

Intersection Control Evaluation Report

TH 2 at Johnson Avenue

**February 2025
MnDOT District 2**

SEI No. T-01191



Intersection Control Evaluation (ICE)

MnDOT District 2

Intersection Control Evaluation (ICE)

For

TH 2 & Johnson Avenue

Fosston, MN

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

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Table of Contents

Contents

| | | |
|-----|--|----|
| 1.0 | Proposed Project Description | 1 |
| 2.0 | Existing Traffic | 3 |
| 3.0 | Future Traffic..... | 4 |
| 4.0 | Intersection Safety Evaluation | 4 |
| 5.0 | Warrant Analysis | 6 |
| 6.0 | Traffic Operations | 8 |
| 6.1 | Level of Service | 8 |
| 6.2 | Vehicle Queuing..... | 9 |
| 6.3 | Intersection Operational Analysis | 9 |
| 7.0 | Scenario Analysis..... | 17 |
| 7.1 | Signal (existing condition) at Johnson | 17 |
| 7.2 | Thru-Stop at Johnson..... | 17 |
| 7.3 | All-way Stop at Johnson | 18 |
| 8.0 | Recommendation..... | 19 |

1.0 Proposed Project Description

MnDOT is making improvements to the Trunk Highway (TH) 2 corridor in the City of Fosston from Omland Avenue to the east city limits. The project limits include the intersection of TH 2 and Johnson Avenue, which is currently a signalized intersection located near the midpoint of the project corridor. Johnson Avenue is also Polk County State Aid Highway (CSAH) 1 to the south and CSAH 6 to the north.

The intent of this document is to analyze existing and alternative intersection controls at TH 2 and Johnson Avenue. It is important that the solution maintains acceptable intersection operations for all intersections along the corridor and ensures the corridor's ability to accommodate future needs. Pedestrian and bicycle traffic are significant attributes within the corridor and will be considered.

This document examines the following intersection control options for the TH 2 and Johnson Avenue intersection:

- Thru-stop control (with existing intersection geometrics)
- All-way stop control (with existing intersection geometrics)
- Signal control (existing condition)

A roundabout alternative was not analyzed due to right-of-way restrictions and the corresponding high level of impact on buildings and businesses as a result of property acquisitions.

The intersection of TH 2 and Johnson is located in the city of Fosston, MN in Polk County, with commercial land use surrounding the intersection. It is currently a 4-leg, signalized intersection. TH 2 is an east/west 3-lane roadway with a posted speed limit of 30 mph. TH 2 has one thru lane and one left-turn lane on each leg. Johnson Avenue is a 2-lane roadway with a posted speed limit of 30 mph. Johnson Avenue does not have dedicated turn lanes, although the roadway is wide to accommodate on-street parking further down the roadway.

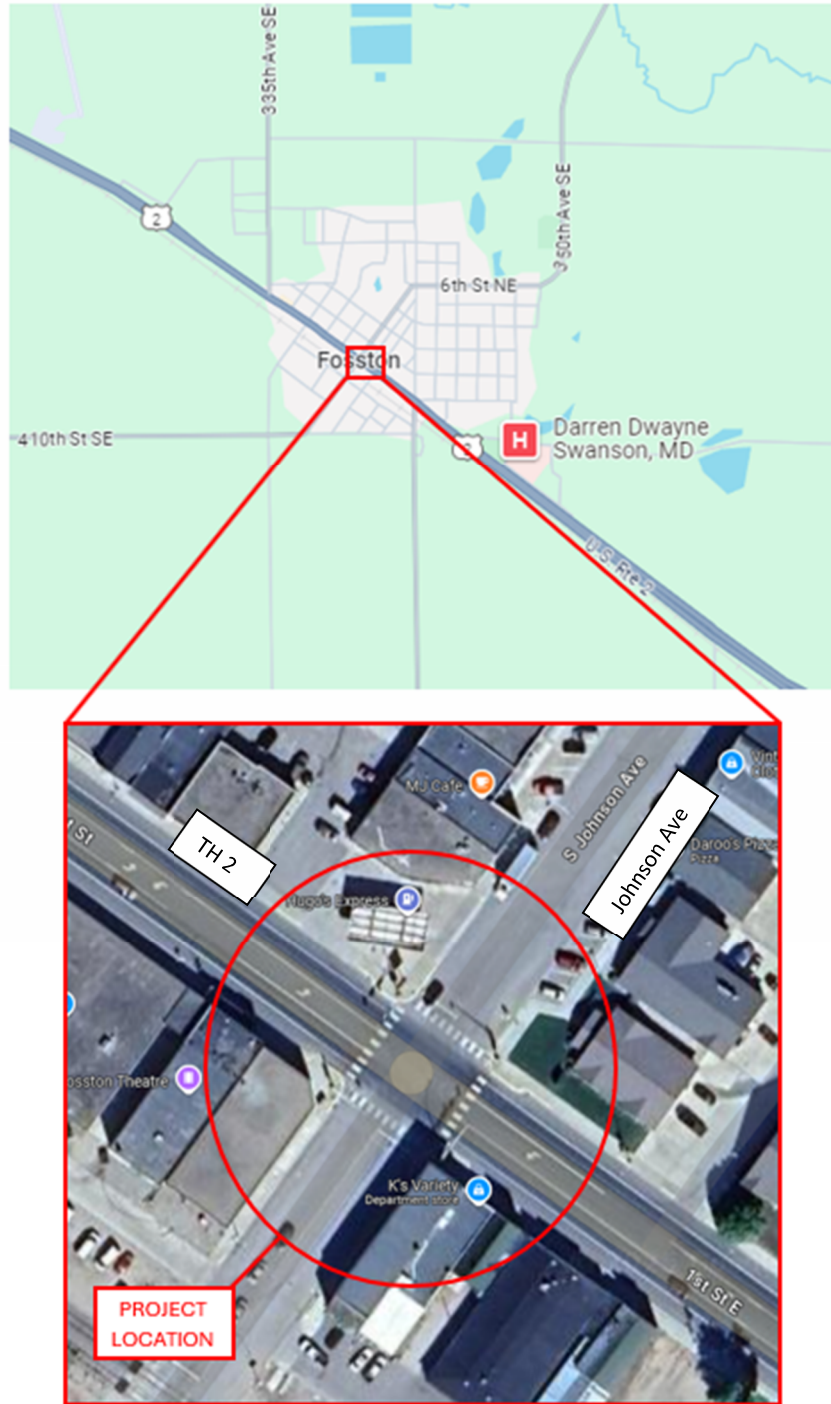


Figure 1 – TH 2 and Johnson Avenue Project and Intersection Location Map

2.0 Existing Traffic

The 2023 AADT on the east and west legs of TH 2 was 5,180, obtained from MnDOT's Traffic Data System. The 2024 AADT on Johnson Avenue was 1,360, obtained from traffic counts taken by Stonebrooke Engineering. Turning movement counts were collected on October 8, 2024.

