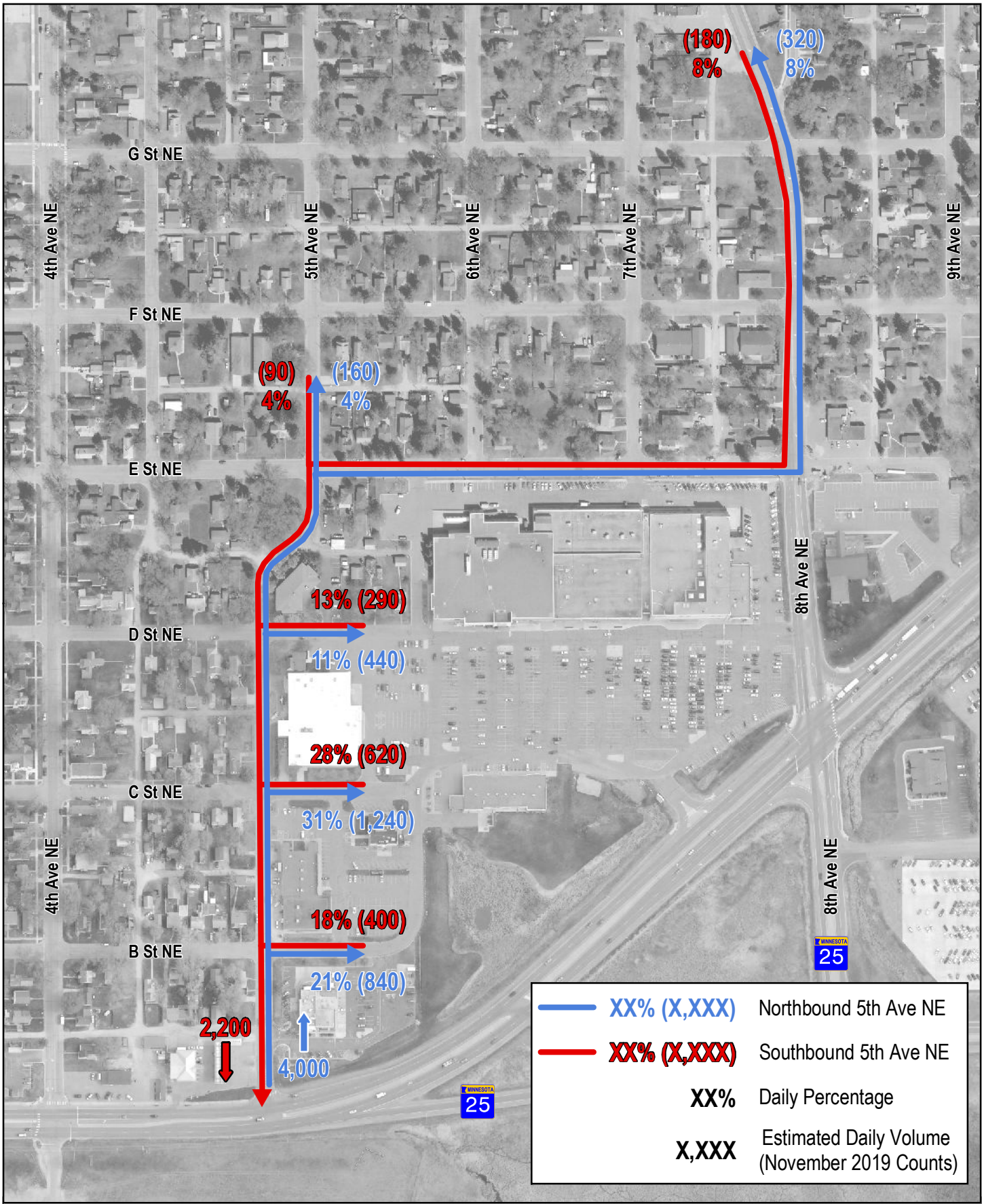
Project: MNT01 152201
Print Date: 3/15/2022

User Name: jdanibas
Projection: Crow Wing County Coords.
Source:

2045 No Build Conditions - Friday and Summer

TH 210/Washington Street Corridor Study
Brainerd, Minnesota

Figure B4



Path: S:\KO\MMn\03\152201\5-final-dsgn\51-drawings\90-GIS\Maps\5th Ave OD.mxd

SEH

Project: MNT01 152201
Print Date: 2/18/2020

Map by: jdanibas
Projection: Crow Wing Co. Coords.
Source:

5th Avenue NE Origin-Destination

TH 210/Washington Street Corridor Study
Brainerd, MN

Figure B5

JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044
Change These In PREFERENCES

File Name : TH 210 & 4th Ave NE_AM_Brainerd_
Site Code : 00000000
Start Date : 10/21/2019
Page No : 1

Groups Printed- Unshifted

	4th Ave NE From North					TH210 From East					4th Ave NE From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	3	0	2	0	5	0	56	6	0	62	0	0	0	0	0	0	54	0	0	54	121
06:15 AM	4	0	0	0	4	1	109	12	0	122	0	0	1	0	1	4	79	0	0	83	210
06:30 AM	3	1	2	0	6	0	142	21	0	163	0	0	0	0	0	8	101	0	0	109	278
06:45 AM	5	2	2	0	9	0	155	11	1	167	0	0	0	0	0	13	91	2	0	106	282
Total	15	3	6	0	24	1	462	50	1	514	0	0	1	0	1	25	325	2	0	352	891
07:00 AM	4	0	0	0	4	0	139	0	0	139	0	0	0	0	0	2	101	1	0	104	247
07:15 AM	9	0	1	0	10	0	217	0	0	217	0	0	0	0	0	0	136	1	0	137	364
07:30 AM	14	0	9	0	23	0	245	0	0	245	0	0	1	0	1	0	163	3	0	166	435
07:45 AM	12	0	5	0	17	2	307	0	0	309	0	0	0	0	0	1	189	2	0	192	518
Total	39	0	15	0	54	2	908	0	0	910	0	0	1	0	1	3	589	7	0	599	1564
08:00 AM	16	0	4	0	20	0	213	1	0	214	1	0	1	0	2	2	170	0	0	172	408
08:15 AM	10	0	4	0	14	0	195	1	0	196	1	1	0	0	2	1	156	0	0	157	369
08:30 AM	6	1	0	0	7	0	196	0	0	196	0	0	1	0	1	0	140	1	0	141	345
08:45 AM	4	0	4	0	8	0	186	0	0	186	0	0	0	0	0	0	119	2	0	121	315
Total	36	1	12	0	49	0	790	2	0	792	2	1	2	0	5	3	585	3	0	591	1437
09:00 AM	3	0	4	0	7	0	167	1	0	168	3	0	0	0	3	1	134	2	0	137	315
09:15 AM	4	0	2	0	6	1	159	2	0	162	0	0	0	0	0	0	125	4	0	129	297
09:30 AM	4	0	3	0	7	1	181	1	0	183	1	0	3	0	4	0	151	1	0	152	346
09:45 AM	6	0	1	0	7	0	196	0	0	196	0	0	1	0	1	0	128	3	0	131	335
Total	17	0	10	0	27	2	703	4	0	709	4	0	4	0	8	1	538	10	0	549	1293
10:00 AM	6	0	2	0	8	0	148	0	0	148	0	0	0	0	0	0	150	4	0	154	310
10:15 AM	11	0	3	0	14	2	187	0	0	189	0	0	0	0	0	1	114	1	0	116	319
10:30 AM	8	0	3	0	11	1	189	1	0	191	0	0	0	0	0	1	175	4	0	180	382
10:45 AM	7	1	10	0	18	1	236	0	0	237	0	0	2	0	2	0	140	2	0	142	399
Total	32	1	18	0	51	4	760	1	0	765	0	0	2	0	2	2	579	11	0	592	1410
11:00 AM	6	0	2	0	8	1	215	1	0	217	0	0	0	0	0	0	172	4	0	176	401
11:15 AM	7	0	8	0	15	2	197	1	0	200	0	0	2	0	2	1	172	4	0	177	394
11:30 AM	13	1	7	0	21	1	210	2	0	213	1	0	1	0	2	1	210	7	0	218	454
11:45 AM	10	0	4	0	14	1	224	0	0	225	1	0	1	0	2	0	167	6	0	173	414
Total	36	1	21	0	58	5	846	4	0	855	2	0	4	0	6	2	721	21	0	744	1663
12:00 PM	12	4	6	0	22	2	198	2	0	202	9	0	3	0	12	5	196	3	0	204	440
12:15 PM	11	0	12	0	23	3	219	4	0	226	0	0	0	0	0	1	185	5	0	191	440
Grand Total	198	10	100	0	308	19	4886	67	1	4973	17	1	17	0	35	42	3718	62	0	3822	9138
Apprch %	64.3	3.2	32.5	0.0		0.4	98.3	1.3	0.0		48.6	2.9	48.6	0.0		1.1	97.3	1.6	0.0		
Total %	2.2	0.1	1.1	0.0	3.4	0.2	53.5	0.7	0.0	54.4	0.2	0.0	0.2	0.0	0.4	0.5	40.7	0.7	0.0	41.8	

JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044
File Name : TH 210 & 4th Ave NE_PM_Brainerd_
Site Code : 00000000
Start Date : 10/16/2019
Page No : 1

Change These In PREFERENCES

Groups Printed- Unshifted

	4th Ave NE From North					TH210 From East					4th Ave NE From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
12:30 PM	6	0	7	0	13	2	210	0	0	212	1	0	0	0	1	1	183	5	0	189	415
12:45 PM	7	0	9	0	16	0	204	0	0	204	1	0	0	0	1	0	212	4	0	216	437
Total	13	0	16	0	29	2	414	0	0	416	2	0	0	0	2	1	395	9	0	405	852
01:00 PM	8	0	5	0	13	1	196	0	0	197	0	0	0	0	0	1	192	5	0	198	408
01:15 PM	7	0	5	1	13	1	179	3	0	183	0	0	0	0	0	0	206	3	0	209	405
01:30 PM	5	2	2	1	10	0	199	0	0	199	1	0	1	0	2	0	199	4	0	203	414
01:45 PM	10	0	4	0	14	1	192	1	0	194	0	0	0	0	0	1	186	4	0	191	399
Total	30	2	16	2	50	3	766	4	0	773	1	0	1	0	2	2	783	16	0	801	1626
02:00 PM	7	0	3	0	10	1	154	0	0	155	0	0	1	0	1	0	184	1	0	185	351
02:15 PM	10	0	12	1	23	2	175	0	0	177	1	0	0	0	1	1	232	2	0	235	436
02:30 PM	12	0	8	0	20	2	146	0	2	150	3	0	0	0	3	0	221	8	0	229	402
02:45 PM	21	0	6	0	27	1	237	0	0	238	0	0	0	0	0	1	213	8	0	222	487
Total	50	0	29	1	80	6	712	0	2	720	4	0	1	0	5	2	850	19	0	871	1676
03:00 PM	11	0	13	0	24	3	200	0	1	204	2	0	1	0	3	0	258	8	0	266	497
03:15 PM	12	0	12	0	24	0	197	0	0	197	4	1	8	0	13	0	283	3	0	286	520
03:30 PM	19	0	13	0	32	1	213	0	0	214	32	1	26	0	59	0	268	6	0	274	579
03:45 PM	11	0	3	0	14	1	241	0	0	242	0	0	0	0	0	0	272	1	0	273	529
Total	53	0	41	0	94	5	851	0	1	857	38	2	35	0	75	0	1081	18	0	1099	2125
04:00 PM	10	0	5	1	16	3	231	0	0	234	0	0	0	0	0	0	247	3	0	250	500
04:15 PM	10	0	3	0	13	2	202	0	0	204	0	0	0	0	0	0	267	5	0	272	489
04:30 PM	11	0	12	0	23	0	230	0	0	230	0	0	0	0	0	0	279	9	0	288	541
04:45 PM	9	0	8	0	17	2	237	0	0	239	2	0	0	0	2	0	251	4	0	255	513
Total	40	0	28	1	69	7	900	0	0	907	2	0	0	0	2	0	1044	21	0	1065	2043
05:00 PM	16	0	7	0	23	1	272	0	0	273	0	0	0	0	0	0	321	5	0	326	622
05:15 PM	12	0	10	0	22	1	212	0	0	213	0	0	0	0	0	0	284	4	0	288	523
05:30 PM	10	0	9	0	19	0	197	0	0	197	0	0	0	0	0	1	229	2	0	232	448
05:45 PM	6	0	4	0	10	2	184	0	0	186	1	0	0	0	1	0	231	3	0	234	431
Total	44	0	30	0	74	4	865	0	0	869	1	0	0	0	1	1	1065	14	0	1080	2024
Grand Total	230	2	160	4	396	27	4508	4	3	4542	48	2	37	0	87	6	5218	97	0	5321	10346
Apprch %	58.1	0.5	40.4	1.0		0.6	99.3	0.1	0.1		55.2	2.3	42.5	0.0		0.1	98.1	1.8	0.0		
Total %	2.2	0.0	1.5	0.0	3.8	0.3	43.6	0.0	0.0	43.9	0.5	0.0	0.4	0.0	0.8	0.1	50.4	0.9	0.0	51.4	

JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044
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5th Avenue NE

File Name : TH210 & 5th St _Brainerd
Site Code : 00000000
Start Date : 11/19/2019
Page No : 1

Groups Printed- Unshifted

	5th St From North					TH210 From East					From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	4	0	0	0	4	4	65	0	0	69	0	1	0	0	1	0	68	9	0	77	151
06:15 AM	5	0	1	0	6	8	93	0	0	101	0	0	0	0	0	0	74	9	0	83	190
06:30 AM	9	0	0	0	9	14	130	0	0	144	0	0	0	0	0	0	98	13	0	111	264
06:45 AM	11	0	1	0	12	6	172	0	0	178	0	0	0	0	0	0	126	14	0	140	330
Total	29	0	2	0	31	32	460	0	0	492	0	1	0	0	1	0	366	45	0	411	935
07:00 AM	15	0	0	0	15	14	151	0	0	165	0	0	0	0	0	0	95	25	0	120	300
07:15 AM	16	0	0	0	16	10	215	0	0	225	0	0	0	0	0	0	115	22	0	137	378
07:30 AM	19	0	0	0	19	4	271	0	0	275	0	0	0	0	0	0	146	36	0	182	476
07:45 AM	19	0	0	0	19	11	263	0	0	274	0	0	0	0	0	0	165	55	0	220	513
Total	69	0	0	0	69	39	900	0	0	939	0	0	0	0	0	0	521	138	0	659	1667
08:00 AM	33	0	0	0	33	12	187	0	0	199	0	0	0	0	0	0	170	46	0	216	448
08:15 AM	28	0	0	0	28	7	195	0	0	202	0	0	0	0	0	0	162	34	0	196	426
08:30 AM	15	0	0	0	15	8	185	0	0	193	0	0	0	0	0	0	138	27	0	165	373
08:45 AM	28	0	0	0	28	8	182	0	0	190	0	0	0	0	0	0	118	37	0	155	373
Total	104	0	0	0	104	35	749	0	0	784	0	0	0	0	0	0	588	144	0	732	1620
09:00 AM	26	0	0	0	26	7	155	0	0	162	0	0	0	0	0	0	135	36	0	171	359
09:15 AM	23	0	0	0	23	10	168	0	0	178	0	0	0	0	0	0	128	31	0	159	360
09:30 AM	34	0	0	0	34	9	162	0	0	171	0	0	0	0	0	0	145	36	0	181	386
09:45 AM	18	0	0	0	18	4	185	0	0	189	0	0	0	0	0	0	132	35	0	167	374
Total	101	0	0	0	101	30	670	0	0	700	0	0	0	0	0	0	540	138	0	678	1479
10:00 AM	36	0	0	0	36	6	163	0	0	169	0	0	0	0	0	0	142	39	0	181	386
10:15 AM	29	0	1	0	30	19	153	0	0	172	0	0	0	0	0	0	120	52	0	172	374
10:30 AM	31	0	0	0	31	5	171	0	0	176	0	0	0	0	0	0	170	47	0	217	424
10:45 AM	42	0	0	0	42	4	208	0	0	212	0	0	0	0	0	0	150	44	0	194	448
Total	138	0	1	0	139	34	695	0	0	729	0	0	0	0	0	0	582	182	0	764	1632
11:00 AM	47	0	0	0	47	12	210	0	0	222	0	0	0	0	0	0	170	49	0	219	488
11:15 AM	48	0	0	0	48	7	197	0	0	204	0	0	0	0	0	0	172	50	0	222	474
11:30 AM	36	0	0	0	36	17	199	0	0	216	0	0	0	0	0	0	200	58	0	258	510
11:45 AM	44	0	0	0	44	15	221	0	0	236	0	0	0	0	0	0	198	87	0	285	565
Total	175	0	0	0	175	51	827	0	0	878	0	0	0	0	0	0	740	244	0	984	2037
12:00 PM	37	0	0	0	37	17	204	0	0	221	0	0	0	0	0	0	192	91	0	283	541
12:15 PM	47	0	0	0	47	10	210	0	0	220	0	0	0	0	0	0	188	80	0	268	535
12:30 PM	53	0	0	0	53	9	211	0	0	220	0	0	0	0	0	0	149	65	0	214	487
12:45 PM	44	0	0	0	44	8	206	0	0	214	0	0	0	0	0	0	198	88	0	286	544
Total	181	0	0	0	181	44	831	0	0	875	0	0	0	0	0	0	727	324	0	1051	2107
01:00 PM	45	0	0	0	45	5	197	0	0	202	0	0	0	0	0	0	185	72	0	257	504
01:15 PM	36	0	0	0	36	7	188	0	0	195	0	0	0	0	0	0	203	69	0	272	503
01:30 PM	35	0	0	0	35	9	187	0	0	196	0	0	0	0	0	0	201	62	0	263	494
01:45 PM	30	0	0	0	30	6	192	0	0	198	0	0	0	0	0	0	199	72	0	271	499
Total	146	0	0	0	146	27	764	0	0	791	0	0	0	0	0	0	788	275	0	1063	2000
02:00 PM	31	0	0	0	31	7	162	0	0	169	0	0	0	0	0	0	179	74	0	253	453
02:15 PM	32	0	0	0	32	2	177	0	0	179	0	0	0	0	0	0	220	77	0	297	508
02:30 PM	48	0	0	0	48	2	151	0	0	153	0	0	0	0	0	0	225	68	0	293	494
02:45 PM	35	0	0	0	35	4	182	0	0	186	0	0	0	0	0	0	210	79	0	289	510
Total	146	0	0	0	146	15	672	0	0	687	0	0	0	0	0	0	834	298	0	1132	1965
03:00 PM	41	0	0	0	41	9	210	0	0	219	0	0	0	0	0	0	248	61	0	309	569
03:15 PM	34	0	0	0	34	5	198	0	0	203	0	0	0	0	0	0	275	85	0	360	597
03:30 PM	41	0	0	0	41	8	218	0	0	226	0	0	0	0	0	0	266	89	0	355	622
03:45 PM	35	0	0	0	35	8	232	0	0	240	0	0	0	0	0	0	271	79	0	350	625
Total	151	0	0	0	151	30	858	0	0	888	0	0	0	0	0	0	1060	314	0	1374	2413

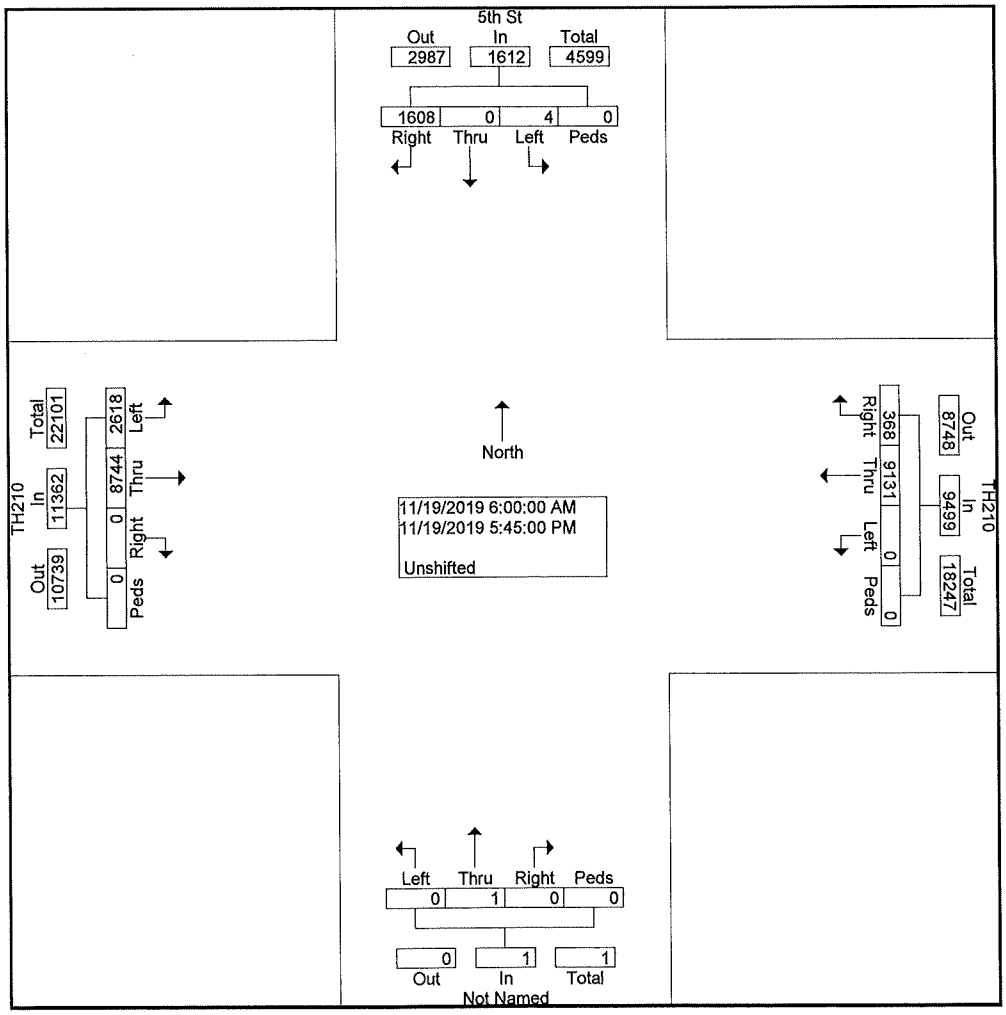
JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044
Change These In PREFERENCES

5th Avenue NE

File Name : TH210 & 5th St _Brainerd
Site Code : 00000000
Start Date : 11/19/2019

Groups Printed- Unshifted

	5th St From North					TH210 From East					From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
04:00 PM	54	0	0	0	54	9	225	0	0	234	0	0	0	0	0	0	238	73	0	311	599
04:15 PM	49	0	1	0	50	8	193	0	0	201	0	0	0	0	0	0	257	90	0	347	598
04:30 PM	46	0	0	0	46	3	224	0	0	227	0	0	0	0	0	0	245	61	0	306	579
04:45 PM	53	0	0	0	53	2	229	0	0	231	0	0	0	0	0	0	251	51	0	302	586
Total	202	0	1	0	203	22	871	0	0	893	0	0	0	0	0	0	991	275	0	1266	2362
05:00 PM	42	0	0	0	42	2	268	0	0	270	0	0	0	0	0	0	255	68	0	323	635
05:15 PM	49	0	0	0	49	0	216	0	0	216	0	0	0	0	0	0	275	66	0	341	606
05:30 PM	53	0	0	0	53	3	195	0	0	198	0	0	0	0	0	0	235	58	0	293	544
05:45 PM	22	0	0	0	22	4	155	0	0	159	0	0	0	0	0	0	242	49	0	291	472
Total	166	0	0	0	166	9	834	0	0	843	0	0	0	0	0	0	1007	241	0	1248	2257
Grand Total	1608	0	4	0	1612	368	9131	0	0	9499	0	1	0	0	1	0	8744	2618	0	11362	22474
Apprch %	99.8	0.0	0.2	0.0		3.9	96.1	0.0	0.0		0.0	100.0	0.0	0.0		0.0	77.0	23.0	0.0		
Total %	7.2	0.0	0.0	0.0	7.2	1.6	40.6	0.0	0.0	42.3	0.0	0.0	0.0	0.0	0.0	0.0	38.9	11.6	0.0	50.6	



TH 25 Eastbound Ramp Connection

	18-Nov	19-Nov	20-Nov
12:00AM		9	7
1:00AM		7	13
2:00AM		5	5
3:00AM		4	2
4:00AM		7	10
5:00AM		49	31
6:00AM	86	93	
7:00AM	146	169	
8:00AM	132	137	
9:00AM	111	108	
10:00AM	120	128	
11:00AM	180	174	
12:00PM	214	203	
1:00PM	192	162	
2:00PM	206	189	
3:00PM	231	260	
4:00PM	251	257	
5:00PM	224	212	
6:00PM	168	152	
7:00PM	59	126	
8:00PM	92	100	
9:00PM	38	63	
10:00PM	32	36	
11:00PM	16	12	
Total			5128

JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044
Change These In PREFERENCES

File Name : TH 210 & 10th Ave NE_AM_Brainerd_
Site Code : 00000000
Start Date : 11/5/2019
Page No : 1

Groups Printed- Unshifted

	10th Ave From North					TH210 From East					10th Ave From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	1	0	0	0	1	0	51	1	0	52	5	2	0	0	7	0	48	1	0	49	109
06:15 AM	3	0	0	0	3	1	66	3	0	70	12	0	1	0	13	0	63	3	0	66	152
06:30 AM	1	1	0	0	2	0	74	5	0	79	9	0	1	0	10	1	53	0	0	54	145
06:45 AM	2	1	0	0	3	0	61	12	0	73	10	0	1	0	11	1	62	0	0	63	150
Total	7	2	0	0	9	1	252	21	0	274	36	2	3	0	41	2	226	4	0	232	556
07:00 AM	2	1	0	0	3	0	82	5	0	87	7	1	1	0	9	1	61	1	0	63	162
07:15 AM	4	4	0	0	8	1	109	8	0	118	14	2	2	0	18	2	79	7	0	88	232
07:30 AM	21	4	2	0	27	1	134	9	0	144	14	5	1	0	20	1	74	12	0	87	278
07:45 AM	14	9	0	0	23	0	115	18	0	133	6	6	4	0	16	2	76	8	0	86	258
Total	41	18	2	0	61	2	440	40	0	482	41	14	8	0	63	6	290	28	0	324	930
08:00 AM	10	9	0	0	19	1	83	3	0	87	9	4	4	0	17	2	65	6	0	73	196
08:15 AM	5	4	0	0	9	0	108	7	0	115	7	2	2	0	11	3	75	3	0	81	216
08:30 AM	4	1	0	0	5	1	111	10	0	122	3	2	2	0	7	0	57	4	0	61	195
08:45 AM	4	2	0	0	6	0	89	4	0	93	5	1	0	0	6	0	52	1	0	53	158
Total	23	16	0	0	39	2	391	24	0	417	24	9	8	0	41	5	249	14	0	268	765
09:00 AM	1	1	0	0	2	0	50	7	0	57	8	2	3	0	13	4	62	0	0	66	138
09:15 AM	3	0	0	0	3	0	104	2	0	106	4	0	1	0	5	2	65	2	0	69	183
09:30 AM	1	0	0	0	1	0	90	4	0	94	3	1	0	0	4	1	74	2	0	77	176
09:45 AM	2	1	0	0	3	2	86	5	0	93	6	0	2	0	8	0	66	1	0	67	171
Total	7	2	0	0	9	2	330	18	0	350	21	3	6	0	30	7	267	5	0	279	668
10:00 AM	2	0	0	0	2	1	97	4	0	102	8	0	0	0	8	1	51	2	0	54	166
10:15 AM	1	2	0	0	3	0	93	7	0	100	2	1	2	0	5	0	68	2	0	70	178
10:30 AM	2	3	0	0	5	0	94	4	0	98	3	2	0	0	5	2	77	7	0	86	194
10:45 AM	0	3	0	0	3	0	82	2	0	84	5	2	0	0	7	1	82	3	0	86	180
Total	5	8	0	0	13	1	366	17	0	384	18	5	2	0	25	4	278	14	0	296	718
11:00 AM	2	2	0	0	4	1	86	8	0	95	10	0	2	0	12	0	82	2	0	84	195
11:15 AM	0	1	2	0	3	0	80	2	0	82	8	0	0	0	8	0	72	4	0	76	169
11:30 AM	3	2	1	0	6	2	96	4	0	102	4	2	0	0	6	0	82	3	0	85	199
11:45 AM	1	0	1	0	2	0	99	6	0	105	12	2	2	0	16	1	107	3	0	111	234
Total	6	5	4	0	15	3	361	20	0	384	34	4	4	0	42	1	343	12	0	356	797
12:00 PM	2	0	0	0	2	0	94	11	0	105	8	4	9	0	21	2	93	7	0	102	230
12:15 PM	2	1	2	0	5	0	70	8	0	78	5	1	3	0	9	3	101	7	0	111	203
Grand Total	93	52	8	0	153	11	2304	159	0	2474	187	42	43	0	272	30	1847	91	0	1968	4867
Apprch %	60.8	34.0	5.2	0.0		0.4	93.1	6.4	0.0		68.8	15.4	15.8	0.0		1.5	93.9	4.6	0.0		
Total %	1.9	1.1	0.2	0.0	3.1	0.2	47.3	3.3	0.0	50.8	3.8	0.9	0.9	0.0	5.6	0.6	37.9	1.9	0.0	40.4	

JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044

File Name : TH210 & 10th Ave NE_PM_Brainerd
Site Code : 00000000
Start Date : 11/6/2019
Page No : 1

Change These In PREFERENCES

Groups Printed- Unshifted

	10th Ave From North					TH210 From East					10th Ave From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
12:30 PM	6	2	0	0	8	0	88	2	0	90	5	0	0	0	5	0	72	0	0	72	175
12:45 PM	3	1	0	0	4	0	81	5	0	86	6	2	1	0	9	1	68	1	0	70	169
Total	9	3	0	0	12	0	169	7	0	176	11	2	1	0	14	1	140	1	0	142	344
01:00 PM	4	1	0	0	5	0	85	6	0	91	8	0	2	0	10	2	112	2	0	116	222
01:15 PM	2	1	0	0	3	2	104	3	0	109	2	1	2	0	5	1	68	0	0	69	186
01:30 PM	1	1	0	0	2	0	98	2	0	100	4	0	3	0	7	0	83	2	0	85	194
01:45 PM	3	1	1	0	5	0	76	8	0	84	4	2	3	0	9	2	101	7	0	110	208
Total	10	4	1	0	15	2	363	19	0	384	18	3	10	0	31	5	364	11	0	380	810
02:00 PM	4	0	0	0	4	1	58	0	0	59	6	2	1	0	9	1	110	4	0	115	187
02:15 PM	1	1	1	0	3	2	86	8	0	96	5	8	0	0	13	2	121	9	0	132	244
02:30 PM	9	2	1	0	12	3	69	8	0	80	12	5	3	0	20	2	94	11	0	107	219
02:45 PM	10	8	0	0	18	2	83	10	0	95	11	4	2	0	17	0	110	4	0	114	244
Total	24	11	2	0	37	8	296	26	0	330	34	19	6	0	59	5	435	28	0	468	894
03:00 PM	4	3	1	0	8	0	90	4	0	94	8	2	4	0	14	2	100	7	0	109	225
03:15 PM	2	4	1	0	7	0	91	10	0	101	13	4	6	0	23	1	103	11	0	115	246
03:30 PM	4	2	0	0	6	0	102	9	0	111	9	3	4	0	16	3	113	4	0	120	253
03:45 PM	3	0	0	0	3	0	100	5	0	105	7	2	4	0	13	1	108	13	0	122	243
Total	13	9	2	0	24	0	383	28	0	411	37	11	18	0	66	7	424	35	0	466	967
04:00 PM	5	4	0	0	9	1	110	9	0	120	12	2	2	0	16	1	122	5	0	128	273
04:15 PM	2	0	0	0	2	0	96	13	0	109	15	0	6	0	21	1	131	7	0	139	271
04:30 PM	5	0	0	0	5	1	130	4	0	135	7	2	0	0	9	1	145	7	0	153	302
04:45 PM	5	1	0	0	6	0	131	6	0	137	8	2	1	0	11	1	85	4	0	90	244
Total	17	5	0	0	22	2	467	32	0	501	42	6	9	0	57	4	483	23	0	510	1090
05:00 PM	6	2	0	0	8	4	115	11	0	130	16	12	10	0	38	2	108	18	0	128	304
05:15 PM	3	1	0	0	4	1	79	4	0	84	5	0	2	0	7	0	106	9	0	115	210
05:30 PM	4	1	0	0	5	1	81	9	0	91	6	1	1	0	8	2	71	6	0	79	183
05:45 PM	0	1	0	0	1	0	57	2	0	59	5	3	1	1	10	0	86	1	0	87	157
Total	13	5	0	0	18	6	332	26	0	364	32	16	14	1	63	4	371	34	0	409	854
Grand Total	86	37	5	0	128	18	2010	138	0	2166	174	57	58	1	290	26	2217	132	0	2375	4959
Apprch %	67.2	28.9	3.9	0.0		0.8	92.8	6.4	0.0		60.0	19.7	20.0	0.3		1.1	93.3	5.6	0.0		
Total %	1.7	0.7	0.1	0.0	2.6	0.4	40.5	2.8	0.0	43.7	3.5	1.1	1.2	0.0	5.8	0.5	44.7	2.7	0.0	47.9	

JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044
Change These In PREFERENCES

File Name : TH210 & TH25 & CR3_AM (Brainerd)
Site Code : 00000000
Start Date : 10/10/2019
Page No : 1

Groups Printed- Unshifted

	CR3 From North					TH210 From East					TH25 From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	23	15	18	0	56	10	44	0	0	54	1	12	23	0	36	1	41	6	0	48	194
06:15 AM	30	19	18	0	67	8	45	0	0	53	0	13	25	0	38	0	53	12	0	65	223
06:30 AM	40	24	18	0	82	12	78	0	0	90	1	24	38	0	63	0	54	18	0	72	307
06:45 AM	42	29	8	0	79	10	86	1	0	97	0	20	48	0	68	1	55	22	0	78	322
Total	135	87	62	0	284	40	253	1	0	294	2	69	134	0	205	2	203	58	0	263	1046
07:00 AM	32	24	14	0	70	6	68	1	1	76	1	23	35	0	59	5	52	17	0	74	279
07:15 AM	59	32	15	0	106	12	101	0	0	113	1	35	53	0	89	12	65	12	0	89	397
07:30 AM	72	19	11	0	102	20	123	2	0	145	3	36	58	0	97	8	75	19	0	102	446
07:45 AM	96	54	5	0	155	14	106	2	0	122	0	21	65	0	86	20	55	28	0	103	466
Total	259	129	45	0	433	52	398	5	1	456	5	115	211	0	331	45	247	76	0	368	1588
08:00 AM	66	46	11	0	123	10	82	2	0	94	1	39	47	0	87	9	70	27	0	106	410
08:15 AM	45	43	19	0	107	12	81	1	0	94	1	38	59	0	98	12	54	16	0	82	381
08:30 AM	50	24	9	1	84	21	91	0	0	112	1	29	52	1	83	4	59	23	0	86	365
08:45 AM	44	19	16	0	79	11	88	2	0	101	0	23	29	0	52	0	47	29	0	76	308
Total	205	132	55	1	393	54	342	5	0	401	3	129	187	1	320	25	230	95	0	350	1464
09:00 AM	33	15	20	0	68	11	54	0	0	65	3	24	33	0	60	2	51	14	0	67	260
09:15 AM	36	16	12	0	64	10	64	0	0	74	0	24	31	0	55	5	68	23	0	96	289
09:30 AM	39	15	8	0	62	18	88	0	0	106	1	26	44	0	71	1	44	24	0	69	308
09:45 AM	49	17	18	0	84	11	87	1	0	99	1	19	44	0	64	3	49	20	0	72	319
Total	157	63	58	0	278	50	293	1	0	344	5	93	152	0	250	11	212	81	0	304	1176
10:00 AM	45	24	10	0	79	9	87	0	0	96	1	22	37	0	60	3	61	19	0	83	318
10:15 AM	35	32	5	0	72	19	97	0	0	116	0	25	58	0	83	8	53	25	0	86	357
10:30 AM	49	16	9	0	74	23	89	0	0	112	1	23	61	0	85	3	48	31	0	82	353
10:45 AM	40	21	18	0	79	19	77	2	0	98	0	30	58	0	88	1	57	32	0	90	355
Total	169	93	42	0	304	70	350	2	0	422	2	100	214	0	316	15	219	107	0	341	1383
11:00 AM	45	41	6	0	92	11	73	1	0	85	2	27	50	0	79	0	60	30	0	90	346
11:15 AM	37	27	17	0	81	15	97	0	0	112	1	22	58	0	81	2	77	35	0	114	388
11:30 AM	43	31	12	0	86	11	76	2	0	89	0	29	58	0	87	5	62	27	0	94	356
11:45 AM	41	27	16	0	84	11	93	3	1	108	0	16	74	0	90	6	73	37	0	116	398
Total	166	126	51	0	343	48	339	6	1	394	3	94	240	0	337	13	272	129	0	414	1488
Grand Total	1091	630	313	1	2035	314	1975	20	2	2311	20	600	1138	1	1759	111	1383	546	0	2040	8145
Apprch %	53.6	31.0	15.4	0.0		13.6	85.5	0.9	0.1		1.1	34.1	64.7	0.1		5.4	67.8	26.8	0.0		
Total %	13.4	7.7	3.8	0.0	25.0	3.9	24.2	0.2	0.0	28.4	0.2	7.4	14.0	0.0	21.6	1.4	17.0	6.7	0.0	25.0	

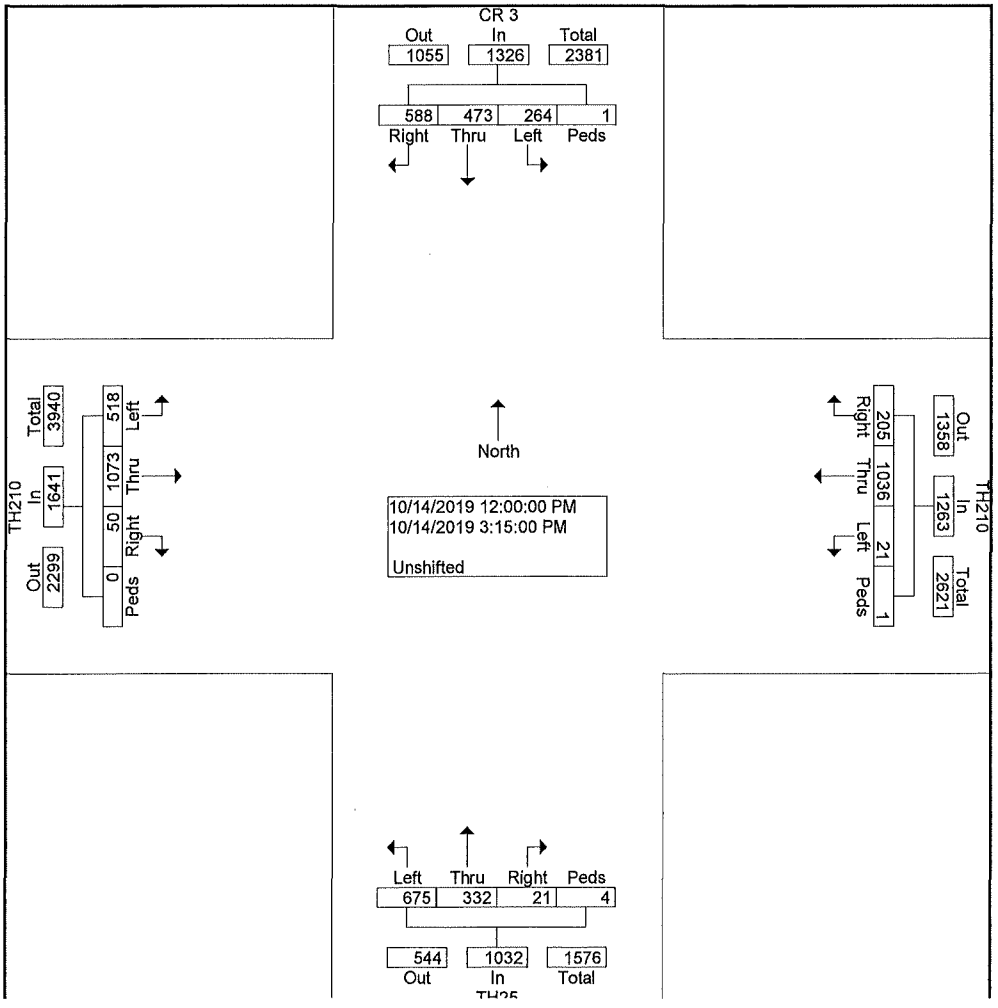
JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044

File Name : TH210 & TH25 & CR3_12 to 3_PM
Site Code : 00000000
Start Date : 10/14/2019
Page No : 1

Change These In PREFERENCES

Groups Printed- Unshifted

	CR 3 From North					TH210 From East					TH25 From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
12:00 PM	31	23	27	0	81	25	70	0	0	95	2	27	93	0	122	8	73	46	0	127	425
12:15 PM	42	38	23	0	103	15	81	0	0	96	3	21	50	0	74	4	76	32	0	112	385
12:30 PM	55	31	18	0	104	18	77	2	0	97	0	30	55	0	85	4	81	32	0	117	403
12:45 PM	40	29	11	0	80	11	82	0	0	93	1	26	43	1	71	4	65	34	0	103	347
Total	168	121	79	0	368	69	310	2	0	381	6	104	241	1	352	20	295	144	0	459	1560
01:00 PM	39	32	26	0	97	8	77	2	0	87	1	26	40	0	67	1	67	36	0	104	355
01:15 PM	41	33	9	0	83	10	87	0	0	97	5	18	41	1	65	6	81	39	0	126	371
01:30 PM	34	37	13	0	84	12	74	1	0	87	5	23	45	0	73	4	61	38	0	103	347
01:45 PM	26	33	22	0	81	15	50	0	0	65	2	12	51	0	65	1	56	35	0	92	303
Total	140	135	70	0	345	45	288	3	0	336	13	79	177	1	270	12	265	148	0	425	1376
02:00 PM	32	21	9	0	62	12	43	4	0	59	0	15	32	0	47	2	80	34	0	116	284
02:15 PM	58	43	19	1	121	11	57	1	0	69	1	22	43	1	67	2	73	31	0	106	363
02:30 PM	48	36	29	0	113	8	78	7	0	93	1	17	37	0	55	8	89	34	0	131	392
02:45 PM	51	45	16	0	112	13	91	2	1	107	0	26	69	1	96	3	92	38	0	133	448
Total	189	145	73	1	408	44	269	14	1	328	2	80	181	2	265	15	334	137	0	486	1487
03:00 PM	55	43	19	0	117	26	104	2	0	132	0	34	41	0	75	3	79	32	0	114	438
03:15 PM	36	29	23	0	88	21	65	0	0	86	0	35	35	0	70	0	100	57	0	157	401
Grand Total	588	473	264	1	1326	205	1036	21	1	1263	21	332	675	4	1032	50	1073	518	0	1641	5262
Apprch %	44.3	35.7	19.9	0.1		16.2	82.0	1.7	0.1		2.0	32.2	65.4	0.4		3.0	65.4	31.6	0.0		
Total %	11.2	9.0	5.0	0.0	25.2	3.9	19.7	0.4	0.0	24.0	0.4	6.3	12.8	0.1	19.6	1.0	20.4	9.8	0.0	31.2	

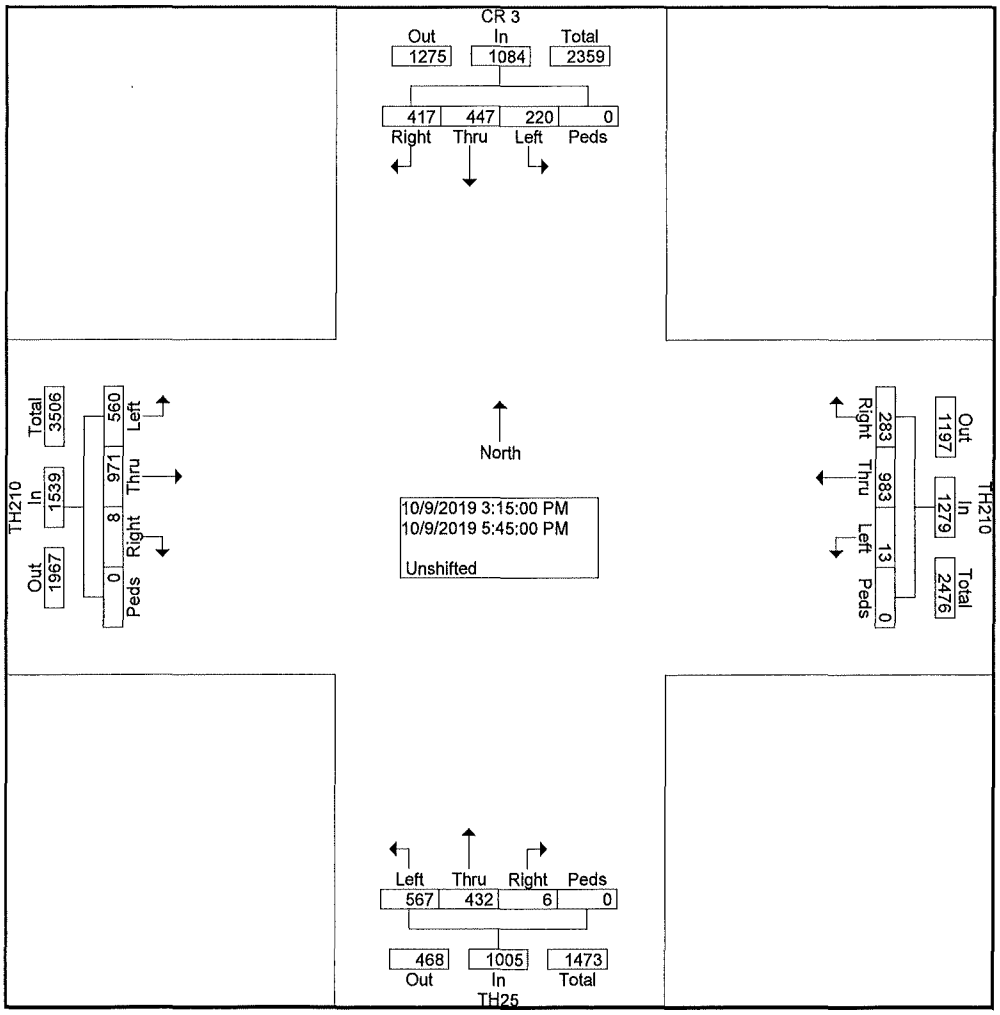


JAMAR Technologies, Inc.
151 Keith Valley Road
Horsham, PA 19044
Change These In PREFERENCES

File Name : TH210 & TH25 & CR3_3-6-PM
Site Code : 00000000
Start Date : 10/9/2019
Page No : 1

Groups Printed- Unshifted

	CR 3 From North					TH210 From East					TH25 From South					TH210 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:15 PM	37	28	25	0	90	22	76	3	0	101	1	47	43	0	91	0	81	46	0	127	409
03:30 PM	49	39	15	0	103	29	86	0	0	115	0	26	44	0	70	1	78	50	0	129	417
03:45 PM	42	53	19	0	114	30	90	2	0	122	2	49	55	0	106	2	86	36	0	124	466
Total	128	120	59	0	307	81	252	5	0	338	3	122	142	0	267	3	245	132	0	380	1292
04:00 PM	25	29	5	0	59	16	92	0	0	108	0	51	48	0	99	1	92	49	0	142	408
04:15 PM	37	44	27	0	108	20	104	2	0	126	0	40	35	0	75	2	108	46	0	156	465
04:30 PM	48	51	33	0	132	37	85	2	0	124	0	35	76	0	111	0	89	51	0	140	507
04:45 PM	31	45	23	0	99	40	115	2	0	157	0	32	34	0	66	2	106	69	0	177	499
Total	141	169	88	0	398	113	396	6	0	515	0	158	193	0	351	5	395	215	0	615	1879
05:00 PM	30	32	23	0	85	40	83	2	0	125	1	67	95	0	163	0	94	59	0	153	526
05:15 PM	39	57	23	0	119	19	80	0	0	99	0	34	43	0	77	0	104	76	0	180	475
05:30 PM	35	37	14	0	86	15	88	0	0	103	2	20	47	0	69	0	65	38	0	103	361
05:45 PM	44	32	13	0	89	15	84	0	0	99	0	31	47	0	78	0	68	40	0	108	374
Total	148	158	73	0	379	89	335	2	0	426	3	152	232	0	387	0	331	213	0	544	1736
Grand Total	417	447	220	0	1084	283	983	13	0	1279	6	432	567	0	1005	8	971	560	0	1539	4907
Apprch %	38.5	41.2	20.3	0.0		22.1	76.9	1.0	0.0		0.6	43.0	56.4	0.0		0.5	63.1	36.4	0.0		
Total %	8.5	9.1	4.5	0.0	22.1	5.8	20.0	0.3	0.0	26.1	0.1	8.8	11.6	0.0	20.5	0.2	19.8	11.4	0.0	31.4	



