Feasibility Report

# CSAH 48 – Main Street (Oak Avenue to Chambers Avenue)

Owatonna, Minnesota

STEEL 164362 | April 10, 2023

SEH
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Engineers | Architects | Planners | Scientists

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April 10, 2023

RE: CSAH 48 – Main Street (Oak Avenue to Chambers Avenue)
Feasibility Report
Owatonna, Minnesota
SEH No. STEEL 164362 4.00

Mr. Paul Sponholz, PE
Steele County Highway Department
PO Box 890, 3000 Hoffman Drive NW
Owatonna, MN 55060-0890

Dear Mr. Sponholz:

Short Elliott Hendrickson Inc. (SEH®) is enclosing our feasibility report for potential modifications and improvements to the CSAH 48 (Main Street) corridor from Oak Avenue to Chambers Avenue.

The report outlines options for road and utility reconstruction, traffic operational improvements, sidewalk improvements, and provides a cost estimate for the project based on SEH's engineering judgement.

We will be available at your convenience to present, review, and discuss the contents of this report, and appreciate the opportunity to serve the City and County.

Sincerely,

Project Manager/ Sr. Traffic Engineer
(Lic. IA, MN, SD)

# Feasibility Report

CSAH 48 – Main Street (Oak Avenue to Chambers Avenue)

Owatonna, Minnesota

SEH No. STEEL 164362

April 10, 2023

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.



Connor R. Burke, PE (MN)

Date: April 10, 2023 License No.: 58829

Reviewed By: Jenna Obernolte Date: April 10, 2023

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# Feasibility Report

## CSAH 48 – Main Street (Oak Avenue to Chambers Avenue)

Prepared for Steele County Highway Department and City of Owatonna, MN

# 1 Introduction

Steele County, together with the City of Owatonna, has requested SEH, Inc to consider options for a rehabilitation of CSAH 48 (Main Street) in Owatonna, Minnesota. The focus will be on the corridor from Oak Avenue to Chambers Avenue. This report outlines the current condition of the street, sidewalks, underground utilities, and traffic. It also offers options to address deficiencies found, provides a cost estimate with funding options, and offers a proposed schedule for completion of work. The project was selected for a feasibility study by the County Engineer based on the existing conditions, vehicular crash history, and pedestrian safety. Improvements to CSAH 48 would address several deficiencies, including deteriorated pavement, traffic flow issues, safety for vehicular, bicycle, and pedestrians, environmental impacts, aging sanitary and watermain, and inefficient/undersized storm sewers. The current infrastructure condition was evaluated via inspection wherever possible. The street condition has been evaluated and recorded in photographs.

Sanitary lines were reviewed by City staff, and sanitary and storm structures were opened and/or observed in applicable areas with the assistance of City of Owatonna and public works staff.

Multiple options for improvement are offered where multiple approaches are feasible and are detailed for consideration by County and City staff. Each option accounts for alterations that impact the cost and functionality of the street provide choices in how to best address deficiencies.

# 2 Existing Conditions

## 2.1 Investigation

To obtain accurate and objective knowledge regarding the existing condition of the infrastructure, it is necessary to examine previously completed studies, review available record plans, and complete field investigations.

Determining the condition of watermain involves evaluating the size, material, age of the main, along with accounting for any known watermain breaks and a determination of fire flow capacity, when necessary.

To determine the condition of the sanitary sewer, available record plans and previous studies were reviewed, including conversations with City staff.

A geotechnical evaluation is completed to determine existing pavement and aggregate base thicknesses, subgrade soil or bedrock types, and depth to groundwater. This information is used to determine feasibility of construction methods, and recommendations to prepare the subgrade

to support utilities and pavement sections. The geotechnical evaluation report can be viewed in Appendix A.

## 2.2 Pavement and Sidewalk

Along the corridor CSAH 48 is an urban, undivided roadway with sidewalks on both sides of the road. CSAH 48 is concrete with bituminous overlay and expansion from Oak Avenue to Elm Avenue, and concrete paved from Elm Avenue to Chambers Avenue. The pavement condition varies along the corridor.

### 2.2.1 Oak Avenue to Elm Avenue

As-builts were obtained from 1984, and 2005. Oak to Elm is an undivided roadway consisting of two traffic lanes in each direction and a parking lane in both directions. The typical section of the right-of-way starting and heading east from Oak Avenue is 65 feet and expands to 74 feet until it extends past Cedar Avenue where it narrows to 69 feet, and then narrowing to 64 feet at Court Avenue. This section is maintained to Elm Avenue.

At the intersection of Oak Avenue and Main Street, the eastbound direction consists of two departing through lanes. The westbound direction consists of a dedicated left turn, one through, and a dedicated right turn lane. At the intersection of Elm Ave and Main St, the eastbound direction consists of a dedicated right turn, one through lane, and a dedicated left turn lane. The westbound direction consists of two departing through lanes, and one parking lane.

According to the as-built construction drawings provided, in 1929, 7 1/2 inches of concrete pavement was placed. In 1970, a 1 3/4-inch bituminous overlay was placed. In 1984, an additional 3/4-inch bituminous overlay was placed, and curb & gutter was replaced. In 2005, the existing pavement section was constructed by mill and overlay. According to the as-builts, the existing section consists of 2 3/4 inches of bituminous over 7 1/2 inches of concrete. According to the information obtained during the geotechnical evaluation, the existing pavement section is shown in Table 2-1 below.

**Table 2-1 – Pavement Thickness – Oak Avenue to Elm Avenue**

| | Oak Avenue to Elm Avenue (Drive Lane) | Oak Avenue to Elm Avenue (Parking Lane) |
|---|---|---|
| Bituminous (inches) | 2 ½ to 3 ¾ | 2 ½ to 2 ¾ |
| Concrete (inches) | 7 to 11 | 6 to 7 ½ |
| Aggregate Base (inches) | 0 to 9 | 0 to 6 |
| Total (inches) | 9 ¾ to 20 ¼ | 10 ¼ to 14 ½ |

The existing bituminous pavement overlay is nearing the end of its design life, and the existing concrete beneath has long surpassed its design life. There is severe cracking throughout the roadway to both the drive lanes and parking lanes, including cracking deteriorated radially from some of the manhole structures. The cracking is likely due to settlement of subsurface soils.

Areas with significant curb and gutter settlement have been observed in front of Central Park causing water to pool and unable to properly drain to storm water catch basins. Catch basins in this area have succumbed to severe edge cracking and edge pop outs. The curbs along this stretch have been deteriorated in most areas, as can be seen in the photos below.

Figure 2-1 – Map of Oak Avenue to Elm Avenue

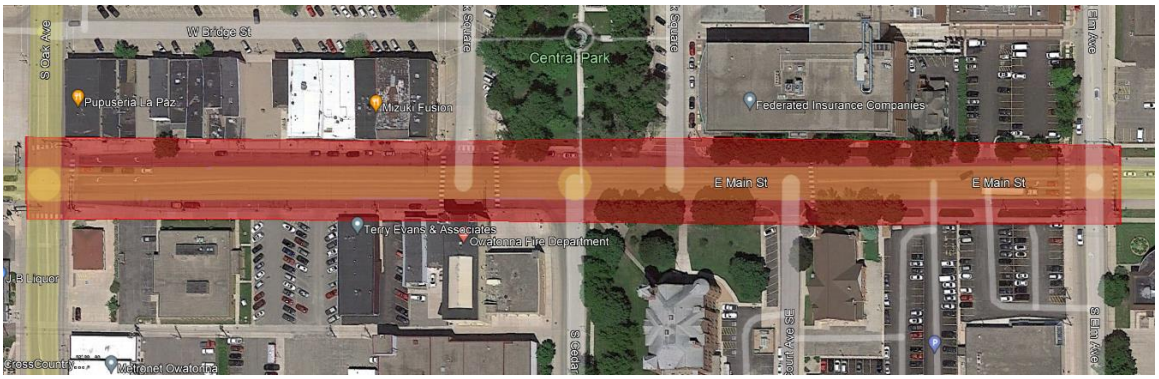



Figure 2-2 – East of Oak Ave and Main St Intersection – Shows cracking, resulting in potholes.



Figure 2-3 – Intersection of Elm Ave and Main St – Shows cracking and previous patching.



Figure 2-4 – Intersection of Cedar Ave and Main St – Cracking



Figure 2-5 – Between Oak and Elm – Storm Water pondage do to inadequate sloping.



Figure 2-6 – In front of Central Park – Catch basin with detioration.



### 2.2.2 Elm Avenue to Chambers Avenue

As-builts from 1998 were obtained and reviewed. Elm Avenue to Chambers Avenue is an undivided roadway consisting of one traffic lane and a parking lane in both directions. The typical section of the right-of-way heading east and starting from Elm Avenue is 66 feet. The street then narrows to 49 feet until it reaches Lincoln Avenue where the section expands to approximately 55 feet, then narrows to 38 feet East of Lincoln Avenue, and finally expanding to 47 feet at the intersection of Chambers Avenue.

At the intersection of Elm Ave and Main Street, the eastbound direction consists of one departing traffic lane and one parking lane. The westbound approach consists of a dedicated left turn, one through, and a dedicated right turn lane.

According to the as-built construction drawings provided to us, prior to 1998, the roadway consisted of 2 inches of bituminous over 7 1/2 inches of concrete. In 1998, the existing pavement section was constructed and consists of 8 inches of non-reinforced concrete over 6 inches of aggregate base, and 6 inches of granular borrow. According to the information obtained during the geotechnical evaluation, the existing pavement section is shown in Table 2-2 below.

**Table 2-2 – Pavement Thickness – Elm Avenue to Chambers Avenue**

| | Oak Avenue to Elm Avenue (Drive Lane) |
|---|---|
| Concrete (inches) | 7 to 8 |
| Aggregate Base (inches) | 15 to 29* |
| Total (inches) | * |

*Unable to be verified during field exploration due to refusal in 3 of the 4 hand auger borings.

Overall, the roadway is in moderate condition with much of the cracking extending longitudinally from the joints in the drive lanes. Approximately 20 percent of the panels have some type of cracking throughout the panel or at the joints.

**Figure 2-7 – Map Elm Avenue to Chambers Avenue**



Figure 2-8 – West of Grove Ave and Main St – Longitudinal Cracking



Figure 2-9 – Mid-Block between Lincoln Ave and Chambers Ave – Longitudinal Cracking



### 2.2.3 Sidewalk and Driveways

The sidewalk on both sides of the roadway spanning the length of the corridor have cracking and surface deterioration in select areas. A review of the pedestrian walk zones and street crossings for ADA compliance was performed, and the majority fall out of current compliance.

Sidewalks from Oak to Elm were constructed prior to 1984. There are areas where the sidewalk does not mean the maximum 2% slope compliance. About 20 percent of the sidewalks and driveways are cracked, textured, or deteriorated along this stretch.

In 1998, records show sidewalks were constructed on both sides from Elm to Chambers. However, based on recent site visits, areas of sidewalks could be from the 1930's to 1940's. Approximately 50 percent of the sidewalks and driveways have cracking at the joints, laterally across the panels, surface deterioration, and areas of textured pavement. These issues can be attributed freeze/thaw cycles, salt placement, past serviceable life, etc.

**Figure 2-10 – South Sidewalk East of Oak Ave – Deteriorated, Cracked and 2.9% slope.**



Figure 2-11 – Mid-Block between Lincoln Ave and Chambers Ave – Detiorated and cracked sidewalk on north side.



## 2.3 Environmental Review

A preliminary environmental desktop review for the project corridor was completed. The desktop review was limited to the following research tasks listed below:

- Environmental Database Review of Minnesota Pollution Control Agency(MPCA) What's in my Neighborhood (WIMN) listings,
- Minnesota Department of Agriculture (MDA) WIMN listings,
- MPCA Spill listings,
- Review of located wells available on the Minnesota Department of Health (MDH) Minnesota Well Index (MWI) website.

Based on the findings of the desktop review, a majority of the listings identified in the report, attached to this study, exist within the western portion of the project corridor. These listings include closed Leaks, closed Tank Sites, active and inactive RCRA generators, and wells. A closed listing registered under the Superfund, Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), and Voluntary Investigation and Cleanup (VIC) programs were also identified in the western portion of the project corridor.

Additionally, an abandoned steam pipe was previously identified running along the project corridor and records of the pipe's location were not available. Municipal steam pipes were

commonly insulated with an asbestos containing pipe wrap or the pipe itself is often transite (an asbestos containing material). If encountered during construction the pipe should be tested for asbestos and if it does contain asbestos, an asbestos abatement company will need to be contracted for proper handling/disposal.

SEH recommends at minimum that an Environmental Review be completed that includes a Phase I Environmental Site Assessment (ESA) type research or a full Phase I ESA be completed for the reconstruction portion of the corridor. This information would then be used as the basis in which to place Phase II ESA borings. Phase II ESA information would then be used to write special provisions for the project and assist with a cost estimate for properly dealing with contamination during construction.

An Environmental Desktop Review is attached in **Appendix F** for review.

## 2.4 Utilities

City of Owatonna and Minnesota Department of Transportation (MnDOT) construction plans from 1984, 1998, 2005, and existing GIS information was used to determine the year of installation and pipe materials for the existing utilities. Andrew Sorenson, City of Owatonna, and public works employees also provided historical and existing conditions of the sanitary and storm sewers within the project limits. In his judgment, both sanitary and storm sewers (main & structures) from Oak Ave to Elm Ave have approximately ten years of serviceable life remaining, however a few manholes appear to be failing based on recent site visits. Both sewers spanning East of Elm Ave are in much better condition and are anticipated to have at least 20 years of service life remaining.

### 2.4.1 Watermain

No record of information for the existing watermain from Oak Ave to Elm Ave was obtained or reviewed during this study, as we were informed no such documents are currently in possession of Owatonna Public Utilities. We assume the watermain along this stretch dates to the late 1800's or early 1900's and consists of cast-iron piping with lead joints.

The existing watermain from Elm Ave to Chambers Ave was installed in 1998 and begins with a 12-inch polyvinyl chloride (PVC) pipe and narrows to an 8-inch PVC at Grove Avenue.

There were no recorded watermain breaks brought to our attention.

### 2.4.2 Sanitary Sewer

The existing sanitary sewer from Oak Ave to Elm Ave is recorded as being installed in the year 1900 timeframe and consists of an 8-inch vitrified clay pipe (VCP). Oak to Cedar was lined in 2018 and Cedar to Elm was lined in 2020.

The existing sanitary sewer from Elm Ave to Sta. 0+504.40 consists of 10-inch PVC that is assumed to have been installed prior to 1998. From Sta. 0+504.40 to Chambers Ave, the sanitary sewer was installed in 1998 and consists of 8-inch PVC.

An inspection by Assistant County Engineer, Paul Sponholz was performed at the three worst/manhole pavement issues on Main Street. It was noted that all were deep sanitary sewer structures with concrete barrels, and all were in rather good condition. The rings and bricks in

the top foot appeared to have minor separation, but nothing major noted. Adjustments could be made to drop the top of the structure to match the roadway profile.

At the open house for this feasibility study in August of 2022, a citizen who is a resident between Lincoln Ave and Chambers Ave informed the County and City of vibrations impacting their house every instance a vehicle drives over the sanitary manhole directly outside her house. County staff made a site visit to this manhole and noted the manhole structure appeared to have pushed up through the concrete, most likely due to freeze/thaw cycles. This potentially could lead to vibrations moving laterally impacting her home, but further investigation may be warranted.

### *2.4.3* Storm Sewer

The existing storm sewer from Oak Ave to W Park Square was installed in 1984 and consists of a 12-inch reinforced concrete pipe (RCP), from W Park Square to E Park Square the pipe is an 18-inch RCP, and from E Park Square to Elm the pipe is a 12-inch RCP. From Elm Ave to approximately Sta. 0+504.40, the storm sewer consists of a 12-inch RCP and was installed prior to 1998. The storm sewer extending from Grove to Chambers was installed in 1998 and consists of a 12-inch, 18-inch, and 24-inch RCP. This stretch also includes an 8-inch perforated drainpipe.

The manhole at W Park Square was observed to be failing and filling in with brick and debris. It is noted that two manholes near Cedar Avenue have both been paved over. At the southeast corner of Elm, concrete debris in the pipe has been observed at the bottom of the catch basin. During a televised inspection, it was documented that from Lincoln to Chambers the camera extended laterally underwater from approximately 40 to 70 feet due to a dip in the pipe.

Figure 2-12 – In front of Central Park – Storm Water manhole with brick and debris.



# 3 Corridor Study

As part of this feasibility study a corridor study was conducted to review existing and future traffic operations and pedestrian crossing improvements. The corridor study reviewed motorized and non-motorized traffic volumes, safety and future traffic patterns along the corridor. Recommendations outlined in this report helped inform the alternatives analysis portion of this feasibility study.

The results of this corridor study identified several improvements along the CSAH 48 corridor:

1. Conversion of the corridor from Oak Avenue to Lincoln Avenue to a three-lane roadway.
2. Removal of the existing signal system at W Park Square and the addition of a center median on the west leg of W Park Square.
3. Addition of a center median on the east leg on E Park Square and pedestrian crossing enhancements in the form of a rectangular rapid flashing beacon system. Crossing to align with the current location of the existing crossing just east of proposed closure of Court Avenue.
4. Closure of Court Avenue SE access point onto CSAH 48 (Main Street)
5. Replacement of signal system at Elm Avenue
6. Single lane roundabout control at the intersection of Grove Avenue.
7. Future consideration of a single lane roundabout control at Lincoln Avenue S. Interim improvements include minor widening to accommodate left turn lanes for both eastbound and westbound.
8. Realignment of Chambers Avenue intersection to better align the northbound and southbound Chambers Avenue approaches.

A detailed corridor study is included in Appendix B of this report.

# 4 Improvements to Consider

This feasibility report provides the following improvement alternatives to consider:

Table 4-1 – Proposed Improvement Alternatives

| Proposed Improvement Alternative | Location | Improvement Type |
|---|---|---|
| 1A | Oak Avenue to Grove Avenue | Full Reconstruction - Concrete |
| 1B | Oak Avenue to Grove Avenue | Full Reconstruction - Bituminous |
| 1C | Oak Avenue to Elm Avenue | Mill & Overlay/Pavement Rehab |
| 2 | Grove Avenue to Chambers Ave | Concrete Pavement Rehab |
| 3A | Owatonna Education Center | Drop-Off Lane |
| 3B | Owatonna Education Center | Pull-Off Lane |
| 4A | Lincoln Ave S | Roundabout |
| 4B | Lincoln Ave S | Turn Lane |

## 4.1 Alternative 1A and 1B: Full Reconstruction Oak Avenue to Grove Avenue

Complete removal of the existing roadway and sidewalk pavement sections and replacing with either bituminous or concrete pavement and aggregate base. This would include replacement of concrete curb and gutter, driveway approaches, sidewalk, and subdrain. Full reconstruction would also include removal and replacement of watermain, sanitary sewer, and storm sewer. The vaults north of the existing roadway from Oak Avenue to West Park Square would also be removed or stabilized if removal isn't feasible.

Roadway replacement is expected to provide a 35+ year lifespan for concrete and 20-25 years for bituminous.

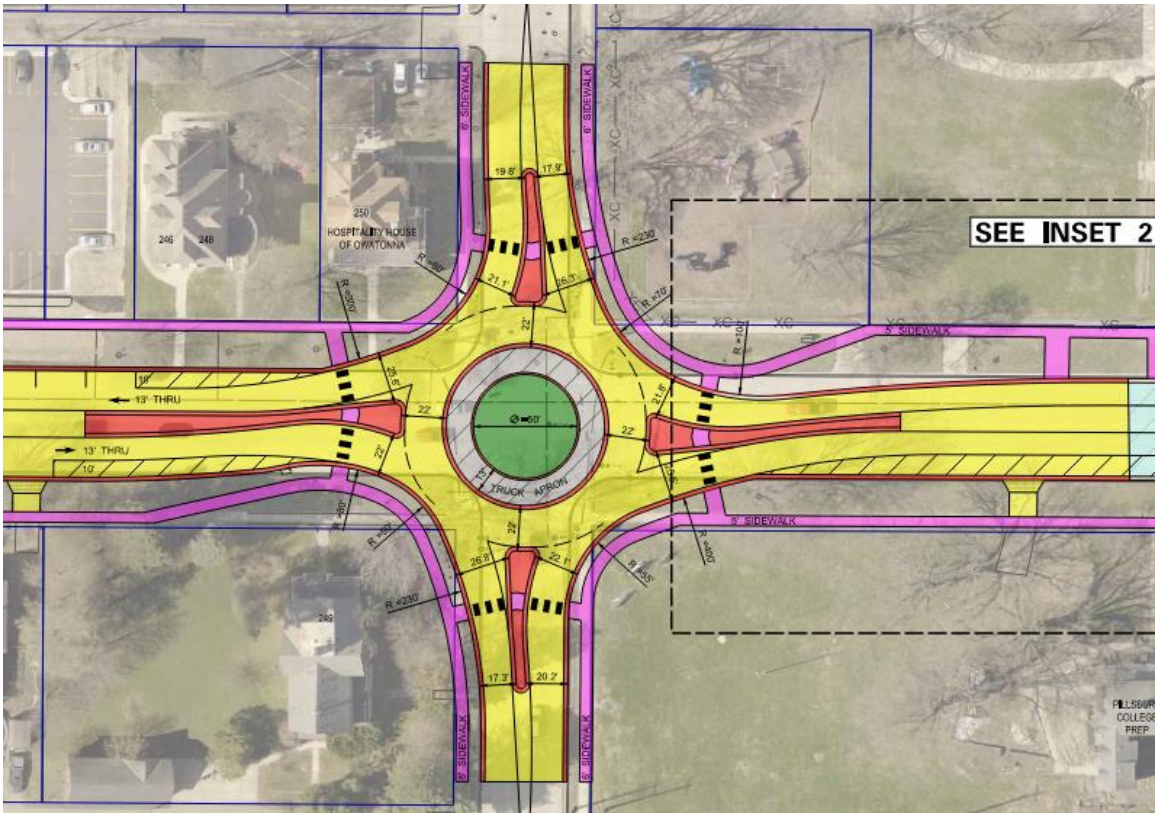
The roadway would be reconstructed to a width from face of curb to face of curb of 58 feet east of the intersection of Oak Avenue, and narrow to 55 feet at W. Park Square, and continue to narrow to 47 feet to Elm Avenue. From Elm Avenue, the width will be 55 feet and extend to Grove Avenue where it narrows to 49 feet until Lincoln Avenue where it continues to narrow to 39 feet, extending to Chambers Avenue.

Full reconstruction from Oak Avenue to Grove Avenue should be considered while Grove Avenue to Chambers Avenue would not be recommended at this time. The utilities and pavement from Oak Avenue to Elm Avenue have surpassed their design life, while the utilities from Oak Avenue to Chambers Avenue have no known indications of needing to be replaced, and existing documents show that the existing utilities still have serviceable life remaining.

Included in the full reconstruction, a roundabout at Grove Avenue would be implemented into design, as seen in Figure 4-1. This roundabout would improve traffic flow and reduce the amount of traffic incidents. The replacement of the Oak Avenue signal system is also included in this reconstruction project due to age of the system approaching 40 years and in need of replacement.

Full reconstruction would restore and improve the roadway and utilities to an acceptable condition. It will reduce maintenance and improve service to the community.

Figure 4-1 – Proposed Roundabout at S Grove Avenue




## 4.2 Alternative 1C: Mill & Overlay/Pavement Rehabilitation

Perform a mill and overlay of the top 2 inches of existing bituminous pavement. The life expectancy is 12 to 15 years.

Considering Oak to Elm, due to the failing manholes, outdated and inefficient utilities, the likelihood of not observing a full life expectancy of the mill and overlay prior to observing utility failure is high, and a risk that would need to be accepted by the owner. Mill & Overlay is not recommended at this time due to the current underground utility condition, however, if full reconstruction is not feasible within the next five years, it may be considered if risk of utility failures is acceptable.

Mill & Overlay from Elm to Chambers is not applicable.

## 4.3 Alternative 2: Concrete Pavement Rehabilitation

Replacing cracked, distressed, deteriorated, or damaged panels in the traffic and parking lanes. This would include methods such as joint repair, partial depth repair, and full depth repair. Considering the stretch east of Grove Avenue, we assumed 20 percent of pavement and 50 percent of all sidewalks would need to be repaired or replaced in some capacity.

CPR should be considered from Grove Avenue to Chambers Avenue as a full reconstruct for pavement and utilities is not necessary at this time. CPR is not applicable from Oak Avenue to Grove Avenue.

## 4.4 Additional Spot Corridor Improvement Alternatives

As part of the corridor wide evaluation, several different intersection and roadway locations were evaluated for a range of alternative options. These additional improvements should be considered after being properly vetted through the final design process. Additional considerations included the following:

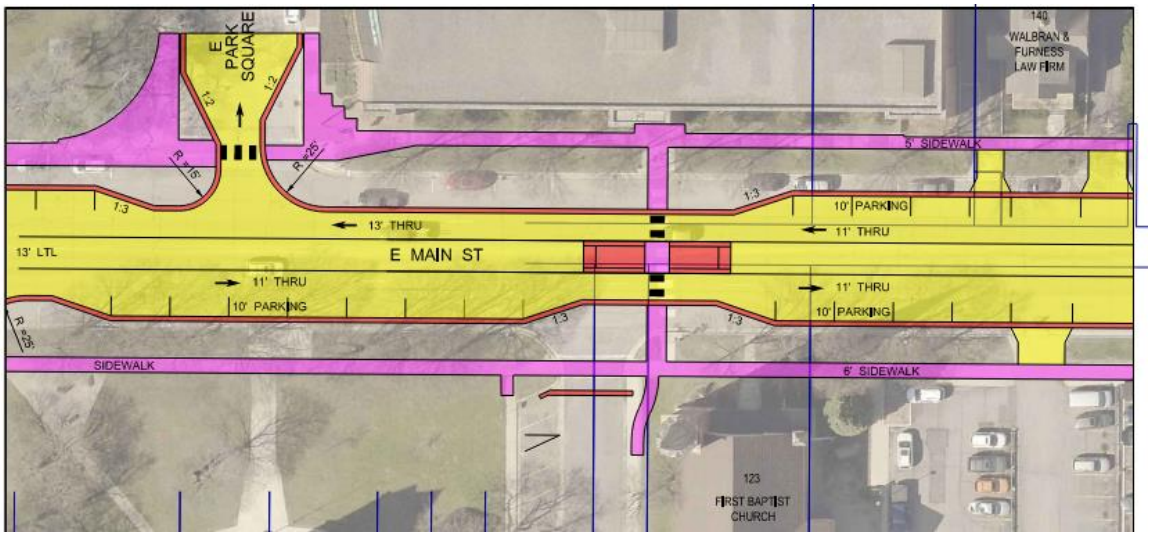
- Crossing improvements near E Park Square and Federated Insurance
- Owatonna Education Center operational and performance improvements associated with drop off and pick up operations. (Alternative 3A & 3B)
- Long term Lincoln Avenue intersection improvements (Alternative 4A and 4B)

### 4.4.1 Crosswalk at Federated Insurance

This option would move the proposed crosswalk east from the intersection of E Park Square to be in line with the access door of Federated Insurance. This would minimize the walking distance for Federated Insurance employees to walk from the parking lot located on the south side of the road however, constructing an intersection at a mid-block may have safety implications for pedestrians as this creates less anticipation for vehicle drivers. This option can be seen in Figure 4-2.

As part of a previous PMT meeting, it was also discussed to extend the center median island between E Park Square and the current Federated crossing to provide two crossing locations with a raised island. This alternative should be vetted further in final design as it does have additional on-street parking impacts between E Park Square and the current Federated insurance crossing location.

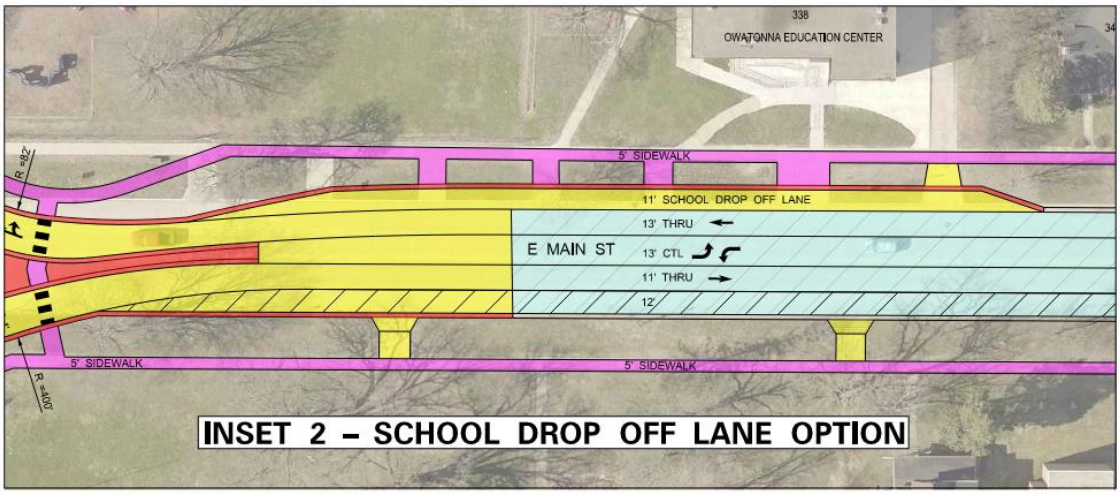
**Figure 4-2 – Proposed Crosswalk at Federarted Insurance**



### 4.4.2 Alternative 3A – Owatonna Education Center School Drop Off Lane

Provide additional lane to facilitate traffic flow and safety of students outside of the Owatonna Education Center. This option is not preferred due to safety issues with merging traffic so close to the intersection. Figure 4-3 shows the proposed drop off lane configuration.

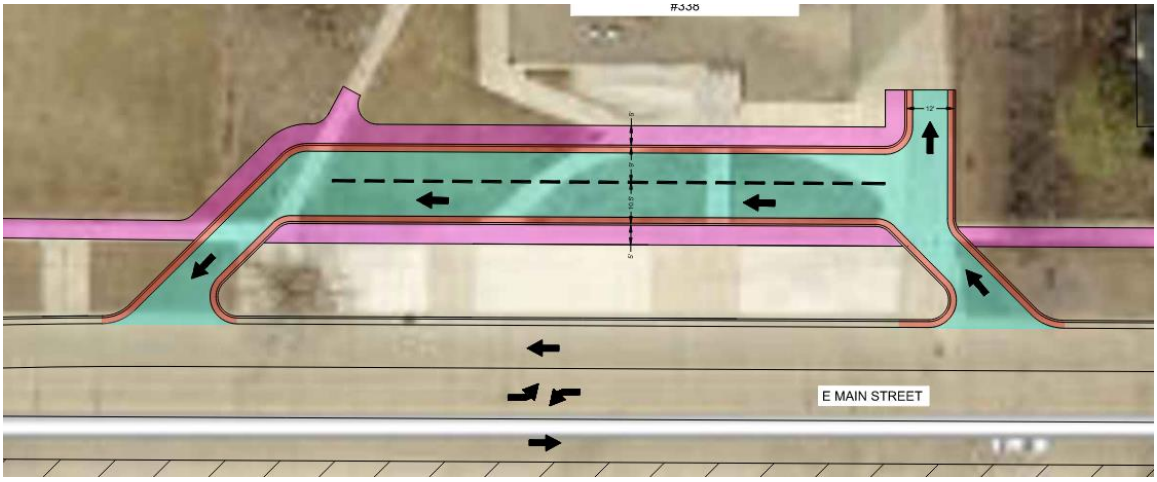
**Figure 4-3 – Proposed Drop Off Lane in front of school**




### 4.4.3 Alternative 3B – Owatonna Education Center Pull Off Lane

With consideration of the school drop off lane being close to the roundabout, this option provides a lane to divide traffic and allow cars to get around each other. With this option, the alley located east of the school would need to be re-routed for this design. This is the preferred option, however, needs to be completed in cooperation with the school district and their future planning. Figure 4-4 shows the proposed pull off lane.

**Figure 4-4 – Proposed Pull Off Lane in front of school**

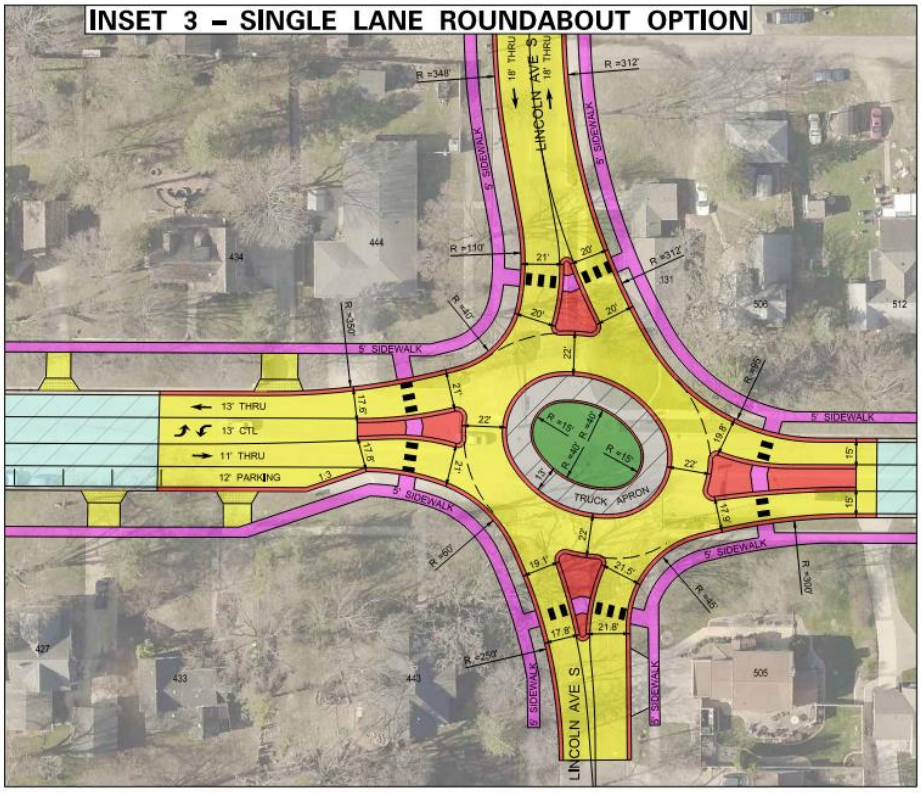


### 4.4.4 Alternative 4A – Roundabout at Lincoln Avenue S

As indicated by the completed corridor study, long term recommended traffic control improvement includes converting the intersection of Lincoln Avenue to roundabout control. This intersection configuration would involve demolishing the existing City owned house on the northeast corner of the intersection. It is recommended that additional traffic analysis is completed to determine when roundabout control would be warranted once traffic patterns in the area change due to the new location of Owatonna High School.

Figure 4-5 shows the proposed roundabout alternative at Lincoln Avenue.

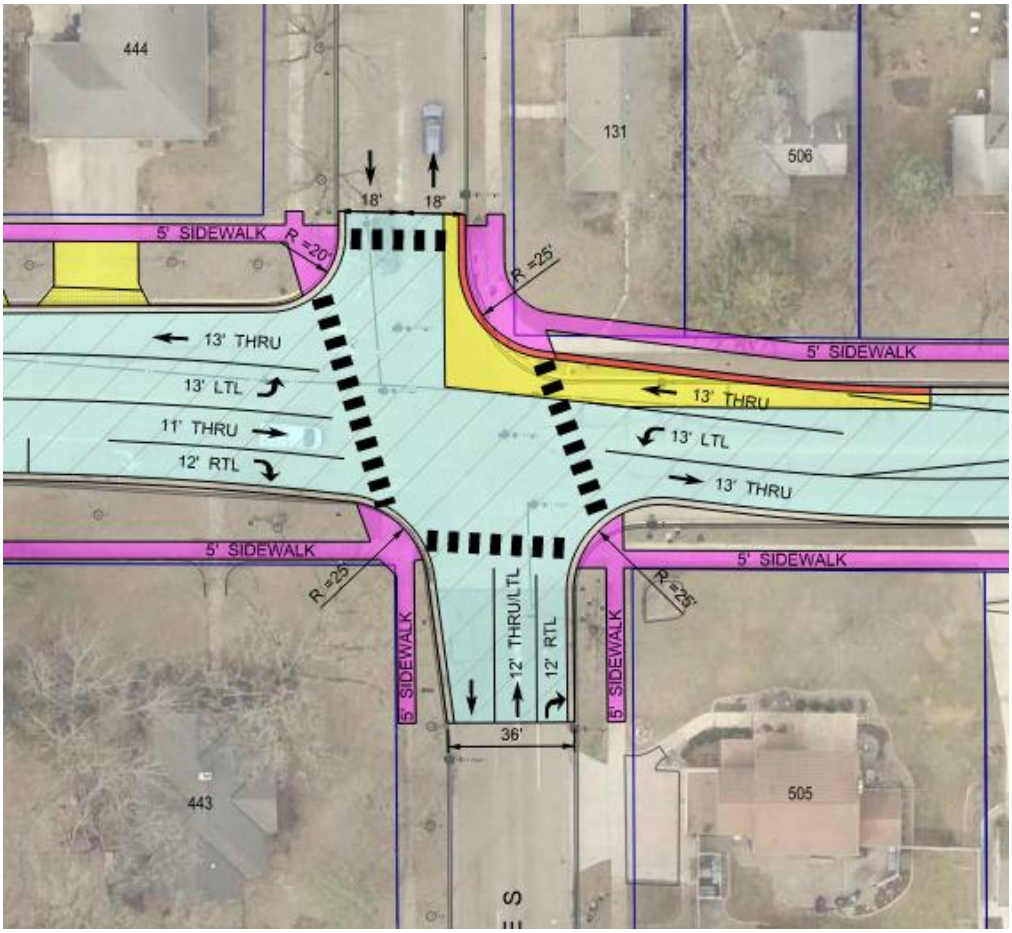
**Figure 4-5 – Proposed Roundabout at Lincoln Avenue**



### 4.4.5 Alternative 4B – Turn lanes at Lincoln Avenue S

Based on information provided as part of the corridor study, it is recommended that this intersection remain an all-way stop controlled intersection. Given the existing site distance constraints as well as the skew both east and west and north and south through this intersection, all-way stop control is the preferred control type. Operational analysis indicates that all-way stop control should provide acceptable levels of operation through the year 2035 before approach delays begin to exceed failing thresholds. To help improve alignment as well as provide additional capacity, widening the intersection would provide additional opportunity to develop dedicated left turn lanes for the eastbound and westbound approaches. Figure 4-6 shows the recommended improvement as widening the intersection and adding turn lanes.

**Figure 4-6 – Proposed Turn lane at Lincoln Avenue**




## 4.5 Sidewalks and Driveways

Recommended to meet the ADA specifications. Select areas of the sidewalk and driveways within the right-of-way show cracking and deterioration and should be replaced as needed for constructability with the design of the proposed project.

## 4.6 Watermain

Replacement of the watermain west of Elm Avenue should be considered as the watermain is old, has an unknown age and material, and is most likely out of compliance with fire protection standards in places. Due to the age, the watermain is likely made of cast iron and has lead jointing. This can lead to leaching of lead into the water system. If roadway reconstruction is selected, replacement of the watermain should be included in project scope, and for logistical reasons should also extend to Grove Avenue. The new main will also address future reliability concerns as the assumed existing cast iron main continues to age.

The watermain from Elm to Chambers was installed in 1998 and begins with a 12-inch polyvinyl chloride (PVC) pipe and narrows to an 8-inch PVC at Grove Avenue. The service life for PVC pipe is approximately 70 years. Therefore, not necessary to be replaced unless it is determined by Owatonna Public Utilities that the current capacity size needs to be increased.

## 4.7 Sanitary Sewer

The condition of the sanitary sewer from Oak Avenue to Elm Avenue is such that further deterioration can be expected in the lines and manholes. If left in place, it is almost certain that the line and/or manholes would require replacement in advance of any new mill and overlays anticipated life-cycle, most likely within 10 years. It is recommended to replace the sanitary sewer mains and structures in conjunction with full reconstruction.

The sanitary from Elm to Chambers was installed in 1998 and begins with a 10-inch polyvinyl chloride (PVC) pipe and narrows to an 8-inch PVC at the mid-block of Elm and Grove. The service life for PVC pipe is approximately 70 years. Therefore, not necessary to be replaced unless it is determined by City of Owatonna that the current capacity size needs to be increased.

## 4.8 Storm Sewer

The existing storm sewer system from Oak Avenue to Elm Avenue is undersized and is recommended to be replaced in conjunction with full reconstruction. The existing system should be evaluated and redesigned with current storm design standards using the latest rainfall data, and replaced with reinforced concrete pipes, precast catch basins, and manhole structures.

The existing storm sewer east of Elm Avenue consists of various sizes of RCP installed in 1998. RCP is anticipated to last at least 75 years. Therefore, not necessary to be replaced unless it is determined by City of Owatonna that the current capacity size needs to be increased.

## 4.9 Owatonna Public Utilities – Gas, Electric & Steam

As previously stated, an abandoned steam pipe was previously identified running along the project corridor and records of the pipe's location were not available. Municipal steam pipes were commonly insulated with an asbestos containing pipe wrap or the pipe itself is often transite (an asbestos containing material). If encountered during construction the pipe should be tested for asbestos and if it does contain asbestos, an asbestos abatement company will need to be contracted for proper handling/disposal.

OPU has also previously provided electronic CADD files of gas and electric power distribution lines located along the corridor. Based on this information, coordination will be needed with OPU for the gas and electric service lines located along the corridor to provide relocation and

adjustments as necessary for the full depth reclamation section from Oak Avenue to Grove Avenue.

## 4.10 Right of Way

Right of Way is determined to be needed for the following options and alternatives.

1. Roundabout control at the intersection of Grove Avenue - The four parcels abutting the Main Street and Grove Avenue intersection have impacts.
2. Realignment of Chambers Avenue – Impacts to Jaycee Park are needed to complete the realignment.
3. School Pull-off Option (Alt. 3B) - Would be needed if the pull-off option at the Owatonna Education Center is considered.

## 4.11 Incorporating City Streetscaping Elements

The City and County would need to be in agreement should the streetscape elements from Oak Avenue to Elm Avenue be incorporated into the redesign. The streetscaping elements have been included in the estimated budget but should be defined further during the design phase.

# 5 Public Engagement

Two public open houses were held to vet design alternatives and present the recommended design to the general public and project stakeholders. The first open house was held on February 17, 2022 and the second project open house was held on August 25th, 2022.

Meeting summaries from both open houses are shown in Appendix C.

# 6 Implementation

## 6.1 Estimated Project Costs

Table 6-1 – Total Estimated Project Costs

| Proposed Improvement | Cost ($)* | Assessment ($/foot) |
|---|---|---|
| 1A: Full Reconstruction Oak Ave to Grove Ave – Concrete Includes Grove Ave Roundabout | $7,645,000 | $138,025 ($52/ft) |
| 1B: Full Reconstruction Oak Ave to Grove Ave – Bituminous Includes Grove Ave Roundabout | $6,985,000 | $138,025 ($52/ft) |
| 1C: Mill and Overlay/Pavement Rehabilitation from Oak Ave to Elm Ave | $1,090,000 | 0 |
| 2: Concrete Pavement Rehab Grove Ave to Chambers Ave | $2,050,000 | 0 |
| 3A:Owatonna Education Center School Drop Off Lane | $65,000 | 0 |
| 3B: Owatonna Education Center School Pull Off Lane | $230,000** | 0 |
| 4A: Lincoln Avenue S Roundabout | $1,030,000 | 0 |
| 4B: Lincoln Avenue Turn Lane improvements | $35,000 | 0 |

**Includes 30% contingency and ELA*

***Would be a cooperative effort between the City, County, and School District*

Table 6-2 – Estimated Project Cost Fund Splits

| Proposed Improvement | Street | Storm Sewer | Watermain | Sanitary Sewer |
|---|---|---|---|---|
| 1A | **$6,150,000** | **$440,000** | **$650,000** | **$405,000** |
| 1B | **$5,545,000** | **$425,000** | **$625,000** | **$390,000** |
| 1C | **$1,090,000** | --- | --- | --- |
| 2 | **$2,050,000** | --- | --- | --- |
| 3A | **$65,000** | --- | --- | --- |
| 3B | **$230,000**** | --- | --- | --- |
| 4A | **$1,030,000** | --- | --- | --- |
| 4B | **$35,000** | --- | --- | --- |

***Would be a cooperative effort between the City, County, and School District for splitting the estimated $230,000.*

## 6.2 Proposed Financing

Financing would come from State Aid, County, and City funds.

Table 6-3 – Proposed Financing

| Financing | Street | Storm Sewer | Watermain | Sanitary Sewer |
|---|---|---|---|---|
| State Aid | **Yes** | **Yes** | **---** | **---** |
| County | **Yes** | **Yes** | **---** | **---** |
| City | **Yes** | **Yes** | **---** | **Yes** |
| OPU | | | **Yes** | |

## 6.3 Special Assessments

Special Assessments for this proposed project were calculated in case the City Council would like to utilize this avenue of financing, which may be decided later in the project. The special assessments are proposed following the City of Owatonna Assessment Policy dated September 1, 1981, revised April 2, 2012 & January 8, 2013. These funds would be applied to the reconstruction of the street and assessed at a rate of $52.00/LF for the assessable frontage of each parcel along the reconstruction project of the project. The preliminary assessment role can be found in Appendix E.

# 7 Recommendations

## 7.1 Improvement Alternative 1 – Oak Avenue to Elm Avenue

Based on present conditions alone, we would recommend full reconstruction take place from Oak Avenue to Grove Avenue, and concrete pavement be placed (Alternate 1A). Considering the current state of the roadway, failing manholes, undersized storm sewer, outdated utilities, non-ADA compliant pedestrian walk zones and sidewalk panels in areas, full reconstruction would be the recommended option. Concrete pavement would be preferred as it has a longer design life, less maintenance, and performs better with heavy vehicle loads and traffic. Traffic control improvements should also be implemented as identified in the attached ICE Study to ensure efficient future operations into the future. A detailed project layout is shown in Appendix D.

Included with these recommendations is the change of traffic control from signalized to roundabout control at the intersection of Grove Avenue as well as replacement of the existing signal system and corresponding ADA improvements at the intersection of Oak Avenue.

## 7.2 Improvement Alternative 2 – Grove Avenue to Chambers Avenue

We recommend performing Concrete Pavement Rehab from Grove Avenue to Chambers Avenue (Alternate 2) at this time. Additionally, future consideration should be given to the restriping of the roadway to include a 3-lane section from Grove Avenue to Lincoln Avenue and a two-lane roadway with parking on one side from Lincoln Avenue to Chambers Avenue.

## 7.3 Improvement Alternative 3 – Owatonna Education Center

We recommend Alternative 3B – Owatonna Education Center – Pull-Off Lane. With consideration of the school drop off lane being close to the roundabout, this option provides a lane to divide

traffic and allow cars to get around each other, which allows for safer vehicular and pedestrian traffic.

Prior to implementing this change, communication should be had with the school district to determine their future plans and use for this site to ensure that the proposed design best meets the needs of the school district both now and into the future.

## 7.4 Improvement Alternative 4 – Lincoln Avenue South

We recommend another future traffic study be conducted when the new high school located on the south side of the City is in-use. This will help determine the validity of a future roundabout at this location. In the meantime, we recommend implementing a left turn lane in both the eastbound and westbound directions.

# 8 Project Schedule

A proposed project schedule has been prepared for both the recommended full reconstruction of CSAH 48 from Oak Avenue to Grove Avenue, and the Concrete Pavement Rehabilitation from Grove Avenue to Chambers Avenue. The proposed schedule can be seen below:

1. Feasibility Study presented to County Board ..... April 2023
2. County Board awards roadway design project ..... May 2023
3. Construction Limits identified and set and ROW acquisition process begins. ..... June 2023
4. 30% Plans ..... August 1, 2023
5. 60% Plans ..... October 1, 2023
6. 90% Plans ..... December 1, 2023
7. 95% Plans ..... January 15, 2024
8. State Aid Approval & 100% Plans ..... March 2024
9. Advertisement for Bids for reconstruction project ..... February 2025
10. Contract Award for reconstruction project ..... March 2025
11. Begin construction for reconstruction project ..... April/May 2025
12. Construction completed for reconstruction project ..... November 2025
13. Advertisement for Bids for Concrete Pavement Repair project ..... Winter 2025/2026
14. Contract Award for Concrete Pavement Repair project ..... Spring 2026
15. Begin construction for Concrete Pavement Repair project ..... Spring 2026
16. Construction completed for Concrete Pavement Repair project ..... Fall 2026

# 9 Conclusion

Based upon our assessment of the current infrastructure condition, the preliminary cost estimates, and traffic engineering analysis, presented as part of this feasibility report, it is recommended that along CSAH 48 (Main Street), full depth reconstruction from Oak Avenue through Grove Avenue should be completed. As part of this reconstruction, a single lane roundabout should be constructed at the intersection of Main Street and Grove Avenue.

East of Grove Avenue, a Concrete Pavement Repair (CPR) (Proposed Improvement Alternative 2) should be completed. As part of this project, left turn lanes should be constructed at the intersection of Lincoln Avenue which includes minor widening of the roadway on the east side of Lincoln Avenue.

We also recommend the Pull-Off Lane option (Proposed Improvement Alternative 3B) at the Owatonna Education Center. Prior to this improvement being designed, further discussions should be had with the Owatonna Public School District to determine the future use for this parcel and whether or not this improvement will benefit the site long term.

# Appendix A

Geotechnical Evaluation Report

# Geotechnical Evaluation Report

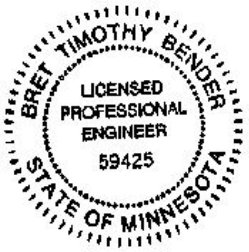
Steele County CSAH 48 Reconstruction
CSAH 48 (E Main Street) from S Oak Avenue to S Chambers Avenue
Owatonna, Minnesota

*Prepared for*

## Short Elliott Hendrickson, Inc.

**Professional Certification:**
I hereby certify that this plan, specification, or 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.

Bret T. Bender, PE
Project Engineer
License Number: 59425
November 11, 2022




Project B2207129

Braun Intertec Corporation

BRAUN INTERTEC
The Science You Build On.

**Braun Intertec Corporation**
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November 11, 2022 Project B2207129

Mr. Connor Burke, PE
Short Elliott Hendrickson, Inc.
717 3rd Ave SE, Suite 101
Rochester, MN 55904

Re: Geotechnical Evaluation
Steele County CSAH 48 Reconstruction
CSAH 48 (E Main Street) from S Oak Avenue to S Chambers Avenue
Owatonna, Minnesota

Dear Mr. Burke:

We are pleased to present this Geotechnical Evaluation Report for the Steele County CSAH 48 Reconstruction project located at the above-referenced site in Owatonna, Minnesota.

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please contact Bret Bender at 612.708.6758 (bbender@braunintertec.com) or Neil Lund at 612.369.3163 (nlund@braunintertec.com).

Sincerely,

BRAUN INTERTEC CORPORATION

Bret T. Bender, PE
Project Engineer

For Neil Lund
Nov 11 2022 1:38 PM

Neil G. Lund, PE
Technical Manager, Senior Engineer

c: Paul Sponholz, Steele County

AA/EOE

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**Appendix**


Soil Boring Location Sketch
Fence Diagram
Log of Boring Sheets B-01 through B-08
Descriptive Terminology of Soil
Pavement Core Photographs B-01 through B-08 and C-01 through C-04
Pavement Surface Photographs P-01 through P-20
Steele County CSAH 48 2020 Pavement Management Data
State Aid 10-ton ESAL Calculator
MnPAVE-Rigid Results
MnPAVE-Flexible Results

# A. Introduction

## A.1. Project Description

This Geotechnical Evaluation Report addresses the proposed design and construction of the County State Aid Highway (CSAH) 48 Reconstruction project, located in Owatonna, Minnesota. The project will include the reconstruction and/or rehabilitation of portions of CSAH 48 (East Main Street) from South Oak Avenue to South Chambers Avenue. We understand that a feasibility study is in progress for the project, that the project will likely occur within the next 2 to 10 years, and that the project will likely include the following:

- Full reconstruction or approximately 0.4 miles of CSAH 48 from Oak Avenue to Grove Avenue including reconstruction of utilities and pavements.
    - Both bituminous and concrete pavement options are under consideration.
    - Utilities to be reconstructed will include sanitary sewer, water main, and storm sewer, as well as underground electric, fiber optic, and gas lines.
    - A new roundabout intersection is planned for the intersection of CSAH 48 and Grove Avenue.
    - This area currently includes existing concrete pavements, with a bituminous overlay from Oak Avenue to Elm Avenue, concrete curb & gutter, sidewalks, and driveway aprons.
- Rehabilitation of approximately 0.4 mile of existing concrete pavements from Grove Avenue to Chambers Avenue
    - This area currently includes existing concrete pavements, concrete curb & gutter, sidewalks, and driveway aprons.

For the purposes of this report, we have assumed that finished grades will remain within 2 feet or less from existing grades.

Based on our understanding of the project, traffic volumes obtained using the Minnesota Department of Transportation (MnDOT) Traffic Mapping Application, and the MnDOT State Aid 10 Ton ESAL Calculator assuming a typical “Urban” traffic distribution, we anticipate the following pavement loads as summarized in Table 1 below.

**Table 1. Proposed Pavement Types and Traffic Loads**

| Aspect | Description |
|---|---|
| Pavement Types | Rigid (Concrete) – CSAH 48, including Roundabout<br>Flexible (Bituminous) – CSAH 48, excluding Roundabout |
| Assumed pavement loads | Concrete Pavement, Oak Ave to Grove Ave, including Roundabout:<br>435 HCADT, 0.5% annual growth* |
| | Concrete Pavement, Grove Ave to Chambers Ave:<br>366 HCADT, 0.5% annual growth* |
| | Bituminous Pavement, Oak Ave to Grove Ave, excluding Roundabout:<br>1,408,000 BESALs, 0.5% annual growth* |

*Equivalent 18,000-lb single axle loads based on 20-year design life for flexible pavement (BESALs). Heavy Commercial Average Daily Traffic (HCADT) and Growth Percentage used in MnPAVE-Rigid for at 35-year concrete pavement design life.

We have described our understanding of the proposed construction and site to the extent others reported it to us. Depending on the extent of available information, we may have made assumptions based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, the project team should notify us. New or changed information could require additional evaluation, analyses and/or recommendations.

## A.2. Site Conditions and History

Currently, the western segment of the project alignment from Oak Avenue to Elm Avenue has two drive lanes in each direction (eastbound and westbound), parking lanes in both directions, and dedicated turn lanes at the Oak Avenue and Elm Avenue intersections. The pavements in the western segment consist of concrete overlain with bituminous.

The eastern segment of the project alignment from Elm Avenue to Chambers Avenue has one drive lane in each direction, parking lanes in both directions, and dedicated turn lanes at the Elm Avenue, Grove Avenue, and Lincoln Avenue intersections. Pavements in the eastern segment are concrete, and were constructed in approximately 1998.

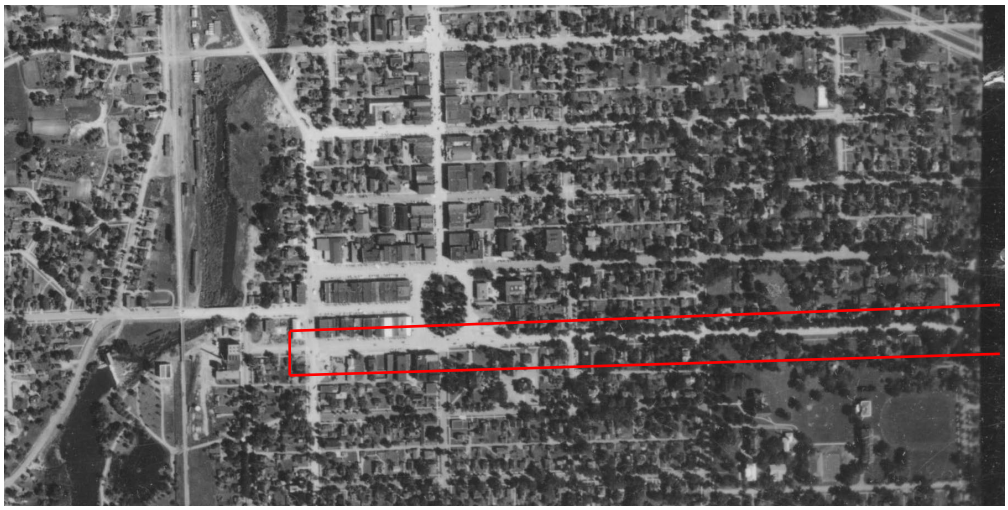
Land uses along the project alignment include a mixture of commercial, government, educational, and single-family residential development. Notable developments along the alignment include:

- The City of Owatonna City Hall and Fire Station
- The Steele County Courthouse
- An office of Federated Insurance Companies
- First Baptist Church
- A United States Post Office
- The Owatonna Education Center
- Pillsbury College Prep dormitories

Terrain along the alignment ranges from flat to rolling, with current grades ranging from approximately elevation 1,150 feet to 1,200 feet (NAVD88). West of Grove Avenue the site is relatively flat with grades generally sloping downward from east to west. Existing grades rise to the east of Grove Avenue, with the highest crest between Lincoln Avenue and Chambers Avenue. The Straight River lies to the west of the project, approximately 475 feet west of Oak Ave, near an elevation of 1,120 feet.

Historically, the land along the alignment appears to have generally been developed by 1938. Photographs 1 through 5 below show aerial views of the site in 1938, 1958, 1991, 2003, and 2017. The approximate project extents are shown outlined in red.

**Photograph 1. Aerial Photograph of the Site in 1938**



Photograph obtained using the University of Minnesota Libraries Historical Aerial Photographs Online web application.

**Photograph 2. Aerial Photograph of the Site in 1958**



Photograph obtained using the University of Minnesota Libraries Historical Aerial Photographs Online web application.

**Photograph 3. Aerial Photograph of the Site in 1991**




Photograph obtained using Google Earth.

**Photograph 4. Aerial Photograph of the Site in 2003**




Photograph obtained using Google Earth.

**Photograph 5. Aerial Photograph of the Site in 2017**




Photograph obtained using Google Earth.

## A.3. Purpose

The purpose of our geotechnical evaluation is to characterize subsurface geologic conditions at selected exploration locations, evaluate their impact on the project, and provide geotechnical recommendations for the design and construction of utilities and pavements.

## A.4. Background Information and Reference Documents

We reviewed the following information in preparation of this report:

- A Request for Proposal letter prepared by Short Elliott Hendrickson, Inc. (SEH) dated July 5, 2022.
- Topographic data obtained using the Minnesota Department of Natural Resources MNTOPO web application.
- Aerial photographs of the site and surrounding area obtained using the University of Minnesota Historical Aerial Photographs Online web application and Google Earth™.
- The University of Minnesota Duluth Natural Resources Research Institute, Minnesota Natural Resource Atlas, Depth to Bedrock – State web application.
- A map of the Surficial Geology of the Faribault 30 x 60 Minute Quadrangle, South-Central Minnesota prepared by The University of Minnesota, Minnesota Geological Survey, dated 2002, numbered Map M-130.
- A bedrock geology map prepared by the University of Minnesota, Minnesota Geological Survey, dated 1966, titles St. Paul Sheet, Bedrock Geology.
- The Minnesota Department of Transportation (MnDOT) *Standard Specifications for Construction,* 2020 Edition.
- The MnDOT *Pavement Design Manual,* dated July 10, 2019.
- The MnDOT *2017 Geotechnical Manual*.
- The MnDOT Network Level Concrete Decision Tree (2016 version) for concrete pavement rehabilitation planning.
- The MnDOT *Distress Identification Manual*, prepared by MnDOT, dated July 2011.
- *An Overview of MnDOT's Pavement Condition Rating Procedures and Indices*, prepared by MnDOT, dated April 2018.
- The MnDOT *Concrete Pavement Rehabilitation Guide* interactive web application available at the following website: http://www.dot.state.mn.us/materials/concretepavementrehabilitation.html
- Steele County Pavement Management Data for CSAH 48 collected by MnDOT in 2020, including Ride Quality Index (RQI), Surface Rating (SR), and Pavement Quality Index (PQI) and supporting data.