The AM Peak hour was determined to be 10:30 AM – 11:30 AM and the PM Peak hour was determined to be 4:30 PM – 5:30 PM. The turning movement counts are summarized in **Table 1** and complete turning movement counts are included in **Appendix A**.

Table 1 – 2024 Peak Hour Turning Movement Counts

| Intersection | Time Period | Johnson Ave | | | | TH 2 | | | | Johnson Ave | | | | TH 2 | | | |
|--------------------|-------------|-------------|----|----|----|-----------|----|-----|----|-------------|----|----|----|-----------|----|-----|----|
| | | Southbound | | | | Westbound | | | | Northbound | | | | Eastbound | | | |
| | | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| TH 2 & Johnson Ave | AM | 0 | 33 | 21 | 28 | 0 | 12 | 153 | 20 | 0 | 12 | 22 | 19 | 0 | 17 | 140 | 6 |
| | PM | 0 | 35 | 20 | 37 | 0 | 27 | 158 | 30 | 0 | 26 | 31 | 50 | 0 | 34 | 200 | 11 |

Because of the location of the intersection, and the propensity for a seasonal peak during the weekends, a seasonal peak was determined and analyzed. MnDOT provided the seasonal counts which were collected in July 2024. A Sunday count was used because it provided a larger volume of vehicles than a Friday count. Seasonal turning movement counts are summarized in **Table 2** and complete turning movement counts are included in **Appendix A**.

Table 2 – 2024 Seasonal Peak Hour Turning Movement Counts

| Intersection | Time Period | Johnson Ave | | | | TH 2 | | | | Johnson Ave | | | | TH 2 | | | |
|--------------------|-------------|-------------|----|----|----|-----------|----|-----|----|-------------|----|----|----|-----------|----|-----|---|
| | | Southbound | | | | Westbound | | | | Northbound | | | | Eastbound | | | |
| | | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| TH 2 & Johnson Ave | AM | 0 | 34 | 16 | 44 | 0 | 9 | 184 | 9 | 0 | 18 | 37 | 14 | 0 | 14 | 269 | 6 |
| | PM | 0 | 28 | 23 | 31 | 0 | 11 | 239 | 22 | 0 | 26 | 26 | 21 | 0 | 26 | 381 | 9 |

3.0 Future Traffic

2044 forecasted AADT's for TH 2 were obtained from linear regression analysis using MnDOT historical AADT data. The existing and projected AADT's are provided in **Table 3**.

Table 3 – Existing and Projected Average Annual Daily Traffic (AADT)

| Approach | 2023 | 2044 | Compound Growth Rate | Annual Growth Rate |
|-------------------------|-------|-------|----------------------|--------------------|
| TH 2 (Omland to Granum) | 5,180 | 5,830 | 1.13 | 0.6% |
| Johnson Ave N** | 2,020 | 2,220 | 1.10 | 0.5% |
| Johnson Ave S** | 1,360 | 1,500 | 1.10 | 0.5% |

**2024 Count

The annual growth rates were calculated from the prior year and existing AADT's and applied to the 2024 turning movement counts to calculate the projected 2044 turning movement counts. The 2044 peak hour turning movement counts are summarized in **Table 4** and the Seasonal 2044 peak hour turning movement counts are summarized in **Table 5**.

Table 4 – 2044 Peak Hour Turning Movement Counts

| Intersection | Time Period | Johnson Ave | | | | TH 2 | | | | Johnson Ave | | | | TH 2 | | | |
|--------------------|-------------|-------------|----|----|----|-----------|----|-----|----|-------------|----|----|----|-----------|----|-----|----|
| | | Southbound | | | | Westbound | | | | Northbound | | | | Eastbound | | | |
| | | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| TH 2 & Johnson Ave | AM | 0 | 37 | 24 | 31 | 0 | 14 | 172 | 23 | 0 | 14 | 25 | 21 | 0 | 20 | 157 | 7 |
| | PM | 0 | 39 | 23 | 41 | 0 | 31 | 177 | 34 | 0 | 29 | 35 | 56 | 0 | 39 | 224 | 13 |

Table 5 – Seasonal 2044 Peak Hour Turning Movement Counts

| Intersection | Time Period | Johnson Ave | | | | TH 2 | | | | Johnson Ave | | | | TH 2 | | | |
|--------------------|-------------|-------------|----|----|----|-----------|----|-----|----|-------------|----|----|----|-----------|----|-----|----|
| | | Southbound | | | | Westbound | | | | Northbound | | | | Eastbound | | | |
| | | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| TH 2 & Johnson Ave | AM | 0 | 38 | 18 | 49 | 0 | 11 | 206 | 11 | 0 | 20 | 41 | 16 | 0 | 16 | 302 | 7 |
| | PM | 0 | 31 | 26 | 35 | 0 | 13 | 268 | 25 | 0 | 29 | 29 | 24 | 0 | 30 | 427 | 11 |

4.0 Intersection Safety Evaluation

One measure to assess the safety performance at intersections is crash rate, which is displayed as number of crashes per million entering vehicles (MEV).

There were 3 reported crashes at the intersection between 7/1/2019 and 6/30/2024. All crashes were property damage only, with the crash types being a left-turn crash, a sideswipe crash, and a rear-end crash involving a vehicle that was parked on TH 2. The five-year crash experience corresponds to an observed

crash rate of 0.24. See **Appendix B** for a detailed intersection crash report. **Table 5** displays statewide average crash rates for similar intersections and various forms of intersection traffic control.