Appendix C

Warrant Analysis

2019 Existing - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	9507
35	Major App3:	TH 210 WB	3	10071
30	Minor App2:	4th Ave NE NB	1	68
30	Minor App4:	4th Ave NE SB	2	440

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	352	489	0	18	841	18	YES / NO	NO / NO	YES / NO
7:00 - 8:00	599	969	0	39	1568	39	YES / NO	YES / NO	YES / NO
8:00 - 9:00	591	853	3	37	1444	37	YES / NO	YES / NO	YES / NO
9:00 - 10:00	549	737	4	17	1286	17	YES / NO	YES / NO	YES / NO
10:00 - 11:00	620	764	0	33	1384	33	YES / NO	YES / NO	YES / NO
11:00 - 12:00	887	919	2	37	1806	37	YES / NO	YES / NO	YES / NO
12:00 - 13:00	955	929	11	40	1884	40	YES / NO	YES / NO	YES / NO
13:00 - 14:00	839	833	1	32	1672	32	YES / NO	YES / NO	YES / NO
14:00 - 15:00	871	751	4	50	1622	50	YES / NO	YES / NO	YES / NO
15:00 - 16:00	1099	923	40	53	2022	53	YES / NO	YES / NO	YES / NO
16:00 - 17:00	1085	987	2	40	2072	40	YES / NO	YES / NO	YES / NO
17:00 - 18:00	1060	917	1	44	1977	44	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**9507**	**10071**	**68**	**440**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	0	4	Not satisfied
Warrant 3	**Peak Hour Volumes**	0	1	Not satisfied
Warrant 7	**Crash Experience**	0	8	Not satisfied

COMMENTS:

2019 Existing - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	9507
35	Major App3:	TH 210 WB	3	10071
30	Minor App2:	4th Ave NE NB	1	68
30	Minor App4:	4th Ave NE SB	2	440

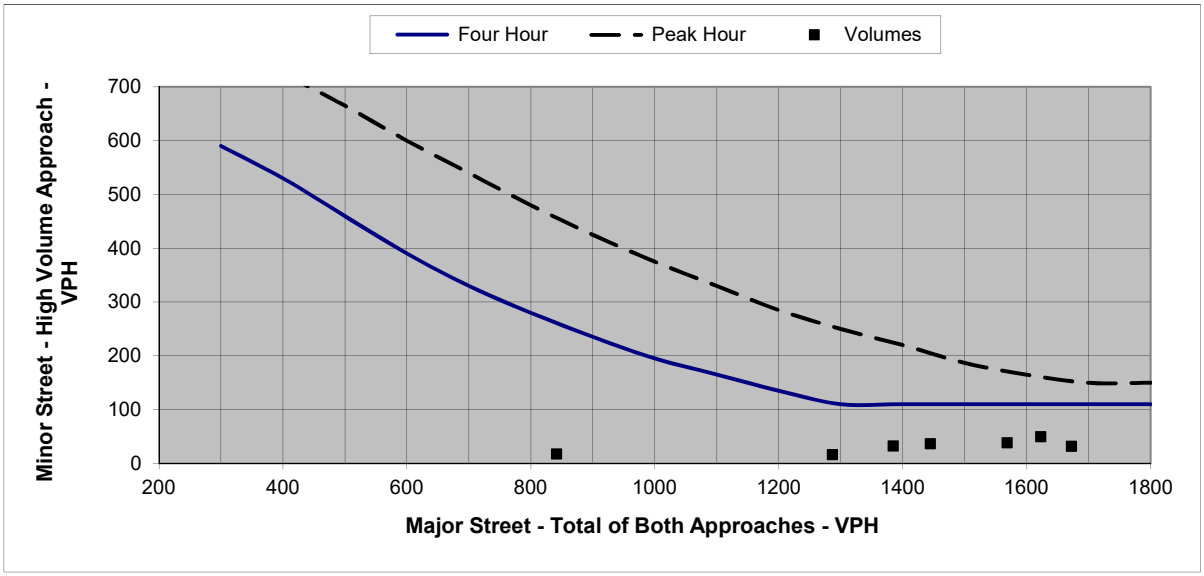


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	841	18	NO	NO
7:00 - 8:00	1568	39	NO	NO
8:00 - 9:00	1444	37	NO	NO
9:00 - 10:00	1286	17	NO	NO
10:00 - 11:00	1384	33	NO	NO
11:00 - 12:00	1806	37	NO	NO
12:00 - 13:00	1884	40	NO	NO
13:00 - 14:00	1672	32	NO	NO
14:00 - 15:00	1622	50	NO	NO
15:00 - 16:00	2022	53	NO	NO
16:00 - 17:00	2072	40	NO	NO
17:00 - 18:00	1977	44	NO	NO
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2019 Existing - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	9507
35	Major App3:	TH 210 WB	3	10071
30	Minor App2:	4th Ave NE NB	1	68
30	Minor App4:	4th Ave NE SB	2	440

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

80%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	480	720	576
Minor Approach	160	80	128

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	352	489	0	18	841	18	YES / NO	YES / NO	YES / NO
7:00 - 8:00	599	969	0	39	1568	39	YES / NO	YES / NO	YES / NO
8:00 - 9:00	591	853	3	37	1444	37	YES / NO	YES / NO	YES / NO
9:00 - 10:00	549	737	4	17	1286	17	YES / NO	YES / NO	YES / NO
10:00 - 11:00	620	764	0	33	1384	33	YES / NO	YES / NO	YES / NO
11:00 - 12:00	887	919	2	37	1806	37	YES / NO	YES / NO	YES / NO
12:00 - 13:00	955	929	11	40	1884	40	YES / NO	YES / NO	YES / NO
13:00 - 14:00	839	833	1	32	1672	32	YES / NO	YES / NO	YES / NO
14:00 - 15:00	871	751	4	50	1622	50	YES / NO	YES / NO	YES / NO
15:00 - 16:00	1099	923	40	53	2022	53	YES / NO	YES / NO	YES / NO
16:00 - 17:00	1085	987	2	40	2072	40	YES / NO	YES / NO	YES / NO
17:00 - 18:00	1060	917	1	44	1977	44	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**9507**	**10071**	**68**	**440**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

2019 Existing - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	9507
35	Major App3:	TH 210 WB	3	10071
30	Minor App2:	4th Ave NE NB	1	68
30	Minor App4:	4th Ave NE SB	2	440

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

60%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	360	540	432
Minor Approach	120	60	96

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	352	489	0	18	841	18	YES / NO	YES / NO	YES / NO
7:00 - 8:00	599	969	0	39	1568	39	YES / NO	YES / NO	YES / NO
8:00 - 9:00	591	853	3	37	1444	37	YES / NO	YES / NO	YES / NO
9:00 - 10:00	549	737	4	17	1286	17	YES / NO	YES / NO	YES / NO
10:00 - 11:00	620	764	0	33	1384	33	YES / NO	YES / NO	YES / NO
11:00 - 12:00	887	919	2	37	1806	37	YES / NO	YES / NO	YES / NO
12:00 - 13:00	955	929	11	40	1884	40	YES / NO	YES / NO	YES / NO
13:00 - 14:00	839	833	1	32	1672	32	YES / NO	YES / NO	YES / NO
14:00 - 15:00	871	751	4	50	1622	50	YES / NO	YES / NO	YES / NO
15:00 - 16:00	1099	923	40	53	2022	53	YES / NO	YES / NO	YES / NO
16:00 - 17:00	1085	987	2	40	2072	40	YES / NO	YES / NO	YES / NO
17:00 - 18:00	1060	917	1	44	1977	44	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**9507**	**10071**	**68**	**440**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

2045 Future - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach Description		Lanes	Approach
35	Major App1:	TH 210 EB	3	10744
35	Major App3:	TH 210 WB	3	11386
30	Minor App2:	4th Ave NE NB	1	74
30	Minor App4:	4th Ave NE SB	2	498

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	398	553	0	21	951	21	YES / NO	YES / NO	YES / NO
7:00 - 8:00	678	1096	0	45	1774	45	YES / NO	YES / NO	YES / NO
8:00 - 9:00	667	964	3	42	1631	42	YES / NO	YES / NO	YES / NO
9:00 - 10:00	621	833	4	20	1454	20	YES / NO	YES / NO	YES / NO
10:00 - 11:00	700	864	0	37	1564	37	YES / NO	YES / NO	YES / NO
11:00 - 12:00	1002	1039	2	42	2041	42	YES / NO	YES / NO	YES / NO
12:00 - 13:00	1080	1051	12	45	2131	45	YES / NO	YES / NO	YES / NO
13:00 - 14:00	948	941	1	36	1889	36	YES / NO	YES / NO	YES / NO
14:00 - 15:00	985	849	4	57	1834	57	YES / NO	YES / NO	YES / NO
15:00 - 16:00	1242	1044	45	59	2286	59	YES / NO	YES / NO	YES / NO
16:00 - 17:00	1226	1115	2	44	2341	44	YES / NO	YES / NO	YES / NO
17:00 - 18:00	1197	1037	1	50	2234	50	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10744**	**11386**	**74**	**498**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	0	4	Not satisfied
Warrant 3	**Peak Hour Volumes**	0	1	Not satisfied
Warrant 7	**Crash Experience**	0	8	Not satisfied

COMMENTS:

2045 Future - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	10744
35	Major App3:	TH 210 WB	3	11386
30	Minor App2:	4th Ave NE NB	1	74
30	Minor App4:	4th Ave NE SB	2	498

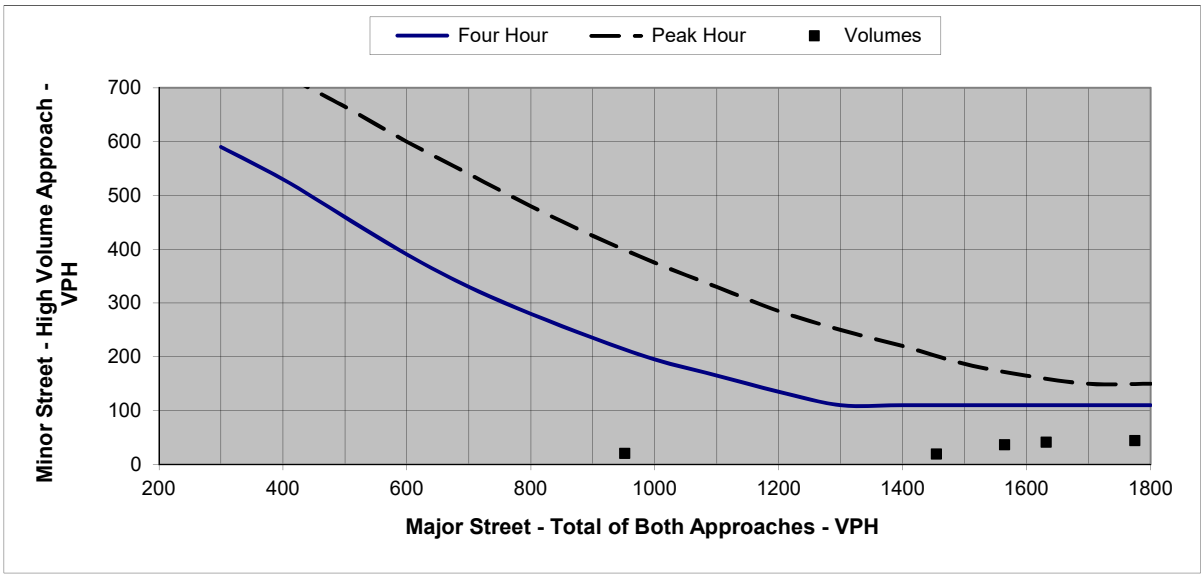


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	951	21	NO	NO
7:00 - 8:00	1774	45	NO	NO
8:00 - 9:00	1631	42	NO	NO
9:00 - 10:00	1454	20	NO	NO
10:00 - 11:00	1564	37	NO	NO
11:00 - 12:00	2041	42	NO	NO
12:00 - 13:00	2131	45	NO	NO
13:00 - 14:00	1889	36	NO	NO
14:00 - 15:00	1834	57	NO	NO
15:00 - 16:00	2286	59	NO	NO
16:00 - 17:00	2341	44	NO	NO
17:00 - 18:00	2234	50	NO	NO
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	10744
35	Major App3:	TH 210 WB	3	11386
30	Minor App2:	4th Ave NE NB	1	74
30	Minor App4:	4th Ave NE SB	2	498

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

80%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	480	720	576
Minor Approach	160	80	128

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	398	553	0	21	951	21	YES / NO	YES / NO	YES / NO
7:00 - 8:00	678	1096	0	45	1774	45	YES / NO	YES / NO	YES / NO
8:00 - 9:00	667	964	3	42	1631	42	YES / NO	YES / NO	YES / NO
9:00 - 10:00	621	833	4	20	1454	20	YES / NO	YES / NO	YES / NO
10:00 - 11:00	700	864	0	37	1564	37	YES / NO	YES / NO	YES / NO
11:00 - 12:00	1002	1039	2	42	2041	42	YES / NO	YES / NO	YES / NO
12:00 - 13:00	1080	1051	12	45	2131	45	YES / NO	YES / NO	YES / NO
13:00 - 14:00	948	941	1	36	1889	36	YES / NO	YES / NO	YES / NO
14:00 - 15:00	985	849	4	57	1834	57	YES / NO	YES / NO	YES / NO
15:00 - 16:00	1242	1044	45	59	2286	59	YES / NO	YES / NO	YES / NO
16:00 - 17:00	1226	1115	2	44	2341	44	YES / NO	YES / NO	YES / NO
17:00 - 18:00	1197	1037	1	50	2234	50	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10744**	**11386**	**74**	**498**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

2045 Future - TH 210 at 4th Ave NE
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: TH 210 at 4th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach Description		Lanes	Approach
35	Major App1:	TH 210 EB	3	10744
35	Major App3:	TH 210 WB	3	11386
30	Minor App2:	4th Ave NE NB	1	74
30	Minor App4:	4th Ave NE SB	2	498

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

60%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	360	540	432
Minor Approach	120	60	96

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	398	553	0	21	951	21	YES / NO	YES / NO	YES / NO
7:00 - 8:00	678	1096	0	45	1774	45	YES / NO	YES / NO	YES / NO
8:00 - 9:00	667	964	3	42	1631	42	YES / NO	YES / NO	YES / NO
9:00 - 10:00	621	833	4	20	1454	20	YES / NO	YES / NO	YES / NO
10:00 - 11:00	700	864	0	37	1564	37	YES / NO	YES / NO	YES / NO
11:00 - 12:00	1002	1039	2	42	2041	42	YES / NO	YES / NO	YES / NO
12:00 - 13:00	1080	1051	12	45	2131	45	YES / NO	YES / NO	YES / NO
13:00 - 14:00	948	941	1	36	1889	36	YES / NO	YES / NO	YES / NO
14:00 - 15:00	985	849	4	57	1834	57	YES / NO	YES / NO	YES / NO
15:00 - 16:00	1242	1044	45	59	2286	59	YES / NO	YES / NO	YES / NO
16:00 - 17:00	1226	1115	2	44	2341	44	YES / NO	YES / NO	YES / NO
17:00 - 18:00	1197	1037	1	50	2234	50	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10744**	**11386**	**74**	**498**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied

COMMENTS:

2019 Existing - TH 210 at 5th Ave NE (EBL as Minor Approach)
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 5th Ave NE (EBL as Minor
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	N/A	0	0
45	Major App3:	TH 210 WB	3	8831
35	Minor App2:	TH 210 EBL	1	2618
30	Minor App4:	N/A	0	0

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	0	492	45	0	492	45	YES / NO	NO / NO	NO / NO
7:00 - 8:00	0	939	138	0	939	138	**YES / YES**	**YES / YES**	**YES / YES**
8:00 - 9:00	0	784	144	0	784	144	**YES / YES**	**YES / YES**	**YES / YES**
9:00 - 10:00	0	666	138	0	666	138	**YES / YES**	**YES / YES**	**YES / YES**
10:00 - 11:00	0	660	182	0	660	182	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	0	795	244	0	795	244	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	0	792	324	0	792	324	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	0	714	275	0	714	275	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	0	620	298	0	620	298	**YES / YES**	NO / YES	**YES / YES**
15:00 - 16:00	0	802	314	0	802	314	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	0	807	275	0	807	275	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	0	760	241	0	760	241	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**0**	**8831**	**2618**	**0**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	11	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	11	8	**Satisfied**
Warrant 1B	Interruption of Continuous Flow	10	8	**Satisfied**
1A & 1B	Combination of Warrants	11	8	**Satisfied**
Warrant 2	**Four Hour Volumes**	10	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	6	1	**Satisfied**
Warrant 7	**Crash Experience**	11	8	Crashes Insufficient

COMMENTS:

S:\KO\M\Mnt03\152201\8-planning\Traffic\Warrant Analysis\2019\[2019_TH 210 at 5th Ave NE (EBL as Minor)_Warrant Analysis.xlsx]SignalWarrant

2019 Existing - TH 210 at 5th Ave NE (EBL as Minor Approach)
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 5th Ave NE (EBL as Minor Approach)
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	N/A	0	0
45	Major App3:	TH 210 WB	3	8831
35	Minor App2:	TH 210 EBL	1	2618
30	Minor App4:	N/A	0	0

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

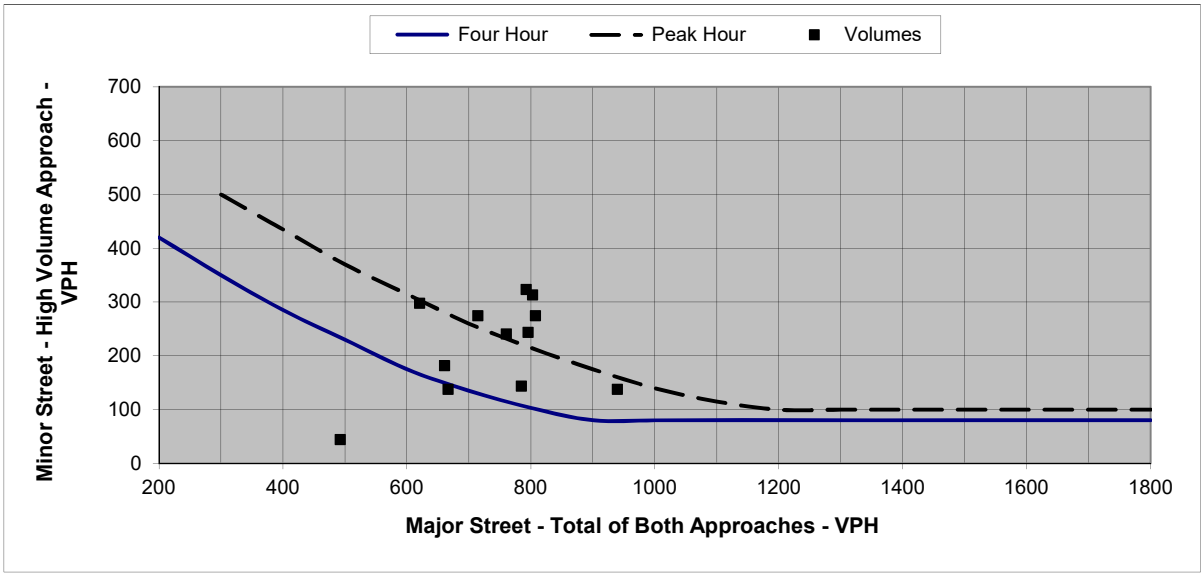


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
400	285	435
500	230	370
600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	492	45	NO	NO
7:00 - 8:00	939	138	**YES**	NO
8:00 - 9:00	784	144	**YES**	NO
9:00 - 10:00	666	138	NO	NO
10:00 - 11:00	660	182	**YES**	NO
11:00 - 12:00	795	244	**YES**	**YES**
12:00 - 13:00	792	324	**YES**	**YES**
13:00 - 14:00	714	275	**YES**	**YES**
14:00 - 15:00	620	298	**YES**	NO
15:00 - 16:00	802	314	**YES**	**YES**
16:00 - 17:00	807	275	**YES**	**YES**
17:00 - 18:00	760	241	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

S:\KO\M\Mnt03\152201\8-planning\Traffic\Warrant Analysis\2019\[2019_TH 210 at 5th Ave NE (EBL as Minor)_Warrant Analysis.xlsx]SignalWarrant

2045 Future - TH 210 at 5th Ave NE (EBL as Minor Approach)
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 5th Ave NE (EBL as Minor
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	N/A	0	0
45	Major App3:	TH 210 WB	3	9981
35	Minor App2:	TH 210 EBL	1	2960
30	Minor App4:	N/A	0	0

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	0	556	51	0	556	51	YES / NO	NO / NO	YES / NO
7:00 - 8:00	0	1061	156	0	1061	156	**YES / YES**	**YES / YES**	**YES / YES**
8:00 - 9:00	0	886	163	0	886	163	**YES / YES**	**YES / YES**	**YES / YES**
9:00 - 10:00	0	752	157	0	752	157	**YES / YES**	**YES / YES**	**YES / YES**
10:00 - 11:00	0	746	206	0	746	206	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	0	898	276	0	898	276	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	0	895	365	0	895	365	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	0	807	310	0	807	310	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	0	701	337	0	701	337	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	0	907	355	0	907	355	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	0	913	311	0	913	311	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	0	859	273	0	859	273	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**0**	**9981**	**2960**	**0**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	11	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	11	8	**Satisfied**
Warrant 1B	Interruption of Continuous Flow	11	8	**Satisfied**
1A & 1B	Combination of Warrants	11	8	**Satisfied**
Warrant 2	**Four Hour Volumes**	11	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	8	1	**Satisfied**
Warrant 7	**Crash Experience**	11	8	Crashes Insufficient

COMMENTS:

2045 Future - TH 210 at 5th Ave NE (EBL as Minor Approach)

SIGNAL WARRANT ANALYSIS

LOCATION: TH 210 at 5th Ave NE (EBL as Minor Approach)
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	N/A	0	0
45	Major App3:	TH 210 WB	3	9981
35	Minor App2:	TH 210 EBL	1	2960
30	Minor App4:	N/A	0	0

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

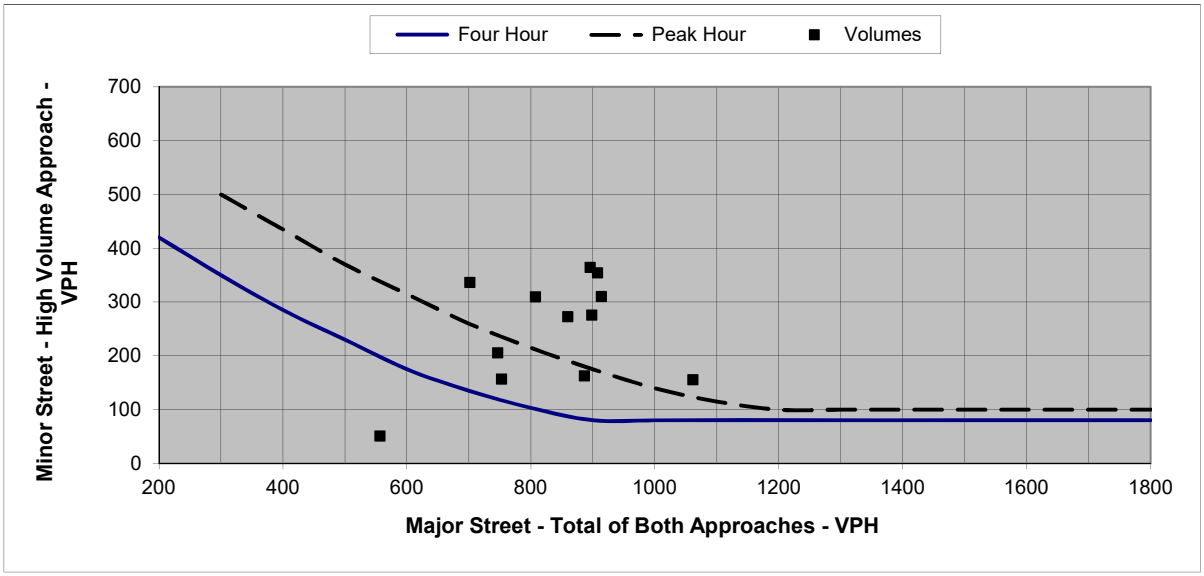


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
400	285	435
500	230	370
600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	556	51	NO	NO
7:00 - 8:00	1061	156	**YES**	**YES**
8:00 - 9:00	886	163	**YES**	NO
9:00 - 10:00	752	157	**YES**	NO
10:00 - 11:00	746	206	**YES**	NO
11:00 - 12:00	898	276	**YES**	**YES**
12:00 - 13:00	895	365	**YES**	**YES**
13:00 - 14:00	807	310	**YES**	**YES**
14:00 - 15:00	701	337	**YES**	**YES**
15:00 - 16:00	907	355	**YES**	**YES**
16:00 - 17:00	913	311	**YES**	**YES**
17:00 - 18:00	859	273	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

S:\KO\M\Mnt03\152201\8-planning\Traffic\Warrant Analysis\2045\[2045_TH 210 at 5th Ave NE (EBL as Minor)_Warrant Analysis.xlsx]SignalWarrant

2019 Existing - TH 210 at 8th Ave NE (TH 25)
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 8th Ave NE (TH 25)
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	5093
45	Major App3:	TH 210 WB	4	4646
30	Minor App2:	8th Ave NE (TH 25) NB	1	3654
30	Minor App4:	8th Ave NE SB	1	2294

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	263	258	203	149	521	203	**YES / YES**	NO / YES	**YES / YES**
7:00 - 8:00	368	503	326	174	871	326	**YES / YES**	**YES / YES**	**YES / YES**
8:00 - 9:00	350	427	316	187	777	316	**YES / YES**	**YES / YES**	**YES / YES**
9:00 - 10:00	304	349	245	121	653	245	**YES / YES**	**YES / YES**	**YES / YES**
10:00 - 11:00	341	373	314	135	714	314	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	414	351	334	177	765	334	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	459	361	345	200	820	345	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	425	395	256	205	820	256	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	486	328	261	218	814	261	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	524	417	319	240	941	319	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	615	511	351	257	1126	351	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	544	373	384	231	917	384	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**5093**	**4646**	**3654**	**2294**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	12	8	Satisfied
Warrant 1A	Minimum Vehicular Volume	12	8	Satisfied
Warrant 1B	Interruption of Continuous Flow	11	8	Satisfied
1A & 1B	Combination of Warrants	12	8	Satisfied
Warrant 2	**Four Hour Volumes**	11	4	Satisfied
Warrant 3	**Peak Hour Volumes**	10	1	Satisfied
Warrant 7	**Crash Experience**	12	8	Crashes Insufficient

COMMENTS:

2019 Existing - TH 210 at 8th Ave NE (TH 25)
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 8th Ave NE (TH 25)
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	5093
45	Major App3:	TH 210 WB	4	4646
30	Minor App2:	8th Ave NE (TH 25) NB	1	3654
30	Minor App4:	8th Ave NE SB	1	2294

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

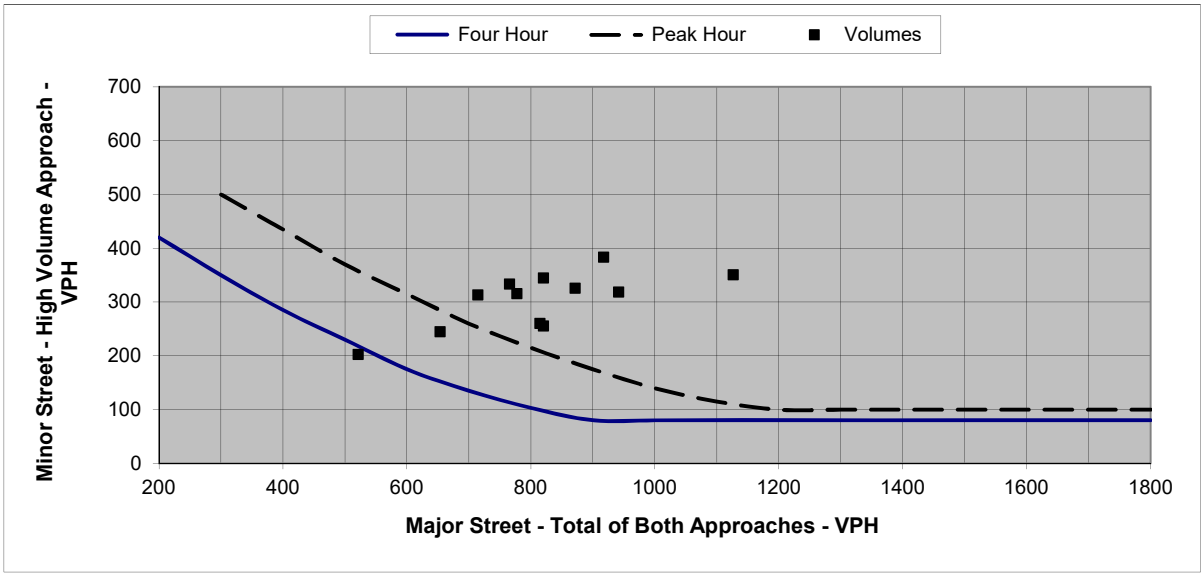


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
400	285	435
500	230	370
600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	521	203	NO	NO
7:00 - 8:00	871	326	**YES**	**YES**
8:00 - 9:00	777	316	**YES**	**YES**
9:00 - 10:00	653	245	**YES**	NO
10:00 - 11:00	714	314	**YES**	**YES**
11:00 - 12:00	765	334	**YES**	**YES**
12:00 - 13:00	820	345	**YES**	**YES**
13:00 - 14:00	820	256	**YES**	**YES**
14:00 - 15:00	814	261	**YES**	**YES**
15:00 - 16:00	941	319	**YES**	**YES**
16:00 - 17:00	1126	351	**YES**	**YES**
17:00 - 18:00	917	384	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at 8th Ave NE (TH 25)
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 8th Ave NE (TH 25)
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	5753
45	Major App3:	TH 210 WB	4	5248
30	Minor App2:	8th Ave NE (TH 25) NB	1	4130
30	Minor App4:	8th Ave NE SB	1	2593

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	296	292	230	168	588	230	**YES / YES**	NO / YES	**YES / YES**
7:00 - 8:00	416	568	368	197	984	368	**YES / YES**	**YES / YES**	**YES / YES**
8:00 - 9:00	396	483	358	211	879	358	**YES / YES**	**YES / YES**	**YES / YES**
9:00 - 10:00	343	394	276	138	737	276	**YES / YES**	**YES / YES**	**YES / YES**
10:00 - 11:00	386	421	355	152	807	355	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	468	397	377	201	865	377	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	519	407	390	226	926	390	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	480	446	290	232	926	290	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	549	370	294	246	919	294	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	592	471	361	271	1063	361	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	694	578	397	290	1272	397	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	614	421	434	261	1035	434	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**5753**	**5248**	**4130**	**2593**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	12	8	Satisfied
Warrant 1A	Minimum Vehicular Volume	12	8	Satisfied
Warrant 1B	Interruption of Continuous Flow	11	8	Satisfied
1A & 1B	Combination of Warrants	12	8	Satisfied
Warrant 2	**Four Hour Volumes**	12	4	Satisfied
Warrant 3	**Peak Hour Volumes**	11	1	Satisfied
Warrant 7	**Crash Experience**	12	8	Crashes Insufficient

COMMENTS:

2045 Future - TH 210 at 8th Ave NE (TH 25)
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 8th Ave NE (TH 25)
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	5753
45	Major App3:	TH 210 WB	4	5248
30	Minor App2:	8th Ave NE (TH 25) NB	1	4130
30	Minor App4:	8th Ave NE SB	1	2593

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

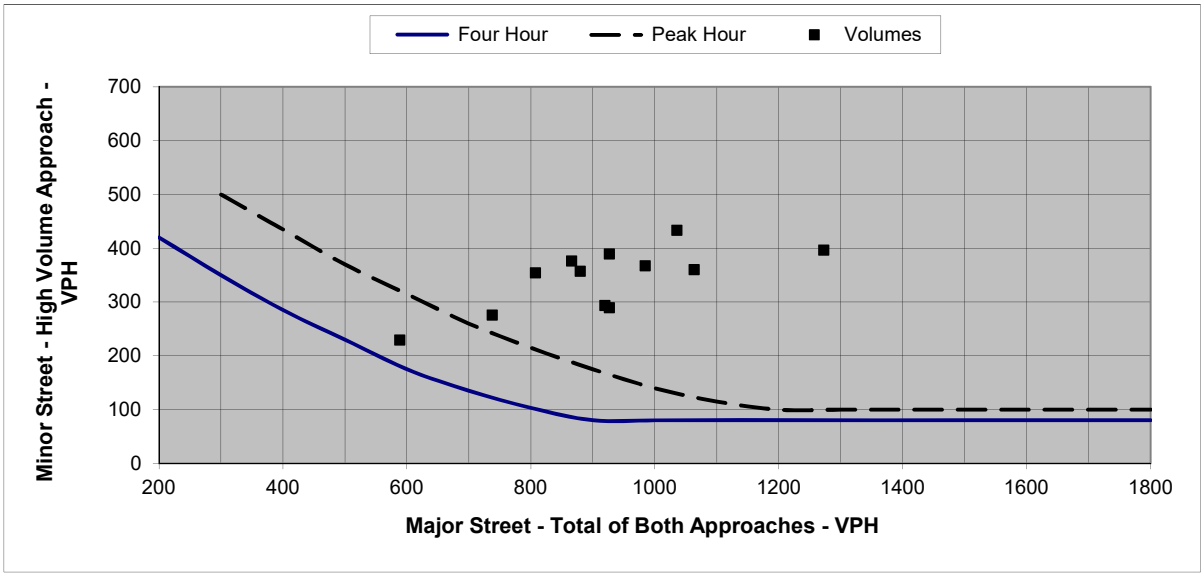


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
400	285	435
500	230	370
600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	588	230	**YES**	NO
7:00 - 8:00	984	368	**YES**	**YES**
8:00 - 9:00	879	358	**YES**	**YES**
9:00 - 10:00	737	276	**YES**	**YES**
10:00 - 11:00	807	355	**YES**	**YES**
11:00 - 12:00	865	377	**YES**	**YES**
12:00 - 13:00	926	390	**YES**	**YES**
13:00 - 14:00	926	290	**YES**	**YES**
14:00 - 15:00	919	294	**YES**	**YES**
15:00 - 16:00	1063	361	**YES**	**YES**
16:00 - 17:00	1272	397	**YES**	**YES**
17:00 - 18:00	1035	434	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2019 Existing - TH 210 at 10th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 10th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach Description		Lanes	Approach
45	Major App1:	TH 210 EB	4	4164
45	Major App3:	TH 210 WB	4	4692
30	Minor App2:	10th Ave NE NB	1	200
30	Minor App4:	10th Ave NE SB	1	102

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	267	270	5	2	537	5	YES / NO	NO / NO	YES / NO
7:00 - 8:00	297	496	22	20	793	22	YES / NO	YES / NO	YES / NO
8:00 - 9:00	288	422	17	16	710	17	YES / NO	YES / NO	YES / NO
9:00 - 10:00	275	356	9	2	631	9	YES / NO	YES / NO	YES / NO
10:00 - 11:00	263	384	7	8	647	8	YES / NO	YES / NO	YES / NO
11:00 - 12:00	326	364	8	9	690	9	YES / NO	YES / NO	YES / NO
12:00 - 13:00	380	361	20	6	741	20	YES / NO	YES / NO	YES / NO
13:00 - 14:00	348	396	13	5	744	13	YES / NO	YES / NO	YES / NO
14:00 - 15:00	409	332	25	13	741	25	YES / NO	YES / NO	YES / NO
15:00 - 16:00	421	414	29	11	835	29	YES / NO	YES / NO	YES / NO
16:00 - 17:00	483	519	15	5	1002	15	YES / NO	YES / NO	YES / NO
17:00 - 18:00	407	378	30	5	785	30	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**4164**	**4692**	**200**	**102**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	0	4	Not satisfied
Warrant 3	**Peak Hour Volumes**	0	1	Not satisfied
Warrant 7	**Crash Experience**	0	8	Not satisfied

COMMENTS:

2019 Existing - TH 210 at 10th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 10th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	4164
45	Major App3:	TH 210 WB	4	4692
30	Minor App2:	10th Ave NE NB	1	200
30	Minor App4:	10th Ave NE SB	1	102

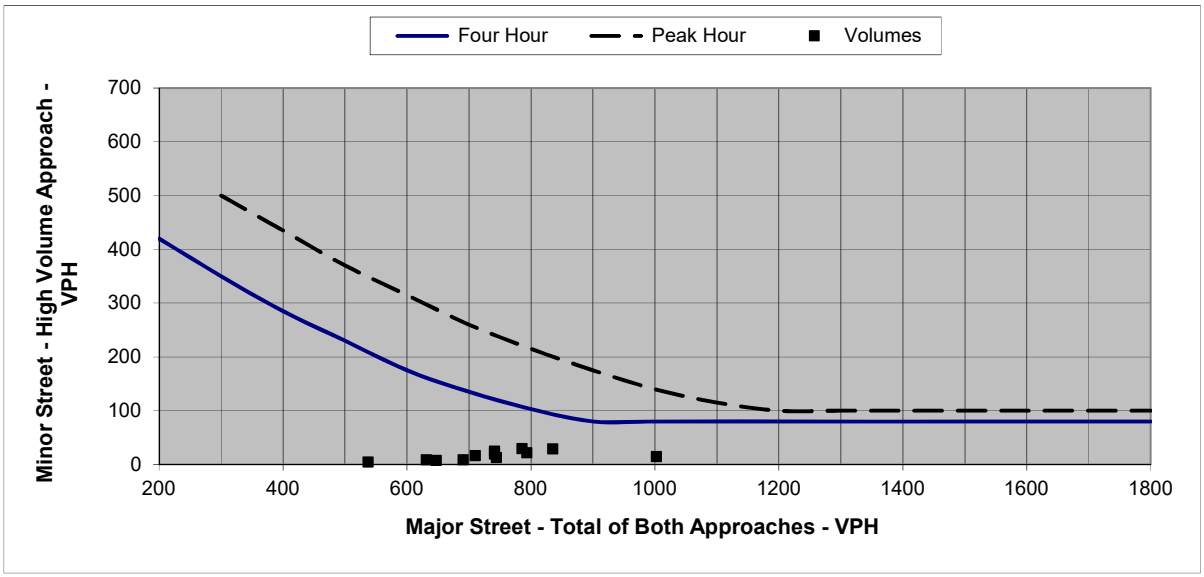


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
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600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	537	5	NO	NO
7:00 - 8:00	793	22	NO	NO
8:00 - 9:00	710	17	NO	NO
9:00 - 10:00	631	9	NO	NO
10:00 - 11:00	647	8	NO	NO
11:00 - 12:00	690	9	NO	NO
12:00 - 13:00	741	20	NO	NO
13:00 - 14:00	744	13	NO	NO
14:00 - 15:00	741	25	NO	NO
15:00 - 16:00	835	29	NO	NO
16:00 - 17:00	1002	15	NO	NO
17:00 - 18:00	785	30	NO	NO
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at 10th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 10th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	4709
45	Major App3:	TH 210 WB	4	5299
30	Minor App2:	10th Ave NE NB	1	225
30	Minor App4:	10th Ave NE SB	1	111

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	105	53	84

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	301	305	5	2	606	5	YES / NO	NO / NO	YES / NO
7:00 - 8:00	337	560	25	23	897	25	YES / NO	YES / NO	YES / NO
8:00 - 9:00	326	476	20	18	802	20	YES / NO	YES / NO	YES / NO
9:00 - 10:00	311	402	10	2	713	10	YES / NO	YES / NO	YES / NO
10:00 - 11:00	298	435	7	8	733	8	YES / NO	YES / NO	YES / NO
11:00 - 12:00	369	410	9	9	779	9	YES / NO	YES / NO	YES / NO
12:00 - 13:00	429	408	23	6	837	23	YES / NO	YES / NO	YES / NO
13:00 - 14:00	392	447	14	5	839	14	YES / NO	YES / NO	YES / NO
14:00 - 15:00	462	375	28	14	837	28	YES / NO	YES / NO	YES / NO
15:00 - 16:00	476	467	33	13	943	33	YES / NO	YES / NO	YES / NO
16:00 - 17:00	547	587	17	6	1134	17	YES / NO	YES / NO	YES / NO
17:00 - 18:00	461	427	34	5	888	34	YES / NO	YES / NO	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**4709**	**5299**	**225**	**111**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	0	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	0	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	0	4	Not satisfied
Warrant 3	**Peak Hour Volumes**	0	1	Not satisfied
Warrant 7	**Crash Experience**	0	8	Not satisfied

COMMENTS:

2045 Future - TH 210 at 10th Ave NE
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 10th Ave NE
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	4709
45	Major App3:	TH 210 WB	4	5299
30	Minor App2:	10th Ave NE NB	1	225
30	Minor App4:	10th Ave NE SB	1	111

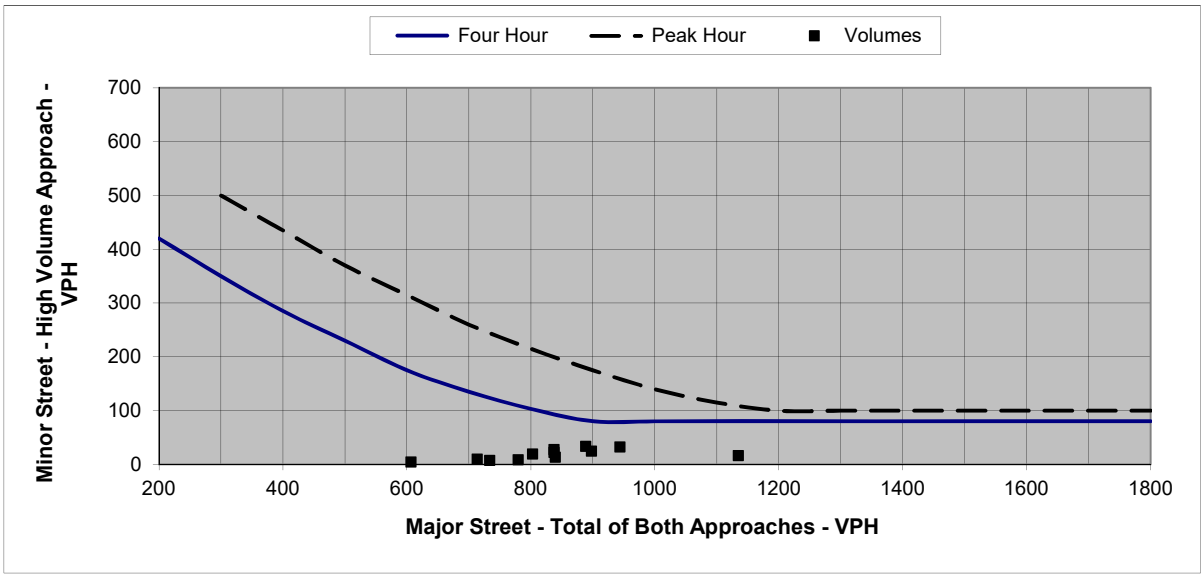


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
400	285	435
500	230	370
600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	606	5	NO	NO
7:00 - 8:00	897	25	NO	NO
8:00 - 9:00	802	20	NO	NO
9:00 - 10:00	713	10	NO	NO
10:00 - 11:00	733	8	NO	NO
11:00 - 12:00	779	9	NO	NO
12:00 - 13:00	837	23	NO	NO
13:00 - 14:00	839	14	NO	NO
14:00 - 15:00	837	28	NO	NO
15:00 - 16:00	943	33	NO	NO
16:00 - 17:00	1134	17	NO	NO
17:00 - 18:00	888	34	NO	NO
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

Appendix D

Operations Analysis

Table 1a
Existing Conditions (2019)
AM Peak Hour (VISSIM)

Queue Storage Issues
Queue extends through intersection.