- Communications with Connor Burke of SEH regarding the scope and schedule of this evaluation and anticipated project details.

## A.5. Scope of Services

We performed our scope of services for the project in accordance with our Proposal numbered QTB162161 to SEH, dated July 18, 2022, and authorized on July 26, 2022. The following list describes the geotechnical tasks completed in accordance with our authorized scope of services.

- Reviewing the background information and reference documents previously cited.
- Staking and clearing the exploration location of underground utilities. SEH selected and we staked the exploration locations. We acquired the surface elevations and locations with GPS technology using the State of Minnesota's permanent GPS base station network. The Soil Boring Location Sketch included in the Appendix shows the approximate locations of the borings.
- Performing eight (8) standard penetration test (SPT) borings, denoted as B-01 to B-08, to nominal depths of 15 to 20 feet below grade across the site.
    - A termination depth of 20 feet was planned at all of the boring locations, but three borings were terminated shallower due to auger refusal.
    - We note that no soil borings were drilled from Elm Avenue to Grove Avenue, as complete reconstruction for this segment of roadway had not been proposed prior to our field exploration. We recommend additional soil borings be drilled in this area.
- Performing four (4) concrete pavement cores, denoted as C-01 to C-04 across the site.
    - Hand auger borings were performed at each location to document apparent aggregate base beneath the pavement. The hand auger borings were extended to depths of 15 to 29 inches below the existing pavement surface.
- Performing laboratory testing on select samples to aid in soil classification and engineering analysis.
- Perform engineering analysis including pavement thickness design and an assessment of concrete pavement rehabilitation options.
- Preparing this report containing a boring location sketch, logs of soil borings, a summary of the soils encountered, results of laboratory tests, and recommendations for pavement subgrade preparation, concrete pavement rehabilitation, and the design of new utilities and pavements.

Our scope of services did not include environmental services or testing and our geotechnical personnel performing this evaluation are not trained to provide environmental services or testing. We can provide environmental services or testing at your request.

# B. Results

## B.1. Geologic Overview

Our review of the surficial geology of the project area suggests native soils will primarily consist of glacial till and outwash deposits related to the Des Moines Lobe. Bedrock is mapped with surface elevations ranging from approximately elevation 1150 feet to 1250 feet, corresponding to depths within 50 feet of existing surface grades. The first-encountered bedrock formation in the area is mapped as the Galena Formation, which includes dolostone and limestone.

We based the geologic origins used in this report on the soil types, in-situ and laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.

## B.2. Boring and Coring Results

Table 2 below provides a summary of the soil boring results, in the general order we encountered the strata, and Table 3 below provides a summary of the pavement core and hand auger results. Please refer to the Log of Boring sheets in the Appendix for additional details. The Descriptive Terminology sheets in the Appendix include definitions of abbreviations used in Tables 2 and 3. For simplicity in this report, we define existing fill to mean existing, uncontrolled or undocumented fill.

**Table 2. Subsurface Profile Summary***

| Strata | Soil Type - ASTM Classification | Range of Penetration Resistances | Commentary and Details |
|---|---|---|---|
| Pavement Section | -- | -- | ▪ Overall thickness at boring locations ranged from 9 ¾ inches to 20 ¼ inches.<br>▪ All boring locations encountered bituminous over concrete. Apparent aggregate base below the concrete was encountered only at Borings B-02 and B-05.<br>▪ Bituminous thickness ranged from 2 ½ to 3 ¾ inches.<br>▪ Concrete thickness ranged from 6 to 11 inches.<br>▪ Apparent aggregate base thickness was 6 inches at B-02 and 9 inches at B-05. |
| Fill | SP, SP-SM, SM, SC, CL | 3 to 25 Blows per foot of sampler penetration (BPF) | ▪ General penetration resistance of 3 to 15 BPF. Blow count of 25 BPF at 5 feet in Boring B-04 likely due to gravel or possible cobble.<br>▪ Moisture condition generally moist. Occasional dry sand layers.<br>▪ Present to depths of 7 to 12 feet at the boring locations.<br>▪ Variable soil types. Soils occasionally intermixed.<br>▪ Upper 2 to 4 feet often included slightly organic soils. Organic soils present to 4 feet in Boring B-06.<br>▪ Existing fill contained trace amounts of bituminous debris at B-02.<br>▪ Variable amounts of Gravel. Possible cobbles at Borings B-03 and B-04. |
| Glacial Deposits | SP, SP-SM, SM | 3 BPF to 50 blows for 0 inches of penetration | ▪ Primarily glacial outwash sands. Glacial till sandy lean clay encountered below 14 feet in Boring B-02 and below 20 feet in boring B-07.<br>▪ Variable amounts of gravel; may contain cobbles and boulders.<br>▪ Moisture condition generally moist.<br>▪ Penetration resistance in sands varied from 3 BPF to 50 blows for 0 inches of penetration indicating the soils varied from very loose to dense. However, blow counts greater than 50 indicated sampler refusal on possible bedrock or other obstruction.<br>▪ Penetration resistance in clays ranged from 17 to 18 BPF indicating the soils were very stiff. |
| | CL | 17 to 18 BPF | |
| Possible Bedrock | Dolostone or Limestone (Galena Formation) | -- | ▪ Borings B-01, B-03, and B-05 met refusal at depths of 15 feet, 18 feet, and 16 feet respectively.<br>▪ Rock coring would be needed to confirm the presence and quality of bedrock as the borings could have potentially met refusal on cobbles, boulders, or bedrock “floats” near the bedrock surface. |

*Abbreviations defined in the attached Descriptive Terminology sheets.

**Table 3. Pavement Core Profile Summary***

| Core Location | Measured Concrete Pavement Thickness** | Commentary and Details |
|---|---|---|
| C-01 | 7 ¾ inches | ▪ Thickness of apparent aggregate base of at least 7 inches. Refusal to hand auger met at depth of 15 inches below pavement surface.<br>▪ Apparent aggregate base classified as Silty Sand with Gravel (SM).<br>▪ Concrete materials appeared to be in good condition. |
| C-02 | 8 inches | ▪ Thickness of apparent aggregate base of at least 7 inches. Refusal to hand auger met at depth of 15 inches below pavement surface.<br>▪ Apparent aggregate base classified as Silty Sand with Gravel (SM).<br>▪ Concrete materials appeared to be in good condition. |
| C-03 | 8 inches | ▪ Thickness of apparent aggregate base of at least 11 inches. Refusal to hand auger met at depth of 18 inches below pavement surface.<br>▪ Apparent aggregate base classified as Silty Sand with Gravel (SM).<br>▪ Concrete materials appeared to be in good condition. |
| C-04 | 7 inches | ▪ Measured thickness of apparent aggregate base of 22 inches. Hand auger terminated at 29 inches below pavement surface.<br>▪ Apparent aggregate base classified as Silty Sand with Gravel (SM).<br>▪ Concrete materials appeared to be in good condition. |

*Abbreviations defined in the attached Descriptive Terminology sheets.

**Average of three measurements taken around the core circumference.

We did not perform gradation analysis on the apparent aggregate base material encountered as part of the pavement section, in accordance with our scope of work. Therefore, we cannot conclusively determine if the encountered material satisfies a particular specification.

The Pavement Core Photographs included in the attached Appendix show the condition and thickness of the existing pavement at each boring and core location, with the exception of boring B-04 where only a partial core was recovered. The overlying bituminous layers appeared to have debonded from the underlying concrete at all of the boring locations except boring B-02 and B-04. Evidence of mild stripping of asphalt from the aggregate was observed in the bituminous layer at boring B-01.

Though difficult to identify in photographs, an apparent wire reinforcement with a diameter of ¼ inch was noted within the concrete layers at locations B-01, B-03, B-05, and B-08. The concrete around the reinforcement did not appear spalled or corroded.

## B.3. Groundwater

We did not observe groundwater while advancing our borings. Therefore, it appears that groundwater is below the depths explored. Project planning should anticipate seasonal and annual fluctuations of groundwater.

## B.4. Laboratory Test Results

The boring logs show the results of the laboratory testing we performed, next to the tested sample depth.

The moisture content (per ASTM D2216) of the tested samples of sandy soils varied from approximately 6 to 9 percent, indicating that the materials ranged from below to well below their probable optimum moisture contents for compaction.

The moisture content of the tested samples of clayey soils varied from approximately 10 to 25 percent, indicating that the materials ranged from slightly below to well above their probable optimum moisture contents for compaction.

Our mechanical analyses through a #200 sieve (per ASTM D1140) indicated that the tested soils contained 19 to 35 percent fines (silt and clay particles) by weight. The tested soils were classified as clayey sand (SC).

Our organic content tests (per ASTM D2974) indicated that the tested soils contained 3 to 6 percent organic matter by weight. The tested soils were classified as “slightly organic” if containing 2 to 5 percent organic content, and as “organic” if containing greater than 5 percent organic content. We generally do not recommend reusing materials with organic contents exceeding 5 percent as fill below pavements.

## B.5. Pavement Reconnaissance Results

### B.5.a. Pavement Management Data

We were provided with pavement management data collected in 2020 by MnDOT for Steele County. The data is included in the attached Appendix, and provides a summary of pavement distresses and quality indices based on a state-wide standardized survey process and rating system. The surveyed portions of CSAH 48 within the project limits had Ride Quality Index (RQI) results ranging from 1.0 to 1.3, Surface Rating (SR) results ranging from 3.5 to 3.9, Pavement Quality Index (PQI) results ranging from 1.9 to 2.3, and International Roughness Index (IRI) results ranging from 217 inches/mile to 262 inches/mile.

The perceived serviceability of pavement is often correlated to road user comfort, as expressed using the RQI rating. The RQI is calculated based upon the SR, PQI, and IRI and can vary from 5.0 for new pavement to 0.0 for worst-case conditions. The RQI results of 1.0 to 1.3 indicate the road user comfort based on the current roadway condition is likely poor to very poor.

Pavement distresses contribute to the pavement quality indices. Common distresses documented in the 2020 data for CSAH 48 included the following:

- Slight transverse joint spalling
- Faulted joints, greater than ¼-inch
- Cracked panels
- Broken panels
- Patches greater than 5 square feet

Additional distresses may be present that are not documented, as surveys do not cover the entire length or every lane of the roadway.

### B.5.b. Site Reconnaissance

We conducted a site reconnaissance on August 10, 2022 to observe and photograph the existing pavement conditions along CSAH 48. The pavement photographs P-01 through P-20 in the attached Appendix document examples of the distresses observed. The observed distresses generally appeared consistent with anticipated conditions based upon review of the provided 2020 pavement management data, with the following additional observations:

- Severe joint spalling and multiple cracking distresses were observed at locations between Oak Avenue and Elm Avenue, similar to the example shown in Photograph P-01.

- MnDOT does not assign severity levels to faulting beyond ¼-inch, however noticeable faulting was observed at numerous locations between Grove Avenue and Chambers Avenue.
    - Faulting generally appeared concentrated near existing manholes, similar to the examples shown in Photographs P-10, P-12, P-17, and P-18.
    - Substantially-faulted panels that were also cracked, broken, and showed evidence of previous patching were observed around a manhole located approximately 275 feet east of Lincoln Avenue as shown in Photograph P-17.

# C. Recommendations

## C.1. Design and Construction Discussion – Reconstruction Area

### C.1.a. Introduction

Based on our understanding of the project as discussed above, and the results of our site reconnaissance, pavement coring, soil borings, and laboratory testing, the subgrade conditions generally appear suitable for support of the proposed construction and rehabilitation. However, appropriate consideration should be given to a number of factors that will impact the design and construction of the project, as discussed in the following sections.

### C.1.b. Recycling and/or Reuse of Existing Pavement Materials

The in-place pavement structure in the reconstruction area from Oak Avenue to Grove Avenue includes both bituminous and concrete materials. Reclamation of the existing bituminous via cold-milling, or of the concrete via breaking, removal, and crushing at an off-site plant for various types of reuse may be a viable option. However, the bituminous and concrete sections were variable in thickness, and apparent aggregate base was only encountered at two boring locations, thus if reuse of removed and processed concrete is planned the contractor should take care to accommodate for variability in the pavement sections, and to avoid contamination of broken concrete with subgrade soil during removal processes. We also recommend frequent sieve analyses and other quality control measures to verify the consistency and suitability of the reclaimed products. The MnDOT Schedule of Materials Control provides guidance on test quantities.

We note that concrete breaking and removal will cause vibrations beyond levels typically expected for city road reconstruction. The design team and contractor should be aware, and could consider pre-construction conditions surveys and/or vibration monitoring. We can provide these services if requested.

### C.1.c. Reuse of On-Site Soils

A complete reconstruction is proposed for the area of the alignment from Oak Avenue to Grove Avenue. The existing fill and native soils in the area of the project from Oak Avenue to Elm Avenue generally appeared suitable for reuse as utility trench backfill and pavement subgrade fill; however:

- Organic soil, i.e. soil having an organic content greater than 5 percent, was present to a depth of 4 feet in Boring B-06. Organic soil is considered unsuitable and should not be reused within roadway embankments or as backfill in utility trenches.
- Slightly organic soils, i.e. soils having an organic content of 2 to 5 percent, were encountered to depths of 2 to 4 feet in several borings. Slightly organic soils can be considered for reuse within roadway embankments and as backfill in utility trenches, though moisture conditioning of these materials to facilitate compaction may prove more challenging or require greater effort relative to non-organic soils.
- Clayey sand and sandy lean clay soils were present at moisture contents ranging from near to well above their probable optimum moisture content for compaction. Moisture conditioning, i.e. spreading and drying, may be required to facilitate compaction of these materials.
- No soil borings were drilled from Elm Avenue to Grove Avenue, as complete reconstruction and a new roundabout were not proposed for this area prior to our field exploration. We recommend that additional soil borings be drilled in this area in order to validate the discussion and recommendations in this report.

### C.1.d. Construction Disturbance

Clayey sand and sandy lean clay soils were present at and near anticipated subgrade elevations in the reconstruction area. These soils are moisture sensitive and may become disturbed if subjected to repeated construction traffic, particularly in times of wet weather. The contractor should take care with means, methods, and equipment to limit disturbance of the soils, and to correct areas that become disturbed.

### C.1.e. Possible Shallow Bedrock

We were not provided with anticipated utility invert depths or elevations for the reconstruction portion of the project. However, if utility invert depths of 15 feet or greater are planned, additional exploration may be warranted, as Borings B-01, B-03, and B-05 met auger refusal at depths of 15 to 18 feet on unknown obstructions that may possibly be the bedrock surface or may be cobbles, boulders, or rock “floats” near the bedrock surface. As such, the contractor should be aware that excavation of cobbles, boulders, or bedrock may be required.

### C.1.f. Dewatering

We did not encounter groundwater in our soil borings. Thus, we do not anticipate dewatering will be required for the reconstruction portion of the project. However, if water, such as stormwater runoff, accumulates in excavations for the project, we recommend removal of the water and any softened, loosened or disturbed soils prior to placement of additional fill.

## C.2. Design and Construction Discussion – Concrete Pavement Rehabilitation

We understand concrete pavement rehabilitation is under consideration for the segment of the project from Grove Avenue to Chambers Avenue. The provided 2020 Ride Quality Index (RQI) data ranges from 1.0 to 1.3, indicating the road user comfort is likely poor to very poor. However, the provided 2020 Surface Rating (SR) data ranges from 3.5 to 3.9, indicating the road surface is generally in fair to good condition overall. Based on the MnDOT Network Level Decision Tree, documented distresses, and the provided RQI and SR data, we anticipate the most-feasible and most-likely treatment options for this segment of roadway are:

- Option 1: Do Nothing
- Option 2: Minor Concrete Pavement Rehabilitation (CPR) & Plane

If Option 1 is selected, it will be of importance for Steele County to continue to monitor distresses along the project alignment. We note that if left as-is, the condition of currently cracked, broken, and/or faulted panels may degrade more quickly over time due to potentially increased water intrusion, impacted surface drainage patterns, crack propagation, and/or traffic damage increasing areas of distress.

If Option 2 is selected, Steele County will have the opportunity to increase road user comfort, increase the performance longevity of the existing pavement, interrupt distresses, and correct some surface drainage patterns. However, the project team should be aware that the short-term cost of Option 2 will be significantly greater than Option 1, and that additional detailed investigation will be required to identify and mark the number and extent of required repairs. The actual extent of required repairs will be preliminarily estimated and undetermined until the investigation is completed. Additional investigation should be performed by qualified personnel, and should include the following:

- Detailed visual documentation
- Chaining
- Hammering
- Additional concrete coring if warranted, such as to identify dowel bar locations or the presence of joint tunneling

## C.3. Site Grading and Subgrade Preparation

### C.3.a. Pavement Subgrade Preparation

For subgrade preparation within the existing roadways in the reconstruction area, we recommend removing the existing pavement section and subcutting to the proposed subgrade depth per the design. In addition, we recommend removing vegetation, topsoil, topsoil fill, organic soils (greater than 5 percent by weight) and soft or unsuitable soils where encountered. The exposed subgrade soils should be evaluated in the field by a geotechnical engineer (or qualified technician working under the direction of a geotechnical engineer), scarified and surface compacted prior to placing additional fill to final grades and/or performing the subgrade proofroll described in Section C.2.e below.

### C.3.b. Excavation Oversizing

When removing unsuitable materials below structures or pavements, we recommend the excavation extend outward and downward at a slope of 1H:1V (horizontal:vertical) or flatter.

### C.3.c. Excavated Slopes

Based on the borings, we anticipate on-site soils in excavations will consist of existing fill and sandy soils. These soils are typically considered Type C Soil under OSHA (Occupational Safety and Health Administration) guidelines. OSHA guidelines indicate unsupported excavations in Type C soils should have a gradient no steeper than 1-1/2H:1V. Slopes constructed in this manner may still exhibit surface sloughing. OSHA requires an engineer to evaluate slopes or excavations over 20 feet in depth.

An OSHA-approved qualified person should review the soil classification in the field. Excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, “Excavations and Trenches.” This document states excavation safety is the responsibility of the contractor. The project specifications should reference these OSHA requirements.

### C.3.d. Excavation Dewatering

We do not anticipate dewatering will be required for the project. However, we recommend removing any accumulated water, such as stormwater runoff, from the excavations. Project planning should include temporary sumps and pumps for excavations in low-permeability soils, such as clays. We caution that dewatering of high-permeability soils (e.g., sands) from within the excavation with conventional pumps has the potential to loosen the soils, due to upward flow.

### C.3.e. Pavement Subgrade Proofroll

After preparing the subgrade as described above and prior to the placement of the aggregate base, we recommend proofrolling (test rolling) the subgrade soils with a fully loaded tandem-axle truck (a TR10 test roller) per MnDOT Specification 2111. We also recommend having a geotechnical representative observe the proofroll. Areas that fail the proofroll likely indicate soft or weak areas that will require additional soil correction work to support pavements.

The contractor should correct areas that display excessive yielding or rutting during the proofroll, as determined by the geotechnical representative. Possible options for subgrade correction include moisture conditioning and recompaction, or subcutting and replacement with soil or crushed aggregate. We recommend performing a second proofroll after the aggregate base material is in place, and prior to placing bituminous or concrete pavement.

### C.3.f. Engineered Fill Materials and Compaction

We recommend embankment (or subgrade) fill and utility trench backfill meet the requirements of MnDOT 2106 for select grading material, which excludes soils with a silt content greater than 80 percent, organic soils, and marl (silty or clayey swamp deposits, unstable when wet, crumbly when dry, often containing shells).

We recommend constructing embankments and compacting engineered fill in accordance with MnDOT Specifications 2106 and 2211. This includes spreading engineered fill in loose lifts of approximately 12 inches or less in thickness. The project documents should specify evaluating compaction using the Specified Density Method in accordance with MnDOT Specification 2106.3G1. A geotechnical representative or MnDOT certified grading and base individual, under the direction of a professional geotechnical engineer, should observe fill placement and perform testing.

The project documents should not allow the contractor to use frozen material as engineered fill or to place engineered fill on frozen material.

We recommend performing density tests in engineered fill to evaluate if the contractors are effectively compacting the soil and meeting project requirements.

## C.4. Pavements

### C.4.a. Design Sections

Our scope of services for this project did not include laboratory tests on subgrade soils to determine an R-value for pavement design. Based on our experience with soils similar to the clayey sand and sandy lean clay soils anticipated at the pavement subgrade elevation, we recommend pavement design assume an R-value of 15. Note the contractor may need to perform limited removal of unsuitable or less suitable soils to achieve this value.

We used MnDOT's MnPAVE-Rigid and MnPAVE-Flexible software for design of the concrete and bituminous pavement sections summarized in Tables 4 and 5 below.

**Table 4. Recommended Concrete Pavement Section, CSAH 48, Oak Ave to Grove Ave and Roundabout**

| Layer | Thickness (inches) | Notes or MnDOT Specification/Designation |
|---|---|---|
| Concrete | 8* | Plain, doweled, tied to curb (or shoulder/parking lane)<br>Assumes 15-foot transverse joint spacing<br>We recommend unsealed, sawed joints (joint type C1U per MnDOT Standard Plan 5-297.221) |
| Aggregate Base | 6* | Class 5 or Class 5Q<br>(MnDOT Spec. 3138) |
| Subbase | 12 | Select Granular (Spec. 3149.2.B.2) |

*Values increased from MnPAVE-Rigid output to facilitate constructability.

**Table 5. Recommended Bituminous Pavement Section, CSAH 48, Oak Ave to Grove Ave***

| Layer | Thickness (inches) | Notes or MnDOT Specification/Designation |
|---|---|---|
| HMA | 3 (2 lifts) | SPWEA340C<br>(MnDOT Spec. 2360) |
| HMA | 1 ½ (1 lift) | SPNWB330C<br>(MnDOT Spec. 2360) |
| Aggregate Base | 8 | Class 5 or Class 5Q<br>(MnDOT Spec. 3138) |
| Subbase | 12 | Select Granular (Spec. 3149.2.B.2) |

*Excluding Roundabout – this design should be reevaluated to accommodate roundabout traffic

### C.4.b. Pavement Materials and Compaction

We recommend specifying materials based on those provided in the above tables.

We recommend compacting the select granular subbase and aggregate base materials to meet the requirements of MnDOT's Penetration Index Method (Specification 2106.3G3).

### C.4.c. Subgrade Drainage

We recommend installing perforated drainpipes along pavement edges such that drainage of the select granular subbase and aggregate base layers will be maintained. The drainpipes should be routed to storm sewers or another approved outlet.

### C.4.d. Performance and Maintenance

We based the above pavement designs on a 20-year performance life for bituminous (flexible) pavements and a 35-year life for concrete (rigid) pavements. This is the amount of time before we anticipate the pavement will require major rehabilitation or reconstruction. This performance life assumes routine maintenance, such as seal coating and crack sealing, will be performed. The actual pavement life will vary depending on variations in weather, traffic conditions and maintenance.

It is common to place the non-wear course of bituminous and then delay placement of wear course. For this situation, we recommend evaluating if the reduced pavement section will have sufficient structure to support any construction, bus, and commercial truck traffic to which the reduced section may be subjected.

## C.5. Utilities

### C.5.a. Subgrade Stabilization

For utilities, we anticipate the soils at typical invert elevations will be suitable for utility support. However, if construction encounters unfavorable conditions such as soft clay, organic soils or perched water at invert grades, the unsuitable soils may require some additional subcutting and replacement with sand or crushed rock to prepare a proper subgrade for pipe support.

### C.5.b. Corrosion Potential

Based on our experience, some of the soils encountered by the borings are moderately corrosive to metallic conduits, but only marginally corrosive to concrete. We recommend specifying non-corrosive materials or providing corrosion protection, unless project planning chooses to perform additional tests to demonstrate the soils are not corrosive.

### C.5.c. Bedrock Removal and Pipe Bedding

Borings B-01, B-03, and B-05 met refusal at depths of 15 feet, 18 feet, and 16 feet respectively, possibly upon bedrock or cobbles, boulders, or slabs near the bedrock surface.

The contractor should be aware that removal of cobbles, boulders, slabs, or bedrock may be required, particularly if the project design places utility inverts or structure bottoms near or below the elevations where auger refusal was encountered. As we were not able to extend the borings using our drill rig's hollow-stem auger, we anticipate that rock removal using toothed buckets and/or ripping teeth may prove challenging and that additional rock removal measures may be required, such as pneumatic hammers or grinding teeth.

If bedrock is present at proposed utility invert elevations or structure bottoms, we recommend subcutting the bedrock a minimum of 6 inches and placement of a granular bedding of sand or crushed rock to minimize the risk of damage due to point loading the pipes or structures. The contractor should take care to follow the pipe or structure manufacturer's recommendations regarding bedding material type and thickness requirements, as some manufacturers may recommend greater than 6 inches of bedding.

# D. Procedures

## D.1. Penetration Test Borings

We drilled the penetration test borings with a truck-mounted core and auger drill equipped with hollow-stem auger. We performed the borings in general accordance with ASTM D6151 taking penetration test samples at 2 1/2- or 5-foot intervals in general accordance to ASTM D1586. The boring logs show the actual sample intervals and corresponding depths.

We sealed penetration test boreholes meeting the Minnesota Department of Health (MDH) Environmental Borehole criteria with an MDH-approved grout. We will forward a sealing record for those boreholes to the Minnesota Department of Health Well Management Section.

## D.2. Manual Exploration

### D.2.a. Hand Auger Borings

We drilled hand auger borings with a 3-inch-diameter bucket auger. We advanced the borings in 3- to 6-inch increments to depths of less than 3 feet below existing pavement surface elevations at the concrete pavement core locations. We then withdrew the auger from the borehole to obtain cuttings. The borings were advanced until apparent aggregate base was penetrated, or until auger refusal was met.

## D.3. Exploration Logs

### D.3.a. Log of Boring Sheets

The Appendix includes Log of Boring sheets for our penetration test borings. The logs identify and describe the penetrated geologic materials, and present the results of penetration resistance tests performed. The logs also present the results of laboratory tests performed on penetration test samples, and groundwater observations. The Appendix also includes a Fence Diagram intended to provide a summarized cross-sectional view of the soil profile across the site.

We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. Because we did not perform continuous sampling, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.

### D.3.b. Geologic Origins

We assigned geologic origins to the materials shown on the logs and referenced within this report, based on the following:

- A review of the background information and reference documents cited above
- Visual classification of the various geologic material samples retrieved during the course of our subsurface exploration
- Penetration resistance testing performed for the project

- Laboratory test results, and
- Available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

## D.4. Material Classification and Testing

### D.4.a. Visual and Manual Classification

We visually and manually classified the geologic materials encountered based on ASTM D2488. When we performed laboratory classification tests, we used the results to classify the geologic materials in accordance with ASTM D2487. The Appendix includes a chart explaining the classification system we used.

### D.4.b. Laboratory Testing

The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with ASTM procedures.

## D.5. Groundwater Measurements

The drillers checked for groundwater while advancing the penetration test borings, and again after auger withdrawal. We then filled the boreholes or allowed them to remain open for an extended period of observation, as noted on the boring logs.

# E. Qualifications

## E.1. Variations in Subsurface Conditions

### E.1.a. Material Strata

We developed our evaluation, analyses and recommendations from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata to vary in depth, elevation and thickness, away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

### E.1.b. Groundwater Levels

We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

## E.2. Continuity of Professional Responsibility

### E.2.a. Plan Review

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

### E.2.b. Construction Observations and Testing

We recommend retaining us to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.

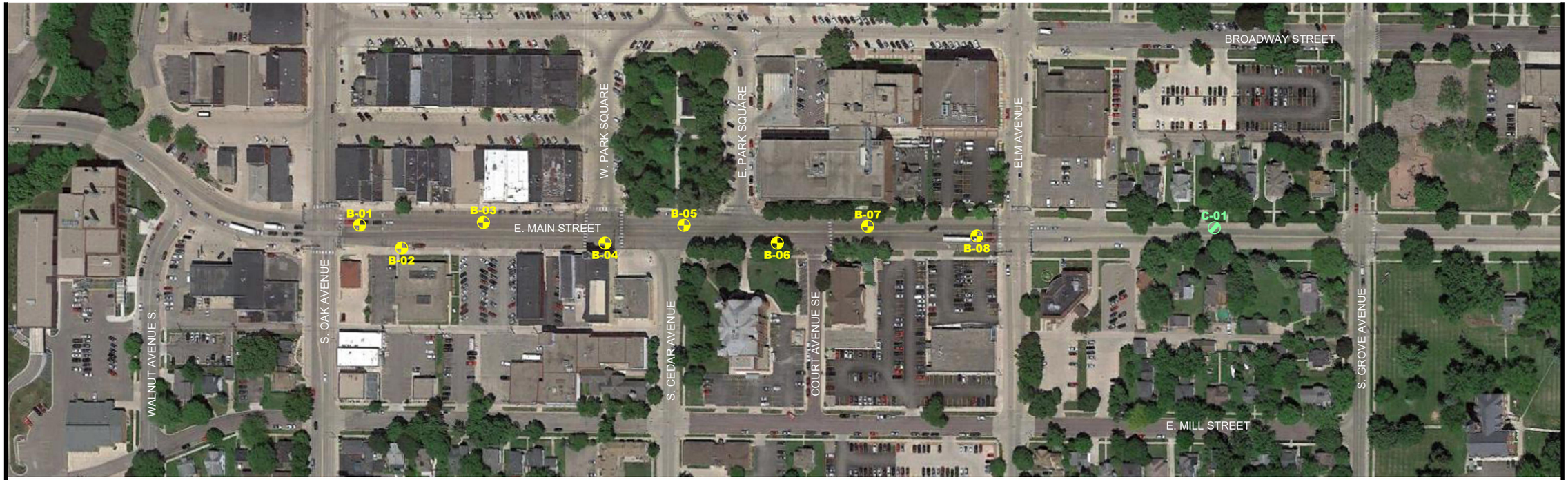
## E.3. Use of Report

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

## E.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

# Appendix

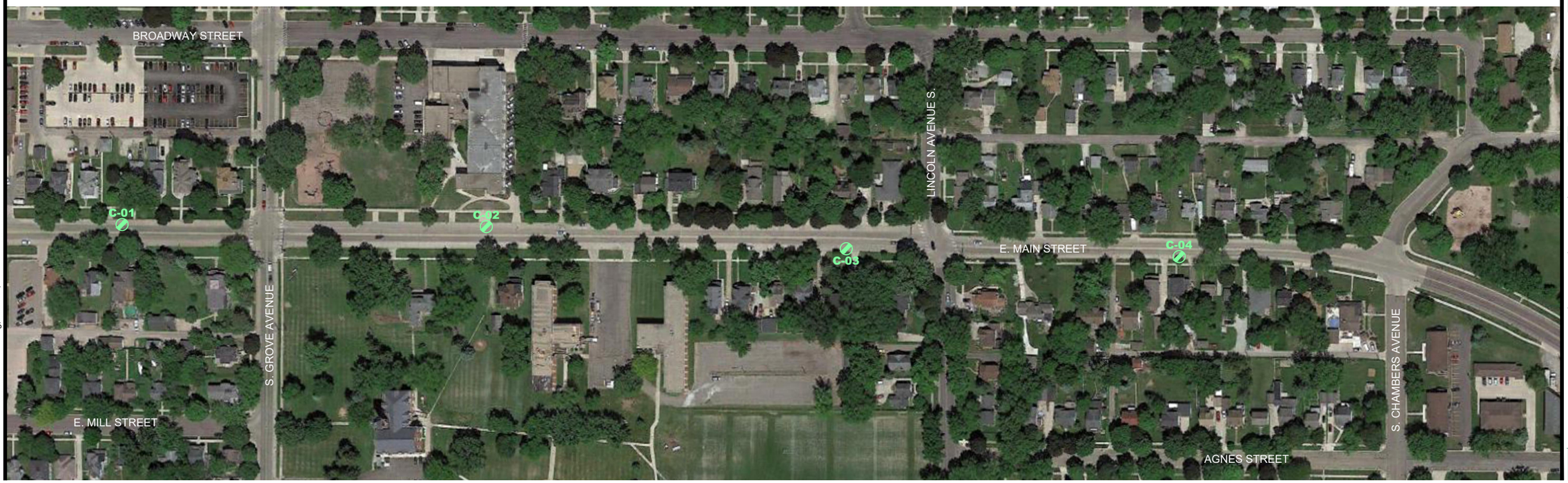



**DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING**

**DENOTES APPROXIMATE LOCATION OF PAVEMENT CORE**

100' 0 200'

SCALE: 1"= 200'




BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No: B2207129

Drawing No: B2207129

| | |
|---|---|
| Drawn By: | JAG |
| Date Drawn: | 8/8/22 |
| Checked By: | BTB |
| Last Modified: | 9/12/22 |

Project Information

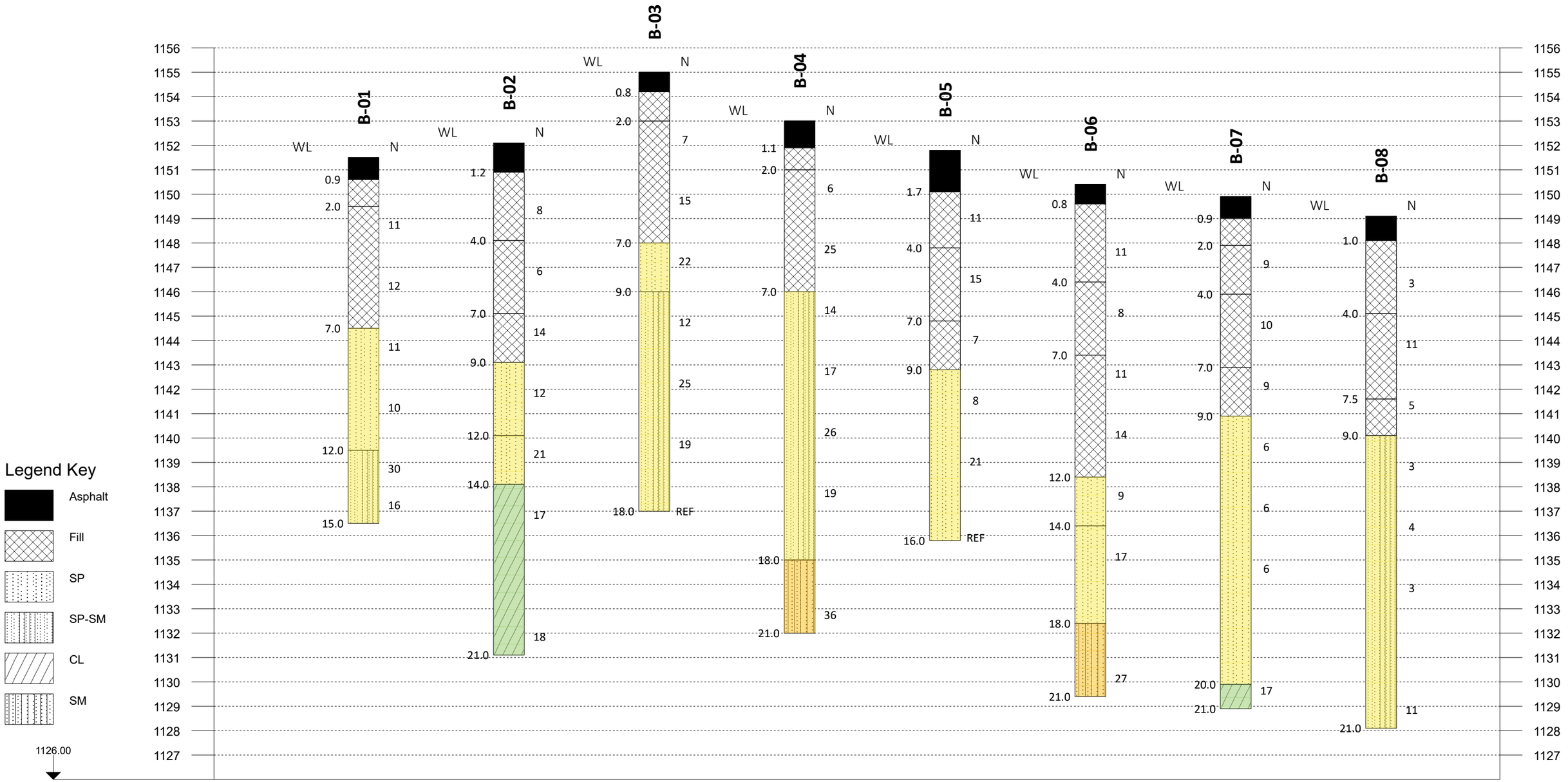
Steele County CSAH 48 Reconstruction

CSAH 48 (E. Main Street) from S. Oak Avenue to S. Chambers Avenue

Owatonna, Minnesota

# Soil Boring Location Sketch

F:\2022\B2207129\CAD\B2207129.dwg,Geotech,9/12/2022 11:11:36 AM




Project ID: B2207129
Vert. Scale: 1"= 4'
Hor. Scale: NTS
Date: 09/08/2022

Fence Diagram
Geotechnical & Environmental Evaluation
Steele County CSAH 48 Reconstruction
E Main Street from S. Oak Ave to S. Chambers Ave
Owatonna, Minnesota

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-01**
LOCATION: See attached sketch. Westbound drive lane.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191257 EASTING: 418120
DRILLER: E. Rislov LOGGED BY: B. Bender START DATE: 08/15/22 END DATE: 08/15/22
SURFACE ELEVATION: 1151.5 ft RIG: 7519 METHOD: 3 1/4" HSA SURFACING: Bituminous WEATHER: Sunny

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1150.6 | | PAVEMENT, 3 1/2 inches of bituminous over 7 inches of concrete, no apparent aggregate base | | | | | |
| 0.9 1149.5 | | FILL: CLAYEY SAND with GRAVEL (SC), dark brown, moist | | 3-6-5 (11) 17" | | 16 | P200=35% |
| 2.0 | | FILL: POORLY GRADED SAND with GRAVEL (SP), fine to coarse-grained, brown, dry | | | | 7 | |
| | | | 5 | 3-4-8 (12) 17" | | | |
| 1144.5 | | | | | | | |
| 7.0 | | POORLY GRADED SAND (SP), fine to medium-grained, trace Gravel, brown, moist, medium dense to loose (GLACIAL OUTWASH) | | 3-5-6 (11) 18" | | | |
| | | | 10 | 3-5-5 (10) 17" | | | |
| 1139.5 | | | | | | | |
| 12.0 | | POORLY GRADED SAND with SILT and GRAVEL (SP-SM), fine to coarse-grained, brown, moist, medium dense (GLACIAL OUTWASH) | | 16-16-14 (30) 16" | | | Auger met refusal at 15 feet. Possible bedrock surface |
| 1136.5 | | | | 4-5-11 (16) 17" | | | |
| 15.0 | | END OF BORING | 15 | | | | Water not observed while drilling. |
| | | Boring immediately backfilled with bentonite grout | | | | | Water not observed to cave-in depth of 12.0 feet immediately after withdrawal of auger. |
| | | | 20 | | | | |
| | | | 25 | | | | |
| | | | 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-02**
LOCATION: See attached sketch. Eastbound parking lane.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191213 EASTING: 418201
DRILLER: E. Rislov LOGGED BY: B. Bender
START DATE: 08/16/22 END DATE: 08/16/22
SURFACE ELEVATION: 1152.1 ft RIG: 7519 METHOD: 3 1/4" HSA
SURFACING: Bituminous WEATHER: Cloudy

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1150.9 | | PAVEMENT, 2 1/2 inches of bituminous over 6 inches of concrete over 6 inches of apparent aggregate base | | | | | |
| 1.2 | | FILL: SANDY LEAN CLAY with GRAVEL (CL), trace bituminous, dark brown to brown, moist *Sand seams at 3 feet* | | 3-4-4 (8) 9" | | 10 | |
| 1148.1 | | | | | | | |
| 4.0 | | FILL: SILTY SAND with GRAVEL (SM), fine to coarse-grained, trace Clay, brown, moist | 5 | 2-3-3 (6) 14" | | 9 | |
| 1145.1 | | | | | | | |
| 7.0 | | FILL: POORLY GRADED SAND with SILT and GRAVEL (SP-SM), fine to medium-grained, brown, moist | | 3-6-8 (14) 17" | | 9 | |
| 1143.1 | | | | | | | |
| 9.0 | | POORLY GRADED SAND (SP), fine to medium-grained, trace Gravel, brown, moist, medium dense (GLACIAL OUTWASH) | 10 | 2-4-8 (12) 17" | | | |
| 1140.1 | | | | | | | |
| 12.0 | | POORLY GRADED SAND with GRAVEL (SP), fine to coarse-grained, brown, moist, medium dense (GLACIAL OUTWASH) | | 7-9-12 (21) 18" | | | |
| 1138.1 | | | | | | | |
| 14.0 | | SANDY LEAN CLAY with GRAVEL (CL), with Sand seams, brown, moist, very stiff (GLACIAL TILL) | 15 | 10-10-7 (17) 18" | | 14 | |
| | | | 20 | 31-13-5 (18) 17" | | | |
| 1131.1 | | | | | | | |
| 21.0 | | END OF BORING | | | | | Water not observed while drilling. |
| | | Boring immediately backfilled with bentonite grout | | | | | Water not observed to cave-in depth of 16.0 feet immediately after withdrawal of auger. |
| | | | 25 | | | | |
| | | | 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-03**
LOCATION: See attached sketch. Westbound drive lane.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191262 EASTING: 418357
DRILLER: E. Rislov LOGGED BY: B. Bender START DATE: 08/15/22 END DATE: 08/15/22
SURFACE ELEVATION: 1155.0 ft RIG: 7519 METHOD: 3 1/4" HSA SURFACING: Bituminous WEATHER: Sunny

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1154.2 | | PAVEMENT, 2.5 inches of bituminous over 7 1/4 inches of concrete, no apparent aggregate base | | | | | |
| 0.8 1153.0 | | FILL: CLAYEY SAND with GRAVEL (SC), slightly organic, dark brown and black, moist | | | | 13 | P200=29% |
| 2.0 | | FILL: CLAYEY SAND with GRAVEL (SC), brown, moist | | 2-2-5 (7) 16" | | 13 | OC=3% P200=19% |
| | | | 5 | 8-6-9 (15) 0" | | | No recovery at 5 feet. Possible Gravel or cobbles. |
| 1148.0 7.0 1146.0 | | POORLY GRADED SAND (SP), fine to coarse-grained, trace Gravel, brown, moist, medium dense (GLACIAL OUTWASH) | | 3-7-15 (22) 16" | | 7 | |
| 9.0 | | POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown, moist, medium dense (GLACIAL OUTWASH) | 10 | 5-5-7 (12) 17" | | | |
| | | *With Gravel at 12 feet* | | 5-11-14 (25) 18" | | | |
| | | | 15 | 11-10-9 (19) 17" | | | Auger met refusal at 18 feet. Split-spoon sampler met refusal at 18 feet. Possible bedrock surface |
| 1137.0 18.0 | | END OF BORING | | 50/0" (REF) 0" | | | Water not observed while drilling. |
| | | Boring immediately backfilled with bentonite grout | 20 | | | | Water not observed at end of drilling. |
| | | | | | | | Water not observed to cave-in depth of 14.0 feet immediately after withdrawal of auger. |
| | | | 25 | | | | |
| | | | 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-04**
LOCATION: See attached sketch. Eastbound drive lane. Drilled 30 feet west of staked location.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191222 EASTING: 418589
DRILLER: E. Rislov LOGGED BY: B. Bender START DATE: 08/16/22 END DATE: 08/16/22
SURFACE ELEVATION: 1153.0 ft RIG: 7519 METHOD: 3 1/4" HSA SURFACING: Bituminous WEATHER: Sunny

| Elev./ Depth ft | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|
| 1151.9 | PAVEMENT, 2 1/2 inches of bituminous over 11 inches of concrete, no apparent aggregate base | | | | | |
| 1.1 | | | | | 23 | OC=5% |
| 1151.0 | FILL: SANDY LEAN CLAY (CL), slightly organic, black, moist | | 1-2-4 (6) 17" | | 10 | |
| 2.0 | FILL: SANDY LEAN CLAY with GRAVEL (CL), with Sand seams, brown and dark brown, moist | | | | | |
| | *Rock fragments recovered at 5 feet. Possible cobble* | 5 | 5-8-17 (25) 1" | | | |
| 1146.0 | | | | | | |
| 7.0 | POORLY GRADED SAND with SILT and GRAVEL (SP-SM), fine to medium-grained, brown, moist, medium dense (GLACIAL OUTWASH) | | 7-7-7 (14) 17" | | | |
| | | 10 | 4-7-10 (17) 18" | | | |
| | *Fine to course-grained at 12 feet* | | 5-11-15 (26) 17" | | | |
| | | 15 | 6-8-11 (19) 18" | | | |
| 1135.0 | | | | | | |
| 18.0 | SILTY SAND with GRAVEL (SM), fine to coarse-grained, trace Clay, brown, moist, dense (GLACIAL OUTWASH) | 20 | 14-22-14 (36) 17" | | | |
| 1132.0 | | | | | | |
| 21.0 | END OF BORING | | | | | Water not observed while drilling. |
| | Boring immediately backfilled with bentonite grout | | | | | Water not observed at end of drilling. |
| | | 25 | | | | |
| | | 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-05**
LOCATION: See attached sketch. Westbound drive lane.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191257 EASTING: 418740
DRILLER: E. Rislov LOGGED BY: B. Bender START DATE: 08/15/22 END DATE: 08/15/22
SURFACE ELEVATION: 1151.8 ft RIG: 7519 METHOD: 3 1/4" HSA SURFACING: Bituminous WEATHER: Sunny

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1150.1 | | PAVEMENT, 3 1/4 inches of bituminous over 8 inches of concrete over 9 inches of apparent aggregate base | | | | | |
| 1.7 / 1147.8 | | FILL: CLAYEY SAND (SC), trace Gravel, slightly organic, dark brown and black, moist | | 3-5-6 (11) 17" | | 15 | P200=34% OC=4% |
| 4.0 / 1144.8 | | FILL: POORLY GRADED SAND (SP), fine to medium-grained, trace Gravel, brown, dry | 5 | 5-6-9 (15) 17" | | 7 | |
| 7.0 / 1142.8 | | FILL: POORLY GRADED SAND (SP), fine to coarse-grained, trace Clay seams, brown, moist | | 1-3-4 (7) 18" | | 6 | |
| 9.0 | | POORLY GRADED SAND (SP), fine to coarse-grained, trace Gravel, brown, moist, loose to medium dense (GLACIAL OUTWASH) | 10 | 2-3-5 (8) 17" | | | |
| | | *With Gravel at 12 feet* | | 10-11-10 (21) 18" | | | |
| | | | 15 | | | | Auger met refusal at 16 feet. Possible bedrock surface |
| 1135.8 | | | | 50/3" (REF) 0" | | | |
| 16.0 | | END OF BORING | | | | | Water not observed while drilling. |
| | | Boring immediately backfilled with bentonite grout | | | | | Water not observed at end of drilling. |
| | | | 20 | | | | Water not observed to cave-in depth of 13.0 feet immediately after withdrawal of auger. |
| | | | 25 | | | | |
| | | | 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-06**
LOCATION: See attached sketch. Eastbound drive lane.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191223 EASTING: 418919
DRILLER: E. Rislov LOGGED BY: B. Bender
START DATE: 08/16/22 END DATE: 08/16/22
SURFACE ELEVATION: 1150.4 ft RIG: 7519 METHOD: 3 1/4" HSA
SURFACING: Bituminous WEATHER: Sunny

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1149.6 | | PAVEMENT, 2 1/2 inches of bituminous over 7 1/2 inches of concrete, no apparent aggregate base | | | | | |
| 0.8 | | FILL: SANDY LEAN CLAY (CL), trace Gravel, organic, brown and black, moist | | 3-5-6 (11) 17" | | 15<br>22 | OC=6% |
| 1146.4 | | | | | | | |
| 4.0 | | FILL: SILTY SAND with GRAVEL (SM), fine to medium-grained, trace Clay, brown, moist | 5 | 3-3-5 (8) 16" | | 9 | |
| 1143.4 | | | | | | | |
| 7.0 | | FILL: POORLY GRADED SAND with SILT and GRAVEL (SP-SM), fine to coarse-grained, brown, dry | | 3-5-6 (11) 17" | | | |
| | | | 10 | 4-9-5 (14) 0" | | | No recovery at 10 feet |
| 1138.4 | | | | | | | |
| 12.0 | | POORLY GRADED SAND with GRAVEL (SP), fine to coarse-grained, brown, dry, loose (GLACIAL OUTWASH) | | 3-4-5 (9) 17" | | | |
| 1136.4 | | | | | | | |
| 14.0 | | POORLY GRADED SAND (SP), fine to medium-grained, brown, moist, medium dense (GLACIAL OUTWASH) | 15 | 3-8-9 (17) 18" | | | |
| 1132.4 | | | | | | | |
| 18.0 | | SILTY SAND with GRAVEL (SM), fine to coarse-grained, with Clay, brown, moist, medium dense (GLACIAL OUTWASH) | 20 | 12-15-12 (27) 17" | | | |
| 1129.4 | | | | | | | |
| 21.0 | | END OF BORING<br><br>Boring immediately backfilled with bentonite grout | | | | | Water not observed while drilling.<br><br>Water not observed to cave-in depth of 16.0 feet immediately after withdrawal of auger. |
| | | | 25 | | | | |
| | | | 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-07**
LOCATION: See attached sketch. Westbound drive lane.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191255 EASTING: 419092
DRILLER: E. Rislov LOGGED BY: B. Bender START DATE: 08/15/22 END DATE: 08/15/22
SURFACE ELEVATION: 1149.9 ft RIG: 7519 METHOD: 3 1/4" HSA SURFACING: Bituminous WEATHER: Sunny

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1149.0 | | PAVEMENT, 2 3/4 inches of bituminous over 7 1/2 inches of concrete, no apparent aggregate base | | | | | |
| 0.9 1147.9 | | FILL: SANDY LEAN CLAY (CL), slightly organic, black, moist | | 4-4-5 (9) 16" | | 25 | OC=5% |
| 2.0 1145.9 | | FILL: CLAYEY SAND with GRAVEL (SC), dark brown and brown, moist | | | | 11 | P200=25% |
| 4.0 1142.9 | | FILL: POORLY GRADED SAND with SILT (SP-SM), fine to coarse-grained, trace Gravel, trace concrete fragments, brown, dry | 5 | 5-5-5 (10) 17" | | 7 | |
| 7.0 1140.9 | | FILL: POORLY GRADED SAND (SP), fine to medium-grained, occasional Clay seams, brown, moist | | 5-4-5 (9) 18" | | 9 | |
| 9.0 | | POORLY GRADED SAND (SP), fine to medium-grained, trace Gravel, brown, moist, loose (GLACIAL OUTWASH) | 10 | 2-3-3 (6) 17" | | | |
| | | | | 3-3-3 (6) 18" | | | |
| | | | 15 | 1-3-3 (6) 17" | | | |
| 1129.9 20.0 | | SANDY LEAN CLAY (CL), trace Gravel, brown, moist, very stiff (GLACIAL TILL) | 20 | 10-9-8 (17) 18" | | | |
| 1128.9 21.0 | | END OF BORING | | | | | Water not observed while drilling. |
| | | Boring immediately backfilled with bentonite grout | | | | | Water not observed at end of drilling. |
| | | | 25 | | | | Water not observed to cave-in depth of 16.0 feet immediately after withdrawal of auger. |
| | | | 30 | | | | |

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# LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

**Project Number B2207129**
**Geotechnical & Environmental Evaluation**
**Steele County CSAH 48 Reconstruction**
**E Main Street from S. Oak Ave to S. Chambers Ave**
**Owatonna, Minnesota**

BORING: **B-08**
LOCATION: See attached sketch. Eastbound left-hand turn lane.
DATUM: NAD 1983 HARN Adj MN Steele (US Feet)
NORTHING: 191236 EASTING: 419301
DRILLER: E. Rislov LOGGED BY: B. Bender START DATE: 08/16/22 END DATE: 08/16/22
SURFACE ELEVATION: 1149.1 ft RIG: 7519 METHOD: 3 1/4" HSA SURFACING: Bituminous WEATHER: Sunny

| Elev./ Depth ft | Water Level | Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908) | Sample | Blows (N-Value) Recovery | $q_p$ tsf | MC % | Tests or Remarks |
|---|---|---|---|---|---|---|---|
| 1148.1 | | PAVEMENT, 3 3/4 inches of bituminous over 7 3/4 inches of concrete, no apparent aggregate base | | | | | |
| 1.0 | | FILL: SANDY LEAN CLAY (CL), slightly organic, black and dark brown, moist | | 1-1-2 (3) 10" | | 19 | OC=4% |
| 1145.1 | | | | | | | |
| 4.0 | | FILL: SANDY LEAN CLAY (CL), trace Gravel, dark brown and brown, moist | 5 | 2-4-7 (11) 17" | | 21 | |
| 1141.6 | | | | 2-2-3 (5) 16" | | | |
| 7.5 | | FILL: CLAYEY SAND with GRAVEL (SC), fine to medium-grained, brown, moist | | | | | |
| 1140.1 | | | | | | | |
| 9.0 | | POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, trace Gravel, occasional Clay seams, brown, moist, very loose to medium dense (GLACIAL OUTWASH) | 10 | 2-1-2 (3) 16" | | | |
| | | | | 2-2-2 (4) 17" | | | |
| | | | 15 | 1-1-2 (3) 18" | | | |
| | | | 20 | 9-7-4 (11) 1" | | | |
| 1128.1 | | *Limestone fragments recovered at 20 feet. Possible bedrock surface* | | | | | |
| 21.0 | | END OF BORING | | | | | Water not observed while drilling. |
| | | Boring immediately backfilled with bentonite grout | | | | | Water not observed to cave-in depth of 14.0 feet immediately after withdrawal of auger. |
| | | | 25 | | | | |
| | | | 30 | | | | |

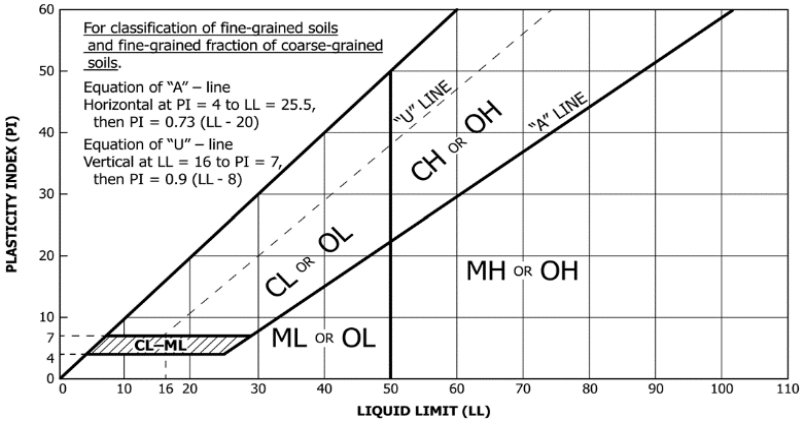
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# Descriptive Terminology of Soil

Based on Standards ASTM D2487/2488
(Unified Soil Classification System)

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A] | | | | Soil Classification | |
|---|---|---|---|---|---|
| | | | | Group Symbol | Group Name[B] |
| Coarse-grained Soils (more than 50% retained on No. 200 sieve) | Gravels (More than 50% of coarse fraction retained on No. 4 sieve) | Clean Gravels (Less than 5% fines[C]) | $C_u \geq 4$ and $1 \leq C_c \leq 3$[D] | GW | Well-graded gravel[E] |
| | | | $C_u < 4$ and/or ($C_c < 1$ or $C_c > 3$)[D] | GP | Poorly graded gravel[E] |
| | | Gravels with Fines (More than 12% fines[C]) | Fines classify as ML or MH | GM | Silty gravel[E F G] |
| | | | Fines Classify as CL or CH | GC | Clayey gravel[E F G] |
| | Sands (50% or more coarse fraction passes No. 4 sieve) | Clean Sands (Less than 5% fines[H]) | $C_u \geq 6$ and $1 \leq C_c \leq 3$[D] | SW | Well-graded sand[I] |
| | | | $C_u < 6$ and/or ($C_c < 1$ or $C_c > 3$)[D] | SP | Poorly graded sand[I] |
| | | Sands with Fines (More than 12% fines[H]) | Fines classify as ML or MH | SM | Silty sand[F G I] |
| | | | Fines classify as CL or CH | SC | Clayey sand[F G I] |
| Fine-grained Soils (50% or more passes the No. 200 sieve) | Silts and Clays (Liquid limit less than 50) | Inorganic | PI > 7 and plots on or above "A" line[J] | CL | Lean clay[K L M] |
| | | | PI < 4 or plots below "A" line[J] | ML | Silt[K L M] |
| | | Organic | Liquid Limit – oven dried / Liquid Limit – not dried <0.75 | OL | Organic clay[K L M N] / Organic silt[K L M O] |
| | Silts and Clays (Liquid limit 50 or more) | Inorganic | PI plots on or above "A" line | CH | Fat clay[K L M] |
| | | | PI plots below "A" line | MH | Elastic silt[K L M] |
| | | Organic | Liquid Limit – oven dried / Liquid Limit – not dried <0.75 | OH | Organic clay[K L M P] / Organic silt[K L M Q] |
| Highly Organic Soils | | Primarily organic matter, dark in color, and organic odor | | PT | Peat |

A. Based on the material passing the 3-inch (75-mm) sieve.
B. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
C. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
D. $C_u = D_{60} / D_{10}$ $C_c = (D_{30})^2 / (D_{10} \times D_{60})$
E. If soil contains ≥ 15% sand, add "with sand" to group name.
F. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
G. If fines are organic, add "with organic fines" to group name.
H. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
I. If soil contains ≥ 15% gravel, add "with gravel" to group name.
J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
K. If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
L. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
M. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
N. PI ≥ 4 and plots on or above "A" line.
O. PI < 4 or plots below "A" line.
P. PI plots on or above "A" line.
Q. PI plots below "A" line.




### Laboratory Tests

| | | | |
|---|---|---|---|
| **DD** | Dry density, pcf | **$q_p$** | Pocket penetrometer strength, tsf |
| **WD** | Wet density, pcf | **$q_U$** | Unconfined compression test, tsf |
| **P200** | % Passing #200 sieve | **LL** | Liquid limit |
| **MC** | Moisture content, % | **PL** | Plastic limit |
| **OC** | Organic content, % | **PI** | Plasticity index |

### Particle Size Identification

Boulders..... over 12"
Cobbles..... 3" to 12"
Gravel
  Coarse..... 3/4" to 3" (19.00 mm to 75.00 mm)
  Fine..... No. 4 to 3/4" (4.75 mm to 19.00 mm)
Sand
  Coarse..... No. 10 to No. 4 (2.00 mm to 4.75 mm)
  Medium..... No. 40 to No. 10 (0.425 mm to 2.00 mm)
  Fine..... No. 200 to No. 40 (0.075 mm to 0.425 mm)
Silt..... No. 200 (0.075 mm) to .005 mm
Clay..... < .005 mm

### Relative Proportions[L, M]

trace..... 0 to 5%
little..... 6 to 14%
with..... ≥ 15%

### Inclusion Thicknesses

lens..... 0 to 1/8"
seam..... 1/8" to 1"
layer..... over 1"

### Apparent Relative Density of Cohesionless Soils

Very loose ..... 0 to 4 BPF
Loose ..... 5 to 10 BPF
Medium dense..... 11 to 30 BPF
Dense..... 31 to 50 BPF
Very dense..... over 50 BPF

| Consistency of Cohesive Soils | Blows Per Foot | Approximate Unconfined Compressive Strength |
|---|---|---|
| Very soft | 0 to 1 BPF | < 0.25 tsf |
| Soft | 2 to 4 BPF | 0.25 to 0.5 tsf |
| Medium | 5 to 8 BPF | 0.5 to 1 tsf |
| Stiff | 9 to 15 BPF | 1 to 2 tsf |
| Very Stiff | 16 to 30 BPF | 2 to 4 tsf |
| Hard | over 30 BPF | > 4 tsf |

### Moisture Content:

**Dry:** Absence of moisture, dusty, dry to the touch.
**Moist:** Damp but no visible water.
**Wet:** Visible free water, usually soil is below water table.