Table 5- Average Crash Rates for Intersection Traffic Control Types

| Intersection Traffic Control | Statewide Average Crash Rate ¹ |
|------------------------------|---|
| Thru-Stop | 0.14 |
| All-way Stop | 0.31 |
| Signalized | 0.64 |

¹ Statewide Crash rates (CR) for thru-stop, all-way stop, signal and roundabout are from MnDOT 2023 Traffic Safety Toolkit, 5 Years of Data

According to the 2023 Trunk Highway Intersection Toolkit, the average crash rate for a signalized intersection is 0.64, indicating that the crash rate at the intersection of TH 2 and Johnson Avenue is lower than the state average.

A critical crash rate is also considered to be a highly effective technique for identifying hazardous locations. The critical crash rate accounts for key variables such as the design of the facility, type of intersection control, amount of exposure, and the random nature of crashes. The concept suggests that if an observed crash rate is above the critical rate (critical index is greater than one), then the location is considered to be unsafe and there is a high probability that conditions at the site are contributing to the higher crash rate. **Table 6** displays the observed and critical crash rates, and critical index for the intersection.

Table 6 - Intersection Critical Crash Rate Analysis Results

| Intersection | Control Type | Observed Crash Rate | Critical Crash Rate | Critical Index |
|-----------------------|--------------|---------------------|---------------------|----------------|
| US 2 & Johnson Avenue | Signal | 0.24 | 1.27 | 0.19 |

The analysis shows there is not currently a site-specific crash problem at the intersection of TH 2 and Johnson Avenue.

For comparison purposes, **Table 7** shows the observed and critical crash rates, and critical index for other intersections along the corridor.

Table 7 - Intersection Critical Crash Rate Analysis Results

| Intersection | Control Type | Observed Crash Rate | Critical Crash Rate | Critical Index |
|------------------------|--------------|---------------------|---------------------|----------------|
| US 2 & Omland Avenue | thru-stop | 0.11 | 0.52 | 0.20 |
| US 2 & Mark Avenue | thru-stop | 0.00 | 0.00 | 0.00 |
| US 2 & Kaiser Avenue | thru-stop | 0.10 | 0.50 | 0.20 |
| US 2 & Inderlee Avenue | thru-stop | 0.00 | 0.00 | 0.00 |
| US 2 & Granum Avenue | thru-stop | 0.17 | 0.47 | 0.36 |

5.0 Warrant Analysis

Traffic signals are warranted based on specific criteria that determine whether a signal is necessary for safety and efficient operations at an intersection. These criteria are generally based on traffic volume, crash history, and specific conditions related to the intersection. The guidelines for warranting traffic signals are outlined in the *Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD)*. Traffic signals that are installed without meeting warrants can lead to negative consequences such as increased traffic congestion, increased rear-end crashes, reduced driver attention, increased fuel consumption and pollution, increased vehicle operating costs, and increased intersection maintenance costs.

The MnMUTCD identifies 9 signal warrants:

- Warrant 1 – Eight-Hour Vehicular Volume
- Warrant 2 – Four-Hour Vehicular Volume
- Warrant 3 – Peak Hour
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing
- Warrant 6 – Coordinated Signal System
- Warrant 7 – Crash Experience
- Warrant 8 – Roadway Network
- Warrant 9 – Intersection Near a Grade Crossing

Traditionally, Warrant 1 (Eight Hour Vehicular Volume Warrant) or Warrant 7 (Crash Experience) need to be met in order to justify the installation and use of a traffic signal at an intersection.

A warrant analysis was completed with the traffic volumes collected in October 2024. MnDOT factors were applied to the single-day count from October to create turning movement counts that represent a yearly average. The factors used are provided by MnDOT's Transportation Data and Analysis Office and can be found in **Appendix C**. The same factors were applied to the 2044 projected counts.

To ensure the analysis was accurately calculating a yearly average, traffic volumes collected in July 2024 were also used in the same manner. The appropriate factor from the table in **Appendix C** was applied to the July 2024 numbers, to again create turning movement counts that represent a yearly average.

These factored volumes were used to analyze the applicable Warrants. The results are shown in **Table 7** and included in **Appendix C**. The analysis followed guidelines laid out in the MnMUTCD for signalized intersection control.

Table 7 – Signal Warrant Results

| WARRANT # | WARRANT NAME | CRITERIA | Results Using Yearly Ave Traffic Based on July 2024 Counts | Forecasted July 2044 | Results Using Yearly Ave Traffic Based on Oct. 2024 Counts | Forecasted October 2044 |
|-----------|------------------------------------|---|--|--------------------------|--|--------------------------|
| 1 | Eight-Hour Vehicular Volume | meet volume criteria for 8 hours in a day | 2/8 hours not met | 5/8 hours not met | 1/8 hours not met | 3/8 hours not met |
| 2 | Four-Hour Vehicular Volume | meet volume criteria for 4 hours in a day | 0/4 hours not met | 0/4 hours not met | 0/4 hours not met | 0/4 hours not met |
| 3 | Peak Hour | meet volume criteria for Peak Hour of day | 0/1 hours not met | 0/1 hours not met | 0/1 hours not met | 0/1 hours not met |
| 4 | Pedestrian Volume | minimum of 75 peds in an hour for 4 hours | 0/4 hours not met | 0/4 hours not met | 0/4 hours not met | 0/4 hours not met |
| 5 | School Crossing | minimum of 20 students crossing in an hour | 0/1 hours not met | 0/1 hours not met | 0/1 hours not met | 0/1 hours not met |
| 6* | Coordinated Signal System | where progressive movement is needed between other signals | - | - | - | - |
| 7 | Crash Experience | 5 or more correctable crashes in a 12-month period | 3 crashes/ 5 years | - | 3 crashes/ 5 years | - |
| 8** | Roadway Network | Intersection between two or more major routes | - | - | - | - |
| 9*** | Intersection Near a Grade Crossing | Intended for use at a location in close proximity to a grade crossing | - | - | - | - |

* Warrant 6 does not apply since there are not other signals in the area.