Coordinated Cycle Length: 115 Seconds
(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
AM PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB	4	678	5	687	43.7	D	0.9	A	1.3	A	1.2	A	4.5	A	175	1	40	700	2	77		1	78
		WB	2	1011	2	1,015	69.1	E	3.7	A	3.1	A	3.9	A			150	1	29	425	10	280		10	280
		NB	2	1	2	5	38.8	D	71.4	E	39.9	D	43.9	D			500	6	137	500	0	0	500	4	110
		SB	52		22	74	50.4	D	0.0	A	7.9	A	37.5	D			150	14	105	500	0	42			
	NE 5th Ave (Stop Control)	EB	171	561		732	27.1	D	0.3	A	0.0	A	6.4	A	3.3	A	175	28	**251**	425	0	0			
		WB		916	34	950	0.0	A	0.1	A	1.5	A	0.2	A						600	0	0	150	0	5
		SB			99	99	0.0	A	0.0	A	10.5	B	10.5	B									500	4	84
	TH 25 Ramp (Stop Control)	EB		393	168	561	0.0	A	0.1	A	0.2	A	0.1	A	0.2	A				600	0	37	150	0	37
		WB		950		950	0.0	A	0.2	A	0.0	A	0.2	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		945	17	962	0.0	A	0.9	A	0.6	A	0.9	A	0.9	A				300	0	0			
		SB			5	5	0.0	A	0.0	A	8.8	A	8.8	A									500	0	61
	TH 210 at NE 8th Ave (Signal Control)	EB	90	254	49	393	65.3	E	28.1	C	1.1	A	33.4	C	36.7	D	400	37	222	800	22	169	350	0	20
		WB	7	454	56	517	74.1	E	42.5	D	1.1	A	38.7	D			400	3	53	850	65	309	400	0	52
		NB	229	134	5	368	50.9	D	51.3	D	6.8	A	50.5	D						600	97	**540**	400	0	55
		SB	46	162	279	487	46.2	D	50.8	D	10.6	B	27.0	C						1000	67	365	1000	67	365
	NE 10th Ave (Stop Control)	EB	29	268	8	305	5.2	A	0.9	A	1.5	A	1.4	A	2.3	A	300	1	53	850	0	0	200	0	0
		WB	37	456	2	495	1.9	A	0.2	A	0.6	A	0.3	A			200	0	35	1400	0	0	300	0	0
		NB	11	17	36	64	14.9	B	22.1	C	7.8	A	12.5	B						1000	2	83			
		SB	2	26	50	78	13.8	B	17.4	C	7.3	A	10.8	B						500	3	67			
	NE 13th Ave (Stop Control)	EB	22	284		306	3.7	A	0.2	A	0.0	A	0.4	A	1.0	A	350	0	47	1400	0	0			
		WB		437	20	457	0.0	A	0.1	A	0.9	A	0.2	A						5000	0	0	150	0	0
		SB	23		58	81	13.2	B	0.0	A	6.8	A	8.8	A			500	2	69				500	2	69
	TH 25 at 8th (Stop Control)	EB		168		168	0.0	A	0.3	A	0.0	A	0.3	A	1.0	A	300	0	0	1000	0	0			
		WB			368	368	0.0	A	0.0	A	1.0	A	1.0	A						2500	0	0	400	1	75
	(used for WB Queue)	SB	218			218	1.6	A	0.0	A	0.0	A	1.6	A			575	1	135					0	86

Signal Major Approach Delays:	197.0 Total Seconds
Signal Minor Approach Delays:	543.5 Total Seconds
Total All Approach Delays:	898.3 Total Seconds

LEGEND:
Queue length at or above 75% of the available storage
Queue length at or above available Storage

Table 1b
Existing Conditions (2019)
PM Peak Hour (VISSIM)

Queue Storage Issues
Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds
(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
PM PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB		1135	22	1,157	0.0	A	1.3	A	1.2	A	1.3	A	4.1	A	175	0	0	700	3	110		2	111
		WB	4	1029		1,033	76.7	E	4.0	A	0.0	A	4.3	A			150	2	40	425	13	**413**		13	413
		NB	2			2	75.1	E	0.0	A	0.0	A	75.1	E			500	3	95	500	0	0	500	2	71
		SB	48		37	85	60.9	E	0.0	A	7.9	A	37.4	D			150	17	**117**	500	1	64			
	NE 5th Ave (Stop Control)	EB	246	937		1,183	20.5	C	0.6	A	0.0	A	4.6	A	3.6	A	175	32	**353**	425	0	7			
		WB		843	7	850	0.0	A	0.2	A	1.6	A	0.2	A						600	0	3	150	0	0
		SB			190	190	0.0	A	0.0	A	12.7	B	12.7	B									500	11	145
	TH 25 Ramp (Stop Control)	EB		650	287	937	0.0	A	0.2	A	0.4	A	0.3	A	0.3	A				600	1	112	150	1	112
		WB		850		850	0.0	A	0.3	A	0.0	A	0.3	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		744	30	774	0.0	A	0.9	A	0.8	A	0.9	A	1.9	A				300	0	0			
		SB			106	106	0.0	A	0.0	A	9.4	A	9.4	A									500	9	139
	TH 210 at NE 8th Ave (Signal Control)	EB	255	393	2	650	80.2	F	34.2	C	1.2	A	53.0	D	55.6	E	400	147	**632**	800	42	295	350	0	0
		WB	6	378	136	520	102.3	F	68.2	E	3.1	A	54.2	D			400	3	45	850	94	378	400	2	98
		NB	248	168	1	417	66.5	E	68.9	E	5.7	A	67.3	E						600	138	**595**	400	0	20
		SB	102	185	148	435	74.6	E	71.0	E	7.6	A	50.0	D						1000	137	530	1000	137	530
	NE 10th Ave (Stop Control)	EB	38	454	4	496	5.1	A	0.8	A	1.4	A	1.2	A	1.8	A	300	1	67	850	0	0	200	0	0
		WB	25	488	6	519	3.7	A	0.2	A	0.7	A	0.3	A			200	0	38	1400	0	0	300	0	0
		NB	13	16	36	65	18.5	C	27.6	D	9.8	A	15.3	C						1000	4	110			
		SB		4	19	23	0.0	A	23.5	C	6.5	A	8.8	A						500	1	37			
	NE 13th Ave (Stop Control)	EB	39	451		490	5.6	A	0.3	A	0.0	A	0.7	A	1.1	A	350	1	67	1400	0	0			
		WB		467	33	500	0.0	A	0.1	A	1.0	A	0.2	A						5000	0	0	150	0	0
		SB	24		52	76	17.3	C	0.0	A	7.0	A	10.7	B			500	2	61				500	2	61
	TH 25 at 8th (Stop Control)	EB		287		287	0.0	A	0.4	A	0.0	A	0.4	A	8.0	A	300	0	0	1000	0	0			
		WB			417	417	0.0	A	0.0	A	15.9	C	15.9	C						2500	0	0	400	49	**717**
	(used for WB Queue)	SB	193			193	3.1	A	0.0	A	0.0	A	3.1	A			575	3	208					1	158

Signal Major Approach Delays:	321.9 Total Seconds
Signal Minor Approach Delays:	706.1 Total Seconds
Total All Approach Delays:	1263.0 Total Seconds

LEGEND:
Queue length at or above 75% of the available storage
Queue length at or above available Storage

Table 1c

Existing Conditions (2019)

Friday Peak Hour (VISSIM) - 5% Increase of PM Peak Hour

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
FRIDAY PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB		1192	23	1,215	0.0	A	1.5	A	1.6	A	1.5	A	4.1	A	175	0	0	700	4	149		3	149
		WB	4	1080		1,084	79.8	E	3.8	A	0.0	A	4.1	A			150	2	40	425	12	**351**		12	351
		NB	2			2	74.9	E	0.0	A	0.0	A	74.9	E			500	3	96	500	0	0	500	2	71
		SB	50		39	89	61.2	E	0.0	A	8.3	A	37.7	D			150	18	**144**	500	1	56			
	NE 5th Ave (Stop Control)	EB	258	984		1,242	22.3	C	0.8	A	0.0	A	5.1	A	3.9	A	175	38	**396**	425	0	9			
		WB		885	7	892	0.0	A	0.1	A	1.3	A	0.1	A						600	0	0	150	0	5
		SB			200	200	0.0	A	0.0	A	13.7	B	13.7	B									500	13	150
	TH 25 Ramp (Stop Control)	EB		683	301	984	0.0	A	0.2	A	0.4	A	0.3	A	0.3	A				600	1	118	150	1	**118**
		WB		893		893	0.0	A	0.3	A	0.0	A	0.3	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		781	32	813	0.0	A	0.9	A	0.8	A	0.9	A	2.0	A				300	0	0			
		SB			111	111	0.0	A	0.0	A	9.7	A	9.7	A									500	10	141
	TH 210 at NE 8th Ave (Signal Control)	EB	268	413	2	683	87.5	F	39.3	D	0.8	A	59.1	E	59.6	E	400	166	**672**	800	52	325	350	0	0
		WB	6	397	143	546	111.4	F	71.4	E	2.8	A	56.6	E			400	3	45	850	103	425	400	2	114
		NB	260	176	1	437	69.8	E	70.2	E	18.4	B	69.8	E						600	166	**611**	400	0	10
		SB	107	194	155	456	79.7	E	77.6	E	7.3	A	53.9	D						1000	154	571	1000	154	571
	NE 10th Ave (Stop Control)	EB	40	477	4	521	6.3	A	0.9	A	1.5	A	1.3	A	1.9	A	300	1	106	850	0	0	200	0	0
		WB	26	512	6	544	3.4	A	0.2	A	0.6	A	0.3	A			200	0	51	1400	0	0	300	0	0
		NB	14	17	38	69	22.9	C	24.3	C	10.6	B	16.1	C						1000	5	118			
		SB		4	20	24	0.0	A	19.7	C	6.1	A	8.4	A						500	1	37			
	NE 13th Ave (Stop Control)	EB	41	474		515	6.2	A	0.3	A	0.0	A	0.7	A	1.1	A	350	1	82	1400	0	0			
		WB		490	35	525	0.0	A	0.2	A	1.0	A	0.2	A						5000	0	0	150	0	0
		SB	25		55	80	17.3	C	0.0	A	7.1	A	10.9	B			500	2	68				500	2	68
	TH 25 at 8th (Stop Control)	EB		301		301	0.0	A	0.4	A	0.0	A	0.4	A	9.9	A	300	0	0	1000	0	0			
		WB			438	438	0.0	A	0.0	A	19.6	C	19.6	C						2500	0	0	400	67	**844**
	(used for WB Queue)	SB	203			203	4.5	A	0.0	A	0.0	A	4.5	A			575	5	261					3	212

Signal Major Approach Delays:	348.2 Total Seconds
Signal Minor Approach Delays:	718.8 Total Seconds
Total All Approach Delays:	1358.8 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 1d

Existing Conditions (2019)

Summer Peak Hour (VISSIM) - 10% Increase of PM Peak Hour

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 160 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
SUMMER PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB		1249	24	1,273	0.0	A	1.2	A	1.6	A	1.2	A	3.6	A	175	0	0	700	2	147		2	148
		WB	4	1132		1,136	87.6	F	2.4	A	0.0	A	2.7	A			150	2	43	425	7	**327**		7	327
		NB	2			2	71.7	E	0.0	A	0.0	A	71.7	E			500	4	93	500	0	0	500	3	71
		SB	53		41	94	73.3	E	0.0	A	8.2	A	43.5	D			150	23	**148**	500	1	51			
	NE 5th Ave (Stop Control)	EB	271	1031		1,302	29.2	D	0.9	A	0.0	A	6.5	A	4.8	A	175	54	**457**	425	0	8			
		WB		927	8	935	0.0	A	0.2	A	1.3	A	0.2	A						600	0	0	150	0	0
		SB			209	209	0.0	A	0.0	A	15.0	B	15.0	C									500	15	157
	TH 25 Ramp (Stop Control)	EB		715	316	1,031	0.0	A	0.2	A	0.5	A	0.3	A	0.3	A				600	1	109	150	1	109
		WB		935		935	0.0	A	0.4	A	0.0	A	0.4	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		818	33	851	0.0	A	0.9	A	0.8	A	0.9	A	2.0	A				300	0	0			
		SB			117	117	0.0	A	0.0	A	10.0	B	10.0	B									500	10	141
	TH 210 at NE 8th Ave (Signal Control)	EB	281	432	2	715	98.3	F	45.1	D	0.8	A	66.9	E	66.6	E	400	202	**713**	800	63	330	350	0	0
		WB	7	416	150	573	106.5	F	79.9	E	3.5	A	63.2	E			400	3	48	850	121	461	400	2	125
		NB	273	185	1	459	77.4	E	78.9	E	11.2	B	77.9	E						600	198	**636**	400	0	24
		SB	112	204	163	479	89.0	F	84.0	F	9.0	A	59.3	E						1000	179	585	1000	179	585
	NE 10th Ave (Stop Control)	EB	42	499	4	545	6.3	A	0.9	A	1.6	A	1.3	A	2.4	A	300	1	85	850	0	0	200	0	0
		WB	28	537	7	572	5.1	A	0.2	A	0.6	A	0.4	A			200	1	53	1400	0	0	300	0	0
		NB	14	18	40	72	37.0	E	32.2	D	15.4	C	23.6	C						1000	8	168			
		SB		4	21	25	0.0	A	17.9	C	6.4	A	8.3	A						500	1	42			
	NE 13th Ave (Stop Control)	EB	43	496		539	7.2	A	0.3	A	0.0	A	0.9	A	1.2	A	350	1	78	1400	0	0			
		WB		514	36	550	0.0	A	0.2	A	1.0	A	0.2	A						5000	0	0	150	0	0
		SB	26		57	83	19.1	C	0.0	A	7.1	A	11.3	B			500	3	66				500	3	66
	TH 25 at 8th (Stop Control)	EB		316		316	0.0	A	0.5	A	0.0	A	0.5	A	17.7	C	300	0	0	1000	0	0			
		WB			459	459	0.0	A	0.0	A	36.1	E	36.1	E						2500	0	0	400	134	**1088**
	(used for WB Queue)	SB	212			212	5.6	A	0.0	A	0.0	A	5.6	A			575	6	258					4	208

Signal Major Approach Delays:	347.4 Total Seconds
Signal Minor Approach Delays:	887.8 Total Seconds
Total All Approach Delays:	1580.9 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 2a

No Build Conditions (2045)

AM Peak Hour (VISSIM)

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 115 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
AM PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB	5	765	5	775	49.2	D	4.8	A	3.7	A	5.1	A	6.7	A	175	2	54	700	11	206		11	207
		WB	5	1125	5	1,135	58.9	E	4.4	A	8.8	A	4.5	A			150	1	31	425	16	**398**		16	398
		NB	5	5	5	15	47.4	D	45.2	D	46.6	D	46.8	D			500	16	208	500	0	0	500	12	181
		SB	60		25	85	52.8	D	0.0	A	8.5	A	40.0	D			150	18	**120**	500	0	45			
	NE 5th Ave (Stop Control)	EB	195	635		830	49.2	E	0.5	A	0.0	A	11.6	B	5.6	A	175	67	**380**	425	0	0			
		WB		1025	40	1,065	0.0	A	0.2	A	1.5	A	0.2	A						600	0	0	150	0	5
		SB			110	110	0.0	A	0.0	A	12.0	B	12.0	B									500	5	101
	TH 25 Ramp (Stop Control)	EB		445	190	635	0.0	A	0.1	A	0.1	A	0.1	A	0.2	A				600	0	33	150	0	33
		WB		1065		1,065	0.0	A	0.2	A	0.0	A	0.2	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		1060	20	1,080	0.0	A	0.9	A	0.7	A	0.9	A	0.9	A				300	0	0			
		SB			5	5	0.0	A	0.0	A	9.0	A	9.0	A									500	0	61
	TH 210 at NE 8th Ave (Signal Control)	EB	100	290	55	445	79.0	E	37.5	D	1.2	A	42.8	D	45.5	D	400	51	264	800	36	249	350	0	18
		WB	10	505	65	580	95.3	F	53.3	D	1.3	A	48.5	D			400	5	65	850	93	419	400	0	74
		NB	260	150	5	415	60.7	E	61.7	E	10.2	B	60.6	E						600	121	**576**	400	0	50
		SB	50	185	315	550	62.4	E	62.0	E	13.0	B	33.5	C						1000	98	465	1000	98	465
	NE 10th Ave (Stop Control)	EB	35	300	10	345	6.0	A	1.0	A	1.8	A	1.5	A	2.8	A	300	1	67	850	0	0	200	0	0
		WB	40	515	5	560	2.6	A	0.2	A	0.5	A	0.4	A			200	0	51	1400	0	0	300	0	0
		NB	10	20	40	70	18.1	C	24.7	C	9.9	A	14.9	B						1000	4	105			
		SB	5	30	55	90	30.4	D	20.2	C	9.0	A	13.1	B						500	4	85			
	NE 13th Ave (Stop Control)	EB	25	320		345	6.5	A	0.3	A	0.0	A	0.7	A	1.1	A	350	1	59	1400	0	0			
		WB		495	25	520	0.0	A	0.2	A	0.9	A	0.2	A						5000	0	0	150	0	0
		SB	25		65	90	14.2	B	0.0	A	6.6	A	8.9	A			500	3	73				500	3	73
	TH 25 at 8th (Stop Control)	EB		190		190	0.0	A	0.3	A	0.0	A	0.3	A	2.7	A	300	0	0	1000	0	0			
		WB			415	415	0.0	A	0.0	A	3.9	A	3.9	A						2500	0	0	400	7	**307**
	(used for WB Queue)	SB	245			245	2.4	A	0.0	A	0.0	A	2.4	A			575	2	225					1	182

Signal Major Approach Delays:	229.6 Total Seconds
Signal Minor Approach Delays:	570.0 Total Seconds
Total All Approach Delays:	999.9 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 2b

No Build Conditions (2045)

PM Peak Hour (VISSIM)

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
PM PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB		1285	25	1,310	0.0	A	1.9	A	1.7	A	1.9	A	4.0	A	175	0	0	700	6	220		5	221
		WB	5	1150		1,155	71.9	E	2.9	A	0.0	A	3.1	A			150	2	51	425	10	**391**		10	391
		NB	5			5	73.2	E	0.0	A	0.0	A	73.2	E			500	7	135	500	0	0	500	5	108
		SB	55		40	95	67.1	E	0.0	A	8.9	A	40.6	D			150	21	**140**	500	1	56			
	NE 5th Ave (Stop Control)	EB	280	1060		1,340	35.7	E	1.1	A	0.0	A	7.9	A	5.7	A	175	69	**468**	425	0	39			
		WB		940	10	950	0.0	A	0.2	A	1.4	A	0.2	A						600	0	5	150	0	0
		SB			215	215	0.0	A	0.0	A	16.3	C	16.3	C									500	18	183
	TH 25 Ramp (Stop Control)	EB		735	325	1,060	0.0	A	0.2	A	0.5	A	0.3	A	0.3	A				600	1	145	150	1	**145**
		WB		950		950	0.0	A	0.4	A	0.0	A	0.4	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		830	35	865	0.0	A	0.9	A	0.9	A	0.9	A	2.1	A				300	0	0			
		SB			120	120	0.0	A	0.0	A	10.3	B	10.3	B									500	11	145
	TH 210 at NE 8th Ave (Signal Control)	EB	290	440	5	735	109.5	F	47.5	D	1.0	A	72.6	E	70.6	E	400	235	**802**	800	67	358	350	0	0
		WB	5	420	155	580	126.5	F	82.1	F	3.9	A	64.8	E			400	3	48	850	126	463	400	3	116
		NB	280	190	5	475	83.0	F	84.7	F	17.1	B	83.5	F						600	223	**636**	400	0	15
		SB	115	210	165	490	88.9	F	89.3	F	8.4	A	61.6	E						1000	196	634	1000	196	634
	NE 10th Ave (Stop Control)	EB	45	510	5	560	7.6	A	0.8	A	1.5	A	1.4	A	2.6	A	300	2	129	850	0	0	200	0	0
		WB	30	545	5	580	4.2	A	0.2	A	0.7	A	0.4	A			200	0	41	1400	0	0	300	0	0
		NB	15	20	40	75	35.3	E	37.5	E	16.5	C	25.1	D						1000	10	177			
		SB		5	20	25	0.0	A	16.5	C	6.5	A	8.1	A						500	1	37			
	NE 13th Ave (Stop Control)	EB	45	505		550	7.5	A	0.3	A	0.0	A	0.9	A	1.2	A	350	1	84	1400	0	0			
		WB		520	35	555	0.0	A	0.2	A	0.9	A	0.2	A						5000	0	0	150	0	0
		SB	25		60	85	19.1	C	0.0	A	6.6	A	11.0	B			500	2	65				500	2	65
	TH 25 at 8th (Stop Control)	EB		325		325	0.0	A	0.5	A	0.0	A	0.5	A	29.4	D	300	0	0	1000	0	0			
		WB			470	470	0.0	A	0.0	A	61.6	F	61.6	F						2500	0	0	400	244	**1550**
	(used for WB Queue)	SB	220			220	6.0	A	0.0	A	0.0	A	6.0	A			575	7	311					4	261

Signal Major Approach Delays:	344.7 Total Seconds
Signal Minor Approach Delays:	792.0 Total Seconds
Total All Approach Delays:	1505.6 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 2c

No Build Conditions (2045)

Friday Peak Hour (VISSIM) - 5% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
FRIDAY PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB		1349	26	1,375	0.0	A	2.6	A	1.8	A	2.6	A	4.7	A	175	0	0	700	9	251		8	252
		WB	5	1208		1,213	65.2	E	3.2	A	0.0	A	3.4	A			150	2	42	425	12	**398**		12	398
		NB	5			5	68.7	E	0.0	A	26.5	C	68.7	E			500	8	139	500	0	0	500	6	112
		SB	58		42	100	72.8	E	0.0	A	9.1	A	44.0	D			150	23	**139**	500	1	62			
	NE 5th Ave (Stop Control)	EB	294	1113		1,407	39.4	E	1.4	A	0.0	A	8.9	A	6.2	A	175	84	**492**	425	1	77			
		WB		987	11	998	0.0	A	0.2	A	1.3	A	0.2	A						600	0	32	150	0	0
		SB			226	226	0.0	A	0.0	A	16.5	C	16.5	C									500	19	166
	TH 25 Ramp (Stop Control)	EB		772	341	1,113	0.0	A	0.5	A	0.5	A	0.5	A	0.5	A				600	2	154	150	2	**154**
		WB		998		998	0.0	A	0.4	A	0.0	A	0.4	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		872	37	909	0.0	A	0.9	A	0.8	A	0.9	A	2.1	A				300	0	0			
		SB			126	126	0.0	A	0.0	A	11.0	B	11.0	B									500	12	149
	TH 210 at NE 8th Ave (Signal Control)	EB	305	462	5	772	145.6	F	55.0	E	2.3	A	91.4	F	80.1	F	400	**341**	**880**	800	81	490	350	0	0
		WB	5	441	163	609	102.4	F	91.3	F	4.6	A	71.7	E			400	3	47	850	148	535	400	4	130
		NB	294	200	5	499	88.9	F	88.2	F	10.9	B	88.4	F						600	252	**632**	400	0	15
		SB	121	221	173	515	92.8	F	94.6	F	10.2	B	64.8	E						1000	217	646	1000	217	646
	NE 10th Ave (Stop Control)	EB	47	536	5	588	6.7	A	0.8	A	1.4	A	1.3	A	2.8	A	300	1	91	850	0	0	200	0	0
		WB	32	572	5	609	5.4	A	0.2	A	0.7	A	0.5	A			200	1	50	1400	0	0	300	0	0
		NB	16	21	42	79	39.9	E	45.7	E	18.9	C	29.1	D						1000	12	182			
		SB		5	21	26	0.0	A	20.4	C	6.6	A	8.8	A						500	1	39			
	NE 13th Ave (Stop Control)	EB	47	530		577	7.5	A	0.3	A	0.0	A	0.9	A	1.2	A	350	2	93	1400	0	0			
		WB		546	37	583	0.0	A	0.2	A	1.0	A	0.2	A						5000	0	0	150	0	0
		SB	26		63	89	18.2	C	0.0	A	7.3	A	11.1	B			500	3	72				500	3	72
	TH 25 at 8th (Stop Control)	EB		341		341	0.0	A	0.5	A	0.0	A	0.5	A	41.5	E	300	0	0	1000	0	0			
		WB			494	494	0.0	A	0.0	A	87.7	F	87.7	F						2500	0	0	400	**367**	**1770**
	(used for WB Queue)	SB	231			231	5.8	A	0.0	A	0.0	A	5.8	A			575	8	329					5	279

Signal Major Approach Delays:	396.3 Total Seconds
Signal Minor Approach Delays:	821.7 Total Seconds
Total All Approach Delays:	1854.9 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 2d

No Build Conditions (2045)

Summer Peak Hour (VISSIM) - 10% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 160 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
SUMMER PEAK HOUR	TH 210 at NE 4th Ave (Signal Control)	EB		1414	28	1,442	0.0	A	5.5	A	3.2	A	5.4	A	6.1	A	175	0	0	700	30	403		30	404
		WB	6	1265		1,271	87.2	F	3.0	A	0.0	A	3.3	A			150	2	54	425	14	**448**		14	448
		NB	6			6	69.7	E	0.0	A	16.5	B	69.7	E			500	8	153	500	0	0	500	6	126
		SB	61		44	105	73.4	E	0.0	A	9.5	A	45.0	D			150	26	**156**	500	1	62			
	NE 5th Ave (Stop Control)	EB	308	1166		1,474	48.8	E	3.4	A	0.0	A	12.4	B	8.4	A	175	119	**576**	425	7	163			
		WB		1034	11	1,045	0.0	A	0.3	A	1.3	A	0.3	A						600	0	27	150	0	0
		SB			237	237	0.0	A	0.0	A	19.6	C	19.6	C									500	24	204
	TH 25 Ramp (Stop Control)	EB		809	358	1,167	0.0	A	3.1	A	1.1	A	2.5	A	1.5	A				600	8	199	150	8	**199**
		WB		1045		1,045	0.0	A	0.4	A	0.0	A	0.4	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		913	39	952	0.0	A	0.9	A	0.9	A	0.9	A	2.2	A				300	0	0			
		SB			132	132	0.0	A	0.0	A	11.3	B	11.3	B									500	13	151
	TH 210 at NE 8th Ave (Signal Control)	EB	319	484	6	809	201.1	F	62.3	E	12.2	B	117.4	F			400	**494**	**932**	800	77	448	350	0	0
		WB	6	462	171	639	116.1	F	95.4	F	5.0	A	75.2	E	92.6	F	400	3	42	850	162	598	400	4	130
		NB	308	209	6	523	100.4	F	98.3	F	26.1	C	99.4	F						600	309	**622**	400	0	20
		SB	127	231	182	540	101.9	F	100.7	F	10.7	B	70.0	E						1000	247	664	1000	247	664
	NE 10th Ave (Stop Control)	EB	50	561	6	617	7.0	A	0.7	A	1.3	A	1.2	A	3.3	A	300	1	92	850	0	0	200	0	0
		WB	33	600	6	639	6.2	A	0.2	A	0.6	A	0.5	A			200	1	67	1400	0	0	300	0	0
		NB	17	22	44	83	49.6	E	57.7	F	23.6	C	36.4	E						1000	17	209			
		SB		6	22	28	0.0	A	22.5	C	6.7	A	9.2	A						500	1	39			
	NE 13th Ave (Stop Control)	EB	50	556		606	8.1	A	0.3	A	0.0	A	0.9	A	1.4	A	350	2	91	1400	0	0			
		WB		572	39	611	0.0	A	0.2	A	1.0	A	0.2	A						5000	0	0	150	0	0
		SB	28		66	94	23.1	C	0.0	A	9.7	A	14.3	B			500	4	79				500	4	79
	TH 25 at 8th (Stop Control)	EB		358		358	0.0	A	0.5	A	0.0	A	0.5	A	66.2	F	300	0	0	1000	0	0			
		WB			517	517	0.0	A	0.0	A	144.8	F	144.8	F						2500	0	0	400	**647**	**2179**
	(used for WB Queue)	SB	242			242	7.6	A	0.0	A	0.0	A	7.6	A			575	11	351					8	301

Signal Major Approach Delays:	443.9 Total Seconds
Signal Minor Approach Delays:	1044.7 Total Seconds
Total All Approach Delays:	2104.6 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 3a

Build Alternative 1 - Conditions (2045) **Added Capacity at 8th Ave Signal**

AM Peak Hour (VISSIM)

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 115 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
AM PEAK HOUR	TH 210 at NE 4th Ave (Stop Control)	EB	5	765	5	775	0.0	A	0.3	A	0.8	A	0.3	A	0.6	A				700	0	48			
		WB	5	1125	5	1,135	0.0	A	0.4	A	1.3	A	0.4	A						425	0	11			
		NB	5	5	5	15	0.0	A	0.0	A	9.9	A	9.9	A									0	2	105
		SB			25	25	0.0	A	0.0	A	10.2	B	10.2	B									500	0	48
	NE 5th Ave (Signal Control)	EB	195	635		830	31.6	C	3.7	A	0.0	A	10.5	B	13.3	B	500	38	279	425	7	153			
		WB		1025	40	1,065	0.0	A	13.5	B	5.8	A	13.2	B						1000	55	566	150	1	62
		SB	60		110	170	52.7	D	0.0	A	11.7	B	26.8	C									500	4	100
	TH 25 Ramp (Stop Control)	EB		635		635	0.0	A	0.4	A	0.0	A	0.4	A	0.4	A				600	0	0	150	0	0
		WB		1065		1,065	0.0	A	0.4	A	0.0	A	0.4	A						550	0	27			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		1060	20	1,080	0.0	A	0.9	A	0.7	A	0.9	A	0.9	A				300	0	0			
		SB			5	5	0.0	A	0.0	A	10.5	B	10.5	B									500	0	61
	TH 210 at NE 8th Ave (Signal Control)	EB	100	290	245	635	64.7	E	29.1	C	2.5	A	25.0	C	29.6	C	**700**	41	241	800	30	218	350	1	129
		WB	10	505	65	580	64.7	E	38.7	D	1.9	A	35.3	D			400	13	105	850	70	397	400	1	67
		NB	260	150	5	415	33.2	C	33.4	C	4.5	A	32.9	C			400	60	**452**	600	33	259	400	0	66
		SB	50	185	315	550	26.9	C	49.8	D	13.0	B	26.4	C			250	7	102	1000	69	437	1000	69	437
	NE 10th Ave (3/4 Access)	EB	35	300	10	345	6.5	A	1.0	A	2.8	A	1.7	A	1.8	A	300	1	72	850	0	0	200	0	30
		WB	40	515	5	560	2.6	A	0.3	A	1.8	A	0.5	A			200	0	50	1400	0	0	300	0	0
		NB	10	20	40	70	0.0	A	0.0	A	7.0	A	7.0	A						1000	0	0	1000	2	86
		SB	5	30	55	90	0.0	A	0.0	A	6.8	A	6.8	A						500	0	0	1000	3	72
	NE 13th Ave (Stop Control)	EB	25	320		345	6.0	A	0.3	A	0.0	A	0.7	A	1.2	A	350	1	125	1400	0	0			
		WB		495	25	520	0.0	A	0.2	A	0.9	A	0.2	A						5000	0	0	150	0	0
		SB	25		65	90	16.7	C	0.0	A	7.5	A	10.3	B			500	3	79				500	3	79

Signal Major Approach Delays:	181.2	Total Seconds
Signal Minor Approach Delays:	467.4	Total Seconds
Total All Approach Delays:	871.9	Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 3b

Build Alternative 1 - Conditions (2045) **Added Capacity at 8th Ave Signal**

PM Peak Hour (VISSIM)

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
PM PEAK HOUR	TH 210 at NE 4th Ave (Stop Control)	EB		1285	25	1,310	0.0	A	0.9	A	1.9	A	0.9	A	0.9	A				700	3	310			
		WB	5	1150		1,155	0.0	A	0.4	A	0.0	A	0.4	A						425	0	0			
		NB	5			5	0.0	A	0.0	A	12.7	B	12.7	B									0	1	78
		SB			40	40	0.0	A	0.0	A	10.7	B	10.7	B									500	1	56
	NE 5th Ave (Signal Control)	EB	280	1060		1,340	53.5	D	1.7	A	0.0	A	12.3	B	14.7	B	500	97	**424**	425	5	152			
		WB		940	10	950	0.0	A	15.2	B	7.1	A	15.1	B						1000	55	481	150	0	44
		SB	55		215	270	67.1	E	0.0	A	15.1	B	26.1	C									500	14	161
	TH 25 Ramp (Stop Control)	EB		1060		1,060	0.0	A	0.5	A	0.0	A	0.5	A	0.5	A				600	0	0	150	0	0
		WB		950		950	0.0	A	0.5	A	0.0	A	0.5	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		830	35	865	0.0	A	1.0	A	0.9	A	1.0	A	2.1	A				300	0	0			
		SB			120	120	0.0	A	0.0	A	10.1	B	10.1	B									500	11	144
	TH 210 at NE 8th Ave (Signal Control)	EB	290	440	330	1,060	59.7	E	24.0	C	4.9	A	27.8	C	35.5	D	**700**	121	**558**	800	32	255	350	6	244
		WB	5	420	155	580	77.6	E	51.5	D	4.7	A	41.2	D			400	3	47	850	81	363	400	4	111
		NB	280	190	5	475	43.9	D	46.6	D	6.5	A	44.9	D			400	85	**527**	600	63	423	400	0	15
		SB	115	210	165	490	34.5	C	58.5	E	8.0	A	36.5	D			250	21	**198**	1000	88	502	1000	88	502
	NE 10th Ave (3/4 Access)	EB	45	510	5	560	6.8	A	0.8	A	1.8	A	1.3	A	1.4	A	300	1	89	850	0	0	200	0	0
		WB	30	545	5	580	3.8	A	0.3	A	1.8	A	0.5	A			200	0	44	1400	0	0	300	0	0
		NB	15	20	40	75	0.0	A	0.0	A	8.1	A	8.1	A						1000	0	0	1000	3	98
		SB		5	20	25	0.0	A	0.0	A	6.4	A	6.4	A						500	0	0	500	1	37
	NE 13th Ave (Stop Control)	EB	45	505		550	7.3	A	0.3	A	0.0	A	0.8	A	1.2	A	350	3	135	1400	0	0			
		WB		520	35	555	0.0	A	0.2	A	1.0	A	0.2	A						5000	0	0	150	0	2
		SB	25		60	85	19.1	C	0.0	A	7.3	A	11.5	B			500	3	73				500	3	73

Signal Major Approach Delays:	245.8 Total Seconds
Signal Minor Approach Delays:	642.0 Total Seconds
Total All Approach Delays:	1169.0 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 3c

Build Alternative 1 - Conditions (2045) **Added Capacity at 8th Ave Signal**

Friday Peak Hour (VISSIM) - 5% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
FRIDAY PEAK HOUR	TH 210 at NE 4th Ave (Stop Control)	EB		1349	26	1,375	0.0	A	1.1	A	2.7	A	1.1	A	1.0	A				700	5	321			
		WB	5	1208		1,213	0.0	A	0.4	A	0.0	A	0.4	A						425	0	0			
		NB	5			5	0.0	A	0.0	A	12.1	B	12.1	B									0	1	82
		SB			42	42	0.0	A	0.0	A	10.5	B	10.5	B									500	1	61
	NE 5th Ave (Signal Control)	EB	294	1113		1,407	54.4	D	2.0	A	0.0	A	12.8	B	15.7	B	500	105	**449**	425	7	156			
		WB		987	11	998	0.0	A	16.6	B	8.1	A	16.5	B						1000	66	548	150	0	51
		SB	58		226	284	71.7	E	0.0	A	16.1	B	27.7	C									500	16	186
	TH 25 Ramp (Stop Control)	EB		1113		1,113	0.0	A	0.5	A	0.0	A	0.5	A	0.5	A				600	0	0	150	0	0
		WB		998		998	0.0	A	0.6	A	0.0	A	0.6	A						550	0	7			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		872	37	909	0.0	A	1.0	A	0.9	A	1.0	A	2.1	A				300	0	0			
		SB			126	126	0.0	A	0.0	A	10.4	B	10.4	B									500	11	147
	TH 210 at NE 8th Ave (Signal Control)	EB	305	462	346	1,113	68.3	E	28.0	C	5.7	A	32.3	C	39.1	D	**700**	147	**651**	800	41	268	350	8	**281**
		WB	5	441	163	609	79.3	E	54.6	D	5.3	A	43.8	D			400	4	57	850	89	388	400	5	129
		NB	294	200	5	499	49.6	D	46.2	D	6.0	A	48.1	D			400	105	**579**	600	63	387	400	0	36
		SB	121	221	173	515	37.7	D	63.2	E	8.0	A	39.3	D			250	24	**201**	1000	102	523	1000	102	523
	NE 10th Ave (3/4 Access)	EB	47	536	5	588	6.8	A	0.9	A	1.7	A	1.4	A	1.5	A	300	1	110	850	0	0	200	0	0
		WB	32	572	5	609	4.5	A	0.3	A	1.9	A	0.5	A			200	1	49	1400	0	0	300	0	0
		NB	16	21	42	79	0.0	A	0.0	A	8.5	A	8.5	A						1000	0	0	1000	3	98
		SB		5	21	26	0.0	A	0.0	A	6.5	A	6.5	A						500	0	0	500	1	37
	NE 13th Ave (Stop Control)	EB	47	530		577	8.8	A	0.3	A	0.0	A	0.9	A	1.4	A	350	3	115	1400	0	0			
		WB		546	37	583	0.0	A	0.2	A	1.0	A	0.2	A						5000	0	0	150	0	4
		SB	26		63	89	23.5	C	0.0	A	9.3	A	14.2	B			500	3	72				500	3	72

Signal Major Approach Delays:	269.2	Total Seconds
Signal Minor Approach Delays:	654.6	Total Seconds
Total All Approach Delays:	1329.8	Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 3d

Build Alternative 1 - Conditions (2045) **Added Capacity at 8th Ave Signal**

Summer Peak Hour (VISSIM) - 10% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 160 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
SUMMER PEAK HOUR	TH 210 at NE 4th Ave (Stop Control)	EB		1414	28	1,442	0.0	A	1.1	A	2.1	A	1.1	A	1.0	A				700	14	335			
		WB	6	1265		1,271	0.0	A	0.4	A	0.0	A	0.4	A						425	0	8			
		NB	6			6	0.0	A	0.0	A	11.7	B	11.7	B									0	1	83
		SB			44	44	0.0	A	0.0	A	10.8	B	10.8	B									500	1	55
	NE 5th Ave (Signal Control)	EB	308	1166		1,474	53.7	D	1.0	A	0.0	A	12.0	B	16.5	B	500	110	**509**	425	12	158			
		WB		1034	11	1,045	0.0	A	19.2	B	9.0	A	19.1	B						1000	83	632	150	0	38
		SB	61		237	298	73.2	E	0.0	A	19.0	B	30.3	C									500	22	227
	TH 25 Ramp (Stop Control)	EB		1166		1,166	0.0	A	0.6	A	0.0	A	0.6	A	0.7	A				600	13	66	150	0	0
		WB		1045		1,045	0.0	A	0.9	A	0.0	A	0.9	A						550	0	36			
		NB					0.0	A	0.0	A	0.0	A	0.0	A			700	0	0						
	Mall RI/RO (Stop Control)	WB		913	39	952	0.0	A	1.0	A	0.8	A	1.0	A	2.3	A				300	0	0			
		SB			132	132	0.0	A	0.0	A	11.3	B	11.3	B									500	13	147
	TH 210 at NE 8th Ave (Signal Control)	EB	319	484	364	1,167	74.8	E	29.9	C	5.7	A	34.8	C	42.8	D	**700**	170	**787**	800	69	373	350	33	**400**
		WB	6	462	171	639	93.4	F	59.3	E	5.6	A	47.7	D			400	5	52	850	102	424	400	5	123
		NB	308	209	6	523	55.7	E	51.8	D	3.8	A	54.0	D			400	141	**666**	600	73	442	400	0	20
		SB	127	231	182	540	41.5	D	69.6	E	8.9	A	43.2	D			250	26	**212**	1000	140	650	1000	140	650
	NE 10th Ave (3/4 Access)	EB	50	561	6	617	6.7	A	0.9	A	1.6	A	1.3	A	1.5	A	300	1	91	850	0	0	200	0	0
		WB	33	600	6	639	4.4	A	0.3	A	2.0	A	0.5	A			200	0	53	1400	0	0	300	0	0
		NB	17	22	44	83	0.0	A	0.0	A	8.5	A	8.5	A						1000	0	0	1000	3	98
		SB		6	22	28	0.0	A	0.0	A	6.5	A	6.5	A						500	0	0	500	1	37
	NE 13th Ave (Stop Control)	EB	50	556		606	8.7	A	0.3	A	0.0	A	1.0	A	1.6	A	350	4	136	1400	0	0			
		WB		572	39	611	0.0	A	0.2	A	1.0	A	0.3	A						5000	0	0	150	0	2
		SB	28		66	94	25.7	D	0.0	A	10.2	B	15.5	C			500	4	84				500	4	84

Signal Major Approach Delays:	298.2	Total Seconds
Signal Minor Approach Delays:	736.4	Total Seconds
Total All Approach Delays:	1591.9	Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 4a

Build Alternative 2 - Conditions (2045) **Single Roundabout at TH 25/8th Ave**

AM Peak Hour (VISSIM)

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 115 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave)

Note: NW 4th Street improvements included.

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
AM PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB		765	5	770	0.0	A	1.3	A	5.9	A	1.4	A	1.2	A	175	0	0	700	0	72			
		WB	5	1125	5	1,135	0.0	A	0.2	A	7.0	A	0.2	A			150	0	0	425	0	60			
		NB			15	15	0.0	A	0.0	A	11.9	B	11.9	B									500	2	109
		SB			85	85	0.0	A	0.0	A	11.5	B	11.5	B									500	3	89
	NE 5th Ave (3/4 Access)	EB	95	735		830	18.2	C	0.2	A	0.0	A	2.4	A	1.6	A	275	13	159	425	0	0			
		WB		1025	40	1,065	0.0	A	0.1	A	1.2	A	0.2	A						600	0	0	150	0	41
		SB			110	110	0.0	A	0.0	A	10.0	A	10.0	B									500	4	88
	TH 25 Ramp (Stop Control)	EB		735		735	0.0	A	0.2	A	0.0	A	0.2	A	0.1	A				600	0	0			
		WB		1065		1,065	0.0	A	0.1	A	0.0	A	0.1	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A											
	Mall 3/4 Access (3/4 Access)	EB	100	635		735	37.0	E	0.3	A	0.0	A	7.0	A	2.4	A	300	21	167	300	0	0			
		WB		1060	20	1,080	0.0	A	0.3	A	0.7	A	0.3	A						550	0	0			
		SB			5	5	0.0	A	0.0	A	2.9	A	2.9	A									500	0	22
	TH 210 at NE 8th Ave (Roundabout Control)	EB	100	290	245	635	2.3	A	1.5	A	2.2	A	1.9	A	10.6	B				1500	2	103	1500	1	139
		WB	10	505	65	580	5.6	A	4.8	A	3.3	A	4.6	A						850	8	152			
		NB	260	150	5	415	4.3	A	4.3	A	0.0	A	4.3	A						600	0	64			
		SB	50	185	315	550	18.3	C	34.3	D	31.9	D	31.5	D						1000	180	**960**			
	NE 10th Ave (3/4 Access)	EB	35	300	10	345	5.3	A	0.8	A	1.6	A	1.3	A	1.6	A	300	1	57	850	0	0	200	0	2
		WB	40	515	5	560	3.1	A	0.3	A	1.7	A	0.5	A			200	0	56	1400	0	0	300	0	0
		NB	10	20	40	70	0.0	A	0.0	A	6.7	A	6.7	A									150	2	87
		SB	5	30	55	90	0.0	A	0.0	A	6.6	A	6.6	A									500	3	72
	NE 13th Ave (Stop Control)	EB	25	320		345	6.0	A	0.2	A	0.0	A	0.6	A	1.1	A	350	1	73	1400	0	0			
		WB		495	25	520	0.0	A	0.2	A	0.9	A	0.2	A						5000	0	0	150	0	8
		SB	25		65	90	15.9	C	0.0	A	6.7	A	9.5	A			500	3	78				500	3	78

Signal Major Approach Delays:	127.6 Total Seconds
Signal Minor Approach Delays:	447.4 Total Seconds
Total All Approach Delays:	748.6 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 4b

Build Alternative 2 - Conditions (2045) **Single Roundabout at TH 25/8th Ave**

PM Peak Hour (VISSIM)

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave)

Note: NW 4th Street improvements included.

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
PM PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB		1285	25	1,310	0.0	A	2.7	A	9.0	A	2.8	A	2.1	A	175	0	0	700	5	293			
		WB	5	1150		1,155	0.0	A	0.3	A	0.0	A	0.3	A			150	0	0	425	0	0			
		NB			5	5	0.0	A	0.0	A	13.8	B	13.8	B									500	1	79
		SB			95	95	0.0	A	0.0	A	12.1	B	12.1	B									500	3	97
	NE 5th Ave (3/4 Access)	EB	180	1160		1,340	15.7	C	0.3	A	0.0	A	1.8	A	2.1	A	275	13	162	425	0	0			
		WB		940	10	950	0.0	A	0.2	A	1.4	A	0.2	A						600	0	0	150	0	17
		SB			215	215	0.0	A	0.0	A	13.5	B	13.5	B									500	14	167
	TH 25 Ramp (Stop Control)	EB		1160		1,160	0.0	A	0.3	A	0.0	A	0.3	A	0.2	A				600	0	3			
		WB		950		950	0.0	A	0.1	A	0.0	A	0.1	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A											
	Mall 3/4 Access (3/4 Access)	EB	100	1060		1,160	17.7	C	0.7	A	0.0	A	3.5	A	1.9	A	300	15	171	300	0	0			
		WB		830	35	865	0.0	A	0.3	A	0.8	A	0.3	A						550	0	0			
		SB			120	120	0.0	A	0.0	A	2.1	A	2.1	A									500	1	66
	TH 210 at NE 8th Ave (Roundabout Control)	EB	290	440	330	1,060	4.3	A	2.6	A	3.7	A	3.4	A	10.0	B				1500	8	207	1500	6	276
		WB	5	420	155	580	14.3	B	11.5	B	6.6	A	10.4	B						850	21	202			
		NB	280	190	5	475	16.2	C	17.4	C	0.0	A	16.7	C						600	5	266			
		SB	115	210	165	490	17.4	C	16.7	C	16.2	C	16.7	C						1000	76	647			
	NE 10th Ave (3/4 Access)	EB	45	510	5	560	4.8	A	0.8	A	1.3	A	1.1	A	1.3	A	300	1	58	850	0	0	200	0	0
		WB	30	545	5	580	4.8	A	0.2	A	1.7	A	0.5	A			200	0	58	1400	0	0	300	0	0
		NB	15	20	40	75	0.0	A	0.0	A	7.8	A	7.8	A									150	3	94
		SB		5	20	25	0.0	A	0.0	A	6.1	A	6.1	A									500	1	37
	NE 13th Ave (Stop Control)	EB	45	505		550	6.3	A	0.1	A	0.0	A	0.6	A	1.2	A	350	2	91	1400	0	0			
		WB		520	35	555	0.0	A	0.2	A	0.9	A	0.2	A						5000	0	0	150	0	9
		SB	25		60	85	23.3	C	0.0	A	7.3	A	13.0	B			500	3	69				500	3	69

Signal Major Approach Delays:	196.6 Total Seconds
Signal Minor Approach Delays:	597.5 Total Seconds
Total All Approach Delays:	1166.1 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 4c

Build Alternative 2 - Conditions (2045) **Single Roundabout at TH 25/8th Ave**

Friday Peak Hour (VISSIM) - 5% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
FRIDAY PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB		1349	26	1,375	0.0	A	2.9	A	8.6	A	3.0	A	2.2	A	175	0	0	700	5	258			
		WB	5	1208		1,213	0.0	A	0.3	A	0.0	A	0.3	A			150	0	0	425	0	0			
		NB			5	5	0.0	A	0.0	A	14.7	B	14.7	B									500	1	84
		SB			100	100	0.0	A	0.0	A	12.1	B	12.1	B									500	4	95
	NE 5th Ave (3/4 Access)	EB	194	1213		1,407	21.4	C	0.4	A	0.0	A	2.4	A	2.4	A	275	19	203	425	0	0			
		WB		987	11	998	0.0	A	0.2	A	1.1	A	0.2	A						600	0	0	150	0	20
		SB			226	226	0.0	A	0.0	A	13.8	B	13.8	B									500	16	156
	TH 25 Ramp (Stop Control)	EB		1213		1,213	0.0	A	0.3	A	0.0	A	0.3	A	0.2	A				600	0	0			
		WB		998		998	0.0	A	0.1	A	0.0	A	0.1	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A											
	Mall 3/4 Access (3/4 Access)	EB	100	1113		1,213	18.9	C	0.7	A	0.0	A	3.6	A	2.0	A	300	17	175	300	0	9			
		WB		872	37	909	0.0	A	0.3	A	0.8	A	0.3	A						550	0	0			
		SB			126	126	0.0	A	0.0	A	2.5	A	2.5	A									500	1	69
	TH 210 at NE 8th Ave (Roundabout Control)	EB	305	462	346	1,113	4.6	A	2.9	A	3.6	A	3.6	A	12.3	B				1500	9	208	1500	5	222
		WB	5	441	163	609	19.3	C	14.1	B	7.6	A	12.7	B						850	28	227			
		NB	294	200	5	499	19.1	C	21.8	C	0.0	A	20.2	C						600	8	377			
		SB	121	221	173	515	24.3	C	22.8	C	21.9	C	22.8	C						1000	113	**767**			
	NE 10th Ave (3/4 Access)	EB	47	536	5	588	5.8	A	0.8	A	1.4	A	1.2	A	1.4	A	300	1	70	850	0	0	200	0	0
		WB	32	572	5	609	6.0	A	0.2	A	1.9	A	0.6	A			200	1	58	1400	0	0	300	0	0
		NB	16	21	42	79	0.0	A	0.0	A	7.9	A	7.9	A									150	3	96
		SB		5	21	26	0.0	A	0.0	A	6.2	A	6.2	A									500	1	37
	NE 13th Ave (Stop Control)	EB	47	530		577	5.5	A	0.1	A	0.0	A	0.5	A	1.2	A	350	2	86	1400	0	0			
		WB		546	37	583	0.0	A	0.2	A	1.0	A	0.2	A						5000	0	0	150	0	4
		SB	26		63	89	26.0	D	0.0	A	8.5	A	14.6	B			500	4	73				500	4	73

Signal Major Approach Delays:	208.8 Total Seconds
Signal Minor Approach Delays:	634.1 Total Seconds
Total All Approach Delays:	1327.5 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 4d

Build Alternative 2 - Conditions (2045) **Single Roundabout at TH 25/8th Ave**

Summer Peak Hour (VISSIM) - 10% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 160 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
SUMMER PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB		1414	28	1,442	0.0	A	3.7	A	9.7	A	3.8	A	2.7	A	175	0	0	700	12	381			
		WB	6	1265		1,271	0.0	A	0.3	A	6.8	A	0.3	A			150	0	0	425	0	16			
		NB			6	6	0.0	A	0.0	A	16.8	C	16.8	C									500	1	89
		SB			105	105	0.0	A	0.0	A	13.7	B	13.7	B									500	4	97
	NE 5th Ave (3/4 Access)	EB	208	1266		1,474	27.1	D	0.4	A	0.0	A	3.0	A	3.0	A	275	28	**240**	425	0	0			
		WB		1034	11	1,045	0.0	A	0.2	A	1.1	A	0.2	A						600	0	0	150	0	23
		SB			237	237	0.0	A	0.0	A	16.5	C	16.5	C									500	20	188
	TH 25 Ramp (Stop Control)	EB		1266		1,266	0.0	A	0.3	A	0.0	A	0.3	A	0.2	A				600	0	6			
		WB		1045		1,045	0.0	A	0.1	A	0.0	A	0.1	A						550	0	0			
		NB					0.0	A	0.0	A	0.0	A	0.0	A											
	Mall 3/4 Access (3/4 Access)	EB	100	1166		1,266	21.5	C	0.9	A	0.0	A	4.2	A	2.3	A	300	21	169	300	0	0			
		WB		913	39	952	0.0	A	0.3	A	0.8	A	0.3	A						550	0	0			
		SB			132	132	0.0	A	0.0	A	2.7	A	2.7	A									500	1	81
	TH 210 at NE 8th Ave (Roundabout Control)	EB	319	484	364	1,167	5.2	A	3.4	A	3.9	A	4.1	A	16.2	C				1500	13	230	1500	7	281
		WB	6	462	171	639	21.7	C	16.8	C	7.4	A	14.8	B						850	36	253			
		NB	308	209	6	523	24.2	C	25.7	D	0.0	A	24.8	C			600	117	442	600	11	391	600	117	442
		SB	127	231	182	540	38.5	E	35.1	E	33.7	D	35.4	E						1000	186	**964**			
	NE 10th Ave (3/4 Access)	EB	50	561	6	617	5.1	A	0.9	A	1.4	A	1.2	A	1.4	A	300	1	54	850	0	0	200	0	0
		WB	33	600	6	639	5.8	A	0.3	A	2.0	A	0.6	A			200	1	51	1400	0	0	300	0	0
		NB	17	22	44	83	0.0	A	0.0	A	8.1	A	8.1	A									150	3	96
		SB		6	22	28	0.0	A	0.0	A	6.2	A	6.2	A									500	1	37
	NE 13th Ave (Stop Control)	EB	50	556		606	6.6	A	0.2	A	0.0	A	0.6	A	1.4	A	350	2	90	1400	0	0			
		WB		572	39	611	0.0	A	0.2	A	1.0	A	0.3	A						5000	0	0	150	0	9
		SB	28		66	94	27.2	D	0.0	A	11.1	B	16.6	C			500	5	89				500	5	89

Signal Major Approach Delays:	243.1 Total Seconds
Signal Minor Approach Delays:	708.3 Total Seconds
Total All Approach Delays:	1565.4 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 5a

Build Alternative 3 - Conditions (2045) **Two Roundabouts at TH 25/8th Ave**

AM Peak Hour (VISSIM)

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 115 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
AM PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB	5	765	5	775	0.0	A	0.2	A	0.6	A	0.2	A	0.4	A	200	0	0	700	0	0			
		WB	5	1125	5	1,135	0.0	A	0.2	A	1.3	A	0.2	A			100	0	0	425	0	5			
		NB			15	15	0.0	A	0.0	A	11.8	B	11.8	B									0	2	114
		SB			85	85	0.0	A	0.0	A	9.7	A	9.7	A									500	0	47
	NE 5th Ave (3/4 Access)	EB	75	705		780	31.6	D	0.2	A	0.0	A	3.9	A	2.5	A	250	23	**206**	425	0	0			
		WB		1025	40	1,065	0.0	A	0.4	A	1.1	A	0.4	A						700	0	0	150	0	6
		SB			110	110	0.0	A	0.0	A	12.5	B	12.5	B									500	5	86
	TH 25 T-Intersection (Roundabout Control)	EB		460	245	705	0.0	A	2.3	A	2.7	A	2.4	A	2.6	A				700	3	172	700	3	172
		WB	195	805		1,000	2.4	A	1.9	A	0.0	A	2.0	A			375	5	154	375	5	154			
		NB	260		155	415	5.3	A	0.0	A	3.0	A	4.3	A			600	7	217				300	1	98
	Mall 3/4 Access (3/4 Access)	EB	120	495		615	45.4	E	0.9	A	0.0	A	7.4	A	3.1	A	250	33	**273**	375	0	0			
		WB		995	20	1,015	0.0	A	0.2	A	0.6	A	0.2	A						350	0	0	350	0	2
		SB			5	5	0.0	A	0.0	A	2.9	A	2.9	A									500	0	21
	NE 8th Ave T-Intersection (Roundabout Control)	EB	250	245		495	0.8	A	0.6	A	0.0	A	0.7	A	3.6	A	350	0	80	350	0	80			
		WB		515	65	580	0.0	A	3.2	A	2.8	A	3.2	A						850	4	128	400	4	128
		SB	50		500	550	4.6	A	0.0	A	7.1	A	6.9	A			1000	33	503				1000	33	503
	NE 10th Ave (3/4 Access)	EB	35	220	40	295	5.5	A	0.8	A	1.4	A	1.3	A	1.7	A	300	1	56	850	0	0	200	0	0
		WB		490	25	515	2.7	A	0.3	A	1.7	A	0.5	A			200	0	51	1400	0	0	300	0	0
		NB			70	70	0.0	A	0.0	A	6.8	A	6.8	A									1000	2	83
		SB			90	90	0.0	A	0.0	A	6.7	A	6.7	A									500	3	72
	NE 13th Ave (Stop Control)	EB	25	320		345	4.6	A	0.2	A	0.0	A	0.5	A	1.1	A	350	1	86	1400	0	0			
		WB		495	25	520	0.0	A	0.2	A	0.9	A	0.2	A						5000	0	0	150	0	0
		SB	25		65	90	15.9	C	0.0	A	6.9	A	9.7	A			500	3	78				500	3	78

Signal Major Approach Delays:	123.6	Total Seconds
Signal Minor Approach Delays:	#REF!	Total Seconds
Total All Approach Delays:	735.7	Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 5b

Build Alternative 3 - Conditions (2045) **Two Roundabouts at TH 25/8th Ave**

PM Peak Hour (VISSIM)

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Note: NW 4th Street improvements included.