### Drilling Notes:

**Blows/N-value:** Blows indicate the driving resistance recorded for each 6-inch interval. The reported N-value is the blows per foot recorded by summing the second and third interval in accordance with the Standard Penetration Test, ASTM D1586.

**Partial Penetration:** If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x" (i.e. 50/2"). The N-value is reported as "REF" indicating refusal.

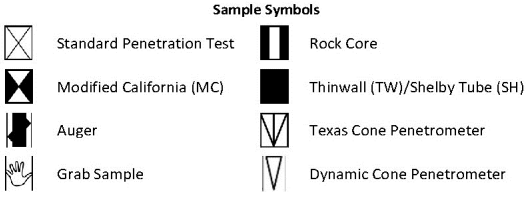
**Recovery:** Indicates the inches of sample recovered from the sampled interval. For a standard penetration test, full recovery is 18", and is 24" for a thinwall/shelby tube sample.

**WOH:** Indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

**WOR:** Indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

**Water Level:** Indicates the water level measured by the drillers either while drilling ( ▽ ), at the end of drilling ( ▼ ), or at some time after drilling ( ▼ ).

### Sample Symbols




5/2021





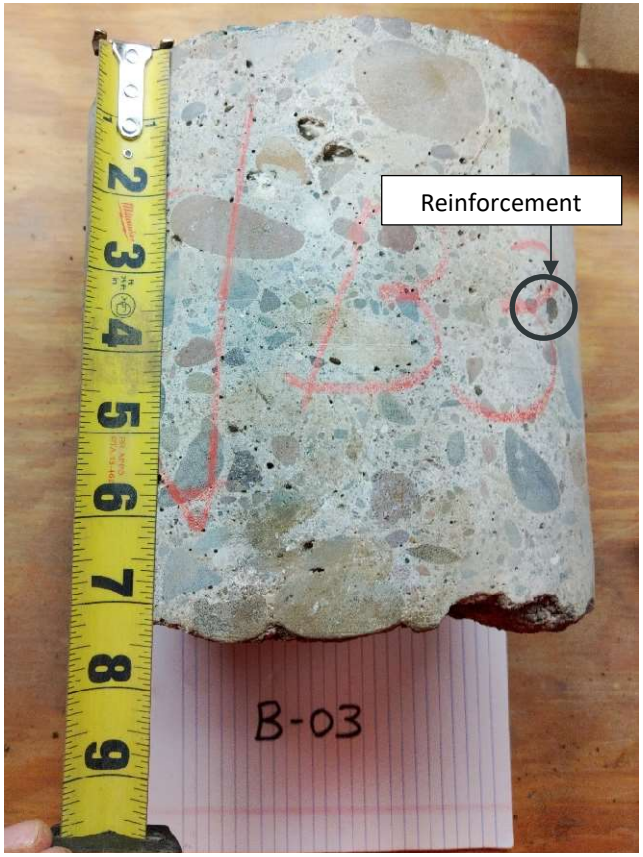


| | | |
|---|---|---|
| Core #: | B-01 | Project: B2207129 |
| Pavement thickness: | 3 1/2 inches bituminous<br>7 inches concrete<br>No apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 15, 2022 | |

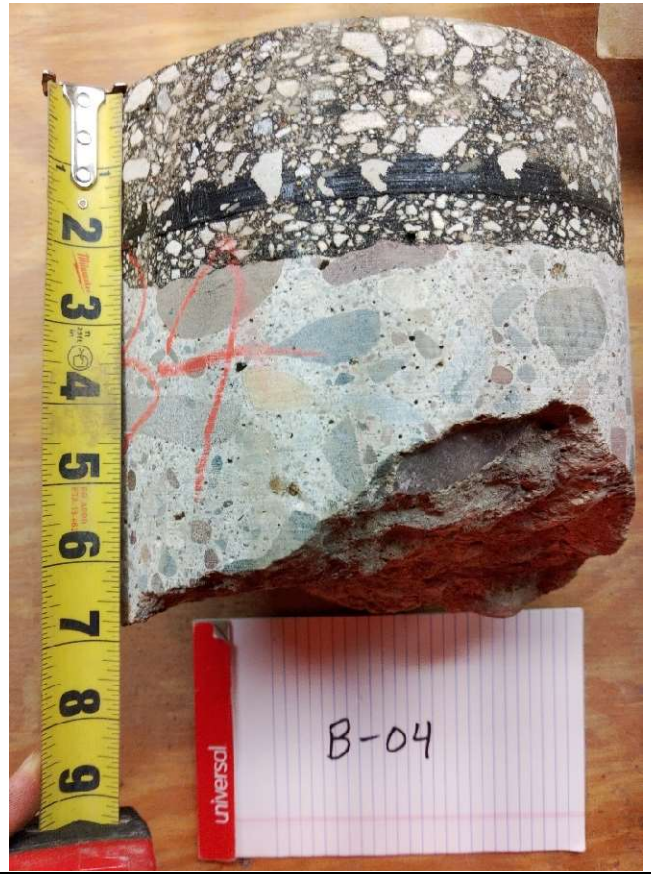



| | | |
|---|---|---|
| Core #: | B-02 | Project: B2207129 |
| Pavement thickness: | 2 1/2 inches bituminous<br>6 inches concrete<br>6 inches apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |

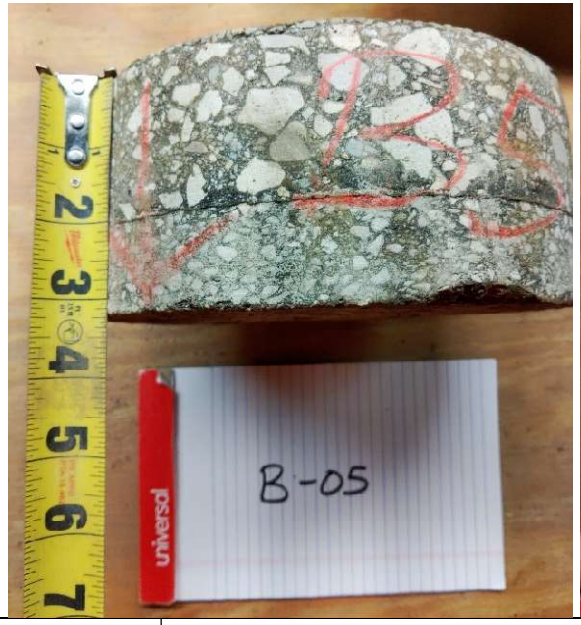


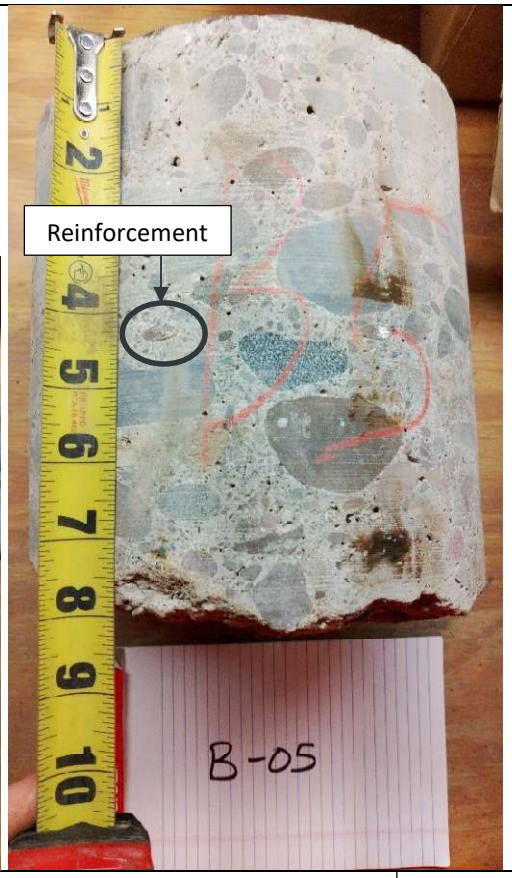




| | | |
|---|---|---|
| Core #: | B-03 | Project: B2207129 |
| Pavement thickness: | 2 1/2 inches bituminous<br>7 1/4 inches concrete<br>No apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 15, 2022 | |

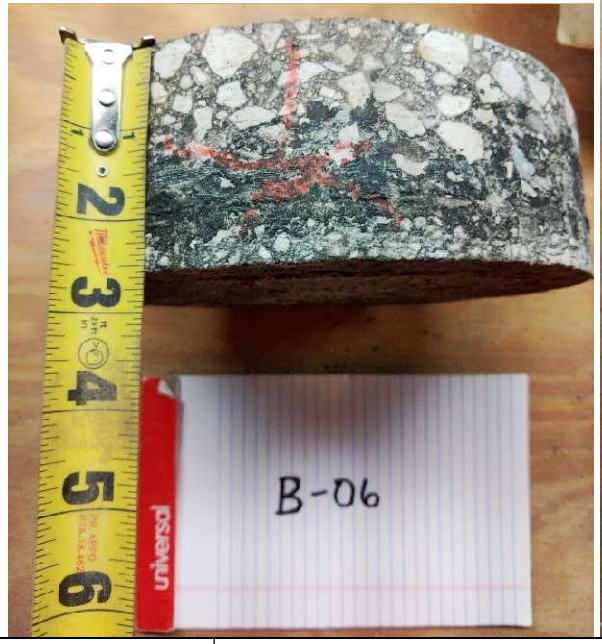



| | | |
|---|---|---|
| Core #: | B-04 | Project: B2207129 |
| Pavement thickness: | 2 1/2 inches bituminous<br>11 inches concrete (only partial core retrieved, bottom destroyed during drilling), No apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |




| | | |
|---|---|---|
| Core #: | B-05 | Project: B2207129 |
| Pavement thickness: | 3 ¼ inches bituminous<br>8 inches concrete<br>9 inches apparent aggregate base | |
| Project: | Steele County CSAH 48 | |
| Date: | August 15, 2022 | |







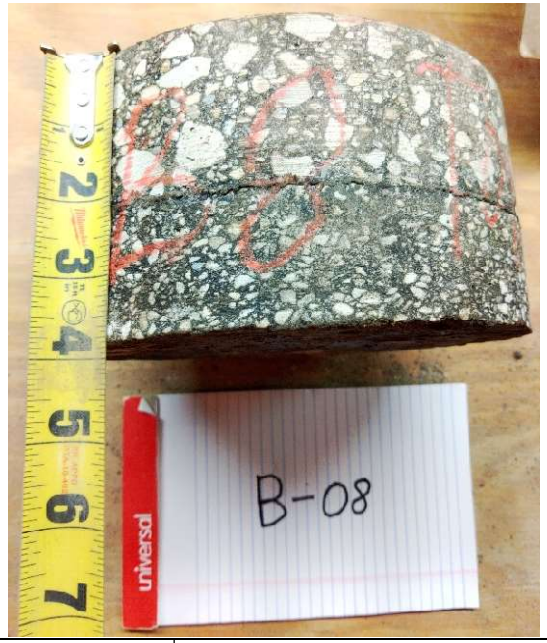
| | | |
|---|---|---|
| Core #: | B-06 | Project: B2207129 |
| Pavement thickness: | 2 ½ inches bituminous<br>7 ½ inches concrete<br>No apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |







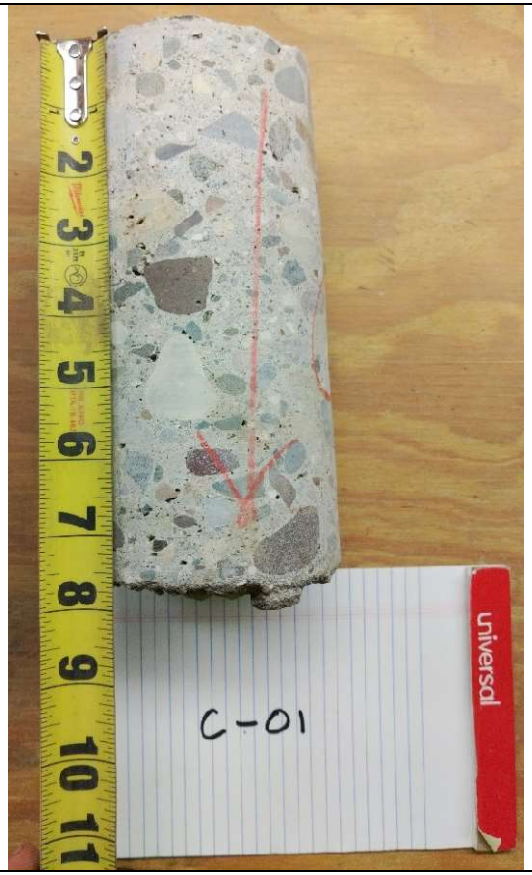
| | | |
|---|---|---|
| Core #: | B-07 | Project: B2207129 |
| Pavement thickness: | 2 ¾ inches bituminous<br>7 ½ inches concrete<br>No apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 15, 2022 | |







| | | |
|---|---|---|
| Core #: | B-08 | Project: B2207129 |
| Pavement thickness: | 3 ¾ inches bituminous<br>7 ¾ inches concrete<br>No apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |




| | | |
|---|---|---|
| Core #: | C-01 | Project: B2207129 |
| Pavement thickness: | 7 ¾ inches concrete<br>7+ inches of apparent aggregate base, refusal to hand auger at 15 inches below surface | |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |




| | | |
|---|---|---|
| Core #: | C-02 | Project: B2207129 |
| Pavement thickness: | 8 inches concrete<br>7+ inches of apparent aggregate base, refusal to hand auger at 15 inches below surface | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |




| | | |
|---|---|---|
| Core #: | C-03 | Project: B2207129 |
| Pavement thickness: | 8 inches concrete<br>11+ inches of apparent aggregate base, refusal to hand auger at 18 inches below surface | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |




| | | |
|---|---|---|
| Core #: | C-04 | Project: B2207129 |
| Pavement thickness: | 7 inches concrete<br>22 inches of apparent aggregate base | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 16, 2022 | |



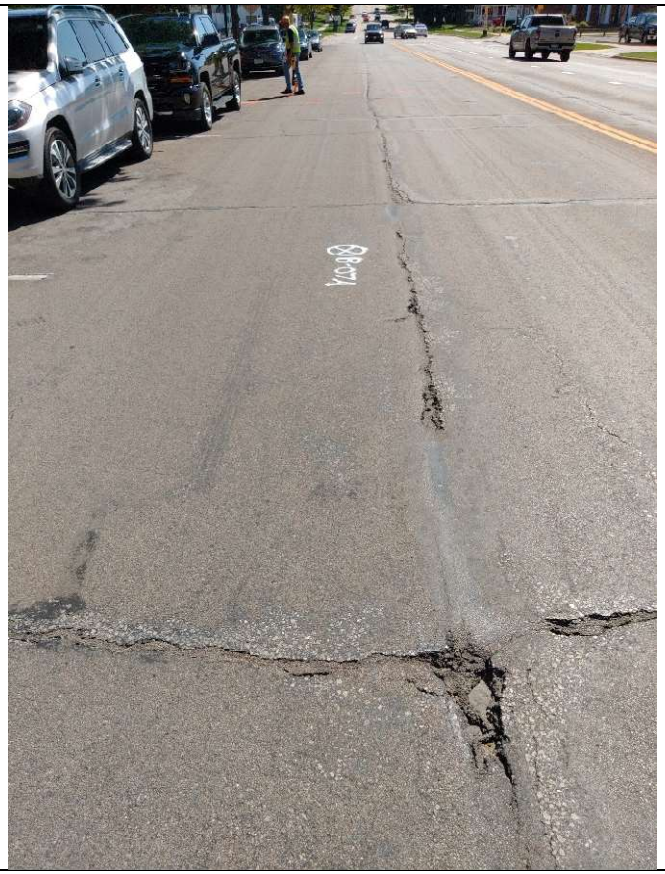
| | | |
|---|---|---|
| Photo #: | P-01 | Project: B2207129 |
| Location Description: | Near Boring B-02, looking east<br>Multiple cracking and joint spalling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |




| | | |
|---|---|---|
| Photo #: | P-02 | Project: B2207129 |
| Location Description: | Near Boring B-03, looking east<br>Joint spalling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |




| | | |
|---|---|---|
| Photo #: | P-03 | Project: B2207129 |
| Location Description: | Near Boring B-05, looking east<br>Longitudinal and transverse cracking | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-04 | Project: B2207129 |
| Location Description: | Near Boring B-07, looking east<br>Joint spalling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |




| | | |
|---|---|---|
| Photo #: | P-05 | Project: B2207129 |
| Location Description: | At Elm Avenue intersection, looking southeast<br>Cracked and broken panels, previous patches, joint spalling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-06 | Project: B2207129 |
| Location Description: | Approx. 250’E of Elm Avenue, looking west<br>Previous panel repair, minor raveling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-07 | Project: B2207129 |
| Location Description: | Approx. 60’W of Grove Avenue, looking east<br>Cracked panels, previous patching | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |




| | | |
|---|---|---|
| Photo #: | P-08 | Project: B2207129 |
| Location Description: | At Grove Avenue intersection, looking northeast<br>Previous panel repair, minor joint spalling, minor raveling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-09 | Project: B2207129 |
| Location Description: | Approx. 175’E of Grove Avenue, looking east<br>Minor joint spalling, minor raveling, previous patching | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-10 | Project: B2207129 |
| Location Description: | Approx. 275’E of Grove Avenue, looking east<br>Cracked and broken panels, previous patching | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-11 | Project: B2207129 |
| Location Description: | Approx. 625’E of Grove Avenue, looking west<br>Cracked and broken panels, previous patching, faulting | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-12 | Project: B2207129 |
| Location Description: | Approx. 500’W of Lincoln Avenue, looking east<br>Previous patching, faulting | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-13 | Project: B2207129 |
| Location Description: | Approx. 290’W of Lincoln Avenue, looking east<br>Cracked and broken panels, previous patching, faulting | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-14 | Project: B2207129 |
| Location Description: | At Lincoln Avenue intersection, looking west<br>Cracked panels, previous patching, minor raveling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-15 | Project: B2207129 |
| Location Description: | Approx. 75’E of Lincoln Avenue, looking east<br>Cracked panels, previous patching, faulting, minor joint spalling | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-16 | Project: B2207129 |
| Location Description: | Approx. 250’E of Lincoln Avenue, looking east<br>Cracked panels, previous patching | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-17 | Project: B2207129 |
| Location Description: | Approx. 275’E of Lincoln Avenue, looking northwest at MH<br>Cracked and broken panels, previous patching, faulting | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-18 | Project: B2207129 |
| Location Description: | Approx. 400’E of Lincoln Avenue, looking east<br>Previous patching, faulting | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-19 | Project: B2207129 |
| Location Description: | Approx. 275’W of Chambers Avenue, looking east<br>Cracked and broken panels, previous patching | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |



| | | |
|---|---|---|
| Photo #: | P-20 | Project: B2207129 |
| Location Description: | At Chambers Avenue intersection, looking northeast<br>Cracked panels, previous patching | BRAUN INTERTEC |
| Project: | Steele County CSAH 48 | |
| Date: | August 10, 2022 | |

| County | Route Type | Route Number | Beginning M.P. | Ending M.P. | Length (miles) | Beginning Termini | Remarks | Number of Lanes | Year | Direction | Pavement Type | RQI | SR | PQI | IRI_LWP (in/mi) | IRI_RWP (in/mi) | SLS | SES | FLJ | CRA | BRO | FLP | OVR | 5SF | DCR | SLJ | SEJ | Faulting (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STEELE | CS | 48 | 2.032 | 2.200 | 0.168 | CHAMBERS AVE RT | CONCRETE | 2 | 2020 | D | CON | 1.0 | | | 248 | 217 | | | | | | | | | | | | |
| STEELE | CS | 48 | 2.032 | 2.200 | 0.168 | CHAMBERS AVE RT | CONCRETE | 2 | 2020 | I | CON | 1.3 | 3.9 | 2.3 | 223 | 254 | | | 2 | 2 | | | | | | | | 0.07 |
| STEELE | CS | 48 | 2.200 | 2.440 | 0.240 | LINCOLN AVE | CONCRETE | 2 | 2020 | D | CON | 1.1 | | | 243 | 218 | | | | | | | | | | | | |
| STEELE | CS | 48 | 2.200 | 2.440 | 0.240 | LINCOLN AVE | CONCRETE | 2 | 2020 | I | CON | 1.0 | 3.7 | 1.9 | 254 | 262 | 2 | | 4 | 6 | 1 | | | 2 | | | | 0.08 |
| STEELE | CS | 48 | 2.440 | 2.570 | 0.130 | GROVE AVE | CONCRETE | 2 | 2020 | D | CON | 1.0 | | | 250 | 278 | | | | | | | | | | | | |
| STEELE | CS | 48 | 2.440 | 2.570 | 0.130 | GROVE AVE | CONCRETE | 2 | 2020 | I | CON | 1.3 | 3.5 | 2.1 | 228 | 246 | | | 9 | 9 | | | | 6 | | | | 0.10 |

# State Aid 10 Ton ESAL Traffic Forecast Calculator

**This ESAL calculator is for use with default Heavy Commerical Traffic values; click "User Defined Traffic Values" sheet below if you wish to enter your own Heavy Commercial Traffic values.**

Instructions: All yellow boxes require an input value.
Dropdown choices are provided for Base Year (C18), Number of Lanes (C19), and Urban or Rural (C21).
You must click on cells C18, C19, and C21 to access the dropdown choices.

**General Information**

| | | |
|---|---|---|
| Date | 9/19/22 | |
| Forecast Performed by | Braun Intertec | |
| Name of County or City | Steele County | |
| Project Number | B2207129 | |
| Project Description | CSAH 48 Reconstruction | |
| Route Number | 48 | |
| Base Year (i.e. opening to traffic) | 2032 | |
| Number of Lanes (total both directions) | 2 = typical 2 lane | |
| Current AADT | 10,000 | |
| Urban or Rural | Urban | |
| Historical AADT (enter a minimum of two years) | **Year** | **AADT** |
| Enter oldest traffic data here | 1995 | 9,700 |
| Enter second oldest traffic data here | 1999 | 10,700 |
| Enter third oldest traffic data here | 2011 | 10,800 |
| Enter fourth oldest traffic data here | 2019 | 10,000 |
| Base Year AADT | 2032 | 10,470 |
| 20-Year AADT | 2052 | 11,517 |
| 35-Year AADT | 2067 | 12,302 |
| Growth Rate | 0.50% | |

| Vehicle Type | Vehicle Class % | ESAL Factors Flexible | Rigid |
|---|---|---|---|
| 2AX-6TIRE SU | 1.46% | 0.25 | 0.24 |
| 3AX+SU | 0.09% | 0.58 | 0.85 |
| 3AX TST | 0.12% | 0.39 | 0.37 |
| 4AX TST | 0.24% | 0.51 | 0.53 |
| 5AX+TST | 1.80% | 1.13 | 1.89 |
| TR TR, BUSES | 0.63% | 0.57 | 0.74 |
| TWIN TRAILERS | 0.00% | 2.40 | 2.33 |
| **Total** | **4.35%** | **NA** | **NA** |

**20-Year Flexible Forecast (10 Ton) = 1,408,000**
**20-Year Rigid Forecast (10 Ton) = 2,109,000**
**35-Year Flexible Forecast (10 Ton) = 2,500,000**
**35-Year Rigid Forecast (10 Ton) = 3,745,000**

Note: This ESAL Calculator provides reasonable estimation of ESAL's based on accurate AADT values. It is limited to an AADT value of 20,000. For roadways exceeding an AADT of 20,000, it is recommended to use the MnDOT ESAL Forecasting Tool found on MnDOT's Pavement Design web page at:
http://www.dot.state.mn.us/materials/pvmtdesign/software.html

Revised: 5/6/2020

DEPARTMENT OF TRANSPORTATION

**MnPAVE Rigid 3.0 Design Summary**

Created 10/5/2022 9:31 AM

**MnPAVE Rigid File:**

## Calculated thickness: 7.2 in.

## Main Inputs

**Design life:** 35 years

**Climate (MnDOT district):** D6

**Initial 2-way traffic:** 435 HCADT

**Linear traffic growth:** 0.5

**Axle load spectra:** MnDOT Average

**Number of lanes (2-way):** 2

**Base material:** Class 5 Aggregate

**Base thickness:** 4.0 in.

**Subbase material:** Select Granular

**Subbase thickness:** 12.0 in.

**Joint spacing:** 15 ft.

**Widened lane?** No

**Shoulder type:** Tied PCC

## Defaults

**Reliability analysis:** Monte Carlo (MnPAVE Flexible)

**Allowable cracked slabs:** 15%

**Reliability level:** 50%

**Flexural strength:** 650 psi

**COV, PCC thickness:** 3.0%

**COV, Flexural strength:** 8.6%

**MEPDG coefficient 1:** 0.90

**MEPDG coefficient 2:** -2.64

**Calculated total trucks over service life:** 2,986,783

**Designer:** TBD

**Notes:**

Disclaimer: The Minnesota Department of Transportation makes no guarantee or warranty, either express or implied, with respect to the reuse of the data provided herewith, regardless of its format or means of its transmission. The user accepts the data "as is", and assumes all risks associated with its use. By accepting of this data, the user agrees not to transmit this data or provide access to it or any part of it to another party unless the user shall include with the data a copy of this disclaimer. The Minnesota Department of Transportation assumes no responsibility, actual or consequential, for damage that results from any user's reliance on this data.

# MnPAVE Design Summary

MnPAVE 6.405 Simulation  Input File: MnPAVE1

Confidence Level for Preliminary Life Estimate = 70%

Confidence and Reliability may not agree. Thickness and modulus are reduced when Confidence > 50%.

Monte Carlo Reliability randomly selects values for each layer.  Use Reliability for final design.

| Preliminary Life Estimate | | 20-Year Reliability (5,000 cycles) | |
|---|---|---|---|
| **Fatigue** | **Rutting** | **Fatigue** | **Rutting** |
| **41 years** | **36 years** | **99.5%** | **98.9%** |

## Project Information

| District | County | City |
|---|---|---|
| 6 | Steele | Owatonna |

| Project Number | Route | Reference Post |
|---|---|---|
| B2207129 | CSAH 48 | from Oak to Grove |

| Letting Date | Construction Type |
|---|---|
| 11/01/22 | Reconstruction |

| Designer | Soils Engineer |
|---|---|
| TBD | Braun Intertec |

## Climate Information

| Seasons | Location |
|---|---|
| 5 | 44˚ 0’ Latitude, 93˚ 11’ Longitude |

## Structural Information (Design Level:  Intermediate)

| Layer | Type | Subtype | Height (in.) |
|---|---|---|---|
| 1a | Hot-Mix Asphalt (Pb = 5.0%) | PG64-34 (2360F 1/2") | 3.00 |
| 1b | Hot-Mix Asphalt (Pb = 5.0%) | PG58-34 (2360F 1/2") | 1.50 |
| 2 | Aggregate Base | MnDOT Class 5 | 8.00 |
| 3 | Aggregate Subbase | MnDOT Select Granular | 12.00 |
| 4 | Engineered Soil | R-Value = 15 (CL) | 12.00 |
| 5 | Undisturbed Soil | Engineered Soil Modulus/2 | |

## Traffic Information (Speed = 30 mph)

| Load Type | First Year ESAL | Growth Rate | Axle Repetitions |
|---|---|---|---|
| ESAL | 67,210 | 0.5% (simple) | 1,408,000 |

**Notes**

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Printed Tuesday, September 27, 2022 at 18:05:18

# Appendix B

CSAH 48 (Main Street) Oak Avenue to Chambers Avenue Intersection Control Evaluation Report

Intersection Control Evaluation Report

# CSAH 48 (Main Street) - Oak Avenue to Chambers Avenue

Owatonna, Minnesota

SEH

Building a Better World for All of Us®

Engineers | Architects | Planners | Scientists

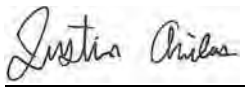
# Intersection Control Evaluation Report

CSAH 48 (Main Street) - Oak Avenue to Chambers Avenue
Owatonna, Minnesota

SEH No. STEEL 164362

July 1, 2022

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.



Justin Anibas, PE (MN)

Date: 07/01/2022 License No.: 59411

Approved By:

MnDOT District 6 State Aid Engineer Date

Steele County Engineer Date

City of Owatonna Engineer Date

Short Elliott Hendrickson Inc.
3535 Vadnais Center Drive
St. Paul, MN 55110

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SEH is a registered trademark of Short Elliott Hendrickson Inc.

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# Intersection Control Evaluation Report

## CSAH 48 (Main Street) - Oak Avenue to Chambers Avenue

Prepared by Short Elliott Hendrickson Inc. for Steele County, in cooperation with the City of Owatonna.

# 1 Background and Description

County State Aid Highway 48 (CSAH 48), also known as Main Street, is an east-west minor arterial roadway in the City of Owatonna. CSAH 48 spans from the west at Oak Avenue to the US Highway 14 Interchange southeast of Owatonna with daily traffic volumes ranging from 5,200 to 10,000 vehicles per day (vpd) through the project area.

The planned project will include rehabilitation of CSAH 48 between Oak Avenue and Chambers Avenue and is anticipated to be constructed in 2024-2026. This project is intended to maintain or improve traffic operations and safety along the corridor as well as improve pedestrian facilities to meet ADA standards.

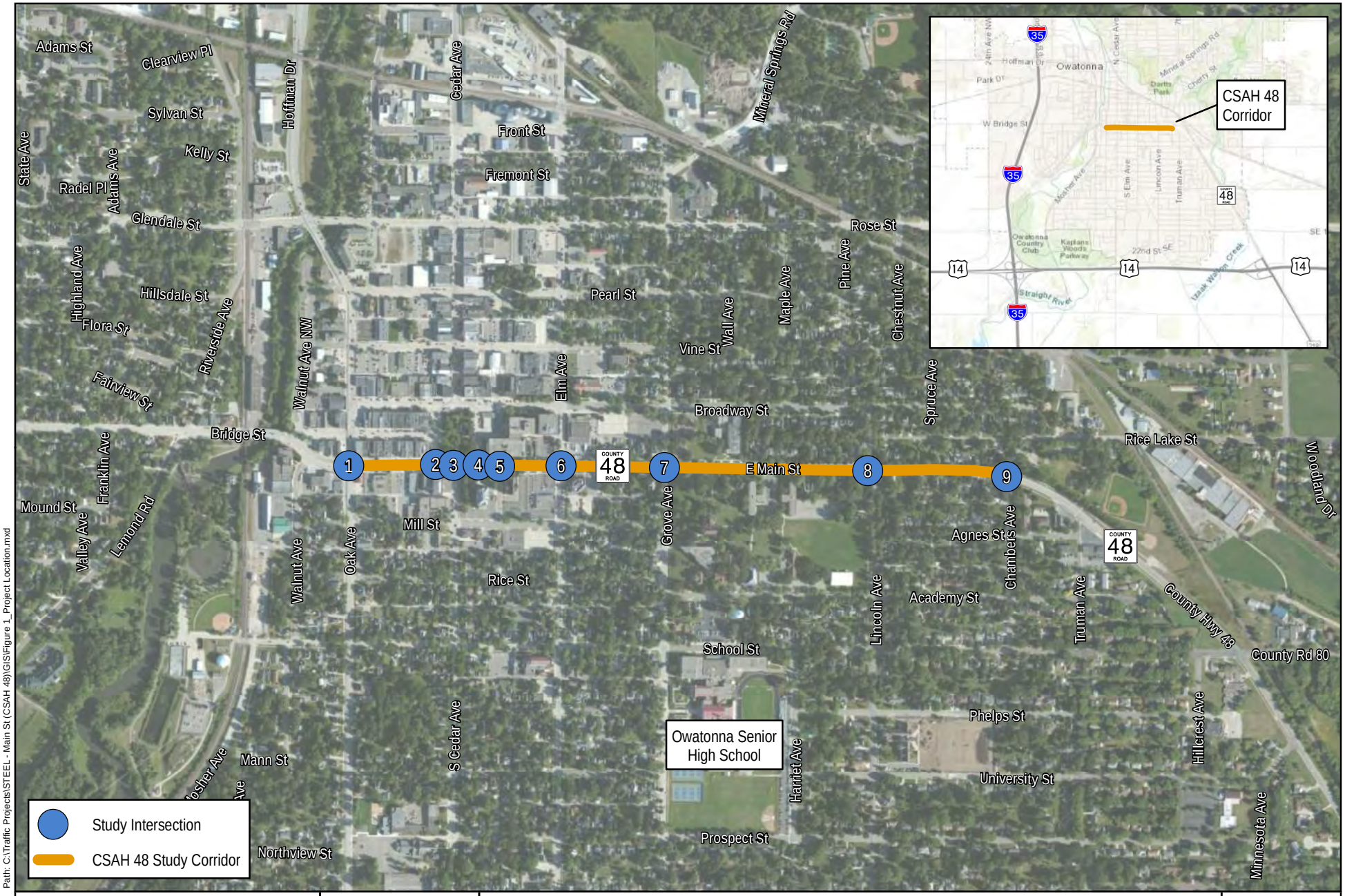
## 1.1 Overview

The primary purpose of this study is to determine the optimal type of intersection traffic control needs for the eight study intersections along CSAH 48 from Oak Avenue to Chambers Avenue. The following identifies the study intersections and their existing control:

- CSAH 48 at Oak Avenue (CSAH 45) (traffic signal control)
- CSAH 48 at W Park Square (traffic signal control)
- CSAH 48 at Cedar Avenue (MSAS 120) (minor stop control)
- CSAH 48 at E Park Square (no control – one-way departing)
- CSAH 48 at Court Avenue (no control – one-way departing)
  - Pedestrian flashing beacon on the east leg of the intersection
- CSAH 48 at Elm Avenue (MSAS 122) (traffic signal control)
- CSAH 48 at Grove Avenue (MSAS 121) (traffic signal control)
- CSAH 48 at Lincoln Ave (MSAS 123) (all-way stop control)
  - Traffic signal removed from the intersection in Spring 2021
- CSAH 48 at Chambers Avenue (minor stop control)

The Minnesota Department of Transportation (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 (2021) and forecast (2045) traffic conditions. The evaluation includes assessing traffic control volume warrants, intersection and roadway safety, and traffic operations.

The range of traffic control options includes a No Build scenario, with no change to the existing control conditions, and viable traffic control changes for each intersection, including all-way stop control, traffic signal control, roundabout control, and minor street stop control. **Figure 1** depicts the study intersections and rehabilitation area in a location map.




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Project: STEEL 164362
Print Date: 6/9/2022

Map by: jdanibas
Projection: Steele Co. Coords.
Source: ESRI Online

# *PROJECT LOCATION*

CSAH 48 (MAIN ST) REHABILITATION PROJECT
Owatonna, MN

Figure 1

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# 2 Existing Conditions

CSAH 48 is a 4-lane undivided roadway west of Elm Avenue and a 2-lane undivided roadway east of Elm Avenue through the project area; there is on-street parallel parking on both sides of the street for most of the project area, with marked parking spaces between Oak Avenue and Elm Avenue. There are currently time of day restrictions on parking through the downtown area. Parking is currently prohibited on the south side of CSAH 48 just east of Grove Avenue near the Owatonna Education Center to avoid parent's dropping off their students on the south side of CSAH 48. The posted speed limit is 30 mph. West of Grove Avenue, CSAH 48 is surrounded by downtown Owatonna, which consists of mostly commercial land uses. East of Grove Avenue, CSAH 48 is surrounded by primarily residential land uses.

There are currently four signalized intersections in the project area, two minor street stop-controlled intersections, and two uncontrolled intersections (minor street is one-way departing), and one all-way stop controlled intersection included in the nine study intersections.

East of the project area, CSAH 48 turns to a primarily north-south roadway and connects to US Highway 14 via a grade-separated interchange.

## 2.1 Crash History

Five years of crash data, from January 1, 2017 through December 31, 2021, was analyzed using MnDOT's crash mapping application (MnCMAT2). The type and severity of crashes were reviewed, and crash rates were calculated for each study intersection. Crash information is summarized in **Table 1** for the study intersections and **Table 2** for study segments; a total of 95 crashes have occurred within the study area in the last 5 years.

The crash rate at each intersection is expressed as the 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 reviewed.

For the purposes of this analysis, the Lincoln Avenue crash rate was compared to a crash rate for a traffic signal as the intersection was traffic signal controlled until Spring 2021 when it was converted to all-way stop control.

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

The following trends were evident from all crashes along CSAH 48 (all 95 crashes):

- 86 of the 95 crashes (91%) occurred at the nine study intersections with the remaining nine occurring between the study intersections.
- Approximately 49% of crashes along CSAH 48 are rear end crashes, 81% of which occurred at the 5 signalized intersections (includes Lincoln Ave) along the corridor.

- Approximately 17% of crashes along CSAH 48 are sideswipe crashes.
- Approximately 12% of crashes along CSAH 48 are right angle crashes.
- There seems to be a higher percentage of crashes during the afternoon peak period (12 PM to 3 PM, 33%) and the PM peak hour (3 to 6 PM, 30%).
- Fridays have the highest percentage (21%) of crashes, there is no definitive pattern of higher crashes on any given weekday.
- 84% of crashes along CSAH 48 were coded as daylight hours.
- 83% of crashes along CSAH 48 occurred in either clear or cloudy conditions, which are generally considered good weather conditions.
  - 10% of crashes occurred when it was snowing/blowing and 7% occurred when it was raining.

### 2.1.1 Pedestrian and Bicycle Crashes

There were a total of 4 reported crashes involving bicyclists and 2 involving pedestrians in the last 5 years (2017-2021). Below is a description of each pedestrian and bicycle crash along the roadway.

**Bicycle Crashes (2017- 2021)**

- All four occurred at the Oak Avenue intersection and were all minor injury crashes
- Two involved a southbound right turning driver failing to yield to a bicyclist in crosswalk on the west leg of the intersection
- One involved a westbound left turning driver failing to yield a bicyclist in the crosswalk on the south leg of the intersection
- One involved a southbound right turning driver attempting to make a right turn on red failing to yield to a bicyclist in the crosswalk on the north leg of the intersection

**Pedestrian Crashes (2017- 2021)**

- One occurred at Oak Avenue (minor injury) and involved an eastbound right turning driver attempting to make a right turn on red failing to yield to a pedestrian in the crosswalk on the west leg of the intersection.
- One occurred at Elm Avenue (fatal) and involved a southbound right turning driver attempting to make a right turn on red, then striking a pedestrian in the crosswalk on the west leg on the intersection.
- Three additional pedestrian crashes have occurred along the corridor between January 2011 and March 2022
  - One occurred in September 2011 at the Court Avenue pedestrian flashing beacon (serious injury) and involved a westbound driver failing to yield to a pedestrian crossing using the marked crosswalk and the pedestrian flashing beacon
  - One occurred in May 2011 at Grove Avenue (minor injury) and involved a pedestrian disregarding the traffic signal crossing the roadway in the crosswalk on the east leg of the intersection and being struck by an eastbound vehicle at low speed.
  - One occurred in January 2022 at Grove Avenue (minor injury) and involved a pedestrian disregarding the traffic signal crossing the roadway in the crosswalk on the west leg of the intersection and being struck by a westbound vehicle at low speed.

### 2.1.2 Intersection Crashes

As shown in **Table 1**, a total 77 crashes occurred at the nine study intersections in the 5-year analysis period. There was one fatal crash and no serious injury crashes. The fatal crash occurred at the Elm Avenue signal and involved a pedestrian as described in the previous section.

Based on the observed crashes rates in comparison to the calculated critical rate, the CSAH 48 intersections at Oak Avenue and Grove Avenue are above the calculated critical crash rate (see **Table 1**); this is an indication of potential safety concerns at those intersections. It should be noted that Oak Avenue was restriped from a 4-lane roadway to a 3-lane roadway in June 2020, which improved safety at the intersection. Prior to Oak Avenue being restriped, the intersection averaged 7.3 crashes per year, which has been reduced to 6.3 crashes per year with the 3-lane section.

Table 1 – Intersection Crash History (2017-2021)

| CSAH 48 at: | Crash Severity | | | | | Crash Rates | |
|---|---|---|---|---|---|---|---|
| | Fatal & Severity A | Severity B | Severity C | Property Damage | Total | Intersection Rate | Critical Rate |
| Oak Ave | 0 | 6 | 1 | 28 | 35 | **0.87** | **0.82** |
| W Park Square | 0 | 0 | 0 | 6 | 6 | 0.27 | 0.93 |
| Cedar Ave | 0 | 0 | 0 | 2 | 2 | 0.10 | 0.45 |
| E Park Square | 0 | 0 | 0 | 1 | 1 | 0.06 | 0.48 |
| Court Ave | 0 | 0 | 0 | 2 | 2 | 0.13 | 0.50 |
| Elm Ave | 1 | 0 | 0 | 5 | 6 | 0.27 | 0.93 |
| Grove Ave | 0 | 1 | 0 | 21 | 22 | **0.94** | **0.92** |
| Lincoln Ave | 0 | 0 | 0 | 10 | 10 | 0.53 | 0.97 |
| Chambers Ave | 0 | 0 | 0 | 2 | 2 | 0.16 | 0.54 |
| **TOTAL** | **1** | **7** | **1** | **77** | **86** | n/a | n/a |

The following trends are evident for each study intersection along CSAH 48:

- CSAH 48 at Oak Avenue (traffic signal) – 35 crashes
  - 18 of the 35 crashes were rear end crashes. 7 of the rear ends involved eastbound vehicles and 0 involved westbound vehicles (4 northbound, 7 southbound).
  - The intersection was restriped from a 4-lane roadway to a 3-lane roadway in 2020 and was completed on June 1, 2020. 25 of the 35 crashes at the intersection occurred before Oak Avenue was restriped (7.3 per year). The remaining 10 occurred after the intersection was restriped (6.3 per year). Overall, the restriping on Oak Avenue has improved safety at the intersection.
  - There were 4 crashes involving bicyclists, all minor injury (see **Section 2.1.1**)
  - There was 1 crash involving a pedestrian, which was a minor injury crash (see **Section 2.1.1**)
- CSAH 48 at W Park Square (traffic signal) – 6 crashes
  - 4 of the 6 crashes were rear end crashes. 3 of the rear ends involved eastbound vehicles and 1 involved westbound vehicles.

- CSAH 48 at Cedar Ave (minor stop) – 2 crashes
  - With only 2 crashes, both were weather related, over the previous 5 years there have been no crash patterns at this intersection.
- CSAH 48 at E Park Square (no control – one-way departing) – 1 crash
  - With 1 crash over the previous 5 years there have been no crash patterns at this intersection.
- CSAH 48 at Court Avenue (no control – one-way departing) – 2 crashes
  - Both crashes were rear end collisions from vehicles stopping for pedestrians crossing using the pedestrian flashing beacon to cross CSAH 48 (one eastbound, one westbound)
- CSAH 48 at Elm Avenue (traffic signal) – 6 crashes
  - 3 of the 6 crashes were sideswipe crashes. 2 of the sideswipe crashes involved eastbound vehicles and 1 involved westbound vehicles
    - Sideswipe crashes at this intersection may be contributed to the lane configuration for eastbound with an existing left turn lane drop occurring as drivers approach the Elm Avenue intersection.
  - There was 1 crash involving a pedestrian, which resulted in a fatality (see **Section 2.1.1**).
- CSAH 48 at Grove Avenue (traffic signal) – 22 crashes
  - 10 of the 22 crashes were rear end crashes. 9 of the rear ends involved eastbound vehicles and 0 involved westbound vehicles (1 southbound).
  - 3 crashes were right-angle, 4 were sideswipes, and 2 were head-on crashes; many involved turning vehicles; the intersection does not have striped turn lanes.
- CSAH 48 at Lincoln Avenue (all-way stop; traffic signal removed in 2021) – 10 crashes
  - 6 of the crashes occurred before 2021, when the intersection was under traffic signal control. 3 of the 6 crashes before 2021 were rear end crashes (1 eastbound, 2 westbound)
  - 4 of the crashes occurred in 2021 after the signal was removed and replaced with an all-way stop. 3 of the 4 crashes under all-way stop control were rear end crashes (1 westbound, 1 northbound, 1 southbound)
    - While crashes have increased since removal of the signal system, after review of the crash data, it appears that rear end crashes have been attributed to motorists still adjusting to the traffic control change at this intersection.
- CSAH 48 at Chambers Avenue (minor stop) – 2 crashes
  - With 2 crashes over the previous 5 years there have been no crash patterns at this intersection.

### 2.1.3 Segment Crashes

An additional 9 crashes occurred along CSAH 48 between the study intersections. These included crashes at business and residential accesses and along the roadway segments between access points. None of the roadway segments have a sustained crash problem. **Table 2** shows a summary of the crashes along the segments of CSAH 48 between intersections.

Table 2 – Segment Crash History (2017-2021)

| From | To | Crash Severity | | | | | Crash Rates | |
|---|---|---|---|---|---|---|---|---|
| | | Fatal & Severity A | Severity B | Severity C | Property Damage | Total | Segment Rate | Critical Rate |
| Oak Ave | W Park Square | 0 | 0 | 0 | 1 | 1 | 0.55 | 7.78 |
| W Park Square | Cedar Ave | 0 | 0 | 0 | 0 | 0 | 0.00 | 5.33 |
| Cedar Ave | E Park Square | 0 | 0 | 0 | 0 | 0 | 0.00 | 5.54 |
| E Park Square | Court Ave | 0 | 0 | 0 | 0 | 0 | 0.00 | 5.63 |
| Court Ave | Elm Ave | 0 | 0 | 0 | 0 | 0 | 0.00 | 9.03 |
| Elm Ave | Grove Ave | 0 | 0 | 0 | 4 | 4 | 2.09 | 5.28 |
| Grove Ave | Lincoln Ave | 0 | 0 | 0 | 3 | 3 | 1.09 | 4.07 |
| Lincoln Ave | Chambers Ave | 0 | 0 | 0 | 1 | 1 | 0.56 | 4.66 |
| **TOTAL** | | **0** | **0** | **0** | **9** | **9** | n/a | n/a |

The following trends are evident for the crashes along segments between the study intersections along CSAH 48:

- 4 of the 9 segment crashes involved parked vehicles or drivers attempting to park along CSAH 48
- 3 of the 9 segment crashes were rear end crashes involving drivers on CSAH 48 rear ending vehicles attempting to enter business accesses. All 3 crashes occurred between Elm Avenue and Grove Avenue.
- 4 of the 9 crashes occurred with poor weather conditions such as rain, snow, ice, etc.

## 2.2 Existing Traffic Volumes

24-hour intersection turning movement counts were collected in December 2021 at all nine study intersections. The AM peak hour was determined to be 7:15 to 8:15 AM and the PM peak hour was determined to be 4:00 to 5:00 PM.

Passenger vehicles, heavy vehicles, pedestrians, and bicyclists were all counted. The intersection daily volumes show around 2% heavy vehicles on CSAH 48. However, based on discussions with the Project Management Team (PMT) and comments from the public, it is understood that there are times of the year where there is higher truck activity along the corridor, especially during the late summer months.

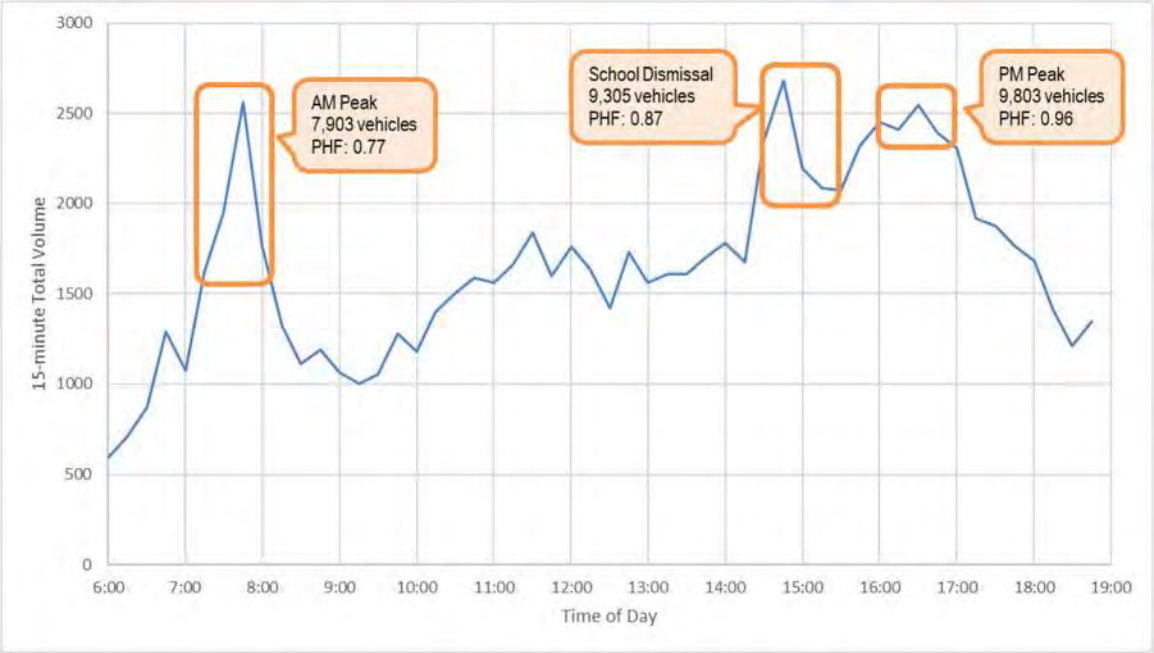
In addition to the AM and PM peak hours, there is also a school dismissal peak hour along CSAH 48 due to the proximity of CSAH 48 to the existing Owatonna Senior High School. The school dismissal peak hour has the highest 15-minute traffic demands of the day. However, the school dismissal peak hour was not analyzed as part of this project because the hourly volumes were lower than the PM peak hour and Owatonna High School is moving to the southeast corner of Owatonna near the CSAH 48/US Highway 14 interchange in 2024.

The PM peak hour has the highest hourly traffic volumes throughout the day, although the AM peak hour has a higher 15-minute peak traffic demand when compared to the PM peak hour due to the school arrival peak for the nearby schools occurring during the AM peak hour. The large 15-minute peak traffic demands during the AM peak compared to the rest of the AM peak hour results in a low peak hour factor (PHF) of 0.77 as compared to the determined PHF for the PM peak hour of 0.96. The PHF is a measure of traffic demand fluctuations within the peak hour, it is calculated by the hourly volume during the peak hour divided by the peak 15-minute traffic volume multiplied by four (Hourly Volume / [Peak 15-min x 4])

**Figure 2** represents the summation of all traffic data collected at the nine study intersections represented as a line graph by time of day; this is the total 15-minute demands for all intersections.

The existing 2021 vehicle turning movement volumes, roadway geometrics, and intersection control are shown in **Figure 3**.

Figure 2 – 2021 Existing CSAH 48 Corridor Volume Graph

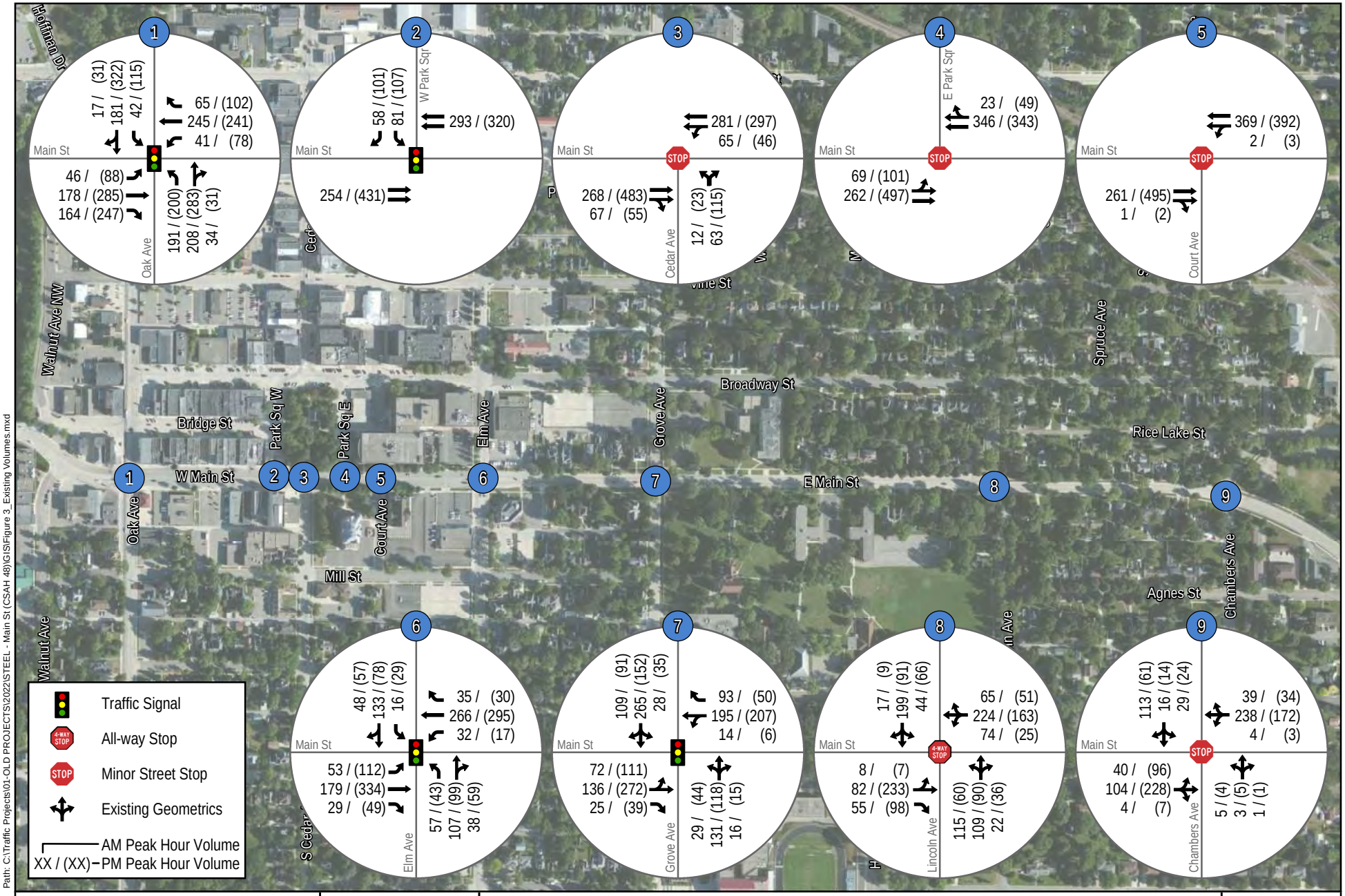



24-hour Pedestrian and bicycle counts were collected at each study intersection in December 2021 as part of the vehicle turning movement counts. It is likely that the December 2021 counts are lower than summer peak pedestrian and bicycle demands due to weather. The pedestrian and bicycle counts show that there are two locations with high pedestrian and bicycle crossing activity. The pedestrian flashing beacon at Court Avenue had 384 pedestrians crossing CSAH 48 and the west leg of the signalized Elm Avenue intersection had 254 pedestrians crossing of CSAH 48. The majority of the pedestrian crossing activity at these locations is generated by the Federated Insurance Company offices, which is located north of CSAH 48 but has a majority of their employee parking south of CSAH 48. It should also be noted that pedestrian demand observed may have been lower due to some of the Federated Insurance workforce potentially working remote.

During the AM peak hour, 55 pedestrians crossed CSAH 48 at Court Avenue and 33 crossed CSAH 48 at the Elm Drive signal. During the PM peak hour, 71 pedestrians crossed CSAH 48 at Court Avenue and 31 crossed CSAH 48 at the Elm Drive signal.

Besides the crossings at Court Avenue and Elm Avenue, none of the other crosswalks have more than 70 daily crossings with most of the crossings serving less than 25 pedestrians/bicycles each day. Looking at the peak hour data, no other crossings have more than 7 crossings in each hour.

The existing peak hour and daily pedestrian/bicycle volumes are shown in **Figure 4**.




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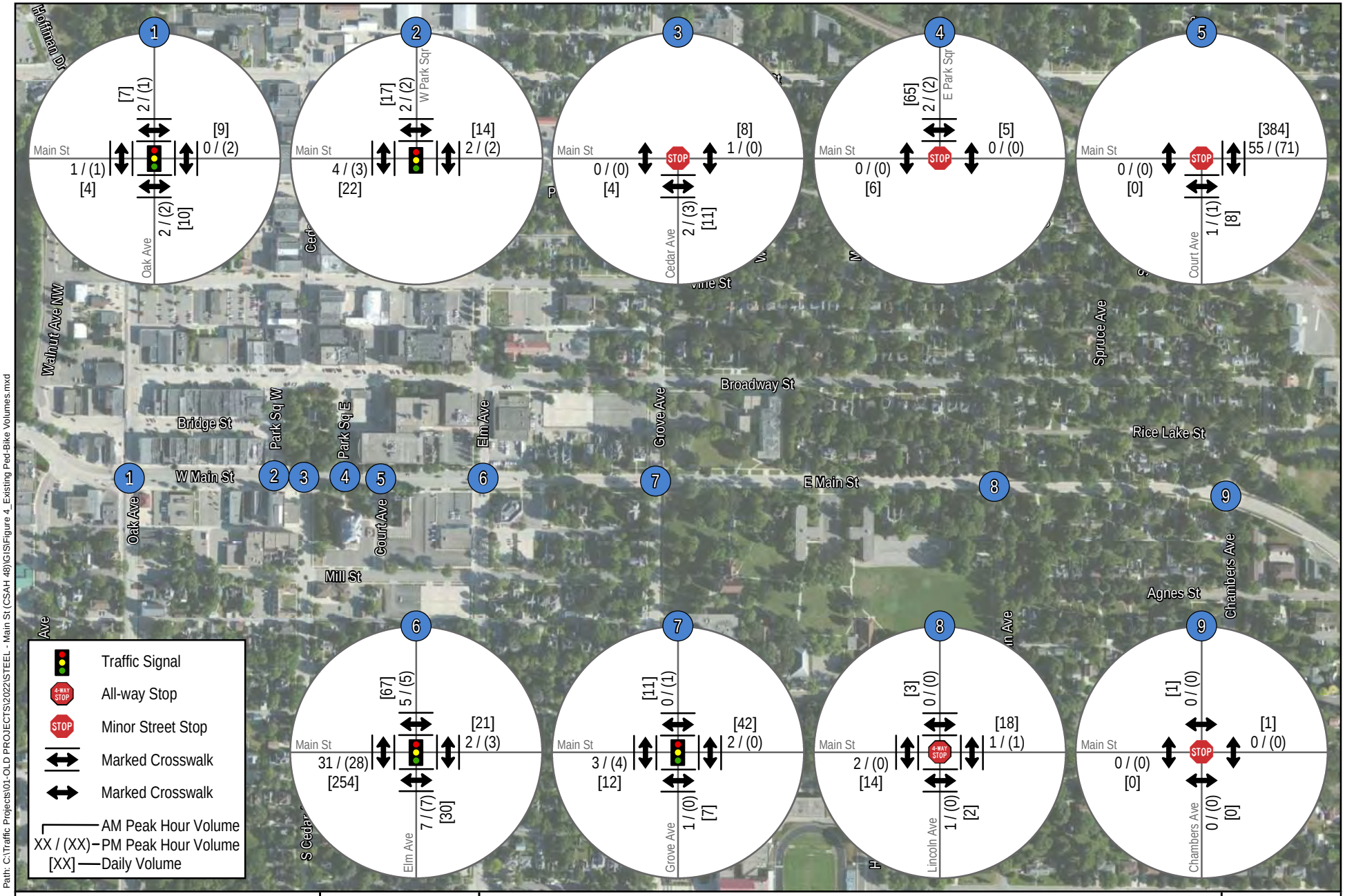
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Projection: Steele Co. Coords.
Source: ESRI Online

# *EXISTING 2021 TRAFFIC VOLUMES*

CSAH 48 (MAIN ST) REHABILITATION PROJECT
Owatonna, MN

Figure 3

This map is neither a legally recorded map nor a survey map and is not intended to be used as one. This map is a compilation of records, information, and data gathered from various sources listed on this map and is to be used for reference purposes only. SEH does not warrant that the Geographic Information System (GIS) Data used to prepare this map are error free, and SEH does not represent that the GIS Data can be used for navigational, tracking, or any other purpose requiring exacting measurement of distance or direction or precision in the depiction of geographic features. The user of this map acknowledges that SEH shall not be liable for any damages which arise out of the user's access or use of data provided.