**Warrant 8 does not apply since it does not meet threshold of 1,000 entering vehicles in a peak hour.

***Warrant 9 does not apply since the Grade-Crossing to the south and signal are not tied together.

In addition to signal warrants, the MnMUTCD identifies a warrant for all-way stop control at intersections. Criteria used in all-way stop warrants include vehicle volumes, accident history, and delay. The warrant analysis for the all-way stop condition is included in **Appendix C**.

The intersection does not meet all-way stop warrants for any of the scenarios mentioned above.

6.0 Traffic Operations

Traffic operations analysis was completed for the project timeframe scenarios of 2024 and 2044 for both the AM and PM peak hours and Seasonal 2024 and 2044 for both the AM and PM peak hours. The intersection operation study was conducted based on the methodology of the Highway Capacity Manual utilizing Synchro/SimTraffic software. The following scenarios were modeled:

1. Signal (existing condition)
2. Thru-stop (with existing geometrics)
3. All-way stop (with existing geometrics)

The results of the analysis are displayed as measures of effectiveness. Measures of effectiveness establish quantitative information about the performance of an intersection. The primary measures that are used in this study are level of service and delay.

Since Johnson Avenue is centralized in the corridor, the whole corridor was analyzed in Synchro/SimTraffic to better understand how the different intersection control alternatives at Johnson Avenue affected operations along the rest of the corridor. The other intersections included in the analysis are Omland Avenue, Mark Avenue, Kaiser Avenue, Inderlee Avenue, and Granum Avenue. With this project, the current intersection configuration at Granum Avenue would be reconstructed to create two perpendicular intersections rather than the 5-legged intersection that exists today. It is anticipated that the reconfiguration of Granum Avenue will result in improved operations and reduce delay time due to the elimination of the skewed approaches and the 5-legged intersection. The proposed condition is not included in the 2044 traffic analysis.

6.1 Level of Service

Operational analysis results are described as a Level of Service (LOS) ranging from "A" to "F" with "A" operating with the least delay and "F" indicating a breakdown in operation. These letters serve to describe a range of operating conditions for different types of facilities. Levels of Service are determined based on methodology from the Highway Capacity Manual, which defines the LOS based on control delay. Control delay is the wait time experienced by vehicles slowing down for an intersection, plus stopped time, plus the time for a vehicle to speed up and traverse the intersection control into the traffic stream. The average intersection control delay is a volume weighted average of delay experienced by all motorists entering the intersections on all approaches for a signalized intersection. LOS "D" is commonly taken as an acceptable design year LOS. The LOS and its associated intersection delay for signalized and un-signalized intersections are presented in **Table 8**. The LOS delay thresholds for un-signalized intersections are lower than signalized intersections, which accounts for the fact that drivers tend to accept longer

delays at signals compared to stop signs. This concept is more defined in the 2022 Highway Capacity Manual.

Note that intersection LOS is not defined by the HCM for thru-stop control intersections. This is because the minor approaches with relatively low percentages of overall traffic could experience excessive delays, while the mainline could experience little or no delay. The result likely would be low overall intersection delay, which on its face would indicate acceptable operations, when individual stop-controlled movements could be failing.

Table 8 - Level of Service by Range of Delay

| LOS | Unsignalized Intersection | Signalized Intersection |
|-----|----------------------------------|----------------------------------|
| | Control Delay Per Vehicle (sec.) | Control Delay Per Vehicle (sec.) |
| A | ≤ 10 | ≤ 10 |
| B | > 10 and ≤ 15 | > 10 and ≤ 20 |
| C | > 15 and ≤ 25 | > 20 and ≤ 35 |
| D | > 25 and ≤ 35 | > 35 and ≤ 55 |
| E | > 35 and ≤ 50 | > 55 and ≤ 80 |
| F | > 50 | > 80 |

6.2 Vehicle Queuing

Queuing analysis results are described with 95th percentile queue length in feet. The 95th percentile queue length is the queue length that only 5% of the vehicle queue lengths exceed. This ensures design infrastructure can handle most traffic conditions without having to plan for the worst-case scenario, which can be expensive.

The average space that a vehicle occupies in a queue is 25-30 feet, this includes the size of the vehicle and the spacing between it and the vehicle in front of it. A queue length of 100 feet is the same as a queue length comprised of 3-4 passenger vehicles.

6.3 Intersection Operational Analysis

The scenarios were analyzed using the operations described previously for the 2024 and 2044 scenarios, for AM and PM peak hours and 2024 and 2044 Seasonal for AM and PM peak hours. Below is a summary of what the following tables summarize:

- **Table 9** - 2024 and 2044 operational conditions with the existing signal control at Johnson Ave
- **Table 10** - 2024 and 2044 operational conditions with a thru-stop control and Johnson Ave
- **Table 11** - 2024 and 2044 operational conditions with an all-way stop control at Johnson Ave
- **Table 12** – 2024 and 2044 Seasonal operational conditions with the existing signal control at Johnson Ave
- **Table 13** - 2024 and 2044 Seasonal operational conditions with a thru-stop control and Johnson Ave

- **Table 14** - 2024 and 2044 Seasonal operational conditions with an all-way stop control at Johnson Ave

In addition to the Vehicle Delay discussed above, the tables summarize the 95th percentile queue for each movement at each intersection.

Synchro traffic operation modeling software output is included in **Appendix D**.

Table 9 - Intersection Operations Summary – Signal control (existing) at Johnson Ave