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
PM PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB		1285	25	1,310	0.0	A	0.5	A	1.0	A	0.5	A	0.6	A	200	0	0	700	0	66			
		WB	5	1150		1,155	0.0	A	0.2	A	0.0	A	0.2	A			100	0	0	425	0	0			
		NB			5	5	0.0	A	0.0	A	16.8	B	16.8	B									0	1	82
		SB			95	95	0.0	A	0.0	A	10.1	B	10.1	B									500	1	59
	NE 5th Ave (3/4 Access)	EB	160	1130		1,290	21.1	C	0.4	A	0.0	A	2.3	A	2.8	A	250	18	**196**	425	0	0			
		WB		940	10	950	0.0	A	0.4	A	1.1	A	0.4	A						700	0	0	150	0	0
		SB			215	215	0.0	A	0.0	A	17.5	C	17.5	C									500	19	171
	TH 25 T-Intersection (Roundabout Control)	EB		800	330	1,130	0.0	A	5.0	A	6.5	A	5.4	A	4.7	A				700	24	421	700	24	421
		WB	215	670		885	2.1	A	1.8	A	0.0	A	1.9	A			375	4	138	375	4	138			
		NB	280		195	475	11.2	B	0.0	A	4.8	A	8.2	A			600	19	346				300	3	134
	Mall 3/4 Access (3/4 Access)	EB	120	875		995	15.9	C	0.4	A	0.0	A	2.7	A	1.7	A	250	15	**220**	375	0	0			
		WB		765	35	800	0.0	A	0.2	A	0.7	A	0.2	A						350	0	0	350	0	7
		SB			120	120	0.0	A	0.0	A	3.0	A	3.0	A									500	1	72
	NE 8th Ave T-Intersection (Roundabout Control)	EB	480	395		875	1.6	A	0.9	A	0.0	A	1.3	A	3.6	A	350	2	185	350	2	185			
		WB		425	155	580	0.0	A	7.4	A	7.4	A	7.4	A						850	15	190			
		SB	115		375	490	3.6	A	0.0	A	3.6	A	3.6	A			1000	13	326				1000	13	326
	NE 10th Ave (3/4 Access)	EB	45	455	10	510	4.8	A	0.8	A	1.3	A	1.1	A	1.3	A	300	1	62	850	0	0	200	0	0
		WB		555	25	580	4.2	A	0.2	A	1.8	A	0.5	A			200	0	53	1400	0	0	300	0	0
		NB			75	75	0.0	A	0.0	A	7.6	A	7.6	A									1000	3	93
		SB			25	25	0.0	A	0.0	A	6.5	A	6.5	A									500	1	37
	NE 13th Ave (Stop Control)	EB	45	505		550	5.8	A	0.1	A	0.0	A	0.6	A	1.2	A	350	2	100	1400	0	0			
		WB		520	35	555	0.0	A	0.2	A	0.9	A	0.2	A						5000	0	0	150	0	9
		SB	25		60	85	23.6	C	0.0	A	7.3	A	13.0	B			500	3	71				500	3	71

Signal Major Approach Delays:	187.1 Total Seconds
Signal Minor Approach Delays:	#REF! Total Seconds
Total All Approach Delays:	1126.3 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 5c

Build Alternative 3 - Conditions (2045) **Two Roundabouts at TH 25/8th Ave**

Friday Peak Hour (VISSIM) - 5% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 150 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
FRIDAY PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB		1349	26	1,375	0.0	A	0.4	A	0.9	A	0.4	A	0.5	A	200	0	0	700	0	32			
		WB	5	1208		1,213	0.0	A	0.2	A	0.0	A	0.2	A			100	0	0	425	0	0			
		NB			5	5	0.0	A	0.0	A	16.9	B	16.9	B									0	1	82
		SB			100	100	0.0	A	0.0	A	10.4	B	10.4	B									500	1	64
	NE 5th Ave (3/4 Access)	EB	174	1180		1,354	27.5	D	0.4	A	0.0	A	3.0	A	3.4	A	250	27	**279**	425	0	0			
		WB		987	11	998	0.0	A	0.4	A	1.2	A	0.4	A						700	0	0	150	0	8
		SB			226	226	0.0	A	0.0	A	20.3	C	20.3	C									500	24	182
	TH 25 T-Intersection (Roundabout Control)	EB		834	346	1,180	0.0	A	5.7	A	7.3	A	6.1	A	5.3	A				700	31	455	700	31	455
		WB	226	704		930	2.3	A	1.9	A	0.0	A	2.0	A			375	5	148	375	5	148			
		NB	294		205	499	12.7	B	0.0	A	5.4	A	9.3	A			600	23	350				300	4	157
	Mall 3/4 Access (3/4 Access)	EB	120	919		1,039	18.6	C	0.6	A	0.0	A	3.2	A	2.0	A	250	20	**240**	375	0	14			
		WB		804	37	841	0.0	A	0.2	A	0.8	A	0.2	A						350	0	0	350	0	9
		SB			126	126	0.0	A	0.0	A	3.4	A	3.4	A									500	1	80
	NE 8th Ave T-Intersection (Roundabout Control)	EB	505	414		919	1.8	A	1.0	A	0.0	A	1.4	A	4.0	A	350	3	207	350	3	207			
		WB		447	163	610	0.0	A	8.5	A	8.0	A	8.4	A						850	19	215	400	19	215
		SB	121		394	515	4.2	A	0.0	A	4.0	A	4.1	A			1000	16	359				1000	16	359
	NE 10th Ave (3/4 Access)	EB	47	478	10	535	5.8	A	0.8	A	1.4	A	1.2	A	1.4	A	300	1	63	850	0	0	200	0	0
		WB		584	26	610	6.0	A	0.2	A	1.9	A	0.6	A			200	1	62	1400	0	0	300	0	2
		NB			79	79	0.0	A	0.0	A	7.8	A	7.8	A									1000	3	93
		SB			26	26	0.0	A	0.0	A	6.7	A	6.7	A									500	1	37
	NE 13th Ave (Stop Control)	EB	47	530		577	6.4	A	0.1	A	0.0	A	0.6	A	1.3	A	350	2	81	1400	0	0			
		WB		546	37	583	0.0	A	0.2	A	1.1	A	0.2	A						5000	0	0	150	0	4
		SB	26		63	89	27.1	D	0.0	A	9.9	A	15.8	C			500	4	82				500	4	82

Signal Major Approach Delays:	199.7 Total Seconds
Signal Minor Approach Delays:	#REF! Total Seconds
Total All Approach Delays:	1232.7 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Table 5d

Build Alternative 3 - Conditions (2045) **Two Roundabouts at TH 25/8th Ave**

Summer Peak Hour (VISSIM) - 10% Increase of PM Peak Hour

Note: NW 4th Street improvements included.

Queue Storage Issues

Queue extends through intersection.

Coordinated Cycle Length: 160 Seconds

(Baxter Dr, NW 4th, N 4th, N 6th, N 8th, 13th/Gillis, NE 4th Ave; NE 8th Ave runs Free)

Peak	Intersection	Approach	Demand Volumes (Veh/Hr)				Delay (S/Veh)						LOS By Approach		LOS By Intersection		Queue (feet)								
																	Left Turn			Through			Right Turn		
			L	T	R	Total	L	LOS	T	LOS	R	LOS	Delay (S/Veh)	LOS	Delay (S/Veh)	LOS	Storage	Avg.	Max	Link Length	Avg.	Max	Storage	Avg.	Max
SUMMER PEAK HOUR	TH 210 at NE 4th Ave (3/4 Access)	EB		1414	28	1,442	0.0	A	0.9	A	1.4	A	0.9	A	0.8	A	200	0	0	700	3	142			
		WB	6	1265		1,271	0.0	A	0.2	A	0.0	A	0.2	A			100	0	0	425	0	0			
		NB			6	6	0.0	A	0.0	A	21.9	C	21.9	C									0	1	87
		SB			105	105	0.0	A	0.0	A	11.2	B	11.2	B									500	1	61
	NE 5th Ave (3/4 Access)	EB	188	1232		1,420	33.4	D	0.6	A	0.0	A	3.7	A	3.9	A	250	37	**303**	425	0	7			
		WB		1034	11	1,045	0.0	A	0.4	A	1.1	A	0.4	A						700	0	0	150	0	3
		SB			237	237	0.0	A	0.0	A	23.1	C	23.1	C									500	28	200
	TH 25 T-Intersection (Roundabout Control)	EB		868	364	1,232	0.0	A	7.4	A	8.0	A	7.6	A	6.9	A				700	43	**547**	700	43	**547**
		WB	237	737		974	2.9	A	2.2	A	0.0	A	2.4	A			375	7	189	375	7	189			
		NB	308		215	523	18.3	C	0.0	A	8.2	A	13.7	B			600	42	368				300	6	**258**
	Mall 3/4 Access (3/4 Access)	EB	120	963		1,083	23.3	C	0.7	A	0.0	A	4.1	A	2.5	A	250	29	**287**	375	0	2			
		WB		842	39	881	0.0	A	0.2	A	0.9	A	0.2	A						350	0	0	350	0	9
		SB			132	132	0.0	A	0.0	A	3.6	A	3.6	A									500	2	85
	NE 8th Ave T-Intersection (Roundabout Control)	EB	528	435		963	2.0	A	1.0	A	0.0	A	1.6	A	5.1	A	350	4	262	350	4	262			
		WB		468	171	639	0.0	A	11.1	B	10.4	B	10.9	B						850	26	245	400	26	245
		SB	127		413	540	5.4	A	0.0	A	5.3	A	5.3	A			1000	24	404				1000	24	404
	NE 10th Ave (3/4 Access)	EB	50	500	12	562	5.7	A	0.8	A	1.3	A	1.2	A	1.4	A	300	1	61	850	0	0	200	0	0
		WB		611	28	639	5.4	A	0.3	A	2.0	A	0.5	A			200	1	64	1400	0	0	300	0	0
		NB			83	83	0.0	A	0.0	A	8.0	A	8.0	A									1000	3	98
		SB			28	28	0.0	A	0.0	A	6.4	A	6.4	A									500	1	37
	NE 13th Ave (Stop Control)	EB	50	556		606	7.0	A	0.2	A	0.0	A	0.7	A	1.4	A	350	3	102	1400	0	0			
		WB		572	39	611	0.0	A	0.2	A	1.1	A	0.3	A						5000	0	0	150	0	3
		SB	28		66	94	25.7	D	0.0	A	9.5	A	15.1	C			500	4	79				500	4	79

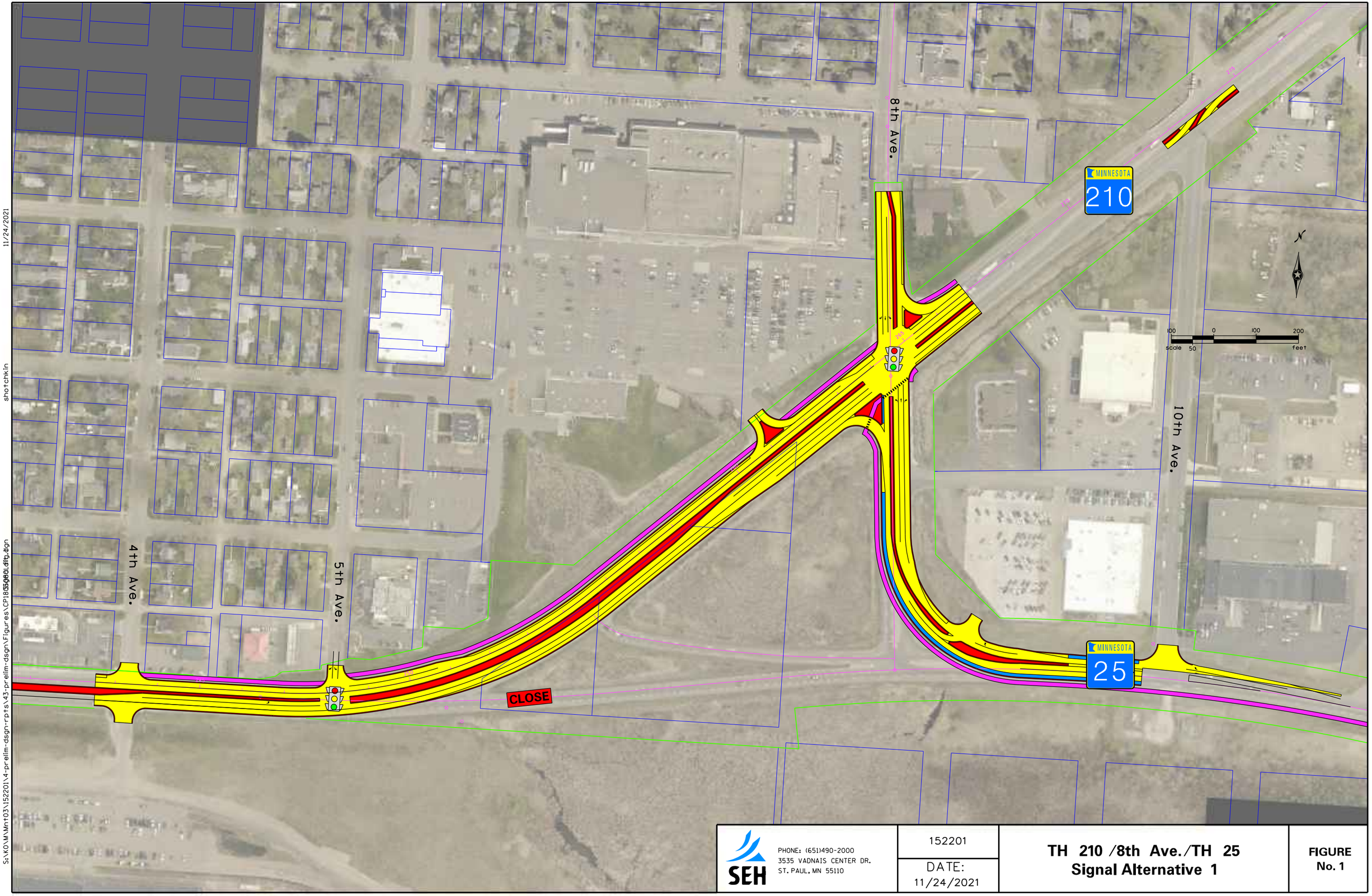
Signal Major Approach Delays:	234.1 Total Seconds
Signal Minor Approach Delays:	#REF! Total Seconds
Total All Approach Delays:	1631.1 Total Seconds

LEGEND:

###	Queue length at or above 75% of the available storage
###	Queue length at or above available Storage

Appendix E

Alternative Layouts



SEH PHONE: (651)490-2000 3535 VADNAIS CENTER DR. ST. PAUL, MN 55110	152201 DATE: 11/24/2021	**TH 210 /8th Ave./TH 25** **Signal Alternative 1**	**FIGURE** **No. 1**

11/24/2021

shotchkin

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8th Ave.

MINNESOTA 210

10th Ave.

MINNESOTA 25

4th Ave.

5th Ave.

CLOSE

100 0 100 200
scale 50 feet

SEH PHONE: (651)490-2000 3535 VADNAIS CENTER DR. ST. PAUL, MN 55110	152201 DATE: 11/24/2021	**TH 210 /8th Ave./TH 25** **Roundabout Alternative 2**	**FIGURE** **No. 2**

11/24/2021

shotchkin

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8th Ave.

MINNESOTA 210

CLOSE

10th Ave.

N

scale 100 50 0 100 200 feet

4th Ave.

5th Ave.

CLOSE

MINNESOTA 25

SEH PHONE: (651)490-2000 3535 VADNAIS CENTER DR. ST. PAUL, MN 55110	152201 DATE: 3/7/2022	**TH 210 /8th Ave./TH 25 Roundabout Alternative 3**	**FIGURE No. 3**

3/7/2022

shotchkin

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MEMORANDUM

TO: Ken Hansen, PE
MnDOT District 3 Traffic Engineer

FROM: Graham Johnson, PE, PTOE (Lic.MN, IA, SD)
Justin Anibas, PE (Lic. MN)

DATE: August 9, 2022

RE: TH 210 at Baxter Drive Intersection Control Evaluation (ICE) Report
SEH No. MNT03 152201 14.00

INTRODUCTION

This memorandum summarizes the Intersection Control Evaluation (ICE) process for the intersection of Trunk Highway (TH) 210 and Baxter Drive in Brainerd, Minnesota. The Minnesota Department of Transportation (MnDOT) ICE is an objective process used to investigate and determine the optimal traffic control that should be provided at an intersection to serve the existing conditions and future needs. This memorandum was prepared for MnDOT by SEH Inc.

As part of a project along TH 210 between Baxter Drive and Pine Shores Road, the intersection of TH 210 and Baxter Drive was evaluated and is proposed to remain under traffic signal control after the project is complete.

The location of the study intersection for this ICE report is shown in **Figure 1**. The proposed intersection control for the TH 210 and Baxter Drive intersection was analyzed based on safety, signal warrants, traffic operations, and pedestrian and bicycle accommodations.

The scope and content of this ICE report was reviewed and agreed to by MnDOT prior to the layout and ICE submittal process. This report summarizes the ICE process and recommendation for the TH 210 and Baxter Drive intersection based on a Phase I analysis according to the *2017 MnDOT ICE Manual*.

APPROVAL

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.

_____ _____
Graham Johnson, PE, PTOE, MN License No. 45429 Date

Approved By:

_____ _____
MnDOT District 3 Traffic Engineer Date

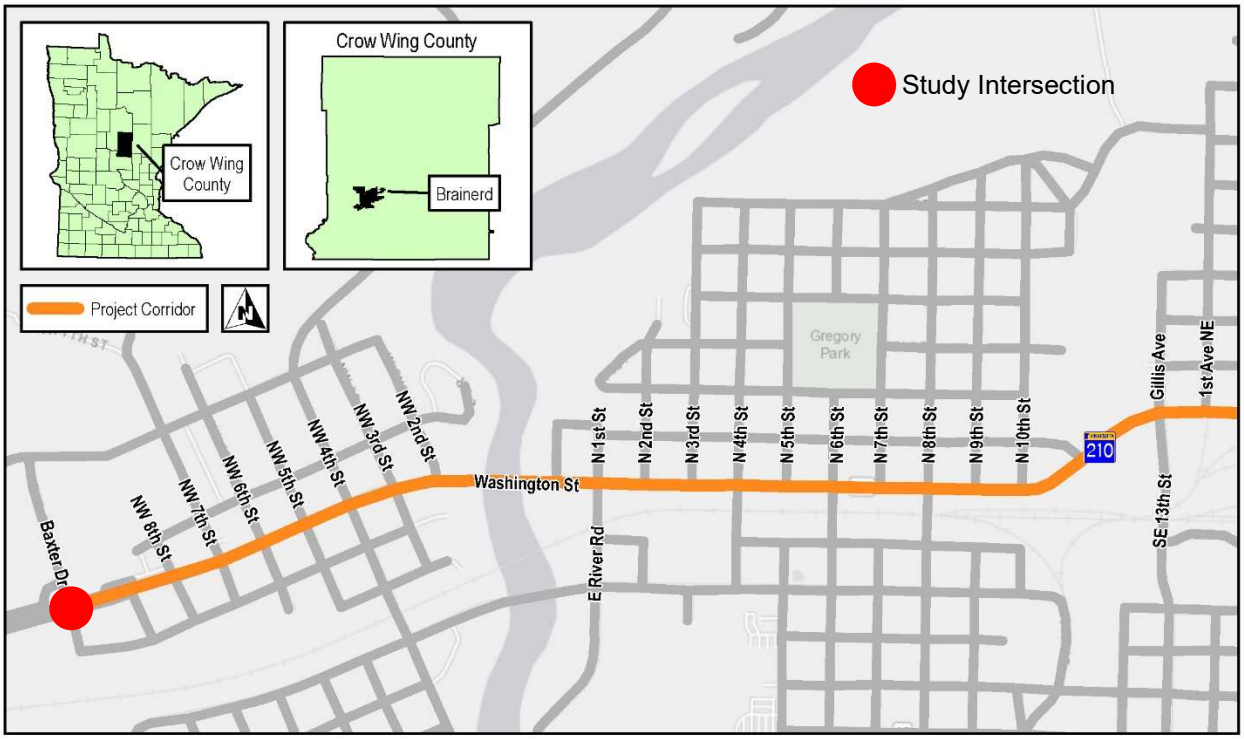
PROJECT DESCRIPTION

MnDOT is conducting the corridor planning study along a 3.9-mile segment of TH 210 to identify the future vision for highway corridor through Brainerd. Reconstruction of TH 210 between Baxter Drive and Pine Shores Road is anticipated to begin in 2025; SP 1805-80.

The primary purpose of the corridor study is to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout. The focus of the improvements is to improve pavement conditions and traveler safety, accommodate the Americans with Disabilities Act (ADA) requirements, and enhance pedestrian accommodations.

For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Figure 1 Project Location



EXISTING CONDITIONS

TH 210 is a major east-west principal arterial through the City of Brainerd that connects near-by cities and regional commerce. TH 210 is generally a 4-lane divided roadway through the City of Brainerd; the posted speed limit is 35 miles-per-hour (mph) at the study intersection; the west leg transitions to 45 mph approximately 400 feet west of the intersection.

Baxter Drive is a local roadway providing access to commercial land uses north and south of TH 210; the posted speed limit is 30 mph.

The nearest existing traffic signals along TH 210 include Cypress Drive approximately 2,300 feet west and NW 4th Street approximately 2,400 feet east.

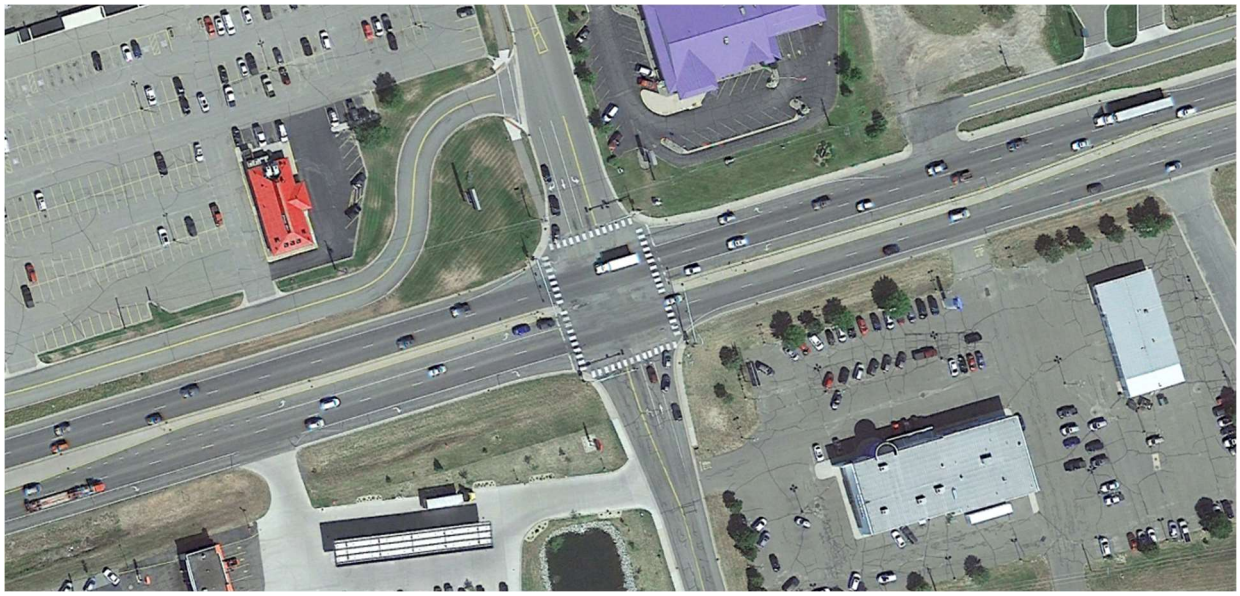
Intersection Characteristics

The existing intersection currently operates with traffic signal control and includes marked pedestrian crossings on all four legs. Eastbound and westbound TH 210 left turns operate with protected left turn phasing only, while the minor street approach left turns operate with protected and permissive left turn phasing.

The existing lane geometrics are described below and shown in **Figure 2**.

- Eastbound Approach: left turn lane, two through lanes, and a right turn lane.
- Westbound Approach: left turn lane, two through lanes, and a right turn lane.
- Northbound Approach: separate left, through, and right turn lanes.
- Southbound Approach: separate left, through, and right turn lanes

Figure 2 Existing Intersection



Traffic Volumes

TH 210 has an existing 2019 Average Annual Daily Traffic (AADT) volume of 24,100 vehicles west of the intersection. While no AADT volumes are provided on the minor street, the existing intersection count data suggests approximately 6,000 on the north leg and 4,000 on the south leg.

The existing intersection turning movement data was collected in August of 2018 as part of a signal timing project along TH 210 and TH 371. **Figure 3** includes the existing AM and PM peak hour volumes; **Attachment 1** includes the raw existing intersection count data.

Crash Analysis

Intersection crash data for the study intersection was collected from the MnDOT Crash Mapping Analysis Tool (MnCMATv2) for a five-year period between 2014 and 2018 as part of the larger corridor study.

The crash rate at an intersection is expressed as a number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on

vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be further reviewed.

The intersection had a total of 33 crashes during the 5-year analysis period:

- 29 of the 33 crashes were rear end crashes: 15 of the rear end crashes were in the westbound direction and 10 were in the eastbound direction, 2 in the northbound direction and 2 southbound. This could indicate that backups are worse for westbound vehicles.
- 3 of the 33 crashes were sideswipe crashes, likely due to vehicles changing lanes to avoid vehicles that are slowing or stopping during congestion.

Table 1 summarizes the crashes for the study intersection; additional crash information is provided in **Attachment 2**. Based on the crash rate, the intersection does not exceed the critical crash rate.

Table 1 Intersection Crash History (2014-2018)

TH 210 at:	Crash Severity					Crash Rates	
	Fatal & Severity A	Severity B	Severity C	Property Damage	Total	Int. Rate	Critical Rate
Baxter Drive	0	0	6	27	33	0.69	1.02

PROPOSED CONDITIONS

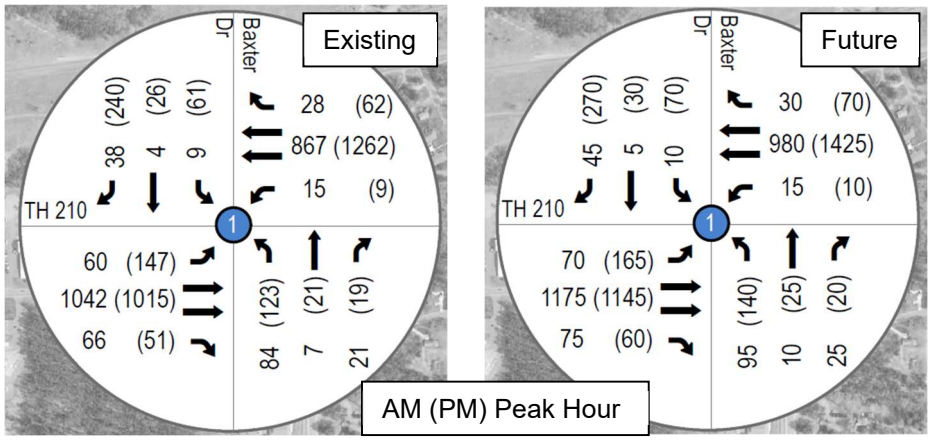
The current layout for the TH 210 corridor between Baxter Drive and Pine Shores Road addresses the needs and use of the roadway, improves pavement conditions, safety, and meets ADA requirements.

The TH 210 and Baxter Drive intersection is located in a segment of the reconstruction project that will primarily include mill and overlay of TH 210 to improve pavement conditions, with modifications for full ADA compliance and wider sidewalks. Therefore, no geometric changes are proposed at this intersection.

Future Traffic Volumes

Traffic forecasts were developed for the entire TH 210 corridor as part of the larger study effort. Future 2045 forecast volumes were developed based on a linear growth rate of 0.5% per year based on historical AADT volumes, population data, and input from the project team. **Figure 3** presents both the existing and future 2045 AM and PM peak intersection volumes.

Figure 3 Existing and Future 2045 Intersection Volumes



Warrant Analysis

Traffic control warrant analysis was conducted on the existing and future traffic volumes following the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) guidelines; all-way stop control warrants were not analyzed as it is not considered a viable control option along TH 210.

Warrants 1 (8-hour), 2 (4-hour), 3 (peak hour), and 7 (crash warrant) were included in the analysis. The following assumptions were used in the analysis:

- All minor street right turning volume was removed from the approaches.
- 70% thresholds used; west leg has adjacent posted speed exceeding 40 mph; posted at 45 mph.
- Warrant 7 was not applicable at the intersection due to insufficient correctable crashes.

The results of the traffic signal warrant analysis are provided in **Table 2**. The intersection currently meets Warrants 1, 2, and 3; the detailed signal warrant analysis is provided as **Attachment 3**.

Table 2 Traffic Signal Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Needed	Existing		Future 2045	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A – 8-hour Minimum Volume	8	5	Not Met	**8**	**MET**
Warrant 1B – 8-hour Interruption of Flow	8	**11**	**MET**	**11**	**MET**
Combination of Warrant 1A and 1B	8	**9**	**MET**	**10**	**MET**
Warrant 2 – 4-hours	4	**11**	**MET**	**11**	**MET**
Warrant 3 – Peak Hour	1	**10**	**MET**	**11**	**MET**

System Limitations and Consistency

TH 210 is a principal arterial through the City of Brainerd that experiences heavy directional volumes in both the AM and PM peak hours, throughout the day, and in the summer months with high tourist traffic. The two adjacent major intersections are both currently signalized.

The study intersection is part of an existing TH 210 signal system coordinated to provide priority to the peak direction of flow, reduce mainline delays, and provide a high level of vehicle progression through the corridor. The coordinated signal system includes all existing traffic signals along TH 210 between TH 371, in the City of Baxter, and 4th Avenue NE in east Brainerd.

Due to limited right-of-way along the TH 210 corridor, expansion of the roadway to accommodate a larger intersection footprint is not feasible. Roundabout intersection control would result in major impacts to adjacent parcels and structures adjacent to the intersection and along the corridor.

In addition, both all-way stop control and roundabout control would alter the traffic flow along TH 210 and severely impede the progression of traffic from the adjacent coordinated signal systems.

Therefore, all-way stop and roundabout intersection control was not considered feasible for this intersection due to right-of-way limitations and the interruption to the existing coordinated signal system.

Traffic Operations

Evaluation of the intersection traffic operations were conducted as part of the overall corridor study using VISSIM software. The evaluation included analysis of the existing conditions, 2045 No Build conditions, and the recommended 2045 Build conditions, which included no geometric changes at the intersection.

The average delay per vehicle and Level of Service (LOS) results for each approach and the overall intersection are provided in **Table 3** for each scenario; all three scenarios include traffic signal control. For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Table 3 Traffic Operations Summary

Scenario	Peak Hour	Approach Delay (sec/veh / LOS)				Intersection Delay (sec/veh / LOS)
		Eastbound	Westbound	Northbound	Southbound	
Existing Conditions	AM	7.9 / A	6.0 / A	**42.0 / D**	19.0 / B	9.1 / A
	PM	20.8 / C	20.5 / C	**45.3 / D**	32.2 / C	23.2 / C
2045 No Build Conditions	AM	9.0 / A	5.8 / A	**43.6 / D**	18.8 / B	9.7 / A
	PM	17.0 / B	14.6 / B	**52.7 / D**	**43.0 / D**	20.6 / C
2045 Build Conditions	AM	15.5 / B	15.1 / B	**36.1 / D**	18.3 / B	16.4 / B
	PM	22.6 / C	29.3 / C	**47.3 / D**	**46.5 / D**	29.3 / C

Based on the results, the intersection is expected to operate at a LOS C or better in all scenarios. The minor street approaches operate with longer delays due to the long cycle length required for coordination along TH 210. It should be noted; the Build conditions do operate slightly worse than the No Build conditions, this is due to more vehicles entering the intersection with improvements to the adjacent intersections along the corridor.

Pedestrian Considerations

The existing intersection provides crosswalks on all four legs of the intersection; however, the existing facilities are not ADA compliant.

As part of the TH 210 reconstruction project, the intersection will be improved to meet ADA requirements. New Accessible Pedestrian Systems (APS) pedestrian push buttons are proposed to be installed and made operational as part of this project, and all pedestrian curb ramps will be upgraded to be ADA compliant.

Revised Signal System

The existing signal system is vehicle actuated and coordinated along TH 210. The TH 210 left turn phases operate under protected phasing only; the minor street approaches have both protected and permissive left turn phasing.

As part of the signal replacement, the new signal system is to remain vehicle actuated and coordinated along TH 210. All four approaches will include Flashing Yellow Arrow (FYA) which provides the flexibility of running both protected and permissive phasing by time-of-day schedules on all approaches and improves the overall safety of the intersection.

RECOMMENDATION

Based on the analysis included in this report, and as part of the larger TH 210 corridor study, it is recommended to retain traffic signal control at the intersection of TH 210 and Baxter Drive.

Traffic signal control is currently warranted at the intersection and traffic operations are acceptable in both the existing conditions and future forecast year. The improvements at the existing intersection will continue to provide a safe intersection for all users.

Roundabout and all-way stop control was not considered feasible at this intersection due to potential right-of-way constraints and impacts, and the impact to the coordinated signal system that provides positive vehicle progression along TH 210.

Attachment 1: Turning Movement Data
Attachment 2: Crash Data
Attachment 3: Warrant Analysis

cc: Luke Wehseler, PE MnDOT District 3
Zachary Whitley, PE MnDOT District 3

File Name: S:\2018\180119\TO OTHERS\TMC\PETRO\342_TH 320 AND BAXTER DRIVE.ppd
Start Date: 8/23/2018
Start Time: 6:00:00 AM
Site Code: 00000342
Comment 1: 342_TH 210 AND BAXTER DRIVE
Comment 2: 0
Comment 3: data by: Alliant Inc
Comment 4: TURN MOVEMENT COUNT

	BAXTER DRIVE Southbound				TH 210 Westbound				BAXTER DRIVE Northbound				TH 210 Eastbound			
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds
06:00 AM	1	1	0	0	1	57	1	0	3	0	2	0	1	59	0	0
06:15 AM	1	0	1	0	2	65	1	0	6	0	3	0	1	88	0	0
06:30 AM	1	0	5	0	2	103	2	0	8	0	6	0	4	148	1	0
06:45 AM	4	1	3	0	2	125	2	0	11	0	4	0	5	154	7	0
07:00 AM	2	0	2	0	1	98	3	0	10	0	2	0	3	143	14	0
07:15 AM	1	0	3	0	4	125	0	1	15	0	1	0	3	186	9	0
07:30 AM	1	0	6	0	6	193	1	0	16	0	7	0	8	227	14	0
07:45 AM	1	0	7	0	3	186	8	0	26	3	2	0	11	237	18	0
08:00 AM	1	1	14	0	3	165	8	0	20	3	7	0	17	163	14	1
08:15 AM	6	3	11	0	3	178	11	0	22	1	5	0	24	192	20	0
08:30 AM	8	1	22	0	4	170	7	0	26	3	4	0	24	193	14	0
08:45 AM	7	3	23	0	5	208	9	0	23	3	2	0	27	206	14	0
09:00 AM	3	6	28	0	2	194	12	0	20	2	2	0	16	159	13	1
09:15 AM	6	2	26	0	6	184	6	0	26	4	5	0	22	222	18	0
09:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 AM	13	2	43	0	5	250	11	0	34	9	4	0	33	238	18	0
10:45 AM	13	5	57	0	3	269	14	0	30	7	13	0	38	210	9	0
11:00 AM	7	7	66	1	10	224	17	0	34	7	8	0	40	224	22	0
11:15 AM	11	2	55	0	7	235	21	0	24	5	5	0	48	263	15	0
11:30 AM	8	6	62	0	2	263	13	0	31	9	10	0	46	243	16	0
11:45 AM	20	3	58	0	5	236	20	0	37	9	5	0	38	244	22	0
12:00 PM	12	7	72	0	8	263	12	0	34	11	6	0	46	247	23	0
12:15 PM	12	7	62	0	6	259	11	0	53	8	8	0	55	238	22	0
12:30 PM	13	7	64	0	8	257	12	1	52	4	4	1	37	247	25	0
12:45 PM	16	7	63	0	6	275	16	0	34	6	5	0	32	255	24	1
01:00 PM	21	6	51	1	0	249	11	0	33	8	1	0	52	286	20	1
01:15 PM	8	17	54	0	7	217	12	0	42	6	7	0	36	237	33	1
01:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:30 PM	15	9	62	0	2	280	7	0	23	5	5	0	35	250	21	0
02:45 PM	10	7	49	0	1	226	16	0	40	4	5	0	47	245	27	0
03:00 PM	16	7	48	0	4	254	4	0	29	5	6	1	31	238	28	0
03:15 PM	12	9	53	0	3	255	10	0	32	2	3	0	23	237	18	0
03:30 PM	14	7	54	0	4	263	17	0	28	4	2	0	39	230	19	0
03:45 PM	12	6	37	0	5	258	6	0	27	7	2	0	37	256	16	1
04:00 PM	14	5	57	0	2	269	16	0	30	5	4	0	27	226	15	1
04:15 PM	19	4	55	0	2	241	14	0	29	4	5	0	38	231	9	0
04:30 PM	19	8	63	0	1	323	13	0	32	8	4	0	36	233	18	0
04:45 PM	10	7	40	0	3	331	19	0	26	3	5	0	44	277	7	2
05:00 PM	14	4	87	0	1	299	12	2	36	7	6	1	33	238	10	0
05:15 PM	18	7	50	0	4	309	18	0	29	3	4	0	34	267	16	2
05:30 PM	10	7	45	0	5	256	10	0	30	4	3	0	33	226	15	0
05:45 PM	11	7	46	0	5	216	8	0	27	2	7	0	28	221	6	0

Intersection Safety Screening

Intersection: TH 210 at Baxter Drive

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	6
Property Damage	27
Total Crashes	33

Intersection Characteristics	
Entering Volume	26,100
Traffic Control	Signals
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $140,640

Statewide Comparison

Signals: high volume, low speed

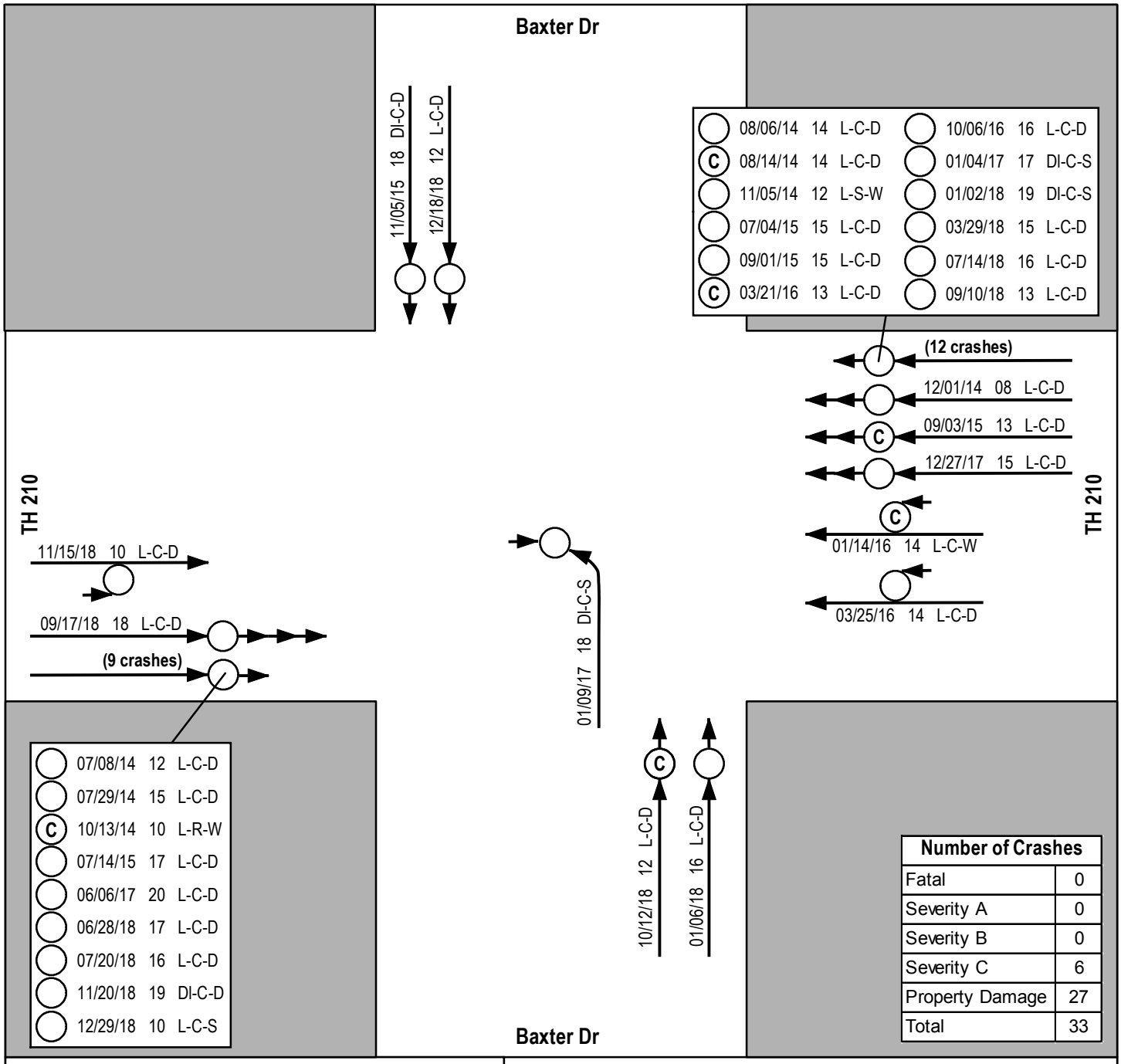
Total Crash Rate	
Observed	0.69
Statewide Average	0.70
Critical Rate	1.02
Critical Index	**0.68**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	3.44
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.69 per MEV; this is 32% below the critical rate. Based on similar statewide intersections, an additional 16 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	0
Severity C	6
Property Damage	27
Total	33