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# *EXISTING 2021 PEDESTRIAN & BIKE VOLUMES*

CSAH 48 (MAIN ST) REHABILITATION PROJECT
Owatonna, MN

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The December 2021 peak hour and daily traffic volumes were compared to historical January 2020 counts at the signalized intersections along CSAH 48 (including Lincoln Ave) and MnDOT's traffic flow maps to ensure that there were no significant COVID impacts to roadway volumes. From this review the following was found:

- The West Park Square southbound approach was adjusted to better match January 2020 volumes due to some construction in the area north of CSAH 48 during December 2021.
- CSAH 48 and all other roadways compared favorably to the January 2020 hourly and MnDOT's traffic flow maps daily volumes and were not adjusted.

According to MnDOT's Traffic Mapping Application the most current "official" Average Annual Daily Traffic (AADT) value is from 2019.The AADT for the different roadways in the study area are shown in **Table 3.** Mainline CSAH 48 AADTs range from 5,200 to 10,000 within the study area.

Table 3 – Existing Daily Traffic Demands

| Roadway | Description | Year | AADT |
|---|---|---|---|
| CSAH 48 | West of Oak Ave | 2019 | 11,900 |
| | Oak Ave to E Park Square | 2019 | 10,000 |
| | E Park Square to Grove Ave | 2019 | 8,400 |
| | Grove Ave to Chambers Ave | 2019 | 6,200 |
| | East of Chambers Ave | 2019 | 5,200 |
| Oak Ave | North of CSAH 48 | 2019 | 10,000 |
| | South of CSAH 48 | 2019 | 11,900 |
| Cedar Ave | South of CSAH 48 | 2019 | 2,900 |
| Elm Ave | North of CSAH 48 | 2019 | 3,050 |
| Grove Ave | North of CSAH 48 | 2019 | 6,900 |
| | South of CSAH 48 | 2019 | 4,250 |
| Lincoln Ave | South of CSAH 48 | 2019 | 4,750 |

# 3 Future Conditions

MnDOT's Office of State Aid maintains current 20-year growth factors for all counties in Minnesota. The current growth factor for Steele County is 1.2, which equates to a linear growth rate of 1% per year over a 20-year projection. Therefore, a linear growth rate of 1% per year was utilized to develop 2045 forecast traffic volumes.

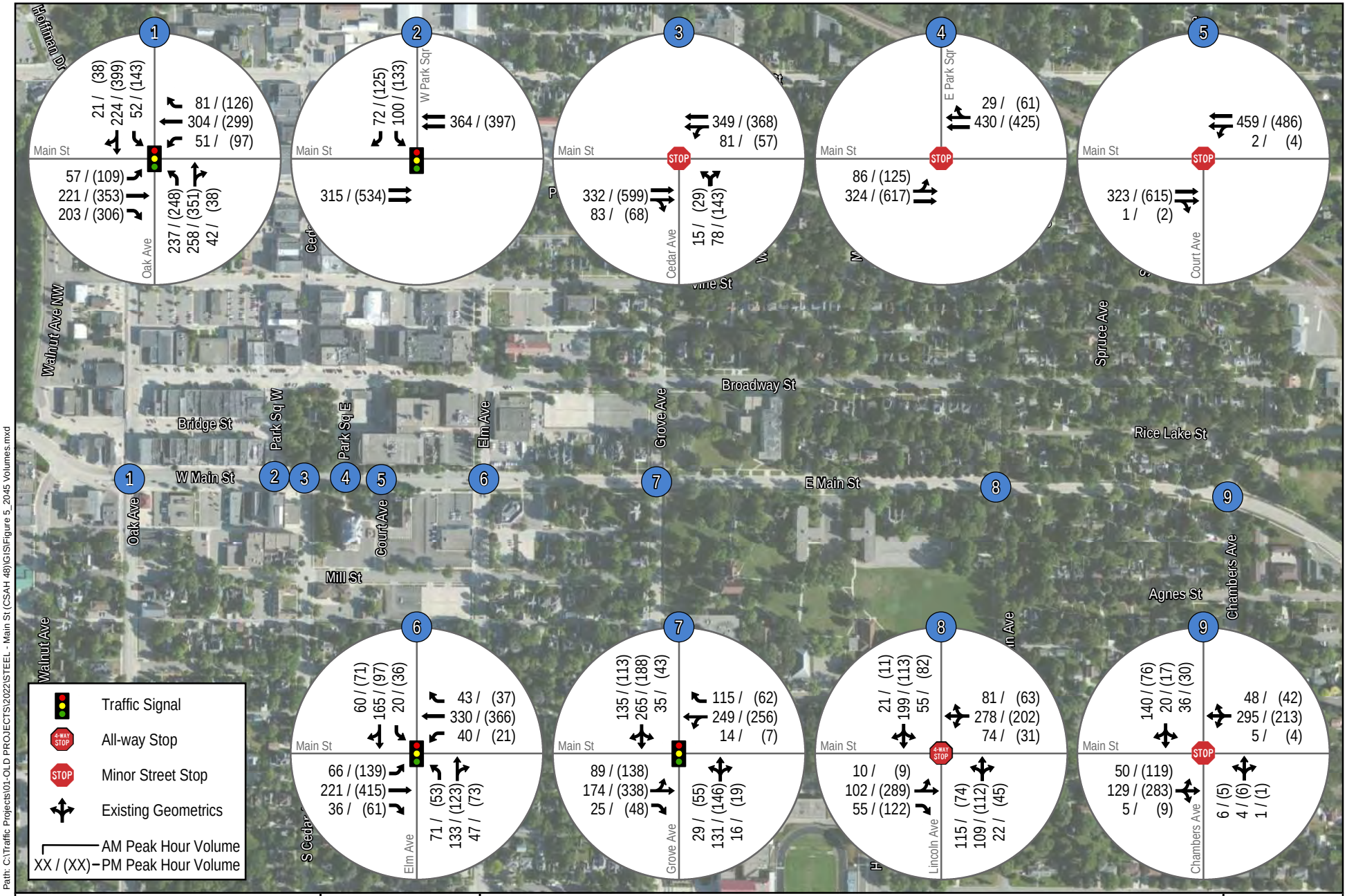
To account for the relocating of Owatonna High School in 2024, the south legs of Grove Avenue and Lincoln Avenue were not increased between 2021 and 2045 during the AM peak hour as much of the growth on these legs would likely be offset by the moving of the high school.

As was discussed in **Section 2.2**, the AM peak hour has a low PHF due to the school arrival peak hour for the High School falling within the AM peak hour. To account for the moving of Owatonna High School, the 15-minute traffic demand splits along CSAH 48 were adjusted to provide more balanced 15-minute demands throughout the hour. After adjustment, the PHF for the AM peak hour changed from 0.77 to approximately 0.85.

**Table 4** shows the most recent AADTs, the 2045 forecast AADTs, and corresponding linear growth rate. The Future 2045 traffic volumes can be found in **Figure 5**.

Table 4 – 2045 Forecasted Traffic Demands

| Roadway | Description | 2019 Existing AADT | 2045 Forecast AADT | Linear Growth Rate |
|---|---|---|---|---|
| CSAH 48 | West of Oak Ave | 11,900 | 15,000 | 1% |
| | Oak Ave to E Park Square | 10,000 | 12,600 | 1% |
| | E Park Square to Grove Ave | 8,400 | 10,600 | 1% |
| | Grove Ave to Chambers Ave | 6,200 | 7,800 | 1% |
| | East of Chambers Ave | 5,200 | 6,550 | 1% |
| Oak Ave | North of CSAH 48 | 10,000 | 12,600 | 1% |
| | South of CSAH 48 | 11,900 | 15,000 | 1% |
| Cedar Ave | South of CSAH 48 | 2,900 | 3,650 | 1% |
| Elm Ave | North of CSAH 48 | 3,050 | 3,850 | 1% |
| Grove Ave | North of CSAH 48 | 6,900 | 8,700 | 1% |
| | South of CSAH 48 | 4,250 | 5,350 | 1% |
| Lincoln Ave | South of CSAH 48 | 4,750 | 6,000 | 1% |




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Projection: Steele Co. Coords.
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# *FUTURE 2045 TRAFFIC VOLUMES*

CSAH 48 (MAIN ST) REHABILITATION PROJECT
Owatonna, MN

Figure 5

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# 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

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.

### 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.

### 4.1.3 Additional Methodology

E Park Square and Court Avenue are both one-way roadways departing CSAH 48 and, therefore, do not have any minor street approach volumes that could be used for warrant analysis.

The MnMUTCD states that the traffic signal warrant analysis can be performed with the major street left turns as the minor street traffic volume. For this analysis, the opposing through and

right turning traffic is used as the major street traffic volume. Therefore, for E Park Square the eastbound left turns were used as the minor street volume and westbound CSAH 48 traffic was used as the major street volume. For Court Avenue, the westbound left turns were used as the minor street volume and eastbound CSAH 48 traffic was used as the major street volume.

## 4.2 Warrant Analysis Assumptions

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 nine 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 85$^{th}$ 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 nine study intersections does not include reductions based on speeds or population as all roadways are posted at 30 mph and the City of Owatonna has a population above 10,000.

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

### 4.2.1 Warrant Results Summary

Based on the existing and 2045 traffic volumes, the following study intersections do not meet the all-way stop warrant or any traffic signal warrant and should retain their existing minor street stop intersection control.

- CSAH 48 at Cedar Avenue (minor stop control)
- CSAH 48 at E Park Square (no control – one-way departing)
- CSAH 48 at Court Avenue (no control – one-way departing)
- CSAH 48 at Chambers Avenue (minor stop control)

***All-Way Stop Warrants***

Based on both the existing and 2045 traffic volumes, the intersections of CSAH 48 at Oak Avenue, Elm Avenue, Grove Avenue, and Lincoln Avenue all meet the volume thresholds for the all-way stop warrants.

The intersection of CSAH 48 at W Park Square does not meet the all-way stop warrant thresholds under either existing or 2045 conditions.

***Traffic Signal Warrants***

Under existing and 2045 conditions, the intersection of CSAH 48 at Oak Avenue meets the full volume thresholds for signal warrants, which means the existing signal control at the intersection is justified.

Under existing and 2045 conditions, the intersection of CSAH 48 at W Park Square meets 60% of the traffic signal warrant volume thresholds but not 80%, this intersection is in the gray area where removal of the traffic signal should be considered.

Under existing and 2045 conditions, the intersection of CSAH 48 at Elm Avenue meets 60% of the traffic signal warrant volume thresholds but not 80%, this intersection is in the gray area where removal of the traffic signal should be considered.

Under existing conditions, the intersection of CSAH 48 at Grove Avenue meets 60% of the traffic signal warrant volume thresholds but not 80%, this intersection is in the gray area where removal of the traffic signal should be considered. However, under 2045 conditions, this intersection meets 80% of the traffic signal warrant volume thresholds, which means the existing signal control is considered justified.

Under existing and 2045 conditions, the intersection of CSAH 48 at Lincoln Avenue does not meet the volume thresholds for Signal Warrant 1 (8 hour). However, volume thresholds are met for Signal Warrant 2 (4 hour) under 2045 conditions, which indicates that there may be a need for a traffic control change in the future as traffic volumes continue to grow from the existing conditions.

**Table 5** provides the all-way stop and traffic signal warrant summary for the 2021 existing and 2045 future volume conditions. Complete all-way stop and traffic signal analysis can be found in **Appendix A**.

Table 5 – Warrant Analysis Results

| Intersection | 2019 Existing | | 2045 Future Demands | |
|---|---|---|---|---|
| TH 19 at: | All-way Stop Warrant | Signal Warrant 1 (8 Hour Volume) | All-way Stop Warrant | Signal Warrant 1 (8 Hour Volume) |
| Oak Avenue (Traffic Signal) | **Met** | **Met** | **Met** | **Met** |
| | **14 of 8 hours** | **10 of 8 hours** | **15 of 8 hours** | **11 of 8 hours** |
| W Park Square (Traffic Signal) | Not Met | Not Met[2] | Not Met | Not Met[2] |
| | 2 of 8 hours | 0 of 8 hours | 7 of 8 hours | 3 of 8 hours |
| Cedar Avenue (Minor Street Stop) | Not Met | Not Met | Not Met | Not Met |
| | 0 of 8 hours | 0 of 8 hours | 0 of 8 hours | 0 of 8 hours |
| E Park Square[4] (No Control) | n/a | Not Met | n/a | Not Met |
| | | 0 of 8 hours | | 0 of 8 hours |
| Court Avenue[4] (No Control) | n/a | Not Met | n/a | Not Met |
| | | 0 of 8 hours | | 0 of 8 hours |
| Elm Avenue (Traffic Signal) | **Met** | Not Met[2] | **Met** | Not Met[2] |
| | **11 of 8 hours** | 0 of 8 hours | **12 of 8 hours** | 2 of 8 hours |
| Grove Avenue (Traffic Signal) | **Met** | Not Met[2] | **Met** | Not Met[1] |
| | **11 of 8 hours** | 1 of 8 hours | **13 of 8 hours** | 5 of 8 hours |
| Lincoln Avenue (All-way Stop) | **Met** | Not Met | **Met** | Not Met |
| | **10 of 8 hours** | 1 of 8 hours | **11 of 8 hours** | 5 of 8 hours |
| Chambers Avenue (Minor Street Stop) | Not Met | Not Met | Not Met | Not Met |
| | 0 of 8 hours | 0 of 8 hours | 0 of 8 hours | 0 of 8 hours |

Notes:

1. Existing signal that does meet the 80 percent volume threshold for Warrant 1.
2. Existing signal that does meet the 60 percent volume threshold, but not the 80 percent threshold for Warrant 1.
3. Existing signal that does not meet the 60 percent volume threshold for Warrant 1.
4. One-way departing roadway; Intersection analyzed with major left turn movement as minor approach

## 4.3 Safety Analysis

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.

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), low volume (<15,000 vpd on highest volume leg) signalized intersections; the average crash rate is 0.52 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 (2x1) roundabouts have a crash rate of 0.76 crashes per MEV.
- 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 0.15 crashes per MEV.
- If an intersection is going to maintain the same signal control but will be improved in some way (improved geometry, FYA, signage, etc.) the intersection would be expected to have a crash rate close to the statewide average.

**Table 6** shows the projected number of total annual crashes at the nine study intersections for each control type for the forecast 2045 traffic conditions.

Table 6 – 2045 Estimated Crashes by Control Type

| CSAH 48 at: | Crash Estimate[1] | Total Annual Crash Estimate by Control Type[2] | | | |
|---|---|---|---|---|---|
| | No Build | Minor Stop | All-Way Stop | Traffic Signal | Roundabout[3] |
| Oak Ave | 8.7 | 1.8 | 3.5 | 5.2 | 7.6 |
| W Park Square | 1.5 | 1.0 | 1.9 | 2.8 | 1.7 |
| Cedar Ave | 0.5 | 0.9 | 1.8 | 2.6 | 1.6 |
| E Park Square | 0.3 | 0.8 | 1.5 | 2.1 | 1.3 |
| Court Ave | 0.5 | 0.7 | 1.3 | 2.0 | 1.2 |
| Elm Ave | 1.5 | 1.0 | 2.0 | 2.9 | 1.8 |
| Grove Ave | 5.5 | 1.1 | 2.1 | 3.0 | 1.9 |
| Lincoln Ave | 2.5 | 0.9 | 1.6 | 2.4 | 1.5 |
| Chambers Ave | 0.5 | 0.6 | 1.1 | 1.6 | 1.0 |

1 Existing Intersection Crash Rate (2017 to 2021; 5-year data) used to calculate No Build estimate.

2 MnDOT Statewide Average Crash Rates (2015 5-year data; latest published) used to calculate control options.

3 Single lane roundabout at all intersections except Oak Avenue, which would require a hybrid design (2x1).

The existing traffic signal control at Oak Avenue and Grove Avenue have a higher crash rate than the average for a similar traffic signal. All other intersections have a calculated crash rate that is below the average crash rate for the existing control type.

With the exception of the hybrid roundabout at Oak Avenue, single lane roundabouts are expected to have fewer total crashes and would significantly reduce the crash severity at the existing signalized or all-way stop controlled intersections. At Oak Avenue, the hybrid design roundabout option would be expected to incur more crashes than an average traffic signal.

## 4.4 Traffic Operations

Traffic operations analyses for the existing conditions and forecast 2045 traffic operations were conducted to determine the level of service (LOS), delay, and queueing information for the AM and PM peak hour conditions of each potential control type.

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 7** shows the LOS thresholds for signalized and unsignalized control. For this study it was assumed that a LOS D or better, for all approaches and the overall intersection, represent acceptable operating conditions.

Table 7 – Level of Service Thresholds

| 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 |

The traffic operations analyses were conducted using the Synchro (Version 11) software package, which utilizes the Highway Capacity Manual calculations; no microsimulations were conducted as part of this study. Synchro 11 calculations more accurately matched traffic operations along the corridor based on field observations and a delay study at the intersection of Main Street at Lincoln Avenue. **Appendix B** includes all relevant operational reports.

### 4.4.1 Existing Conditions

Many of the existing intersections operate acceptably in both the AM and PM peak hours.

In the AM peak hour, the recent intersection control change at Lincoln Avenue to an all-way stop has delays issues in the morning peak due to the high directional traffic patterns and limited turn lanes at the intersection. In the morning, the westbound approach has the highest overall volume in a single shared use lane compared to the other three intersection approaches, and thus incurs the highest overall delays and longest queues. Under existing conditions, there are long delays and queues during for 15-20 minutes just before the nearby High School begins. With the High School moving in 2024, the 15-minute peaks on Main Street during school arrival and dismissal are expected to be lower.

In the PM peak hour, all intersections operate at a LOS C or better. At Grove Avenue, the northbound approach does operate at a LOS E due to the shared left-through lanes on the minor street approaches. **Table 8** presents the existing traffic operations for the AM and PM peak hours.

Table 8 – Existing Traffic Operations

| CSAH 48 at: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Oak Ave (Signal) | EB | 21.8 / C | 25.6 / C | 24.6 / C | 30.1 / C |
| | WB | 30.5 / C | | 27.5 / C | |
| | NB | 21.2 / C | | 30.7 / C | |
| | SB | 34.4 / C | | 39.1 / D | |
| W Park Sq. (Signal) | EB | 3.8 / A | 8.5 / A | 4.0 / A | 11.5 / B |
| | WB | 1.9 / A | | 8.7 / A | |
| | SB | 28.3 / C | | 30.6 / C | |
| Cedar Ave (minor stop) | EB | 0.0 / A | 2.3 / A | 0.0 / A | 2.5 / A |
| | WB | 2.2 / A | | 1.4 / A | |
| | NB | 12.3 / B | | 13.3 / B | |
| E Park Sq. (no control) | EB | 2.3 / A | 1.3 / A | 1.8 / A | 1.1 / A |
| | WB | 0.0 / A | | 0.0 / A | |
| Court Ave (no control) | EB | 0.0 / A | 0.1 / A | 0.0 / A | 0.0 / A |
| | WB | 0.1 / A | | 0.1 / A | |
| Elm Ave (Signal) | EB | 11.9 / B | 20.1 / C | 11.5 / B | 19.5 / B |
| | WB | 15.0 / B | | 13.5 / B | |
| | NB | 23.4 / C | | 37.7 / D | |
| | SB | 34.1 / C | | 33.6 / C | |
| Grove Ave (Signal) | EB | 9.8 / A | 16.0 / B | 6.7 / A | 21.9 / C |
| | WB | 10.3 / B | | 6.0 / A | |
| | NB | 18.7 / B | | **57.9 / E** | |
| | SB | 22.0 / C | | 34.4 / C | |
| Lincoln Ave (all-way stop) | EB | 15.4 / C | **50.7 / F** | 14.3 / B | 14.9 / B |
| | WB | **78.8 / F** | | 16.1 / C | |
| | NB | **42.7 / E** | | 15.3 / C | |
| | SB | **40.6 / E** | | 13.9 / B | |
| Chambers Ave (minor stop) | EB | 2.4 / A | 5.1 / A | 2.1 / A | 3.8 / A |
| | WB | 0.2 / A | | 0.1 / A | |
| | NB | 16.7 / C | | 17.3 / C | |
| | SB | 15.5 / C | | 14.0 / B | |

### 4.4.2 2045 Future No Build Conditions

With increased traffic volumes under the future 2045 conditions, delays at all intersections have increased; however, many intersections are still expected to operate acceptably.

In the AM peak hour, Lincoln Avenue as an all-way stop has increased delays issues in the morning peak due to the high directional traffic patterns and limited turn lanes at the intersection. Due to the removal of the peak 15-minute high school arrival demand at the intersection, the

northbound and southbound approaches will see a slight improvement; overall intersection LOS is worse than existing.

In the PM peak hour, all intersections are expected to operate at a LOS D or better. At Grove Avenue, the northbound approach is still expected to operate at a LOS E due to the shared left-through lanes on the minor street approaches.

**Table 9** presents the 2045 No Build traffic operations for the AM and PM peak hours.

Table 9 – Future 2045 No Build Traffic Operations

| CSAH 48 at: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Oak Ave (Signal) | EB | 21.5 / C | 28.3 / C | 36.0 / D | 39.6 / D |
| | WB | 32.7 / C | | 33.8 / C | |
| | NB | 25.1 / C | | 39.0 / D | |
| | SB | 38.8 / D | | 50.5 / D | |
| W Park Sq. (Signal) | EB | 3.9 / A | 7.8 / A | 4.9 / A | 9.7 / A |
| | WB | 2.8 / A | | 2.5 / A | |
| | SB | 25.7 / C | | 29.7 / C | |
| Cedar Ave (minor stop) | EB | 0.0 / A | 2.6 / A | 0.0 / A | 3.1 / A |
| | WB | 2.4 / A | | 1.7 / A | |
| | NB | 13.9 / B | | 16.3 / C | |
| E Park Sq. (no control) | EB | 2.0 / A | 1.0 / A | 2.2 / A | 1.3 / A |
| | WB | 0.0 / A | | 0.0 / A | |
| Court Ave (no control) | EB | 0.0 / A | 0.1 / A | 0.0 / A | 0.1 / A |
| | WB | 0.1 / A | | 0.3 / A | |
| Elm Ave (Signal) | EB | 8.4 / A | 19.4 / C | 8.9 / A | 20.5 / C |
| | WB | 15.1 / B | | 16.2 / B | |
| | NB | 25.8 / C | | 41.4 / D | |
| | SB | 35.2 / D | | 37.6 / D | |
| Grove Ave (Signal) | EB | 7.0 / A | 14.9 / B | 9.1 / A | 24.2 / C |
| | WB | 8.8 / A | | 7.9 / A | |
| | NB | 21.2 / C | | **64.8 / E** | |
| | SB | 22.7 / C | | 33.5 / C | |
| Lincoln Ave (all-way stop) | EB | 15.7 / C | **58.6 / F** | 24.7 / C | 26.8 / D |
| | WB | **109.3 / F** | | 32.7 / D | |
| | NB | 26.1 / D | | 27.3 / D | |
| | SB | 31.0 / D | | 21.8 / C | |
| Chambers Ave (minor stop) | EB | 2.7 / A | 7.2 / A | 2.2 / A | 4.7 / A |
| | WB | 0.2 / A | | 0.1 / A | |
| | NB | 21.1 / C | | 23.6 / C | |
| | SB | 21.1 / C | | 18.4 / C | |

### 4.4.3 Intersection Control Options

Based on the existing and future 2045 traffic volumes and intersection operations, some of the study intersections warrant a traffic control change. Based on the traffic control warrant analysis, some of the study intersections justify evaluation of all-way stop control, traffic signal control, and roundabout control as future control options.

To improve corridor safety and accessibility for all modes of travel, CSAH 48 is planned to have an overall reduction in travel lanes between Oak Avenue and Elm Avenue. The current roadway is a 4-lane undivided facility between the intersections, the proposed 3-lane design will include a single through lane in each direction and a Two Way Center Left Turn Lane (TWCLTL). Between Elm Avenue and Chamber Avenue, the existing 2-lane undivided roadway is proposed to include a TWCLTL as well.

This proposed “Base” condition, 3-lane roadway between Oak Avenue and Chambers Avenue was evaluated under the existing traffic control as well as all viable traffic control alternatives at each intersection.

In addition to the operational results, discussion with the Project Management Team (PMT) about the results and impacts of each alternative was considered.

#### 4.4.3.1 CSAH 48 at Oak Avenue

The existing traffic signal control at the Oak Avenue intersection operates well but has a crash rate that is higher than the critical crash rate; the intersection meets all control warrants.

Control options evaluated for this study intersection included retaining the traffic signal control and providing roundabout control. All-way stop control was not considered at this intersection due to the existing signal and the high daily volumes on both Main Street and Oak Avenue.

The existing traffic signal control is expected to continue to operate acceptably through 2045. The proposed base build condition would reconfigure the east leg of the intersection for better lane alignments and extending the westbound left turn lane. The inclusion of Flashing Yellow Arrows (FYA) is recommended to improve the overall safety of the intersection.

A single lane roundabout was evaluated at the intersection but resulted in failing traffic operations. Therefore, a hybrid roundabout design was considered to serve the intersection demands. Based on the traffic volumes, CSAH 48 would remain two-lanes through the roundabout and Oak Avenue would have single lane approaches.

It should be noted that the existing signal at Oak Avenue was installed in 1982 with minor revisions in 1991 and 2022 and is approximately 41 years old and at the end of its useful life. This signal should be replaced prior to any operational or geometric improvements are made to the intersection.

**Table 10** presents the traffic operations for the control options evaluated at the Oak Avenue intersection.

Table 10 – 2045 CSAH 48 at Oak Avenue Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Traffic Signal (Base Build) | EB | 21.5 / C | 28.3 / C | 36.0 / D | 39.9 / D |
| | WB | 32.7 / C | | 34.9 / C | |
| | NB | 25.1 / C | | 39.0 / D | |
| | SB | 38.8 / D | | 50.5 / D | |
| Single Lane Roundabout | EB | 14.0 / B | 17.3 / C | **117.2 / F** | **64.2 / E** |
| | WB | 23.3 / C | | **36.2 / E** | |
| | NB | 16.5 / C | | **44.7 / E** | |
| | SB | 15.4 / C | | **40.5 / E** | |
| Hybrid Roundabout (2 EB/WB lanes) | EB | 6.8 / A | 10.1 / B | 12.7 / B | 17.8 / C |
| | WB | 8.9 / A | | 10.3 / B | |
| | NB | 13.0 / B | | 25.2 / D | |
| | SB | 11.7 / B | | 23.3 / C | |

While the hybrid roundabout design does provide the best overall traffic operations, the multi-lane design is expected to have a higher crash frequency than the traffic signal alternative. Additionally, the hybrid design requires a larger construction footprint that would have significant right-of-way impacts to the adjacent buildings abutting CSAH 48.

Therefore, the only viable traffic control option for the Oak Avenue intersection is traffic signal control; inclusion of FYA on all approaches and restriping of the east leg is expected to improve the overall safety of the intersection.

#### 4.4.3.2 CSAH 48 at West Park Square

The existing traffic signal control is expected to operate acceptably through 2045. The existing and future intersection volumes do not meet the all-way stop warrants and are in the “gray area” for traffic signal warrants; the gray area indicates the control could potentially be removed.

Control options evaluated for this study intersection included retaining the traffic signal control and converting to a minor street stop-controlled intersection. All-way stop and roundabout control are not warranted at this intersection.

**Table 11** presents the traffic operations for the control options evaluated at the West Park Square intersection.

Table 11 – 2045 CSAH 48 at West Park Square Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Traffic Signal (Base Build) | EB | 5.2 / A | 9.2 / A | 8.5 / A | 11.9 / B |
| | WB | 4.8 / A | | 3.9 / A | |
| | SB | 25.8 / C | | 30.1 / C | |
| Minor Stop Control | EB | 0.0 / A | 2.7 / A | 0.0 / A | 4.0 / A |
| | WB | 0.0 / A | | 0.0 / A | |
| | SB | 13.6 / B | | 17.7 / C | |

Both control options have acceptable operations, but the minor street stop control is expected to have lower overall intersection delays. The CSAH 48 mainline traffic would no longer be controlled with no eastbound/westbound turns at the intersection; the southbound approach has improved delays as traffic can enter CSAH 48 with any gap in traffic and no longer has to wait for the signal to switch phases.

#### 4.4.3.3 CSAH 48 at Cedar Avenue

The existing minor street stop control is expected to operate acceptably through 2045. The existing and future intersection volumes do not meet the all-way stop or traffic signal warrants. Therefore, only the existing minor street stop control was evaluated with the proposed 3-lane configuration along Main Street.

**Table 12** presents the traffic operations for the control options evaluated at the Cedar Avenue intersection.

Table 12 – 2045 CSAH 48 at Cedar Avenue Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Minor Street Stop (Base Build) | EB | 0.0 / A | 2.4 / A | 0.0 / A | 3.4 / A |
| | WB | 2.1 / A | | 1.3 / A | |
| | NB | 13.6 / B | | 19.4 / C | |

#### 4.4.3.4 CSAH 48 at East Park Square

The existing intersection has no control with only a departing minor roadway at the intersection, the current intersection is expected to operate acceptably through 2045. The existing and future intersection volumes do not meet the all-way stop warrants or traffic signal warrants.

**Table 13** presents the traffic operations for the control options evaluated at the East Park Square intersection.

Table 13 – 2045 CSAH 48 at East Park Square Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| No Control (Base Build) | EB | 1.6 / A | 0.8 / A | 1.6 / A | 0.9 / A |
| | WB | 0.0 / A | | 0.0 / A | |

#### 4.4.3.5 CSAH 48 at Court Avenue

The existing intersection has no control with only a departing minor roadway at the intersection, the current intersection is expected to operate acceptably through 2045. The existing and future intersection volumes do not meet the all-way stop warrants or traffic signal warrants.

The intersection currently has very low volumes utilizing the Court Avenue departing leg; less than 100 vehicles per day use the roadway. The intersection currently has a pedestrian flashing beacon on the east leg that is heavily used by Federated Insurance employees. The pedestrian flashing beacon is proposed to be upgraded to include a Rectangular Rapid Flashing Beacon (RRFB). Due to the low volume, it is proposed to close the Court Avenue intersection to provide a pedestrian median refuge island on the east leg. The proposed pedestrian refuge island and RRFB system will increase pedestrian visibility at the intersection and allow pedestrians to cross CSAH 48 one direction and one lane at a time, increasing pedestrian safety at the intersection.

**Table 14** presents the traffic operations for the control options evaluated at the Court Avenue intersection; intersection closure is not shown as there are no delays because vehicles would only be able to travel eastbound and westbound through the intersection.

Table 14 – 2045 CSAH 48 at Court Avenue Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| No Control (Base Build) | EB | 0.0 / A | 0.1 / A | 0.0 / A | 0.1 / A |
| | WB | 0.1 / A | | 0.2 / A | |

While the existing intersection is expected to operate acceptably, closure of the intersection has negligible impacts to vehicle operations along the corridor, but a substantial benefit to pedestrians crossing CSAH 48.

#### 4.4.3.6 CSAH 48 at Elm Avenue

The existing traffic signal control at the Elm Avenue intersection is expected to operate well through 2045. The existing and future intersection volumes meet the all-way stop warrants and are in the “gray area” for traffic signal warrants; the gray area indicates the control could potentially be removed.

Control options evaluated for this study intersection included retaining the traffic signal control, all-way stop control, minor stop control, and providing roundabout control.

The existing traffic signal control is expected to continue to operate acceptably through 2045. Under minor street stop control, the Elm Avenue approaches would operate at a LOS F and the high volume of pedestrians on the west leg of the intersection would have trouble crossing CSAH 48. Under all-way stop control, the CSAH 48 approaches have significant delays and the intersection would operate at a LOS F. Under single lane roundabout control, the intersection would operate at LOS A for all approaches.

**Table 15** presents the traffic operations for the control options evaluated at the Elm Avenue intersection.

Table 15 – 2045 CSAH 48 at Elm Avenue Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Traffic Signal (Base Build) | EB | 10.3 / B | 21.3 / C | 10.5 / B | 21.8 / C |
| | WB | 19.5 / B | | 17.7 / B | |
| | NB | 25.8 / C | | 42.0 / D | |
| | SB | 35.2 / D | | 38.4 / D | |
| Minor Stop Control | EB | 1.3 / A | **65.8 / F** | 2.0 / A | **211.7 / F** |
| | WB | 0.9 / A | | 0.5 / A | |
| | NB | **231.9 / F** | | **>300 / F** | |
| | SB | **82.2 / F** | | **>300 / F** | |
| All Way Stop Control | EB | 32.8 / D | 32.3 / D | **108.8 / F** | **79.1 / F** |
| | WB | **47.6 / E** | | **100.7 / F** | |
| | NB | 18.5 / C | | 20.7 / C | |
| | SB | 22.2 / C | | 18.9 / C | |
| Single Lane Roundabout | EB | 7.6 / A | 8.5 / A | 9.8 / A | 9.2 / A |
| | WB | 9.8 / A | | 9.2 / A | |
| | NB | 7.2 / A | | 9.5 / A | |
| | SB | 8.9 / A | | 6.9 / A | |

Traffic signal control and roundabout control are the only two viable control options for this study intersection. The existing signal control has a crash rate that is less than the single lane roundabout. A single lane roundabout would also have right-of-way impacts; therefore, based on discussion with the PMT, the signal control is recommended.

#### 4.4.3.7 CSAH 48 at Grove Avenue

The existing traffic signal control at the Grove Avenue intersection is expected to generally operate well through 2045; the existing crash rate does exceed the critical crash rate. The existing and future intersection volumes meet the all-way stop warrants and meet the 80% criteria for traffic signal warrants.

Control options evaluated for this study intersection included retaining the traffic signal control, all-way stop control, minor stop control, and providing roundabout control.

The existing traffic signal control is expected to continue to operate acceptably through 2045, except for the northbound approach in the PM peak hour due to the shared through/left turn lane. Under minor street stop control, the Grove Avenue approaches would operate with significant delays at a LOS F. Under all-way stop control, the CSAH 48 approaches have poor operations and the intersection would operate at LOS E. Under single lane roundabout control, the intersection would operate at LOS A and all approaches at LOS B or better.

**Table 16** presents the traffic operations for the control options evaluated at the Grove Avenue intersection.

Table 16 – 2045 CSAH 48 at Grove Avenue Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Traffic Signal (Base Build) | EB | 6.4 / A | 15.6 / B | 6.9 / A | 25.8 / C |
| | WB | 11.8 / B | | 9.2 / A | |
| | NB | 21.2 / C | | **76.1 / E** | |
| | SB | 22.7 / C | | 34.8 / C | |
| Minor Stop Control | EB | 3.0 / A | **78.4 / F** | 2.4 / A | **>300 / F** |
| | WB | 0.3 / A | | 0.3 / A | |
| | NB | **>300 / F** | | **>300 / F** | |
| | SB | **>300 / F** | | **>300 / F** | |
| All Way Stop Control | EB | 19.5 / C | 29.6 / D | **63.0 / F** | **43.2 / E** |
| | WB | **44.2 / E** | | **44.7 / E** | |
| | NB | 18.7 / C | | 26.0 / D | |
| | SB | 30.4 / D | | 24.3 / C | |
| Single Lane Roundabout | EB | 8.0 / A | 9.1 / A | 9.5 / A | 8.4 / A |
| | WB | 8.9 / A | | 7.6 / A | |
| | NB | 5.9 / A | | 7.9 / A | |
| | SB | 11.1 / B | | 7.6 / A | |

To improve traffic operations under signal control, the northbound and southbound approaches would likely need to be widened to include dedicated northbound and southbound left turn lanes. A single lane roundabout would also require some widening of the north and south intersection legs but would improve safety and would result in lower overall vehicle delays the intersection. Therefore, based on discussions with the PMT, a single lane roundabout is recommended at this intersection.

#### 4.4.3.8 CSAH 48 at Lincoln Avenue

The existing all-way stop control at the Lincoln Avenue intersection is expected to operate acceptably have degrading operations through 2045. The existing and future intersection volumes meet the all-way stop warrants but does not meet the traffic signal warrants.

Control options evaluated for this study intersection included retaining the all-way stop control, minor stop control, and providing roundabout control.

The existing intersection at Lincoln Avenue has some alignment issues where the CSAH 48 approaches and Lincoln Avenue approaches are offset from one another and through vehicles must do a lane shift through the intersection. The offset along Lincoln Avenue could be realigned but it would require a shift of the roadway north of CSAH 48. If the intersection control remains all-way stop control, shifting Lincoln Avenue would not be necessary as each vehicle would need to stop at the intersection. However, if the intersection were changed to roundabout control, Lincoln Avenue would be shifted to improve the through route along Lincoln Avenue.

The existing all-way stop control is expected to continue to operate acceptably once the High School moves in 2024 but will have degrading operations through 2045. Under minor street stop control, the Lincoln Avenue approaches would operate with significant delays at a LOS F. Under single lane roundabout control, the intersection would operate at LOS A and all approaches at LOS B or better.

**Table 17** presents the traffic operations for the control options evaluated at the Lincoln Avenue intersection.

Table 17 – 2045 CSAH 48 at Lincoln Avenue Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| All Way Stop Control (Base Build) | EB | 18.0 / C | 34.9 / D | **77.0 / F** | **44.6 / E** |
| | WB | **48.3 / E** | | 28.7 / D | |
| | NB | 26.0 / D | | 30.3 / D | |
| | SB | 31.1 / D | | 23.8 / C | |
| Minor Stop Control | EB | 0.6 / A | **>300 / F** | 0.3 / A | **91.8 / F** |
| | WB | 1.7 / A | | 1.0 / A | |
| | NB | **>300 / F** | | **216.9 / F** | |
| | SB | **>300 / F** | | **239.2 / F** | |
| Single Lane Roundabout | EB | 6.2 / A | 8.5 / A | 8.0 / A | 6.9 / A |
| | WB | 9.8 / A | | 6.0 / A | |
| | NB | 6.2 / A | | 7.0 / A | |
| | SB | 10.1 / B | | 5.9 / A | |

#### 4.4.3.8.1 Lincoln Avenue All-way Stop Capacity Analysis

Based on observations of the intersection of CSAH 48 at Lincoln Avenue, the existing all-way stop control has minimal delay and queuing issues except for the 15-minutes right before and after the nearby High School starts and ends. When the High School moves in 2024, it is expected that those 15-minute peaks in traffic demands will lessen, and the intersection is expected to overall perform acceptably during the AM and PM peak hours. However, as traffic volumes continue to grow through the 2045 design year, operations at the all-way stop are expected to degrade and the intersection may require a traffic control change.

An iterative capacity analysis of the all-way stop control at the intersection was performed to estimate how long the all-way stop could provide acceptable traffic operations and when the intersection may need to be upgraded to a single lane roundabout. Intersection demands were

grown linearly at 1% growth per year except for the south leg, which was not grown to account for the removal of school volumes. This is the same growth rate used for the rest of the analysis for CSAH 48.

Analysis of the all-way stop with the proposed 3-lane section on CSAH 48 were completed for 2025 (year after school moves) and 2045 (design year) as well as iteratively to determine when the first approach would operate at LOS E and LOS F, which were estimated to be 2032 and 2038, respectively.

In 2025 once the school moves, the intersection is expected to operate acceptably with LOS C during the AM and PM peak hour with each approach operating at LOS D or better. Based on the forecast traffic growth along CSAH 48, the eastbound approach would operate at LOS E in the PM peak hour starting in 2032 but the intersection would operate at LOS C. The eastbound approach would be expected to operate at LOS F in the PM peak hour in 2038, with the intersection operating at LOS D. As was discussed previously, by 2045 the eastbound approach will operate at LOS F during the PM peak hour with the intersection operating at LOS E.

**Table 18** presents the traffic operations for the CSAH 48 at Lincoln Avenue all-way stop capacity analysis based on forecast traffic volumes in 2025, 2033, 2040, and 2045.

Table 18 – 2045 CSAH 48 at Lincoln Avenue All-way Stop Capacity Analysis

| Year | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| 2025 | EB | 15.2 / B | 22.0 / C | 25.7 / D | 19.6 / C |
| | WB | 24.6 / C | | 16.7 / C | |
| | NB | 21.4 / C | | 17.2 / C | |
| | SB | 22.6 / C | | 15.4 / C | |
| 2032 (First approach at LOS E) | EB | 16.0 / C | 25.4 / D | **36.0 / E** | 25.2 / D |
| | WB | 30.6 / D | | 20.1 / C | |
| | NB | 22.8 / C | | 20.7 / C | |
| | SB | 25.3 / D | | 17.9 / C | |
| 2038 (First approach at LOS F) | EB | 16.9 / C | 28.8 / D | **50.0 / F** | 32.3 / D |
| | WB | **36.8 / E** | | 23.9 / C | |
| | NB | 24.1 / C | | 24.5 / C | |
| | SB | 27.4 / D | | 20.4 / C | |
| 2045 | EB | 18.0 / C | 34.9 / D | **77.0 / F** | **44.6 / E** |
| | WB | **48.3 / E** | | 28.7 / D | |
| | NB | 26.0 / D | | 30.3 / D | |
| | SB | 31.1 / D | | 23.8 / C | |

Based on the capacity analysis of the all-way stop control at Lincoln Avenue, it is expected that the all-way stop control will provide acceptable traffic operations for the next 10-15 years after the High School moves in 2024 and the 15-minute peak traffic demands lessen. It is still possible that there will be peak times of the day where there are longer delays and queues, but the

intersection is expected to function well overall. Based on this finding, it is recommended that the intersection of CSAH 48 at Lincoln Avenue remain all-way stop controlled at this time. This means that the north leg of Lincoln Avenue does not need to be shifted to align with the south leg at this time because all vehicles are required to stop. This intersection should continue to be monitored after the High School moves in 2024 and as traffic volumes continue to grow to determine when an intersection capacity improvement may be needed, at which point a single-lane roundabout would be recommended.

#### 4.4.3.9 CSAH 48 at Chambers Avenue

The existing minor street stop control is expected to operate acceptably through 2045. The existing and future intersection volumes do not meet the all-way stop warrants or traffic signal warrants. Therefore, only the existing minor street stop control was evaluated.

The existing intersection at Chambers Avenue has some alignment issues where the Chambers Avenue approaches are offset from one another and through vehicles must do a lane shift through the intersection. It is proposed that the alignment of Chambers Avenue north of CSAH 48 be fixed as part of this project to improve the operations of the intersection.

**Table 19** presents the traffic operations for the control options evaluated at the Chambers Avenue intersection.

Table 19 – 2045 CSAH 48 at Chambers Avenue Options

| Control Option: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Minor Street Stop (Base Build) | EB | 2.7 / A | 7.2 / A | 2.2 / A | 4.7 / A |
| | WB | 0.2 / A | | 0.1 / A | |
| | NB | 20.9 / C | | 23.2 / C | |
| | SB | 20.9 / C | | 18.1 / C | |

### 4.4.4 Proposed Build Traffic Operations

Based on the traffic control analysis of each intersection individually, the proposed build improvements are listed below. A full preliminary layout for the proposed build conditions can be found in **Appendix C**.

- Convert CSAH 48 to a 3-lane roadway with a continuous two-way left turn lane (TWLTL) between Oak Avenue and Chambers Avenue
- CSAH 48 at Oak Avenue remains signalized with restriping on the east leg to create a longer westbound left turn lane and create more defined lane assignments
  - Flashing yellow arrow (FYA) added to the intersection to improve safety
- CSAH 48 at W Park Square converted to minor stop control
  - The north leg could be reconstructed to eliminate the median between the turn lanes
  - A pedestrian refuge island could be considered on the west leg to improve pedestrian safety at the uncontrolled crossing; the east leg pedestrian crossing could be removed
- CSAH 48 at Cedar Avenue remains minor stop controlled
- CSAH 48 at E Park Square remains uncontrolled
- Court Avenue access to CSAH 48 is closed to provide a pedestrian refuge island and an RRFB on the east leg of the intersection, which is heavily used by Federated Insurance employees to cross CSAH 48.
- CSAH 48 at Elm Avenue to remain signalized
  - Signal would no longer be coordinated because the W Park Square and Grove Avenue signals are proposed to be removed
- CSAH 48 at Grove Avenue convert to a single lane roundabout
- CSAH 48 at Lincoln Avenue to remain all-way stop for the next 10-15 years until traffic demands require the need for a single-lane roundabout.
- CSAH 48 at Chambers Avenue remains minor stop controlled
  - Realign the north leg of the intersection so that the two Chambers Avenue approaches align with one another

Based on the existing crash rates, the nine study intersections are estimated to have 21.5 crashes per year in 2045 under No Build conditions. With the above proposed improvements, the Build conditions are expected to have 12.4 crashes per year in 2045, which is a 42% reduction in crashes along the corridor.

The above proposed improvements along CSAH 48 are expected to provide acceptable traffic operations at all study intersections through the 2045 design year. **Table 20** presents the traffic operations for the proposed 2045 Build conditions. It should be noted that the 2045 Build conditions operations analysis included a single lane roundabout at Lincoln Avenue because that is the long-term solution at the intersection. The green highlighted intersections show where traffic control changes are recommended.

Table 20 – Future 2045 No Build Traffic Operations

| CSAH 48 at: | Approach | AM Peak Hour | | PM Peak Hour | |
|---|---|---|---|---|---|
| | | Approach (delay / LOS) | Intersection (delay / LOS) | Approach (delay / LOS) | Intersection (delay / LOS) |
| Oak Ave (Signal) | EB | 21.5 / C | 28.3 / C | 36.0 / D | 39.9 / D |
| | WB | 32.7 / C | | 34.9 / C | |
| | NB | 25.1 C | | 39.0 / D | |
| | SB | 38.8 / D | | 50.5 / D | |
| W Park Sq. (minor stop) | EB | 0.0 / A | 2.7 / A | 0.0 / A | 4.0 / A |
| | WB | 0.0 / A | | 0.0 / A | |
| | SB | 13.6 / B | | 17.7 / B | |
| Cedar Ave (minor stop) | EB | 0.0 / A | 2.4 / A | 0.0 / A | 3.4 / A |
| | WB | 2.1 / A | | 1.3 / A | |
| | NB | 13.5 / B | | 19.7 / C | |
| E Park Sq. (no control) | EB | 1.6 / A | 0.8 / A | 1.6 / A | 0.9 / A |
| | WB | 0.0 / A | | 0.0 / A | |
| Court Ave (CLOSED) | | | | | |
| Elm Ave (Signal) | EB | 15.4 / B | 23.0 / C | 14.8 / B | 23.6 / C |
| | WB | 29.9 / C | | 30.1 / C | |
| | NB | 19.8 / B | | 29.8 / C | |
| | SB | 26.6 / C | | 27.5 / C | |
| Grove Ave (single lane roundabout) | EB | 8.0 / A | 9.1 / A | 9.5 / A | 8.4 / A |
| | WB | 8.9 / A | | 7.6 / A | |
| | NB | 5.9 / A | | 7.9 / A | |
| | SB | 11.1 / B | | 7.6 / A | |
| Lincoln Ave (single lane roundabout) | EB | 6.2 / A | 8.5 / A | 8.0 / A | 6.9 / A |
| | WB | 9.8 / A | | 6.0 / A | |
| | NB | 6.2 / A | | 7.0 / A | |
| | SB | 10.1 / B | | 5.9 / A | |
| Chambers Ave (minor stop) | EB | 2.7 / A | 7.2 / A | 2.2 / A | 4.7 / A |
| | WB | 0.2 / A | | 0.1 / A | |
| | NB | 20.9 / C | | 23.2 / C | |
| | SB | 20.9 / C | | 18.1 / C | |

# 5 Other Considerations

In addition to traffic operations along the corridor, pedestrian safety and parking demands were also considered.

## 5.1 Pedestrian Considerations

CSAH 48 in the project area runs through downtown Owatonna from Oak Avenue to Elm Avenue. Within the downtown area, there are many businesses that generate consistent pedestrian activity along CSAH 48 throughout the year. One of the more significant pedestrian generators in the area is Federated Insurance, which has an office on the north side of CSAH 48 just west of Elm Avenue with most of their employee parking on the south side of CSAH 48. This results in a significant number of pedestrians crossing CSAH 48 using the pedestrian beacon at Court Avenue and the signalized intersection at Elm Avenue.

Many of the existing sidewalks are aging and the pedestrian curb ramps along the corridor are not American Disabilities Act (ADA) compliant, which makes navigating the corridor as a pedestrian or bicyclist difficult currently. As part of this project, it is anticipated that all sidewalks and pedestrian curb ramps will be upgraded so that they are ADA compliant.

The current pedestrian flashing beacon is proposed to be replaced by a Rectangular Rapid Flashing Beacon (RRFB) to improve pedestrian visibility and safety at the crossing on the east side of Court Avenue. In addition to the RRFB, it is proposed that the Court Avenue access at CSAH 48 be closed and a pedestrian refuge island be constructed on the east side of Court Avenue to increase pedestrian visibility and allow pedestrians to cross one direction of CSAH 48 at a time.

Other pedestrian enhancements considered along the corridor include:

- Restriping CSAH 48 as a 3-lane roadway between Oak Avenue and Elm Avenue, which shortens the pedestrian crossing distance compared to the existing 4-lane roadway section
- Providing curb bump-outs to shorten pedestrian crossing distances and increase pedestrian visibility and sight lines as they look for a gap in traffic to cross.
- A pedestrian refuge island could be considered on the west leg at West Park Square to improve pedestrian safety at the uncontrolled crossing; the east leg pedestrian crossing could be removed when the signal is removed

## 5.2 Parking Considerations

There are currently time of day restrictions on parking through the downtown area. Parking is currently prohibited on the south side of CSAH 48 just east of Grove Avenue near the Owatonna Education Center to avoid parent's dropping off their students on the south side of CSAH 48. There is also a bus drop-off/pick-up zone on the north side of CSAH 48 at the Owatonna Education center The no parking on the south side and the bus drop-off/pick-up zone on the north side of CSAH 48 near the Owatonna Education Center are proposed to remain in place. However, there are expected to be changes to parking elsewhere along the corridor.

West of Grove Avenue, there are proposed 10' parking bays created by curb bump-outs that will serve to better separate the drive lanes from the parking stalls. Time of day restrictions in the downtown area are expected to continue. From Grove Avenue to Lincoln Avenue, it is proposed that there will be marked parking stalls on the south side of the roadway only so that the roadway can be restriped as a 3-lane road. East of Lincoln Avenue, all on-street parking would be eliminated when CSAH 48 is restriped as a 3-lane roadway.

**Table 21** compares the existing and proposed parking spaces along CSAH 48 from Oak Avenue to Chambers Avenue. There are currently 153 parking spaces along CSAH 48, the proposed layout reduces the number of parking spaces to 83. However, only 3 of the eliminated parking spaces are located west of Grove Avenue in the downtown area where parking demand is higher. Most of the eliminated parking spaces are east of Grove Avenue in the residential areas, which currently has low parking demand.

Table 21 – Existing vs. Proposed Parking Spaces

| Area | CSAH 48 Section | Existing Spaces | Proposed Spaces | Difference |
|---|---|---|---|---|
| Downtown | Oak Ave to W Park Square | 25 | 21 | -4 |
| | W Park Square to Elm Ave | 23 | 24 | 1 |
| | Elm Ave to Grove Ave | 22 | 22 | 0 |
| Residential | Grove Ave to Lincoln Ave | 35 | 16 | -19 |
| | Lincoln Ave to Chambers Ave | 48 | 0 | -48 |
| Downtown Area | | 70 | 67 | -3 |
| Residential Area | | 83 | 16 | -67 |
| **Total** | | **153** | **83** | **-70** |

# 6 Conclusions

Based on the warrant analysis and existing traffic operations analysis, most of the existing intersections along CSAH 48 between Oak Avenue and Chambers Avenue are expected to operate acceptably through the 2045 design year. All of the existing minor stop controlled, and uncontrolled intersections are expected to operate acceptably through the 2045 design year and do not have traffic demands that meet all-way or traffic signal warrants.

The following operational issues are expected under 2045 No Build conditions:

- The northbound approach to the Grove St signal is expected to operate at LOS E due to the shared through/left turn lanes on the minor street approaches
- The all-way stop control at the Lincoln Avenue intersection is expected to be over capacity and have operational issues by 2045, even with the nearby High School expected to relocate in 2024 and change traffic patterns in the area

As part of the reconstruction/restriping project, CSAH 48 will be restriped as a 3-lane roadway with a Two Way Center Left Turn Lane (TWCLTL). All build alternatives were analyzed with the 3-lane section on CSAH 48 between Oak Avenue and Chambers Avenue.

Different traffic control alternatives were considered at each intersection based on warrant analysis, 2045 traffic operations, safety, pedestrian considerations, and right-of-way impacts. Below is a summary of each intersection and the alternatives analyzed.

**Oak Avenue**

- Intersection meets all-way stop and traffic signal warrants
- Existing signal has a crash issue
- Traffic control alternatives analyzed:
  - Traffic signal with restriped east leg for 3-lane CSAH 48 section – operates acceptably; FYA could be added to improve overall safety
  - Single lane roundabout – operates at LOS E during the PM peak hour
  - Hybrid Roundabout with 2 through lanes EB/WB – operates acceptably but has significant right-of-way impacts

**West Park Square**

- Intersection does not meet all-way stop warrants and is in the “gray area” for signal removal
- Traffic control alternatives analyzed:
  - Traffic signal – operates acceptably
  - Minor stop control – operates acceptably with less overall delay than the existing signal

**Cedar Avenue**

- Intersection does not meet all-way stop or signal warrants
- Existing minor stop control operates acceptably and should be maintained

**E Park Square**

- Intersection does not meet all-way stop or signal warrants
- Currently there is no intersection control because E Park Square is one-way departing CSAH 48; this control should be maintained

**Court Avenue**

- Intersection does not meet all-way stop or signal warrants
- Currently there is no intersection control because Court Avenue is one-way departing CSAH 48
- Court Avenue currently serves less than 100 vehicles per day and the pedestrian beacon crossing on the east leg is heavily used by Federated Insurance employees throughout the day
- Court Avenue access to CSAH 48 could be closed to improve the pedestrian crossing at the intersection and provide a pedestrian refuge island on the east leg of the intersection, increasing pedestrian visibility and allowing pedestrians to cross one direction of CSAH 48 traffic at a time

**Elm Avenue**

- Intersection meets all-way stop warrants and is in the “gray area” for signal removal
- Traffic control alternatives analyzed:
  - Traffic signal – operates acceptably
  - Minor stop control – Elm Avenue approaches operate at LOS E during the PM peak hour
  - All-way stop control – operates at LOS F during the PM peak hour
  - Single lane roundabout – operates acceptably but has right-of-way impacts

**Grove Avenue**

- Intersection meets all-way stop warrants and 80% of the volume thresholds for traffic signal warrants
- Existing signal has a crash issue
- Traffic control alternatives analyzed:
  - Traffic signal – operates acceptably but has higher delays northbound during the PM peak hour due to the shared through/left turn lanes on Grove Avenue; would likely require roadway expansion/restriping to provide a northbound and southbound left turn lane
  - Minor stop control – Grove Avenue approaches operate at LOS F during the PM peak hour
  - All-way stop control – eastbound approach operates at LOS E during the PM peak hour
  - Single lane roundabout – operates acceptably

**Lincoln Avenue**

- Intersection meets all-way stop warrants but not signal warrants
- Current all-way stop has delay and queuing issues during the 15-minute arrival and dismissal peaks for the High School, which will be relocated in 2024
- Traffic control alternatives analyzed:
  - All-way stop control – based on capacity analysis could operate acceptably for the next 10-15 years before intersection operations degrade
  - Minor stop control – Lincoln Avenue approaches and the intersection operate at LOS F during the AM peak hour
  - Single lane roundabout – operates acceptably

**Chambers Avenue**

- Intersection does not meet all-way stop or signal warrants
- Existing minor stop control operates acceptably and should be maintained
- North leg of the intersection should be realigned to line up with the south leg

## 6.1 Recommendations

Based on the traffic control analysis of each intersection individually, the proposed build improvements are listed below. A full preliminary layout for the proposed build conditions can be found in **Appendix C**.

- Convert CSAH 48 to a 3-lane roadway with a continuous two-way left turn lane (TWLTL) between Oak Avenue and Chambers Avenue
- Curb bump-outs to shorten pedestrian crossing distances and increase pedestrian visibility and sight lines as they look for a gap in traffic to cross.
- CSAH 48 at Oak Avenue remains signalized with restriping on the east leg to create a longer westbound left turn lane and create more defined lane assignments
  - Flashing yellow arrow (FYA) added to the intersection to improve safety
- CSAH 48 at W Park Square converted to minor stop control
  - The north leg could be reconstructed to eliminate the median between the turn lanes
  - A pedestrian refuge island could be considered on the west leg to improve pedestrian safety at the uncontrolled crossing; the east leg pedestrian crossing could be removed
- CSAH 48 at Cedar Avenue remains minor stop controlled
- CSAH 48 at E Park Square remains uncontrolled
- Court Avenue access to CSAH 48 is closed to provide a pedestrian refuge island and an RRFB on the east leg of the intersection, which is heavily used by Federated Insurance employees to cross CSAH 48.
- CSAH 48 at Elm Avenue to remains signalized
  - Signal would no longer be coordinated because the W Park Square and Grove Avenue signals are proposed to be removed
- CSAH 48 at Grove Avenue converted to a single lane roundabout
- CSAH 48 at Lincoln Avenue to remain all-way stop for the next 10-15 years until traffic demands require the need for a single-lane roundabout.