| Intersection | Year | Period | Average Intersection Delay (s) | Intersection LOS ¹ | Worst Movement | | | 95th Queue (ft) | | | | |
|---------------------------------|------|--------|--------------------------------|-------------------------------|----------------|-----------|-----|-----------------|----|----|-----|--------|
| | | | | | Movement | Delay (s) | LOS | EB | NB | SB | WB | WB 1st |
| TH 2 & Omland Ave (Thru-stop) | 2024 | AM | 1.8 | n/a | SB Left | 7.8 | A | 7 | 22 | 42 | 0 | - |
| | | PM | 2.0 | n/a | SB Left | 8.7 | A | 14 | 16 | 45 | 3 | - |
| | 2044 | AM | 2.0 | n/a | SB Thru | 9.6 | A | 16 | 27 | 46 | 5 | - |
| | | PM | 2.1 | n/a | NB Thru | 10.8 | B | 22 | 22 | 49 | 5 | - |
| TH 2 & Mark Ave (Thru-stop) | 2024 | AM | 1.0 | n/a | NB & SB Thru | 7.1 | A | 6 | 10 | 40 | 31 | - |
| | | PM | 1.3 | n/a | NB Left | 8.2 | A | 7 | 43 | 37 | 24 | - |
| | 2044 | AM | 1.1 | n/a | SB Thru | 7.4 | A | 8 | 42 | 34 | 15 | - |
| | | PM | 1.7 | n/a | NB & SB Thru | 8.1 | A | 8 | 44 | 54 | 28 | - |
| TH 2 & Kaiser Ave (Thru-stop) | 2024 | AM | 1.5 | n/a | SB Thru | 7.3 | A | 29 | 7 | 29 | 27 | - |
| | | PM | 1.4 | n/a | NB Thru | 8.8 | A | 20 | 31 | 29 | 17 | - |
| | 2044 | AM | 1.4 | n/a | SB Left & Thru | 6.5 | A | 22 | 28 | 30 | 6 | - |
| | | PM | 1.4 | n/a | NB Thru | 7.5 | A | 16 | 33 | 34 | 9 | - |
| TH 2 & Johnson Ave (Signalized) | 2024 | AM | 12.3 | B | WB Left & Thru | 14.3 | B | 116 | 54 | 71 | 133 | - |
| | | PM | 12.8 | B | EB Thru | 15.4 | B | 151 | 77 | 70 | 139 | - |
| | 2044 | AM | 8.3 | A | EB Left | 12.2 | B | 106 | 53 | 65 | 113 | - |
| | | PM | 9.7 | A | EB Left | 13.1 | B | 142 | 70 | 65 | 129 | - |
| TH 2 & Inderlee Ave (Thru-stop) | 2024 | AM | 1.3 | n/a | NB Thru | 9.5 | A | 2 | 11 | 33 | 5 | - |
| | | PM | 1.5 | n/a | NB Thru | 7.6 | A | 15 | 17 | 37 | 0 | - |
| | 2044 | AM | 1.4 | n/a | SB Thru | 7.5 | A | 23 | 13 | 39 | 12 | - |
| | | PM | 1.6 | n/a | NB Thru | 10.4 | B | 30 | 21 | 39 | 10 | - |
| TH 2 & Granum Ave (Thru-stop) | 2024 | AM | 2.1 | n/a | NB Thru | 12.5 | B | 15 | 37 | 34 | 25 | 27 |
| | | PM | 2.4 | n/a | NB Thru | 12.4 | B | 25 | 42 | 33 | 33 | 13 |
| | 2044 | AM | 2.2 | n/a | WB Left | 11.6 | B | 16 | 40 | 33 | 25 | 31 |
| | | PM | 2.8 | n/a | NB Thru | 16.3 | C | 26 | 47 | 38 | 46 | 10 |

¹ Intersection LOS is not defined by the HCM for thru-stop control intersections.

Table 10 - Intersection Operations Summary – Thru-Stop control at Johnson Ave

| Intersection | Year | Period | Average Intersection Delay (s) | Intersection LOS ¹ | Worst Movement | | | 95th Queue (ft) | | | | |
|---------------------------------|------|--------|--------------------------------|-------------------------------|----------------|-----------|-----|-----------------|----|----|----|--------|
| | | | | | Movement | Delay (s) | LOS | EB | NB | SB | WB | WB 1st |
| TH 2 & Omland Ave (Thru-stop) | 2024 | AM | 1.6 | n/a | SB Thru | 8.3 | A | 7 | 22 | 43 | 0 | - |
| | | PM | 1.9 | n/a | SB Left | 9.9 | A | 15 | 16 | 48 | 3 | - |
| | 2044 | AM | 1.9 | n/a | NB Left | 10.0 | A | 8 | 27 | 46 | 4 | - |
| | | PM | 2.0 | n/a | NB Thru | 10.1 | B | 21 | 22 | 48 | 3 | - |
| TH 2 & Mark Ave (Thru-stop) | 2024 | AM | 0.9 | n/a | NB Thru | 8.0 | A | 5 | 41 | 31 | 14 | - |
| | | PM | 1.2 | n/a | SB Thru | 8.8 | A | 16 | 43 | 37 | 24 | - |
| | 2044 | AM | 1.1 | n/a | NB Thru | 7.3 | A | 5 | 42 | 35 | 16 | - |
| | | PM | 1.6 | n/a | SB Thru | 8.9 | A | 11 | 44 | 53 | 23 | - |
| TH 2 & Kaiser Ave (Thru-stop) | 2024 | AM | 0.8 | n/a | SB Thru | 7.3 | A | 26 | 29 | 27 | 6 | - |
| | | PM | 0.9 | n/a | NB Thru | 7.7 | A | 16 | 31 | 29 | 14 | - |
| | 2044 | AM | 0.8 | n/a | SB Left | 6.5 | A | 24 | 28 | 30 | 5 | - |
| | | PM | 0.9 | n/a | NB Thru | 9.3 | A | 17 | 33 | 33 | 15 | - |
| TH 2 & Johnson Ave (Thru-Stop) | 2024 | AM | 2.1 | n/a | NB Thru | 7.7 | A | 25 | 48 | 56 | 19 | - |
| | | PM | 2.8 | n/a | NB Thru | 9.0 | A | 39 | 65 | 58 | 30 | - |
| | 2044 | AM | 2.2 | n/a | SB Thru | 8.6 | A | 25 | 54 | 57 | 20 | - |
| | | PM | 3.0 | n/a | NB Thru | 9.6 | A | 45 | 70 | 63 | 37 | - |
| TH 2 & Inderlee Ave (Thru-stop) | 2024 | AM | 0.8 | n/a | NB Thru | 11.6 | B | 10 | 11 | 33 | 7 | - |
| | | PM | 0.9 | n/a | NB Thru | 7.5 | A | 22 | 16 | 37 | 2 | - |
| | 2044 | AM | 0.9 | n/a | SB Thru | 7.4 | A | 17 | 13 | 39 | 13 | - |
| | | PM | 1.1 | n/a | NB Thru | 10.7 | B | 23 | 21 | 39 | 6 | - |
| TH 2 & Granum Ave (Thru-stop) | 2024 | AM | 1.9 | n/a | NB Thru | 11.5 | B | 26 | 39 | 34 | 27 | 27 |
| | | PM | 2.2 | n/a | NB Thru | 13.1 | B | 19 | 42 | 34 | 34 | 13 |
| | 2044 | AM | 2.2 | n/a | WB 1st Left | 12.9 | B | 14 | 41 | 33 | 35 | 26 |
| | | PM | 2.7 | n/a | NB Thru | 14.7 | B | 27 | 45 | 37 | 43 | 10 |

¹ Intersection LOS is not defined by the HCM for thru-stop control intersections.