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
A Severity A
B Severity B
C Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:

Project: MNT03 152201
Print Date: 2/27/2020
Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at Baxter Dr
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A1

Path: S:\KO\MM\t03\15220118-planning\Traffic\crashes\Crash Diagrams\A1_TH 210 at Baxter Dr_Crash Diagrams.mxd

2019 Existing - TH 210 at Baxter Dr
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at Baxter Dr
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	13374
35	Major App3:	TH 210 WB	4	11871
30	Minor App2:	Baxter Dr NB	3	1557
30	Minor App4:	Baxter Dr SB	3	727

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	140	70	112

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	559	433	28	9	992	28	YES / NO	YES / NO	YES / NO
7:00 - 8:00	1055	749	70	5	1804	70	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	1095	916	101	30	2011	101	YES / NO	**YES / YES**	YES / NO
9:00 - 10:00	1060	979	112	39	2039	112	YES / NO	**YES / YES**	**YES / YES**
10:00 - 11:00	1090	1088	154	63	2178	154	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	1221	1053	156	64	2274	156	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	1251	1133	202	81	2384	202	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	1321	1003	175	103	2324	175	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	1262	1057	150	86	2319	150	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1172	1083	134	83	2255	134	YES / NO	**YES / YES**	**YES / YES**
16:00 - 17:00	1161	1234	137	86	2395	137	YES / NO	**YES / YES**	**YES / YES**
17:00 - 18:00	1127	1143	138	78	2270	138	YES / NO	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**13374**	**11871**	**1557**	**727**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	**11**	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	5	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	**11**	8	**Satisfied**
1A & 1B	Combination of Warrants	**9**	8	**Satisfied**
Warrant 2	**Four Hour Volumes**	**11**	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	**10**	1	**Satisfied**
Warrant 7	**Crash Experience**	**10**	8	Crashes Insufficient

COMMENTS:

2019 Existing - TH 210 at Baxter Dr
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at Baxter Dr
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	13374
35	Major App3:	TH 210 WB	4	11871
30	Minor App2:	Baxter Dr NB	3	1557
30	Minor App4:	Baxter Dr SB	3	727

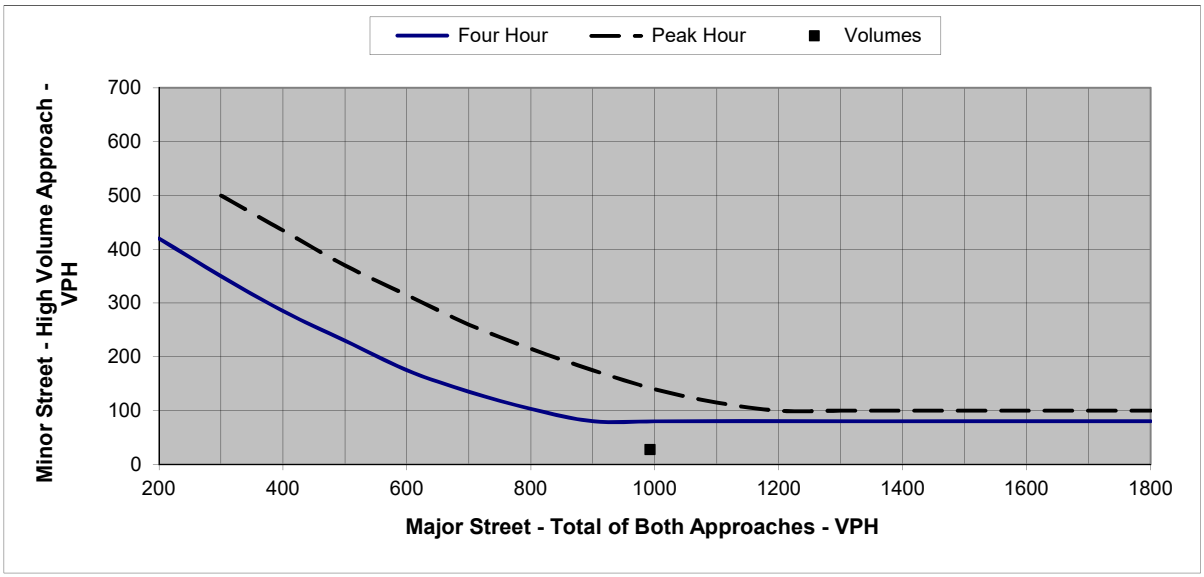


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
400	285	435
500	230	370
600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	992	28	NO	NO
7:00 - 8:00	1804	70	**YES**	NO
8:00 - 9:00	2011	101	**YES**	**YES**
9:00 - 10:00	2039	112	**YES**	**YES**
10:00 - 11:00	2178	154	**YES**	**YES**
11:00 - 12:00	2274	156	**YES**	**YES**
12:00 - 13:00	2384	202	**YES**	**YES**
13:00 - 14:00	2324	175	**YES**	**YES**
14:00 - 15:00	2319	150	**YES**	**YES**
15:00 - 16:00	2255	134	**YES**	**YES**
16:00 - 17:00	2395	137	**YES**	**YES**
17:00 - 18:00	2270	138	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at Baxter Dr
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at Baxter Dr
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	15114
35	Major App3:	TH 210 WB	4	13418
30	Minor App2:	Baxter Dr NB	3	1756
30	Minor App4:	Baxter Dr SB	3	819

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	420	630	504
Minor Approach	140	70	112

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	632	490	31	10	1122	31	YES / NO	YES / NO	YES / NO
7:00 - 8:00	1193	846	79	5	2039	79	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	1237	1035	114	33	2272	114	YES / NO	**YES / YES**	**YES / YES**
9:00 - 10:00	1198	1106	126	44	2304	126	YES / NO	**YES / YES**	**YES / YES**
10:00 - 11:00	1232	1230	174	71	2462	174	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	1380	1190	176	73	2570	176	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	1413	1281	228	91	2694	228	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	1493	1134	197	117	2627	197	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	1426	1196	170	97	2622	170	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1324	1224	150	94	2548	150	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	1312	1394	155	97	2706	155	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	1274	1292	156	87	2566	156	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**15114**	**13418**	**1756**	**819**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	11	8	Satisfied
Warrant 1A	Minimum Vehicular Volume	8	8	Satisfied
Warrant 1B	Interruption of Continuous Flow	11	8	Satisfied
1A & 1B	Combination of Warrants	10	8	Satisfied
Warrant 2	**Four Hour Volumes**	11	4	Satisfied
Warrant 3	**Peak Hour Volumes**	11	1	Satisfied
Warrant 7	**Crash Experience**	10	8	Crashes Insufficient

COMMENTS:

2045 Future - TH 210 at Baxter Dr
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at Baxter Dr
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	YES
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**YES**

85th% Speed	Approach	Description	Lanes	Approach
45	Major App1:	TH 210 EB	4	15114
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30	Minor App2:	Baxter Dr NB	3	1756
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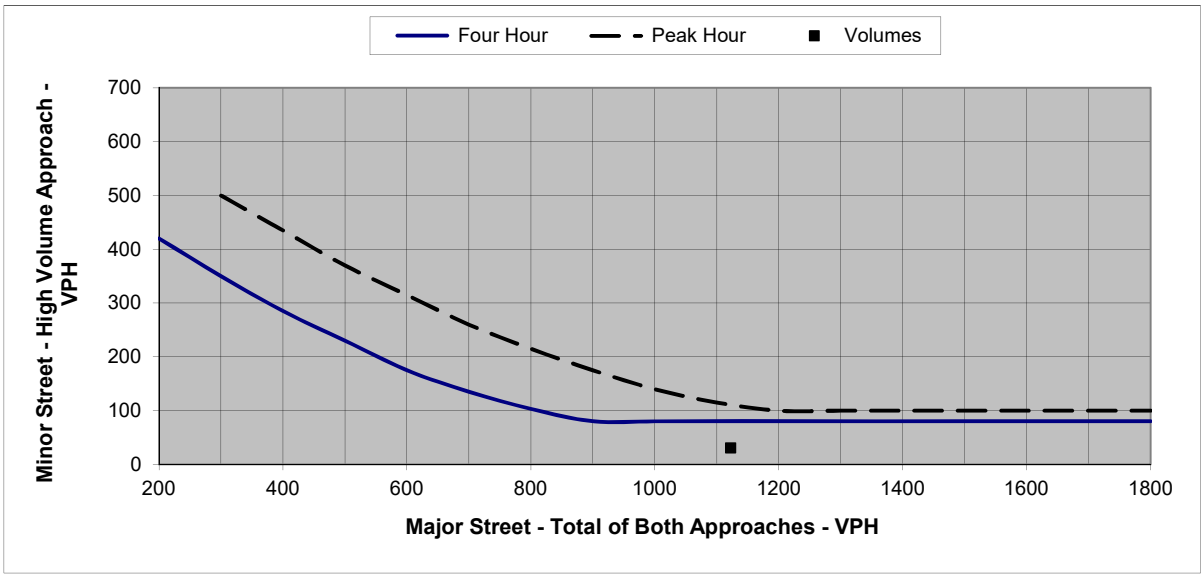


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200	420	
300	350	500
400	285	435
500	230	370
600	175	315
700	135	260
800	103	215
900	80	175
1000	80	140
1100	80	115
1200	80	100
1300	80	100
1400	80	100
1500	80	100
1600	80	100
1700	80	100
1800	80	100

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	1122	31	NO	NO
7:00 - 8:00	2039	79	**YES**	**YES**
8:00 - 9:00	2272	114	**YES**	**YES**
9:00 - 10:00	2304	126	**YES**	**YES**
10:00 - 11:00	2462	174	**YES**	**YES**
11:00 - 12:00	2570	176	**YES**	**YES**
12:00 - 13:00	2694	228	**YES**	**YES**
13:00 - 14:00	2627	197	**YES**	**YES**
14:00 - 15:00	2622	170	**YES**	**YES**
15:00 - 16:00	2548	150	**YES**	**YES**
16:00 - 17:00	2706	155	**YES**	**YES**
17:00 - 18:00	2566	156	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

MEMORANDUM

TO: Ken Hansen, PE
MnDOT District 3 Traffic Engineer

FROM: Graham Johnson, PE, PTOE (Lic.MN, IA, SD)
Justin Anibas, PE (Lic. MN)

DATE: August 9, 2022

RE: TH 210 at 13th Street/Gillis Avenue Intersection Control Evaluation (ICE) Report
SEH No. MNT03 152201 14.00

INTRODUCTION

This memorandum summarizes the Intersection Control Evaluation (ICE) process for the intersection of Trunk Highway (TH) 210 and 13th Street/Gillis Avenue in Brainerd, Minnesota. The Minnesota Department of Transportation (MnDOT) ICE is an objective process used to investigate and determine the optimal traffic control that should be provided at an intersection to serve the existing conditions and future needs. This memorandum was prepared for MnDOT by SEH Inc.

As part of a project along TH 210 between Baxter Drive and Pine Shores Road, the intersection of TH 210 and 13th Street/Gillis Avenue was evaluated and is proposed to remain under traffic signal control after the project is complete.

The location of the study intersection for this ICE report is shown in **Figure 1**. The proposed intersection control for the TH 210 and 13th Street/Gillis Avenue intersection was analyzed based on safety, signal warrants, traffic operations, and pedestrian and bicycle accommodations.

The scope and content of this ICE report was reviewed and agreed to by MnDOT prior to the layout and ICE submittal process. This report summarizes the ICE process and recommendation for the TH 210 and 13th Street/Gillis Avenue intersection based on a Phase I analysis according to the *2017 MnDOT ICE Manual*.

APPROVAL

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.

_____ _____
Graham Johnson, PE, PTOE, MN License No. 45429 Date

Approved By:

_____ _____
MnDOT District 3 Traffic Engineer Date

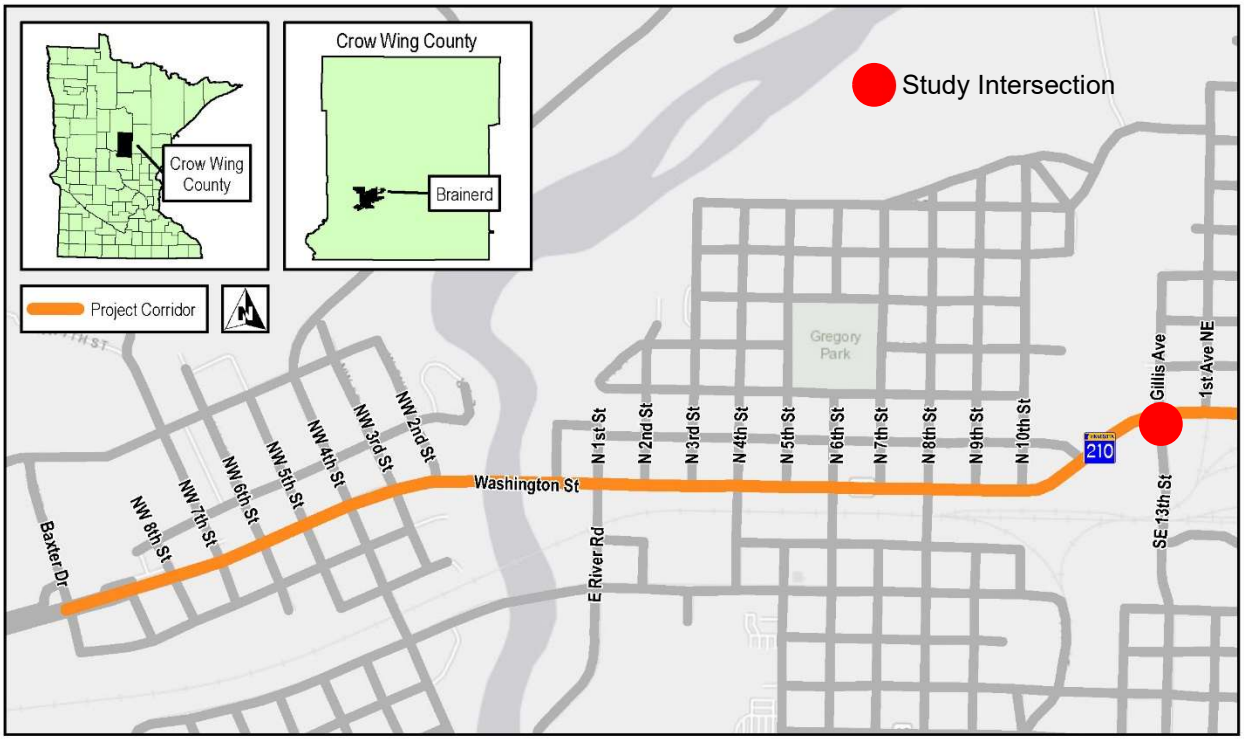
PROJECT DESCRIPTION

MnDOT is conducting the corridor planning study along a 3.9-mile segment of TH 210 to identify the future vision for highway corridor through Brainerd. Reconstruction of TH 210 between Baxter Drive and Pine Shores Road is anticipated to begin in 2025; SP 1805-80.

The primary purpose of the corridor study is to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout. The focus of the improvements is to improve pavement conditions and traveler safety, accommodate the Americans with Disabilities Act (ADA) requirements, and enhance pedestrian accommodations.

For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Figure 1 Project Location



EXISTING CONDITIONS

TH 210 is a major east-west principal arterial through the City of Brainerd that connects near-by cities and regional commerce. TH 210 is generally a 4-lane divided roadway through the City of Brainerd; the posted speed limit is 35 miles-per-hour (mph) at the study intersection.

13th Street, southern leg, is a north-south minor arterial that connects the east side of the City of Brainerd and provides access to both commercial and residential lane uses. Gillis Avenue, northern leg, is a local roadway providing access to residential land uses; the posted speed limit on both roads is 30 mph.

The nearest existing traffic signals along TH 210 include N 8th Street approximately 2,000 feet west and 4th Avenue NE approximately 1,500 feet east.

Intersection Characteristics

The existing intersection currently operates with traffic signal control and includes marked pedestrian crossings on all four legs. Eastbound and westbound TH 210 left turns operate with protected left turn phasing only, while the minor street approach left turns operate under permissive phasing only.

The existing lane geometrics are described below and shown in **Figure 2**.

- Eastbound Approach: left turn lane, two through lanes, and a right turn lane.
- Westbound Approach: left turn lane, one through lanes, and one shared through-right lane.
- Northbound Approach: shared left-through lane, and a separate right turn lane.
- Southbound Approach: shared left-through lane, and a separate right turn lane

Figure 2 Existing Intersection

Traffic Volumes

TH 210 has an existing 2019 Average Annual Daily Traffic (AADT) volume of 25,500 vehicles east of the intersection; Gillis Avenue has an existing 2019 AADT of 560 vehicles and 13th Street has an existing 2019 AADT of 6,900 vehicles.

The existing intersection turning movement data was collected in October of 2019 as part of a signal timing project along TH 210 and TH 371. **Figure 3** includes the existing AM and PM peak hour volumes; **Attachment 1** includes the raw existing intersection count data.

Crash Analysis

Intersection crash data for the study intersection was collected from the MnDOT Crash Mapping Analysis Tool (MnCMATv2) for a five-year period between 2014 and 2018 as part of the larger corridor study.

The crash rate at an intersection is expressed as a number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a

crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be further reviewed.

The intersection had a total of 51 crashes during the 5-year analysis period:

- 41 of the 51 crashes were rear end crashes: 24 of the rear end crashes were in the eastbound direction and 16 were in the westbound direction, 1 in the northbound direction. This could indicate that backups are worse for eastbound vehicles.
- 4 of the 51 crashes were sideswipe crashes, likely due to vehicles changing lanes to avoid vehicles that are slowing or stopping during congestion.

Table 1 summarizes the crashes for the study intersection; additional crash information is provided in **Attachment 2**. Based on the crash rate, the intersection is just under the critical crash rate indicating safety improvements should be considered.

Table 1 Intersection Crash History (2014-2018)

TH 210 at:	Crash Severity					Crash Rates	
	Fatal & Severity A	Severity B	Severity C	Property Damage	Total	Int. Rate	Critical Rate
13th Street/Gillis Avenue	0	2	11	38	51	**0.99**	1.01

PROPOSED CONDITIONS

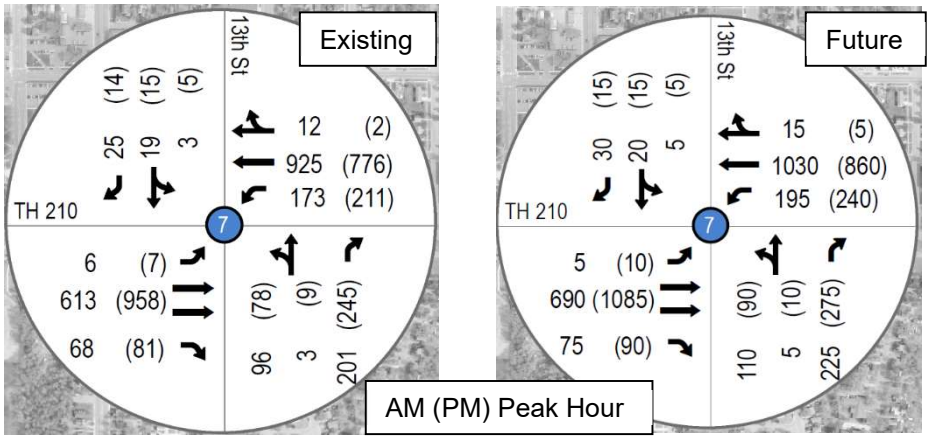
The current layout for the TH 210 corridor between Baxter Drive and Pine Shores Road addresses the needs and use of the roadway, improves pavement conditions, safety, and meets ADA requirements.

The TH 210 and 13th Street/Gillis Avenue intersection is located in a segment of the reconstruction project that will include mill and overlay west of the intersection on TH 210 to improve pavement conditions, and reconstruction of TH 210 to the east, with modifications for full ADA compliance and wider sidewalks. The westbound left turn lane will be extended to keep turning vehicles out of the TH 210 through lanes.

Future Traffic Volumes

Traffic forecasts were developed for the entire TH 210 corridor as part of the larger study effort. Future 2045 forecast volumes were developed based on a linear growth rate of 0.5% per year based on historical AADT volumes, population data, and input from the project team. **Figure 3** presents both the

Figure 3 Existing and Future 2045 Intersection Volumes



Warrant Analysis

Traffic control warrant analysis was conducted on the existing and future traffic volumes following the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) guidelines; all-way stop control warrants were not analyzed as it is not considered a viable control option along TH 210.

Warrants 1 (8-hour), 2 (4-hour), 3 (peak hour), and 7 (crash warrant) were included in the analysis. The following assumptions were used in the analysis:

- All minor street right turning volume was removed from the approaches.
- Warrant 7 was not applicable at the intersection due to insufficient correctable crashes.

The results of the traffic signal warrant analysis are provided in **Table 2**. The intersection currently meets Warrants 1, 2, and 3; the detailed signal warrant analysis is provided as **Attachment 3**.

Table 2 Traffic Signal Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Needed	Existing		Future 2045	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A – 8-hour Minimum Volume	8	0	Not Met	0	Not Met
Warrant 1B – 8-hour Interruption of Flow	8	6	Not Met**	**8**	**MET**
Combination of Warrant 1A and 1B	8	0	Not Met	1	Not Met
Warrant 2 – 4-hours	4	**5**	**MET**	**7**	**MET**
Warrant 3 – Peak Hour	1	**5**	**MET**	**6**	**MET**

Note: ** 80% thresholds for Warrant 1B are met for 10 hours in 2019, indicating the existing signal is justified based on the MnDOT Traffic Engineering Manual (TEM) guidance in Chapter 9, section 9-5.02.05.

System Limitations and Consistency

TH 210 is a principal arterial through the City of Brainerd that experiences heavy directional volumes in both the AM and PM peak hours, throughout the day, and in the summer months with high tourist traffic. The two adjacent major intersections are both currently signalized.

The study intersection is part of an existing TH 210 signal system coordinated to provide priority to the peak direction of flow, reduce mainline delays, and provide a high level of vehicle progression through the corridor. The coordinated signal system includes all existing traffic signals along TH 210 between TH 371, in the City of Baxter, and 4th Avenue NE in east Brainerd.

Due to limited right-of-way along the TH 210 corridor, expansion of the roadway to accommodate a larger intersection footprint is not feasible. Roundabout intersection control would result in major impacts to adjacent parcels and structures adjacent to the intersection and along the corridor.

In addition, both all-way stop control and roundabout control would alter the traffic flow along TH 210 and severely impede the progression of traffic from the adjacent coordinated signal systems.

Therefore, all-way stop and roundabout intersection control was not considered feasible for this intersection due to right-of-way limitations and the interruption to the existing coordinated signal system.

Traffic Operations

Evaluation of the intersection traffic operations were conducted as part of the overall corridor study using VISSIM software. The evaluation included analysis of the existing conditions, 2045 No Build conditions, and the recommended 2045 Build conditions, which included extending the westbound left turn lane at the intersection.

The average delay per vehicle and Level of Service (LOS) results for each approach and the overall intersection are provided in **Table 3** for each scenario; all three scenarios include traffic signal control. For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Table 3 Traffic Operations Summary

Scenario	Peak Hour	Approach Delay (sec/veh / LOS)				Intersection Delay (sec/veh / LOS)
		Eastbound	Westbound	Northbound	Southbound	
Existing Conditions	AM	6.7 / A	10.0 / B	23.8 / C	22.2 / C	11.1 / B
	PM	7.4 / A	16.4 / B	29.4 / C	33.7 / C	14.3 / B
2045 No Build Conditions	AM	5.3 / A	10.9 / B	24.0 / C	26.1 / C	11.2 / B
	PM	6.7 / A	19.6 / B	33.4 / C	**38.9 / D**	15.9 / B
2045 Build Conditions	AM	7.5 / A	13.6 / B	24.2 / C	25.6 / C	13.4 / B
	PM	7.9 / A	17.7 / B	33.7 / C	34.9 / C	15.7 / B

Based on the results, the intersection is expected to operate at a LOS B in all scenarios. The minor street approaches operate with longer delays due to the long cycle length required for coordination along TH 210.

Extending the westbound left turn lane to approximately 470 feet allows the queued left turning vehicles to stack without blocking the westbound through lanes. The extension does require the 1st Avenue NE intersection to be converted to a right-in/right-out (RI/RO) access. It should be noted; the Build conditions can operate slightly worse than the No Build conditions, this is due to more vehicles entering the intersection with improvements to the adjacent intersections along the corridor.

Pedestrian Considerations

The existing intersection provides crosswalks on all four legs of the intersection; however, the existing facilities are not ADA compliant.

As part of the TH 210 reconstruction project, the intersection will be improved to meet ADA requirements. New Accessible Pedestrian Systems (APS) pedestrian push buttons are proposed to be installed and made operational as part of this project, and all pedestrian curb ramps will be upgraded to be ADA compliant.

Revised Signal System

The existing signal system is vehicle actuated and coordinated along TH 210. The TH 210 left turn phases operate under protected phasing only; the minor street approaches only operate under permissive phasing.

As part of the signal replacement, the new signal system is to remain vehicle actuated and coordinated along TH 210. Both major TH 210 approaches will include Flashing Yellow Arrow (FYA) which provides the flexibility of running both protected and permissive phasing by time-of-day schedules and improves the overall safety of the intersection. The minor street approaches will remain under permissive phasing.

RECOMMENDATION

Based on the analysis included in this report, and as part of the larger TH 210 corridor study, it is recommended to retain traffic signal control at the intersection of TH 210 and 13th Street/Gillis Avenue.

Traffic signal control is currently warranted at the intersection and traffic operations are acceptable in both the existing conditions and future forecast year. The improvements at the existing intersection will continue to provide a safe intersection for all users.

Roundabout and all-way stop control was not considered feasible at this intersection due to potential right-of-way constraints and impacts, and the impact to the coordinated signal system that provides positive vehicle progression along TH 210.

Attachment 1: Turning Movement Data
Attachment 2: Crash Data
Attachment 3: Warrant Analysis

cc: Luke Wehseler, PE MnDOT District 3
Zachary Whitley, PE MnDOT District 3

File Name: TH 210 AND 13TH STREET
Start Date: 10/14/2019
Start Time: 6:00:00 AM
Site Code:
Comment 1:
Comment 2:
Comment 3:
Comment 4: TURN MOVEMENT COUNT

	Gillis Avenue Southbound				TH 210 Westbound				13th Street Northbound				TH 210 Eastbound			
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds
06:00 AM	0	4	0	0	17	54	0	0	5	0	20	0	1	52	4	0
06:15 AM	0	2	0	0	19	81	0	0	7	0	29	0	0	62	3	0
06:30 AM	1	3	1	1	38	109	0	1	7	0	30	0	0	86	11	0
06:45 AM	0	0	0	0	33	131	0	0	15	1	33	0	0	109	7	0
07:00 AM	0	2	4	1	23	145	1	0	9	0	34	0	0	85	4	0
07:15 AM	1	8	2	0	45	189	0	1	17	1	48	0	2	112	7	0
07:30 AM	1	5	8	0	49	261	1	1	36	0	57	1	0	165	16	0
07:45 AM	1	6	6	0	45	269	3	1	28	2	53	0	5	153	20	0
08:00 AM	0	6	7	0	40	218	4	1	13	0	40	0	0	148	18	0
08:15 AM	1	2	4	0	39	177	4	0	19	1	51	0	1	147	14	0
08:30 AM	0	0	5	0	31	175	1	0	20	0	33	0	0	122	10	0
08:45 AM	0	3	3	0	33	167	2	0	9	3	36	0	0	96	8	0
09:00 AM	1	1	3	0	22	133	0	0	9	0	27	0	2	117	8	0
09:15 AM	0	4	0	0	21	171	0	0	11	1	30	0	3	116	15	0
09:30 AM	0	2	3	0	24	162	0	0	9	1	32	0	2	140	8	0
09:45 AM	0	5	2	1	26	175	1	1	11	2	29	0	0	123	9	0
10:00 AM	0	1	3	0	15	180	2	1	8	1	43	0	1	140	7	0
10:15 AM	0	2	4	0	27	175	1	2	18	2	37	0	0	166	15	0
10:30 AM	0	5	2	0	28	184	1	0	18	3	37	0	1	119	9	0
10:45 AM	0	1	3	0	19	160	0	1	14	1	34	2	3	126	11	0
11:00 AM	1	4	2	1	31	165	0	0	16	1	40	2	2	163	5	0
11:15 AM	1	3	3	0	31	171	1	1	17	2	25	0	2	142	13	0
11:30 AM	0	4	4	0	34	164	0	0	14	2	29	0	3	167	13	0
11:45 AM	2	0	5	0	33	124	1	0	16	2	32	0	6	131	8	0
12:00 PM	0	2	5	0	36	207	1	0	13	5	47	2	7	221	16	0
12:15 PM	1	6	5	1	34	205	1	0	23	0	49	2	3	206	8	0
12:30 PM	1	5	5	1	45	228	2	1	19	1	49	0	4	174	9	0
12:45 PM	1	1	4	0	42	192	1	1	16	6	43	0	4	202	14	0
01:00 PM	1	3	10	1	29	205	0	1	15	2	40	0	6	206	14	0
01:15 PM	1	2	4	0	29	199	1	0	13	2	32	0	5	195	11	0
01:30 PM	0	6	2	0	32	154	0	0	13	0	34	0	6	178	5	0
01:45 PM	2	0	6	0	38	188	0	0	14	1	42	0	6	172	17	0
02:00 PM	0	2	4	0	30	193	3	0	18	2	50	0	1	217	13	0
02:15 PM	2	4	1	0	36	189	4	1	21	3	43	0	4	224	16	0
02:30 PM	1	3	10	0	38	201	0	0	18	3	55	1	4	253	17	0
02:45 PM	1	7	7	1	48	193	0	2	23	2	63	1	5	201	15	0
03:00 PM	2	8	5	0	38	239	0	0	18	3	45	0	2	252	17	0
03:15 PM	1	4	1	0	35	193	0	0	28	1	43	0	4	257	16	0
03:30 PM	0	1	1	1	48	262	0	1	24	3	50	0	3	268	12	0
03:45 PM	1	3	1	0	39	185	0	0	26	2	53	0	3	240	17	0
04:00 PM	4	3	5	0	49	218	3	0	16	3	54	0	1	261	19	0
04:15 PM	1	4	6	0	41	204	4	0	20	0	67	1	4	202	13	0
04:30 PM	1	5	4	0	44	180	0	1	21	6	66	0	2	269	17	0
04:45 PM	0	3	5	0	58	196	1	0	12	2	56	0	0	236	21	0
05:00 PM	3	3	3	0	45	233	0	0	28	1	66	0	4	243	22	0
05:15 PM	1	4	2	0	64	167	1	0	17	0	57	0	1	210	21	0
05:30 PM	2	3	3	2	52	179	0	0	21	1	52	0	2	200	23	0
05:45 PM	0	0	3	0	39	142	1	0	17	2	39	0	0	137	18	0

Intersection Safety Screening

Intersection: TH 210 at 13th Street-Gillis Avenue

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	2
Possible Injury	11
Property Damage	38
Total Crashes	51

Intersection Characteristics	
Entering Volume	28,160
Traffic Control	Signals
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $308,360

Statewide Comparison

Signals: high volume, low speed

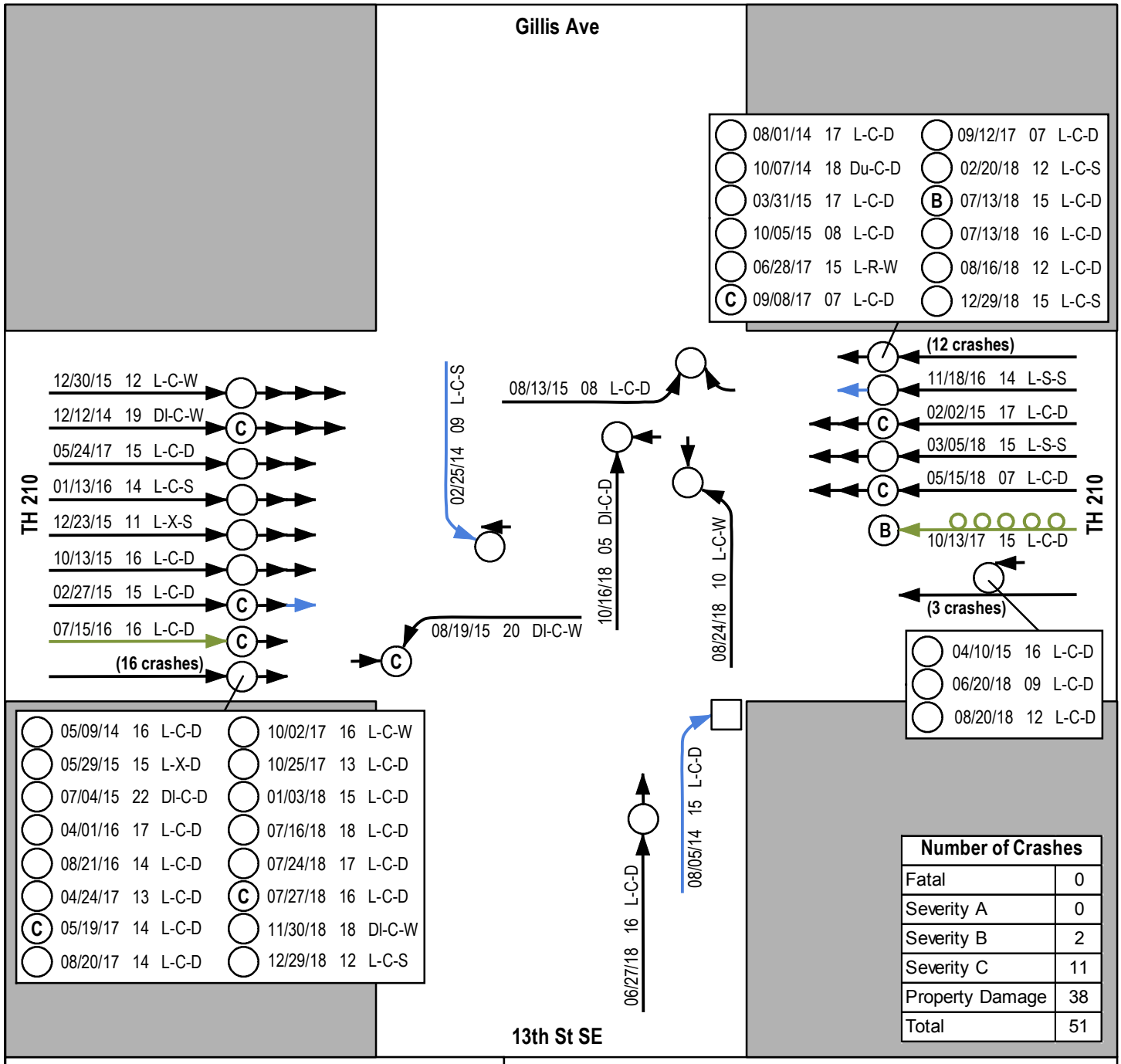
Total Crash Rate	
Observed	0.99
Statewide Average	0.70
Critical Rate	1.01
Critical Index	**0.98**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	3.30
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.99 per MEV; this is 2% below the critical rate. Based on similar statewide intersections, an additional 1 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	2
Severity C	11
Property Damage	38
Total	51

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
A Severity A
B Severity B
C Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → (Injury Type) → Other Vehicle(s)

Notes:

Path: C:\Traffic Projects\Brainerd- TH 210\Crashes\Crash Diagrams\A7_TH 210 at 13th St SE_Crash Diagram.mxd

Project: MNT03 152201
Print Date: 3/2/2020
Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at Gillis Ave/13th St SE
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A7

2019 Existing - TH 210 at 13th St SE/Gillis Ave
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 13th St SE/Gillis Ave
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	8940
35	Major App3:	TH 210 WB	3	10450
30	Minor App2:	13th St SE NB	1	877
30	Minor App4:	Gillis Ave SB	1	192

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	150	75	120

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	335	482	35	10	817	35	YES / NO	NO / NO	YES / NO
7:00 - 8:00	569	1031	93	24	1600	93	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	564	891	65	12	1455	65	YES / NO	YES / NO	YES / NO
9:00 - 10:00	543	735	44	13	1278	44	YES / NO	YES / NO	YES / NO
10:00 - 11:00	598	792	65	9	1390	65	YES / NO	YES / NO	YES / NO
11:00 - 12:00	655	755	70	15	1410	70	YES / NO	YES / NO	YES / NO
12:00 - 13:00	868	994	83	17	1862	83	YES / NO	**YES / YES**	YES / NO
13:00 - 14:00	821	875	60	15	1696	60	YES / NO	YES / NO	YES / NO
14:00 - 15:00	970	935	90	20	1905	90	YES / NO	**YES / YES**	YES / NO
15:00 - 16:00	1091	1039	105	20	2130	105	YES / NO	**YES / YES**	YES / NO
16:00 - 17:00	1045	998	80	21	2043	80	YES / NO	**YES / YES**	YES / NO
17:00 - 18:00	881	923	87	16	1804	87	YES / NO	**YES / YES**	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**8940**	**10450**	**877**	**192**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	6	8	Not satisfied
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	6	8	Not satisfied
1A & 1B	Combination of Warrants	0	8	Not satisfied
Warrant 2	**Four Hour Volumes**	**5**	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	**5**	1	**Satisfied**
Warrant 7	**Crash Experience**	**10**	8	Crashes Insufficient

COMMENTS:

2019 Existing - TH 210 at 13th St SE/Gillis Ave
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 13th St SE/Gillis Ave
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	8940
35	Major App3:	TH 210 WB	3	10450
30	Minor App2:	13th St SE NB	1	877
30	Minor App4:	Gillis Ave SB	1	192

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

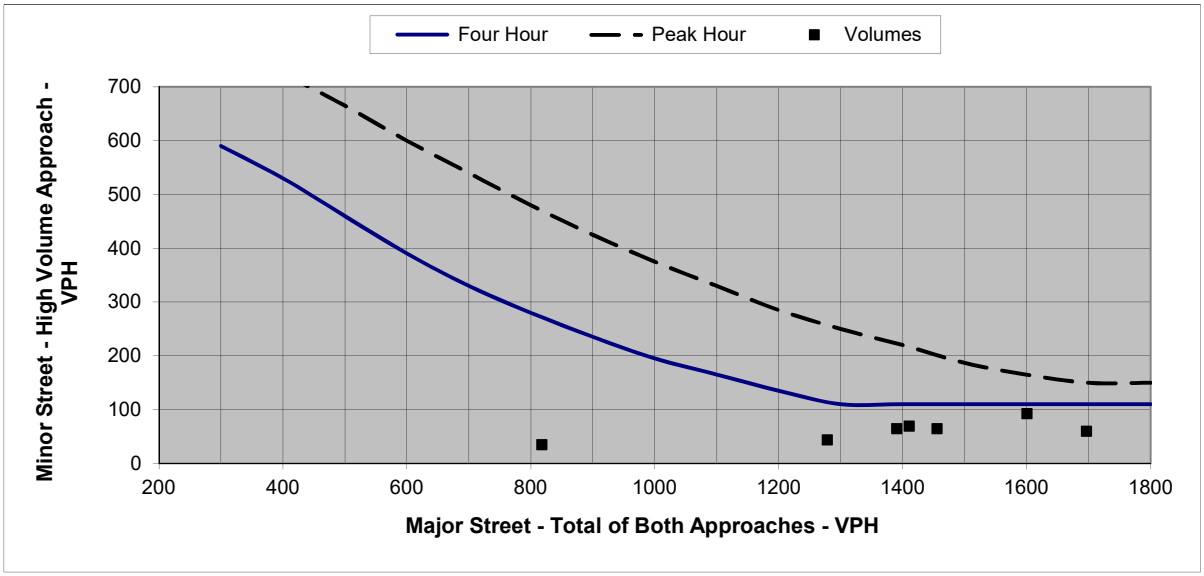


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major	Minor App.	Minor App.
Approach	Four Hour	Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrants Met: Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	817	35	NO	NO
7:00 - 8:00	1600	93	NO	NO
8:00 - 9:00	1455	65	NO	NO
9:00 - 10:00	1278	44	NO	NO
10:00 - 11:00	1390	65	NO	NO
11:00 - 12:00	1410	70	NO	NO
12:00 - 13:00	1862	83	**YES**	**YES**
13:00 - 14:00	1696	60	NO	NO
14:00 - 15:00	1905	90	**YES**	**YES**
15:00 - 16:00	2130	105	**YES**	**YES**
16:00 - 17:00	2043	80	**YES**	**YES**
17:00 - 18:00	1804	87	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

2019 Existing - TH 210 at 13th St SE/Gillis Ave
SIGNAL WARRANT
ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: TH 210 at 13th St SE/Gillis Ave
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	8940
35	Major App3:	TH 210 WB	3	10450
30	Minor App2:	13th St SE NB	1	877
30	Minor App4:	Gillis Ave SB	1	192

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

80%

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	480	720	576
Minor Approach	120	60	96

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	335	482	35	10	817	35	YES / NO	YES / NO	YES / NO
7:00 - 8:00	569	1031	93	24	1600	93	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	564	891	65	12	1455	65	YES / NO	**YES / YES**	YES / NO
9:00 - 10:00	543	735	44	13	1278	44	YES / NO	YES / NO	YES / NO
10:00 - 11:00	598	792	65	9	1390	65	YES / NO	**YES / YES**	YES / NO
11:00 - 12:00	655	755	70	15	1410	70	YES / NO	**YES / YES**	YES / NO
12:00 - 13:00	868	994	83	17	1862	83	YES / NO	**YES / YES**	YES / NO
13:00 - 14:00	821	875	60	15	1696	60	YES / NO	**YES / YES**	YES / NO
14:00 - 15:00	970	935	90	20	1905	90	YES / NO	**YES / YES**	YES / NO
15:00 - 16:00	1091	1039	105	20	2130	105	YES / NO	**YES / YES**	**YES / YES**
16:00 - 17:00	1045	998	80	21	2043	80	YES / NO	**YES / YES**	YES / NO
17:00 - 18:00	881	923	87	16	1804	87	YES / NO	**YES / YES**	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**8940**	**10450**	**877**	**192**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	**10**	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	**10**	8	**Satisfied**
1A & 1B	Combination of Warrants	1	8	Not satisfied

COMMENTS:

2045 Future - TH 210 at 13th St SE/Gillis Ave
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 13th St SE/Gillis Ave
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	10103
35	Major App3:	TH 210 WB	3	11806
30	Minor App2:	13th St SE NB	1	995
30	Minor App4:	Gillis Ave SB	1	220

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	150	75	120

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	378	544	40	12	922	40	YES / NO	YES / NO	YES / NO
7:00 - 8:00	644	1164	105	27	1808	105	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	638	1007	75	13	1645	75	YES / NO	**YES / YES**	YES / NO
9:00 - 10:00	614	830	50	15	1444	50	YES / NO	YES / NO	YES / NO
10:00 - 11:00	676	895	74	10	1571	74	YES / NO	YES / NO	YES / NO
11:00 - 12:00	740	853	78	18	1593	78	YES / NO	**YES / YES**	YES / NO
12:00 - 13:00	981	1124	94	19	2105	94	YES / NO	**YES / YES**	YES / NO
13:00 - 14:00	927	988	68	17	1915	68	YES / NO	YES / NO	YES / NO
14:00 - 15:00	1097	1056	102	23	2153	102	YES / NO	**YES / YES**	YES / NO
15:00 - 16:00	1233	1174	120	23	2407	120	YES / NO	**YES / YES**	**YES / YES**
16:00 - 17:00	1180	1127	91	24	2307	91	YES / NO	**YES / YES**	YES / NO
17:00 - 18:00	995	1044	98	19	2039	98	YES / NO	**YES / YES**	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10103**	**11806**	**995**	**220**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	**8**	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	0	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	**8**	8	**Satisfied**
1A & 1B	Combination of Warrants	1	8	Not satisfied
Warrant 2	**Four Hour Volumes**	**7**	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	**6**	1	**Satisfied**
Warrant 7	**Crash Experience**	**10**	8	Crashes Insufficient

COMMENTS:

2045 Future - TH 210 at 13th St SE/Gillis Ave
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at 13th St SE/Gillis Ave
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	10103
35	Major App3:	TH 210 WB	3	11806
30	Minor App2:	13th St SE NB	1	995
30	Minor App4:	Gillis Ave SB	1	220

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

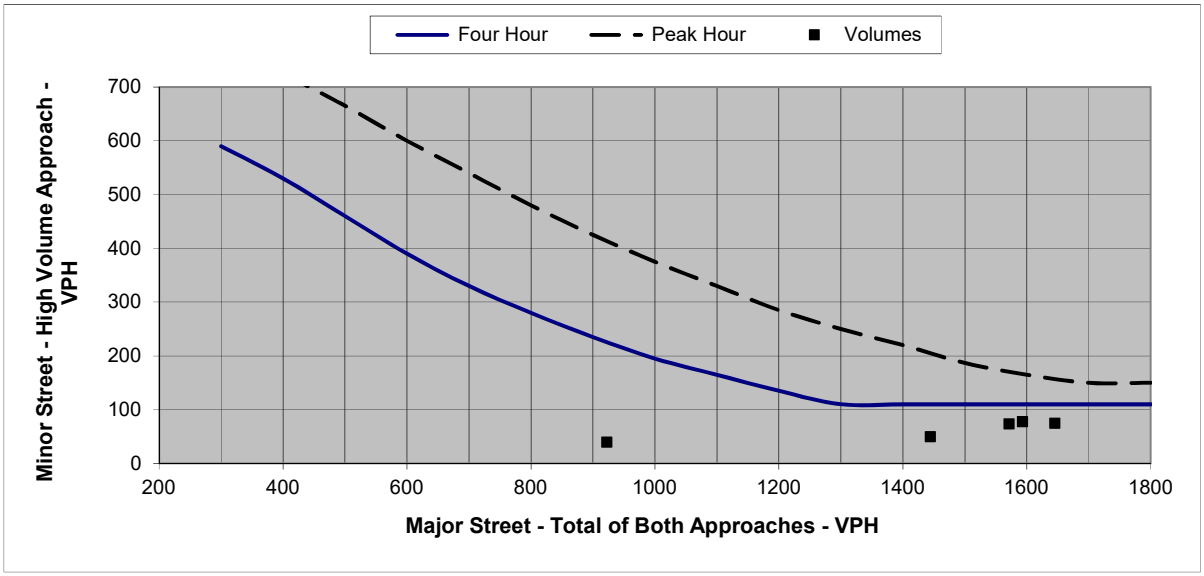


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	922	40	NO	NO
7:00 - 8:00	1808	105	**YES**	**YES**
8:00 - 9:00	1645	75	NO	NO
9:00 - 10:00	1444	50	NO	NO
10:00 - 11:00	1571	74	NO	NO
11:00 - 12:00	1593	78	NO	NO
12:00 - 13:00	2105	94	**YES**	**YES**
13:00 - 14:00	1915	68	**YES**	NO
14:00 - 15:00	2153	102	**YES**	**YES**
15:00 - 16:00	2407	120	**YES**	**YES**
16:00 - 17:00	2307	91	**YES**	**YES**
17:00 - 18:00	2039	98	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

MEMORANDUM

TO: Ken Hansen, PE
MnDOT District 3 Traffic Engineer

FROM: Graham Johnson, PE, PTOE (Lic.MN, IA, SD)
Justin Anibas, PE (Lic. MN)

DATE: August 9, 2022

RE: TH 210 at N 4th Street Intersection Control Evaluation (ICE) Report
SEH No. MNT03 152201 14.00

INTRODUCTION

This memorandum summarizes the Intersection Control Evaluation (ICE) process for the intersection of Trunk Highway (TH) 210 and N 4th Street in Brainerd, Minnesota. The Minnesota Department of Transportation (MnDOT) ICE is an objective process used to investigate and determine the optimal traffic control that should be provided at an intersection to serve the existing conditions and future needs. This memorandum was prepared for MnDOT by SEH Inc.

As part of a project along TH 210 between Baxter Drive and Pine Shores Road, the intersection of TH 210 and N 4th Street was evaluated and is proposed to remain under traffic signal control after the project is complete.