  - Realign CSAH 48 to fix the existing alignment issues for CSAH 48 through vehicles
- CSAH 48 at Chambers Avenue remains minor stop controlled
  - Realign the north leg of the intersection so that the two Chambers Avenue approaches align with one another

# Appendix A

Traffic Control Warrants

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A1a

## 2021 Existing - CSAH 48 at Oak Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Oak Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | Lanes | Approach Total |
|---|---|---|---|
| 30 | Major App1: CSAH 48 EB | 3 | 6162 |
| 30 | Major App3: CSAH 48 WB | 3 | 4584 |
| 30 | Minor App2: Oak Ave NB | 3 | 5818 |
| 30 | Minor App4: Oak Ave SB | 2 | 4721 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 20 | 9 | 11 | 11 | 29 | 22 | NO / NO |
| 1:00 - 2:00 | 18 | 1 | 4 | 5 | 19 | 9 | NO / NO |
| 2:00 - 3:00 | 13 | 12 | 4 | 14 | 25 | 18 | NO / NO |
| 3:00 - 4:00 | 10 | 18 | 15 | 9 | 28 | 24 | NO / NO |
| 4:00 - 5:00 | 19 | 78 | 70 | 25 | 97 | 95 | NO / NO |
| 5:00 - 6:00 | 64 | 127 | 129 | 47 | 191 | 176 | NO / NO |
| 6:00 - 7:00 | 166 | 179 | 215 | 105 | 345 | 320 | **YES / YES** |
| 7:00 - 8:00 | 382 | 300 | 405 | 208 | 682 | 613 | **YES / YES** |
| 8:00 - 9:00 | 271 | 281 | 318 | 220 | 552 | 538 | **YES / YES** |
| 9:00 - 10:00 | 235 | 227 | 306 | 233 | 462 | 539 | **YES / YES** |
| 10:00 - 11:00 | 337 | 273 | 344 | 291 | 610 | 635 | **YES / YES** |
| 11:00 - 12:00 | 434 | 310 | 425 | 333 | 744 | 758 | **YES / YES** |
| 12:00 - 13:00 | 432 | 324 | 455 | 417 | 756 | 872 | **YES / YES** |
| 13:00 - 14:00 | 417 | 306 | 411 | 327 | 723 | 738 | **YES / YES** |
| 14:00 - 15:00 | 493 | 410 | 459 | 375 | 903 | 834 | **YES / YES** |
| 15:00 - 16:00 | 615 | 359 | 478 | 432 | 974 | 910 | **YES / YES** |
| 16:00 - 17:00 | 620 | 421 | 514 | 468 | 1041 | 982 | **YES / YES** |
| 17:00 - 18:00 | 552 | 300 | 450 | 427 | 852 | 877 | **YES / YES** |
| 18:00 - 19:00 | 427 | 215 | 282 | 245 | 642 | 527 | **YES / YES** |
| 19:00 - 20:00 | 262 | 170 | 208 | 225 | 432 | 433 | **YES / YES** |
| 20:00 - 21:00 | 169 | 122 | 145 | 118 | 291 | 263 | NO / YES |
| 21:00 - 22:00 | 92 | 77 | 106 | 102 | 169 | 208 | NO / YES |
| 22:00 - 23:00 | 66 | 40 | 44 | 54 | 106 | 98 | NO / NO |
| 23:00 - 24:00 | 48 | 25 | 20 | 30 | 73 | 50 | NO / NO |
| **Daily** | **6162** | **4584** | **5818** | **4721** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **14** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A1b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Oak Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Oak Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 6162 |
| 30 | Major App3: | CSAH 48 WB | 3 | 4584 |
| 30 | Minor App2: | Oak Ave NB | 3 | 5411 |
| 30 | Minor App4: | Oak Ave SB | 2 | 4311 |

| | |
|---|---|
| 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 | 20 | 9 | 11 | 10 | 29 | 11 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 18 | 1 | 4 | 5 | 19 | 5 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 13 | 12 | 4 | 12 | 25 | 12 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 10 | 18 | 15 | 9 | 28 | 15 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 19 | 78 | 66 | 17 | 97 | 66 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 64 | 127 | 127 | 42 | 191 | 127 | NO / NO | NO / YES | NO / NO |
| 6:00 - 7:00 | 166 | 179 | 205 | 91 | 345 | 205 | NO / YES | NO / YES | NO / YES |
| 7:00 - 8:00 | 382 | 300 | 370 | 192 | 682 | 370 | **YES / YES** | NO / YES | NO / YES |
| 8:00 - 9:00 | 271 | 281 | 301 | 199 | 552 | 301 | NO / YES | NO / YES | NO / YES |
| 9:00 - 10:00 | 235 | 227 | 286 | 208 | 462 | 286 | NO / YES | NO / YES | NO / YES |
| 10:00 - 11:00 | 337 | 273 | 322 | 266 | 610 | 322 | **YES / YES** | NO / YES | NO / YES |
| 11:00 - 12:00 | 434 | 310 | 399 | 304 | 744 | 399 | **YES / YES** | NO / YES | **YES / YES** |
| 12:00 - 13:00 | 432 | 324 | 426 | 369 | 756 | 426 | **YES / YES** | NO / YES | **YES / YES** |
| 13:00 - 14:00 | 417 | 306 | 370 | 302 | 723 | 370 | **YES / YES** | NO / YES | **YES / YES** |
| 14:00 - 15:00 | 493 | 410 | 421 | 355 | 903 | 421 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 615 | 359 | 438 | 402 | 974 | 438 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 620 | 421 | 483 | 437 | 1041 | 483 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 552 | 300 | 417 | 396 | 852 | 417 | **YES / YES** | NO / YES | **YES / YES** |
| 18:00 - 19:00 | 427 | 215 | 266 | 221 | 642 | 266 | **YES / YES** | NO / YES | NO / YES |
| 19:00 - 20:00 | 262 | 170 | 190 | 196 | 432 | 196 | NO / NO | NO / YES | NO / YES |
| 20:00 - 21:00 | 169 | 122 | 137 | 109 | 291 | 137 | NO / NO | NO / YES | NO / NO |
| 21:00 - 22:00 | 92 | 77 | 94 | 89 | 169 | 94 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 66 | 40 | 42 | 52 | 106 | 52 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 48 | 25 | 17 | 28 | 73 | 28 | NO / NO | NO / NO | NO / NO |
| **Daily** | **6162** | **4584** | **5411** | **4311** | | | | | |

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

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A1c

## 2021 Existing - CSAH 48 at Oak Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Oak Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 6162 |
| 30 | Major App3: | CSAH 48 WB | 3 | 4584 |
| 30 | Minor App2: | Oak Ave NB | 3 | 5411 |
| 30 | Minor App4: | Oak Ave SB | 2 | 4311 |

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

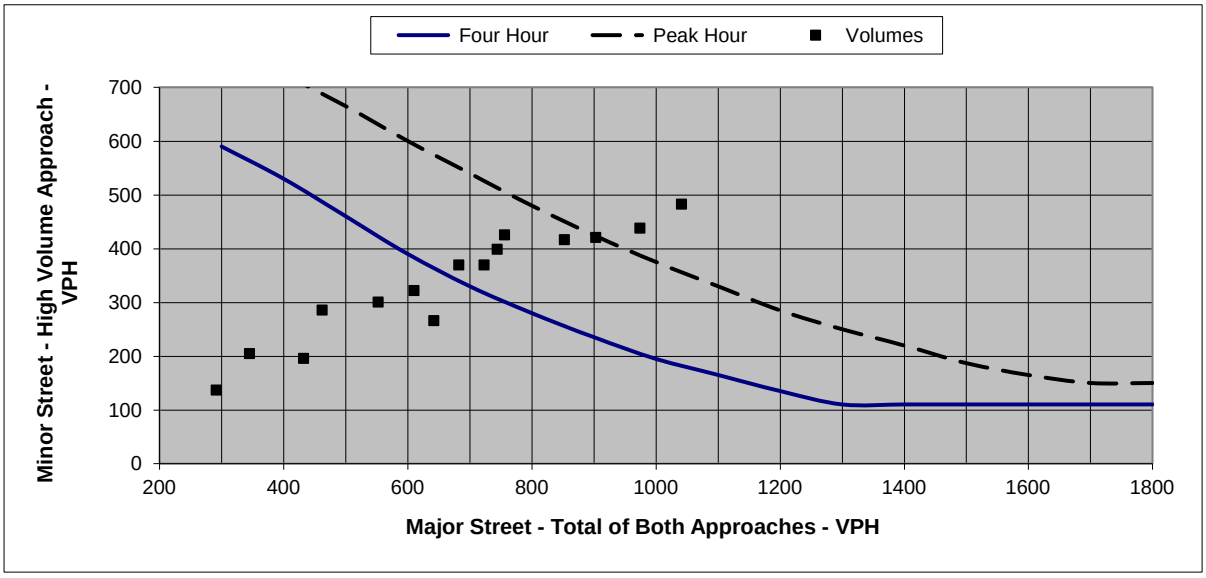



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 29 | 11 | NO | NO |
| 1:00 - 2:00 | 19 | 5 | NO | NO |
| 2:00 - 3:00 | 25 | 12 | NO | NO |
| 3:00 - 4:00 | 28 | 15 | NO | NO |
| 4:00 - 5:00 | 97 | 66 | NO | NO |
| 5:00 - 6:00 | 191 | 127 | NO | NO |
| 6:00 - 7:00 | 345 | 205 | NO | NO |
| 7:00 - 8:00 | 682 | 370 | **YES** | NO |
| 8:00 - 9:00 | 552 | 301 | NO | NO |
| 9:00 - 10:00 | 462 | 286 | NO | NO |
| 10:00 - 11:00 | 610 | 322 | NO | NO |
| 11:00 - 12:00 | 744 | 399 | **YES** | NO |
| 12:00 - 13:00 | 756 | 426 | **YES** | NO |
| 13:00 - 14:00 | 723 | 370 | **YES** | NO |
| 14:00 - 15:00 | 903 | 421 | **YES** | NO |
| 15:00 - 16:00 | 974 | 438 | **YES** | **YES** |
| 16:00 - 17:00 | 1041 | 483 | **YES** | **YES** |
| 17:00 - 18:00 | 852 | 417 | **YES** | NO |
| 18:00 - 19:00 | 642 | 266 | NO | NO |
| 19:00 - 20:00 | 432 | 196 | NO | NO |
| 20:00 - 21:00 | 291 | 137 | NO | NO |
| 21:00 - 22:00 | 169 | 94 | NO | NO |
| 22:00 - 23:00 | 106 | 52 | NO | NO |
| 23:00 - 24:00 | 73 | 28 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A1d

## 2045 Future - CSAH 48 at Oak Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Oak Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 7637 |
| 30 | Major App3: | CSAH 48 WB | 3 | 5681 |
| 30 | Minor App2: | Oak Ave NB | 3 | 7217 |
| 30 | Minor App4: | Oak Ave SB | 2 | 5846 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 25 | 11 | 14 | 14 | 36 | 28 | NO / NO |
| 1:00 - 2:00 | 22 | 1 | 5 | 5 | 23 | 10 | NO / NO |
| 2:00 - 3:00 | 15 | 15 | 4 | 17 | 30 | 21 | NO / NO |
| 3:00 - 4:00 | 11 | 21 | 17 | 10 | 32 | 27 | NO / NO |
| 4:00 - 5:00 | 23 | 97 | 87 | 31 | 120 | 118 | NO / NO |
| 5:00 - 6:00 | 80 | 157 | 160 | 58 | 237 | 218 | NO / YES |
| 6:00 - 7:00 | 206 | 222 | 267 | 130 | 428 | 397 | **YES / YES** |
| 7:00 - 8:00 | 473 | 372 | 502 | 257 | 845 | 759 | **YES / YES** |
| 8:00 - 9:00 | 337 | 349 | 394 | 273 | 686 | 667 | **YES / YES** |
| 9:00 - 10:00 | 291 | 281 | 380 | 289 | 572 | 669 | **YES / YES** |
| 10:00 - 11:00 | 418 | 339 | 427 | 361 | 757 | 788 | **YES / YES** |
| 11:00 - 12:00 | 539 | 384 | 527 | 413 | 923 | 940 | **YES / YES** |
| 12:00 - 13:00 | 536 | 401 | 564 | 516 | 937 | 1080 | **YES / YES** |
| 13:00 - 14:00 | 516 | 379 | 510 | 405 | 895 | 915 | **YES / YES** |
| 14:00 - 15:00 | 611 | 509 | 569 | 465 | 1120 | 1034 | **YES / YES** |
| 15:00 - 16:00 | 763 | 444 | 593 | 535 | 1207 | 1128 | **YES / YES** |
| 16:00 - 17:00 | 769 | 522 | 638 | 580 | 1291 | 1218 | **YES / YES** |
| 17:00 - 18:00 | 684 | 372 | 559 | 530 | 1056 | 1089 | **YES / YES** |
| 18:00 - 19:00 | 530 | 267 | 350 | 303 | 797 | 653 | **YES / YES** |
| 19:00 - 20:00 | 325 | 211 | 259 | 279 | 536 | 538 | **YES / YES** |
| 20:00 - 21:00 | 209 | 150 | 181 | 146 | 359 | 327 | **YES / YES** |
| 21:00 - 22:00 | 113 | 96 | 131 | 126 | 209 | 257 | NO / YES |
| 22:00 - 23:00 | 81 | 50 | 55 | 67 | 131 | 122 | NO / NO |
| 23:00 - 24:00 | 60 | 31 | 24 | 36 | 91 | 60 | NO / NO |
| **Daily** | **7637** | **5681** | **7217** | **5846** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **15** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A1e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Oak Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Oak Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 7637 |
| 30 | Major App3: | CSAH 48 WB | 3 | 5681 |
| 30 | Minor App2: | Oak Ave NB | 3 | 6714 |
| 30 | Minor App4: | Oak Ave SB | 2 | 5343 |

| | |
|---|---|
| 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 | 25 | 11 | 14 | 12 | 36 | 14 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 22 | 1 | 5 | 5 | 23 | 5 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 15 | 15 | 4 | 14 | 30 | 14 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 11 | 21 | 17 | 10 | 32 | 17 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 23 | 97 | 82 | 20 | 120 | 82 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 80 | 157 | 158 | 52 | 237 | 158 | NO / NO | NO / YES | NO / NO |
| 6:00 - 7:00 | 206 | 222 | 254 | 113 | 428 | 254 | NO / YES | NO / YES | NO / YES |
| 7:00 - 8:00 | 473 | 372 | 459 | 238 | 845 | 459 | **YES / YES** | NO / YES | **YES / YES** |
| 8:00 - 9:00 | 337 | 349 | 373 | 247 | 686 | 373 | **YES / YES** | NO / YES | NO / YES |
| 9:00 - 10:00 | 291 | 281 | 355 | 258 | 572 | 355 | NO / YES | NO / YES | NO / YES |
| 10:00 - 11:00 | 418 | 339 | 400 | 330 | 757 | 400 | **YES / YES** | NO / YES | **YES / YES** |
| 11:00 - 12:00 | 539 | 384 | 495 | 377 | 923 | 495 | **YES / YES** | **YES / YES** | **YES / YES** |
| 12:00 - 13:00 | 536 | 401 | 529 | 458 | 937 | 529 | **YES / YES** | **YES / YES** | **YES / YES** |
| 13:00 - 14:00 | 516 | 379 | 459 | 374 | 895 | 459 | **YES / YES** | NO / YES | **YES / YES** |
| 14:00 - 15:00 | 611 | 509 | 523 | 440 | 1120 | 523 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 763 | 444 | 543 | 499 | 1207 | 543 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 769 | 522 | 599 | 543 | 1291 | 599 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 684 | 372 | 518 | 491 | 1056 | 518 | **YES / YES** | **YES / YES** | **YES / YES** |
| 18:00 - 19:00 | 530 | 267 | 330 | 275 | 797 | 330 | **YES / YES** | NO / YES | **YES / YES** |
| 19:00 - 20:00 | 325 | 211 | 236 | 243 | 536 | 243 | NO / YES | NO / YES | NO / YES |
| 20:00 - 21:00 | 209 | 150 | 170 | 134 | 359 | 170 | NO / NO | NO / YES | NO / YES |
| 21:00 - 22:00 | 113 | 96 | 118 | 111 | 209 | 118 | NO / NO | NO / YES | NO / NO |
| 22:00 - 23:00 | 81 | 50 | 52 | 65 | 131 | 65 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 60 | 31 | 21 | 34 | 91 | 34 | NO / NO | NO / NO | NO / NO |
| **Daily** | **7637** | **5681** | **6714** | **5343** | | | | | |

| | | 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 | 6 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | **10** | 8 | **Satisfied** |
| **Warrant 2** | **Four Hour Volumes** | **11** | 4 | **Satisfied** |
| **Warrant 3** | **Peak Hour Volumes** | **8** | 1 | **Satisfied** |
| **Warrant 7** | **Crash Experience** | **13** | 8 | Crashes Insufficient |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A1f

## 2045 Future - CSAH 48 at Oak Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Oak Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 7637 |
| 30 | Major App3: | CSAH 48 WB | 3 | 5681 |
| 30 | Minor App2: | Oak Ave NB | 3 | 6714 |
| 30 | Minor App4: | Oak Ave SB | 2 | 5343 |

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

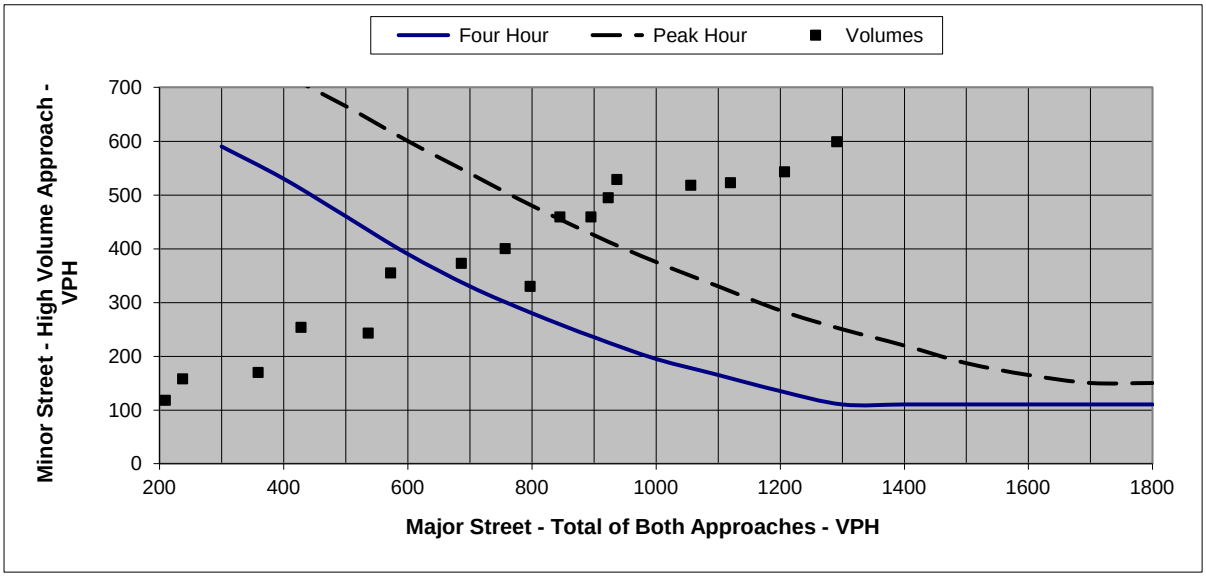



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 36 | 14 | NO | NO |
| 1:00 - 2:00 | 23 | 5 | NO | NO |
| 2:00 - 3:00 | 30 | 14 | NO | NO |
| 3:00 - 4:00 | 32 | 17 | NO | NO |
| 4:00 - 5:00 | 120 | 82 | NO | NO |
| 5:00 - 6:00 | 237 | 158 | NO | NO |
| 6:00 - 7:00 | 428 | 254 | NO | NO |
| 7:00 - 8:00 | 845 | 459 | **YES** | **YES** |
| 8:00 - 9:00 | 686 | 373 | **YES** | NO |
| 9:00 - 10:00 | 572 | 355 | NO | NO |
| 10:00 - 11:00 | 757 | 400 | **YES** | NO |
| 11:00 - 12:00 | 923 | 495 | **YES** | **YES** |
| 12:00 - 13:00 | 937 | 529 | **YES** | **YES** |
| 13:00 - 14:00 | 895 | 459 | **YES** | **YES** |
| 14:00 - 15:00 | 1120 | 523 | **YES** | **YES** |
| 15:00 - 16:00 | 1207 | 543 | **YES** | **YES** |
| 16:00 - 17:00 | 1291 | 599 | **YES** | **YES** |
| 17:00 - 18:00 | 1056 | 518 | **YES** | **YES** |
| 18:00 - 19:00 | 797 | 330 | **YES** | NO |
| 19:00 - 20:00 | 536 | 243 | NO | NO |
| 20:00 - 21:00 | 359 | 170 | NO | NO |
| 21:00 - 22:00 | 209 | 118 | NO | NO |
| 22:00 - 23:00 | 131 | 65 | NO | NO |
| 23:00 - 24:00 | 91 | 34 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A2a

## 2021 Existing - CSAH 48 at W Park Square
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4106 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3606 |
| 30 | Minor App2: | W Park Square SB | 2 | 2071 |
| 30 | Minor App4: | N/A | 0 | 0 |

0.70 SPEED FACTOR USED? **No**

| Minimum Volume Requirement | |
|---|---|
| **300** | **200** |

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 17 | 7 | 2 | 0 | 24 | 2 | NO / NO |
| 1:00 - 2:00 | 11 | 1 | 1 | 0 | 12 | 1 | NO / NO |
| 2:00 - 3:00 | 17 | 11 | 1 | 0 | 28 | 1 | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 1 | 0 | 24 | 1 | NO / NO |
| 4:00 - 5:00 | 20 | 77 | 1 | 0 | 97 | 1 | NO / NO |
| 5:00 - 6:00 | 36 | 124 | 6 | 0 | 160 | 6 | NO / NO |
| 6:00 - 7:00 | 118 | 162 | 37 | 0 | 280 | 37 | NO / NO |
| 7:00 - 8:00 | 253 | 251 | 116 | 0 | 504 | 116 | YES / NO |
| 8:00 - 9:00 | 178 | 237 | 93 | 0 | 415 | 93 | YES / NO |
| 9:00 - 10:00 | 161 | 179 | 101 | 0 | 340 | 101 | YES / NO |
| 10:00 - 11:00 | 236 | 214 | 132 | 0 | 450 | 132 | YES / NO |
| 11:00 - 12:00 | 263 | 216 | 174 | 0 | 479 | 174 | YES / NO |
| 12:00 - 13:00 | 259 | 226 | 206 | 0 | 485 | 206 | **YES / YES** |
| 13:00 - 14:00 | 288 | 224 | 168 | 0 | 512 | 168 | YES / NO |
| 14:00 - 15:00 | 333 | 328 | 179 | 0 | 661 | 179 | YES / NO |
| 15:00 - 16:00 | 385 | 274 | 182 | 0 | 659 | 182 | YES / NO |
| 16:00 - 17:00 | 431 | 320 | 208 | 0 | 751 | 208 | **YES / YES** |
| 17:00 - 18:00 | 365 | 215 | 181 | 0 | 580 | 181 | YES / NO |
| 18:00 - 19:00 | 254 | 172 | 117 | 0 | 426 | 117 | YES / NO |
| 19:00 - 20:00 | 184 | 120 | 80 | 0 | 304 | 80 | YES / NO |
| 20:00 - 21:00 | 123 | 103 | 48 | 0 | 226 | 48 | NO / NO |
| 21:00 - 22:00 | 91 | 65 | 24 | 0 | 156 | 24 | NO / NO |
| 22:00 - 23:00 | 45 | 39 | 5 | 0 | 84 | 5 | NO / NO |
| 23:00 - 24:00 | 32 | 23 | 8 | 0 | 55 | 8 | NO / NO |
| **Daily** | **4106** | **3606** | **2071** | **0** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **2** | **8** |

**All-way Stop Warrant:** **Not satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at W Park Square
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4106 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3606 |
| 30 | Minor App2: | W Park Square SB | 1 | 1093 |
| 30 | Minor App4: | N/A | 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 | 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 | 17 | 7 | 0 | 0 | 24 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 11 | 1 | 1 | 0 | 12 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 17 | 11 | 0 | 0 | 28 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 1 | 0 | 24 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 20 | 77 | 0 | 0 | 97 | 0 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 36 | 124 | 3 | 0 | 160 | 3 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 118 | 162 | 20 | 0 | 280 | 20 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 253 | 251 | 67 | 0 | 504 | 67 | NO / NO | NO / NO | NO / NO |
| 8:00 - 9:00 | 178 | 237 | 49 | 0 | 415 | 49 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 161 | 179 | 53 | 0 | 340 | 53 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 236 | 214 | 73 | 0 | 450 | 73 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 263 | 216 | 80 | 0 | 479 | 80 | NO / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 259 | 226 | 108 | 0 | 485 | 108 | NO / NO | NO / YES | NO / NO |
| 13:00 - 14:00 | 288 | 224 | 86 | 0 | 512 | 86 | NO / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 333 | 328 | 97 | 0 | 661 | 97 | YES / NO | NO / YES | NO / NO |
| 15:00 - 16:00 | 385 | 274 | 97 | 0 | 659 | 97 | YES / NO | NO / YES | NO / NO |
| 16:00 - 17:00 | 431 | 320 | 107 | 0 | 751 | 107 | YES / NO | NO / YES | YES / NO |
| 17:00 - 18:00 | 365 | 215 | 96 | 0 | 580 | 96 | NO / NO | NO / YES | NO / NO |
| 18:00 - 19:00 | 254 | 172 | 74 | 0 | 426 | 74 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 184 | 120 | 30 | 0 | 304 | 30 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 123 | 103 | 29 | 0 | 226 | 29 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 91 | 65 | 12 | 0 | 156 | 12 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 45 | 39 | 4 | 0 | 84 | 4 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 32 | 23 | 6 | 0 | 55 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4106** | **3606** | **1093** | **0** | | | | | |

| | | 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** | 1 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A2c

## 2021 Existing - CSAH 48 at W Park Square
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4106 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3606 |
| 30 | Minor App2: | W Park Square SB | 1 | 1093 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

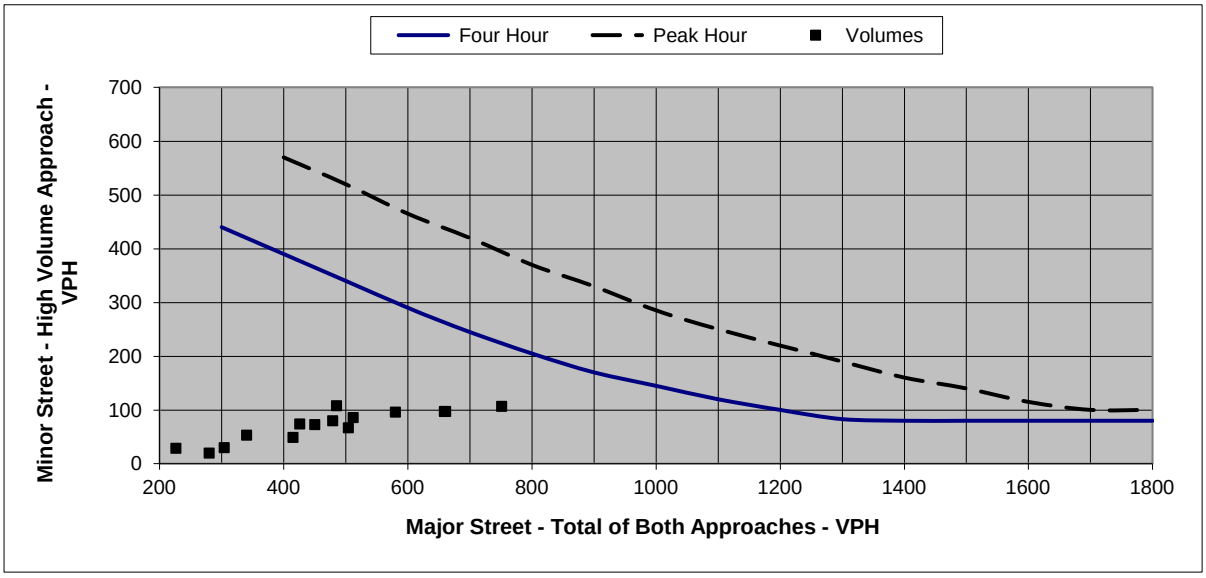



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 24 | 0 | NO | NO |
| 1:00 - 2:00 | 12 | 1 | NO | NO |
| 2:00 - 3:00 | 28 | 0 | NO | NO |
| 3:00 - 4:00 | 24 | 1 | NO | NO |
| 4:00 - 5:00 | 97 | 0 | NO | NO |
| 5:00 - 6:00 | 160 | 3 | NO | NO |
| 6:00 - 7:00 | 280 | 20 | NO | NO |
| 7:00 - 8:00 | 504 | 67 | NO | NO |
| 8:00 - 9:00 | 415 | 49 | NO | NO |
| 9:00 - 10:00 | 340 | 53 | NO | NO |
| 10:00 - 11:00 | 450 | 73 | NO | NO |
| 11:00 - 12:00 | 479 | 80 | NO | NO |
| 12:00 - 13:00 | 485 | 108 | NO | NO |
| 13:00 - 14:00 | 512 | 86 | NO | NO |
| 14:00 - 15:00 | 661 | 97 | NO | NO |
| 15:00 - 16:00 | 659 | 97 | NO | NO |
| 16:00 - 17:00 | 751 | 107 | NO | NO |
| 17:00 - 18:00 | 580 | 96 | NO | NO |
| 18:00 - 19:00 | 426 | 74 | NO | NO |
| 19:00 - 20:00 | 304 | 30 | NO | NO |
| 20:00 - 21:00 | 226 | 29 | NO | NO |
| 21:00 - 22:00 | 156 | 12 | NO | NO |
| 22:00 - 23:00 | 84 | 4 | NO | NO |
| 23:00 - 24:00 | 55 | 6 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2d

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at W Park Square
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4106 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3606 |
| 30 | Minor App2: | W Park Square SB | 1 | 1093 |
| 30 | Minor App4: | N/A | 0 | 0 |

| | |
|---|---|
| 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 | 17 | 7 | 0 | 0 | 24 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 11 | 1 | 1 | 0 | 12 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 17 | 11 | 0 | 0 | 28 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 1 | 0 | 24 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 20 | 77 | 0 | 0 | 97 | 0 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 36 | 124 | 3 | 0 | 160 | 3 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 118 | 162 | 20 | 0 | 280 | 20 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 253 | 251 | 67 | 0 | 504 | 67 | YES / NO | NO / YES | NO / NO |
| 8:00 - 9:00 | 178 | 237 | 49 | 0 | 415 | 49 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 161 | 179 | 53 | 0 | 340 | 53 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 236 | 214 | 73 | 0 | 450 | 73 | NO / NO | NO / YES | NO / NO |
| 11:00 - 12:00 | 263 | 216 | 80 | 0 | 479 | 80 | NO / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 259 | 226 | 108 | 0 | 485 | 108 | YES / NO | NO / YES | NO / YES |
| 13:00 - 14:00 | 288 | 224 | 86 | 0 | 512 | 86 | YES / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 333 | 328 | 97 | 0 | 661 | 97 | YES / NO | NO / YES | **YES / YES** |
| 15:00 - 16:00 | 385 | 274 | 97 | 0 | 659 | 97 | YES / NO | NO / YES | **YES / YES** |
| 16:00 - 17:00 | 431 | 320 | 107 | 0 | 751 | 107 | YES / NO | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 365 | 215 | 96 | 0 | 580 | 96 | YES / NO | NO / YES | **YES / YES** |
| 18:00 - 19:00 | 254 | 172 | 74 | 0 | 426 | 74 | NO / NO | NO / YES | NO / NO |
| 19:00 - 20:00 | 184 | 120 | 30 | 0 | 304 | 30 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 123 | 103 | 29 | 0 | 226 | 29 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 91 | 65 | 12 | 0 | 156 | 12 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 45 | 39 | 4 | 0 | 84 | 4 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 32 | 23 | 6 | 0 | 55 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4106** | **3606** | **1093** | **0** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 4 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 0 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 1 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 4 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at W Park Square
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4106 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3606 |
| 30 | Minor App2: | W Park Square SB | 1 | 1093 |
| 30 | Minor App4: | N/A | 0 | 0 |

| | |
|---|---|
| 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 | 90 | 45 | 72 |

| 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 | 17 | 7 | 0 | 0 | 24 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 11 | 1 | 1 | 0 | 12 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 17 | 11 | 0 | 0 | 28 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 1 | 0 | 24 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 20 | 77 | 0 | 0 | 97 | 0 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 36 | 124 | 3 | 0 | 160 | 3 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 118 | 162 | 20 | 0 | 280 | 20 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 253 | 251 | 67 | 0 | 504 | 67 | YES / NO | NO / YES | YES / NO |
| 8:00 - 9:00 | 178 | 237 | 49 | 0 | 415 | 49 | YES / NO | NO / YES | NO / NO |
| 9:00 - 10:00 | 161 | 179 | 53 | 0 | 340 | 53 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 236 | 214 | 73 | 0 | 450 | 73 | YES / NO | NO / YES | **YES / YES** |
| 11:00 - 12:00 | 263 | 216 | 80 | 0 | 479 | 80 | YES / NO | NO / YES | **YES / YES** |
| 12:00 - 13:00 | 259 | 226 | 108 | 0 | 485 | 108 | **YES / YES** | NO / YES | **YES / YES** |
| 13:00 - 14:00 | 288 | 224 | 86 | 0 | 512 | 86 | YES / NO | NO / YES | **YES / YES** |
| 14:00 - 15:00 | 333 | 328 | 97 | 0 | 661 | 97 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 385 | 274 | 97 | 0 | 659 | 97 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 431 | 320 | 107 | 0 | 751 | 107 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 365 | 215 | 96 | 0 | 580 | 96 | **YES / YES** | **YES / YES** | **YES / YES** |
| 18:00 - 19:00 | 254 | 172 | 74 | 0 | 426 | 74 | YES / NO | NO / YES | NO / YES |
| 19:00 - 20:00 | 184 | 120 | 30 | 0 | 304 | 30 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 123 | 103 | 29 | 0 | 226 | 29 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 91 | 65 | 12 | 0 | 156 | 12 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 45 | 39 | 4 | 0 | 84 | 4 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 32 | 23 | 6 | 0 | 55 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4106** | **3606** | **1093** | **0** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | **8** | 8 | **Satisfied** |
| Warrant 1A | Minimum Vehicular Volume | 5 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 4 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | **8** | 8 | **Satisfied** |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A2f

## 2045 Future - CSAH 48 at W Park Square
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5085 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4465 |
| 30 | Minor App2: | W Park Square SB | 2 | 2564 |
| 30 | Minor App4: | N/A | 0 | 0 |

0.70 SPEED FACTOR USED? **No**

| **Minimum Volume Requirement** | |
|---|---|
| **300** | **200** |

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 20 | 8 | 2 | 0 | 28 | 2 | NO / NO |
| 1:00 - 2:00 | 13 | 1 | 1 | 0 | 14 | 1 | NO / NO |
| 2:00 - 3:00 | 20 | 14 | 1 | 0 | 34 | 1 | NO / NO |
| 3:00 - 4:00 | 7 | 21 | 1 | 0 | 28 | 1 | NO / NO |
| 4:00 - 5:00 | 25 | 96 | 1 | 0 | 121 | 1 | NO / NO |
| 5:00 - 6:00 | 44 | 153 | 6 | 0 | 197 | 6 | NO / NO |
| 6:00 - 7:00 | 146 | 201 | 46 | 0 | 347 | 46 | YES / NO |
| 7:00 - 8:00 | 314 | 311 | 145 | 0 | 625 | 145 | YES / NO |
| 8:00 - 9:00 | 221 | 294 | 115 | 0 | 515 | 115 | YES / NO |
| 9:00 - 10:00 | 200 | 222 | 125 | 0 | 422 | 125 | YES / NO |
| 10:00 - 11:00 | 292 | 264 | 163 | 0 | 556 | 163 | YES / NO |
| 11:00 - 12:00 | 325 | 267 | 216 | 0 | 592 | 216 | **YES / YES** |
| 12:00 - 13:00 | 321 | 280 | 256 | 0 | 601 | 256 | **YES / YES** |
| 13:00 - 14:00 | 358 | 277 | 209 | 0 | 635 | 209 | **YES / YES** |
| 14:00 - 15:00 | 413 | 406 | 221 | 0 | 819 | 221 | **YES / YES** |
| 15:00 - 16:00 | 478 | 339 | 227 | 0 | 817 | 227 | **YES / YES** |
| 16:00 - 17:00 | 534 | 397 | 257 | 0 | 931 | 257 | **YES / YES** |
| 17:00 - 18:00 | 452 | 266 | 224 | 0 | 718 | 224 | **YES / YES** |
| 18:00 - 19:00 | 315 | 214 | 145 | 0 | 529 | 145 | YES / NO |
| 19:00 - 20:00 | 228 | 149 | 98 | 0 | 377 | 98 | YES / NO |
| 20:00 - 21:00 | 152 | 128 | 60 | 0 | 280 | 60 | NO / NO |
| 21:00 - 22:00 | 112 | 80 | 30 | 0 | 192 | 30 | NO / NO |
| 22:00 - 23:00 | 56 | 48 | 6 | 0 | 104 | 6 | NO / NO |
| 23:00 - 24:00 | 39 | 29 | 9 | 0 | 68 | 9 | NO / NO |
| **Daily** | **5085** | **4465** | **2564** | **0** | | | |

| | **Met (Hr)** | **Required (Hr)** |
|---|---|---|
| **Hours met for warrant:** | **7** | **8** |

**All-way Stop Warrant:** **Not satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2g

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at W Park Square
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5085 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4465 |
| 30 | Minor App2: | W Park Square SB | 1 | 1354 |
| 30 | Minor App4: | N/A | 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 | 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 | 20 | 8 | 0 | 0 | 28 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 1 | 1 | 0 | 14 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 20 | 14 | 0 | 0 | 34 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 7 | 21 | 1 | 0 | 28 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 25 | 96 | 0 | 0 | 121 | 0 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 44 | 153 | 3 | 0 | 197 | 3 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 146 | 201 | 24 | 0 | 347 | 24 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 314 | 311 | 83 | 0 | 625 | 83 | YES / NO | NO / YES | NO / NO |
| 8:00 - 9:00 | 221 | 294 | 61 | 0 | 515 | 61 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 200 | 222 | 66 | 0 | 422 | 66 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 292 | 264 | 92 | 0 | 556 | 92 | NO / NO | NO / YES | NO / NO |
| 11:00 - 12:00 | 325 | 267 | 100 | 0 | 592 | 100 | NO / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 321 | 280 | 134 | 0 | 601 | 134 | YES / NO | NO / YES | NO / YES |
| 13:00 - 14:00 | 358 | 277 | 107 | 0 | 635 | 107 | YES / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 413 | 406 | 120 | 0 | 819 | 120 | YES / NO | NO / YES | **YES / YES** |
| 15:00 - 16:00 | 478 | 339 | 121 | 0 | 817 | 121 | YES / NO | NO / YES | **YES / YES** |
| 16:00 - 17:00 | 534 | 397 | 133 | 0 | 931 | 133 | YES / NO | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 452 | 266 | 120 | 0 | 718 | 120 | YES / NO | NO / YES | NO / YES |
| 18:00 - 19:00 | 315 | 214 | 92 | 0 | 529 | 92 | NO / NO | NO / YES | NO / NO |
| 19:00 - 20:00 | 228 | 149 | 36 | 0 | 377 | 36 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 152 | 128 | 36 | 0 | 280 | 36 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 112 | 80 | 14 | 0 | 192 | 14 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 56 | 48 | 4 | 0 | 104 | 4 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 39 | 29 | 6 | 0 | 68 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5085** | **4465** | **1354** | **0** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 3 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 0 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 1 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 3 | 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** | 5 | 8 | Not satisfied |

COMMENTS:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A2h

# 2045 Future - CSAH 48 at W Park Square
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5085 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4465 |
| 30 | Minor App2: | W Park Square SB | 1 | 1354 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

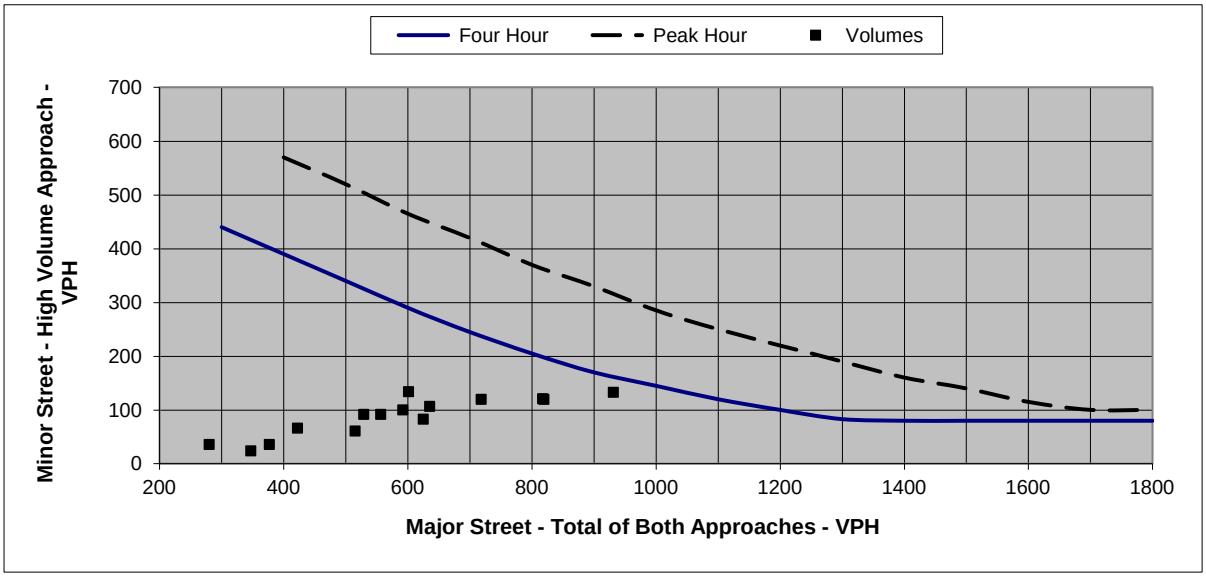



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 28 | 0 | NO | NO |
| 1:00 - 2:00 | 14 | 1 | NO | NO |
| 2:00 - 3:00 | 34 | 0 | NO | NO |
| 3:00 - 4:00 | 28 | 1 | NO | NO |
| 4:00 - 5:00 | 121 | 0 | NO | NO |
| 5:00 - 6:00 | 197 | 3 | NO | NO |
| 6:00 - 7:00 | 347 | 24 | NO | NO |
| 7:00 - 8:00 | 625 | 83 | NO | NO |
| 8:00 - 9:00 | 515 | 61 | NO | NO |
| 9:00 - 10:00 | 422 | 66 | NO | NO |
| 10:00 - 11:00 | 556 | 92 | NO | NO |
| 11:00 - 12:00 | 592 | 100 | NO | NO |
| 12:00 - 13:00 | 601 | 134 | NO | NO |
| 13:00 - 14:00 | 635 | 107 | NO | NO |
| 14:00 - 15:00 | 819 | 120 | NO | NO |
| 15:00 - 16:00 | 817 | 121 | NO | NO |
| 16:00 - 17:00 | 931 | 133 | NO | NO |
| 17:00 - 18:00 | 718 | 120 | NO | NO |
| 18:00 - 19:00 | 529 | 92 | NO | NO |
| 19:00 - 20:00 | 377 | 36 | NO | NO |
| 20:00 - 21:00 | 280 | 36 | NO | NO |
| 21:00 - 22:00 | 192 | 14 | NO | NO |
| 22:00 - 23:00 | 104 | 4 | NO | NO |
| 23:00 - 24:00 | 68 | 6 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2i

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at W Park Square
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5085 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4465 |
| 30 | Minor App2: | W Park Square SB | 1 | 1354 |
| 30 | Minor App4: | N/A | 0 | 0 |

| | |
|---|---|
| 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 | 20 | 8 | 0 | 0 | 28 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 1 | 1 | 0 | 14 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 20 | 14 | 0 | 0 | 34 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 7 | 21 | 1 | 0 | 28 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 25 | 96 | 0 | 0 | 121 | 0 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 44 | 153 | 3 | 0 | 197 | 3 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 146 | 201 | 24 | 0 | 347 | 24 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 314 | 311 | 83 | 0 | 625 | 83 | YES / NO | NO / YES | YES / NO |
| 8:00 - 9:00 | 221 | 294 | 61 | 0 | 515 | 61 | YES / NO | NO / YES | NO / NO |
| 9:00 - 10:00 | 200 | 222 | 66 | 0 | 422 | 66 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 292 | 264 | 92 | 0 | 556 | 92 | YES / NO | NO / YES | NO / NO |
| 11:00 - 12:00 | 325 | 267 | 100 | 0 | 592 | 100 | YES / NO | NO / YES | **YES / YES** |
| 12:00 - 13:00 | 321 | 280 | 134 | 0 | 601 | 134 | **YES / YES** | NO / YES | **YES / YES** |
| 13:00 - 14:00 | 358 | 277 | 107 | 0 | 635 | 107 | YES / NO | NO / YES | **YES / YES** |
| 14:00 - 15:00 | 413 | 406 | 120 | 0 | 819 | 120 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 478 | 339 | 121 | 0 | 817 | 121 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 534 | 397 | 133 | 0 | 931 | 133 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 452 | 266 | 120 | 0 | 718 | 120 | **YES / YES** | NO / YES | **YES / YES** |
| 18:00 - 19:00 | 315 | 214 | 92 | 0 | 529 | 92 | YES / NO | NO / YES | NO / NO |
| 19:00 - 20:00 | 228 | 149 | 36 | 0 | 377 | 36 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 152 | 128 | 36 | 0 | 280 | 36 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 112 | 80 | 14 | 0 | 192 | 14 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 56 | 48 | 4 | 0 | 104 | 4 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 39 | 29 | 6 | 0 | 68 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5085** | **4465** | **1354** | **0** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 7 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 5 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 3 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 7 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A2j

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at W Park Square
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at W Park Square
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5085 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4465 |
| 30 | Minor App2: | W Park Square SB | 1 | 1354 |
| 30 | Minor App4: | N/A | 0 | 0 |

| | |
|---|---|
| 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 | 90 | 45 | 72 |

| 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 | 20 | 8 | 0 | 0 | 28 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 1 | 1 | 0 | 14 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 20 | 14 | 0 | 0 | 34 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 7 | 21 | 1 | 0 | 28 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 25 | 96 | 0 | 0 | 121 | 0 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 44 | 153 | 3 | 0 | 197 | 3 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 146 | 201 | 24 | 0 | 347 | 24 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 314 | 311 | 83 | 0 | 625 | 83 | YES / NO | **YES / YES** | **YES / YES** |
| 8:00 - 9:00 | 221 | 294 | 61 | 0 | 515 | 61 | YES / NO | NO / YES | YES / NO |
| 9:00 - 10:00 | 200 | 222 | 66 | 0 | 422 | 66 | YES / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 292 | 264 | 92 | 0 | 556 | 92 | **YES / YES** | **YES / YES** | **YES / YES** |
| 11:00 - 12:00 | 325 | 267 | 100 | 0 | 592 | 100 | **YES / YES** | **YES / YES** | **YES / YES** |
| 12:00 - 13:00 | 321 | 280 | 134 | 0 | 601 | 134 | **YES / YES** | **YES / YES** | **YES / YES** |
| 13:00 - 14:00 | 358 | 277 | 107 | 0 | 635 | 107 | **YES / YES** | **YES / YES** | **YES / YES** |
| 14:00 - 15:00 | 413 | 406 | 120 | 0 | 819 | 120 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 478 | 339 | 121 | 0 | 817 | 121 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 534 | 397 | 133 | 0 | 931 | 133 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 452 | 266 | 120 | 0 | 718 | 120 | **YES / YES** | **YES / YES** | **YES / YES** |
| 18:00 - 19:00 | 315 | 214 | 92 | 0 | 529 | 92 | **YES / YES** | NO / YES | **YES / YES** |
| 19:00 - 20:00 | 228 | 149 | 36 | 0 | 377 | 36 | YES / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 152 | 128 | 36 | 0 | 280 | 36 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 112 | 80 | 14 | 0 | 192 | 14 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 56 | 48 | 4 | 0 | 104 | 4 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 39 | 29 | 6 | 0 | 68 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5085** | **4465** | **1354** | **0** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | **10** | 8 | **Satisfied** |
| Warrant 1A | Minimum Vehicular Volume | **9** | 8 | **Satisfied** |
| Warrant 1B | Interruption of Continuous Flow | **9** | 8 | **Satisfied** |
| 1A & 1B | Combination of Warrants | **10** | 8 | **Satisfied** |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A3a

## 2021 Existing - CSAH 48 at Cedar Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Cedar Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5199 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3765 |
| 30 | Minor App2: | Cedar Ave NB | 1 | 1266 |
| 30 | Minor App4: | N/A | 0 | 0 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 17 | 7 | 5 | 0 | 24 | 5 | NO / NO |
| 1:00 - 2:00 | 12 | 2 | 3 | 0 | 14 | 3 | NO / NO |
| 2:00 - 3:00 | 17 | 9 | 5 | 0 | 26 | 5 | NO / NO |
| 3:00 - 4:00 | 7 | 18 | 1 | 0 | 25 | 1 | NO / NO |
| 4:00 - 5:00 | 20 | 73 | 8 | 0 | 93 | 8 | NO / NO |
| 5:00 - 6:00 | 39 | 128 | 6 | 0 | 167 | 6 | NO / NO |
| 6:00 - 7:00 | 138 | 165 | 40 | 0 | 303 | 40 | YES / NO |
| 7:00 - 8:00 | 320 | 309 | 72 | 0 | 629 | 72 | YES / NO |
| 8:00 - 9:00 | 227 | 245 | 54 | 0 | 472 | 54 | YES / NO |
| 9:00 - 10:00 | 214 | 181 | 60 | 0 | 395 | 60 | YES / NO |
| 10:00 - 11:00 | 309 | 215 | 69 | 0 | 524 | 69 | YES / NO |
| 11:00 - 12:00 | 343 | 225 | 92 | 0 | 568 | 92 | YES / NO |
| 12:00 - 13:00 | 367 | 224 | 98 | 0 | 591 | 98 | YES / NO |
| 13:00 - 14:00 | 374 | 230 | 86 | 0 | 604 | 86 | YES / NO |
| 14:00 - 15:00 | 430 | 336 | 117 | 0 | 766 | 117 | YES / NO |
| 15:00 - 16:00 | 482 | 285 | 126 | 0 | 767 | 126 | YES / NO |
| 16:00 - 17:00 | 538 | 343 | 138 | 0 | 881 | 138 | YES / NO |
| 17:00 - 18:00 | 461 | 230 | 79 | 0 | 691 | 79 | YES / NO |
| 18:00 - 19:00 | 328 | 184 | 84 | 0 | 512 | 84 | YES / NO |
| 19:00 - 20:00 | 214 | 117 | 39 | 0 | 331 | 39 | YES / NO |
| 20:00 - 21:00 | 152 | 104 | 42 | 0 | 256 | 42 | NO / NO |
| 21:00 - 22:00 | 103 | 68 | 24 | 0 | 171 | 24 | NO / NO |
| 22:00 - 23:00 | 49 | 44 | 11 | 0 | 93 | 11 | NO / NO |
| 23:00 - 24:00 | 38 | 23 | 7 | 0 | 61 | 7 | NO / NO |
| **Daily** | **5199** | **3765** | **1266** | **0** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **0** | **8** |

**All-way Stop Warrant:** **Not satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A3b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Cedar Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Cedar Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5199 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3765 |
| 30 | Minor App2: | Cedar Ave NB | 1 | 225 |
| 30 | Minor App4: | N/A | 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 | 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 | 17 | 7 | 1 | 0 | 24 | 1 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 12 | 2 | 0 | 0 | 14 | 0 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 17 | 9 | 2 | 0 | 26 | 2 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 7 | 18 | 1 | 0 | 25 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 20 | 73 | 5 | 0 | 93 | 5 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 39 | 128 | 2 | 0 | 167 | 2 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 138 | 165 | 6 | 0 | 303 | 6 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 320 | 309 | 12 | 0 | 629 | 12 | YES / NO | NO / NO | NO / NO |
| 8:00 - 9:00 | 227 | 245 | 7 | 0 | 472 | 7 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 214 | 181 | 13 | 0 | 395 | 13 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 309 | 215 | 14 | 0 | 524 | 14 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 343 | 225 | 11 | 0 | 568 | 11 | NO / NO | NO / NO | NO / NO |
| 12:00 - 13:00 | 367 | 224 | 17 | 0 | 591 | 17 | NO / NO | NO / NO | NO / NO |
| 13:00 - 14:00 | 374 | 230 | 10 | 0 | 604 | 10 | YES / NO | NO / NO | NO / NO |
| 14:00 - 15:00 | 430 | 336 | 25 | 0 | 766 | 25 | YES / NO | NO / NO | YES / NO |
| 15:00 - 16:00 | 482 | 285 | 14 | 0 | 767 | 14 | YES / NO | NO / NO | YES / NO |
| 16:00 - 17:00 | 538 | 343 | 23 | 0 | 881 | 23 | YES / NO | NO / NO | YES / NO |
| 17:00 - 18:00 | 461 | 230 | 11 | 0 | 691 | 11 | YES / NO | NO / NO | NO / NO |
| 18:00 - 19:00 | 328 | 184 | 12 | 0 | 512 | 12 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 214 | 117 | 16 | 0 | 331 | 16 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 152 | 104 | 11 | 0 | 256 | 11 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 103 | 68 | 5 | 0 | 171 | 5 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 49 | 44 | 2 | 0 | 93 | 2 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 38 | 23 | 5 | 0 | 61 | 5 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5199** | **3765** | **225** | **0** | | | | | |

| | | 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:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A3c

## 2021 Existing - CSAH 48 at Cedar Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Cedar Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 5199 |
| 30 | Major App3: | CSAH 48 WB | 2 | 3765 |
| 30 | Minor App2: | Cedar Ave NB | 1 | 225 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

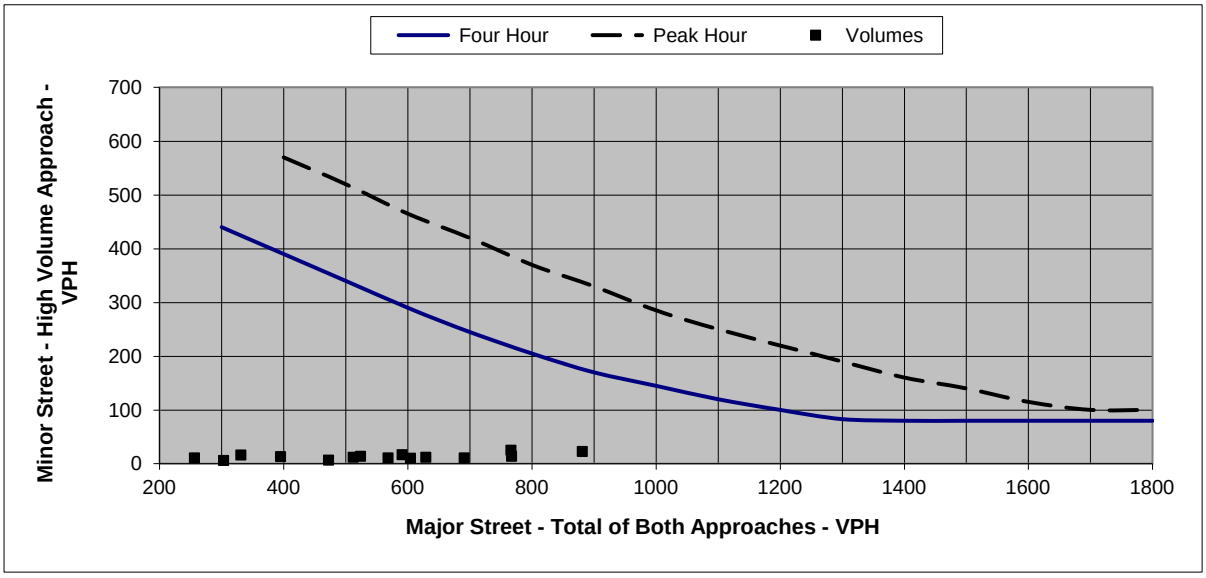



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 24 | 1 | NO | NO |
| 1:00 - 2:00 | 14 | 0 | NO | NO |
| 2:00 - 3:00 | 26 | 2 | NO | NO |
| 3:00 - 4:00 | 25 | 1 | NO | NO |
| 4:00 - 5:00 | 93 | 5 | NO | NO |
| 5:00 - 6:00 | 167 | 2 | NO | NO |
| 6:00 - 7:00 | 303 | 6 | NO | NO |
| 7:00 - 8:00 | 629 | 12 | NO | NO |
| 8:00 - 9:00 | 472 | 7 | NO | NO |
| 9:00 - 10:00 | 395 | 13 | NO | NO |
| 10:00 - 11:00 | 524 | 14 | NO | NO |
| 11:00 - 12:00 | 568 | 11 | NO | NO |
| 12:00 - 13:00 | 591 | 17 | NO | NO |
| 13:00 - 14:00 | 604 | 10 | NO | NO |
| 14:00 - 15:00 | 766 | 25 | NO | NO |
| 15:00 - 16:00 | 767 | 14 | NO | NO |
| 16:00 - 17:00 | 881 | 23 | NO | NO |
| 17:00 - 18:00 | 691 | 11 | NO | NO |
| 18:00 - 19:00 | 512 | 12 | NO | NO |
| 19:00 - 20:00 | 331 | 16 | NO | NO |
| 20:00 - 21:00 | 256 | 11 | NO | NO |
| 21:00 - 22:00 | 171 | 5 | NO | NO |
| 22:00 - 23:00 | 93 | 2 | NO | NO |
| 23:00 - 24:00 | 61 | 5 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A3d

## 2024 Future - CSAH 48 at Cedar Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Cedar Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 6437 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4667 |
| 30 | Minor App2: | Cedar Ave NB | 1 | 1564 |
| 30 | Minor App4: | N/A | 0 | 0 |

0.70 SPEED FACTOR USED? **No**

| Minimum Volume Requirement | |
|---|---|
| **300** | **200** |

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 20 | 8 | 5 | 0 | 28 | 5 | NO / NO |
| 1:00 - 2:00 | 14 | 2 | 3 | 0 | 16 | 3 | NO / NO |
| 2:00 - 3:00 | 20 | 11 | 5 | 0 | 31 | 5 | NO / NO |
| 3:00 - 4:00 | 9 | 22 | 1 | 0 | 31 | 1 | NO / NO |
| 4:00 - 5:00 | 25 | 91 | 9 | 0 | 116 | 9 | NO / NO |
| 5:00 - 6:00 | 47 | 158 | 7 | 0 | 205 | 7 | NO / NO |
| 6:00 - 7:00 | 171 | 204 | 50 | 0 | 375 | 50 | YES / NO |
| 7:00 - 8:00 | 396 | 383 | 90 | 0 | 779 | 90 | YES / NO |
| 8:00 - 9:00 | 281 | 304 | 67 | 0 | 585 | 67 | YES / NO |
| 9:00 - 10:00 | 265 | 224 | 74 | 0 | 489 | 74 | YES / NO |
| 10:00 - 11:00 | 383 | 267 | 85 | 0 | 650 | 85 | YES / NO |
| 11:00 - 12:00 | 425 | 279 | 114 | 0 | 704 | 114 | YES / NO |
| 12:00 - 13:00 | 455 | 277 | 121 | 0 | 732 | 121 | YES / NO |
| 13:00 - 14:00 | 464 | 286 | 107 | 0 | 750 | 107 | YES / NO |
| 14:00 - 15:00 | 534 | 416 | 146 | 0 | 950 | 146 | YES / NO |
| 15:00 - 16:00 | 597 | 354 | 156 | 0 | 951 | 156 | YES / NO |
| 16:00 - 17:00 | 666 | 425 | 172 | 0 | 1091 | 172 | YES / NO |
| 17:00 - 18:00 | 571 | 285 | 97 | 0 | 856 | 97 | YES / NO |
| 18:00 - 19:00 | 406 | 229 | 104 | 0 | 635 | 104 | YES / NO |
| 19:00 - 20:00 | 266 | 145 | 48 | 0 | 411 | 48 | YES / NO |
| 20:00 - 21:00 | 187 | 129 | 52 | 0 | 316 | 52 | YES / NO |
| 21:00 - 22:00 | 128 | 85 | 29 | 0 | 213 | 29 | NO / NO |
| 22:00 - 23:00 | 61 | 54 | 14 | 0 | 115 | 14 | NO / NO |
| 23:00 - 24:00 | 46 | 29 | 8 | 0 | 75 | 8 | NO / NO |
| **Daily** | **6437** | **4667** | **1564** | **0** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **0** | **8** |