Table 11 - Intersection Operations Summary – All-way Stop Control at Johnson Ave

| Intersection | Year | Period | Average Intersection Delay (s) | Intersection LOS ¹ | Worst Movement | | | 95th Queue (ft) | | | | |
|-----------------------------------|------|--------|--------------------------------|-------------------------------|----------------|-----------|-----|-----------------|----|----|----|--------|
| | | | | | Movement | Delay (s) | LOS | EB | NB | SB | WB | WB 1st |
| TH 2 & Omland Ave (Thru-stop) | 2024 | AM | 1.5 | n/a | SB Thru | 7.8 | A | 8 | 22 | 42 | 1 | - |
| | | PM | 1.8 | n/a | SB Left | 9.2 | A | 14 | 16 | 46 | 4 | - |
| | 2044 | AM | 1.8 | n/a | NB Left | 9.7 | A | 9 | 27 | 44 | 1 | - |
| | | PM | 2.0 | n/a | NB Thru | 10.1 | A | 21 | 22 | 48 | 3 | - |
| TH 2 & Mark Ave (Thru-stop) | 2024 | AM | 0.8 | n/a | NB Thru | 7.2 | A | 5 | 40 | 32 | 13 | - |
| | | PM | 1.1 | n/a | SB Thru | 7.9 | A | 14 | 43 | 37 | 26 | - |
| | 2044 | AM | 0.9 | n/a | NB Thru | 7.1 | A | 9 | 42 | 35 | 13 | - |
| | | PM | 1.6 | n/a | SB Thru | 8.9 | A | 11 | 44 | 53 | 23 | - |
| TH 2 & Kaiser Ave (Thru-stop) | 2024 | AM | 1.7 | n/a | SB Thru | 7.7 | A | 32 | 29 | 27 | 4 | - |
| | | PM | 1.5 | n/a | NB Thru | 9.8 | A | 16 | 31 | 29 | 9 | - |
| | 2044 | AM | 1.7 | n/a | NB Left | 7.0 | A | 24 | 28 | 30 | 8 | - |
| | | PM | 0.9 | n/a | NB Thru | 9.3 | A | 17 | 33 | 33 | 15 | - |
| TH 2 & Johnson Ave (All-way Stop) | 2024 | AM | 6.3 | A | WB Thru | 7.0 | A | 73 | 47 | 53 | 78 | - |
| | | PM | 6.4 | A | EB Thru | 7.7 | A | 87 | 58 | 53 | 81 | - |
| | 2044 | AM | 6.4 | A | WB Thru | 7.1 | A | 75 | 52 | 52 | 78 | - |
| | | PM | 3.0 | A | NB Thru | 9.6 | A | 45 | 70 | 63 | 37 | - |
| TH 2 & Inderlee Ave (Thru-stop) | 2024 | AM | 1.5 | n/a | NB Thru | 11.8 | B | 10 | 11 | 33 | 6 | - |
| | | PM | 1.7 | n/a | NB Thru | 7.2 | A | 18 | 17 | 37 | 4 | - |
| | 2044 | AM | 1.6 | n/a | SB Left | 6.8 | A | 15 | 13 | 39 | 11 | - |
| | | PM | 1.1 | n/a | NB Thru | 10.7 | B | 23 | 21 | 39 | 6 | - |
| TH 2 & Granum Ave (Thru-stop) | 2024 | AM | 1.8 | n/a | NB Thru | 10.6 | B | 10 | 37 | 34 | 29 | 27 |
| | | PM | 2.2 | n/a | SB Left | 14.2 | B | 22 | 42 | 36 | 32 | 14 |
| | 2044 | AM | 2.0 | n/a | NB Left | 11.0 | B | 10 | 41 | 33 | 32 | 26 |
| | | PM | 8.5 | n/a | NB Thru | 14.7 | B | 27 | 45 | 37 | 43 | 10 |

¹ Intersection LOS is not defined by the HCM for thru-stop control intersections.

Table 12 - Intersection Operations Summary – Seasonal Signal control (existing) at Johnson Ave