The location of the study intersection for this ICE report is shown in **Figure 1**. The proposed intersection control for the TH 210 and N 4th Street intersection was analyzed based on safety, signal warrants, traffic operations, and pedestrian and bicycle accommodations.

The scope and content of this ICE report was reviewed and agreed to by MnDOT prior to the layout and ICE submittal process. This report summarizes the ICE process and recommendation for the TH 210 and N 4th Street intersection based on a Phase I analysis according to the *2017 MnDOT ICE Manual*.

APPROVAL

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.

_____ _____
Graham Johnson, PE, PTOE, MN License No. 45429 Date

Approved By:

_____ _____
MnDOT District 3 Traffic Engineer Date

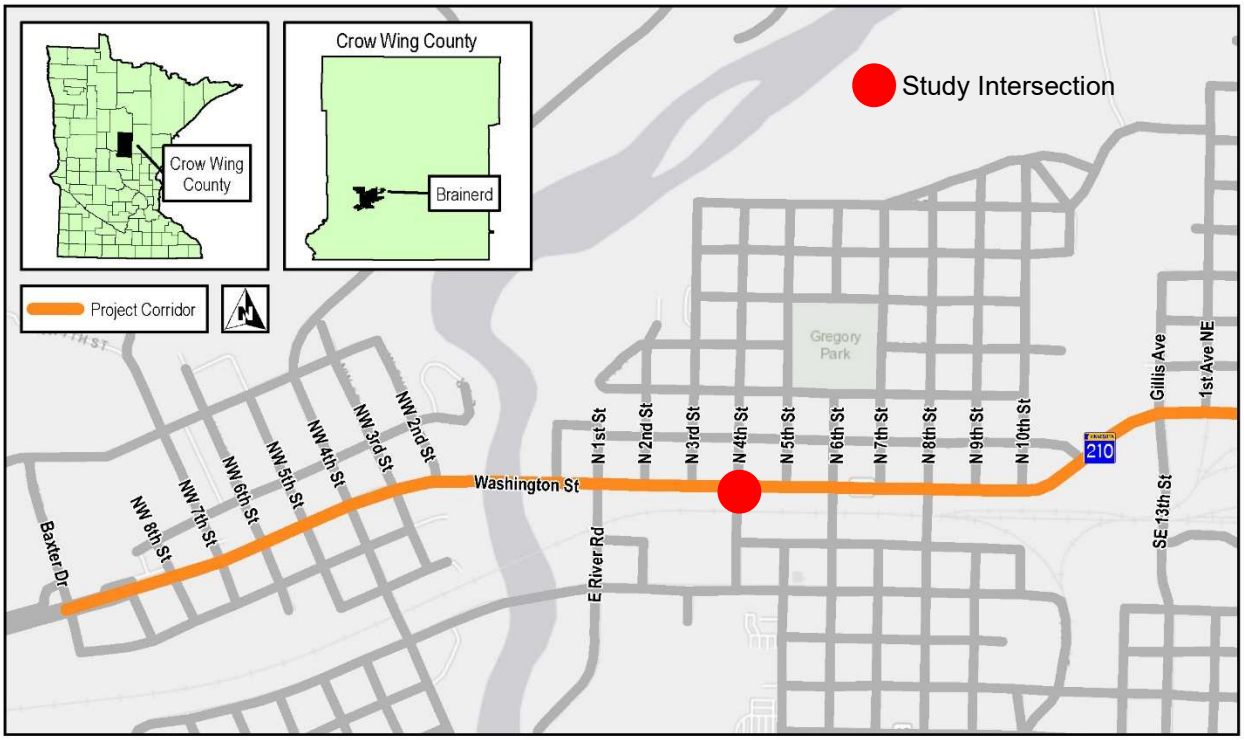
PROJECT DESCRIPTION

MnDOT is conducting the corridor planning study along a 3.9-mile segment of TH 210 to identify the future vision for highway corridor through Brainerd. Reconstruction of TH 210 between Baxter Drive and Pine Shores Road is anticipated to begin in 2025; SP 1805-80.

The primary purpose of the corridor study is to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout. The focus of the improvements is to improve pavement conditions and traveler safety, accommodate the Americans with Disabilities Act (ADA) requirements, and enhance pedestrian accommodations.

For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Figure 1 Project Location



EXISTING CONDITIONS

TH 210 is a major east-west principal arterial through the City of Brainerd that connects near-by cities and regional commerce. TH 210 is generally a 4-lane divided roadway through the City of Brainerd; the posted speed limit is 35 miles-per-hour (mph) at the study intersection.

N 4th Street is a major collector providing access to commercial land uses to the south, the downtown business district, and residential land uses to the north of TH 210; the posted speed limit is 30 mph.

The nearest existing traffic signals along TH 210 include NW 4th Avenue approximately 3,200 feet west and N 6th Street approximately 750 feet east.

Intersection Characteristics

The existing intersection currently operates with traffic signal control and includes marked pedestrian crossings on all four legs. Eastbound and westbound TH 210 left turns operate with protected left turn phasing only, while the minor street approach left turns operate with protected and permissive left turn phasing.

The existing lane geometrics are described below and shown in **Figure 2**.

- Eastbound Approach: left turn lane, one through lane, and a shared through-right lane.
- Westbound Approach: left turn lane, one through lane, and a shared through-right lane.
- Northbound Approach: separate left, through, and right turn lanes.
  - Approach storage lanes are limited due to proximity of railroad crossing.
- Southbound Approach: separate left, and a shared through-right lane.

Figure 2 Existing Intersection

Traffic Volumes

TH 210 has an existing 2019 Average Annual Daily Traffic (AADT) volume of 32,500 vehicles west of the intersection and 26,000 to the east. N 4th Street has an existing 2019 AADT of 2,400 vehicles to the north and 4,200 vehicles to the south.

The existing intersection turning movement data was collected in August of 2018 as part of a signal timing project along TH 210 and TH 371. **Figure 3** includes the existing AM and PM peak hour volumes; **Attachment 1** includes the raw existing intersection count data.

Crash Analysis

Intersection crash data for the study intersection was collected from the MnDOT Crash Mapping Analysis Tool (MnCMATv2) for a five-year period between 2014 and 2018 as part of the larger corridor study.

The crash rate at an intersection is expressed as a number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be further reviewed.

The intersection had a total of 49 crashes during the 5-year analysis period:

- 41 of the 49 crashes were rear end crashes: 25 of the rear end crashes were in the eastbound direction and 15 were in the westbound direction, and 1 southbound. This could indicate that backups are worse for eastbound vehicles and influenced by the high right turn volume in the shared through-right lane.

Table 1 summarizes the crashes for the study intersection; additional crash information is provided in **Attachment 2**. Based on the crash rate, the intersection does not exceed the critical crash rate.

Table 1 Intersection Crash History (2014-2018)

TH 210 at:	Crash Severity					Crash Rates	
	Fatal & Severity A	Severity B	Severity C	Property Damage	Total	Int. Rate	Critical Rate
N 4th Street	0	1	9	39	49	0.87	0.99

PROPOSED CONDITIONS

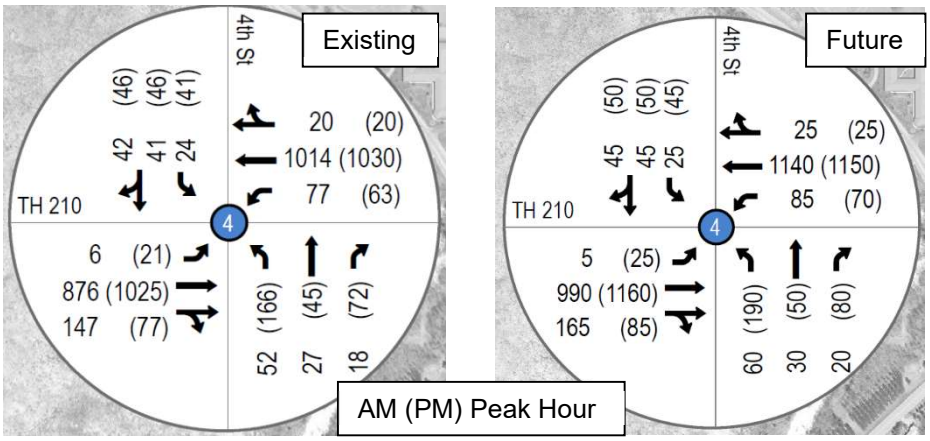
The current layout for the TH 210 corridor between Baxter Drive and Pine Shores Road addresses the needs and use of the roadway, improves pavement conditions, safety, and meets ADA requirements.

The TH 210 and N 4th Street intersection is located in a segment of the project that will primarily include reconstruction of the roadway, with modifications for full ADA compliance, wider sidewalks, and medians. Lane improvements include extending the eastbound and westbound left turn lanes on TH 210.

Future Traffic Volumes

Traffic forecasts were developed for the entire TH 210 corridor as part of the larger study effort. Future 2045 forecast volumes were developed based on a linear growth rate of 0.5% per year based on historical AADT volumes, population data, and input from the project team. **Figure 3** presents both the existing and future 2045 AM and PM peak intersection volumes.

Figure 3 Existing and Future 2045 Intersection Volumes



Warrant Analysis

Traffic control warrant analysis was conducted on the existing and future traffic volumes following the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) guidelines; all-way stop control warrants were not analyzed as it is not considered a viable control option along TH 210.

Warrants 1 (8-hour), 2 (4-hour), 3 (peak hour), and 7 (crash warrant) were included in the analysis. The following assumptions were used in the analysis:

- All minor street right turning volume was removed from the approaches.
- Warrant 7 was not applicable at the intersection due to insufficient correctable crashes.

The results of the traffic signal warrant analysis are provided in **Table 2**. The intersection currently meets Warrants 1, 2, and 3; the detailed signal warrant analysis is provided as **Attachment 3**.

Table 2 Traffic Signal Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Needed	Existing		Future 2045	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A – 8-hour Minimum Volume	8	3	Not Met	6	Not Met
Warrant 1B – 8-hour Interruption of Flow	8	**10**	**MET**	**10**	**MET**
Combination of Warrant 1A and 1B	8	7	Not Met	**8**	**MET**
Warrant 2 – 4-hours	4	**10**	**MET**	**11**	**MET**
Warrant 3 – Peak Hour	1	**9**	**MET**	**9**	**MET**

System Limitations and Consistency

TH 210 is a principal arterial through the City of Brainerd that experiences heavy directional volumes in both the AM and PM peak hours, throughout the day, and in the summer months with high tourist traffic. The two adjacent major intersections are both currently signalized.

The study intersection is part of an existing TH 210 signal system coordinated to provide priority to the peak direction of flow, reduce mainline delays, and provide a high level of vehicle progression through the corridor. The coordinated signal system includes all existing traffic signals along TH 210 between TH 371, in the City of Baxter, and 4th Avenue NE in east Brainerd.

Due to limited right-of-way along the TH 210 corridor, expansion of the roadway to accommodate a larger intersection footprint is not feasible. Roundabout intersection control would result in major impacts to adjacent parcels and structures adjacent to the intersection and along the corridor.

In addition, both all-way stop control and roundabout control would alter the traffic flow along TH 210 and severely impede the progression of traffic from the adjacent coordinated signal systems.

Therefore, all-way stop and roundabout intersection control was not considered feasible for this intersection due to right-of-way limitations and the interruption to the existing coordinated signal system.

Traffic Operations

Evaluation of the intersection traffic operations were conducted as part of the overall corridor study using VISSIM software. The evaluation included analysis of the existing conditions, 2045 No Build conditions,

and the recommended 2045 Build conditions, which included extending the eastbound and westbound left turn lanes on TH 210.

The average delay per vehicle and Level of Service (LOS) results for each approach and the overall intersection are provided in **Table 3** for each scenario; all three scenarios include traffic signal control. For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Table 3 Traffic Operations Summary

Scenario	Peak Hour	Approach Delay (sec/veh / LOS)				Intersection Delay (sec/veh / LOS)
		Eastbound	Westbound	Northbound	Southbound	
Existing Conditions	AM	14.4 / B	5.5 / A	**36.7 / D**	**38.2 / D**	12.3 / B
	PM	11.5 / B	8.1 / A	**41.4 / D**	**47.7 / D**	15.3 / B
2045 No Build Conditions	AM	11.0 / B	7.4 / A	**37.7 / D**	**36.4 / D**	11.6 / B
	PM	15.0 / B	7.9 / A	**44.5 / D**	**52.0 / D**	17.3 / B
2045 Build Conditions	AM	15.4 / B	10.6 / B	34.3 / C	34.2 / C	14.8 / B
	PM	21.2 / C	9.3 / A	**41.2 / D**	**49.8 / D**	20.0 / C

Based on the results, the intersection is expected to operate at a LOS B or better in all scenarios. The minor street approaches operate with longer delays due to the long cycle length required for coordination along TH 210.

Extending the eastbound and westbound left turn lanes allows vehicles to enter the storage lane without being blocked by the through vehicle queues. It should be noted; the Build conditions can operate slightly worse than the No Build conditions, this is due to more vehicles entering the intersection with improvements to the adjacent intersections along the corridor.

Pedestrian Considerations

The existing intersection provides crosswalks on all four legs of the intersection; however, the existing facilities are not ADA compliant.

As part of the TH 210 reconstruction project, the intersection will be improved to meet ADA requirements. New Accessible Pedestrian Systems (APS) pedestrian push buttons are proposed to be installed and made operational as part of this project, and all pedestrian curb ramps will be upgraded to be ADA compliant.

Revised Signal System

The existing signal system is vehicle actuated and coordinated along TH 210. The TH 210 left turn phases operate under protected phasing only; the minor street approaches have both protected and permissive left turn phasing.

As part of the signal replacement, the new signal system is to remain vehicle actuated and coordinated along TH 210. All four approaches will include Flashing Yellow Arrow (FYA) which provides the flexibility of running both protected and permissive phasing by time-of-day schedules on all approaches and improves the overall safety of the intersection.

RECOMMENDATION

Based on the analysis included in this report, and as part of the larger TH 210 corridor study, it is recommended to retain traffic signal control at the intersection of TH 210 and N 4th Street.

Traffic signal control is currently warranted at the intersection and traffic operations are acceptable in both the existing conditions and future forecast year. The improvements at the existing intersection will continue to provide a safe intersection for all users.

Roundabout and all-way stop control was not considered feasible at this intersection due to potential right-of-way constraints and impacts, and the impact to the coordinated signal system that provides positive vehicle progression along TH 210.

Attachment 1: Turning Movement Data
Attachment 2: Crash Data
Attachment 3: Warrant Analysis

cc: Luke Wehseler, PE MnDOT District 3
Zachary Whitley, PE MnDOT District 3

File Name: S:\2018\180119\TO OTHERS\TMC\PETRO\344_TH 210 AND 4TH STREET.ppd
Start Date: 8/23/2018
Start Time: 6:00:00 AM
Site Code: 00000344
Comment 1: 344_TH 210 AND 4TH STREET
Comment 2: 0
Comment 3: data by: Alliant Inc
Comment 4: TURN MOVEMENT COUNT

	N 4TH STREET Southbound				TH 210 Westbound				N 4TH STREET Northbound				TH 210 Eastbound			
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds
06:00 AM	1	1	0	0	5	73	1	0	5	2	0	1	0	49	4	0
06:15 AM	1	2	3	0	2	70	0	0	7	3	2	0	1	65	5	0
06:30 AM	4	3	7	0	6	115	9	0	8	4	6	0	0	112	17	0
06:45 AM	2	5	3	0	4	151	7	0	9	7	4	0	4	107	12	1
07:00 AM	1	6	5	0	4	104	1	0	4	5	4	0	1	106	19	0
07:15 AM	2	8	8	1	13	154	13	2	6	9	4	0	2	132	20	0
07:30 AM	8	7	15	0	11	179	7	0	6	8	4	0	2	161	25	0
07:45 AM	9	17	10	1	26	221	4	0	14	7	5	0	3	170	49	3
08:00 AM	5	8	10	0	20	183	6	0	16	3	3	0	1	130	30	0
08:15 AM	2	9	7	0	20	168	3	1	16	9	6	0	0	134	18	0
08:30 AM	4	5	6	1	17	159	4	2	18	7	5	0	2	143	27	1
08:45 AM	7	3	9	0	13	141	3	1	29	11	12	0	4	156	33	0
09:00 AM	3	9	9	1	19	191	2	3	28	4	10	0	5	125	17	0
09:15 AM	6	3	4	1	12	181	10	1	23	4	9	0	2	140	20	1
09:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 AM	6	4	11	0	19	226	3	1	34	10	10	0	0	116	12	0
10:45 AM	8	10	4	2	16	223	5	1	39	13	10	1	5	117	8	1
11:00 AM	9	7	10	0	14	210	7	3	42	12	27	3	2	122	5	0
11:15 AM	6	14	14	0	19	183	6	2	36	16	22	0	5	124	7	7
11:30 AM	14	15	12	0	21	221	2	4	35	16	18	0	2	118	6	0
11:45 AM	9	14	3	1	24	233	5	0	37	16	16	0	2	131	5	0
12:00 PM	9	11	14	1	17	209	5	0	45	20	23	0	6	132	9	1
12:15 PM	8	9	8	2	15	239	7	3	33	15	30	0	2	122	7	2
12:30 PM	11	11	5	0	17	238	6	2	43	7	10	0	1	131	6	3
12:45 PM	8	12	12	1	27	216	8	0	33	17	19	0	4	124	15	1
01:00 PM	9	18	12	2	21	192	8	2	33	9	19	0	2	105	9	0
01:15 PM	8	12	9	1	21	201	2	0	35	20	26	1	2	110	4	0
01:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:30 PM	7	12	13	3	20	212	12	0	36	10	20	0	3	193	15	3
02:45 PM	8	22	4	0	9	195	8	0	31	14	19	0	3	194	19	0
03:00 PM	16	9	7	0	16	182	5	0	26	8	16	0	8	211	14	2
03:15 PM	15	10	8	1	17	187	4	2	31	15	11	0	3	253	27	5
03:30 PM	19	14	12	0	16	235	6	1	36	11	22	0	4	189	22	2
03:45 PM	14	10	13	0	12	217	5	3	37	7	10	1	4	210	17	2
04:00 PM	14	16	6	1	13	219	6	0	39	15	11	0	4	207	20	0
04:15 PM	9	15	4	1	16	222	2	1	41	14	17	0	4	252	12	4
04:30 PM	14	15	15	2	19	266	6	0	56	15	31	1	0	227	12	1
04:45 PM	5	8	12	0	16	238	3	1	37	12	15	0	7	243	22	0
05:00 PM	11	10	12	0	12	278	6	1	39	11	11	2	8	225	19	1
05:15 PM	11	13	7	2	16	234	5	0	34	7	15	1	6	240	12	0
05:30 PM	11	6	7	0	10	210	4	0	21	10	11	0	4	189	8	0
05:45 PM	8	3	6	1	7	183	0	0	18	8	13	0	5	210	7	3

Intersection Safety Screening

Intersection: TH 210 at N 4th Street

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	1
Possible Injury	9
Property Damage	39
Total Crashes	49

Intersection Characteristics	
Entering Volume	30,750
Traffic Control	Signals
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $242,680

Statewide Comparison

Signals: high volume, low speed

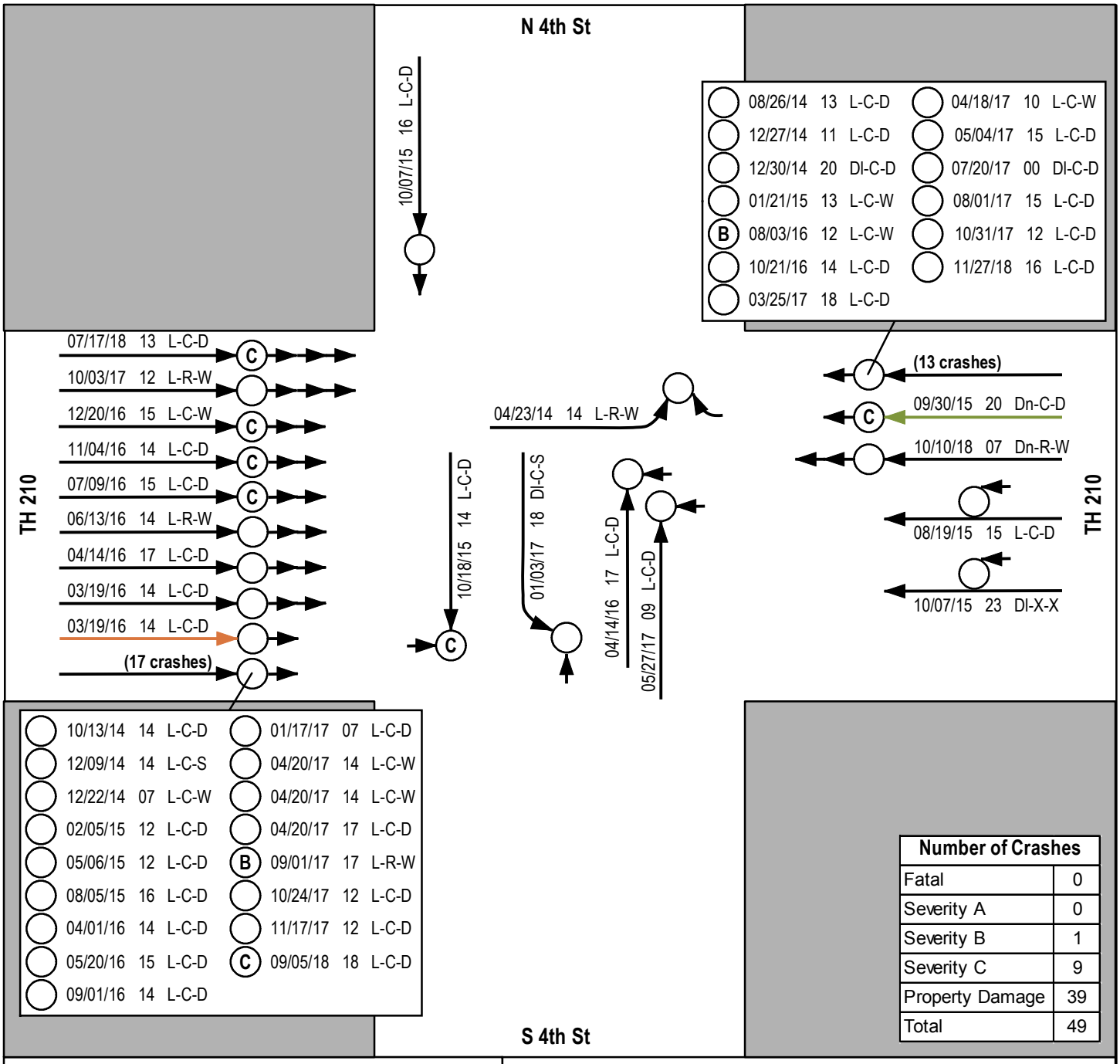
Total Crash Rate	
Observed	0.87
Statewide Average	0.70
Critical Rate	0.99
Critical Index	**0.88**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	3.15
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.87 per MEV; this is 12% below the critical rate. Based on similar statewide intersections, an additional 7 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	1
Severity C	9
Property Damage	39
Total	49

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:

Path: C:\Traffic Projects\Brainerd- TH 210\Crashes\Crash Diagrams\A4_TH 210 at N 4th St_Crash Diagrams.mxd

Project: MNT03 152201
Print Date: 3/2/2020

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at N 4th St

TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A4

2019 Existing - TH 210 at N 4th ST
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 4th ST
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach Description		Lanes	Approach
35	Major App1:	TH 210 EB	3	10622
35	Major App3:	TH 210 WB	3	11517
30	Minor App2:	N 4th St NB	2	1877
30	Minor App4:	N 4th St SB	2	858

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	453	505	45	19	958	45	YES / NO	YES / NO	YES / NO
7:00 - 8:00	973	929	59	58	1902	59	YES / NO	YES / NO	YES / NO
8:00 - 9:00	868	1017	109	43	1885	109	YES / NO	**YES / YES**	YES / NO
9:00 - 10:00	712	823	129	45	1535	129	YES / NO	**YES / YES**	YES / NO
10:00 - 11:00	793	940	185	55	1733	185	YES / NO	**YES / YES**	**YES / YES**
11:00 - 12:00	786	1026	210	88	1812	210	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	911	1085	213	79	1996	213	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	865	990	194	96	1855	194	YES / NO	**YES / YES**	**YES / YES**
14:00 - 15:00	1036	1025	185	99	2061	185	YES / NO	**YES / YES**	**YES / YES**
15:00 - 16:00	1111	1128	171	107	2239	171	YES / NO	**YES / YES**	**YES / YES**
16:00 - 17:00	1114	1102	229	96	2216	229	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	1000	947	148	73	1947	148	YES / NO	**YES / YES**	YES / NO
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10622**	**11517**	**1877**	**858**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	**10**	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	3	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	**10**	8	**Satisfied**
1A & 1B	Combination of Warrants	7	8	Not satisfied
Warrant 2	**Four Hour Volumes**	**10**	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	**9**	1	**Satisfied**
Warrant 7	**Crash Experience**	**10**	8	Crashes Insufficient

COMMENTS:

2019 Existing - TH 210 at N 4th ST
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 4th ST
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	10622
35	Major App3:	TH 210 WB	3	11517
30	Minor App2:	N 4th St NB	2	1877
30	Minor App4:	N 4th St SB	2	858

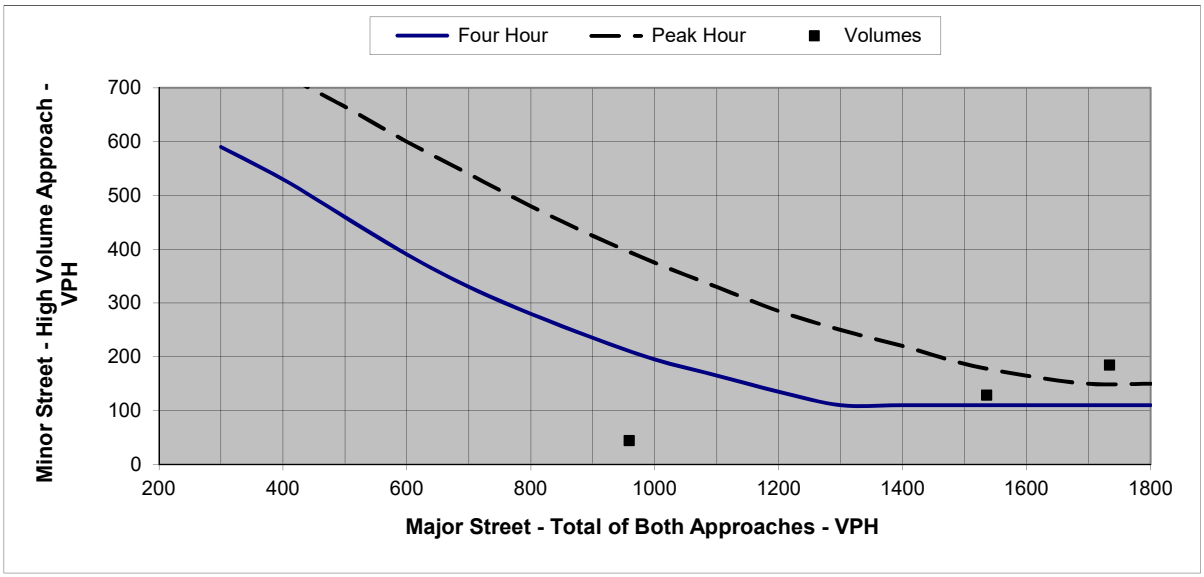


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	958	45	NO	NO
7:00 - 8:00	1902	59	NO	NO
8:00 - 9:00	1885	109	**YES**	**YES**
9:00 - 10:00	1535	129	**YES**	NO
10:00 - 11:00	1733	185	**YES**	**YES**
11:00 - 12:00	1812	210	**YES**	**YES**
12:00 - 13:00	1996	213	**YES**	**YES**
13:00 - 14:00	1855	194	**YES**	**YES**
14:00 - 15:00	2061	185	**YES**	**YES**
15:00 - 16:00	2239	171	**YES**	**YES**
16:00 - 17:00	2216	229	**YES**	**YES**
17:00 - 18:00	1947	148	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at N 4th ST
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 4th ST
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	12005
35	Major App3:	TH 210 WB	3	13016
30	Minor App2:	N 4th St NB	2	2119
30	Minor App4:	N 4th St SB	2	968

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	512	572	51	21	1084	51	YES / NO	YES / NO	YES / NO
7:00 - 8:00	1100	1050	67	65	2150	67	YES / NO	YES / NO	YES / NO
8:00 - 9:00	981	1150	122	48	2131	122	YES / NO	**YES / YES**	YES / NO
9:00 - 10:00	805	930	146	51	1735	146	YES / NO	**YES / YES**	YES / NO
10:00 - 11:00	896	1062	209	62	1958	209	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	889	1160	238	100	2049	238	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	1030	1225	241	90	2255	241	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	977	1119	218	109	2096	218	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	1171	1159	209	111	2330	209	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1255	1274	193	120	2529	193	YES / NO	**YES / YES**	**YES / YES**
16:00 - 17:00	1259	1245	258	109	2504	258	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	1130	1070	167	82	2200	167	YES / NO	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**12005**	**13016**	**2119**	**968**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	**10**	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	6	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	**10**	8	**Satisfied**
1A & 1B	Combination of Warrants	**8**	8	**Satisfied**
Warrant 2	**Four Hour Volumes**	**11**	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	**9**	1	**Satisfied**
Warrant 7	**Crash Experience**	**10**	8	Crashes Insufficient

COMMENTS:

2045 Future - TH 210 at N 4th ST
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 4th ST
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	12005
35	Major App3:	TH 210 WB	3	13016
30	Minor App2:	N 4th St NB	2	2119
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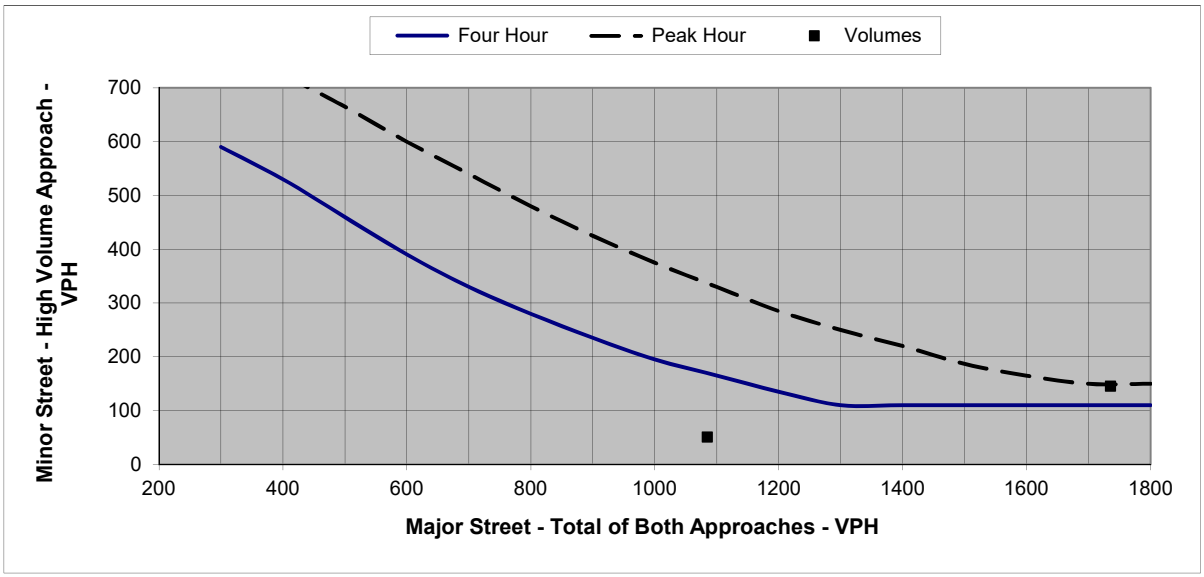


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	1084	51	NO	NO
7:00 - 8:00	2150	67	**YES**	NO
8:00 - 9:00	2131	122	**YES**	**YES**
9:00 - 10:00	1735	146	**YES**	NO
10:00 - 11:00	1958	209	**YES**	**YES**
11:00 - 12:00	2049	238	**YES**	**YES**
12:00 - 13:00	2255	241	**YES**	**YES**
13:00 - 14:00	2096	218	**YES**	**YES**
14:00 - 15:00	2330	209	**YES**	**YES**
15:00 - 16:00	2529	193	**YES**	**YES**
16:00 - 17:00	2504	258	**YES**	**YES**
17:00 - 18:00	2200	167	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

MEMORANDUM

TO: Ken Hansen, PE
MnDOT District 3 Traffic Engineer

FROM: Graham Johnson, PE, PTOE (Lic.MN, IA, SD)
Justin Anibas, PE (Lic. MN)

DATE: August 9, 2022

RE: TH 210 at N 6th Street Intersection Control Evaluation (ICE) Report
SEH No. MNT03 152201 14.00

INTRODUCTION

This memorandum summarizes the Intersection Control Evaluation (ICE) process for the intersection of Trunk Highway (TH) 210 and N 6th Street in Brainerd, Minnesota. The Minnesota Department of Transportation (MnDOT) ICE is an objective process used to investigate and determine the optimal traffic control that should be provided at an intersection to serve the existing conditions and future needs. This memorandum was prepared for MnDOT by SEH Inc.

As part of a project along TH 210 between Baxter Drive and Pine Shores Road, the intersection of TH 210 and N 6th Street was evaluated and is proposed to remain under traffic signal control after the project is complete.

The location of the study intersection for this ICE report is shown in **Figure 1**. The proposed intersection control for the TH 210 and N 6th Street intersection was analyzed based on safety, signal warrants, traffic operations, and pedestrian and bicycle accommodations.

The scope and content of this ICE report was reviewed and agreed to by MnDOT prior to the layout and ICE submittal process. This report summarizes the ICE process and recommendation for the TH 210 and N 6th Street intersection based on a Phase I analysis according to the *2017 MnDOT ICE Manual*.

APPROVAL

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.

_____ _____
Graham Johnson, PE, PTOE, MN License No. 45429 Date

Approved By:

_____ _____
MnDOT District 3 Traffic Engineer Date

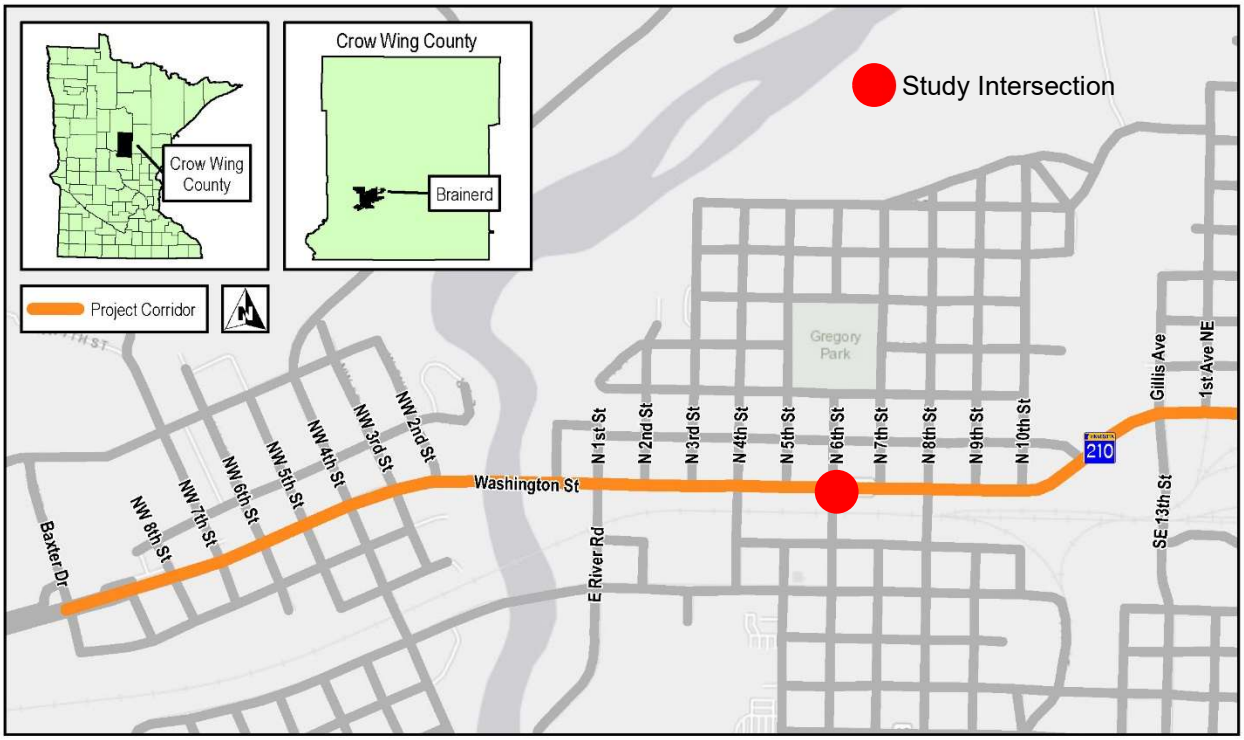
PROJECT DESCRIPTION

MnDOT is conducting the corridor planning study along a 3.9-mile segment of TH 210 to identify the future vision for highway corridor through Brainerd. Reconstruction of TH 210 between Baxter Drive and Pine Shores Road is anticipated to begin in 2025; SP 1805-80.

The primary purpose of the corridor study is to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout. The focus of the improvements is to improve pavement conditions and traveler safety, accommodate the Americans with Disabilities Act (ADA) requirements, and enhance pedestrian accommodations.

For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Figure 1 Project Location



EXISTING CONDITIONS

TH 210 is a major east-west principal arterial through the City of Brainerd that connects near-by cities and regional commerce. TH 210 is generally a 4-lane divided roadway through the City of Brainerd; the posted speed limit is 35 miles-per-hour (mph) at the study intersection.

N 6th Street is a principal arterial to the south, providing a regional connection to TH 371 via TH 371B and access to commercial and residential land uses; to the north it is a local roadway providing access to residential land uses; the posted speed limit is 30 mph.

The nearest existing traffic signals along TH 210 include N 4th Street approximately 750 feet west and N 8th Street approximately 750 feet east.

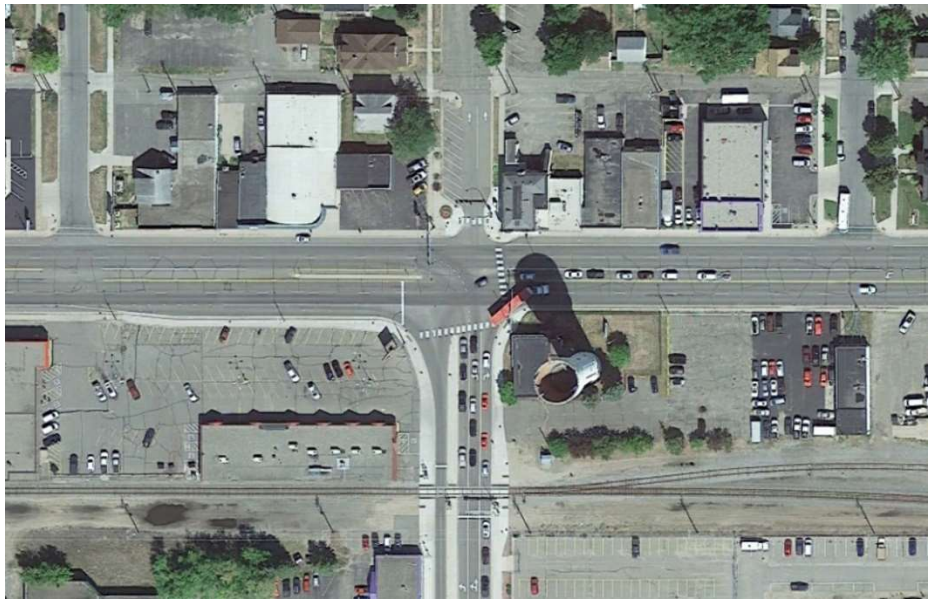
Intersection Characteristics

The existing intersection currently operates with traffic signal control and includes marked pedestrian crossings on three legs; no crossing provided on the west leg. Westbound TH 210 left turns operate with protected left turn phasing only, the eastbound left turn movement is not allowed. With no southbound approach, the northbound approach operates on its own protected phasing.

The existing lane geometrics are described below and shown in **Figure 2**.

- Eastbound Approach: two through lanes, and a right turn lane; no left turns allowed.
- Westbound Approach: left turn lane, one through lane, and a shared through-right lane.
- Northbound Approach: separate left, a shared left-through, and right turn lane.
  - Approach storage lanes are limited due to proximity of railroad crossing.
- Southbound Approach: no approach movements provided.

Figure 2 Existing Intersection



Traffic Volumes

TH 210 has an existing 2019 Average Annual Daily Traffic (AADT) volume of 26,000 vehicles on both the east and west side of the intersection. N 6th Street has an existing 2019 AADT of 11,000 vehicles to the south, no posted AADT on the north leg.

The existing intersection turning movement data was collected in November of 2018 as part of a signal timing project along TH 210 and TH 371. **Figure 3** includes the existing AM and PM peak hour volumes; **Attachment 1** includes the raw existing intersection count data.

Crash Analysis

Intersection crash data for the study intersection was collected from the MnDOT Crash Mapping Analysis Tool (MnCMATv2) for a five-year period between 2014 and 2018 as part of the larger corridor study.

The crash rate at an intersection is expressed as a number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be further reviewed.

The intersection had a total of 61 crashes during the 5-year analysis period:

- 40 of the 61 crashes were rear end crashes: 20 of the rear end crashes were in the eastbound direction and 17 were in the westbound direction, and 3 northbound.
- 12 of the 61 crashes were side-swipe collisions, likely due to vehicles changing lanes to avoid vehicles that are slowing or stopping during congestion.

Table 1 summarizes the crashes for the study intersection; additional crash information is provided in **Attachment 2**. Based on the crash rate, the intersection does exceed the critical crash rate and safety improvements should be considered.

Table 1 Intersection Crash History (2014-2018)

TH 210 at:	Crash Severity					Crash Rates	
	Fatal & Severity A	Severity B	Severity C	Property Damage	Total	Int. Rate	Critical Rate
N 6th Street	0	1	10	50	61	**1.06**	0.99

PROPOSED CONDITIONS

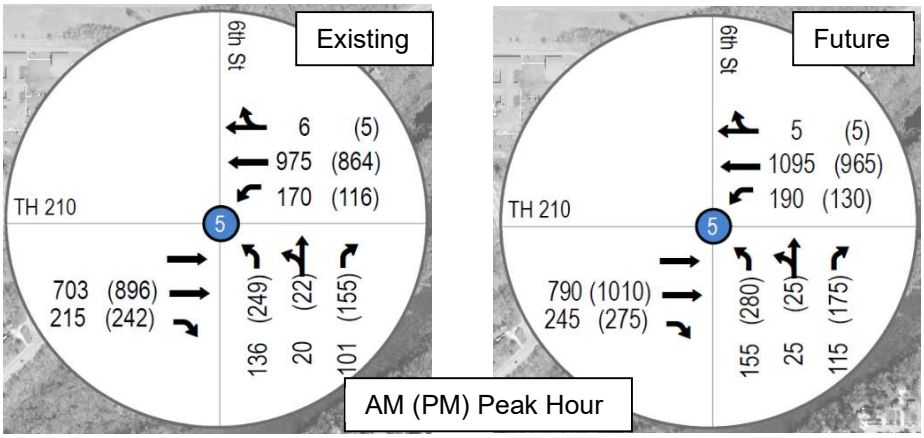
The current layout for the TH 210 corridor between Baxter Drive and Pine Shores Road addresses the needs and use of the roadway, improves pavement conditions, safety, and meets ADA requirements.

The TH 210 and N 6th Street intersection is located in a segment of the project that will primarily include reconstruction of the roadway, with modifications for full ADA compliance, wider sidewalks, and medians. No geometric changes are proposed at this intersection.

Future Traffic Volumes

Traffic forecasts were developed for the entire TH 210 corridor as part of the larger study effort. Future 2045 forecast volumes were developed based on a linear growth rate of 0.5% per year based on historical AADT volumes, population data, and input from the project team. **Figure 3** presents both the existing and future 2045 AM and PM peak intersection volumes.

Figure 3 Existing and Future 2045 Intersection Volumes



Warrant Analysis

Traffic control warrant analysis was conducted on the existing and future traffic volumes following the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) guidelines; all-way stop control warrants were not analyzed as it is not considered a viable control option along TH 210.

Warrants 1 (8-hour), 2 (4-hour), 3 (peak hour), and 7 (crash warrant) were included in the analysis. The following assumptions were used in the analysis:

- All minor street right turning volume was removed from the approaches.
- Warrant 7 was not applicable at the intersection due to insufficient correctable crashes.

The results of the traffic signal warrant analysis are provided in **Table 2**. The intersection currently meets Warrants 1, 2, and 3; the detailed signal warrant analysis is provided as **Attachment 3**.

Table 2 Traffic Signal Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Needed	Existing		Future 2045	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A – 8-hour Minimum Volume	8	**8**	**MET**	**8**	**MET**
Warrant 1B – 8-hour Interruption of Flow	8	**11**	**MET**	**11**	**MET**
Combination of Warrant 1A and 1B	8	**10**	**MET**	**10**	**MET**
Warrant 2 – 4-hours	4	**11**	**MET**	**11**	**MET**
Warrant 3 – Peak Hour	1	**10**	**MET**	**11**	**MET**

System Limitations and Consistency

TH 210 is a principal arterial through the City of Brainerd that experiences heavy directional volumes in both the AM and PM peak hours, throughout the day, and in the summer months with high tourist traffic. The two adjacent major intersections are both currently signalized.

The study intersection is part of an existing TH 210 signal system coordinated to provide priority to the peak direction of flow, reduce mainline delays, and provide a high level of vehicle progression through the corridor. The coordinated signal system includes all existing traffic signals along TH 210 between TH 371, in the City of Baxter, and 4th Avenue NE in east Brainerd.

Due to limited right-of-way along the TH 210 corridor, expansion of the roadway to accommodate a larger intersection footprint is not feasible. Roundabout intersection control would result in major impacts to adjacent parcels and structures adjacent to the intersection and along the corridor.

In addition, both all-way stop control and roundabout control would alter the traffic flow along TH 210 and severely impede the progression of traffic from the adjacent coordinated signal systems.

Therefore, all-way stop and roundabout intersection control was not considered feasible for this intersection due to right-of-way limitations and the interruption to the existing coordinated signal system.

Traffic Operations

Evaluation of the intersection traffic operations were conducted as part of the overall corridor study using VISSIM software. The evaluation included analysis of the existing conditions, 2045 No Build conditions, and the recommended 2045 Build conditions, which included no geometric changes at the intersection.

The average delay per vehicle and Level of Service (LOS) results for each approach and the overall intersection are provided in **Table 3** for each scenario; all three scenarios include traffic signal control. For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Table 3 Traffic Operations Summary

Scenario	Peak Hour	Approach Delay (sec/veh / LOS)				Intersection Delay (sec/veh / LOS)
		Eastbound	Westbound	Northbound	Southbound	
Existing Conditions	AM	5.0 / A	7.0 / A	32.2 / C		9.1 / A
	PM	4.8 / A	11.4 / B	**41.7 / D**		13.4 / B
2045 No Build Conditions	AM	8.3 / A	6.8 / A	32.1 / C		10.4 / B
	PM	6.7 / A	11.2 / B	**42.9 / D**		14.4 / B
2045 Build Conditions	AM	9.6 / A	6.4 / A	30.7 / C		10.5 / B
	PM	10.0 / B	11.3 / B	**41.8 / D**		15.7 / B

Based on the results, the intersection is expected to operate at a LOS B or better in all scenarios. The minor street approaches operate with longer delays due to the long cycle length required for coordination along TH 210.

Pedestrian Considerations

The existing intersection provides crosswalks on three of the four legs of the intersection; however, the existing facilities are not ADA compliant.

As part of the TH 210 reconstruction project, the intersection will be improved to meet ADA requirements. New Accessible Pedestrian Systems (APS) pedestrian push buttons are proposed to be installed and made operational as part of this project, and all pedestrian curb ramps will be upgraded to be ADA compliant.