**All-way Stop Warrant:** **Not satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A3e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2024 Future - CSAH 48 at Cedar Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Cedar Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 6437 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4667 |
| 30 | Minor App2: | Cedar Ave NB | 1 | 272 |
| 30 | Minor App4: | N/A | 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 | 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 | 20 | 8 | 1 | 0 | 28 | 1 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 14 | 2 | 0 | 0 | 16 | 0 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 20 | 11 | 2 | 0 | 31 | 2 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 9 | 22 | 1 | 0 | 31 | 1 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 25 | 91 | 5 | 0 | 116 | 5 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 47 | 158 | 2 | 0 | 205 | 2 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 171 | 204 | 7 | 0 | 375 | 7 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 396 | 383 | 14 | 0 | 779 | 14 | YES / NO | NO / NO | YES / NO |
| 8:00 - 9:00 | 281 | 304 | 8 | 0 | 585 | 8 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 265 | 224 | 16 | 0 | 489 | 16 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 383 | 267 | 17 | 0 | 650 | 17 | YES / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 425 | 279 | 14 | 0 | 704 | 14 | YES / NO | NO / NO | NO / NO |
| 12:00 - 13:00 | 455 | 277 | 21 | 0 | 732 | 21 | YES / NO | NO / NO | YES / NO |
| 13:00 - 14:00 | 464 | 286 | 12 | 0 | 750 | 12 | YES / NO | NO / NO | YES / NO |
| 14:00 - 15:00 | 534 | 416 | 31 | 0 | 950 | 31 | YES / NO | YES / NO | YES / NO |
| 15:00 - 16:00 | 597 | 354 | 18 | 0 | 951 | 18 | YES / NO | YES / NO | YES / NO |
| 16:00 - 17:00 | 666 | 425 | 29 | 0 | 1091 | 29 | YES / NO | YES / NO | YES / NO |
| 17:00 - 18:00 | 571 | 285 | 14 | 0 | 856 | 14 | YES / NO | NO / NO | YES / NO |
| 18:00 - 19:00 | 406 | 229 | 15 | 0 | 635 | 15 | YES / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 266 | 145 | 19 | 0 | 411 | 19 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 187 | 129 | 13 | 0 | 316 | 13 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 128 | 85 | 6 | 0 | 213 | 6 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 61 | 54 | 2 | 0 | 115 | 2 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 46 | 29 | 5 | 0 | 75 | 5 | NO / NO | NO / NO | NO / NO |
| **Daily** | **6437** | **4667** | **272** | **0** | | | | | |

| | | 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:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A3f

# 2024 Future - CSAH 48 at Cedar Ave
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at Cedar Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 6437 |
| 30 | Major App3: | CSAH 48 WB | 2 | 4667 |
| 30 | Minor App2: | Cedar Ave NB | 1 | 272 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

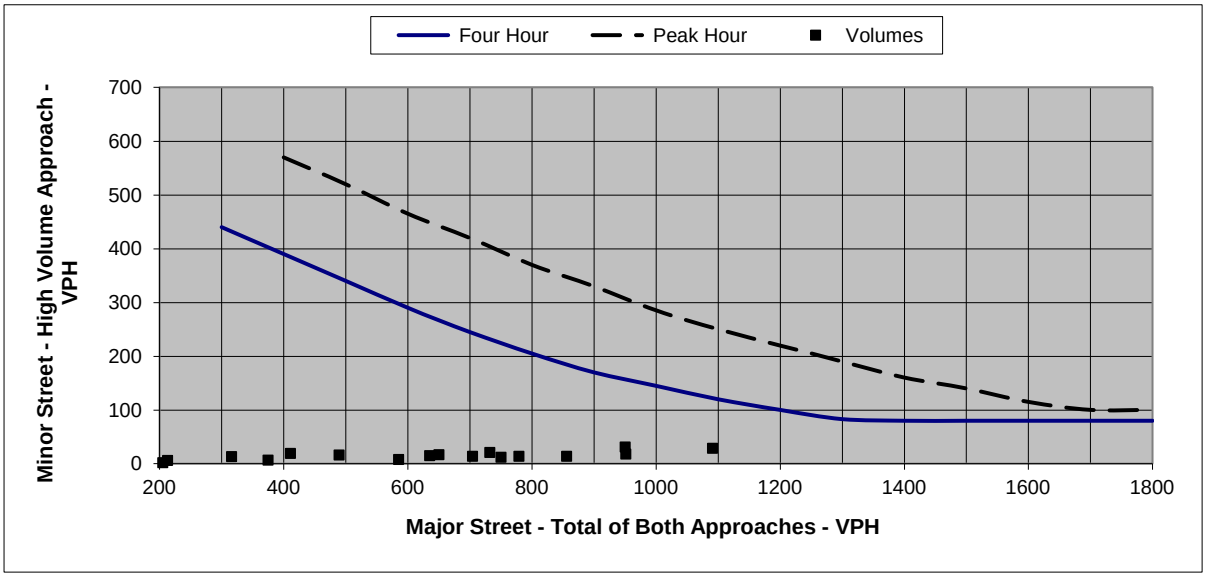



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 28 | 1 | NO | NO |
| 1:00 - 2:00 | 16 | 0 | NO | NO |
| 2:00 - 3:00 | 31 | 2 | NO | NO |
| 3:00 - 4:00 | 31 | 1 | NO | NO |
| 4:00 - 5:00 | 116 | 5 | NO | NO |
| 5:00 - 6:00 | 205 | 2 | NO | NO |
| 6:00 - 7:00 | 375 | 7 | NO | NO |
| 7:00 - 8:00 | 779 | 14 | NO | NO |
| 8:00 - 9:00 | 585 | 8 | NO | NO |
| 9:00 - 10:00 | 489 | 16 | NO | NO |
| 10:00 - 11:00 | 650 | 17 | NO | NO |
| 11:00 - 12:00 | 704 | 14 | NO | NO |
| 12:00 - 13:00 | 732 | 21 | NO | NO |
| 13:00 - 14:00 | 750 | 12 | NO | NO |
| 14:00 - 15:00 | 950 | 31 | NO | NO |
| 15:00 - 16:00 | 951 | 18 | NO | NO |
| 16:00 - 17:00 | 1091 | 29 | NO | NO |
| 17:00 - 18:00 | 856 | 14 | NO | NO |
| 18:00 - 19:00 | 635 | 15 | NO | NO |
| 19:00 - 20:00 | 411 | 19 | NO | NO |
| 20:00 - 21:00 | 316 | 13 | NO | NO |
| 21:00 - 22:00 | 213 | 6 | NO | NO |
| 22:00 - 23:00 | 115 | 2 | NO | NO |
| 23:00 - 24:00 | 75 | 5 | NO | NO |

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A4a

# 2021 Existing - CSAH 48 at E Park Square (Major Left Turn)
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at E Park Square (Major Lef
COUNTY: Steele
REF. POINT: 0
DATE: 6/9/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 WBT+WBR | 2 | 4289 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 EBL | 1 | 1151 |
| 30 | Minor App4: | N/A | 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 | 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 | 7 | 0 | 1 | 0 | 7 | 1 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 2 | 0 | 2 | 0 | 2 | 2 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 9 | 0 | 2 | 0 | 9 | 2 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 19 | 0 | 0 | 0 | 19 | 0 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 74 | 0 | 5 | 0 | 74 | 5 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 131 | 0 | 12 | 0 | 131 | 12 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 184 | 0 | 32 | 0 | 184 | 32 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 332 | 0 | 68 | 0 | 332 | 68 | NO / NO | NO / NO | NO / NO |
| 8:00 - 9:00 | 268 | 0 | 53 | 0 | 268 | 53 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 207 | 0 | 66 | 0 | 207 | 66 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 253 | 0 | 94 | 0 | 253 | 94 | NO / NO | NO / YES | NO / NO |
| 11:00 - 12:00 | 287 | 0 | 97 | 0 | 287 | 97 | NO / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 284 | 0 | 121 | 0 | 284 | 121 | NO / NO | NO / YES | NO / YES |
| 13:00 - 14:00 | 282 | 0 | 96 | 0 | 282 | 96 | NO / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 379 | 0 | 89 | 0 | 379 | 89 | NO / NO | NO / YES | NO / NO |
| 15:00 - 16:00 | 324 | 0 | 96 | 0 | 324 | 96 | NO / NO | NO / YES | NO / NO |
| 16:00 - 17:00 | 392 | 0 | 101 | 0 | 392 | 101 | NO / NO | NO / YES | NO / NO |
| 17:00 - 18:00 | 257 | 0 | 77 | 0 | 257 | 77 | NO / NO | NO / YES | NO / NO |
| 18:00 - 19:00 | 215 | 0 | 65 | 0 | 215 | 65 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 129 | 0 | 28 | 0 | 129 | 28 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 114 | 0 | 21 | 0 | 114 | 21 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 70 | 0 | 14 | 0 | 70 | 14 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 47 | 0 | 10 | 0 | 47 | 10 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 23 | 0 | 1 | 0 | 23 | 1 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4289** | **0** | **1151** | **0** | | | | | |

| | | 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:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A4b

## 2021 Existing - CSAH 48 at E Park Square (Major Left Turn)
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at E Park Square (Major Left Turn)
COUNTY: Steele
REF. POINT: 0
DATE: 6/9/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 WBT+WBR | 2 | 4289 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 EBL | 1 | 1151 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

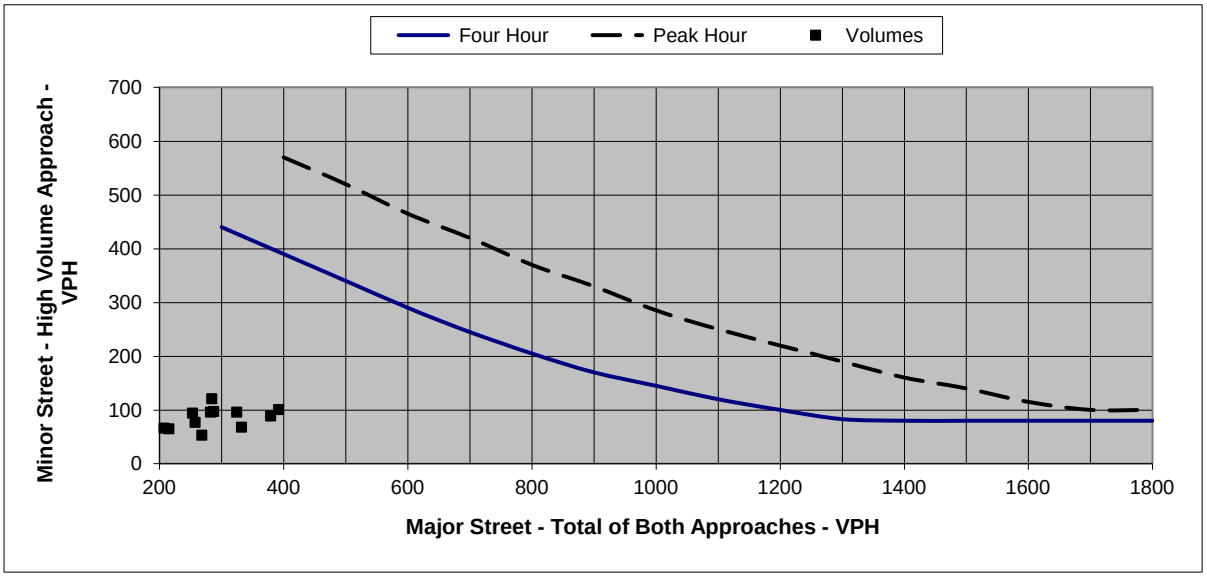



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 7 | 1 | NO | NO |
| 1:00 - 2:00 | 2 | 2 | NO | NO |
| 2:00 - 3:00 | 9 | 2 | NO | NO |
| 3:00 - 4:00 | 19 | 0 | NO | NO |
| 4:00 - 5:00 | 74 | 5 | NO | NO |
| 5:00 - 6:00 | 131 | 12 | NO | NO |
| 6:00 - 7:00 | 184 | 32 | NO | NO |
| 7:00 - 8:00 | 332 | 68 | NO | NO |
| 8:00 - 9:00 | 268 | 53 | NO | NO |
| 9:00 - 10:00 | 207 | 66 | NO | NO |
| 10:00 - 11:00 | 253 | 94 | NO | NO |
| 11:00 - 12:00 | 287 | 97 | NO | NO |
| 12:00 - 13:00 | 284 | 121 | NO | NO |
| 13:00 - 14:00 | 282 | 96 | NO | NO |
| 14:00 - 15:00 | 379 | 89 | NO | NO |
| 15:00 - 16:00 | 324 | 96 | NO | NO |
| 16:00 - 17:00 | 392 | 101 | NO | NO |
| 17:00 - 18:00 | 257 | 77 | NO | NO |
| 18:00 - 19:00 | 215 | 65 | NO | NO |
| 19:00 - 20:00 | 129 | 28 | NO | NO |
| 20:00 - 21:00 | 114 | 21 | NO | NO |
| 21:00 - 22:00 | 70 | 14 | NO | NO |
| 22:00 - 23:00 | 47 | 10 | NO | NO |
| 23:00 - 24:00 | 23 | 1 | NO | NO |

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A4c

# 2045 Future - CSAH 48 at E Park Square (Major Left Turn)
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at E Park Square (Major Lef
COUNTY: Steele
REF. POINT: 0
DATE: 6/9/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 WBT+WBR | 2 | 5321 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 EBL | 1 | 1423 |
| 30 | Minor App4: | N/A | 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 | 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 | 8 | 0 | 1 | 0 | 8 | 1 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 2 | 0 | 2 | 0 | 2 | 2 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 11 | 0 | 2 | 0 | 11 | 2 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 24 | 0 | 0 | 0 | 24 | 0 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 92 | 0 | 5 | 0 | 92 | 5 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 163 | 0 | 14 | 0 | 163 | 14 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 229 | 0 | 39 | 0 | 229 | 39 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 412 | 0 | 84 | 0 | 412 | 84 | NO / NO | NO / YES | NO / NO |
| 8:00 - 9:00 | 333 | 0 | 65 | 0 | 333 | 65 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 256 | 0 | 82 | 0 | 256 | 82 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 314 | 0 | 116 | 0 | 314 | 116 | NO / NO | NO / YES | NO / NO |
| 11:00 - 12:00 | 356 | 0 | 121 | 0 | 356 | 121 | NO / NO | NO / YES | NO / YES |
| 12:00 - 13:00 | 352 | 0 | 150 | 0 | 352 | 150 | NO / YES | NO / YES | NO / YES |
| 13:00 - 14:00 | 350 | 0 | 120 | 0 | 350 | 120 | NO / NO | NO / YES | NO / YES |
| 14:00 - 15:00 | 470 | 0 | 110 | 0 | 470 | 110 | NO / NO | NO / YES | NO / NO |
| 15:00 - 16:00 | 401 | 0 | 120 | 0 | 401 | 120 | NO / NO | NO / YES | NO / YES |
| 16:00 - 17:00 | 487 | 0 | 126 | 0 | 487 | 126 | NO / NO | NO / YES | NO / YES |
| 17:00 - 18:00 | 319 | 0 | 95 | 0 | 319 | 95 | NO / NO | NO / YES | NO / NO |
| 18:00 - 19:00 | 266 | 0 | 81 | 0 | 266 | 81 | NO / NO | NO / YES | NO / NO |
| 19:00 - 20:00 | 160 | 0 | 35 | 0 | 160 | 35 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 142 | 0 | 26 | 0 | 142 | 26 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 87 | 0 | 17 | 0 | 87 | 17 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 58 | 0 | 11 | 0 | 58 | 11 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 29 | 0 | 1 | 0 | 29 | 1 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5321** | **0** | **1423** | **0** | | | | | |

| | | 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** | 1 | 8 | Not satisfied |

COMMENTS:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A4d

# 2045 Future - CSAH 48 at E Park Square (Major Left Turn)
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at E Park Square (Major Left Turn)
COUNTY: Steele
REF. POINT: 0
DATE: 6/9/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 WBT+WBR | 2 | 5321 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 EBL | 1 | 1423 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

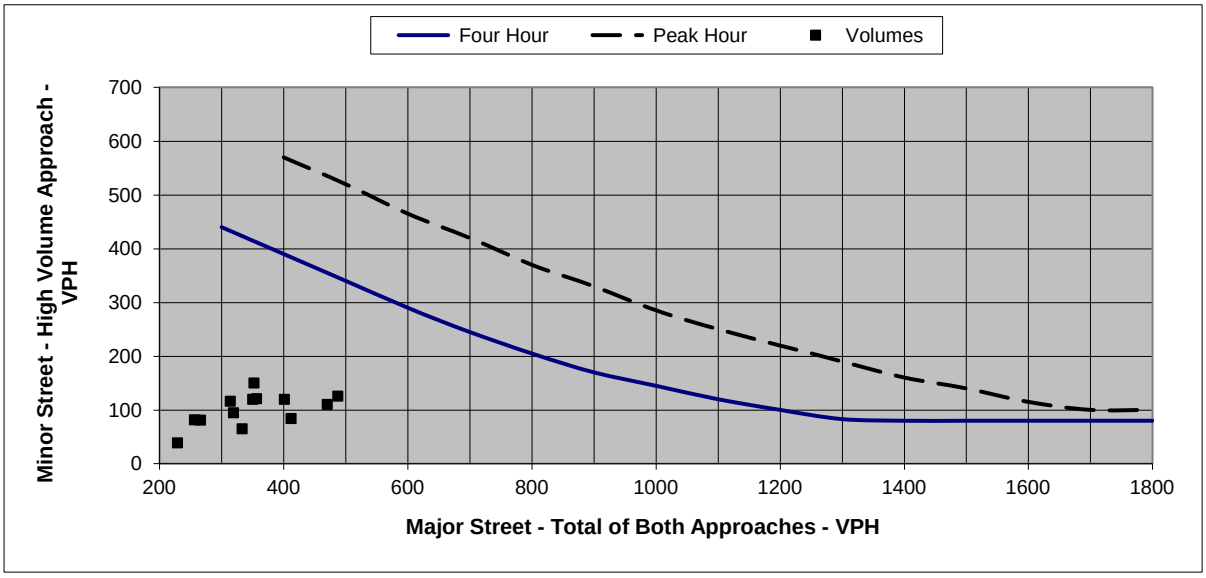



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 8 | 1 | NO | NO |
| 1:00 - 2:00 | 2 | 2 | NO | NO |
| 2:00 - 3:00 | 11 | 2 | NO | NO |
| 3:00 - 4:00 | 24 | 0 | NO | NO |
| 4:00 - 5:00 | 92 | 5 | NO | NO |
| 5:00 - 6:00 | 163 | 14 | NO | NO |
| 6:00 - 7:00 | 229 | 39 | NO | NO |
| 7:00 - 8:00 | 412 | 84 | NO | NO |
| 8:00 - 9:00 | 333 | 65 | NO | NO |
| 9:00 - 10:00 | 256 | 82 | NO | NO |
| 10:00 - 11:00 | 314 | 116 | NO | NO |
| 11:00 - 12:00 | 356 | 121 | NO | NO |
| 12:00 - 13:00 | 352 | 150 | NO | NO |
| 13:00 - 14:00 | 350 | 120 | NO | NO |
| 14:00 - 15:00 | 470 | 110 | NO | NO |
| 15:00 - 16:00 | 401 | 120 | NO | NO |
| 16:00 - 17:00 | 487 | 126 | NO | NO |
| 17:00 - 18:00 | 319 | 95 | NO | NO |
| 18:00 - 19:00 | 266 | 81 | NO | NO |
| 19:00 - 20:00 | 160 | 35 | NO | NO |
| 20:00 - 21:00 | 142 | 26 | NO | NO |
| 21:00 - 22:00 | 87 | 17 | NO | NO |
| 22:00 - 23:00 | 58 | 11 | NO | NO |
| 23:00 - 24:00 | 29 | 1 | NO | NO |

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A5a

# 2021 Existing - CSAH 48 at Court Ave (Major Left Turn)
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at Court Ave (Major Left Tur
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EBT+EBR | 2 | 4475 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 WBL | 1 | 25 |
| 30 | Minor App4: | N/A | 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 | 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 | 17 | 0 | 0 | 0 | 17 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 0 | 0 | 0 | 13 | 0 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 18 | 0 | 0 | 0 | 18 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 0 | 0 | 0 | 6 | 0 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 18 | 0 | 1 | 0 | 18 | 1 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 28 | 0 | 0 | 0 | 28 | 0 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 120 | 0 | 3 | 0 | 120 | 3 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 257 | 0 | 2 | 0 | 257 | 2 | NO / NO | NO / NO | NO / NO |
| 8:00 - 9:00 | 188 | 0 | 2 | 0 | 188 | 2 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 169 | 0 | 3 | 0 | 169 | 3 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 225 | 0 | 1 | 0 | 225 | 1 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 296 | 0 | 2 | 0 | 296 | 2 | NO / NO | NO / NO | NO / NO |
| 12:00 - 13:00 | 268 | 0 | 3 | 0 | 268 | 3 | NO / NO | NO / NO | NO / NO |
| 13:00 - 14:00 | 312 | 0 | 1 | 0 | 312 | 1 | NO / NO | NO / NO | NO / NO |
| 14:00 - 15:00 | 376 | 0 | 0 | 0 | 376 | 0 | NO / NO | NO / NO | NO / NO |
| 15:00 - 16:00 | 437 | 0 | 2 | 0 | 437 | 2 | NO / NO | NO / NO | NO / NO |
| 16:00 - 17:00 | 497 | 0 | 3 | 0 | 497 | 3 | NO / NO | NO / NO | NO / NO |
| 17:00 - 18:00 | 411 | 0 | 2 | 0 | 411 | 2 | NO / NO | NO / NO | NO / NO |
| 18:00 - 19:00 | 287 | 0 | 0 | 0 | 287 | 0 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 191 | 0 | 0 | 0 | 191 | 0 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 154 | 0 | 0 | 0 | 154 | 0 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 103 | 0 | 0 | 0 | 103 | 0 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 46 | 0 | 0 | 0 | 46 | 0 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 38 | 0 | 0 | 0 | 38 | 0 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4475** | **0** | **25** | **0** | | | | | |

| | | 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:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A5b

## 2021 Existing - CSAH 48 at Court Ave (Major Left Turn)
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Court Ave (Major Left Turn)
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EBT+EBR | 2 | 4475 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 WBL | 1 | 25 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

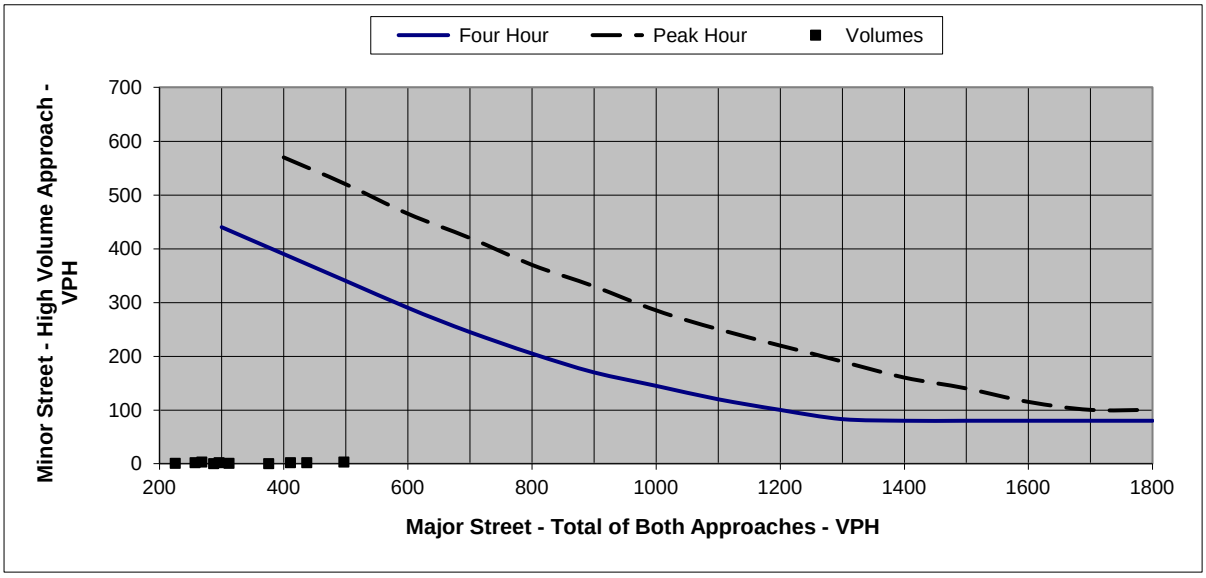



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 17 | 0 | NO | NO |
| 1:00 - 2:00 | 13 | 0 | NO | NO |
| 2:00 - 3:00 | 18 | 0 | NO | NO |
| 3:00 - 4:00 | 6 | 0 | NO | NO |
| 4:00 - 5:00 | 18 | 1 | NO | NO |
| 5:00 - 6:00 | 28 | 0 | NO | NO |
| 6:00 - 7:00 | 120 | 3 | NO | NO |
| 7:00 - 8:00 | 257 | 2 | NO | NO |
| 8:00 - 9:00 | 188 | 2 | NO | NO |
| 9:00 - 10:00 | 169 | 3 | NO | NO |
| 10:00 - 11:00 | 225 | 1 | NO | NO |
| 11:00 - 12:00 | 296 | 2 | NO | NO |
| 12:00 - 13:00 | 268 | 3 | NO | NO |
| 13:00 - 14:00 | 312 | 1 | NO | NO |
| 14:00 - 15:00 | 376 | 0 | NO | NO |
| 15:00 - 16:00 | 437 | 2 | NO | NO |
| 16:00 - 17:00 | 497 | 3 | NO | NO |
| 17:00 - 18:00 | 411 | 2 | NO | NO |
| 18:00 - 19:00 | 287 | 0 | NO | NO |
| 19:00 - 20:00 | 191 | 0 | NO | NO |
| 20:00 - 21:00 | 154 | 0 | NO | NO |
| 21:00 - 22:00 | 103 | 0 | NO | NO |
| 22:00 - 23:00 | 46 | 0 | NO | NO |
| 23:00 - 24:00 | 38 | 0 | NO | NO |

Exhibit A5c

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Court Ave (Major Left Turn)
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Court Ave (Major Left Tur
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EBT+EBR | 2 | 5552 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 WBL | 1 | 25 |
| 30 | Minor App4: | N/A | 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 | 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 | 21 | 0 | 0 | 0 | 21 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 16 | 0 | 0 | 0 | 16 | 0 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 21 | 0 | 0 | 0 | 21 | 0 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 8 | 0 | 0 | 0 | 8 | 0 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 22 | 0 | 1 | 0 | 22 | 1 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 35 | 0 | 0 | 0 | 35 | 0 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 149 | 0 | 3 | 0 | 149 | 3 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 319 | 0 | 2 | 0 | 319 | 2 | NO / NO | NO / NO | NO / NO |
| 8:00 - 9:00 | 234 | 0 | 2 | 0 | 234 | 2 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 210 | 0 | 3 | 0 | 210 | 3 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 279 | 0 | 1 | 0 | 279 | 1 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 367 | 0 | 2 | 0 | 367 | 2 | NO / NO | NO / NO | NO / NO |
| 12:00 - 13:00 | 332 | 0 | 3 | 0 | 332 | 3 | NO / NO | NO / NO | NO / NO |
| 13:00 - 14:00 | 388 | 0 | 1 | 0 | 388 | 1 | NO / NO | NO / NO | NO / NO |
| 14:00 - 15:00 | 467 | 0 | 0 | 0 | 467 | 0 | NO / NO | NO / NO | NO / NO |
| 15:00 - 16:00 | 542 | 0 | 2 | 0 | 542 | 2 | NO / NO | NO / NO | NO / NO |
| 16:00 - 17:00 | 616 | 0 | 3 | 0 | 616 | 3 | YES / NO | NO / NO | NO / NO |
| 17:00 - 18:00 | 510 | 0 | 2 | 0 | 510 | 2 | NO / NO | NO / NO | NO / NO |
| 18:00 - 19:00 | 356 | 0 | 0 | 0 | 356 | 0 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 238 | 0 | 0 | 0 | 238 | 0 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 191 | 0 | 0 | 0 | 191 | 0 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 127 | 0 | 0 | 0 | 127 | 0 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 57 | 0 | 0 | 0 | 57 | 0 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 47 | 0 | 0 | 0 | 47 | 0 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5552** | **0** | **25** | **0** | | | | | |

| | | 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:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A5d

## 2045 Future - CSAH 48 at Court Ave (Major Left Turn)
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Court Ave (Major Left Turn)
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EBT+EBR | 2 | 5552 |
| 30 | Major App3: | N/A | 0 | 0 |
| 30 | Minor App2: | CSAH 48 WBL | 1 | 25 |
| 30 | Minor App4: | N/A | 0 | 0 |

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

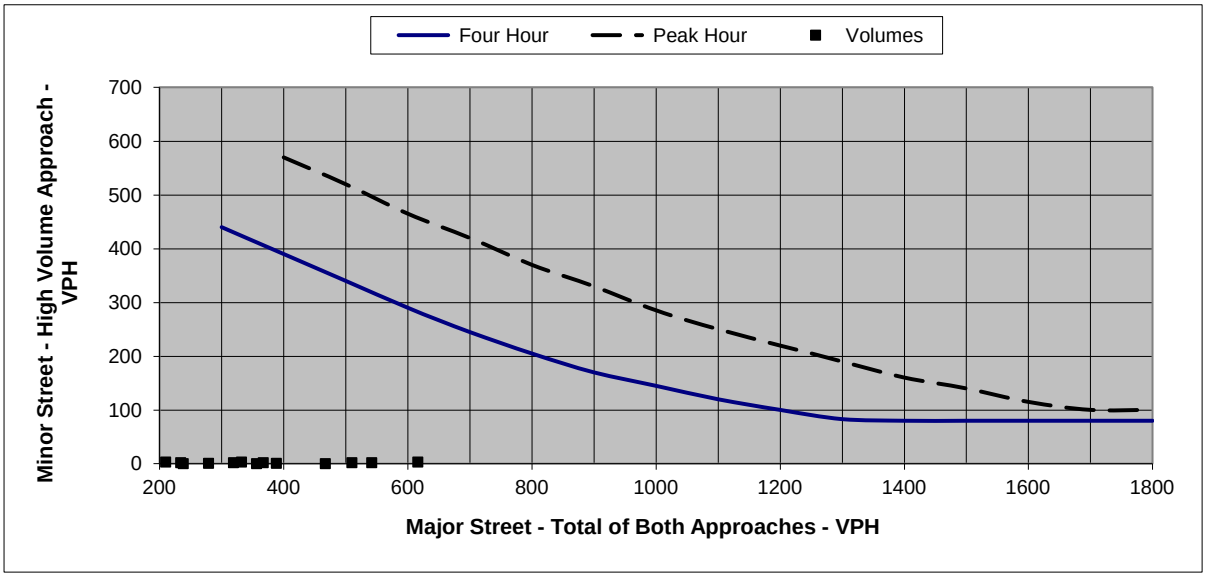



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 21 | 0 | NO | NO |
| 1:00 - 2:00 | 16 | 0 | NO | NO |
| 2:00 - 3:00 | 21 | 0 | NO | NO |
| 3:00 - 4:00 | 8 | 0 | NO | NO |
| 4:00 - 5:00 | 22 | 1 | NO | NO |
| 5:00 - 6:00 | 35 | 0 | NO | NO |
| 6:00 - 7:00 | 149 | 3 | NO | NO |
| 7:00 - 8:00 | 319 | 2 | NO | NO |
| 8:00 - 9:00 | 234 | 2 | NO | NO |
| 9:00 - 10:00 | 210 | 3 | NO | NO |
| 10:00 - 11:00 | 279 | 1 | NO | NO |
| 11:00 - 12:00 | 367 | 2 | NO | NO |
| 12:00 - 13:00 | 332 | 3 | NO | NO |
| 13:00 - 14:00 | 388 | 1 | NO | NO |
| 14:00 - 15:00 | 467 | 0 | NO | NO |
| 15:00 - 16:00 | 542 | 2 | NO | NO |
| 16:00 - 17:00 | 616 | 3 | NO | NO |
| 17:00 - 18:00 | 510 | 2 | NO | NO |
| 18:00 - 19:00 | 356 | 0 | NO | NO |
| 19:00 - 20:00 | 238 | 0 | NO | NO |
| 20:00 - 21:00 | 191 | 0 | NO | NO |
| 21:00 - 22:00 | 127 | 0 | NO | NO |
| 22:00 - 23:00 | 57 | 0 | NO | NO |
| 23:00 - 24:00 | 47 | 0 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A6a

## 2021 Existing - CSAH 48 at Elm Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 4431 |
| 30 | Major App3: | CSAH 48 WB | 3 | 3887 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1837 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1896 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 17 | 7 | 2 | 5 | 24 | 7 | NO / NO |
| 1:00 - 2:00 | 13 | 2 | 0 | 4 | 15 | 4 | NO / NO |
| 2:00 - 3:00 | 18 | 8 | 3 | 0 | 26 | 3 | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 4 | 7 | 24 | 11 | NO / NO |
| 4:00 - 5:00 | 18 | 72 | 12 | 9 | 90 | 21 | NO / NO |
| 5:00 - 6:00 | 27 | 124 | 23 | 20 | 151 | 43 | NO / NO |
| 6:00 - 7:00 | 112 | 201 | 39 | 62 | 313 | 101 | YES / NO |
| 7:00 - 8:00 | 254 | 317 | 158 | 150 | 571 | 308 | **YES / YES** |
| 8:00 - 9:00 | 187 | 245 | 130 | 135 | 432 | 265 | **YES / YES** |
| 9:00 - 10:00 | 164 | 166 | 80 | 127 | 330 | 207 | **YES / YES** |
| 10:00 - 11:00 | 223 | 245 | 87 | 119 | 468 | 206 | **YES / YES** |
| 11:00 - 12:00 | 294 | 263 | 135 | 118 | 557 | 253 | **YES / YES** |
| 12:00 - 13:00 | 264 | 254 | 115 | 152 | 518 | 267 | **YES / YES** |
| 13:00 - 14:00 | 308 | 246 | 102 | 123 | 554 | 225 | **YES / YES** |
| 14:00 - 15:00 | 374 | 329 | 181 | 177 | 703 | 358 | **YES / YES** |
| 15:00 - 16:00 | 434 | 282 | 154 | 169 | 716 | 323 | **YES / YES** |
| 16:00 - 17:00 | 495 | 342 | 201 | 164 | 837 | 365 | **YES / YES** |
| 17:00 - 18:00 | 405 | 239 | 108 | 143 | 644 | 251 | **YES / YES** |
| 18:00 - 19:00 | 287 | 187 | 103 | 80 | 474 | 183 | YES / NO |
| 19:00 - 20:00 | 190 | 115 | 80 | 48 | 305 | 128 | YES / NO |
| 20:00 - 21:00 | 154 | 93 | 61 | 39 | 247 | 100 | NO / NO |
| 21:00 - 22:00 | 103 | 61 | 41 | 24 | 164 | 65 | NO / NO |
| 22:00 - 23:00 | 46 | 46 | 11 | 14 | 92 | 25 | NO / NO |
| 23:00 - 24:00 | 38 | 25 | 7 | 7 | 63 | 14 | NO / NO |
| **Daily** | **4431** | **3887** | **1837** | **1896** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **11** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A6b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Elm Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 4431 |
| 30 | Major App3: | CSAH 48 WB | 3 | 3887 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1473 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1312 |

| | |
|---|---|
| 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 | 17 | 7 | 2 | 5 | 24 | 5 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 2 | 0 | 3 | 15 | 3 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 18 | 8 | 3 | 0 | 26 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 3 | 6 | 24 | 6 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 18 | 72 | 10 | 4 | 90 | 10 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 27 | 124 | 20 | 10 | 151 | 20 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 112 | 201 | 37 | 46 | 313 | 46 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 254 | 317 | 117 | 108 | 571 | 117 | NO / NO | NO / YES | NO / NO |
| 8:00 - 9:00 | 187 | 245 | 115 | 109 | 432 | 115 | NO / NO | NO / YES | NO / NO |
| 9:00 - 10:00 | 164 | 166 | 77 | 75 | 330 | 77 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 223 | 245 | 78 | 77 | 468 | 78 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 294 | 263 | 114 | 76 | 557 | 114 | NO / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 264 | 254 | 98 | 97 | 518 | 98 | NO / NO | NO / NO | NO / NO |
| 13:00 - 14:00 | 308 | 246 | 96 | 72 | 554 | 96 | NO / NO | NO / NO | NO / NO |
| 14:00 - 15:00 | 374 | 329 | 150 | 131 | 703 | 150 | YES / NO | NO / YES | NO / NO |
| 15:00 - 16:00 | 434 | 282 | 129 | 124 | 716 | 129 | YES / NO | NO / YES | NO / NO |
| 16:00 - 17:00 | 495 | 342 | 142 | 107 | 837 | 142 | YES / NO | NO / YES | YES / NO |
| 17:00 - 18:00 | 405 | 239 | 76 | 111 | 644 | 111 | YES / NO | NO / YES | NO / NO |
| 18:00 - 19:00 | 287 | 187 | 71 | 56 | 474 | 71 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 190 | 115 | 56 | 42 | 305 | 56 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 154 | 93 | 43 | 19 | 247 | 43 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 103 | 61 | 26 | 18 | 164 | 26 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 46 | 46 | 6 | 10 | 92 | 10 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 38 | 25 | 4 | 6 | 63 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4431** | **3887** | **1473** | **1312** | | | | | |

| | | 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** | 1 | 8 | Not satisfied |

COMMENTS:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A6c

# 2021 Existing - CSAH 48 at Elm Ave
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 4431 |
| 30 | Major App3: | CSAH 48 WB | 3 | 3887 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1473 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1312 |

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

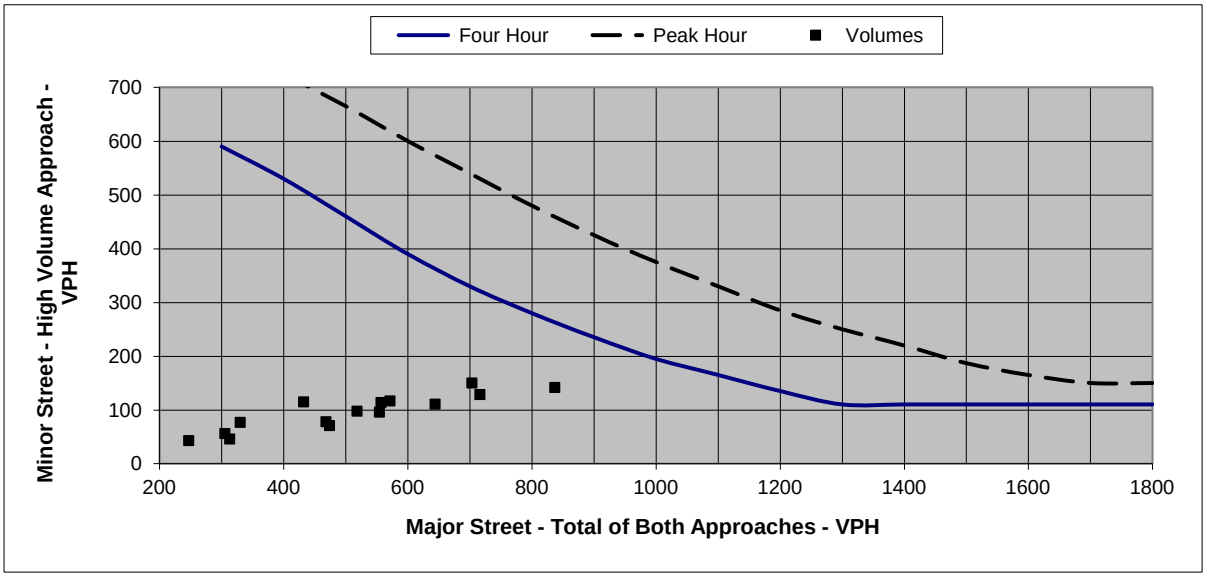



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | Warrant 3 |
| HOUR | Sum Major App. | Max Minor App. | Four Hour | Peak Hour |
| 0:00 - 1:00 | 24 | 5 | NO | NO |
| 1:00 - 2:00 | 15 | 3 | NO | NO |
| 2:00 - 3:00 | 26 | 3 | NO | NO |
| 3:00 - 4:00 | 24 | 6 | NO | NO |
| 4:00 - 5:00 | 90 | 10 | NO | NO |
| 5:00 - 6:00 | 151 | 20 | NO | NO |
| 6:00 - 7:00 | 313 | 46 | NO | NO |
| 7:00 - 8:00 | 571 | 117 | NO | NO |
| 8:00 - 9:00 | 432 | 115 | NO | NO |
| 9:00 - 10:00 | 330 | 77 | NO | NO |
| 10:00 - 11:00 | 468 | 78 | NO | NO |
| 11:00 - 12:00 | 557 | 114 | NO | NO |
| 12:00 - 13:00 | 518 | 98 | NO | NO |
| 13:00 - 14:00 | 554 | 96 | NO | NO |
| 14:00 - 15:00 | 703 | 150 | NO | NO |
| 15:00 - 16:00 | 716 | 129 | NO | NO |
| 16:00 - 17:00 | 837 | 142 | NO | NO |
| 17:00 - 18:00 | 644 | 111 | NO | NO |
| 18:00 - 19:00 | 474 | 71 | NO | NO |
| 19:00 - 20:00 | 305 | 56 | NO | NO |
| 20:00 - 21:00 | 247 | 43 | NO | NO |
| 21:00 - 22:00 | 164 | 26 | NO | NO |
| 22:00 - 23:00 | 92 | 10 | NO | NO |
| 23:00 - 24:00 | 63 | 6 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A6d

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Elm Ave
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 4431 |
| 30 | Major App3: | CSAH 48 WB | 3 | 3887 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1473 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1312 |

| | |
|---|---|
| 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 | 17 | 7 | 2 | 5 | 24 | 5 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 2 | 0 | 3 | 15 | 3 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 18 | 8 | 3 | 0 | 26 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 3 | 6 | 24 | 6 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 18 | 72 | 10 | 4 | 90 | 10 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 27 | 124 | 20 | 10 | 151 | 20 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 112 | 201 | 37 | 46 | 313 | 46 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 254 | 317 | 117 | 108 | 571 | 117 | YES / NO | NO / YES | NO / NO |
| 8:00 - 9:00 | 187 | 245 | 115 | 109 | 432 | 115 | NO / NO | NO / YES | NO / NO |
| 9:00 - 10:00 | 164 | 166 | 77 | 75 | 330 | 77 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 223 | 245 | 78 | 77 | 468 | 78 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 294 | 263 | 114 | 76 | 557 | 114 | YES / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 264 | 254 | 98 | 97 | 518 | 98 | YES / NO | NO / YES | NO / NO |
| 13:00 - 14:00 | 308 | 246 | 96 | 72 | 554 | 96 | YES / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 374 | 329 | 150 | 131 | 703 | 150 | YES / NO | NO / YES | **YES / YES** |
| 15:00 - 16:00 | 434 | 282 | 129 | 124 | 716 | 129 | YES / NO | NO / YES | **YES / YES** |
| 16:00 - 17:00 | 495 | 342 | 142 | 107 | 837 | 142 | YES / NO | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 405 | 239 | 76 | 111 | 644 | 111 | YES / NO | NO / YES | YES / NO |
| 18:00 - 19:00 | 287 | 187 | 71 | 56 | 474 | 71 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 190 | 115 | 56 | 42 | 305 | 56 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 154 | 93 | 43 | 19 | 247 | 43 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 103 | 61 | 26 | 18 | 164 | 26 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 46 | 46 | 6 | 10 | 92 | 10 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 38 | 25 | 4 | 6 | 63 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4431** | **3887** | **1473** | **1312** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 3 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 0 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 1 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 3 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A6e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Elm Ave
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 4431 |
| 30 | Major App3: | CSAH 48 WB | 3 | 3887 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1473 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1312 |

| | |
|---|---|
| 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 | 17 | 7 | 2 | 5 | 24 | 5 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 2 | 0 | 3 | 15 | 3 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 18 | 8 | 3 | 0 | 26 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 18 | 3 | 6 | 24 | 6 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 18 | 72 | 10 | 4 | 90 | 10 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 27 | 124 | 20 | 10 | 151 | 20 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 112 | 201 | 37 | 46 | 313 | 46 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 254 | 317 | 117 | 108 | 571 | 117 | YES / NO | **YES / YES** | **YES / YES** |
| 8:00 - 9:00 | 187 | 245 | 115 | 109 | 432 | 115 | YES / NO | NO / YES | **YES / YES** |
| 9:00 - 10:00 | 164 | 166 | 77 | 75 | 330 | 77 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 223 | 245 | 78 | 77 | 468 | 78 | YES / NO | NO / YES | YES / NO |
| 11:00 - 12:00 | 294 | 263 | 114 | 76 | 557 | 114 | YES / NO | **YES / YES** | **YES / YES** |
| 12:00 - 13:00 | 264 | 254 | 98 | 97 | 518 | 98 | YES / NO | NO / YES | **YES / YES** |
| 13:00 - 14:00 | 308 | 246 | 96 | 72 | 554 | 96 | YES / NO | **YES / YES** | **YES / YES** |
| 14:00 - 15:00 | 374 | 329 | 150 | 131 | 703 | 150 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 434 | 282 | 129 | 124 | 716 | 129 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 495 | 342 | 142 | 107 | 837 | 142 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 405 | 239 | 76 | 111 | 644 | 111 | YES / NO | **YES / YES** | **YES / YES** |
| 18:00 - 19:00 | 287 | 187 | 71 | 56 | 474 | 71 | YES / NO | NO / YES | YES / NO |
| 19:00 - 20:00 | 190 | 115 | 56 | 42 | 305 | 56 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 154 | 93 | 43 | 19 | 247 | 43 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 103 | 61 | 26 | 18 | 164 | 26 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 46 | 46 | 6 | 10 | 92 | 10 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 38 | 25 | 4 | 6 | 63 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4431** | **3887** | **1473** | **1312** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | **9** | 8 | **Satisfied** |
| Warrant 1A | Minimum Vehicular Volume | 3 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 7 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | **9** | 8 | **Satisfied** |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A6f

## 2045 Future - CSAH 48 at Elm Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 5496 |
| 30 | Major App3: | CSAH 48 WB | 3 | 4818 |
| 30 | Minor App2: | Elm Ave NB | 2 | 2273 |
| 30 | Minor App4: | Elm Ave SB | 2 | 2349 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 21 | 8 | 2 | 5 | 29 | 7 | NO / NO |
| 1:00 - 2:00 | 16 | 2 | 0 | 4 | 18 | 4 | NO / NO |
| 2:00 - 3:00 | 21 | 10 | 3 | 0 | 31 | 3 | NO / NO |
| 3:00 - 4:00 | 8 | 22 | 4 | 8 | 30 | 12 | NO / NO |
| 4:00 - 5:00 | 22 | 89 | 16 | 10 | 111 | 26 | NO / NO |
| 5:00 - 6:00 | 34 | 155 | 28 | 24 | 189 | 52 | NO / NO |
| 6:00 - 7:00 | 139 | 249 | 48 | 77 | 388 | 125 | YES / NO |
| 7:00 - 8:00 | 314 | 393 | 196 | 187 | 707 | 383 | **YES / YES** |
| 8:00 - 9:00 | 233 | 304 | 160 | 167 | 537 | 327 | **YES / YES** |
| 9:00 - 10:00 | 204 | 205 | 99 | 158 | 409 | 257 | **YES / YES** |
| 10:00 - 11:00 | 276 | 304 | 109 | 147 | 580 | 256 | **YES / YES** |
| 11:00 - 12:00 | 365 | 327 | 167 | 147 | 692 | 314 | **YES / YES** |
| 12:00 - 13:00 | 328 | 315 | 142 | 189 | 643 | 331 | **YES / YES** |
| 13:00 - 14:00 | 381 | 305 | 125 | 153 | 686 | 278 | **YES / YES** |
| 14:00 - 15:00 | 465 | 408 | 225 | 220 | 873 | 445 | **YES / YES** |
| 15:00 - 16:00 | 538 | 349 | 192 | 209 | 887 | 401 | **YES / YES** |
| 16:00 - 17:00 | 614 | 423 | 249 | 204 | 1037 | 453 | **YES / YES** |
| 17:00 - 18:00 | 502 | 297 | 133 | 178 | 799 | 311 | **YES / YES** |
| 18:00 - 19:00 | 356 | 232 | 127 | 99 | 588 | 226 | **YES / YES** |
| 19:00 - 20:00 | 237 | 142 | 100 | 59 | 379 | 159 | YES / NO |
| 20:00 - 21:00 | 191 | 115 | 75 | 49 | 306 | 124 | YES / NO |
| 21:00 - 22:00 | 127 | 76 | 51 | 29 | 203 | 80 | NO / NO |
| 22:00 - 23:00 | 57 | 58 | 14 | 17 | 115 | 31 | NO / NO |
| 23:00 - 24:00 | 47 | 30 | 8 | 9 | 77 | 17 | NO / NO |
| **Daily** | **5496** | **4818** | **2273** | **2349** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **12** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A6g

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Elm Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 5496 |
| 30 | Major App3: | CSAH 48 WB | 3 | 4818 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1820 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1623 |

| | |
|---|---|
| 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 | 21 | 8 | 2 | 5 | 29 | 5 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 16 | 2 | 0 | 3 | 18 | 3 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 21 | 10 | 3 | 0 | 31 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 8 | 22 | 3 | 7 | 30 | 7 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 22 | 89 | 12 | 4 | 111 | 12 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 34 | 155 | 24 | 12 | 189 | 24 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 139 | 249 | 46 | 57 | 388 | 57 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 314 | 393 | 144 | 134 | 707 | 144 | YES / NO | NO / YES | NO / NO |
| 8:00 - 9:00 | 233 | 304 | 143 | 135 | 537 | 143 | NO / NO | NO / YES | NO / NO |
| 9:00 - 10:00 | 204 | 205 | 95 | 93 | 409 | 95 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 276 | 304 | 97 | 96 | 580 | 97 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 365 | 327 | 141 | 94 | 692 | 141 | YES / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 328 | 315 | 121 | 120 | 643 | 121 | YES / NO | NO / YES | NO / NO |
| 13:00 - 14:00 | 381 | 305 | 119 | 90 | 686 | 119 | YES / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 465 | 408 | 185 | 163 | 873 | 185 | YES / NO | NO / YES | **YES / YES** |
| 15:00 - 16:00 | 538 | 349 | 159 | 154 | 887 | 159 | YES / NO | NO / YES | YES / NO |
| 16:00 - 17:00 | 614 | 423 | 176 | 133 | 1037 | 176 | YES / NO | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 502 | 297 | 94 | 138 | 799 | 138 | YES / NO | NO / YES | YES / NO |
| 18:00 - 19:00 | 356 | 232 | 89 | 69 | 588 | 89 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 237 | 142 | 70 | 52 | 379 | 70 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 191 | 115 | 53 | 23 | 306 | 53 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 127 | 76 | 33 | 22 | 203 | 33 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 57 | 58 | 7 | 12 | 115 | 12 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 47 | 30 | 4 | 7 | 77 | 7 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5496** | **4818** | **1820** | **1623** | | | | | |

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

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A6h

## 2045 Future - CSAH 48 at Elm Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

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

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 5496 |
| 30 | Major App3: | CSAH 48 WB | 3 | 4818 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1820 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1623 |

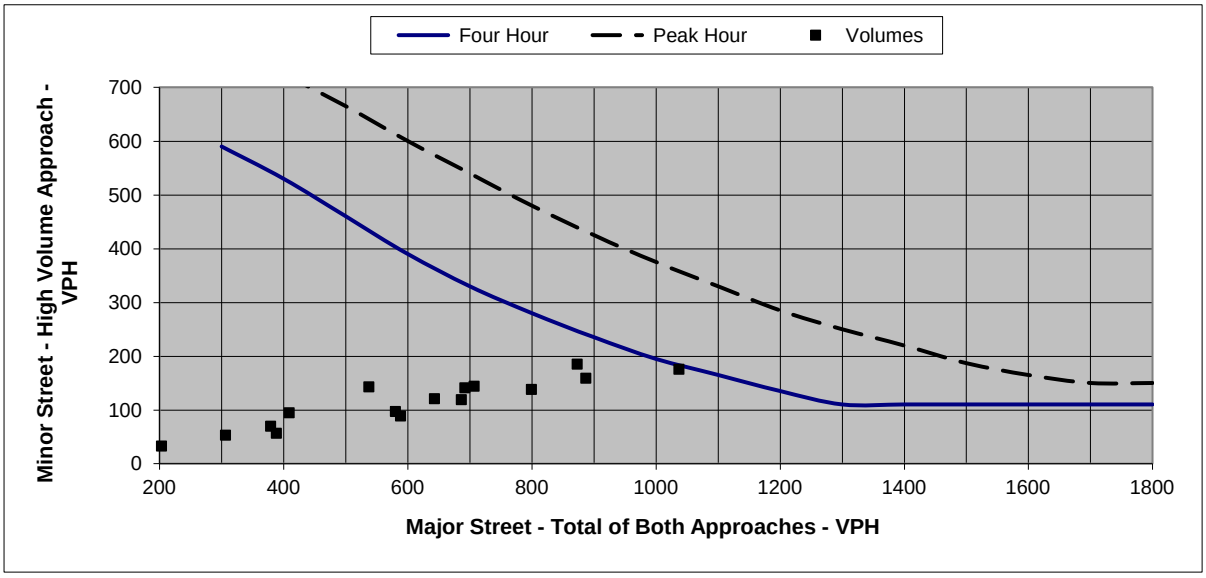



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 29 | 5 | NO | NO |
| 1:00 - 2:00 | 18 | 3 | NO | NO |
| 2:00 - 3:00 | 31 | 3 | NO | NO |
| 3:00 - 4:00 | 30 | 7 | NO | NO |
| 4:00 - 5:00 | 111 | 12 | NO | NO |
| 5:00 - 6:00 | 189 | 24 | NO | NO |
| 6:00 - 7:00 | 388 | 57 | NO | NO |
| 7:00 - 8:00 | 707 | 144 | NO | NO |
| 8:00 - 9:00 | 537 | 143 | NO | NO |
| 9:00 - 10:00 | 409 | 95 | NO | NO |
| 10:00 - 11:00 | 580 | 97 | NO | NO |
| 11:00 - 12:00 | 692 | 141 | NO | NO |
| 12:00 - 13:00 | 643 | 121 | NO | NO |
| 13:00 - 14:00 | 686 | 119 | NO | NO |
| 14:00 - 15:00 | 873 | 185 | NO | NO |
| 15:00 - 16:00 | 887 | 159 | NO | NO |
| 16:00 - 17:00 | 1037 | 176 | NO | NO |
| 17:00 - 18:00 | 799 | 138 | NO | NO |
| 18:00 - 19:00 | 588 | 89 | NO | NO |
| 19:00 - 20:00 | 379 | 70 | NO | NO |
| 20:00 - 21:00 | 306 | 53 | NO | NO |
| 21:00 - 22:00 | 203 | 33 | NO | NO |
| 22:00 - 23:00 | 115 | 12 | NO | NO |
| 23:00 - 24:00 | 77 | 7 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A6i

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Elm Ave
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 5496 |
| 30 | Major App3: | CSAH 48 WB | 3 | 4818 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1820 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1623 |

| | |
|---|---|
| 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 | 21 | 8 | 2 | 5 | 29 | 5 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 16 | 2 | 0 | 3 | 18 | 3 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 21 | 10 | 3 | 0 | 31 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 8 | 22 | 3 | 7 | 30 | 7 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 22 | 89 | 12 | 4 | 111 | 12 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 34 | 155 | 24 | 12 | 189 | 24 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 139 | 249 | 46 | 57 | 388 | 57 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 314 | 393 | 144 | 134 | 707 | 144 | YES / NO | NO / YES | **YES / YES** |
| 8:00 - 9:00 | 233 | 304 | 143 | 135 | 537 | 143 | YES / NO | NO / YES | NO / YES |
| 9:00 - 10:00 | 204 | 205 | 95 | 93 | 409 | 95 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 276 | 304 | 97 | 96 | 580 | 97 | YES / NO | NO / YES | YES / NO |
| 11:00 - 12:00 | 365 | 327 | 141 | 94 | 692 | 141 | YES / NO | NO / YES | **YES / YES** |
| 12:00 - 13:00 | 328 | 315 | 121 | 120 | 643 | 121 | YES / NO | NO / YES | YES / NO |
| 13:00 - 14:00 | 381 | 305 | 119 | 90 | 686 | 119 | YES / NO | NO / YES | YES / NO |
| 14:00 - 15:00 | 465 | 408 | 185 | 163 | 873 | 185 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 538 | 349 | 159 | 154 | 887 | 159 | YES / NO | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 614 | 423 | 176 | 133 | 1037 | 176 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 502 | 297 | 94 | 138 | 799 | 138 | YES / NO | **YES / YES** | **YES / YES** |
| 18:00 - 19:00 | 356 | 232 | 89 | 69 | 588 | 89 | YES / NO | NO / YES | YES / NO |
| 19:00 - 20:00 | 237 | 142 | 70 | 52 | 379 | 70 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 191 | 115 | 53 | 23 | 306 | 53 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 127 | 76 | 33 | 22 | 203 | 33 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 57 | 58 | 7 | 12 | 115 | 12 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 47 | 30 | 4 | 7 | 77 | 7 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5496** | **4818** | **1820** | **1623** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 6 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 2 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 4 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 6 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A6j

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Elm Ave
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at Elm Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 3 | 5496 |
| 30 | Major App3: | CSAH 48 WB | 3 | 4818 |
| 30 | Minor App2: | Elm Ave NB | 2 | 1820 |
| 30 | Minor App4: | Elm Ave SB | 2 | 1623 |

| | |
|---|---|
| 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 | 21 | 8 | 2 | 5 | 29 | 5 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 16 | 2 | 0 | 3 | 18 | 3 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 21 | 10 | 3 | 0 | 31 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 8 | 22 | 3 | 7 | 30 | 7 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 22 | 89 | 12 | 4 | 111 | 12 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 34 | 155 | 24 | 12 | 189 | 24 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 139 | 249 | 46 | 57 | 388 | 57 | YES / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 314 | 393 | 144 | 134 | 707 | 144 | **YES / YES** | **YES / YES** | **YES / YES** |
| 8:00 - 9:00 | 233 | 304 | 143 | 135 | 537 | 143 | **YES / YES** | NO / YES | **YES / YES** |
| 9:00 - 10:00 | 204 | 205 | 95 | 93 | 409 | 95 | YES / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 276 | 304 | 97 | 96 | 580 | 97 | YES / NO | **YES / YES** | **YES / YES** |
| 11:00 - 12:00 | 365 | 327 | 141 | 94 | 692 | 141 | **YES / YES** | **YES / YES** | **YES / YES** |
| 12:00 - 13:00 | 328 | 315 | 121 | 120 | 643 | 121 | **YES / YES** | **YES / YES** | **YES / YES** |
| 13:00 - 14:00 | 381 | 305 | 119 | 90 | 686 | 119 | YES / NO | **YES / YES** | **YES / YES** |
| 14:00 - 15:00 | 465 | 408 | 185 | 163 | 873 | 185 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 538 | 349 | 159 | 154 | 887 | 159 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 614 | 423 | 176 | 133 | 1037 | 176 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 502 | 297 | 94 | 138 | 799 | 138 | **YES / YES** | **YES / YES** | **YES / YES** |
| 18:00 - 19:00 | 356 | 232 | 89 | 69 | 588 | 89 | YES / NO | **YES / YES** | YES / NO |
| 19:00 - 20:00 | 237 | 142 | 70 | 52 | 379 | 70 | YES / NO | NO / YES | NO / NO |
| 20:00 - 21:00 | 191 | 115 | 53 | 23 | 306 | 53 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 127 | 76 | 33 | 22 | 203 | 33 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 57 | 58 | 7 | 12 | 115 | 12 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 47 | 30 | 4 | 7 | 77 | 7 | NO / NO | NO / NO | NO / NO |
| **Daily** | **5496** | **4818** | **1820** | **1623** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | **10** | 8 | **Satisfied** |
| Warrant 1A | Minimum Vehicular Volume | **8** | 8 | **Satisfied** |
| Warrant 1B | Interruption of Continuous Flow | **10** | 8 | **Satisfied** |
| 1A & 1B | Combination of Warrants | **10** | 8 | **Satisfied** |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A7a