| Intersection | SeasonalYear | Period | Average Intersection Delay (s) | Intersection LOS ¹ | Worst Movement | | | 95th Queue (ft) | | | | |
|---------------------------------|--------------|--------|--------------------------------|-------------------------------|----------------|-----------|-----|-----------------|----|----|-----|--------|
| | | | | | Movement | Delay (s) | LOS | EB | NB | SB | WB | WB 1st |
| TH 2 & Omland Ave (Thru-stop) | 2024 | AM | 2.2 | n/a | SB Left | 9.7 | A | 9 | 24 | 48 | 4 | - |
| | | PM | 2.3 | n/a | SB Left | 11.4 | B | 17 | 19 | 48 | 9 | - |
| | 2044 | AM | 2.6 | n/a | SB Thru | 12.0 | B | 16 | 29 | 59 | 6 | - |
| | | PM | 3.2 | n/a | SB Thru | 17.7 | C | 29 | 22 | 57 | 8 | - |
| TH 2 & Mark Ave (Thru-stop) | 2024 | AM | 1.2 | n/a | NB Thru | 7.9 | A | 9 | 42 | 37 | 14 | - |
| | | PM | 1.9 | n/a | SB Thru | 10.9 | B | 14 | 47 | 53 | 27 | - |
| | 2044 | AM | 1.5 | n/a | SB Thru | 9.5 | A | 7 | 43 | 38 | 23 | - |
| | | PM | 2.3 | n/a | NB Thru | 10.9 | B | 22 | 52 | 58 | 38 | - |
| TH 2 & Kaiser Ave (Thru-stop) | 2024 | AM | 1.5 | n/a | SB Thru | 8.6 | A | 23 | 30 | 32 | 8 | - |
| | | PM | 1.7 | n/a | NB Left | 8.8 | A | 33 | 37 | 31 | 2 | - |
| | 2044 | AM | 1.7 | n/a | SB Thru | 10.6 | B | 40 | 30 | 36 | 14 | - |
| | | PM | 1.8 | n/a | SB Left | 14.1 | B | 21 | 44 | 34 | 18 | - |
| TH 2 & Johnson Ave (Signalized) | 2024 | AM | 12.7 | B | EB Left | 15.4 | B | 148 | 64 | 67 | 130 | - |
| | | PM | 17.0 | B | WB Left | 23.1 | C | 242 | 66 | 66 | 174 | - |
| | 2044 | AM | 11.0 | B | WB Left | 15.9 | B | 204 | 63 | 66 | 119 | - |
| | | PM | 10.8 | B | NB Left | 14.2 | B | 230 | 71 | 72 | 134 | - |
| TH 2 & Inderlee Ave (Thru-stop) | 2024 | AM | 1.5 | n/a | SB Thru | 8.6 | A | 11 | 12 | 39 | 10 | - |
| | | PM | 2.0 | n/a | SB Thru | 12.4 | B | 37 | 16 | 35 | 4 | - |
| | 2044 | AM | 1.9 | n/a | SB Thru | 13.2 | B | 24 | 13 | 42 | 11 | - |
| | | PM | 2.0 | n/a | NB Thru | 14.5 | B | 40 | 23 | 37 | 5 | - |
| TH 2 & Granum Ave (Thru-stop) | 2024 | AM | 2.2 | n/a | NB Thru | 11.5 | B | 17 | 38 | 35 | 27 | 22 |
| | | PM | 3.3 | n/a | NB Thru | 17.1 | C | 53 | 52 | 38 | 52 | 14 |
| | 2044 | AM | 2.9 | n/a | WB Left | 17.2 | C | 28 | 40 | 38 | 51 | 23 |
| | | PM | 4.4 | n/a | NB Thru | 28.4 | D | 59 | 62 | 40 | 69 | 18 |

¹ Intersection LOS is not defined by the HCM for thru-stop control intersections.

Table 13 - Intersection Operations Summary – Seasonal Thru-Stop control at Johnson Ave

| Intersection | SeasonalYear | Period | Average Intersection Delay (s) | Intersection LOS ¹ | Worst Movement | | | 95th Queue (ft) | | | | |
|---------------------------------|--------------|--------|--------------------------------|-------------------------------|-------------------|-----------|-----|-----------------|----|----|----|--------|
| | | | | | Movement | Delay (s) | LOS | EB | NB | SB | WB | WB 1st |
| TH 2 & Omland Ave (Thru-stop) | 2024 | AM | 2.3 | n/a | NB Left | 12.1 | B | 12 | 25 | 53 | 7 | - |
| | | PM | 2.6 | n/a | SB Left | 12.6 | B | 23 | 20 | 49 | 6 | - |
| | 2044 | AM | 2.5 | n/a | SB Thru | 12.2 | A | 14 | 29 | 62 | 3 | - |
| | | PM | 3.1 | n/a | SB Left | 17.2 | C | 30 | 22 | 57 | 5 | - |
| TH 2 & Mark Ave (Thru-stop) | 2024 | AM | 1.2 | n/a | SB Thru | 8.8 | A | 9 | 41 | 36 | 19 | - |
| | | PM | 2.1 | n/a | NB Thru | 9.7 | A | 15 | 48 | 55 | 31 | - |
| | 2044 | AM | 1.4 | n/a | SB Thru | 9.5 | A | 12 | 44 | 38 | 17 | - |
| | | PM | 2.2 | n/a | NB Thru | 10.2 | B | 24 | 52 | 56 | 38 | - |
| TH 2 & Kaiser Ave (Thru-stop) | 2024 | AM | 0.9 | n/a | SB Left | 6.9 | A | 23 | 27 | 31 | 4 | - |
| | | PM | 1.3 | n/a | SB Left | 7.9 | A | 24 | 36 | 31 | 16 | - |
| | 2044 | AM | 1.2 | n/a | SB Thru | 10.3 | B | 38 | 30 | 36 | 6 | - |
| | | PM | 1.4 | n/a | SB Left | 11.8 | B | 18 | 44 | 34 | 26 | - |
| TH 2 & Johnson Ave (Thru-stop) | 2024 | AM | 2.1 | n/a | NB Thru & SB Left | 8.8 | A | 17 | 57 | 61 | 20 | - |
| | | PM | 2.4 | n/a | NB Thru | 11.3 | B | 42 | 65 | 62 | 28 | - |
| | 2044 | AM | 2.4 | n/a | SB Thru | 11.2 | B | 27 | 61 | 63 | 30 | - |
| | | PM | 2.7 | n/a | NB Thru | 12.8 | B | 43 | 69 | 64 | 29 | - |
| TH 2 & Inderlee Ave (Thru-stop) | 2024 | AM | 0.8 | n/a | SB Thru | 9.7 | A | 10 | 8 | 38 | 14 | - |
| | | PM | 1.1 | n/a | SB Left | 8.1 | A | 26 | 18 | 35 | 8 | - |
| | 2044 | AM | 1.0 | n/a | SB Thru | 13.1 | B | 16 | 13 | 42 | 13 | - |
| | | PM | 1.2 | n/a | NB Thru | 13.7 | B | 37 | 23 | 37 | 10 | - |
| TH 2 & Granum Ave (Thru-stop) | 2024 | AM | 2.3 | n/a | SB Left | 13.0 | B | 31 | 42 | 35 | 37 | 22 |
| | | PM | 3.1 | n/a | NB Left | 21.0 | C | 30 | 56 | 35 | 48 | 12 |
| | 2044 | AM | 2.8 | n/a | SB Left | 17.2 | C | 24 | 42 | 38 | 50 | 24 |
| | | PM | 4.3 | n/a | NB Thru | 31.9 | D | 51 | 70 | 43 | 61 | 16 |

¹ Intersection LOS is not defined by the HCM for thru-stop control intersections.