Revised Signal System

The existing signal system is vehicle actuated and coordinated along TH 210. The TH 210 left turn phase for westbound operates under protected phasing only; the northbound minor street approach operates under protected phasing as there is no southbound approach. The existing signal system was installed in the fall of 2018 as part of a project along N 6th Street.

As part of the reconstruction project, the existing signal system can be reinstalled at the intersection. The current signal system is less than 5-years old and is still fully functional; the signal system is to remain vehicle actuated and coordinated along TH 210. The westbound and northbound approaches will be upgraded to include Flashing Yellow Arrow (FYA) which provides the flexibility of running both protected and permissive phasing by time-of-day schedules on all approaches and improves the overall safety of the intersection.

RECOMMENDATION

Based on the analysis included in this report, and as part of the larger TH 210 corridor study, it is recommended to retain traffic signal control at the intersection of TH 210 and N 6th Street.

Traffic signal control is currently warranted at the intersection and traffic operations are acceptable in both the existing conditions and future forecast year. The improvements at the existing intersection will continue to provide a safe intersection for all users.

Roundabout and all-way stop control was not considered feasible at this intersection due to potential right-of-way constraints and impacts, and the impact to the coordinated signal system that provides positive vehicle progression along TH 210.

Attachment 1: Turning Movement Data
Attachment 2: Crash Data
Attachment 3: Warrant Analysis

cc: Luke Wehseler, PE MnDOT District 3
Zachary Whitley, PE MnDOT District 3

File Name: S:\2018\180119\TO OTHERS\TMC\PETRO\345_TH 210 AND 6TH STREET.ppd
Start Date: 11/13/2018
Start Time: 6:00:00 AM
Site Code: 00000345
Comment 1: 345_TH 210 AND 6TH STREET
Comment 2: 0
Comment 3: data by: Alliant Inc
Comment 4: TURN MOVEMENT COUNT

	BAXTER DRIVE Southbound				TH 210 Westbound				BAXTER DRIVE Northbound				TH 210 Eastbound			
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds
06:00 AM	0	0	0	0	6	43	0	0	9	0	6	0	0	55	7	0
06:15 AM	0	0	0	0	12	81	1	0	23	0	9	0	0	59	19	0
06:30 AM	0	0	0	0	17	89	0	0	20	1	11	0	0	85	17	0
06:45 AM	0	0	0	0	21	139	1	0	30	2	10	0	0	86	25	0
07:00 AM	0	0	0	0	29	95	0	0	16	0	14	0	0	102	23	0
07:15 AM	0	0	0	0	40	149	0	0	30	7	19	0	0	129	38	0
07:30 AM	0	0	0	0	36	205	2	0	38	5	29	0	0	135	39	0
07:45 AM	0	0	0	0	49	228	1	0	32	6	24	0	0	201	54	0
08:00 AM	0	0	0	0	42	188	1	1	28	6	24	0	0	136	46	0
08:15 AM	0	0	0	1	43	191	2	0	38	3	24	0	0	114	40	0
08:30 AM	0	0	0	0	32	173	1	0	43	4	15	0	0	106	46	0
08:45 AM	0	0	0	0	37	176	3	0	34	5	8	0	0	107	52	0
09:00 AM	0	0	0	1	23	124	2	0	35	0	19	0	0	118	34	0
09:15 AM	0	0	0	1	24	147	1	0	41	6	28	1	0	92	27	0
09:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 AM	0	0	0	0	26	185	2	0	40	2	34	0	0	141	45	0
10:45 AM	0	0	0	0	33	193	2	0	61	3	25	0	0	145	56	0
11:00 AM	0	0	0	0	30	191	0	0	49	1	39	0	0	132	38	0
11:15 AM	0	0	1	0	38	176	3	0	62	6	29	0	0	147	40	0
11:30 AM	0	0	0	0	28	195	3	2	79	3	34	0	0	163	55	0
11:45 AM	0	0	0	0	26	205	0	0	69	4	37	0	0	205	52	0
12:00 PM	0	0	0	0	42	228	2	0	67	4	46	0	0	171	53	0
12:15 PM	0	0	0	0	36	178	3	1	44	7	28	0	0	172	57	0
12:30 PM	0	0	0	0	28	229	3	0	66	1	42	0	0	194	53	0
12:45 PM	0	0	0	0	23	207	2	1	66	3	33	0	0	192	39	0
01:00 PM	0	0	0	0	32	175	1	2	68	3	36	0	0	190	49	0
01:15 PM	0	0	0	0	37	188	2	0	60	1	34	0	0	148	52	0
01:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:30 PM	0	0	0	0	29	176	1	0	49	11	43	0	0	226	49	0
02:45 PM	0	0	0	0	39	227	1	1	62	4	36	0	0	188	54	0
03:00 PM	0	0	0	0	53	245	0	3	52	10	34	1	0	200	76	0
03:15 PM	0	0	0	0	36	197	0	3	60	3	66	0	0	212	48	0
03:30 PM	0	0	0	0	42	196	1	3	77	2	38	1	0	232	53	0
03:45 PM	0	0	0	0	32	240	0	2	61	3	35	0	0	211	43	0
04:00 PM	0	0	0	0	23	195	2	1	66	1	39	0	0	214	50	0
04:15 PM	0	0	0	0	31	212	2	1	67	2	42	0	0	232	49	0
04:30 PM	0	0	0	0	26	199	1	0	58	6	40	0	0	244	41	0
04:45 PM	0	0	0	0	33	232	2	1	73	4	40	0	1	215	53	0
05:00 PM	0	0	0	0	28	228	1	2	61	5	39	0	0	217	53	0
05:15 PM	0	0	0	0	29	205	1	1	57	7	36	2	0	220	54	0
05:30 PM	0	0	0	0	25	162	0	0	54	2	32	0	0	163	42	0
05:45 PM	0	0	0	0	26	140	0	0	40	2	32	0	0	185	41	0

Intersection Safety Screening

Intersection: TH 210 at N 6th Street

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	1
Possible Injury	10
Property Damage	50
Total Crashes	61

Intersection Characteristics	
Entering Volume	31,500
Traffic Control	Signals
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $276,000

Statewide Comparison

Signals: high volume, low speed

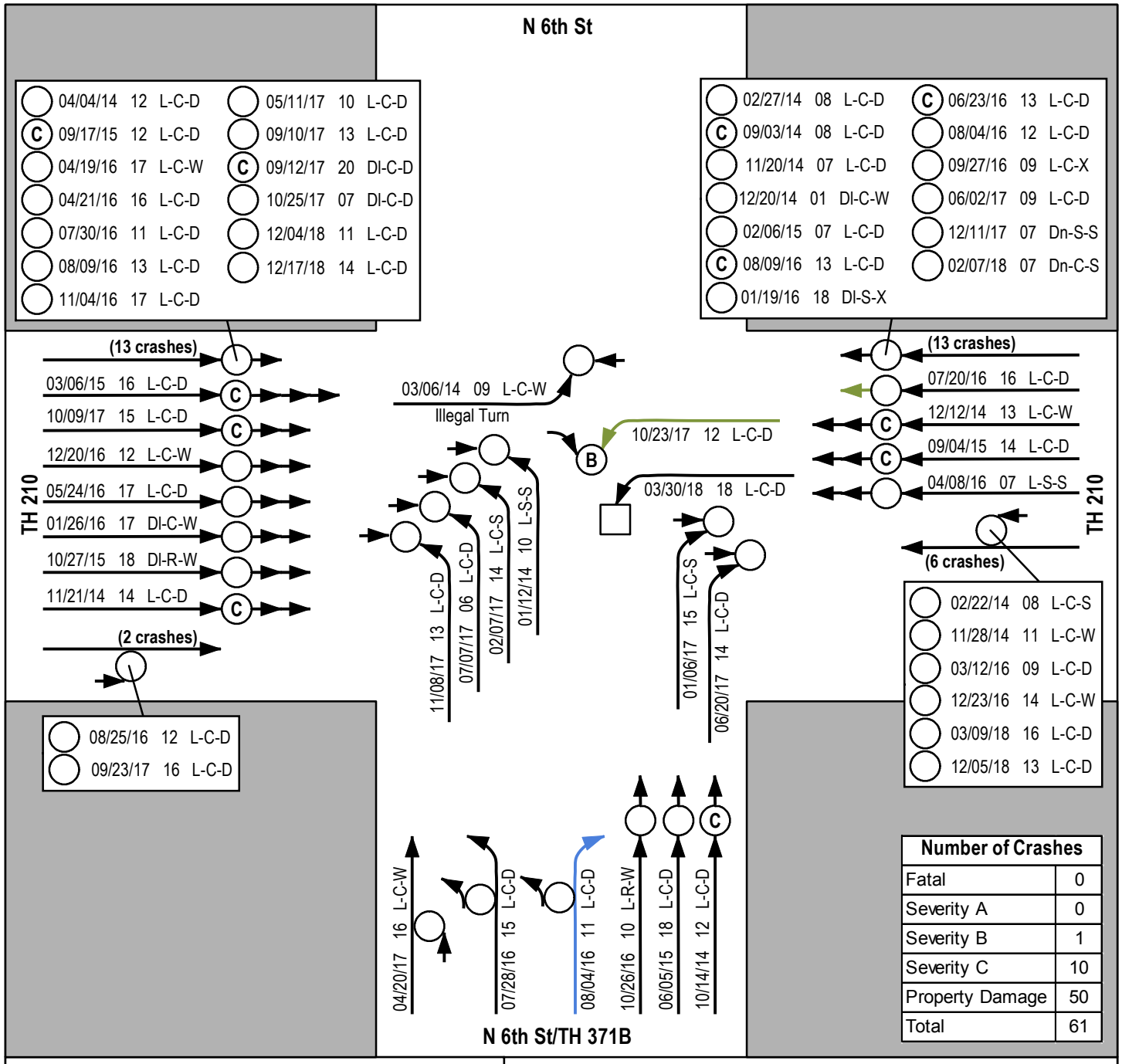
Total Crash Rate	
Observed	1.06
Statewide Average	0.70
Critical Rate	0.99
Critical Index	**1.07**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	3.11
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 1.06 per MEV; this is 1.1 times the critical rate. If crashes were reduced by 4 over five years, this intersection would perform within normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	1
Severity C	10
Property Damage	50
Total	61

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:

Project: MNT03 152201
Print Date: 3/2/2020

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at N 6th St/TH 371B
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A5

Path: C:\Traffic Projects\Brainerd- TH 210\Crashes\Crash Diagrams\A5_TH 210 at N 6th St_Crash Diagrams.mxd

2019 Existing - TH 210 at N 6th St/TH 371B
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 6th St/TH 371B
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	10638
35	Major App3:	TH 210 WB	3	10665
30	Minor App2:	N 6th St (TH 371B) NB	3	2581
30	Minor App4:	N 6th St SB (no approach volumes)	0	0

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	423	481	85	0	904	85	YES / NO	YES / NO	YES / NO
7:00 - 8:00	866	970	134	0	1836	134	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	775	1035	161	0	1810	161	YES / NO	**YES / YES**	**YES / YES**
9:00 - 10:00	672	769	171	0	1441	171	YES / NO	**YES / YES**	**YES / YES**
10:00 - 11:00	795	867	208	0	1662	208	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	869	895	273	0	1764	273	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	972	981	258	0	1953	258	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	939	883	263	0	1822	263	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	1057	939	255	0	1996	255	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1120	1042	268	0	2162	268	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	1137	958	277	0	2095	277	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	1013	845	228	0	1858	228	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10638**	**10665**	**2581**	**0**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	11	8	Satisfied
Warrant 1A	Minimum Vehicular Volume	8	8	Satisfied
Warrant 1B	Interruption of Continuous Flow	11	8	Satisfied
1A & 1B	Combination of Warrants	10	8	Satisfied
Warrant 2	**Four Hour Volumes**	11	4	Satisfied
Warrant 3	**Peak Hour Volumes**	10	1	Satisfied
Warrant 7	**Crash Experience**	12	8	Crashes Insufficient

COMMENTS:

2019 Existing - TH 210 at N 6th St/TH 371B
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 6th St/TH 371B
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	10638
35	Major App3:	TH 210 WB	3	10665
30	Minor App2:	N 6th St (TH 371B) NB	3	2581
30	Minor App4:	N 6th St SB (no approach volumes)	0	0

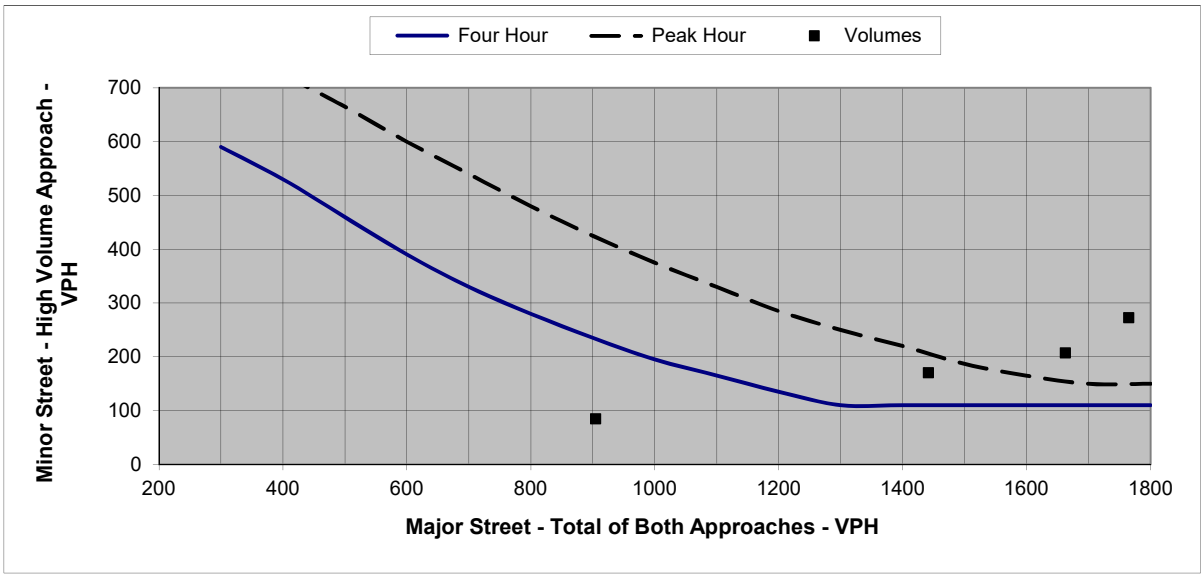


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	904	85	NO	NO
7:00 - 8:00	1836	134	**YES**	**YES**
8:00 - 9:00	1810	161	**YES**	**YES**
9:00 - 10:00	1441	171	**YES**	NO
10:00 - 11:00	1662	208	**YES**	**YES**
11:00 - 12:00	1764	273	**YES**	**YES**
12:00 - 13:00	1953	258	**YES**	**YES**
13:00 - 14:00	1822	263	**YES**	**YES**
14:00 - 15:00	1996	255	**YES**	**YES**
15:00 - 16:00	2162	268	**YES**	**YES**
16:00 - 17:00	2095	277	**YES**	**YES**
17:00 - 18:00	1858	228	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at N 6th St/TH 371B
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 6th St/TH 371B
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	12023
35	Major App3:	TH 210 WB	3	12055
30	Minor App2:	N 6th St (TH 371B) NB	3	2914
30	Minor App4:	N 6th St SB (no approach volumes)	0	0

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	478	544	96	0	1022	96	YES / NO	YES / NO	YES / NO
7:00 - 8:00	979	1096	152	0	2075	152	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	876	1170	181	0	2046	181	YES / NO	**YES / YES**	**YES / YES**
9:00 - 10:00	759	870	193	0	1629	193	YES / NO	**YES / YES**	**YES / YES**
10:00 - 11:00	899	981	234	0	1880	234	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	982	1011	309	0	1993	309	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	1099	1108	292	0	2207	292	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	1061	998	297	0	2059	297	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	1195	1062	288	0	2257	288	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1265	1177	302	0	2442	302	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	1285	1083	313	0	2368	313	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	1145	955	257	0	2100	257	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**12023**	**12055**	**2914**	**0**					

		Met (Hr)	Required (Hr)	WARRANT MET:
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Warrant 7	**Crash Experience**	12	8	Crashes Insufficient

COMMENTS:

2045 Future - TH 210 at N 6th St/TH 371B
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 6th St/TH 371B
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	12023
35	Major App3:	TH 210 WB	3	12055
30	Minor App2:	N 6th St (TH 371B) NB	3	2914
30	Minor App4:	N 6th St SB (no approach volumes)	0	0

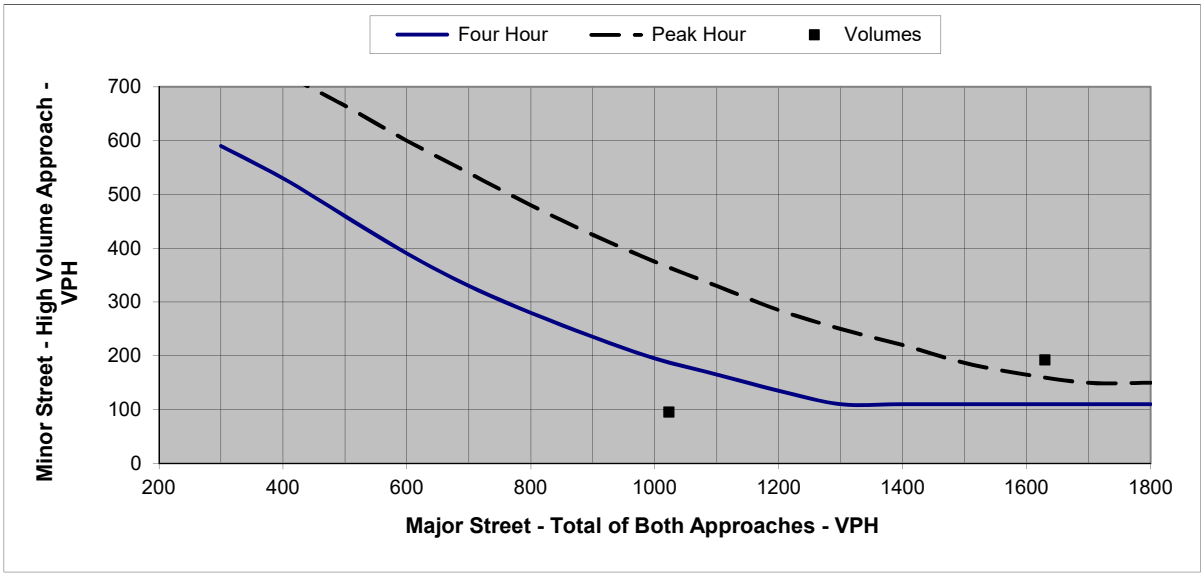


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	1022	96	NO	NO
7:00 - 8:00	2075	152	**YES**	**YES**
8:00 - 9:00	2046	181	**YES**	**YES**
9:00 - 10:00	1629	193	**YES**	**YES**
10:00 - 11:00	1880	234	**YES**	**YES**
11:00 - 12:00	1993	309	**YES**	**YES**
12:00 - 13:00	2207	292	**YES**	**YES**
13:00 - 14:00	2059	297	**YES**	**YES**
14:00 - 15:00	2257	288	**YES**	**YES**
15:00 - 16:00	2442	302	**YES**	**YES**
16:00 - 17:00	2368	313	**YES**	**YES**
17:00 - 18:00	2100	257	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

MEMORANDUM

TO: Ken Hansen, PE
MnDOT District 3 Traffic Engineer

FROM: Graham Johnson, PE, PTOE (Lic.MN, IA, SD)
Justin Anibas, PE (Lic. MN)

DATE: August 9, 2022

RE: TH 210 at NW 4th Street Intersection Control Evaluation (ICE) Report
SEH No. MNT03 152201 14.00

INTRODUCTION

This memorandum summarizes the Intersection Control Evaluation (ICE) process for the intersection of Trunk Highway (TH) 210 and NW 4th Street in Brainerd, Minnesota. The Minnesota Department of Transportation (MnDOT) ICE is an objective process used to investigate and determine the optimal traffic control that should be provided at an intersection to serve the existing conditions and future needs. This memorandum was prepared for MnDOT by SEH Inc.

As part of a project along TH 210 between Baxter Drive and Pine Shores Road, the intersection of TH 210 and NW 4th Street was evaluated and is proposed to remain under traffic signal control after the project is complete.

The location of the study intersection for this ICE report is shown in **Figure 1**. The proposed intersection control for the TH 210 and NW 4th Street intersection was analyzed based on safety, signal warrants, traffic operations, and pedestrian and bicycle accommodations.

The scope and content of this ICE report was reviewed and agreed to by MnDOT prior to the layout and ICE submittal process. This report summarizes the ICE process and recommendation for the TH 210 and NW 4th Street intersection based on a Phase I analysis according to the *2017 MnDOT ICE Manual*.

APPROVAL

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.

_____ _____
Graham Johnson, PE, PTOE, MN License No. 45429 Date

Approved By:

_____ _____
MnDOT District 3 Traffic Engineer Date

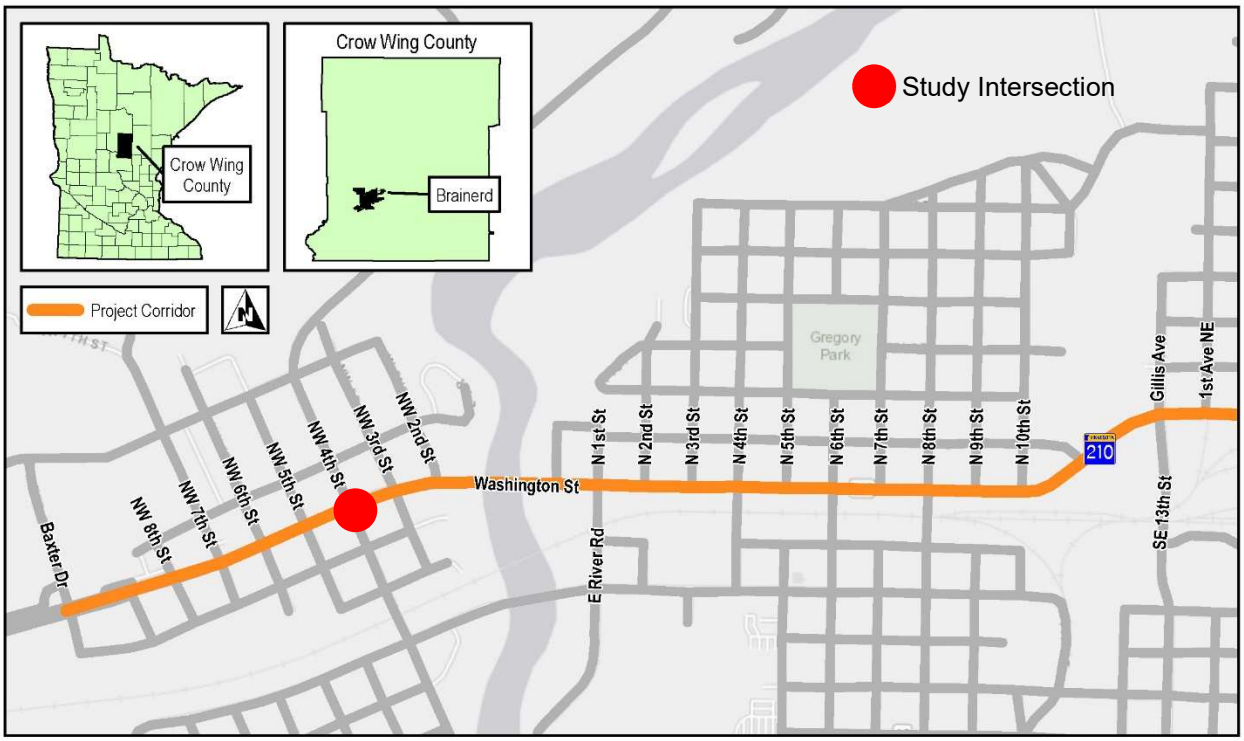
PROJECT DESCRIPTION

MnDOT is conducting the corridor planning study along a 3.9-mile segment of TH 210 to identify the future vision for highway corridor through Brainerd. Reconstruction of TH 210 between Baxter Drive and Pine Shores Road is anticipated to begin in 2025; SP 1805-80.

The primary purpose of the corridor study is to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout. The focus of the improvements is to improve pavement conditions and traveler safety, accommodate the Americans with Disabilities Act (ADA) requirements, and enhance pedestrian accommodations.

For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Figure 1 Project Location



EXISTING CONDITIONS

TH 210 is a major east-west principal arterial through the City of Brainerd that connects near-by cities and regional commerce. TH 210 is generally a 4-lane divided roadway through the City of Brainerd; the posted speed limit is 35 miles-per-hour (mph) at the study intersection.

NW 4th Street is a minor arterial providing access to both commercial and residential land uses to the north and south of TH 210; the posted speed limit is 30 mph.

The nearest existing traffic signals along TH 210 include Baxter Drive approximately 2,400 feet west and N 4th Street approximately 3,200 feet east.

Intersection Characteristics

The existing intersection currently operates with traffic signal control and includes marked pedestrian crossings on all four legs. Eastbound and westbound TH 210 left turns operate with protected left turn phasing only. The minor street approaches operate under split phasing with northbound and southbound having separate protected phases for each approach. The north leg of NW 4th Street was recently reconstructed as part of a City of Brainerd led project.

The existing lane geometrics are described below and shown in **Figure 2**.

- Eastbound Approach: left turn lane, two through lanes, and a right turn lane.
- Westbound Approach: left turn lane, two through lanes, and a right turn lane.
- Northbound Approach: separate left, and a shared through-right lane.
- Southbound Approach: dual left turn lanes, and a shared through-right lane.

Figure 2 Existing Intersection

Traffic Volumes

TH 210 has an existing 2019 Average Annual Daily Traffic (AADT) volume of 32,500 vehicles east of the intersection. NW 4th Street has an existing 2019 AADT of 9,900 vehicles to the north and 9,100 vehicles to the south.

The existing intersection turning movement data was collected in August of 2018 as part of a signal timing project along TH 210 and TH 371. **Figure 3** includes the existing AM and PM peak hour volumes; **Attachment 1** includes the raw existing intersection count data.

Crash Analysis

Intersection crash data for the study intersection was collected from the MnDOT Crash Mapping Analysis Tool (MnCMATv2) for a five-year period between 2014 and 2018 as part of the larger corridor study.

The crash rate at an intersection is expressed as a number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a

crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be further reviewed.

The intersection had a total of 74 crashes during the 5-year analysis period:

- 53 of the 74 crashes were rear end crashes: 35 of the rear end crashes were in the westbound direction and 11 were in the eastbound direction, 5 were northbound and 2 southbound. This could indicate that backups are worse for westbound vehicles.
- 14 of the 74 crashes were sideswipe crashes, likely due to vehicles changing lanes to avoid vehicles that are slowing or stopping during congestion.

Table 1 summarizes the crashes for the study intersection; additional crash information is provided in **Attachment 2**. Based on the crash rate, the intersection is just under the critical crash rate indicating safety improvements should be considered.

Table 1 Intersection Crash History (2014-2018)

TH 210 at:	Crash Severity					Crash Rates	
	Fatal & Severity A	Severity B	Severity C	Property Damage	Total	Int. Rate	Critical Rate
NW 4th Street	0	2	9	63	74	**0.94**	0.95

PROPOSED CONDITIONS

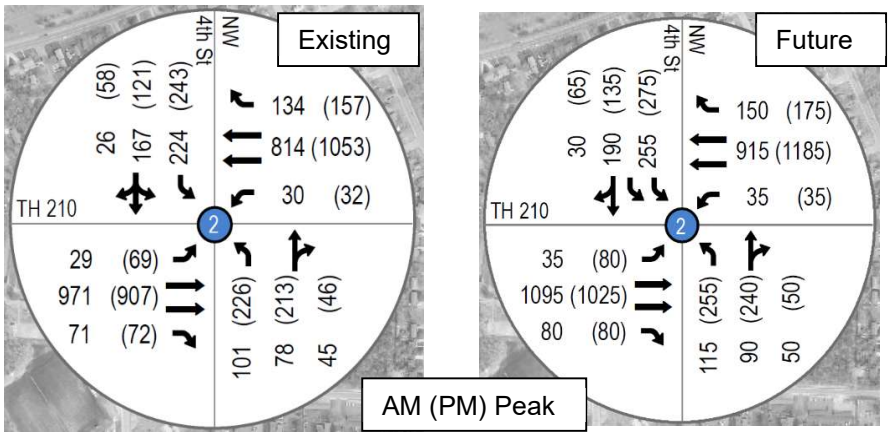
The current layout for the TH 210 corridor between Baxter Drive and Pine Shores Road addresses the needs and use of the roadway, improves pavement conditions, safety, and meets ADA requirements.

The TH 210 and NW 4th Street intersection is located in a segment of the project that will include mill and overlay west of the intersection to improve pavement conditions and reconstruction of TH 210 to the east, with modifications for full ADA compliance, and wider sidewalks. Lane improvements include extending the TH 210 left turn lanes and adding capacity on the south leg to remove the split phasing.

Future Traffic Volumes

Traffic forecasts were developed for the entire TH 210 corridor as part of the larger study effort. Future 2045 forecast volumes were developed based on a linear growth rate of 0.5% per year based on historical AADT volumes, population data, and input from the project team. **Figure 3** presents both the existing and future 2045 AM and PM peak intersection volumes.

Figure 3 Existing and Future 2045 Intersection Volumes



Warrant Analysis

Traffic control warrant analysis was conducted on the existing and future traffic volumes following the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) guidelines; all-way stop control warrants were not analyzed as it is not considered a viable control option along TH 210.

Warrants 1 (8-hour), 2 (4-hour), 3 (peak hour), and 7 (crash warrant) were included in the analysis. The following assumptions were used in the analysis:

- All minor street right turning volume was removed from the approaches.
- Warrant 7 was not applicable at the intersection due to insufficient correctable crashes.

The results of the traffic signal warrant analysis are provided in **Table 2**. The intersection currently meets Warrants 1, 2, and 3; the detailed signal warrant analysis is provided as **Attachment 3**.

Table 2 Traffic Signal Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Needed	Existing		Future 2045	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A – 8-hour Minimum Volume	8	**11**	**MET**	**11**	**MET**
Warrant 1B – 8-hour Interruption of Flow	8	**11**	**MET**	**12**	**MET**
Combination of Warrant 1A and 1B	8	**12**	**MET**	**12**	**MET**
Warrant 2 – 4-hours	4	**11**	**MET**	**11**	**MET**
Warrant 3 – Peak Hour	1	**11**	**MET**	**11**	**MET**

System Limitations and Consistency

TH 210 is a principal arterial through the City of Brainerd that experiences heavy directional volumes in both the AM and PM peak hours, throughout the day, and in the summer months with high tourist traffic. The two adjacent major intersections are both currently signalized.

The study intersection is part of an existing TH 210 signal system coordinated to provide priority to the peak direction of flow, reduce mainline delays, and provide a high level of vehicle progression through the corridor. The coordinated signal system includes all existing traffic signals along TH 210 between TH 371, in the City of Baxter, and 4th Avenue NE in east Brainerd.

Due to limited right-of-way along the TH 210 corridor, expansion of the roadway to accommodate a larger intersection footprint is not feasible. Roundabout intersection control would result in major impacts to adjacent parcels and structures adjacent to the intersection and along the corridor.

In addition, both all-way stop control and roundabout control would alter the traffic flow along TH 210 and severely impede the progression of traffic from the adjacent coordinated signal systems.

Therefore, all-way stop and roundabout intersection control was not considered feasible for this intersection due to right-of-way limitations and the interruption to the existing coordinated signal system.

Traffic Operations

Evaluation of the intersection traffic operations were conducted as part of the overall corridor study using VISSIM software. The evaluation included analysis of the existing conditions, 2045 No Build conditions,

and the recommended 2045 Build conditions, which included extending the TH 210 left turn lanes and adding capacity on the south leg to remove the split phasing.

The average delay per vehicle and Level of Service (LOS) results for each approach and the overall intersection are provided in **Table 3** for each scenario; all three scenarios include traffic signal control. For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Table 3 Traffic Operations Summary

Scenario	Peak Hour	Approach Delay (sec/veh / LOS)				Intersection Delay (sec/veh / LOS)
		Eastbound	Westbound	Northbound	Southbound	
Existing Conditions**	AM	18.8 / B	17.2 / B	**47.0 / D**	**45.1 / D**	24.6 / C
	PM	30.4 / C	**41.8 / D**	**60.0 / E**	**60.5 / E**	**43.2 / D**
2045 No Build Conditions	AM	23.1 / C	21.0 / C	**48.8 / D**	**45.7 / D**	27.9 / C
	PM	31.7 / C	33.5 / C	**72.5 / E**	**60.4 / E**	**42.1 / D**
2045 Build Conditions	AM	24.0 / C	22.0 / C	**45.3 / D**	**46.2 / D**	28.4 / C
	PM	20.3 / C	19.3 / B	**75.1 / E**	**62.1 / E**	33.2 / C

Notes: **Existing conditions did not include the NW 4th Street Project on the southbound approach; No Build included improvements.

Based on the results, the existing conditions show both of the NW 4th Street approaches operating at a LOS E in the PM peak. In the future No Build conditions, with the southbound improvements, both NW 4th Street approaches would still operate at a LOS E due to the cycle length and time required to serve the northbound left in a single turn lane.

With the proposed Build conditions, the intersection is expected to operate at a LOS C or better in the future Build scenario. The minor street approaches still operate with longer delays due to the long cycle length required for coordination along TH 210 but the additional capacity allows TH 210 additional green time to improve the eastbound and westbound approaches.

Extending both the eastbound and westbound left turn lanes along TH 210 are necessary to improve the efficiency of the intersection; the existing left turn volumes are low, but vehicles cannot access the turn lanes due to through queue blocking. The extensions allow the left turning vehicles to enter the storage and approach the signal, shortening the through queues and improving the efficiency of the signal operations. The extensions do require both the NW 5th Street and NW 3rd Street intersections to be converted to right-in/right-out (RI/RO) intersections.

The northbound NW 4th Street approach mitigations include dual left turns and a separate through-right lane; this requires a single departing lane and mirrors the recently constructed southbound approach. While additional capacity would improve operations further, the right-of-way impacts were considered too extensive.

Pedestrian Considerations

The existing intersection provides crosswalks on all four legs of the intersection; however, all of the existing facilities are not ADA compliant.

As part of the TH 210 reconstruction project, the intersection will be improved to meet ADA requirements. New Accessible Pedestrian Systems (APS) pedestrian push buttons are proposed to be installed and

made operational as part of this project, and all pedestrian curb ramps will be upgraded to be ADA compliant.

Revised Signal System

The existing signal system is vehicle actuated and coordinated along TH 210. The TH 210 left turn phases operate under protected phasing only; the minor street approaches operate under split phasing.

As part of the signal replacement, the new signal system is to remain vehicle actuated and coordinated along TH 210. All four approaches will include Flashing Yellow Arrow (FYA) which provides the flexibility of running both protected and permissive phasing by time-of-day schedules on all approaches and improves the overall safety of the intersection.

The minor approach lane improvements allow the removal of the existing split phasing to improve the overall efficiency of the signal, coordination along TH 210, and improved intersection safety. Vehicle turning paths of the northbound and southbound dual left turn lanes do overlap, therefore the protected left turn phases should run separate from each other in a lead-lag operation.

RECOMMENDATION

Based on the analysis included in this report, and as part of the larger TH 210 corridor study, it is recommended to retain traffic signal control at the intersection of TH 210 and NW 4th Street.

Traffic signal control is currently warranted at the intersection and traffic operations are acceptable in the future Build conditions. The improvements at the existing intersection will continue to provide a safe intersection for all users.

Roundabout and all-way stop control was not considered feasible at this intersection due to potential right-of-way constraints and impacts, and the impact to the coordinated signal system that provides positive vehicle progression along TH 210.

Attachment 1: Turning Movement Data
Attachment 2: Crash Data
Attachment 3: Warrant Analysis

cc: Luke Wehseler, PE MnDOT District 3
Zachary Whitley, PE MnDOT District 3

File Name: S:\2018\180119\TO OTHERS\TMC\PETRO\343_TH 210 AND 4TH STREET NW.ppd
Start Date: 8/23/2018
Start Time: 6:00:00 AM
Site Code: 00000343
Comment 1: 343_TH 210 AND 4TH STREET NW
Comment 2: 0
Comment 3: data by: Alliant Inc
Comment 4: TURN MOVEMENT COUNT

	BAXTER DRIVE Southbound				TH 210 Westbound				BAXTER DRIVE Northbound				TH 210 Eastbound			
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds
06:00 AM	6	7	5	0	1	64	5	0	7	1	7	1	2	50	5	0
06:15 AM	15	10	6	0	1	58	7	0	4	5	5	0	0	78	7	0
06:30 AM	35	18	6	0	1	107	12	0	5	13	9	0	2	131	9	0
06:45 AM	39	33	6	0	7	119	12	0	15	8	7	0	5	139	14	0
07:00 AM	33	22	8	0	4	87	10	0	12	6	8	0	3	120	16	0
07:15 AM	48	21	9	1	3	117	21	0	15	10	8	0	5	145	14	1
07:30 AM	67	59	2	0	8	175	34	0	26	20	9	0	7	193	16	0
07:45 AM	64	47	8	0	9	174	40	2	26	21	16	0	9	204	14	2
08:00 AM	47	36	8	1	8	164	34	1	27	21	10	0	5	141	24	0
08:15 AM	46	25	8	0	5	165	26	0	22	16	10	0	8	154	17	0
08:30 AM	45	38	20	0	9	178	25	1	24	36	11	0	11	159	16	0
08:45 AM	49	34	11	0	5	170	28	0	28	31	11	0	13	152	19	0
09:00 AM	39	29	20	0	8	181	33	0	25	19	17	0	8	108	13	0
09:15 AM	34	24	17	1	8	170	22	0	32	27	14	0	15	139	18	0
09:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 AM	43	29	20	2	10	248	32	1	43	26	13	0	17	164	23	0
10:45 AM	47	26	18	0	18	220	40	1	36	28	13	0	10	121	39	0
11:00 AM	35	35	20	0	10	237	34	0	40	20	20	1	7	127	41	1
11:15 AM	37	30	17	3	19	187	26	1	51	33	21	1	8	117	23	0
11:30 AM	33	31	15	0	10	223	29	1	52	34	19	0	14	128	29	0
11:45 AM	38	38	24	1	21	214	27	0	40	24	13	1	14	150	35	0
12:00 PM	61	41	14	0	10	188	42	0	56	41	14	0	7	98	42	1
12:15 PM	35	32	12	2	10	264	30	1	48	32	27	0	11	139	41	0
12:30 PM	46	39	16	0	16	236	29	0	42	32	9	0	13	133	46	0
12:45 PM	45	53	19	0	10	210	37	1	51	25	11	0	8	111	35	0
01:00 PM	45	33	19	1	12	223	43	4	35	33	14	0	5	134	28	0
01:15 PM	65	49	12	0	14	207	31	0	41	36	24	1	6	86	22	0
01:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:30 PM	46	26	18	0	13	237	31	1	43	25	16	0	19	170	42	0
02:45 PM	50	41	17	0	7	192	39	0	36	27	8	0	10	176	27	1
03:00 PM	40	27	11	2	7	219	28	0	42	32	18	0	13	207	21	0
03:15 PM	39	29	23	0	3	181	29	0	50	40	14	0	14	191	18	0
03:30 PM	32	27	9	0	7	251	35	0	60	38	12	0	9	219	21	0
03:45 PM	53	28	14	1	6	229	51	1	39	28	7	0	23	193	14	0
04:00 PM	65	26	22	3	11	183	35	0	47	55	11	2	17	185	11	0
04:15 PM	41	25	8	0	13	245	50	2	36	36	19	0	14	243	20	0
04:30 PM	61	42	9	0	10	264	52	0	56	65	7	0	15	190	18	0
04:45 PM	51	29	17	2	5	278	40	1	59	60	13	0	18	224	17	0
05:00 PM	66	31	14	0	7	285	33	2	55	40	11	1	19	212	22	1
05:15 PM	65	19	18	1	10	226	32	2	56	48	15	1	17	235	15	0
05:30 PM	41	27	8	0	4	221	32	1	49	43	10	0	20	194	12	0
05:45 PM	37	16	9	0	8	211	15	0	31	22	6	0	17	193	14	0

Intersection Safety Screening

Intersection: TH 210 at NW 4th Street

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	2
Possible Injury	9
Property Damage	63
Total Crashes	74

Intersection Characteristics	
Entering Volume	43,200
Traffic Control	Signals
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $313,160

Statewide Comparison

Signals: high volume, low speed

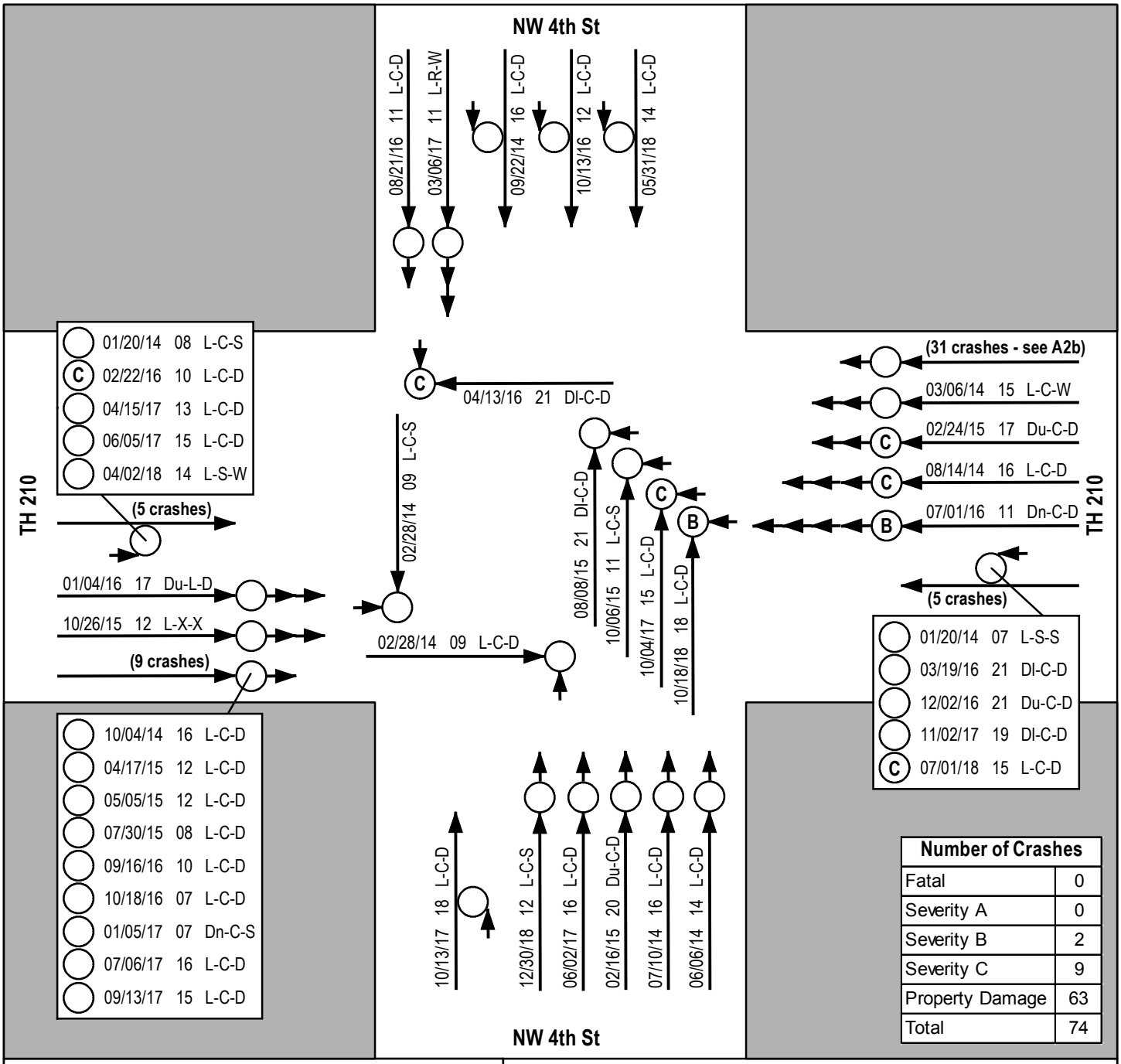
Total Crash Rate	
Observed	0.94
Statewide Average	0.70
Critical Rate	0.95
Critical Index	**0.99**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	2.66
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.94 per MEV; this is 1% below the critical rate. Based on similar statewide intersections, an additional 1 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	2
Severity C	9
Property Damage	63
Total	74

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:

Project: MNT03 152201
Print Date: 2/27/2020

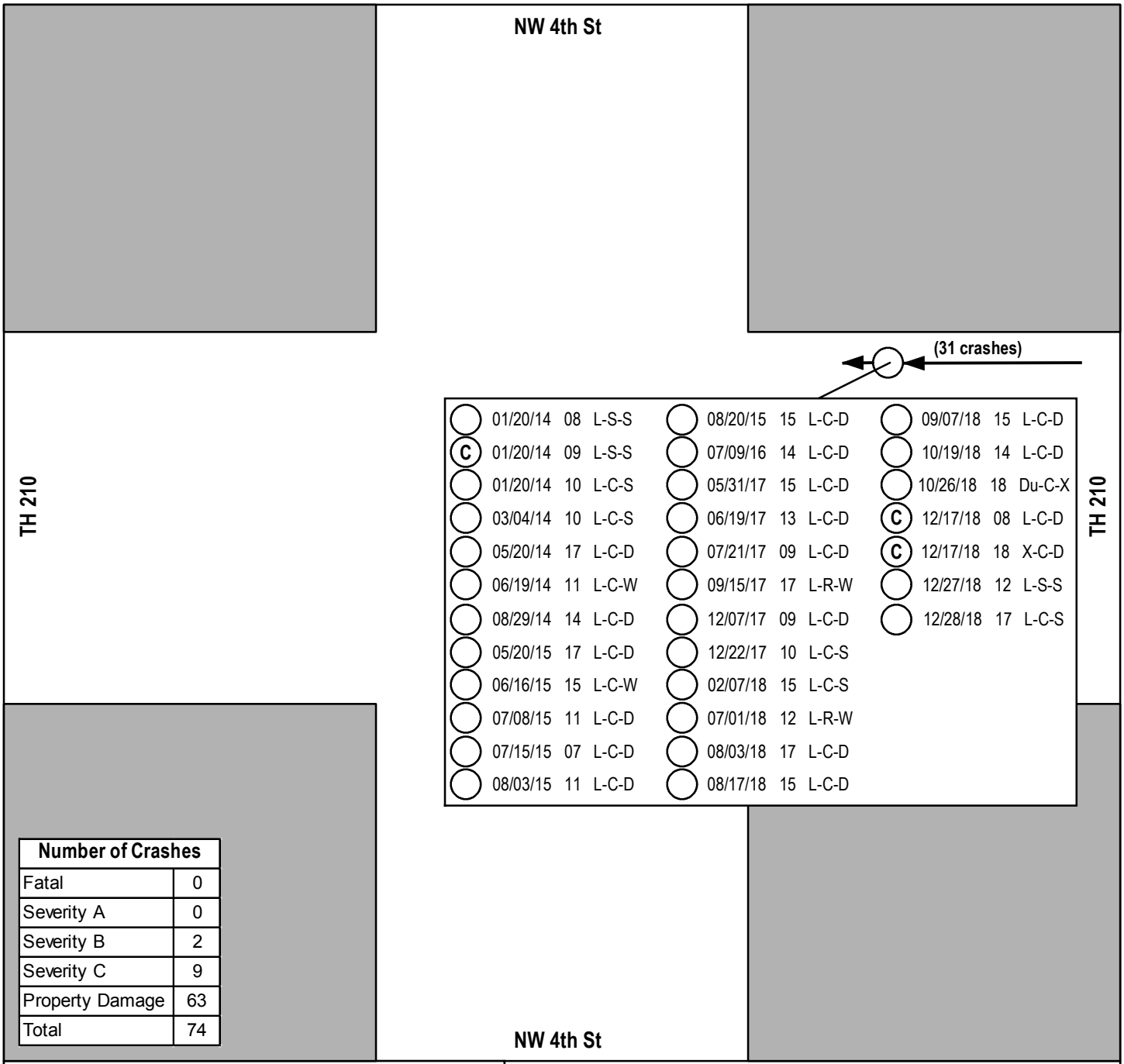
Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at NW 4th St

TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A2a

Path: S:\KO\MM\nt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A2a_TH 210 at NW 4th St_Crash Diagrams.mxd



Number of Crashes	
Fatal	0
Severity A	0
Severity B	2
Severity C	9
Property Damage	63
Total	74

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:
Westbound rear ends only, see Figure A1a for other crashes

Path: S:\KO\MM\nt03\152201\8-planning\Traffic\crashes\Crash Diagrams\A2b_TH 210 at NW 4th St (WB Rear Ends)_Crash Diagrams.mxd

Project: MNT03 152201
Print Date: 2/27/2020
Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at NW 4th St (WB Rear Ends)

TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A2b

2019 Existing - TH 210 at NW 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at NW 4th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	10169
35	Major App3:	TH 210 WB	4	11917
30	Minor App2:	NW 4th St NB	2	3137
30	Minor App4:	NW 4th St SB	2	3649

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	397	464	58	163	861	163	YES / NO	NO / YES	**YES / YES**
7:00 - 8:00	916	816	136	361	1732	361	**YES / YES**	**YES / YES**	**YES / YES**
8:00 - 9:00	775	929	205	320	1704	320	**YES / YES**	**YES / YES**	**YES / YES**
9:00 - 10:00	609	1005	215	259	1614	259	**YES / YES**	**YES / YES**	**YES / YES**
10:00 - 11:00	789	1118	260	287	1907	287	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	877	1037	294	277	1914	294	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	934	1132	327	352	2066	352	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	891	1058	288	378	1949	378	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	1030	1042	267	335	2072	335	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1016	1046	329	275	2062	329	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	999	1186	414	340	2185	414	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	936	1084	344	302	2020	344	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10169**	**11917**	**3137**	**3649**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	12	8	Satisfied
Warrant 1A	Minimum Vehicular Volume	11	8	Satisfied
Warrant 1B	Interruption of Continuous Flow	11	8	Satisfied
1A & 1B	Combination of Warrants	12	8	Satisfied
Warrant 2	**Four Hour Volumes**	11	4	Satisfied
Warrant 3	**Peak Hour Volumes**	11	1	Satisfied
Warrant 7	**Crash Experience**	12	8	Crashes Insufficient

COMMENTS:

2019 Existing - TH 210 at NW 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at NW 4th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	10169
35	Major App3:	TH 210 WB	4	11917
30	Minor App2:	NW 4th St NB	2	3137
30	Minor App4:	NW 4th St SB	2	3649

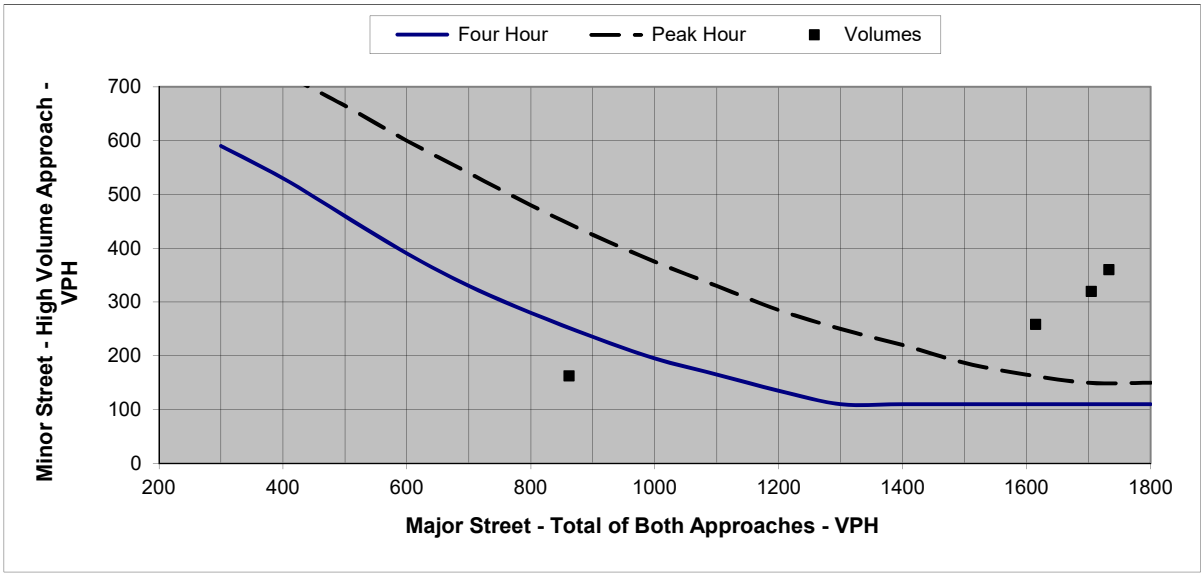


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	861	163	NO	NO
7:00 - 8:00	1732	361	**YES**	**YES**
8:00 - 9:00	1704	320	**YES**	**YES**
9:00 - 10:00	1614	259	**YES**	**YES**
10:00 - 11:00	1907	287	**YES**	**YES**
11:00 - 12:00	1914	294	**YES**	**YES**
12:00 - 13:00	2066	352	**YES**	**YES**
13:00 - 14:00	1949	378	**YES**	**YES**
14:00 - 15:00	2072	335	**YES**	**YES**
15:00 - 16:00	2062	329	**YES**	**YES**
16:00 - 17:00	2185	414	**YES**	**YES**
17:00 - 18:00	2020	344	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at NW 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at NW 4th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	4	11492
35	Major App3:	TH 210 WB	4	13467
30	Minor App2:	NW 4th St NB	2	3546
30	Minor App4:	NW 4th St SB	2	4124

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	449	524	65	184	973	184	YES / NO	**YES / YES**	**YES / YES**
7:00 - 8:00	1036	922	153	407	1958	407	**YES / YES**	**YES / YES**	**YES / YES**
8:00 - 9:00	876	1050	232	362	1926	362	**YES / YES**	**YES / YES**	**YES / YES**
9:00 - 10:00	688	1136	244	293	1824	293	**YES / YES**	**YES / YES**	**YES / YES**
10:00 - 11:00	892	1264	294	323	2156	323	**YES / YES**	**YES / YES**	**YES / YES**
11:00 - 12:00	991	1172	332	313	2163	332	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	1056	1280	370	398	2336	398	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	1006	1195	325	427	2201	427	**YES / YES**	**YES / YES**	**YES / YES**
14:00 - 15:00	1163	1178	302	379	2341	379	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1148	1182	373	312	2330	373	**YES / YES**	**YES / YES**	**YES / YES**
16:00 - 17:00	1129	1340	467	384	2469	467	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	1058	1224	389	342	2282	389	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
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Daily	**11492**	**13467**	**3546**	**4124**					

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COMMENTS:

2045 Future - TH 210 at NW 4th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at NW 4th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
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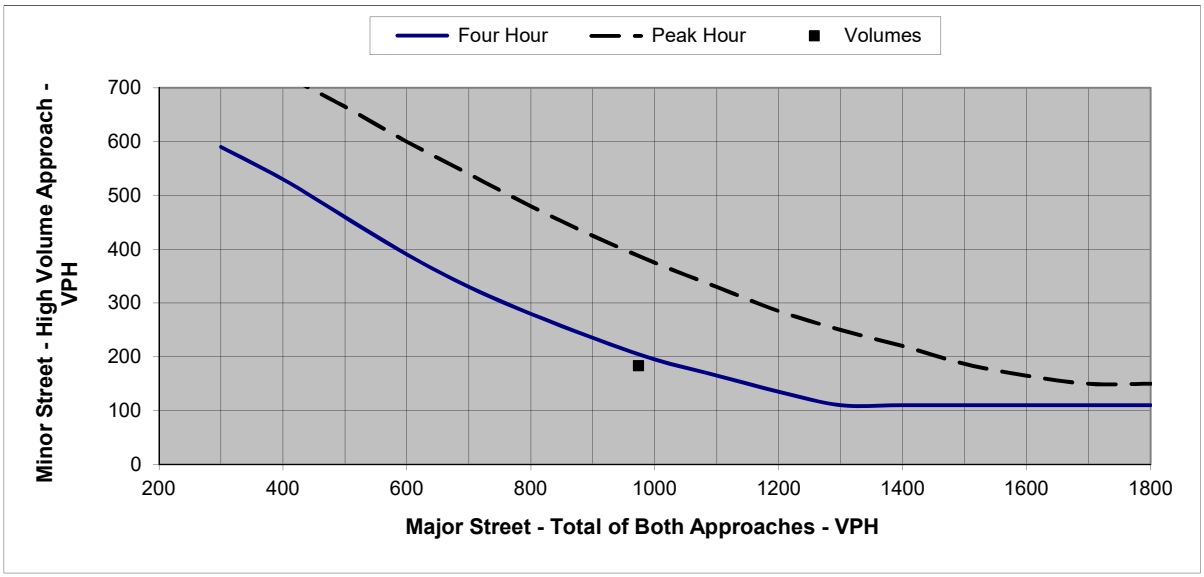

Figure 1. Four Hour and Peak Hour Warrant Analysis

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1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	973	184	NO	NO
7:00 - 8:00	1958	407	**YES**	**YES**
8:00 - 9:00	1926	362	**YES**	**YES**
9:00 - 10:00	1824	293	**YES**	**YES**
10:00 - 11:00	2156	323	**YES**	**YES**
11:00 - 12:00	2163	332	**YES**	**YES**
12:00 - 13:00	2336	398	**YES**	**YES**
13:00 - 14:00	2201	427	**YES**	**YES**
14:00 - 15:00	2341	379	**YES**	**YES**
15:00 - 16:00	2330	373	**YES**	**YES**
16:00 - 17:00	2469	467	**YES**	**YES**
17:00 - 18:00	2282	389	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

MEMORANDUM

TO: Ken Hansen, PE
MnDOT District 3 Traffic Engineer

FROM: Graham Johnson, PE, PTOE (Lic.MN, IA, SD)
Justin Anibas, PE (Lic. MN)

DATE: August 9, 2022

RE: TH 210 at N 8th Street Intersection Control Evaluation (ICE) Report
SEH No. MNT03 152201 14.00

INTRODUCTION

This memorandum summarizes the Intersection Control Evaluation (ICE) process for the intersection of Trunk Highway (TH) 210 and N 8th Street in Brainerd, Minnesota. The Minnesota Department of Transportation (MnDOT) ICE is an objective process used to investigate and determine the optimal traffic control that should be provided at an intersection to serve the existing conditions and future needs. This memorandum was prepared for MnDOT by SEH Inc.

As part of a project along TH 210 between Baxter Drive and Pine Shores Road, the intersection of TH 210 and N 8th Street was evaluated and is proposed to remain under traffic signal control after the project is complete.

The location of the study intersection for this ICE report is shown in **Figure 1**. The proposed intersection control for the TH 210 and N 8th Street intersection was analyzed based on safety, signal warrants, traffic operations, and pedestrian and bicycle accommodations.

The scope and content of this ICE report was reviewed and agreed to by MnDOT prior to the layout and ICE submittal process. This report summarizes the ICE process and recommendation for the TH 210 and N 8th Street intersection based on a Phase I analysis according to the *2017 MnDOT ICE Manual*.

APPROVAL

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.

_____ _____
Graham Johnson, PE, PTOE, MN License No. 45429 Date

Approved By:

_____ _____
MnDOT District 3 Traffic Engineer Date

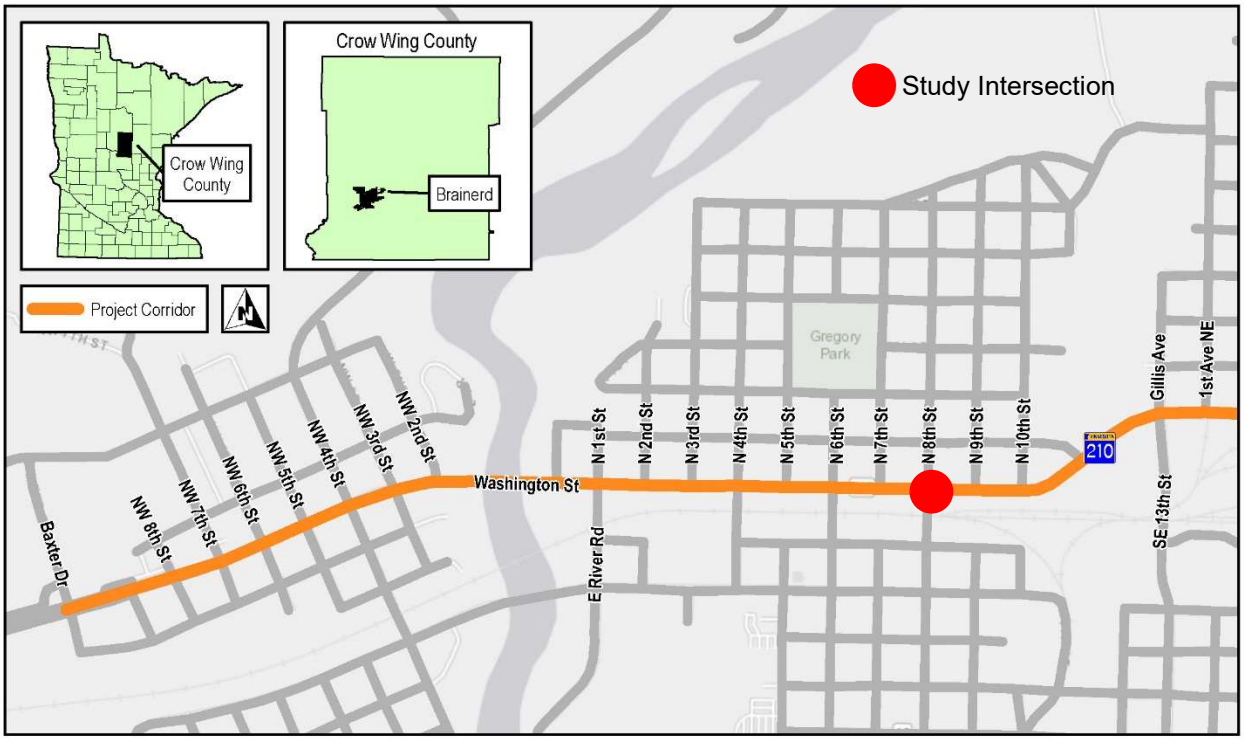
PROJECT DESCRIPTION

MnDOT is conducting the corridor planning study along a 3.9-mile segment of TH 210 to identify the future vision for highway corridor through Brainerd. Reconstruction of TH 210 between Baxter Drive and Pine Shores Road is anticipated to begin in 2025; SP 1805-80.

The primary purpose of the corridor study is to better understand the community issues, needs and use of the roadway, assess improvement options, select a preferred alternative, and prepare a geometric layout. The focus of the improvements is to improve pavement conditions and traveler safety, accommodate the Americans with Disabilities Act (ADA) requirements, and enhance pedestrian accommodations.

For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Figure 1 Project Location



EXISTING CONDITIONS

TH 210 is a major east-west principal arterial through the City of Brainerd that connects near-by cities and regional commerce. TH 210 is generally a 4-lane divided roadway through the City of Brainerd; the posted speed limit is 35 miles-per-hour (mph) at the study intersection.

N 8th Street is a major collector providing access to commercial and residential land uses to the south and residential land uses to the north of TH 210; the posted speed limit is 30 mph.

The nearest existing traffic signals along TH 210 include N 6th Street approximately 750 feet west and 13th Street/Gillis Avenue approximately 2,000 feet east.

Intersection Characteristics

The existing intersection currently operates with traffic signal control and includes marked pedestrian crossings on all four legs. Eastbound and westbound TH 210 left turns operate with protected left turn phasing only, while the minor approach left turns operate with protected and permissive left turn phasing.

The existing lane geometrics are described below and shown in **Figure 2**.

- Eastbound Approach: left turn lane, one through lane, and a shared through-right lane.
- Westbound Approach: left turn lane, one through lane, and a shared through-right lane.
- Northbound Approach: separate left, through, and right turn lanes.
  - Approach storage lanes are limited due to proximity of railroad crossing.
- Southbound Approach: separate left, through, and right turn lanes.

Figure 2 Existing Intersection

Traffic Volumes

TH 210 has an existing 2019 Average Annual Daily Traffic (AADT) volume of 26,000 vehicles west of the intersection. N 8th Street has an existing 2019 AADT of 2,050 vehicles to the north and 4,700 vehicles to the south.

The existing intersection turning movement data was collected in August of 2018 as part of a signal timing project along TH 210 and TH 371. **Figure 3** includes the existing AM and PM peak hour volumes; **Attachment 1** includes the raw existing intersection count data.

Crash Analysis

Intersection crash data for the study intersection was collected from the MnDOT Crash Mapping Analysis Tool (MnCMATv2) for a five-year period between 2014 and 2018 as part of the larger corridor study. The crash rate at an intersection is expressed as a number of crashes per million entering vehicles (MEV). The critical crash rate is a statistical value that is unique to each intersection and is based on vehicular exposure and the statewide average crash rate for similar intersections. An intersection with a

crash rate higher than the critical rate can indicate a safety concern at the intersection and the site should be further reviewed.

The intersection had a total of 31 crashes during the 5-year analysis period:

- 24 of the 31 crashes were rear end crashes: 16 of the rear end crashes were in the eastbound direction and 7 were in the westbound direction, and 1 northbound. This could indicate that backups are worse for eastbound vehicles and influenced by the high right turn volume in the shared through-right lane.
- 6 of the 31 crashes were right-angle crashes: all disregarded the traffic control or failure to yield.
- One pedestrian and one bicycle crash occurred on the west leg crossing TH 210.

Table 1 summarizes the crashes for the study intersection; additional crash information is provided in **Attachment 2**. Based on the crash rate, the intersection does not exceed the critical crash rate.

Table 1 Intersection Crash History (2014-2018)

TH 210 at:	Crash Severity					Crash Rates	
	Fatal & Severity A	Severity B	Severity C	Property Damage	Total	Int. Rate	Critical Rate
N 8th Street	0	3	4	24	31	0.61	1.01

PROPOSED CONDITIONS

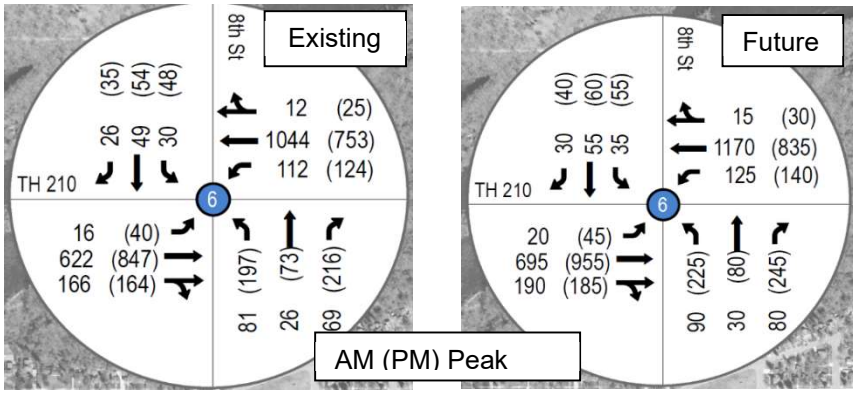
The current layout for the TH 210 corridor between Baxter Drive and Pine Shores Road addresses the needs and use of the roadway, improves pavement conditions, safety, and meets ADA requirements.

The TH 210 and N 8th Street intersection is located in a segment of the project that will primarily include reconstruction of the roadway, with modifications for full ADA compliance, wider sidewalks, and medians. Lane improvements include extending the westbound left turn lane on TH 210.

Future Traffic Volumes

Traffic forecasts were developed for the entire TH 210 corridor as part of the larger study effort. Future 2045 forecast volumes were developed based on a linear growth rate of 0.5% per year based on historical AADT volumes, population data, and input from the project team. **Figure 3** presents both the existing and future 2045 AM and PM peak intersection volumes.

Figure 3 Existing and Future 2045 Intersection Volumes



Warrant Analysis

Traffic control warrant analysis was conducted on the existing and future traffic volumes following the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) guidelines; all-way stop control warrants were not analyzed as it is not considered a viable control option along TH 210.

Warrants 1 (8-hour), 2 (4-hour), 3 (peak hour), and 7 (crash warrant) were included in the analysis. The following assumptions were used in the analysis:

- All minor street right turning volume was removed from the approaches.
- Warrant 7 was not applicable at the intersection due to insufficient correctable crashes.

The results of the traffic signal warrant analysis are provided in **Table 2**. The intersection currently meets Warrants 1, 2, and 3; the detailed signal warrant analysis is provided as **Attachment 3**.

Table 2 Traffic Signal Warrant Analysis Summary

MnMUTCD Signal Warrant	Hours Needed	Existing		Future 2045	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
Warrant 1A – 8-hour Minimum Volume	8	3	Not Met	5	Not Met
Warrant 1B – 8-hour Interruption of Flow	8	**10**	**MET**	**11**	**MET**
Combination of Warrant 1A and 1B	8	7	Not Met	**8**	**MET**
Warrant 2 – 4-hours	4	**10**	**MET**	**11**	**MET**
Warrant 3 – Peak Hour	1	**7**	**MET**	**10**	**MET**

System Limitations and Consistency

TH 210 is a principal arterial through the City of Brainerd that experiences heavy directional volumes in both the AM and PM peak hours, throughout the day, and in the summer months with high tourist traffic. The two adjacent major intersections are both currently signalized.

The study intersection is part of an existing TH 210 signal system coordinated to provide priority to the peak direction of flow, reduce mainline delays, and provide a high level of vehicle progression through the corridor. The coordinated signal system includes all existing traffic signals along TH 210 between TH 371, in the City of Baxter, and 4th Avenue NE in east Brainerd.

Due to limited right-of-way along the TH 210 corridor, expansion of the roadway to accommodate a larger intersection footprint is not feasible. Roundabout intersection control would result in major impacts to adjacent parcels and structures adjacent to the intersection and along the corridor.

In addition, both all-way stop control and roundabout control would alter the traffic flow along TH 210 and severely impede the progression of traffic from the adjacent coordinated signal systems.

Therefore, all-way stop and roundabout intersection control was not considered feasible for this intersection due to right-of-way limitations and the interruption to the existing coordinated signal system.

Traffic Operations

Evaluation of the intersection traffic operations were conducted as part of the overall corridor study using VISSIM software. The evaluation included analysis of the existing conditions, 2045 No Build conditions,

and the recommended 2045 Build conditions, which included extending the westbound left turn lane on TH 210.

The average delay per vehicle and Level of Service (LOS) results for each approach and the overall intersection are provided in **Table 3** for each scenario; all three scenarios include traffic signal control. For more detailed traffic information, see both the *Existing and 2045 No Build Conditions Report – TH 210/Washington Street Corridor Study* and the *TH 210 Build Conditions Report*.

Table 3 Traffic Operations Summary

Scenario	Peak Hour	Approach Delay (sec/veh / LOS)				Intersection Delay (sec/veh / LOS)
		Eastbound	Westbound	Northbound	Southbound	
Existing Conditions	AM	5.9 / A	15.4 / B	31.5 / C	**39.9 / D**	14.3 / B
	PM	7.5 / A	28.5 / C	32.8 / C	**40.2 / D**	21.2 / C
2045 No Build Conditions	AM	5.9 / A	14.2 / B	30.7 / C	**38.4 / D**	13.7 / B
	PM	9.1 / A	29.3 / C	**38.1 / D**	**43.5 / D**	23.3 / C
2045 Build Conditions	AM	10.4 / B	20.1 / C	26.6 / C	32.9 / C	17.8 / B
	PM	13.0 / B	29.5 / C	**35.9 / D**	**40.5 / D**	24.5 / C

Based on the results, the intersection is expected to operate at a LOS C or better in all scenarios. The minor street approaches operate with longer delays due to the long cycle length required for coordination along TH 210.

Extending the westbound left turn lane to approximately 420 feet allows the queued left turning vehicles to stack without blocking the westbound through lanes. The extension does require the N 9th Street intersections to be converted to a right-in/right-out (RI/RO) access. It should be noted; the Build conditions can operate slightly worse than the No Build conditions, this is due to more vehicles entering the intersection with improvements to the adjacent intersections along the corridor.

Pedestrian Considerations

The existing intersection provides crosswalks on all four legs of the intersection; however, the existing facilities are not ADA compliant.

As part of the TH 210 reconstruction project, the intersection will be improved to meet ADA requirements. New Accessible Pedestrian Systems (APS) pedestrian push buttons are proposed to be installed and made operational as part of this project, and all pedestrian curb ramps will be upgraded to be ADA compliant.

Revised Signal System

The existing signal system is vehicle actuated and coordinated along TH 210. The TH 210 left turn phases operate under protected phasing only; the minor street approaches have both protected and permissive left turn phasing.

As part of the signal replacement, the new signal system is to remain vehicle actuated and coordinated along TH 210. All four approaches will include Flashing Yellow Arrow (FYA) which provides the flexibility of running both protected and permissive phasing by time-of-day schedules on all approaches and improves the overall safety of the intersection.

RECOMMENDATION

Based on the analysis included in this report, and as part of the larger TH 210 corridor study, it is recommended to retain traffic signal control at the intersection of TH 210 and N 8th Street.

Traffic signal control is currently warranted at the intersection and traffic operations are acceptable in both the existing conditions and future forecast year. The improvements at the existing intersection will continue to provide a safe intersection for all users.

Roundabout and all-way stop control was not considered feasible at this intersection due to potential right-of-way constraints and impacts, and the impact to the coordinated signal system that provides positive vehicle progression along TH 210.

Attachment 1: Turning Movement Data
Attachment 2: Crash Data
Attachment 3: Warrant Analysis

cc: Luke Wehseler, PE MnDOT District 3
Zachary Whitley, PE MnDOT District 3

File Name: S:\2018\180119\TO OTHERS\TMC\PETRO\346_TH 210 AND 8TH STREET.ppd
Start Date: 8/23/2018
Start Time: 6:00:00 AM
Site Code: 00000346
Comment 1: 346_TH 210 AND 8TH STREET
Comment 2: 0
Comment 3: data by: Alliant Inc
Comment 4: TURN MOVEMENT COUNT

	BAXTER DRIVE Southbound				TH 210 Westbound				BAXTER DRIVE Northbound				TH 210 Eastbound			
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds
06:00 AM	3	0	5	0	1	63	0	1	6	1	2	1	0	45	4	1
06:15 AM	4	1	3	0	7	60	1	1	9	7	4	0	4	49	9	1
06:30 AM	8	6	5	0	11	125	0	1	9	10	8	0	5	93	20	0
06:45 AM	4	2	3	0	19	139	3	0	16	4	10	0	2	80	17	0
07:00 AM	3	7	5	0	17	82	0	0	12	4	9	0	1	97	21	0
07:15 AM	4	9	6	0	28	156	0	0	17	4	15	0	3	90	21	3
07:30 AM	9	18	5	0	28	171	3	0	20	5	22	0	6	115	35	1
07:45 AM	11	14	6	0	28	195	3	2	26	8	22	0	5	135	38	2
08:00 AM	7	11	9	0	28	180	1	1	16	5	11	0	4	105	29	0
08:15 AM	3	6	6	1	28	164	5	1	19	8	14	0	1	88	36	0
08:30 AM	11	8	6	0	34	179	5	1	30	6	9	0	6	92	40	1
08:45 AM	3	6	4	0	30	168	1	3	34	5	20	0	4	105	48	1
09:00 AM	3	9	7	1	23	155	1	2	27	5	22	0	2	100	29	1
09:15 AM	6	10	5	1	24	169	2	0	25	3	26	0	1	108	27	1
09:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10:30 AM	4	12	6	0	18	186	0	0	33	5	31	0	0	107	30	1
10:45 AM	7	11	5	0	31	191	1	4	39	13	29	0	4	103	16	3
11:00 AM	14	8	4	0	26	160	2	1	33	14	39	0	7	118	20	0
11:15 AM	15	5	7	0	23	152	0	2	23	13	45	0	3	127	11	1
11:30 AM	18	8	5	1	28	157	0	2	34	12	47	0	6	120	18	0
11:45 AM	12	16	5	1	39	135	5	2	46	11	49	0	5	130	16	1
12:00 PM	17	15	6	2	33	152	5	2	47	10	57	0	7	125	11	1
12:15 PM	18	18	8	1	24	166	3	2	43	9	57	0	3	123	17	2
12:30 PM	15	20	6	1	33	226	5	3	32	12	47	0	6	120	17	2
12:45 PM	17	10	7	0	32	211	4	7	27	11	38	0	2	119	19	1
01:00 PM	7	18	10	1	24	173	6	3	31	9	43	0	8	121	11	1
01:15 PM	20	8	11	2	23	193	3	0	35	11	40	0	4	112	13	4
01:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:30 PM	10	13	8	0	33	194	3	3	47	10	51	0	5	149	29	4
02:45 PM	8	14	5	0	22	171	4	4	35	10	47	0	9	176	25	1
03:00 PM	13	11	6	1	18	163	7	2	20	9	53	0	8	174	47	0
03:15 PM	11	10	10	0	18	161	2	3	32	10	25	0	1	178	34	4
03:30 PM	7	16	5	0	39	184	4	0	29	13	46	0	5	173	37	0
03:45 PM	14	14	9	0	31	167	8	6	35	9	43	0	8	161	43	2
04:00 PM	8	15	11	0	21	171	4	5	29	5	44	0	6	175	33	3
04:15 PM	12	7	10	2	22	195	4	4	43	11	51	0	4	167	40	3
04:30 PM	14	10	10	2	38	197	6	3	49	15	57	1	12	190	21	0
04:45 PM	10	19	10	0	26	196	8	0	50	19	50	0	5	183	46	0
05:00 PM	11	14	9	0	23	220	8	3	53	18	52	0	11	167	31	4
05:15 PM	13	11	6	0	37	200	3	0	45	21	57	1	12	181	39	4
05:30 PM	11	15	3	0	18	180	6	1	30	16	41	0	7	174	32	0
05:45 PM	9	4	9	2	22	157	10	5	25	6	24	0	9	163	29	2

Intersection Safety Screening

Intersection: TH 210 at N 8th Street

Crash Data: 2014 to 2018 (5-years)

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	3
Possible Injury	4
Property Damage	24
Total Crashes	31

Intersection Characteristics	
Entering Volume	28,030
Traffic Control	Signals
Environment	Urban
Speed Limit	35 mph

Annual crash cost = $204,880

Statewide Comparison

Signals: high volume, low speed

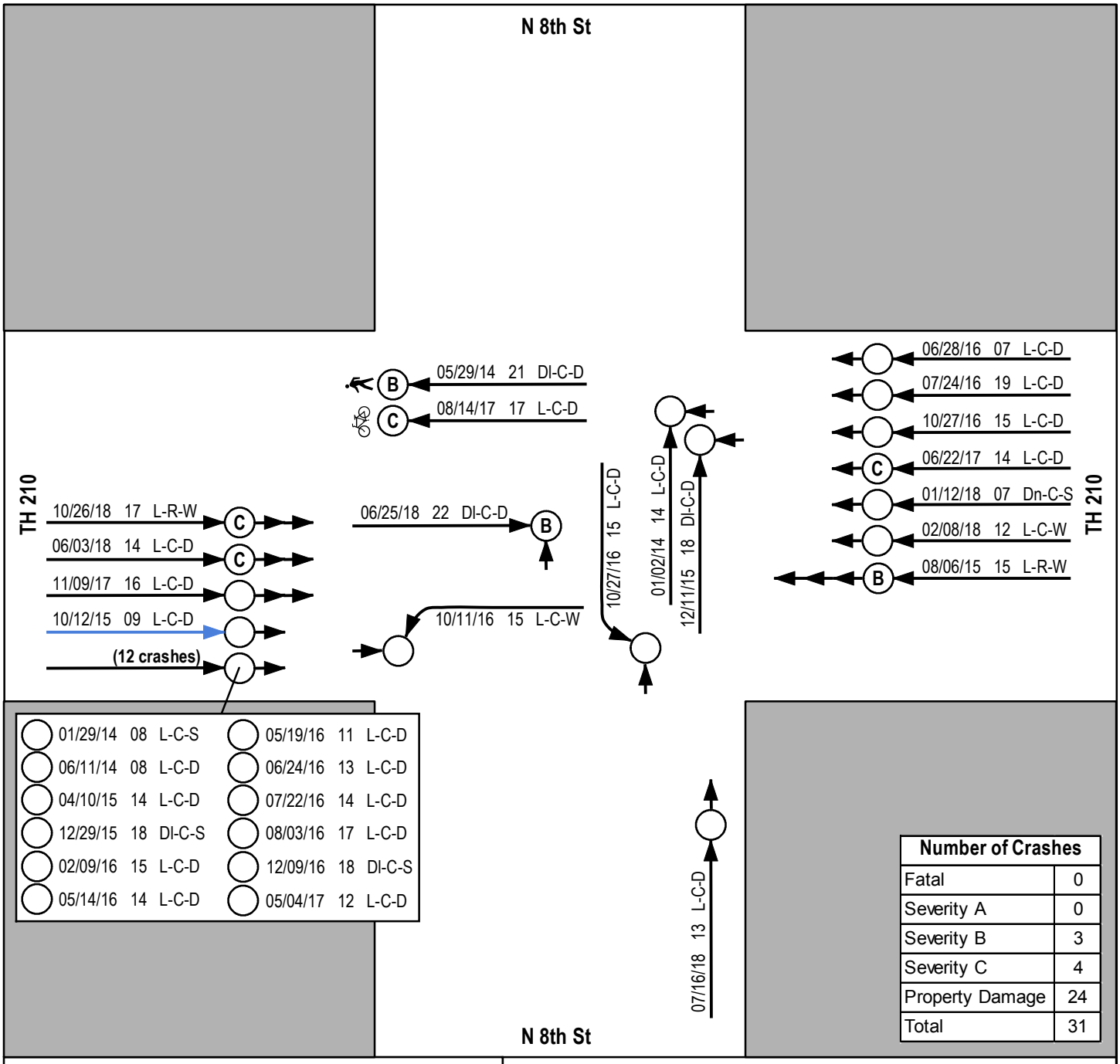
Total Crash Rate	
Observed	0.61
Statewide Average	0.70
Critical Rate	1.01
Critical Index	**0.60**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.76
Critical Rate	3.31
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.61 per MEV; this is 40% below the critical rate. Based on similar statewide intersections, an additional 21 crashes over the five years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.



Number of Crashes	
Fatal	0
Severity A	0
Severity B	3
Severity C	4
Property Damage	24
Total	31

Passenger Vehicle
Heavy Vehicle
Bus
Motorcycle
Fixed Object
Pedestrian
Bicycle

Fatal
Severity A
Severity B
Severity C
Property Damage Only
Vehicle Out of Control

Light
L = Daylight
Dn = Dawn
Du = Dusk
Dl = Dark, Lighted
Do = Dark, Lights Off
D = Dark, Unlighted
X = Unkown

Weather
C = Clear or Cloudy
R = Rain
S = Snow/Sleet/Hail/Freexing Rain
F = Fog/Smog/Smoke
B = Blowing Sand/Dust/Snow
W = Severe Cross Winds
X = Other or Unknown

Surface
D = Dry
W = Wet or Water
S = Snow/Slush/Ice
M = Muddy
Db = Debris
O = Oily
X = Other or Unkown

Date Time(Hr) Light-Weather-Surface → Injury Type → Other Vehicle(s)

Notes:

Project: MNT03 152201
Print Date: 3/2/2020

Map by: jdanibas
Projection:
Source:

Crash Diagrams (2014-2018)
TH 210 at N 8th St
TH 210/Washington Street Corridor Study
Brainerd, MN

Figure A6

Path: C:\Traffic Projects\Brainerd- TH 210\Crashes\Crash Diagrams\A6_TH 210 at N 8th St_Crash Diagram.mxd

2019 Existing - TH 210 at N 8th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 8th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	9551
35	Major App3:	TH 210 WB	3	10225
30	Minor App2:	N 8th St NB	3	1927
30	Minor App4:	N 8th St SB	3	992

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	378	467	62	28	845	62	YES / NO	NO / NO	YES / NO
7:00 - 8:00	766	980	96	75	1746	96	YES / NO	YES / NO	YES / NO
8:00 - 9:00	626	1043	123	55	1669	123	YES / NO	**YES / YES**	YES / NO
9:00 - 10:00	612	738	128	60	1350	128	YES / NO	**YES / YES**	YES / NO
10:00 - 11:00	680	808	173	69	1488	173	YES / NO	**YES / YES**	**YES / YES**
11:00 - 12:00	786	861	186	96	1647	186	YES / NO	**YES / YES**	**YES / YES**
12:00 - 13:00	878	944	191	130	1822	191	YES / NO	**YES / YES**	**YES / YES**
13:00 - 14:00	840	820	176	106	1660	176	YES / NO	**YES / YES**	**YES / YES**
14:00 - 15:00	967	874	200	94	1841	200	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1028	1023	157	96	2051	157	YES / NO	**YES / YES**	YES / NO
16:00 - 17:00	1066	875	221	95	1941	221	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	924	792	214	88	1716	214	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**9551**	**10225**	**1927**	**992**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	**10**	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	3	8	Not satisfied
Warrant 1B	Interruption of Continuous Flow	**10**	8	**Satisfied**
1A & 1B	Combination of Warrants	7	8	Not satisfied
Warrant 2	**Four Hour Volumes**	**10**	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	**7**	1	**Satisfied**
Warrant 7	**Crash Experience**	**11**	8	Crashes Insufficient

COMMENTS:

2019 Existing - TH 210 at N 8th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 8th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	9551
35	Major App3:	TH 210 WB	3	10225
30	Minor App2:	N 8th St NB	3	1927
30	Minor App4:	N 8th St SB	3	992

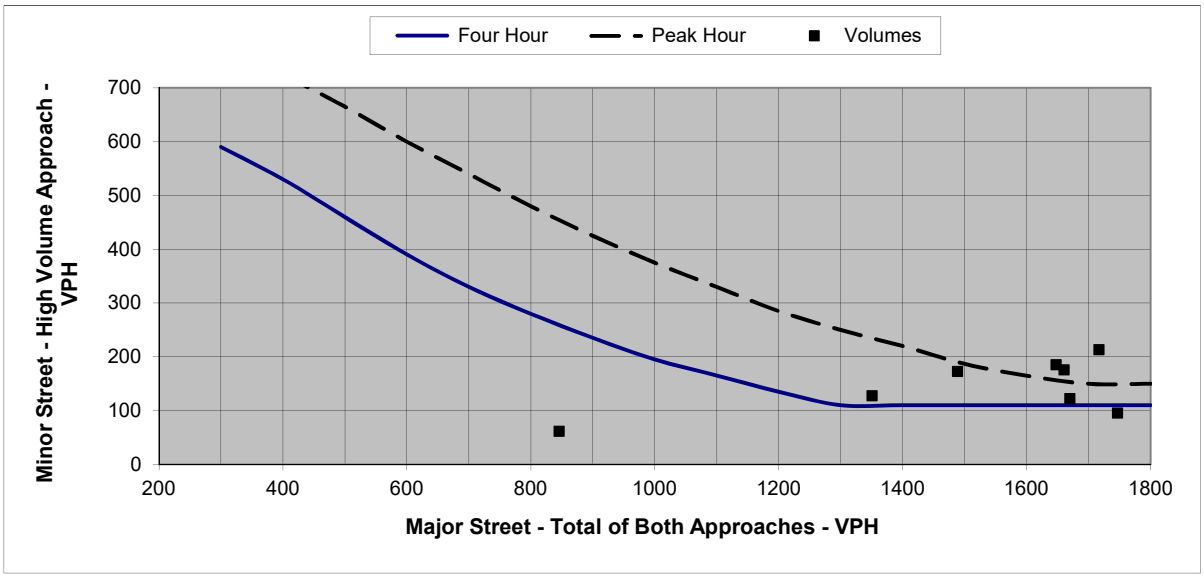


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria (Graph)		
Major Approach	Minor App. Four Hour	Minor App. Peak Hour
200		
300	590	
400	530	725
500	460	665
600	390	600
700	330	540
800	280	480
900	235	425
1000	195	375
1100	165	330
1200	135	285
1300	110	250
1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	845	62	NO	NO
7:00 - 8:00	1746	96	NO	NO
8:00 - 9:00	1669	123	**YES**	NO
9:00 - 10:00	1350	128	**YES**	NO
10:00 - 11:00	1488	173	**YES**	NO
11:00 - 12:00	1647	186	**YES**	**YES**
12:00 - 13:00	1822	191	**YES**	**YES**
13:00 - 14:00	1660	176	**YES**	**YES**
14:00 - 15:00	1841	200	**YES**	**YES**
15:00 - 16:00	2051	157	**YES**	**YES**
16:00 - 17:00	1941	221	**YES**	**YES**
17:00 - 18:00	1716	214	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO

2045 Future - TH 210 at N 8th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 8th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020
OPERATOR: JDA

85th% Speed	Approach	Description	Lanes	Approach
35	Major App1:	TH 210 EB	3	10792
35	Major App3:	TH 210 WB	3	11554
30	Minor App2:	N 8th St NB	3	2178
30	Minor App4:	N 8th St SB	3	1121

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**
CORRECTABLE CRASHES: (12-month period)	0

	Minimum Volume Requirement		
	1A	1B	1A&B (80%)
Major Total	600	900	720
Minor Approach	200	100	160

HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3)	MAX MINOR APPROACH (APP. 2 or 4)	WARRANT 1A - 8 hr MAJOR/MINOR	WARRANT 1B - 8 hr MAJOR/MINOR	WARRANT 1A & B MAJOR/MINOR
0:00 - 1:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
1:00 - 2:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
2:00 - 3:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
3:00 - 4:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
4:00 - 5:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
5:00 - 6:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
6:00 - 7:00	427	528	70	32	955	70	YES / NO	YES / NO	YES / NO
7:00 - 8:00	866	1108	108	85	1974	108	YES / NO	**YES / YES**	YES / NO
8:00 - 9:00	707	1179	140	61	1886	140	YES / NO	**YES / YES**	YES / NO
9:00 - 10:00	692	834	145	68	1526	145	YES / NO	**YES / YES**	YES / NO
10:00 - 11:00	768	913	196	77	1681	196	YES / NO	**YES / YES**	**YES / YES**
11:00 - 12:00	888	973	210	109	1861	210	**YES / YES**	**YES / YES**	**YES / YES**
12:00 - 13:00	992	1066	216	148	2058	216	**YES / YES**	**YES / YES**	**YES / YES**
13:00 - 14:00	950	927	199	120	1877	199	YES / NO	**YES / YES**	**YES / YES**
14:00 - 15:00	1093	988	226	106	2081	226	**YES / YES**	**YES / YES**	**YES / YES**
15:00 - 16:00	1161	1156	177	109	2317	177	YES / NO	**YES / YES**	**YES / YES**
16:00 - 17:00	1205	988	249	107	2193	249	**YES / YES**	**YES / YES**	**YES / YES**
17:00 - 18:00	1043	894	242	99	1937	242	**YES / YES**	**YES / YES**	**YES / YES**
18:00 - 19:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
19:00 - 20:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
20:00 - 21:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
21:00 - 22:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
22:00 - 23:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
23:00 - 24:00	0	0	0	0	0	0	NO / NO	NO / NO	NO / NO
Daily	**10792**	**11554**	**2178**	**1121**					

		Met (Hr)	Required (Hr)	WARRANT MET:
Warrant 1	**Eight Hour Volumes**	**11**	8	**Satisfied**
Warrant 1A	Minimum Vehicular Volume	5	8	Not satisfied
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1A & 1B	Combination of Warrants	**8**	8	**Satisfied**
Warrant 2	**Four Hour Volumes**	**11**	4	**Satisfied**
Warrant 3	**Peak Hour Volumes**	**10**	1	**Satisfied**
Warrant 7	**Crash Experience**	**11**	8	Crashes Insufficient

COMMENTS:

2045 Future - TH 210 at N 8th St
SIGNAL WARRANT
ANALYSIS

LOCATION: TH 210 at N 8th St
COUNTY: Crow Wing
REF. POINT: 0
DATE: 3/12/2020

OPERATOR: JDA

40 MPH OR FASTER?	NO
POPULATION < 10,000?	NO
VOLUME REQ. AT 70%?	**NO**

85th% Speed	Approach	Description	Lanes	Approach
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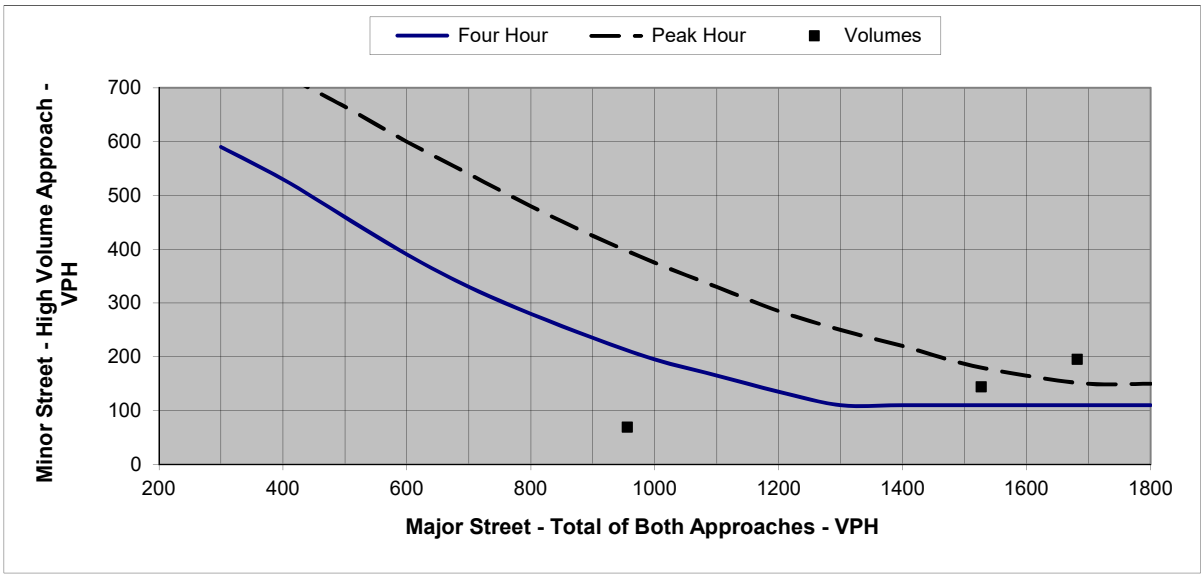

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1400	110	220
1500	110	187
1600	110	165
1700	110	150
1800	110	150

Actual Hourly Count			Warrants Met: Warrant 2	Warrant 3
HOUR	Sum Major App.	Max Minor App.	Four Hour	Peak Hour
0:00 - 1:00	0	0	NO	NO
1:00 - 2:00	0	0	NO	NO
2:00 - 3:00	0	0	NO	NO
3:00 - 4:00	0	0	NO	NO
4:00 - 5:00	0	0	NO	NO
5:00 - 6:00	0	0	NO	NO
6:00 - 7:00	955	70	NO	NO
7:00 - 8:00	1974	108	**YES**	**YES**
8:00 - 9:00	1886	140	**YES**	**YES**
9:00 - 10:00	1526	145	**YES**	NO
10:00 - 11:00	1681	196	**YES**	**YES**
11:00 - 12:00	1861	210	**YES**	**YES**
12:00 - 13:00	2058	216	**YES**	**YES**
13:00 - 14:00	1877	199	**YES**	**YES**
14:00 - 15:00	2081	226	**YES**	**YES**
15:00 - 16:00	2317	177	**YES**	**YES**
16:00 - 17:00	2193	249	**YES**	**YES**
17:00 - 18:00	1937	242	**YES**	**YES**
18:00 - 19:00	0	0	NO	NO
19:00 - 20:00	0	0	NO	NO
20:00 - 21:00	0	0	NO	NO
21:00 - 22:00	0	0	NO	NO
22:00 - 23:00	0	0	NO	NO
23:00 - 24:00	0	0	NO	NO