## 2021 Existing - CSAH 48 at Grove Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 3711 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3195 |
| 30 | Minor App2: | Grove Ave NB | 1 | 2000 |
| 30 | Minor App4: | Grove Ave SB | 1 | 3258 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 8 | 4 | 6 | 9 | 12 | 15 | NO / NO |
| 1:00 - 2:00 | 10 | 2 | 5 | 8 | 12 | 13 | NO / NO |
| 2:00 - 3:00 | 13 | 4 | 3 | 8 | 17 | 11 | NO / NO |
| 3:00 - 4:00 | 3 | 16 | 0 | 7 | 19 | 7 | NO / NO |
| 4:00 - 5:00 | 11 | 56 | 14 | 16 | 67 | 30 | NO / NO |
| 5:00 - 6:00 | 26 | 121 | 17 | 42 | 147 | 59 | NO / NO |
| 6:00 - 7:00 | 81 | 158 | 40 | 155 | 239 | 195 | NO / NO |
| 7:00 - 8:00 | 231 | 281 | 154 | 359 | 512 | 513 | **YES / YES** |
| 8:00 - 9:00 | 161 | 204 | 120 | 208 | 365 | 328 | **YES / YES** |
| 9:00 - 10:00 | 108 | 144 | 89 | 129 | 252 | 218 | NO / YES |
| 10:00 - 11:00 | 173 | 233 | 69 | 156 | 406 | 225 | **YES / YES** |
| 11:00 - 12:00 | 236 | 232 | 109 | 169 | 468 | 278 | **YES / YES** |
| 12:00 - 13:00 | 205 | 203 | 102 | 172 | 408 | 274 | **YES / YES** |
| 13:00 - 14:00 | 219 | 208 | 91 | 173 | 427 | 264 | **YES / YES** |
| 14:00 - 15:00 | 302 | 254 | 198 | 313 | 556 | 511 | **YES / YES** |
| 15:00 - 16:00 | 344 | 236 | 148 | 251 | 580 | 399 | **YES / YES** |
| 16:00 - 17:00 | 422 | 263 | 177 | 278 | 685 | 455 | **YES / YES** |
| 17:00 - 18:00 | 371 | 191 | 159 | 270 | 562 | 429 | **YES / YES** |
| 18:00 - 19:00 | 266 | 155 | 135 | 196 | 421 | 331 | **YES / YES** |
| 19:00 - 20:00 | 186 | 76 | 133 | 140 | 262 | 273 | NO / YES |
| 20:00 - 21:00 | 157 | 69 | 98 | 95 | 226 | 193 | NO / NO |
| 21:00 - 22:00 | 102 | 40 | 89 | 56 | 142 | 145 | NO / NO |
| 22:00 - 23:00 | 40 | 25 | 29 | 32 | 65 | 61 | NO / NO |
| 23:00 - 24:00 | 36 | 20 | 15 | 16 | 56 | 31 | NO / NO |
| **Daily** | **3711** | **3195** | **2000** | **3258** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **11** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A7b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Grove Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 3711 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3195 |
| 30 | Minor App2: | Grove Ave NB | 1 | 1865 |
| 30 | Minor App4: | Grove Ave SB | 1 | 2216 |

| | |
|---|---|
| 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 | 8 | 4 | 6 | 6 | 12 | 6 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 10 | 2 | 5 | 6 | 12 | 6 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 13 | 4 | 3 | 6 | 17 | 6 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 3 | 16 | 0 | 4 | 19 | 4 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 11 | 56 | 14 | 4 | 67 | 14 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 26 | 121 | 15 | 27 | 147 | 27 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 81 | 158 | 40 | 83 | 239 | 83 | NO / NO | NO / YES | NO / NO |
| 7:00 - 8:00 | 231 | 281 | 139 | 250 | 512 | 250 | NO / YES | NO / YES | NO / YES |
| 8:00 - 9:00 | 161 | 204 | 113 | 140 | 365 | 140 | NO / NO | NO / YES | NO / YES |
| 9:00 - 10:00 | 108 | 144 | 85 | 95 | 252 | 95 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 173 | 233 | 66 | 100 | 406 | 100 | NO / NO | NO / YES | NO / NO |
| 11:00 - 12:00 | 236 | 232 | 98 | 103 | 468 | 103 | NO / NO | NO / YES | NO / NO |
| 12:00 - 13:00 | 205 | 203 | 90 | 98 | 408 | 98 | NO / NO | NO / YES | NO / NO |
| 13:00 - 14:00 | 219 | 208 | 88 | 104 | 427 | 104 | NO / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 302 | 254 | 186 | 219 | 556 | 219 | NO / YES | NO / YES | NO / YES |
| 15:00 - 16:00 | 344 | 236 | 138 | 172 | 580 | 172 | NO / YES | NO / YES | NO / YES |
| 16:00 - 17:00 | 422 | 263 | 162 | 187 | 685 | 187 | **YES / YES** | NO / YES | NO / YES |
| 17:00 - 18:00 | 371 | 191 | 149 | 212 | 562 | 212 | NO / YES | NO / YES | NO / YES |
| 18:00 - 19:00 | 266 | 155 | 127 | 152 | 421 | 152 | NO / YES | NO / YES | NO / YES |
| 19:00 - 20:00 | 186 | 76 | 126 | 107 | 262 | 126 | NO / NO | NO / YES | NO / YES |
| 20:00 - 21:00 | 157 | 69 | 94 | 77 | 226 | 94 | NO / NO | NO / YES | NO / NO |
| 21:00 - 22:00 | 102 | 40 | 78 | 39 | 142 | 78 | NO / NO | NO / YES | NO / NO |
| 22:00 - 23:00 | 40 | 25 | 28 | 14 | 65 | 28 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 36 | 20 | 15 | 11 | 56 | 15 | NO / NO | NO / NO | NO / NO |
| **Daily** | **3711** | **3195** | **1865** | **2216** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 1 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 1 | 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** | 5 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A7c

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Grove Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 3711 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3195 |
| 30 | Minor App2: | Grove Ave NB | 1 | 1865 |
| 30 | Minor App4: | Grove Ave SB | 1 | 2216 |

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

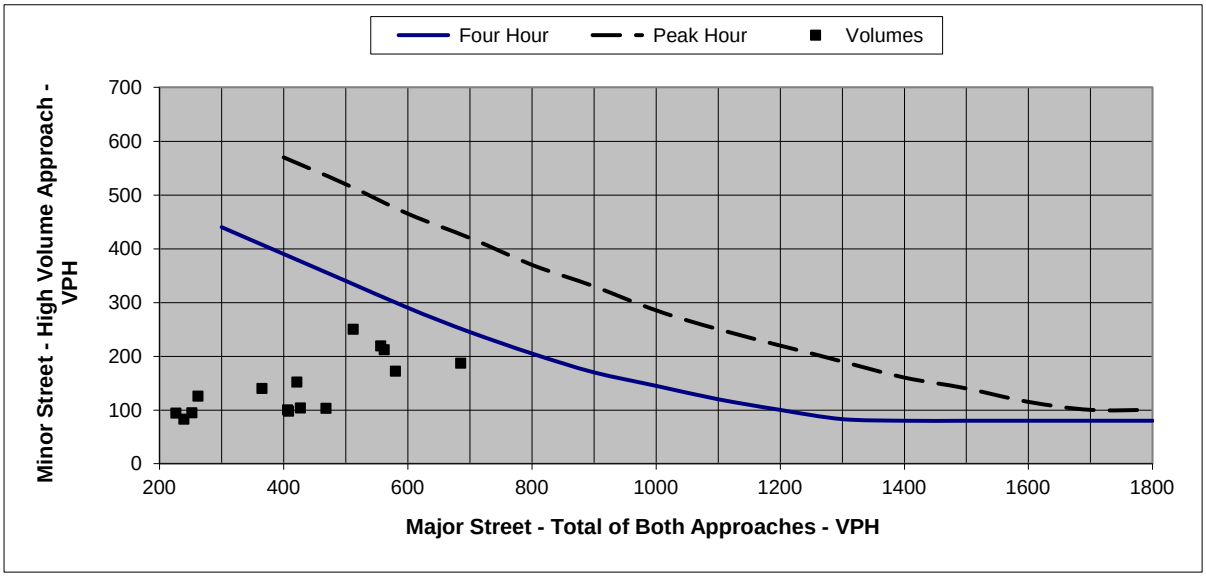



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 12 | 6 | NO | NO |
| 1:00 - 2:00 | 12 | 6 | NO | NO |
| 2:00 - 3:00 | 17 | 6 | NO | NO |
| 3:00 - 4:00 | 19 | 4 | NO | NO |
| 4:00 - 5:00 | 67 | 14 | NO | NO |
| 5:00 - 6:00 | 147 | 27 | NO | NO |
| 6:00 - 7:00 | 239 | 83 | NO | NO |
| 7:00 - 8:00 | 512 | 250 | NO | NO |
| 8:00 - 9:00 | 365 | 140 | NO | NO |
| 9:00 - 10:00 | 252 | 95 | NO | NO |
| 10:00 - 11:00 | 406 | 100 | NO | NO |
| 11:00 - 12:00 | 468 | 103 | NO | NO |
| 12:00 - 13:00 | 408 | 98 | NO | NO |
| 13:00 - 14:00 | 427 | 104 | NO | NO |
| 14:00 - 15:00 | 556 | 219 | NO | NO |
| 15:00 - 16:00 | 580 | 172 | NO | NO |
| 16:00 - 17:00 | 685 | 187 | NO | NO |
| 17:00 - 18:00 | 562 | 212 | NO | NO |
| 18:00 - 19:00 | 421 | 152 | NO | NO |
| 19:00 - 20:00 | 262 | 126 | NO | NO |
| 20:00 - 21:00 | 226 | 94 | NO | NO |
| 21:00 - 22:00 | 142 | 78 | NO | NO |
| 22:00 - 23:00 | 65 | 28 | NO | NO |
| 23:00 - 24:00 | 56 | 15 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A7d

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Grove Ave
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 3711 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3195 |
| 30 | Minor App2: | Grove Ave NB | 1 | 1865 |
| 30 | Minor App4: | Grove Ave SB | 1 | 2216 |

| | |
|---|---|
| 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 | 8 | 4 | 6 | 6 | 12 | 6 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 10 | 2 | 5 | 6 | 12 | 6 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 13 | 4 | 3 | 6 | 17 | 6 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 3 | 16 | 0 | 4 | 19 | 4 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 11 | 56 | 14 | 4 | 67 | 14 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 26 | 121 | 15 | 27 | 147 | 27 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 81 | 158 | 40 | 83 | 239 | 83 | NO / NO | NO / YES | NO / NO |
| 7:00 - 8:00 | 231 | 281 | 139 | 250 | 512 | 250 | **YES / YES** | NO / YES | NO / YES |
| 8:00 - 9:00 | 161 | 204 | 113 | 140 | 365 | 140 | NO / YES | NO / YES | NO / YES |
| 9:00 - 10:00 | 108 | 144 | 85 | 95 | 252 | 95 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 173 | 233 | 66 | 100 | 406 | 100 | NO / NO | NO / YES | NO / YES |
| 11:00 - 12:00 | 236 | 232 | 98 | 103 | 468 | 103 | NO / NO | NO / YES | NO / YES |
| 12:00 - 13:00 | 205 | 203 | 90 | 98 | 408 | 98 | NO / NO | NO / YES | NO / YES |
| 13:00 - 14:00 | 219 | 208 | 88 | 104 | 427 | 104 | NO / NO | NO / YES | NO / YES |
| 14:00 - 15:00 | 302 | 254 | 186 | 219 | 556 | 219 | **YES / YES** | NO / YES | NO / YES |
| 15:00 - 16:00 | 344 | 236 | 138 | 172 | 580 | 172 | **YES / YES** | NO / YES | **YES / YES** |
| 16:00 - 17:00 | 422 | 263 | 162 | 187 | 685 | 187 | **YES / YES** | NO / YES | **YES / YES** |
| 17:00 - 18:00 | 371 | 191 | 149 | 212 | 562 | 212 | **YES / YES** | NO / YES | NO / YES |
| 18:00 - 19:00 | 266 | 155 | 127 | 152 | 421 | 152 | NO / YES | NO / YES | NO / YES |
| 19:00 - 20:00 | 186 | 76 | 126 | 107 | 262 | 126 | NO / YES | NO / YES | NO / YES |
| 20:00 - 21:00 | 157 | 69 | 94 | 77 | 226 | 94 | NO / NO | NO / YES | NO / NO |
| 21:00 - 22:00 | 102 | 40 | 78 | 39 | 142 | 78 | NO / NO | NO / YES | NO / NO |
| 22:00 - 23:00 | 40 | 25 | 28 | 14 | 65 | 28 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 36 | 20 | 15 | 11 | 56 | 15 | NO / NO | NO / NO | NO / NO |
| **Daily** | **3711** | **3195** | **1865** | **2216** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 5 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 5 | 8 | Not satisfied |
| Warrant 1B | Interruption of Continuous Flow | 0 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 2 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A7e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Grove Ave
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 60% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 3711 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3195 |
| 30 | Minor App2: | Grove Ave NB | 1 | 1865 |
| 30 | Minor App4: | Grove Ave SB | 1 | 2216 |

| | |
|---|---|
| 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 | 90 | 45 | 72 |

| 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 | 8 | 4 | 6 | 6 | 12 | 6 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 10 | 2 | 5 | 6 | 12 | 6 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 13 | 4 | 3 | 6 | 17 | 6 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 3 | 16 | 0 | 4 | 19 | 4 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 11 | 56 | 14 | 4 | 67 | 14 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 26 | 121 | 15 | 27 | 147 | 27 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 81 | 158 | 40 | 83 | 239 | 83 | NO / NO | NO / YES | NO / YES |
| 7:00 - 8:00 | 231 | 281 | 139 | 250 | 512 | 250 | **YES / YES** | NO / YES | **YES / YES** |
| 8:00 - 9:00 | 161 | 204 | 113 | 140 | 365 | 140 | **YES / YES** | NO / YES | NO / YES |
| 9:00 - 10:00 | 108 | 144 | 85 | 95 | 252 | 95 | NO / YES | NO / YES | NO / YES |
| 10:00 - 11:00 | 173 | 233 | 66 | 100 | 406 | 100 | **YES / YES** | NO / YES | NO / YES |
| 11:00 - 12:00 | 236 | 232 | 98 | 103 | 468 | 103 | **YES / YES** | NO / YES | **YES / YES** |
| 12:00 - 13:00 | 205 | 203 | 90 | 98 | 408 | 98 | **YES / YES** | NO / YES | NO / YES |
| 13:00 - 14:00 | 219 | 208 | 88 | 104 | 427 | 104 | **YES / YES** | NO / YES | NO / YES |
| 14:00 - 15:00 | 302 | 254 | 186 | 219 | 556 | 219 | **YES / YES** | **YES / YES** | **YES / YES** |
| 15:00 - 16:00 | 344 | 236 | 138 | 172 | 580 | 172 | **YES / YES** | **YES / YES** | **YES / YES** |
| 16:00 - 17:00 | 422 | 263 | 162 | 187 | 685 | 187 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 371 | 191 | 149 | 212 | 562 | 212 | **YES / YES** | **YES / YES** | **YES / YES** |
| 18:00 - 19:00 | 266 | 155 | 127 | 152 | 421 | 152 | **YES / YES** | NO / YES | NO / YES |
| 19:00 - 20:00 | 186 | 76 | 126 | 107 | 262 | 126 | NO / YES | NO / YES | NO / YES |
| 20:00 - 21:00 | 157 | 69 | 94 | 77 | 226 | 94 | NO / YES | NO / YES | NO / YES |
| 21:00 - 22:00 | 102 | 40 | 78 | 39 | 142 | 78 | NO / NO | NO / YES | NO / YES |
| 22:00 - 23:00 | 40 | 25 | 28 | 14 | 65 | 28 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 36 | 20 | 15 | 11 | 56 | 15 | NO / NO | NO / NO | NO / NO |
| **Daily** | **3711** | **3195** | **1865** | **2216** | | | | | |

| | | 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 | 4 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 6 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A7f

## 2045 Future - CSAH 48 at Grove Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4597 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3958 |
| 30 | Minor App2: | Grove Ave NB | 1 | 2474 |
| 30 | Minor App4: | Grove Ave SB | 1 | 4033 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 9 | 4 | 7 | 11 | 13 | 18 | NO / NO |
| 1:00 - 2:00 | 12 | 2 | 5 | 9 | 14 | 14 | NO / NO |
| 2:00 - 3:00 | 15 | 4 | 3 | 10 | 19 | 13 | NO / NO |
| 3:00 - 4:00 | 3 | 20 | 0 | 8 | 23 | 8 | NO / NO |
| 4:00 - 5:00 | 13 | 70 | 16 | 20 | 83 | 36 | NO / NO |
| 5:00 - 6:00 | 32 | 150 | 21 | 51 | 182 | 72 | NO / NO |
| 6:00 - 7:00 | 101 | 196 | 50 | 192 | 297 | 242 | NO / YES |
| 7:00 - 8:00 | 287 | 349 | 190 | 445 | 636 | 635 | **YES / YES** |
| 8:00 - 9:00 | 200 | 253 | 149 | 257 | 453 | 406 | **YES / YES** |
| 9:00 - 10:00 | 134 | 179 | 111 | 160 | 313 | 271 | **YES / YES** |
| 10:00 - 11:00 | 214 | 289 | 86 | 192 | 503 | 278 | **YES / YES** |
| 11:00 - 12:00 | 292 | 288 | 134 | 210 | 580 | 344 | **YES / YES** |
| 12:00 - 13:00 | 254 | 251 | 126 | 214 | 505 | 340 | **YES / YES** |
| 13:00 - 14:00 | 271 | 258 | 113 | 214 | 529 | 327 | **YES / YES** |
| 14:00 - 15:00 | 374 | 314 | 244 | 387 | 688 | 631 | **YES / YES** |
| 15:00 - 16:00 | 427 | 292 | 184 | 311 | 719 | 495 | **YES / YES** |
| 16:00 - 17:00 | 524 | 326 | 219 | 344 | 850 | 563 | **YES / YES** |
| 17:00 - 18:00 | 460 | 238 | 197 | 335 | 698 | 532 | **YES / YES** |
| 18:00 - 19:00 | 330 | 192 | 168 | 243 | 522 | 411 | **YES / YES** |
| 19:00 - 20:00 | 232 | 95 | 166 | 173 | 327 | 339 | **YES / YES** |
| 20:00 - 21:00 | 194 | 85 | 122 | 118 | 279 | 240 | NO / YES |
| 21:00 - 22:00 | 126 | 49 | 110 | 70 | 175 | 180 | NO / NO |
| 22:00 - 23:00 | 49 | 30 | 35 | 39 | 79 | 74 | NO / NO |
| 23:00 - 24:00 | 44 | 24 | 18 | 20 | 68 | 38 | NO / NO |
| **Daily** | **4597** | **3958** | **2474** | **4033** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **13** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A7g

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Grove Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4597 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3958 |
| 30 | Minor App2: | Grove Ave NB | 1 | 2310 |
| 30 | Minor App4: | Grove Ave SB | 1 | 2743 |

| | |
|---|---|
| 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 | 9 | 4 | 7 | 6 | 13 | 7 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 12 | 2 | 5 | 7 | 14 | 7 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 15 | 4 | 3 | 7 | 19 | 7 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 3 | 20 | 0 | 5 | 23 | 5 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 13 | 70 | 16 | 5 | 83 | 16 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 32 | 150 | 18 | 33 | 182 | 33 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 101 | 196 | 50 | 104 | 297 | 104 | NO / NO | NO / YES | NO / NO |
| 7:00 - 8:00 | 287 | 349 | 172 | 310 | 636 | 310 | **YES / YES** | NO / YES | NO / YES |
| 8:00 - 9:00 | 200 | 253 | 141 | 173 | 453 | 173 | NO / YES | NO / YES | NO / YES |
| 9:00 - 10:00 | 134 | 179 | 105 | 117 | 313 | 117 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 214 | 289 | 82 | 125 | 503 | 125 | NO / NO | NO / YES | NO / YES |
| 11:00 - 12:00 | 292 | 288 | 122 | 128 | 580 | 128 | NO / NO | NO / YES | NO / YES |
| 12:00 - 13:00 | 254 | 251 | 112 | 120 | 505 | 120 | NO / NO | NO / YES | NO / YES |
| 13:00 - 14:00 | 271 | 258 | 110 | 129 | 529 | 129 | NO / NO | NO / YES | NO / YES |
| 14:00 - 15:00 | 374 | 314 | 231 | 271 | 688 | 271 | **YES / YES** | NO / YES | NO / YES |
| 15:00 - 16:00 | 427 | 292 | 171 | 213 | 719 | 213 | **YES / YES** | NO / YES | NO / YES |
| 16:00 - 17:00 | 524 | 326 | 200 | 232 | 850 | 232 | **YES / YES** | NO / YES | **YES / YES** |
| 17:00 - 18:00 | 460 | 238 | 185 | 263 | 698 | 263 | **YES / YES** | NO / YES | NO / YES |
| 18:00 - 19:00 | 330 | 192 | 158 | 188 | 522 | 188 | NO / YES | NO / YES | NO / YES |
| 19:00 - 20:00 | 232 | 95 | 156 | 132 | 327 | 156 | NO / YES | NO / YES | NO / YES |
| 20:00 - 21:00 | 194 | 85 | 117 | 96 | 279 | 117 | NO / NO | NO / YES | NO / NO |
| 21:00 - 22:00 | 126 | 49 | 97 | 49 | 175 | 97 | NO / NO | NO / YES | NO / NO |
| 22:00 - 23:00 | 49 | 30 | 34 | 18 | 79 | 34 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 44 | 24 | 18 | 12 | 68 | 18 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4597** | **3958** | **2310** | **2743** | | | | | |

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

COMMENTS:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A7h

# 2045 Future - CSAH 48 at Grove Ave
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4597 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3958 |
| 30 | Minor App2: | Grove Ave NB | 1 | 2310 |
| 30 | Minor App4: | Grove Ave SB | 1 | 2743 |

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

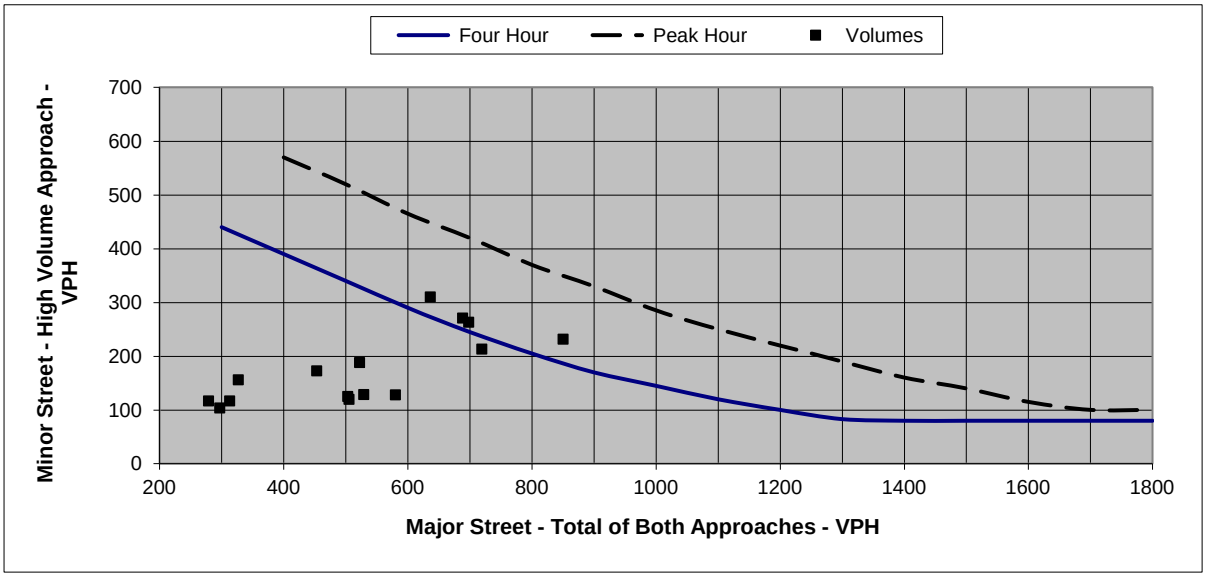



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 440 | |
| 400 | 390 | 570 |
| 500 | 340 | 520 |
| 600 | 290 | 465 |
| 700 | 245 | 420 |
| 800 | 205 | 370 |
| 900 | 170 | 330 |
| 1000 | 145 | 285 |
| 1100 | 120 | 250 |
| 1200 | 100 | 220 |
| 1300 | 83 | 190 |
| 1400 | 80 | 160 |
| 1500 | 80 | 140 |
| 1600 | 80 | 115 |
| 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 | 13 | 7 | NO | NO |
| 1:00 - 2:00 | 14 | 7 | NO | NO |
| 2:00 - 3:00 | 19 | 7 | NO | NO |
| 3:00 - 4:00 | 23 | 5 | NO | NO |
| 4:00 - 5:00 | 83 | 16 | NO | NO |
| 5:00 - 6:00 | 182 | 33 | NO | NO |
| 6:00 - 7:00 | 297 | 104 | NO | NO |
| 7:00 - 8:00 | 636 | 310 | **YES** | NO |
| 8:00 - 9:00 | 453 | 173 | NO | NO |
| 9:00 - 10:00 | 313 | 117 | NO | NO |
| 10:00 - 11:00 | 503 | 125 | NO | NO |
| 11:00 - 12:00 | 580 | 128 | NO | NO |
| 12:00 - 13:00 | 505 | 120 | NO | NO |
| 13:00 - 14:00 | 529 | 129 | NO | NO |
| 14:00 - 15:00 | 688 | 271 | **YES** | NO |
| 15:00 - 16:00 | 719 | 213 | NO | NO |
| 16:00 - 17:00 | 850 | 232 | **YES** | NO |
| 17:00 - 18:00 | 698 | 263 | **YES** | NO |
| 18:00 - 19:00 | 522 | 188 | NO | NO |
| 19:00 - 20:00 | 327 | 156 | NO | NO |
| 20:00 - 21:00 | 279 | 117 | NO | NO |
| 21:00 - 22:00 | 175 | 97 | NO | NO |
| 22:00 - 23:00 | 79 | 34 | NO | NO |
| 23:00 - 24:00 | 68 | 18 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A7i

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Grove Ave
## SIGNAL WARRANT
## ANALYSIS

Volume Threshold Reduced to 80% of Full Volume Warrant Thresholds

LOCATION: CSAH 48 at Grove Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 2 | 4597 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3958 |
| 30 | Minor App2: | Grove Ave NB | 1 | 2310 |
| 30 | Minor App4: | Grove Ave SB | 1 | 2743 |

| | |
|---|---|
| 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 | 9 | 4 | 7 | 6 | 13 | 7 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 12 | 2 | 5 | 7 | 14 | 7 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 15 | 4 | 3 | 7 | 19 | 7 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 3 | 20 | 0 | 5 | 23 | 5 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 13 | 70 | 16 | 5 | 83 | 16 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 32 | 150 | 18 | 33 | 182 | 33 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 101 | 196 | 50 | 104 | 297 | 104 | NO / NO | NO / YES | NO / YES |
| 7:00 - 8:00 | 287 | 349 | 172 | 310 | 636 | 310 | **YES / YES** | NO / YES | **YES / YES** |
| 8:00 - 9:00 | 200 | 253 | 141 | 173 | 453 | 173 | NO / YES | NO / YES | NO / YES |
| 9:00 - 10:00 | 134 | 179 | 105 | 117 | 313 | 117 | NO / NO | NO / YES | NO / YES |
| 10:00 - 11:00 | 214 | 289 | 82 | 125 | 503 | 125 | **YES / YES** | NO / YES | NO / YES |
| 11:00 - 12:00 | 292 | 288 | 122 | 128 | 580 | 128 | **YES / YES** | NO / YES | **YES / YES** |
| 12:00 - 13:00 | 254 | 251 | 112 | 120 | 505 | 120 | **YES / YES** | NO / YES | NO / YES |
| 13:00 - 14:00 | 271 | 258 | 110 | 129 | 529 | 129 | **YES / YES** | NO / YES | NO / YES |
| 14:00 - 15:00 | 374 | 314 | 231 | 271 | 688 | 271 | **YES / YES** | NO / YES | **YES / YES** |
| 15:00 - 16:00 | 427 | 292 | 171 | 213 | 719 | 213 | **YES / YES** | NO / YES | **YES / YES** |
| 16:00 - 17:00 | 524 | 326 | 200 | 232 | 850 | 232 | **YES / YES** | **YES / YES** | **YES / YES** |
| 17:00 - 18:00 | 460 | 238 | 185 | 263 | 698 | 263 | **YES / YES** | NO / YES | **YES / YES** |
| 18:00 - 19:00 | 330 | 192 | 158 | 188 | 522 | 188 | **YES / YES** | NO / YES | NO / YES |
| 19:00 - 20:00 | 232 | 95 | 156 | 132 | 327 | 156 | NO / YES | NO / YES | NO / YES |
| 20:00 - 21:00 | 194 | 85 | 117 | 96 | 279 | 117 | NO / NO | NO / YES | NO / YES |
| 21:00 - 22:00 | 126 | 49 | 97 | 49 | 175 | 97 | NO / NO | NO / YES | NO / YES |
| 22:00 - 23:00 | 49 | 30 | 34 | 18 | 79 | 34 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 44 | 24 | 18 | 12 | 68 | 18 | NO / NO | NO / NO | NO / NO |
| **Daily** | **4597** | **3958** | **2310** | **2743** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | **10** | 8 | **Satisfied** |
| Warrant 1A | Minimum Vehicular Volume | **10** | 8 | **Satisfied** |
| Warrant 1B | Interruption of Continuous Flow | 1 | 8 | Not satisfied |
| 1A & 1B | Combination of Warrants | 6 | 8 | Not satisfied |

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A8a

## 2021 Existing - CSAH 48 at Lincoln Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Lincoln Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 2739 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2920 |
| 30 | Minor App2: | Lincoln Ave NB | 1 | 2258 |
| 30 | Minor App4: | Lincoln Ave SB | 1 | 1868 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 4 | 6 | 2 | 2 | 10 | 4 | NO / NO |
| 1:00 - 2:00 | 10 | 3 | 1 | 7 | 13 | 8 | NO / NO |
| 2:00 - 3:00 | 12 | 6 | 0 | 3 | 18 | 3 | NO / NO |
| 3:00 - 4:00 | 4 | 9 | 11 | 2 | 13 | 13 | NO / NO |
| 4:00 - 5:00 | 9 | 35 | 22 | 9 | 44 | 31 | NO / NO |
| 5:00 - 6:00 | 24 | 101 | 39 | 25 | 125 | 64 | NO / NO |
| 6:00 - 7:00 | 64 | 162 | 90 | 63 | 226 | 153 | NO / NO |
| 7:00 - 8:00 | 129 | 336 | 222 | 209 | 465 | 431 | **YES / YES** |
| 8:00 - 9:00 | 126 | 188 | 130 | 139 | 314 | 269 | **YES / YES** |
| 9:00 - 10:00 | 87 | 148 | 94 | 84 | 235 | 178 | NO / NO |
| 10:00 - 11:00 | 155 | 178 | 126 | 95 | 333 | 221 | **YES / YES** |
| 11:00 - 12:00 | 163 | 195 | 149 | 112 | 358 | 261 | **YES / YES** |
| 12:00 - 13:00 | 157 | 163 | 106 | 89 | 320 | 195 | YES / NO |
| 13:00 - 14:00 | 169 | 167 | 126 | 89 | 336 | 215 | **YES / YES** |
| 14:00 - 15:00 | 214 | 212 | 260 | 146 | 426 | 406 | **YES / YES** |
| 15:00 - 16:00 | 280 | 203 | 187 | 207 | 483 | 394 | **YES / YES** |
| 16:00 - 17:00 | 338 | 239 | 186 | 166 | 577 | 352 | **YES / YES** |
| 17:00 - 18:00 | 256 | 216 | 151 | 151 | 472 | 302 | **YES / YES** |
| 18:00 - 19:00 | 172 | 144 | 113 | 112 | 316 | 225 | **YES / YES** |
| 19:00 - 20:00 | 134 | 77 | 83 | 62 | 211 | 145 | NO / NO |
| 20:00 - 21:00 | 103 | 55 | 68 | 47 | 158 | 115 | NO / NO |
| 21:00 - 22:00 | 69 | 32 | 59 | 26 | 101 | 85 | NO / NO |
| 22:00 - 23:00 | 37 | 30 | 28 | 18 | 67 | 46 | NO / NO |
| 23:00 - 24:00 | 23 | 15 | 5 | 5 | 38 | 10 | NO / NO |
| **Daily** | **2739** | **2920** | **2258** | **1868** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **10** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A8b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Lincoln Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Lincoln Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 2739 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2920 |
| 30 | Minor App2: | Lincoln Ave NB | 1 | 1930 |
| 30 | Minor App4: | Lincoln Ave SB | 1 | 1753 |

| | |
|---|---|
| 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 | 500 | 750 | 600 |
| 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 | 4 | 6 | 2 | 2 | 10 | 2 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 10 | 3 | 1 | 7 | 13 | 7 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 12 | 6 | 0 | 2 | 18 | 2 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 4 | 9 | 10 | 1 | 13 | 10 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 9 | 35 | 21 | 8 | 44 | 21 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 24 | 101 | 36 | 20 | 125 | 36 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 64 | 162 | 84 | 61 | 226 | 84 | NO / NO | NO / YES | NO / NO |
| 7:00 - 8:00 | 129 | 336 | 205 | 198 | 465 | 205 | NO / YES | NO / YES | NO / YES |
| 8:00 - 9:00 | 126 | 188 | 117 | 125 | 314 | 125 | NO / NO | NO / YES | NO / YES |
| 9:00 - 10:00 | 87 | 148 | 84 | 82 | 235 | 84 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 155 | 178 | 111 | 77 | 333 | 111 | NO / NO | NO / YES | NO / NO |
| 11:00 - 12:00 | 163 | 195 | 123 | 108 | 358 | 123 | NO / NO | NO / YES | NO / YES |
| 12:00 - 13:00 | 157 | 163 | 88 | 84 | 320 | 88 | NO / NO | NO / YES | NO / NO |
| 13:00 - 14:00 | 169 | 167 | 111 | 82 | 336 | 111 | NO / NO | NO / YES | NO / NO |
| 14:00 - 15:00 | 214 | 212 | 236 | 132 | 426 | 236 | NO / YES | NO / YES | NO / YES |
| 15:00 - 16:00 | 280 | 203 | 150 | 194 | 483 | 194 | NO / YES | NO / YES | NO / YES |
| 16:00 - 17:00 | 338 | 239 | 150 | 157 | 577 | 157 | **YES / YES** | NO / YES | NO / YES |
| 17:00 - 18:00 | 256 | 216 | 121 | 148 | 472 | 148 | NO / NO | NO / YES | NO / YES |
| 18:00 - 19:00 | 172 | 144 | 98 | 111 | 316 | 111 | NO / NO | NO / YES | NO / NO |
| 19:00 - 20:00 | 134 | 77 | 63 | 59 | 211 | 63 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 103 | 55 | 55 | 47 | 158 | 55 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 69 | 32 | 41 | 25 | 101 | 41 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 37 | 30 | 19 | 18 | 67 | 19 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 23 | 15 | 4 | 5 | 38 | 5 | NO / NO | NO / NO | NO / NO |
| **Daily** | **2739** | **2920** | **1930** | **1753** | | | | | |

| | | Met (Hr) | Required (Hr) | WARRANT MET: |
|---|---|---|---|---|
| **Warrant 1** | **Eight Hour Volumes** | 1 | 8 | Not satisfied |
| Warrant 1A | Minimum Vehicular Volume | 1 | 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** | 5 | 8 | Not satisfied |

COMMENTS:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A8c

# 2021 Existing - CSAH 48 at Lincoln Ave
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at Lincoln Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

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

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 2739 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2920 |
| 30 | Minor App2: | Lincoln Ave NB | 1 | 1930 |
| 30 | Minor App4: | Lincoln Ave SB | 1 | 1753 |

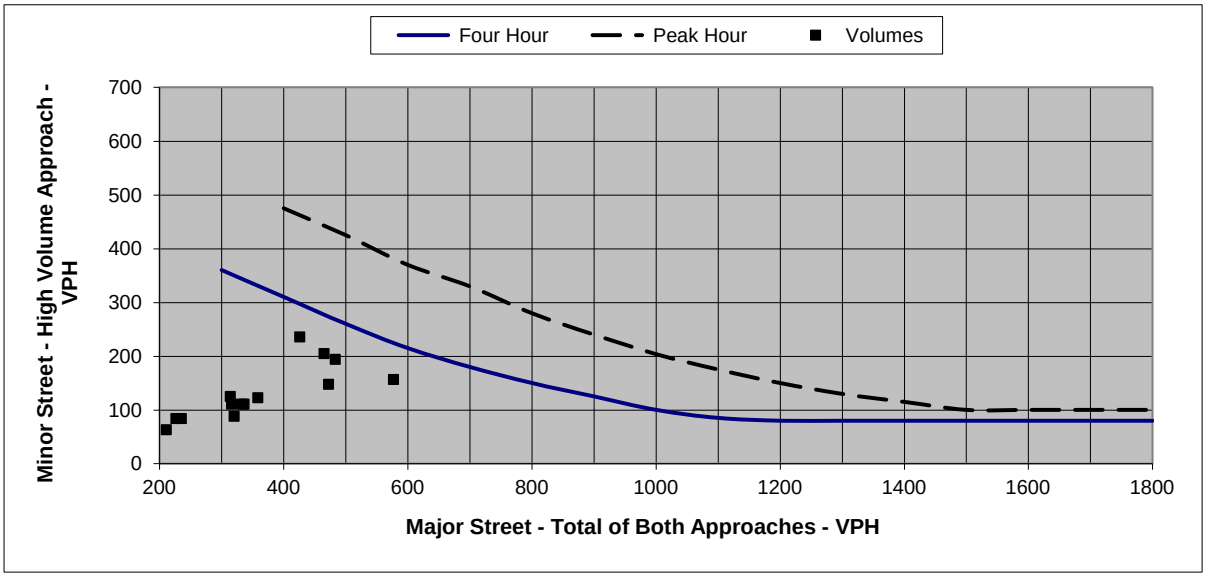



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 360 | |
| 400 | 310 | 475 |
| 500 | 260 | 425 |
| 600 | 215 | 370 |
| 700 | 180 | 330 |
| 800 | 150 | 280 |
| 900 | 125 | 240 |
| 1000 | 100 | 204 |
| 1100 | 85 | 175 |
| 1200 | 80 | 150 |
| 1300 | 80 | 130 |
| 1400 | 80 | 115 |
| 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 | 10 | 2 | NO | NO |
| 1:00 - 2:00 | 13 | 7 | NO | NO |
| 2:00 - 3:00 | 18 | 2 | NO | NO |
| 3:00 - 4:00 | 13 | 10 | NO | NO |
| 4:00 - 5:00 | 44 | 21 | NO | NO |
| 5:00 - 6:00 | 125 | 36 | NO | NO |
| 6:00 - 7:00 | 226 | 84 | NO | NO |
| 7:00 - 8:00 | 465 | 205 | NO | NO |
| 8:00 - 9:00 | 314 | 125 | NO | NO |
| 9:00 - 10:00 | 235 | 84 | NO | NO |
| 10:00 - 11:00 | 333 | 111 | NO | NO |
| 11:00 - 12:00 | 358 | 123 | NO | NO |
| 12:00 - 13:00 | 320 | 88 | NO | NO |
| 13:00 - 14:00 | 336 | 111 | NO | NO |
| 14:00 - 15:00 | 426 | 236 | NO | NO |
| 15:00 - 16:00 | 483 | 194 | NO | NO |
| 16:00 - 17:00 | 577 | 157 | NO | NO |
| 17:00 - 18:00 | 472 | 148 | NO | NO |
| 18:00 - 19:00 | 316 | 111 | NO | NO |
| 19:00 - 20:00 | 211 | 63 | NO | NO |
| 20:00 - 21:00 | 158 | 55 | NO | NO |
| 21:00 - 22:00 | 101 | 41 | NO | NO |
| 22:00 - 23:00 | 67 | 19 | NO | NO |
| 23:00 - 24:00 | 38 | 5 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A8d

## 2045 Future - CSAH 48 at Lincoln Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Lincoln Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 3396 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3619 |
| 30 | Minor App2: | Lincoln Ave NB | 1 | 2800 |
| 30 | Minor App4: | Lincoln Ave SB | 1 | 2315 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 5 | 7 | 2 | 2 | 12 | 4 | NO / NO |
| 1:00 - 2:00 | 13 | 3 | 1 | 8 | 16 | 9 | NO / NO |
| 2:00 - 3:00 | 15 | 6 | 0 | 3 | 21 | 3 | NO / NO |
| 3:00 - 4:00 | 5 | 11 | 13 | 2 | 16 | 15 | NO / NO |
| 4:00 - 5:00 | 11 | 44 | 27 | 11 | 55 | 38 | NO / NO |
| 5:00 - 6:00 | 30 | 125 | 48 | 31 | 155 | 79 | NO / NO |
| 6:00 - 7:00 | 78 | 201 | 111 | 78 | 279 | 189 | NO / NO |
| 7:00 - 8:00 | 159 | 418 | 276 | 259 | 577 | 535 | **YES / YES** |
| 8:00 - 9:00 | 156 | 232 | 161 | 172 | 388 | 333 | **YES / YES** |
| 9:00 - 10:00 | 108 | 184 | 117 | 106 | 292 | 223 | NO / YES |
| 10:00 - 11:00 | 192 | 221 | 157 | 119 | 413 | 276 | **YES / YES** |
| 11:00 - 12:00 | 203 | 242 | 185 | 139 | 445 | 324 | **YES / YES** |
| 12:00 - 13:00 | 195 | 203 | 132 | 111 | 398 | 243 | **YES / YES** |
| 13:00 - 14:00 | 210 | 207 | 156 | 110 | 417 | 266 | **YES / YES** |
| 14:00 - 15:00 | 266 | 263 | 322 | 180 | 529 | 502 | **YES / YES** |
| 15:00 - 16:00 | 346 | 251 | 232 | 257 | 597 | 489 | **YES / YES** |
| 16:00 - 17:00 | 420 | 295 | 232 | 206 | 715 | 438 | **YES / YES** |
| 17:00 - 18:00 | 317 | 268 | 187 | 187 | 585 | 374 | **YES / YES** |
| 18:00 - 19:00 | 213 | 179 | 140 | 138 | 392 | 278 | **YES / YES** |
| 19:00 - 20:00 | 167 | 95 | 103 | 78 | 262 | 181 | NO / NO |
| 20:00 - 21:00 | 128 | 69 | 84 | 58 | 197 | 142 | NO / NO |
| 21:00 - 22:00 | 85 | 40 | 74 | 32 | 125 | 106 | NO / NO |
| 22:00 - 23:00 | 45 | 37 | 34 | 22 | 82 | 56 | NO / NO |
| 23:00 - 24:00 | 29 | 18 | 6 | 6 | 47 | 12 | NO / NO |
| **Daily** | **3396** | **3619** | **2800** | **2315** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **11** | **8** |

**All-way Stop Warrant:** **Satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A8e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Lincoln Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Lincoln Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 3396 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3619 |
| 30 | Minor App2: | Lincoln Ave NB | 1 | 2391 |
| 30 | Minor App4: | Lincoln Ave SB | 1 | 2171 |

| | |
|---|---|
| 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 | 500 | 750 | 600 |
| 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 | 5 | 7 | 2 | 2 | 12 | 2 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 13 | 3 | 1 | 8 | 16 | 8 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 15 | 6 | 0 | 2 | 21 | 2 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 5 | 11 | 12 | 1 | 16 | 12 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 11 | 44 | 25 | 10 | 55 | 25 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 30 | 125 | 45 | 25 | 155 | 45 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 78 | 201 | 104 | 76 | 279 | 104 | NO / NO | NO / YES | NO / NO |
| 7:00 - 8:00 | 159 | 418 | 253 | 246 | 577 | 253 | **YES / YES** | NO / YES | NO / YES |
| 8:00 - 9:00 | 156 | 232 | 145 | 155 | 388 | 155 | NO / YES | NO / YES | NO / YES |
| 9:00 - 10:00 | 108 | 184 | 105 | 102 | 292 | 105 | NO / NO | NO / YES | NO / NO |
| 10:00 - 11:00 | 192 | 221 | 137 | 96 | 413 | 137 | NO / NO | NO / YES | NO / YES |
| 11:00 - 12:00 | 203 | 242 | 152 | 134 | 445 | 152 | NO / YES | NO / YES | NO / YES |
| 12:00 - 13:00 | 195 | 203 | 109 | 104 | 398 | 109 | NO / NO | NO / YES | NO / NO |
| 13:00 - 14:00 | 210 | 207 | 138 | 101 | 417 | 138 | NO / NO | NO / YES | NO / YES |
| 14:00 - 15:00 | 266 | 263 | 294 | 164 | 529 | 294 | **YES / YES** | NO / YES | NO / YES |
| 15:00 - 16:00 | 346 | 251 | 185 | 240 | 597 | 240 | **YES / YES** | NO / YES | NO / YES |
| 16:00 - 17:00 | 420 | 295 | 186 | 195 | 715 | 195 | **YES / YES** | NO / YES | **YES / YES** |
| 17:00 - 18:00 | 317 | 268 | 150 | 183 | 585 | 183 | **YES / YES** | NO / YES | NO / YES |
| 18:00 - 19:00 | 213 | 179 | 123 | 137 | 392 | 137 | NO / NO | NO / YES | NO / YES |
| 19:00 - 20:00 | 167 | 95 | 79 | 74 | 262 | 79 | NO / NO | NO / YES | NO / NO |
| 20:00 - 21:00 | 128 | 69 | 68 | 58 | 197 | 68 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 85 | 40 | 51 | 30 | 125 | 51 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 45 | 37 | 23 | 22 | 82 | 23 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 29 | 18 | 4 | 6 | 47 | 6 | NO / NO | NO / NO | NO / NO |
| **Daily** | **3396** | **3619** | **2391** | **2171** | | | | | |

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

COMMENTS:

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A8f

## 2045 Future - CSAH 48 at Lincoln Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Lincoln Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 3396 |
| 30 | Major App3: | CSAH 48 WB | 1 | 3619 |
| 30 | Minor App2: | Lincoln Ave NB | 1 | 2391 |
| 30 | Minor App4: | Lincoln Ave SB | 1 | 2171 |

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

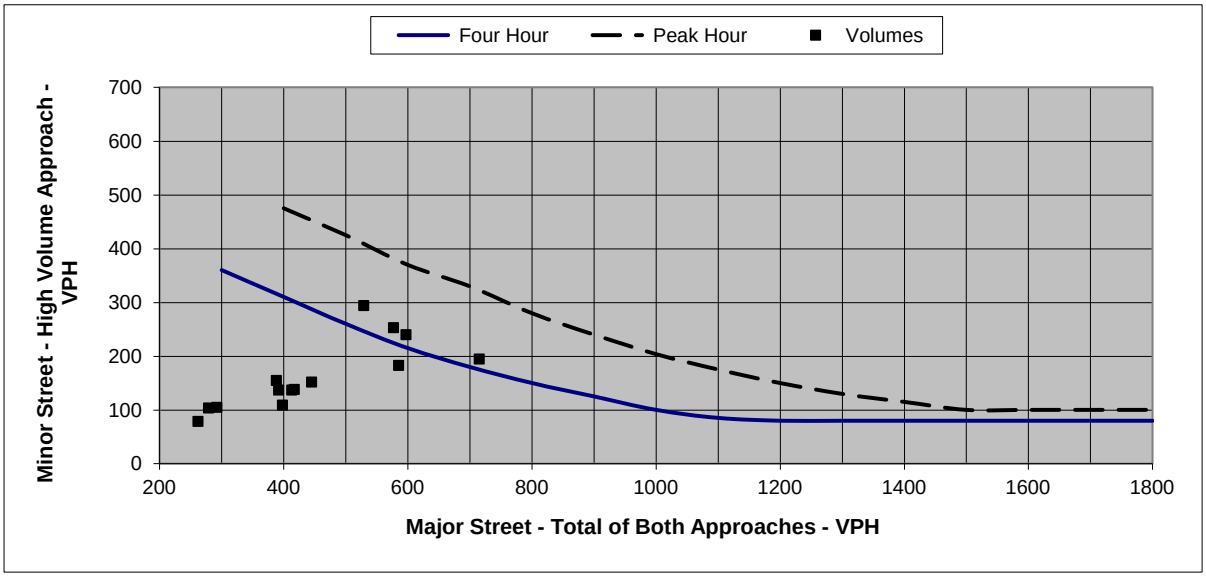



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 360 | |
| 400 | 310 | 475 |
| 500 | 260 | 425 |
| 600 | 215 | 370 |
| 700 | 180 | 330 |
| 800 | 150 | 280 |
| 900 | 125 | 240 |
| 1000 | 100 | 204 |
| 1100 | 85 | 175 |
| 1200 | 80 | 150 |
| 1300 | 80 | 130 |
| 1400 | 80 | 115 |
| 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 | 12 | 2 | NO | NO |
| 1:00 - 2:00 | 16 | 8 | NO | NO |
| 2:00 - 3:00 | 21 | 2 | NO | NO |
| 3:00 - 4:00 | 16 | 12 | NO | NO |
| 4:00 - 5:00 | 55 | 25 | NO | NO |
| 5:00 - 6:00 | 155 | 45 | NO | NO |
| 6:00 - 7:00 | 279 | 104 | NO | NO |
| 7:00 - 8:00 | 577 | 253 | **YES** | NO |
| 8:00 - 9:00 | 388 | 155 | NO | NO |
| 9:00 - 10:00 | 292 | 105 | NO | NO |
| 10:00 - 11:00 | 413 | 137 | NO | NO |
| 11:00 - 12:00 | 445 | 152 | NO | NO |
| 12:00 - 13:00 | 398 | 109 | NO | NO |
| 13:00 - 14:00 | 417 | 138 | NO | NO |
| 14:00 - 15:00 | 529 | 294 | **YES** | NO |
| 15:00 - 16:00 | 597 | 240 | **YES** | NO |
| 16:00 - 17:00 | 715 | 195 | **YES** | NO |
| 17:00 - 18:00 | 585 | 183 | NO | NO |
| 18:00 - 19:00 | 392 | 137 | NO | NO |
| 19:00 - 20:00 | 262 | 79 | NO | NO |
| 20:00 - 21:00 | 197 | 68 | NO | NO |
| 21:00 - 22:00 | 125 | 51 | NO | NO |
| 22:00 - 23:00 | 82 | 23 | NO | NO |
| 23:00 - 24:00 | 47 | 6 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A9a

## 2021 Existing - CSAH 48 at Chambers Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Chambers Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 2746 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2393 |
| 30 | Minor App2: | Chambers Ave NB | 1 | 149 |
| 30 | Minor App4: | Chambers Ave SB | 1 | 973 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 3 | 7 | 0 | 0 | 10 | 0 | NO / NO |
| 1:00 - 2:00 | 8 | 4 | 1 | 1 | 12 | 2 | NO / NO |
| 2:00 - 3:00 | 10 | 6 | 0 | 3 | 16 | 3 | NO / NO |
| 3:00 - 4:00 | 5 | 7 | 0 | 2 | 12 | 2 | NO / NO |
| 4:00 - 5:00 | 13 | 30 | 2 | 5 | 43 | 7 | NO / NO |
| 5:00 - 6:00 | 37 | 78 | 8 | 24 | 115 | 32 | NO / NO |
| 6:00 - 7:00 | 89 | 124 | 3 | 54 | 213 | 57 | NO / NO |
| 7:00 - 8:00 | 134 | 259 | 11 | 145 | 393 | 156 | YES / NO |
| 8:00 - 9:00 | 118 | 139 | 6 | 66 | 257 | 72 | NO / NO |
| 9:00 - 10:00 | 94 | 115 | 7 | 50 | 209 | 57 | NO / NO |
| 10:00 - 11:00 | 138 | 142 | 11 | 53 | 280 | 64 | NO / NO |
| 11:00 - 12:00 | 173 | 156 | 4 | 69 | 329 | 73 | YES / NO |
| 12:00 - 13:00 | 144 | 137 | 7 | 42 | 281 | 49 | NO / NO |
| 13:00 - 14:00 | 147 | 141 | 9 | 46 | 288 | 55 | NO / NO |
| 14:00 - 15:00 | 197 | 187 | 23 | 61 | 384 | 84 | YES / NO |
| 15:00 - 16:00 | 287 | 181 | 14 | 60 | 468 | 74 | YES / NO |
| 16:00 - 17:00 | 331 | 209 | 10 | 99 | 540 | 109 | YES / NO |
| 17:00 - 18:00 | 275 | 166 | 10 | 81 | 441 | 91 | YES / NO |
| 18:00 - 19:00 | 161 | 119 | 7 | 39 | 280 | 46 | NO / NO |
| 19:00 - 20:00 | 137 | 65 | 5 | 27 | 202 | 32 | NO / NO |
| 20:00 - 21:00 | 105 | 47 | 4 | 19 | 152 | 23 | NO / NO |
| 21:00 - 22:00 | 82 | 35 | 5 | 8 | 117 | 13 | NO / NO |
| 22:00 - 23:00 | 34 | 25 | 1 | 14 | 59 | 15 | NO / NO |
| 23:00 - 24:00 | 24 | 14 | 1 | 5 | 38 | 6 | NO / NO |
| **Daily** | **2746** | **2393** | **149** | **973** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **0** | **8** |

**All-way Stop Warrant:** **Not satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A9b

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2021 Existing - CSAH 48 at Chambers Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Chambers Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 2746 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2393 |
| 30 | Minor App2: | Chambers Ave NB | 1 | 139 |
| 30 | Minor App4: | Chambers Ave SB | 1 | 288 |

| | |
|---|---|
| 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 | 500 | 750 | 600 |
| 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 | 3 | 7 | 0 | 0 | 10 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 8 | 4 | 1 | 1 | 12 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 10 | 6 | 0 | 3 | 16 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 5 | 7 | 0 | 0 | 12 | 0 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 13 | 30 | 2 | 2 | 43 | 2 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 37 | 78 | 7 | 4 | 115 | 7 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 89 | 124 | 2 | 12 | 213 | 12 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 134 | 259 | 10 | 46 | 393 | 46 | NO / NO | NO / NO | NO / NO |
| 8:00 - 9:00 | 118 | 139 | 5 | 12 | 257 | 12 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 94 | 115 | 7 | 15 | 209 | 15 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 138 | 142 | 9 | 11 | 280 | 11 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 173 | 156 | 4 | 20 | 329 | 20 | NO / NO | NO / NO | NO / NO |
| 12:00 - 13:00 | 144 | 137 | 7 | 10 | 281 | 10 | NO / NO | NO / NO | NO / NO |
| 13:00 - 14:00 | 147 | 141 | 9 | 15 | 288 | 15 | NO / NO | NO / NO | NO / NO |
| 14:00 - 15:00 | 197 | 187 | 23 | 19 | 384 | 23 | NO / NO | NO / NO | NO / NO |
| 15:00 - 16:00 | 287 | 181 | 11 | 19 | 468 | 19 | NO / NO | NO / NO | NO / NO |
| 16:00 - 17:00 | 331 | 209 | 9 | 38 | 540 | 38 | YES / NO | NO / NO | NO / NO |
| 17:00 - 18:00 | 275 | 166 | 10 | 22 | 441 | 22 | NO / NO | NO / NO | NO / NO |
| 18:00 - 19:00 | 161 | 119 | 7 | 9 | 280 | 9 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 137 | 65 | 5 | 10 | 202 | 10 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 105 | 47 | 4 | 9 | 152 | 9 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 82 | 35 | 5 | 4 | 117 | 5 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 34 | 25 | 1 | 6 | 59 | 6 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 24 | 14 | 1 | 1 | 38 | 1 | NO / NO | NO / NO | NO / NO |
| **Daily** | **2746** | **2393** | **139** | **288** | | | | | |

| | | 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:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A9c

# 2021 Existing - CSAH 48 at Chambers Ave
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at Chambers Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 2746 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2393 |
| 30 | Minor App2: | Chambers Ave NB | 1 | 139 |
| 30 | Minor App4: | Chambers Ave SB | 1 | 288 |

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

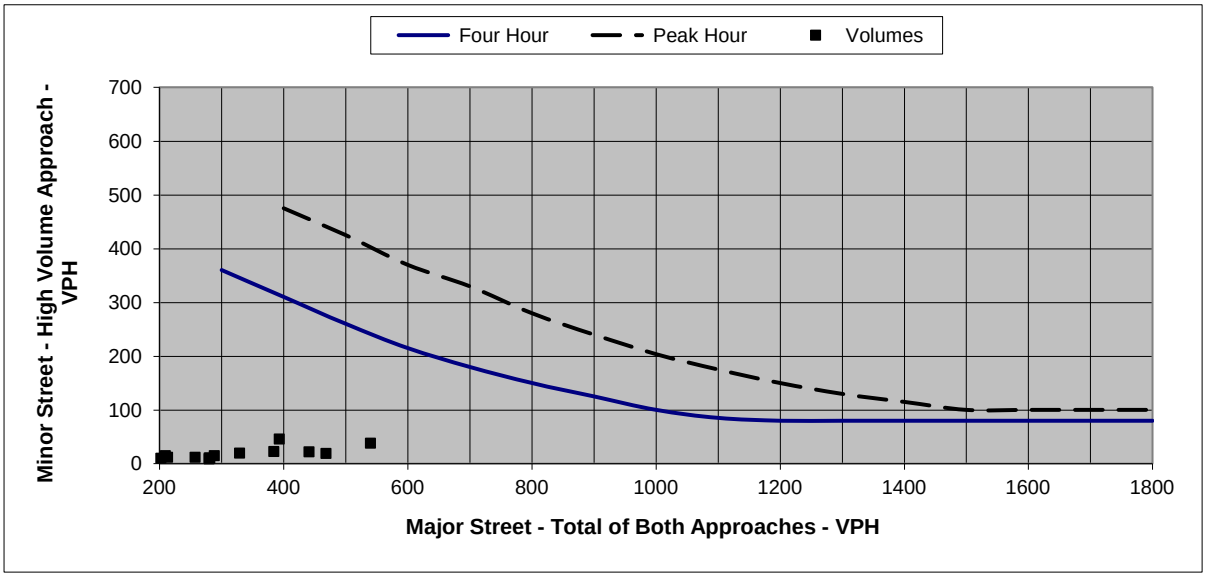



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 360 | |
| 400 | 310 | 475 |
| 500 | 260 | 425 |
| 600 | 215 | 370 |
| 700 | 180 | 330 |
| 800 | 150 | 280 |
| 900 | 125 | 240 |
| 1000 | 100 | 204 |
| 1100 | 85 | 175 |
| 1200 | 80 | 150 |
| 1300 | 80 | 130 |
| 1400 | 80 | 115 |
| 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 | 10 | 0 | NO | NO |
| 1:00 - 2:00 | 12 | 1 | NO | NO |
| 2:00 - 3:00 | 16 | 3 | NO | NO |
| 3:00 - 4:00 | 12 | 0 | NO | NO |
| 4:00 - 5:00 | 43 | 2 | NO | NO |
| 5:00 - 6:00 | 115 | 7 | NO | NO |
| 6:00 - 7:00 | 213 | 12 | NO | NO |
| 7:00 - 8:00 | 393 | 46 | NO | NO |
| 8:00 - 9:00 | 257 | 12 | NO | NO |
| 9:00 - 10:00 | 209 | 15 | NO | NO |
| 10:00 - 11:00 | 280 | 11 | NO | NO |
| 11:00 - 12:00 | 329 | 20 | NO | NO |
| 12:00 - 13:00 | 281 | 10 | NO | NO |
| 13:00 - 14:00 | 288 | 15 | NO | NO |
| 14:00 - 15:00 | 384 | 23 | NO | NO |
| 15:00 - 16:00 | 468 | 19 | NO | NO |
| 16:00 - 17:00 | 540 | 38 | NO | NO |
| 17:00 - 18:00 | 441 | 22 | NO | NO |
| 18:00 - 19:00 | 280 | 9 | NO | NO |
| 19:00 - 20:00 | 202 | 10 | NO | NO |
| 20:00 - 21:00 | 152 | 9 | NO | NO |
| 21:00 - 22:00 | 117 | 5 | NO | NO |
| 22:00 - 23:00 | 59 | 6 | NO | NO |
| 23:00 - 24:00 | 38 | 1 | NO | NO |