Table 14 - Intersection Operations Summary – Seasonal All-Way Stop Control at Johnson Ave

| Intersection | SeasonalYear | Period | Average Intersection Delay (s) | Intersection LOS ¹ | Worst Movement | | | 95th Queue (ft) | | | | |
|-----------------------------------|--------------|--------|--------------------------------|-------------------------------|----------------|-----------|-----|-----------------|----|----|----|--------|
| | | | | | Movement | Delay (s) | LOS | EB | NB | SB | WB | WB 1st |
| TH 2 & Omland Ave (Thru-stop) | 2024 | AM | 2.2 | n/a | NB Left | 12.2 | B | 9 | 25 | 52 | 3 | - |
| | | PM | 2.6 | n/a | SB Left | 14.1 | B | 22 | 20 | 49 | 5 | - |
| | 2044 | AM | 2.4 | n/a | SB Left | 10.9 | B | 13 | 31 | 60 | 1 | - |
| | | PM | 3.0 | n/a | SB Left | 15.0 | B | 23 | 22 | 52 | 7 | - |
| TH 2 & Mark Ave (Thru-stop) | 2024 | AM | 1.1 | n/a | SB Thru | 9.8 | A | 7 | 42 | 36 | 15 | - |
| | | PM | 2.0 | n/a | SB Left | 10.1 | B | 7 | 47 | 55 | 31 | - |
| | 2044 | AM | 1.2 | n/a | NB Left | 7.8 | A | 11 | 43 | 32 | 18 | - |
| | | PM | 2.0 | n/a | NB Left | 10.8 | B | 29 | 49 | 50 | 56 | - |
| TH 2 & Kaiser Ave (Thru-stop) | 2024 | AM | 1.6 | n/a | SB Left | 7.3 | A | 27 | 27 | 31 | 3 | - |
| | | PM | 1.8 | n/a | SB Left | 9.9 | A | 19 | 35 | 32 | 14 | - |
| | 2044 | AM | 1.8 | n/a | SB Left | 13.0 | B | 25 | 31 | 33 | 0 | - |
| | | PM | 2.0 | n/a | SB Left | 24.1 | C | 13 | 40 | 35 | 32 | - |
| TH 2 & Johnson Ave (All-way Stop) | 2024 | AM | 7.1 | A | EB Thru | 8.3 | A | 101 | 52 | 57 | 74 | - |
| | | PM | 8.9 | A | EB Thru | 10.8 | B | 162 | 56 | 83 | 54 | - |
| | 2044 | AM | 7.8 | A | WB Left | 10.0 | A | 127 | 51 | 54 | 79 | - |
| | | PM | 9.9 | A | EB Thru | 12.3 | B | 196 | 80 | 53 | 57 | - |
| TH 2 & Inderlee Ave (Thru-stop) | 2024 | AM | 1.9 | n/a | SB Thru | 8.0 | A | 8 | 8 | 38 | 21 | - |
| | | PM | 2.2 | n/a | NB Thru | 15.1 | C | 21 | 18 | 36 | 4 | - |
| | 2044 | AM | 2.2 | n/a | SB left | 9.7 | A | 15 | 14 | 43 | 26 | - |
| | | PM | 2.4 | n/a | SB Left | 9.3 | A | 30 | 19 | 37 | 8 | - |
| TH 2 & Granum Ave (Thru-stop) | 2024 | AM | 2.0 | n/a | NB Left | 16.5 | C | 13 | 42 | 35 | 36 | 22 |
| | | PM | 2.8 | n/a | SB left | 25.0 | C | 20 | 55 | 37 | 49 | 12 |
| | 2044 | AM | 2.5 | n/a | SB Left | 17.4 | C | 24 | 41 | 36 | 56 | 24 |
| | | PM | 4.3 | n/a | WB 1st Left | 40.6 | E | 27 | 79 | 45 | 70 | 25 |

¹ Intersection LOS is not defined by the HCM for thru-stop control intersections.

7.0 Scenario Analysis

The following scenarios were analyzed and are described in the next section:

- Signal (existing condition) at Johnson
- Thru-Stop at Johnson
- All-way Stop at Johnson

7.1 Signal (existing condition) at Johnson

Signal control with existing geometrics was analyzed at the study intersection and found to operate with an overall LOS B in all peak periods of 2024 and 2044. The worst individual movement operated at LOS B in 2024 and 2044 AM and PM Peaks and was either for eastbound or westbound traffic.

The seasonal 2024 and 2044 volumes were found to operate with an overall LOS B in 2024 and 2044. The worst individual movement operated at a LOS C in the seasonal 2024 PM Peak for westbound traffic.

In 2024 and 2044 the 95th percentile queues were approximately 5-6 vehicles on TH 2 and 2-3 vehicles on Johnson Avenue.

The seasonal 2024 and 2044 95th percentile queues were approximately 6-10 vehicles on TH 2 and 3 vehicles on Johnson Avenue.

2024 and 2044 operations along the corridor show an acceptable LOS at each intersection analyzed with the worst movement being a LOS C in 2044 at northbound Granum Avenue.

Seasonal 2024 and 2044 operations along the corridor show an acceptable LOS at each intersection analyzed with the worst movement being a LOS D in 2044 at northbound Granum Avenue, the new configuration at Granum Avenue will likely improve this LOS.

Pedestrians would cross the intersection with a pedestrian phase in the signal operations.

The existing crash rate is below the statewide average for similar signalized intersections, and below the critical crash rate which indicates the intersection currently does not have a crash problem.

Signal warrants are not met for the intersection for any scenario.

Because signal warrants are not met, signal control is **not considered** a viable option.

7.2 Thru-Stop at Johnson

Thru-stop control with existing geometrics was analyzed at the study intersection, with Johnson stopping for TH 2 traffic. The intersection was found to operate at an acceptable overall level of service in all the peak periods of 2024 and 2044. All movements operated at LOS A in 2024 and 2044 AM and PM peak hours.

The seasonal 2024 and 2044 volumes were found to operate with an acceptable overall LOS in all the peak periods of 2024 and 2044. The worst individual movements operated at a LOS A for the 2024 AM Peak, and a LOS B for the 2024 PM peak, 2044 AM peak, and 2044 PM peak.