# SHORT ELLIOTT HENDRICKSON INC.

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A9d

## 2045 Future - CSAH 48 at Chambers Ave
## ALL WAY STOP
## WARRANT ANALYSIS

LOCATION: CSAH 48 at Chambers Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach Description | | Lanes | Approach Total |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 3403 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2963 |
| 30 | Minor App2: | Chambers Ave NB | 1 | 177 |
| 30 | Minor App4: | Chambers Ave SB | 1 | 1198 |

0.70 SPEED FACTOR USED? **No**

**Minimum Volume Requirement**
**300** **200**

| HOUR | MAJOR APP. 1 | MAJOR APP. 3 | MINOR APP. 2 | MINOR APP. 4 | MAJOR APPROACH TOTAL Σ (APP.1 + APP. 3) | MINOR APPROACH TOTAL Σ (APP.2 + APP. 4) | WARRANT MET MAJOR / MINOR |
|---|---|---|---|---|---|---|---|
| 0:00 - 1:00 | 3 | 8 | 0 | 0 | 11 | 0 | NO / NO |
| 1:00 - 2:00 | 10 | 4 | 1 | 1 | 14 | 2 | NO / NO |
| 2:00 - 3:00 | 11 | 6 | 0 | 3 | 17 | 3 | NO / NO |
| 3:00 - 4:00 | 6 | 7 | 0 | 2 | 13 | 2 | NO / NO |
| 4:00 - 5:00 | 16 | 37 | 2 | 5 | 53 | 7 | NO / NO |
| 5:00 - 6:00 | 46 | 96 | 10 | 29 | 142 | 39 | NO / NO |
| 6:00 - 7:00 | 110 | 153 | 3 | 67 | 263 | 70 | NO / NO |
| 7:00 - 8:00 | 166 | 321 | 13 | 180 | 487 | 193 | YES / NO |
| 8:00 - 9:00 | 147 | 173 | 8 | 81 | 320 | 89 | YES / NO |
| 9:00 - 10:00 | 117 | 143 | 8 | 62 | 260 | 70 | NO / NO |
| 10:00 - 11:00 | 171 | 176 | 14 | 65 | 347 | 79 | YES / NO |
| 11:00 - 12:00 | 214 | 194 | 4 | 86 | 408 | 90 | YES / NO |
| 12:00 - 13:00 | 178 | 170 | 8 | 52 | 348 | 60 | YES / NO |
| 13:00 - 14:00 | 182 | 174 | 10 | 57 | 356 | 67 | YES / NO |
| 14:00 - 15:00 | 244 | 232 | 28 | 75 | 476 | 103 | YES / NO |
| 15:00 - 16:00 | 356 | 225 | 18 | 74 | 581 | 92 | YES / NO |
| 16:00 - 17:00 | 411 | 260 | 12 | 122 | 671 | 134 | YES / NO |
| 17:00 - 18:00 | 341 | 206 | 12 | 100 | 547 | 112 | YES / NO |
| 18:00 - 19:00 | 200 | 147 | 8 | 48 | 347 | 56 | YES / NO |
| 19:00 - 20:00 | 170 | 81 | 6 | 34 | 251 | 40 | NO / NO |
| 20:00 - 21:00 | 130 | 59 | 4 | 24 | 189 | 28 | NO / NO |
| 21:00 - 22:00 | 102 | 43 | 6 | 9 | 145 | 15 | NO / NO |
| 22:00 - 23:00 | 42 | 31 | 1 | 16 | 73 | 17 | NO / NO |
| 23:00 - 24:00 | 30 | 17 | 1 | 6 | 47 | 7 | NO / NO |
| **Daily** | **3403** | **2963** | **177** | **1198** | | | |

| | Met (Hr) | Required (Hr) |
|---|---|---|
| **Hours met for warrant:** | **0** | **8** |

**All-way Stop Warrant:** **Not satisfied**

REMARKS:

# SHORT ELLIOTT HENDRICKSON INC.

Exhibit A9e

10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

## 2045 Future - CSAH 48 at Chambers Ave
## SIGNAL WARRANT
## ANALYSIS

LOCATION: CSAH 48 at Chambers Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022
OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 3403 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2963 |
| 30 | Minor App2: | Chambers Ave NB | 1 | 162 |
| 30 | Minor App4: | Chambers Ave SB | 1 | 349 |

| | |
|---|---|
| 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 | 500 | 750 | 600 |
| 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 | 3 | 8 | 0 | 0 | 11 | 0 | NO / NO | NO / NO | NO / NO |
| 1:00 - 2:00 | 10 | 4 | 1 | 1 | 14 | 1 | NO / NO | NO / NO | NO / NO |
| 2:00 - 3:00 | 11 | 6 | 0 | 3 | 17 | 3 | NO / NO | NO / NO | NO / NO |
| 3:00 - 4:00 | 6 | 7 | 0 | 0 | 13 | 0 | NO / NO | NO / NO | NO / NO |
| 4:00 - 5:00 | 16 | 37 | 2 | 2 | 53 | 2 | NO / NO | NO / NO | NO / NO |
| 5:00 - 6:00 | 46 | 96 | 8 | 5 | 142 | 8 | NO / NO | NO / NO | NO / NO |
| 6:00 - 7:00 | 110 | 153 | 2 | 14 | 263 | 14 | NO / NO | NO / NO | NO / NO |
| 7:00 - 8:00 | 166 | 321 | 12 | 57 | 487 | 57 | NO / NO | NO / NO | NO / NO |
| 8:00 - 9:00 | 147 | 173 | 6 | 14 | 320 | 14 | NO / NO | NO / NO | NO / NO |
| 9:00 - 10:00 | 117 | 143 | 8 | 18 | 260 | 18 | NO / NO | NO / NO | NO / NO |
| 10:00 - 11:00 | 171 | 176 | 10 | 13 | 347 | 13 | NO / NO | NO / NO | NO / NO |
| 11:00 - 12:00 | 214 | 194 | 4 | 24 | 408 | 24 | NO / NO | NO / NO | NO / NO |
| 12:00 - 13:00 | 178 | 170 | 8 | 13 | 348 | 13 | NO / NO | NO / NO | NO / NO |
| 13:00 - 14:00 | 182 | 174 | 10 | 19 | 356 | 19 | NO / NO | NO / NO | NO / NO |
| 14:00 - 15:00 | 244 | 232 | 28 | 24 | 476 | 28 | NO / NO | NO / NO | NO / NO |
| 15:00 - 16:00 | 356 | 225 | 14 | 22 | 581 | 22 | YES / NO | NO / NO | NO / NO |
| 16:00 - 17:00 | 411 | 260 | 11 | 48 | 671 | 48 | YES / NO | NO / NO | YES / NO |
| 17:00 - 18:00 | 341 | 206 | 12 | 27 | 547 | 27 | YES / NO | NO / NO | NO / NO |
| 18:00 - 19:00 | 200 | 147 | 8 | 10 | 347 | 10 | NO / NO | NO / NO | NO / NO |
| 19:00 - 20:00 | 170 | 81 | 6 | 11 | 251 | 11 | NO / NO | NO / NO | NO / NO |
| 20:00 - 21:00 | 130 | 59 | 4 | 11 | 189 | 11 | NO / NO | NO / NO | NO / NO |
| 21:00 - 22:00 | 102 | 43 | 6 | 5 | 145 | 6 | NO / NO | NO / NO | NO / NO |
| 22:00 - 23:00 | 42 | 31 | 1 | 7 | 73 | 7 | NO / NO | NO / NO | NO / NO |
| 23:00 - 24:00 | 30 | 17 | 1 | 1 | 47 | 1 | NO / NO | NO / NO | NO / NO |
| **Daily** | **3403** | **2963** | **162** | **349** | | | | | |

| | | 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:

**SHORT ELLIOTT HENDRICKSON INC.**
10901 Red Circle Drive, Suite 200
Minnetonka, MN 55343

Exhibit A9f

# 2045 Future - CSAH 48 at Chambers Ave
# SIGNAL WARRANT
# ANALYSIS

LOCATION: CSAH 48 at Chambers Ave
COUNTY: Steele
REF. POINT: 0
DATE: 1/17/2022

OPERATOR: JDA

| 85th% Speed | Approach | Description | Lanes | Approach |
|---|---|---|---|---|
| 30 | Major App1: | CSAH 48 EB | 1 | 3403 |
| 30 | Major App3: | CSAH 48 WB | 1 | 2963 |
| 30 | Minor App2: | Chambers Ave NB | 1 | 162 |
| 30 | Minor App4: | Chambers Ave SB | 1 | 349 |

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

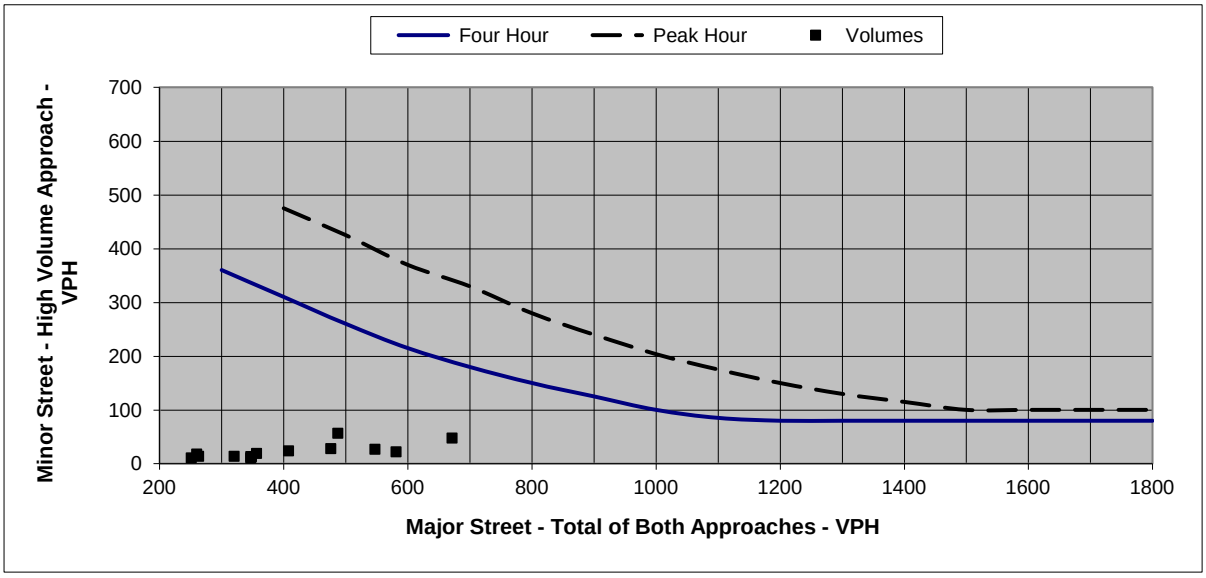



Figure 1. Four Hour and Peak Hour Warrant Analysis

*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 | 360 | |
| 400 | 310 | 475 |
| 500 | 260 | 425 |
| 600 | 215 | 370 |
| 700 | 180 | 330 |
| 800 | 150 | 280 |
| 900 | 125 | 240 |
| 1000 | 100 | 204 |
| 1100 | 85 | 175 |
| 1200 | 80 | 150 |
| 1300 | 80 | 130 |
| 1400 | 80 | 115 |
| 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 | 11 | 0 | NO | NO |
| 1:00 - 2:00 | 14 | 1 | NO | NO |
| 2:00 - 3:00 | 17 | 3 | NO | NO |
| 3:00 - 4:00 | 13 | 0 | NO | NO |
| 4:00 - 5:00 | 53 | 2 | NO | NO |
| 5:00 - 6:00 | 142 | 8 | NO | NO |
| 6:00 - 7:00 | 263 | 14 | NO | NO |
| 7:00 - 8:00 | 487 | 57 | NO | NO |
| 8:00 - 9:00 | 320 | 14 | NO | NO |
| 9:00 - 10:00 | 260 | 18 | NO | NO |
| 10:00 - 11:00 | 347 | 13 | NO | NO |
| 11:00 - 12:00 | 408 | 24 | NO | NO |
| 12:00 - 13:00 | 348 | 13 | NO | NO |
| 13:00 - 14:00 | 356 | 19 | NO | NO |
| 14:00 - 15:00 | 476 | 28 | NO | NO |
| 15:00 - 16:00 | 581 | 22 | NO | NO |
| 16:00 - 17:00 | 671 | 48 | NO | NO |
| 17:00 - 18:00 | 547 | 27 | NO | NO |
| 18:00 - 19:00 | 347 | 10 | NO | NO |
| 19:00 - 20:00 | 251 | 11 | NO | NO |
| 20:00 - 21:00 | 189 | 11 | NO | NO |
| 21:00 - 22:00 | 145 | 6 | NO | NO |
| 22:00 - 23:00 | 73 | 7 | NO | NO |
| 23:00 - 24:00 | 47 | 1 | NO | NO |

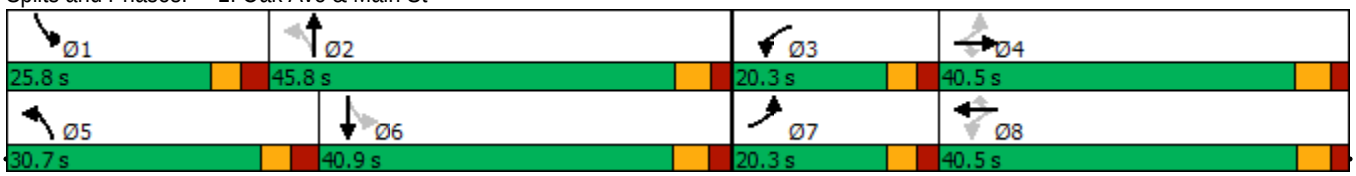
# Appendix B

Traffic Operations Analysis Reports

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 46 | 178 | 164 | 41 | 245 | 65 | 191 | 208 | 34 | 42 | 181 | 17 |
| Future Volume (vph) | 46 | 178 | 164 | 41 | 245 | 65 | 191 | 208 | 34 | 42 | 181 | 17 |
| Satd. Flow (prot) | 1770 | 1827 | 1599 | 1687 | 1863 | 1538 | 1770 | 1821 | 0 | 1641 | 1783 | 0 |
| Flt Permitted | 0.366 | | | 0.459 | | | 0.358 | | | 0.556 | | |
| Satd. Flow (perm) | 682 | 1827 | 1599 | 815 | 1863 | 1538 | 667 | 1821 | 0 | 960 | 1783 | 0 |
| Satd. Flow (RTOR) | | | 256 | | | 115 | | 8 | | | 4 | |
| Peak Hour Factor | 0.64 | 0.70 | 0.64 | 0.73 | 0.91 | 0.90 | 0.71 | 0.74 | 0.57 | 0.66 | 0.75 | 0.71 |
| Heavy Vehicles (%) | 2% | 4% | 1% | 7% | 2% | 5% | 2% | 2% | 0% | 10% | 5% | 6% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 72 | 254 | 256 | 56 | 269 | 72 | 269 | 341 | 0 | 64 | 265 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 23.9 | 17.6 | 17.6 | 22.1 | 16.8 | 16.8 | 40.1 | 30.2 | | 25.3 | 18.2 | |
| Actuated g/C Ratio | 0.30 | 0.22 | 0.22 | 0.28 | 0.21 | 0.21 | 0.51 | 0.38 | | 0.32 | 0.23 | |
| v/c Ratio | 0.23 | 0.62 | 0.46 | 0.19 | 0.68 | 0.17 | 0.48 | 0.49 | | 0.17 | 0.64 | |
| Control Delay | 20.2 | 37.1 | 7.1 | 20.0 | 40.2 | 2.6 | 16.4 | 24.9 | | 15.5 | 38.9 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 20.2 | 37.1 | 7.1 | 20.0 | 40.2 | 2.6 | 16.4 | 24.9 | | 15.5 | 38.9 | |
| LOS | C | D | A | B | D | A | B | C | | B | D | |
| Approach Delay | | 21.8 | | | 30.5 | | | 21.2 | | | 34.4 | |
| Approach LOS | | C | | | C | | | C | | | C | |
| Queue Length 50th (ft) | 22 | 109 | 0 | 17 | 118 | 0 | 76 | 133 | | 16 | 118 | |
| Queue Length 95th (ft) | 43 | 176 | 2 | 41 | 256 | 12 | 121 | 207 | | 33 | 205 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 100 | | | 150 | | | 225 | | |
| Base Capacity (vph) | 469 | 866 | 893 | 473 | 886 | 792 | 713 | 993 | | 641 | 847 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.15 | 0.29 | 0.29 | 0.12 | 0.30 | 0.09 | 0.38 | 0.34 | | 0.10 | 0.31 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 78.9 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.68 | |
| Intersection Signal Delay: 25.6 | Intersection LOS: C |
| Intersection Capacity Utilization 58.7% | ICU Level of Service B |
| Analysis Period (min) 15 | |

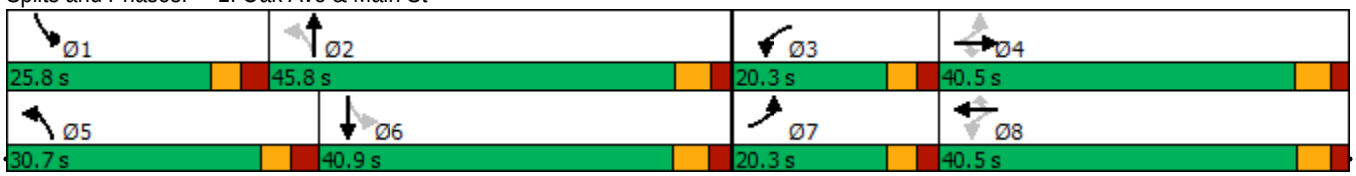
Splits and Phases: 1: Oak Ave & Main St



| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 88 | 285 | 247 | 78 | 241 | 102 | 200 | 283 | 31 | 115 | 322 | 31 |
| Future Volume (vph) | 88 | 285 | 247 | 78 | 241 | 102 | 200 | 283 | 31 | 115 | 322 | 31 |
| Satd. Flow (prot) | 1805 | 1881 | 1615 | 1805 | 1863 | 1583 | 1770 | 1870 | 0 | 1787 | 1835 | 0 |
| Flt Permitted | 0.394 | | | 0.361 | | | 0.224 | | | 0.361 | | |
| Satd. Flow (perm) | 749 | 1881 | 1615 | 686 | 1863 | 1583 | 417 | 1870 | 0 | 679 | 1835 | 0 |
| Satd. Flow (RTOR) | | | 260 | | | 116 | | 5 | | | 4 | |
| Peak Hour Factor | 0.85 | 0.81 | 0.95 | 0.81 | 0.93 | 0.88 | 0.98 | 0.85 | 0.78 | 0.76 | 0.93 | 0.86 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 2% | 2% | 0% | 0% | 1% | 2% | 3% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 104 | 352 | 260 | 96 | 259 | 116 | 204 | 373 | 0 | 151 | 382 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 32.6 | 25.1 | 25.1 | 29.1 | 21.1 | 21.1 | 39.8 | 26.5 | | 33.3 | 23.2 | |
| Actuated g/C Ratio | 0.36 | 0.28 | 0.28 | 0.32 | 0.23 | 0.23 | 0.44 | 0.29 | | 0.37 | 0.26 | |
| v/c Ratio | 0.28 | 0.67 | 0.41 | 0.30 | 0.60 | 0.25 | 0.53 | 0.68 | | 0.40 | 0.80 | |
| Control Delay | 21.1 | 39.3 | 6.2 | 21.8 | 38.4 | 7.7 | 20.9 | 36.1 | | 19.2 | 47.0 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 21.1 | 39.3 | 6.2 | 21.8 | 38.4 | 7.7 | 20.9 | 36.1 | | 19.2 | 47.0 | |
| LOS | C | D | A | C | D | A | C | D | | B | D | |
| Approach Delay | | 24.6 | | | 27.5 | | | 30.7 | | | 39.1 | |
| Approach LOS | | C | | | C | | | C | | | D | |
| Queue Length 50th (ft) | 36 | 179 | 0 | 33 | 127 | 0 | 65 | 179 | | 46 | 198 | |
| Queue Length 95th (ft) | 82 | 307 | 63 | 73 | 257 | 43 | 142 | 327 | | 89 | 387 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 100 | | | 150 | | | 225 | | |
| Base Capacity (vph) | 481 | 773 | 817 | 465 | 768 | 721 | 595 | 881 | | 574 | 757 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.22 | 0.46 | 0.32 | 0.21 | 0.34 | 0.16 | 0.34 | 0.42 | | 0.26 | 0.50 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 90.2 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.80 | |
| Intersection Signal Delay: 30.1 | Intersection LOS: C |
| Intersection Capacity Utilization 67.9% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 1: Oak Ave & Main St



| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 254 | 293 | 0 | 81 | 58 |
| Future Volume (vph) | 0 | 254 | 293 | 0 | 81 | 58 |
| Satd. Flow (prot) | 0 | 3298 | 3330 | 0 | 1787 | 1583 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 3298 | 3330 | 0 | 1787 | 1583 |
| Satd. Flow (RTOR) | | | | | | 64 |
| Peak Hour Factor | 1.00 | 0.67 | 0.94 | 1.00 | 0.63 | 0.91 |
| Heavy Vehicles (%) | 0% | 4% | 3% | 0% | 1% | 2% |
| Parking (#/hr) | | 0 | 0 | | | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 379 | 312 | 0 | 129 | 64 |
| Turn Type | | NA | NA | | Perm | Perm |
| Protected Phases | | 2 | 6 | | | |
| Permitted Phases | | | | | 4 | 4 |
| Total Split (s) | | 60.0 | 60.0 | | 20.0 | 20.0 |
| Total Lost Time (s) | | 5.5 | 5.6 | | 5.2 | 5.2 |
| Act Effct Green (s) | | 61.3 | 61.2 | | 11.7 | 11.7 |
| Actuated g/C Ratio | | 0.77 | 0.76 | | 0.15 | 0.15 |
| v/c Ratio | | 0.15 | 0.12 | | 0.49 | 0.22 |
| Control Delay | | 3.8 | 1.9 | | 37.4 | 10.1 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 3.8 | 1.9 | | 37.4 | 10.1 |
| LOS | | A | A | | D | B |
| Approach Delay | | 3.8 | 1.9 | | 28.3 | |
| Approach LOS | | A | A | | C | |
| Queue Length 50th (ft) | | 26 | 4 | | 60 | 0 |
| Queue Length 95th (ft) | | 32 | 12 | | 72 | 32 |
| Internal Link Dist (ft) | | 459 | 42 | | 556 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 2526 | 2547 | | 330 | 345 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.15 | 0.12 | | 0.39 | 0.19 |

## Intersection Summary

Cycle Length: 80
Actuated Cycle Length: 80
Offset: 23 (29%), Referenced to phase 2:EBT and 6:WBT, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.49
Intersection Signal Delay: 8.5 — Intersection LOS: A
Intersection Capacity Utilization 27.3% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 2: Main St & W Park Square



| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 431 | 320 | 0 | 107 | 101 |
| Future Volume (vph) | 0 | 431 | 320 | 0 | 107 | 101 |
| Satd. Flow (prot) | 0 | 3396 | 3396 | 0 | 1805 | 1615 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 3396 | 3396 | 0 | 1805 | 1615 |
| Satd. Flow (RTOR) | | | | | | 116 |
| Peak Hour Factor | 1.00 | 0.86 | 0.88 | 1.00 | 0.79 | 0.87 |
| Heavy Vehicles (%) | 0% | 1% | 1% | 0% | 0% | 0% |
| Parking (#/hr) | | 0 | 0 | | | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 501 | 364 | 0 | 135 | 116 |
| Turn Type | | NA | NA | | Perm | Perm |
| Protected Phases | | 2 | 6 | | | |
| Permitted Phases | | | | | 4 | 4 |
| Total Split (s) | | 75.0 | 75.0 | | 25.0 | 25.0 |
| Total Lost Time (s) | | 5.5 | 5.6 | | 5.2 | 5.2 |
| Act Effct Green (s) | | 75.6 | 75.5 | | 13.7 | 13.7 |
| Actuated g/C Ratio | | 0.76 | 0.76 | | 0.14 | 0.14 |
| v/c Ratio | | 0.20 | 0.14 | | 0.55 | 0.36 |
| Control Delay | | 4.0 | 8.7 | | 48.1 | 10.3 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 4.0 | 8.7 | | 48.1 | 10.3 |
| LOS | | A | A | | D | B |
| Approach Delay | | 4.0 | 8.7 | | 30.6 | |
| Approach LOS | | A | A | | C | |
| Queue Length 50th (ft) | | 39 | 58 | | 81 | 0 |
| Queue Length 95th (ft) | | 64 | 116 | | 117 | 43 |
| Internal Link Dist (ft) | | 459 | 42 | | 556 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 2568 | 2565 | | 357 | 412 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.20 | 0.14 | | 0.38 | 0.28 |

| Intersection Summary | |
|---|---|
| Cycle Length: 100 | |
| Actuated Cycle Length: 100 | |
| Offset: 96 (96%), Referenced to phase 2:EBT and 6:WBT, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.55 | |
| Intersection Signal Delay: 11.5 | Intersection LOS: B |
| Intersection Capacity Utilization 27.8% | ICU Level of Service A |
| Analysis Period (min) 15 | |

Splits and Phases: 2: Main St & W Park Square



| Intersection | |
|---|---|
| Int Delay, s/veh | 2.3 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 268 | 67 | 65 | 281 | 12 | 63 |
| Future Vol, veh/h | 268 | 67 | 65 | 281 | 12 | 63 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 67 | 62 | 71 | 91 | 50 | 68 |
| Heavy Vehicles, % | 4 | 3 | 3 | 3 | 8 | 5 |
| Mvmt Flow | 400 | 108 | 92 | 309 | 24 | 93 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 508 | 0 | 793 | 254 |
| Stage 1 | - | - | - | - | 454 | - |
| Stage 2 | - | - | - | - | 339 | - |
| Critical Hdwy | - | - | 4.16 | - | 6.96 | 7 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.96 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.96 | - |
| Follow-up Hdwy | - | - | 2.23 | - | 3.58 | 3.35 |
| Pot Cap-1 Maneuver | - | - | 1046 | - | 314 | 736 |
| Stage 1 | - | - | - | - | 589 | - |
| Stage 2 | - | - | - | - | 676 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1046 | - | 281 | 736 |
| Mov Cap-2 Maneuver | - | - | - | - | 281 | - |
| Stage 1 | - | - | - | - | 589 | - |
| Stage 2 | - | - | - | - | 604 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 2.2 | 12.3 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 281 | 736 | - | - | 1046 | - |
| HCM Lane V/C Ratio | 0.085 | 0.126 | - | - | 0.088 | - |
| HCM Control Delay (s) | 19 | 10.6 | - | - | 8.8 | 0.3 |
| HCM Lane LOS | C | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.3 | 0.4 | - | - | 0.3 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.5 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 483 | 55 | 46 | 297 | 23 | 115 |
| Future Vol, veh/h | 483 | 55 | 46 | 297 | 23 | 115 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 88 | 76 | 82 | 85 | 64 | 78 |
| Heavy Vehicles, % | 1 | 0 | 2 | 1 | 0 | 0 |
| Mvmt Flow | 549 | 72 | 56 | 349 | 36 | 147 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 621 | 0 | 872 | 311 |
| Stage 1 | - | - | - | - | 585 | - |
| Stage 2 | - | - | - | - | 287 | - |
| Critical Hdwy | - | - | 4.14 | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | - | - | 2.22 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 956 | - | 294 | 691 |
| Stage 1 | - | - | - | - | 526 | - |
| Stage 2 | - | - | - | - | 742 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 956 | - | 273 | 691 |
| Mov Cap-2 Maneuver | - | - | - | - | 273 | - |
| Stage 1 | - | - | - | - | 526 | - |
| Stage 2 | - | - | - | - | 688 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 1.4 | 13.3 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 273 | 691 | - | - | 956 | - |
| HCM Lane V/C Ratio | 0.132 | 0.213 | - | - | 0.059 | - |
| HCM Control Delay (s) | 20.2 | 11.6 | - | - | 9 | 0.2 |
| HCM Lane LOS | C | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.4 | 0.8 | - | - | 0.2 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.3 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 69 | 262 | 346 | 23 | 0 | 0 |
| Future Vol, veh/h | 69 | 262 | 346 | 23 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 58 | 70 | 96 | 64 | 100 | 100 |
| Heavy Vehicles, % | 1 | 5 | 3 | 4 | 0 | 0 |
| Mvmt Flow | 119 | 374 | 360 | 36 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 396 | 0 | - | 0 | 803 | 198 |
| Stage 1 | - | - | - | - | 378 | - |
| Stage 2 | - | - | - | - | 425 | - |
| Critical Hdwy | 4.12 | - | - | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | 2.21 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1166 | - | - | - | 325 | 816 |
| Stage 1 | - | - | - | - | 669 | - |
| Stage 2 | - | - | - | - | 633 | - |
| Platoon blocked, % | | | - | - | - | |
| Mov Cap-1 Maneuver | 1166 | - | - | - | 283 | 816 |
| Mov Cap-2 Maneuver | - | - | - | - | 283 | - |
| Stage 1 | - | - | - | - | 583 | - |
| Stage 2 | - | - | - | - | 633 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 2.3 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1166 | - | - | - | - |
| HCM Lane V/C Ratio | 0.102 | - | - | - | - |
| HCM Control Delay (s) | 8.4 | 0.3 | - | - | 0 |
| HCM Lane LOS | A | A | - | - | A |
| HCM 95th %tile Q(veh) | 0.3 | - | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.1 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 101 | 497 | 343 | 49 | 0 | 0 |
| Future Vol, veh/h | 101 | 497 | 343 | 49 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 90 | 92 | 86 | 82 | 100 | 100 |
| Heavy Vehicles, % | 0 | 0 | 1 | 0 | 0 | 0 |
| Mvmt Flow | 112 | 540 | 399 | 60 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 459 | 0 | - | 0 | 923 | 230 |
| Stage 1 | - | - | - | - | 429 | - |
| Stage 2 | - | - | - | - | 494 | - |
| Critical Hdwy | 4.1 | - | - | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | 2.2 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1113 | - | - | - | 273 | 779 |
| Stage 1 | - | - | - | - | 630 | - |
| Stage 2 | - | - | - | - | 584 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1113 | - | - | - | 234 | 779 |
| Mov Cap-2 Maneuver | - | - | - | - | 234 | - |
| Stage 1 | - | - | - | - | 539 | - |
| Stage 2 | - | - | - | - | 584 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 1.8 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1113 | - | - | - | - |
| HCM Lane V/C Ratio | 0.101 | - | - | - | - |
| HCM Control Delay (s) | 8.6 | 0.4 | - | - | 0 |
| HCM Lane LOS | A | A | - | - | A |
| HCM 95th %tile Q(veh) | 0.3 | - | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 261 | 1 | 2 | 369 | 0 | 0 |
| Future Vol, veh/h | 261 | 1 | 2 | 369 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 50 | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 70 | 25 | 50 | 93 | 100 | 100 |
| Heavy Vehicles, % | 5 | 0 | 0 | 3 | 0 | 0 |
| Mvmt Flow | 373 | 4 | 4 | 397 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 377 | 0 | 582 | 189 |
| Stage 1 | - | - | - | - | 375 | - |
| Stage 2 | - | - | - | - | 207 | - |
| Critical Hdwy | - | - | 4.1 | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | - | - | 2.2 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 1193 | - | 449 | 827 |
| Stage 1 | - | - | - | - | 671 | - |
| Stage 2 | - | - | - | - | 814 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1193 | - | 447 | 827 |
| Mov Cap-2 Maneuver | - | - | - | - | 447 | - |
| Stage 1 | - | - | - | - | 671 | - |
| Stage 2 | - | - | - | - | 811 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0.1 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | - | 1193 | - |
| HCM Lane V/C Ratio | - | - | - | 0.003 | - |
| HCM Control Delay (s) | 0 | - | - | 8 | 0 |
| HCM Lane LOS | A | - | - | A | A |
| HCM 95th %tile Q(veh) | - | - | - | 0 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 495 | 2 | 3 | 392 | 0 | 0 |
| Future Vol, veh/h | 495 | 2 | 3 | 392 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 50 | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 50 | 38 | 87 | 100 | 100 |
| Heavy Vehicles, % | 1 | 0 | 0 | 1 | 0 | 0 |
| Mvmt Flow | 538 | 4 | 8 | 451 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 542 | 0 | 782 | 271 |
| Stage 1 | - | - | - | - | 540 | - |
| Stage 2 | - | - | - | - | 242 | - |
| Critical Hdwy | - | - | 4.1 | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | - | - | 2.2 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 1037 | - | 335 | 733 |
| Stage 1 | - | - | - | - | 554 | - |
| Stage 2 | - | - | - | - | 782 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1037 | - | 332 | 733 |
| Mov Cap-2 Maneuver | - | - | - | - | 332 | - |
| Stage 1 | - | - | - | - | 554 | - |
| Stage 2 | - | - | - | - | 774 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0.1 | 0 |
| HCM LOS | | | A |

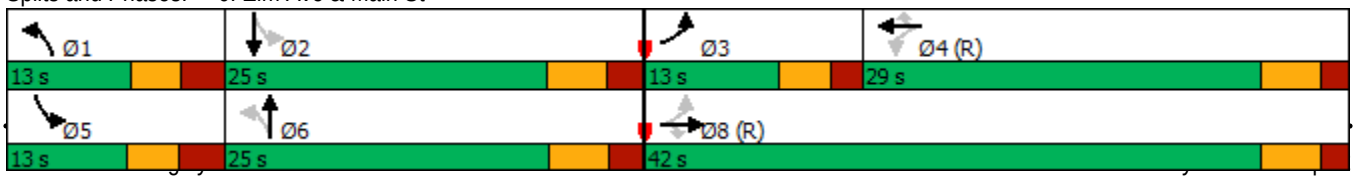
| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | - | 1037 | - |
| HCM Lane V/C Ratio | - | - | - | 0.008 | - |
| HCM Control Delay (s) | 0 | - | - | 8.5 | 0 |
| HCM Lane LOS | A | - | - | A | A |
| HCM 95th %tile Q(veh) | - | - | - | 0 | - |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 53 | 179 | 29 | 32 | 266 | 35 | 57 | 107 | 38 | 16 | 133 | 48 |
| Future Volume (vph) | 53 | 179 | 29 | 32 | 266 | 35 | 57 | 107 | 38 | 16 | 133 | 48 |
| Satd. Flow (prot) | 1736 | 1845 | 1468 | 1805 | 1845 | 1568 | 1805 | 1797 | 0 | 1805 | 1805 | 0 |
| Flt Permitted | 0.432 | | | 0.599 | | | 0.406 | | | 0.621 | | |
| Satd. Flow (perm) | 789 | 1845 | 1468 | 1138 | 1845 | 1568 | 771 | 1797 | 0 | 1180 | 1805 | 0 |
| Satd. Flow (RTOR) | | | 117 | | | 185 | | 18 | | | 15 | |
| Peak Hour Factor | 0.95 | 0.69 | 0.52 | 0.80 | 0.94 | 0.73 | 0.75 | 0.64 | 0.73 | 0.57 | 0.67 | 0.92 |
| Heavy Vehicles (%) | 4% | 3% | 10% | 0% | 3% | 3% | 0% | 1% | 5% | 0% | 2% | 2% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 56 | 259 | 56 | 40 | 283 | 48 | 76 | 219 | 0 | 28 | 251 | 0 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | 8 | 4 | | 4 | 6 | | | 2 | | |
| Total Split (s) | 13.0 | 42.0 | 42.0 | 29.0 | 29.0 | 29.0 | 13.0 | 25.0 | | 13.0 | 25.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 42.5 | 42.2 | 42.2 | 35.0 | 35.0 | 35.0 | 24.9 | 21.8 | | 21.2 | 16.4 | |
| Actuated g/C Ratio | 0.53 | 0.53 | 0.53 | 0.44 | 0.44 | 0.44 | 0.31 | 0.27 | | 0.26 | 0.20 | |
| v/c Ratio | 0.11 | 0.27 | 0.07 | 0.08 | 0.35 | 0.06 | 0.23 | 0.44 | | 0.08 | 0.66 | |
| Control Delay | 12.9 | 13.7 | 2.7 | 15.8 | 17.4 | 0.3 | 18.0 | 25.3 | | 16.4 | 36.0 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 12.9 | 13.7 | 2.7 | 15.8 | 17.4 | 0.3 | 18.0 | 25.3 | | 16.4 | 36.0 | |
| LOS | B | B | A | B | B | A | B | C | | B | D | |
| Approach Delay | | 11.9 | | | 15.0 | | | 23.4 | | | 34.1 | |
| Approach LOS | | B | | | B | | | C | | | C | |
| Queue Length 50th (ft) | 14 | 72 | 0 | 9 | 118 | 1 | 25 | 72 | | 9 | 111 | |
| Queue Length 95th (ft) | 37 | 97 | 0 | 23 | 178 | 0 | 40 | 98 | | 15 | 121 | |
| Internal Link Dist (ft) | | 301 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 115 | | | 65 | | 65 | 65 | | | 60 | | |
| Base Capacity (vph) | 514 | 973 | 830 | 498 | 807 | 790 | 335 | 524 | | 383 | 444 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.11 | 0.27 | 0.07 | 0.08 | 0.35 | 0.06 | 0.23 | 0.42 | | 0.07 | 0.57 | |

**Intersection Summary**

Cycle Length: 80
Actuated Cycle Length: 80
Offset: 73 (91%), Referenced to phase 4:WBTL and 8:EBTL, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.66
Intersection Signal Delay: 20.1 — Intersection LOS: C
Intersection Capacity Utilization 54.6% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 6: Elm Ave & Main St



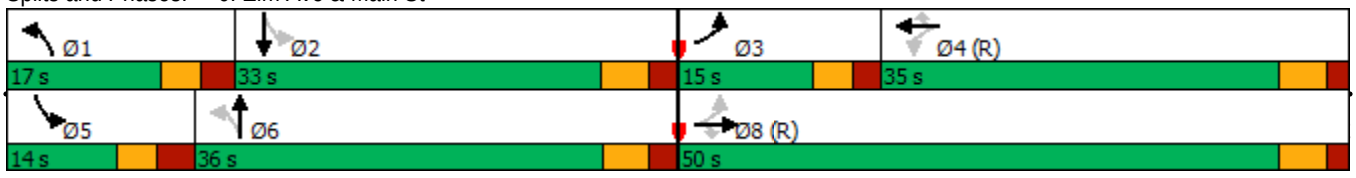

AM Peak Hour

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 112 | 334 | 49 | 17 | 295 | 30 | 43 | 99 | 59 | 29 | 78 | 57 |
| Future Volume (vph) | 112 | 334 | 49 | 17 | 295 | 30 | 43 | 99 | 59 | 29 | 78 | 57 |
| Satd. Flow (prot) | 1805 | 1881 | 1615 | 1805 | 1863 | 1615 | 1805 | 1796 | 0 | 1805 | 1768 | 0 |
| Flt Permitted | 0.427 | | | 0.541 | | | 0.560 | | | 0.482 | | |
| Satd. Flow (perm) | 811 | 1881 | 1615 | 1028 | 1863 | 1615 | 1064 | 1796 | 0 | 916 | 1768 | 0 |
| Satd. Flow (RTOR) | | | 94 | | | 148 | | 30 | | | 37 | |
| Peak Hour Factor | 0.88 | 0.90 | 0.72 | 0.71 | 0.83 | 0.63 | 0.90 | 0.83 | 0.87 | 0.66 | 0.85 | 0.84 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 0% | 0% | 0% | 0% | 0% | 1% | 0% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 127 | 371 | 68 | 24 | 355 | 48 | 48 | 187 | 0 | 44 | 160 | 0 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | 8 | 4 | | 4 | 6 | | | 2 | | |
| Total Split (s) | 15.0 | 50.0 | 50.0 | 35.0 | 35.0 | 35.0 | 17.0 | 36.0 | | 14.0 | 33.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 65.1 | 64.8 | 64.8 | 52.0 | 52.0 | 52.0 | 21.1 | 16.3 | | 20.5 | 16.0 | |
| Actuated g/C Ratio | 0.65 | 0.65 | 0.65 | 0.52 | 0.52 | 0.52 | 0.21 | 0.16 | | 0.20 | 0.16 | |
| v/c Ratio | 0.21 | 0.30 | 0.06 | 0.04 | 0.37 | 0.05 | 0.17 | 0.59 | | 0.18 | 0.51 | |
| Control Delay | 11.6 | 12.9 | 3.6 | 13.8 | 15.3 | 0.5 | 27.5 | 40.3 | | 27.8 | 35.1 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 11.6 | 12.9 | 3.6 | 13.8 | 15.3 | 0.5 | 27.5 | 40.3 | | 27.8 | 35.1 | |
| LOS | B | B | A | B | B | A | C | D | | C | D | |
| Approach Delay | | 11.5 | | | 13.5 | | | 37.7 | | | 33.6 | |
| Approach LOS | | B | | | B | | | D | | | C | |
| Queue Length 50th (ft) | 39 | 131 | 0 | 8 | 130 | 1 | 23 | 94 | | 21 | 73 | |
| Queue Length 95th (ft) | 79 | 225 | 2 | m18 | 183 | 0 | 46 | 142 | | 31 | 122 | |
| Internal Link Dist (ft) | | 301 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 115 | | | 65 | | 65 | 65 | | | 60 | | |
| Base Capacity (vph) | 628 | 1218 | 1079 | 534 | 968 | 910 | 331 | 565 | | 264 | 507 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.20 | 0.30 | 0.06 | 0.04 | 0.37 | 0.05 | 0.15 | 0.33 | | 0.17 | 0.32 | |

**Intersection Summary**

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 47 (47%), Referenced to phase 4:WBTL and 8:EBTL, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.59
Intersection Signal Delay: 19.5 — Intersection LOS: B
Intersection Capacity Utilization 60.1% — ICU Level of Service B
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

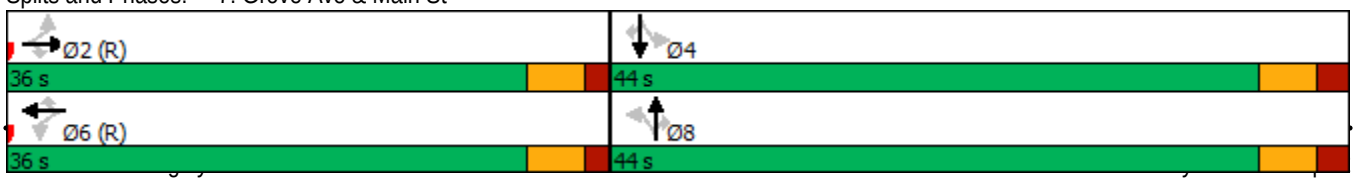
Splits and Phases: 6: Elm Ave & Main St



| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 72 | 136 | 25 | 14 | 195 | 93 | 29 | 131 | 16 | 28 | 265 | 109 |
| Future Volume (vph) | 72 | 136 | 25 | 14 | 195 | 93 | 29 | 131 | 16 | 28 | 265 | 109 |
| Satd. Flow (prot) | 0 | 1810 | 1615 | 0 | 1816 | 1524 | 0 | 1868 | 1615 | 0 | 1818 | 1568 |
| Flt Permitted | | 0.803 | | | 0.972 | | | 0.768 | | | 0.945 | |
| Satd. Flow (perm) | 0 | 1481 | 1615 | 0 | 1772 | 1524 | 0 | 1447 | 1615 | 0 | 1726 | 1568 |
| Satd. Flow (RTOR) | | | 56 | | | 133 | | | 36 | | | 77 |
| Peak Hour Factor | 0.67 | 0.79 | 0.45 | 0.88 | 0.96 | 0.70 | 0.66 | 0.66 | 0.44 | 0.64 | 0.68 | 0.85 |
| Heavy Vehicles (%) | 3% | 3% | 0% | 7% | 4% | 6% | 0% | 1% | 0% | 4% | 4% | 3% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 279 | 56 | 0 | 219 | 133 | 0 | 242 | 36 | 0 | 434 | 128 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | |
| Permitted Phases | 2 | | 2 | 6 | | 6 | 8 | | 8 | 4 | | 4 |
| Total Split (s) | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 |
| Total Lost Time (s) | | 5.1 | 5.1 | | 5.1 | 5.1 | | 5.5 | 5.5 | | 5.5 | 5.5 |
| Act Effct Green (s) | | 40.1 | 40.1 | | 40.1 | 40.1 | | 29.3 | 29.3 | | 29.3 | 29.3 |
| Actuated g/C Ratio | | 0.50 | 0.50 | | 0.50 | 0.50 | | 0.37 | 0.37 | | 0.37 | 0.37 |
| v/c Ratio | | 0.38 | 0.07 | | 0.25 | 0.16 | | 0.46 | 0.06 | | 0.69 | 0.21 |
| Control Delay | | 11.4 | 2.1 | | 14.4 | 3.6 | | 20.8 | 4.6 | | 26.4 | 7.1 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 11.4 | 2.1 | | 14.4 | 3.6 | | 20.8 | 4.6 | | 26.4 | 7.1 |
| LOS | | B | A | | B | A | | C | A | | C | A |
| Approach Delay | | 9.8 | | | 10.3 | | | 18.7 | | | 22.0 | |
| Approach LOS | | A | | | B | | | B | | | C | |
| Queue Length 50th (ft) | | 66 | 2 | | 59 | 0 | | 90 | 0 | | 179 | 16 |
| Queue Length 95th (ft) | | 84 | 1 | | 128 | 15 | | 83 | 2 | | 151 | 37 |
| Internal Link Dist (ft) | | 581 | | | 1203 | | | 622 | | | 478 | |
| Turn Bay Length (ft) | | | 100 | | | 185 | | | 50 | | | 50 |
| Base Capacity (vph) | | 741 | 836 | | 887 | 829 | | 696 | 795 | | 830 | 794 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.38 | 0.07 | | 0.25 | 0.16 | | 0.35 | 0.05 | | 0.52 | 0.16 |

| Intersection Summary | |
|---|---|
| Cycle Length: 80 | |
| Actuated Cycle Length: 80 | |
| Offset: 71 (89%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.69 | |
| Intersection Signal Delay: 16.0 | Intersection LOS: B |
| Intersection Capacity Utilization 66.7% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 7: Grove Ave & Main St



| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 111 | 272 | 39 | 6 | 207 | 50 | 44 | 118 | 15 | 35 | 152 | 91 |
| Future Volume (vph) | 111 | 272 | 39 | 6 | 207 | 50 | 44 | 118 | 15 | 35 | 152 | 91 |
| Satd. Flow (prot) | 0 | 1857 | 1568 | 0 | 1876 | 1615 | 0 | 1858 | 1615 | 0 | 1883 | 1599 |
| Flt Permitted | | 0.813 | | | 0.977 | | | 0.619 | | | 0.835 | |
| Satd. Flow (perm) | 0 | 1534 | 1568 | 0 | 1839 | 1615 | 0 | 1169 | 1615 | 0 | 1586 | 1599 |
| Satd. Flow (RTOR) | | | 60 | | | 64 | | | 23 | | | 84 |
| Peak Hour Factor | 0.79 | 0.92 | 0.65 | 0.50 | 0.91 | 0.78 | 0.69 | 0.87 | 0.63 | 0.88 | 0.84 | 0.76 |
| Heavy Vehicles (%) | 0% | 1% | 3% | 0% | 1% | 0% | 2% | 0% | 0% | 0% | 0% | 1% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 437 | 60 | 0 | 239 | 64 | 0 | 200 | 24 | 0 | 221 | 120 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | |
| Permitted Phases | 2 | | 2 | 6 | | 6 | 8 | | 8 | 4 | | 4 |
| Total Split (s) | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 |
| Total Lost Time (s) | | 5.1 | 5.1 | | 5.1 | 5.1 | | 5.5 | 5.5 | | 5.5 | 5.5 |
| Act Effct Green (s) | | 68.6 | 68.6 | | 68.6 | 68.6 | | 20.8 | 20.8 | | 20.8 | 20.8 |
| Actuated g/C Ratio | | 0.69 | 0.69 | | 0.69 | 0.69 | | 0.21 | 0.21 | | 0.21 | 0.21 |
| v/c Ratio | | 0.42 | 0.05 | | 0.19 | 0.06 | | 0.83 | 0.07 | | 0.67 | 0.30 |
| Control Delay | | 7.5 | 1.1 | | 7.0 | 2.1 | | 63.4 | 11.7 | | 45.9 | 13.1 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 7.5 | 1.1 | | 7.0 | 2.1 | | 63.4 | 11.7 | | 45.9 | 13.1 |
| LOS | | A | A | | A | A | | E | B | | D | B |
| Approach Delay | | 6.7 | | | 6.0 | | | 57.9 | | | 34.4 | |
| Approach LOS | | A | | | A | | | E | | | C | |
| Queue Length 50th (ft) | | 67 | 1 | | 48 | 0 | | 123 | 1 | | 131 | 19 |
| Queue Length 95th (ft) | | 92 | 2 | | 100 | 11 | | 181 | 10 | | 175 | 43 |
| Internal Link Dist (ft) | | 581 | | | 1203 | | | 622 | | | 478 | |
| Turn Bay Length (ft) | | | 100 | | | 185 | | | 50 | | | 50 |
| Base Capacity (vph) | | 1052 | 1094 | | 1261 | 1128 | | 356 | 508 | | 483 | 546 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.42 | 0.05 | | 0.19 | 0.06 | | 0.56 | 0.05 | | 0.46 | 0.22 |

| Intersection Summary | |
|---|---|
| Cycle Length: 100 | |
| Actuated Cycle Length: 100 | |
| Offset: 49 (49%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.83 | |
| Intersection Signal Delay: 21.9 | Intersection LOS: C |
| Intersection Capacity Utilization 69.2% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 7: Grove Ave & Main St



| Intersection | |
|---|---|
| Intersection Delay, s/veh | 50.7 |
| Intersection LOS | F |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 8 | 82 | 55 | 74 | 224 | 65 | 115 | 109 | 22 | 44 | 199 | 17 |
| Future Vol, veh/h | 8 | 82 | 55 | 74 | 224 | 65 | 115 | 109 | 22 | 44 | 199 | 17 |
| Peak Hour Factor | 0.67 | 0.73 | 0.92 | 0.60 | 0.79 | 0.86 | 0.64 | 0.65 | 0.55 | 0.69 | 0.68 | 0.53 |
| Heavy Vehicles, % | 13 | 5 | 0 | 1 | 3 | 2 | 8 | 10 | 9 | 2 | 1 | 0 |
| Mvmt Flow | 12 | 112 | 60 | 123 | 284 | 76 | 180 | 168 | 40 | 64 | 293 | 32 |
| Number of Lanes | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 1 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 1 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 1 | 2 |
| HCM Control Delay | 15.4 | 78.8 | 42.7 | 40.6 |
| HCM LOS | C | F | E | E |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | SBLn1 |
|---|---|---|---|---|---|
| Vol Left, % | 47% | 9% | 0% | 20% | 17% |
| Vol Thru, % | 44% | 91% | 0% | 62% | 77% |
| Vol Right, % | 9% | 0% | 100% | 18% | 7% |
| Sign Control | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 246 | 90 | 55 | 363 | 260 |
| LT Vol | 115 | 8 | 0 | 74 | 44 |
| Through Vol | 109 | 82 | 0 | 224 | 199 |
| RT Vol | 22 | 0 | 55 | 65 | 17 |
| Lane Flow Rate | 387 | 124 | 60 | 482 | 388 |
| Geometry Grp | 2 | 7 | 7 | 5 | 2 |
| Degree of Util (X) | 0.849 | 0.319 | 0.14 | 1.034 | 0.837 |
| Departure Headway (Hd) | 8.195 | 9.565 | 8.647 | 7.716 | 8.065 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes |
| Cap | 445 | 378 | 417 | 473 | 451 |
| Service Time | 6.195 | 7.265 | 6.347 | 5.719 | 6.065 |
| HCM Lane V/C Ratio | 0.87 | 0.328 | 0.144 | 1.019 | 0.86 |
| HCM Control Delay | 42.7 | 16.7 | 12.7 | 78.8 | 40.6 |
| HCM Lane LOS | E | C | B | F | E |
| HCM 95th-tile Q | 8.4 | 1.3 | 0.5 | 14.5 | 8.1 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 14.9 |
| Intersection LOS | B |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 7 | 233 | 98 | 25 | 163 | 51 | 60 | 90 | 36 | 66 | 91 | 9 |
| Future Vol, veh/h | 7 | 233 | 98 | 25 | 163 | 51 | 60 | 90 | 36 | 66 | 91 | 9 |
| Peak Hour Factor | 0.44 | 0.91 | 0.79 | 0.69 | 0.85 | 0.67 | 0.68 | 0.75 | 0.64 | 0.75 | 0.84 | 0.75 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 16 | 256 | 124 | 36 | 192 | 76 | 88 | 120 | 56 | 88 | 108 | 12 |
| Number of Lanes | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 1 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 1 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 1 | 2 |
| HCM Control Delay | 14.3 | 16.1 | 15.3 | 13.9 |
| HCM LOS | B | C | C | B |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | SBLn1 |
|---|---|---|---|---|---|
| Vol Left, % | 32% | 3% | 0% | 10% | 40% |
| Vol Thru, % | 48% | 97% | 0% | 68% | 55% |
| Vol Right, % | 19% | 0% | 100% | 21% | 5% |
| Sign Control | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 186 | 240 | 98 | 239 | 166 |
| LT Vol | 60 | 7 | 0 | 25 | 66 |
| Through Vol | 90 | 233 | 0 | 163 | 91 |
| RT Vol | 36 | 0 | 98 | 51 | 9 |
| Lane Flow Rate | 264 | 272 | 124 | 304 | 208 |
| Geometry Grp | 2 | 7 | 7 | 5 | 2 |
| Degree of Util (X) | 0.476 | 0.504 | 0.205 | 0.528 | 0.386 |
| Departure Headway (Hd) | 6.474 | 6.672 | 5.96 | 6.252 | 6.666 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes |
| Cap | 555 | 538 | 600 | 575 | 540 |
| Service Time | 4.524 | 4.422 | 3.709 | 4.304 | 4.721 |
| HCM Lane V/C Ratio | 0.476 | 0.506 | 0.207 | 0.529 | 0.385 |
| HCM Control Delay | 15.3 | 16.1 | 10.3 | 16.1 | 13.9 |
| HCM Lane LOS | C | C | B | C | B |
| HCM 95th-tile Q | 2.5 | 2.8 | 0.8 | 3.1 | 1.8 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 5.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ⇕ | | | ⇕ | | | ⇕ | | | ⇕ | |
| Traffic Vol, veh/h | 40 | 104 | 4 | 4 | 238 | 39 | 5 | 3 | 1 | 29 | 16 | 113 |
| Future Vol, veh/h | 40 | 104 | 4 | 4 | 238 | 39 | 5 | 3 | 1 | 29 | 16 | 113 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 63 | 70 | 50 | 50 | 86 | 51 | 42 | 38 | 25 | 60 | 67 | 86 |
| Heavy Vehicles, % | 5 | 5 | 25 | 25 | 3 | 0 | 0 | 0 | 100 | 3 | 6 | 2 |
| Mvmt Flow | 63 | 149 | 8 | 8 | 277 | 76 | 12 | 8 | 4 | 48 | 24 | 131 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 353 | 0 | 0 | 157 | 0 | 0 | 688 | 648 | 153 | 616 | 614 | 315 |
| Stage 1 | - | - | - | - | - | - | 279 | 279 | - | 331 | 331 | - |
| Stage 2 | - | - | - | - | - | - | 409 | 369 | - | 285 | 283 | - |
| Critical Hdwy | 4.15 | - | - | 4.35 | - | - | 7.1 | 6.5 | 7.2 | 7.13 | 6.56 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.425 | - | - | 3.5 | 4 | 4.2 | 3.527 | 4.054 | 3.318 |
| Pot Cap-1 Maneuver | 1189 | - | - | 1294 | - | - | 363 | 392 | 689 | 401 | 402 | 725 |
| Stage 1 | - | - | - | - | - | - | 732 | 683 | - | 680 | 638 | - |
| Stage 2 | - | - | - | - | - | - | 623 | 624 | - | 720 | 670 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1189 | - | - | 1294 | - | - | 269 | 366 | 689 | 373 | 375 | 725 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 269 | 366 | - | 373 | 375 | - |
| Stage 1 | - | - | - | - | - | - | 690 | 643 | - | 641 | 633 | - |
| Stage 2 | - | - | - | - | - | - | 487 | 619 | - | 666 | 631 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.4 | 0.2 | 16.7 | 15.5 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 332 | 1189 | - | - | 1294 | - | - | 544 |
| HCM Lane V/C Ratio | 0.072 | 0.053 | - | - | 0.006 | - | - | 0.374 |
| HCM Control Delay (s) | 16.7 | 8.2 | 0 | - | 7.8 | 0 | - | 15.5 |
| HCM Lane LOS | C | A | A | - | A | A | - | C |
| HCM 95th %tile Q(veh) | 0.2 | 0.2 | - | - | 0 | - | - | 1.7 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 3.8 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ⇕ | | | ⇕ | | | ⇕ | | | ⇕ | |
| Traffic Vol, veh/h | 96 | 228 | 7 | 3 | 172 | 34 | 4 | 5 | 1 | 24 | 14 | 61 |
| Future Vol, veh/h | 96 | 228 | 7 | 3 | 172 | 34 | 4 | 5 | 1 | 24 | 14 | 61 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 96 | 88 | 58 | 75 | 81 | 77 | 33 | 63 | 25 | 86 | 88 | 76 |
| Heavy Vehicles, % | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 4 | 0 | 0 |
| Mvmt Flow | 100 | 259 | 12 | 4 | 212 | 44 | 12 | 8 | 4 | 28 | 16 | 80 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 256 | 0 | 0 | 271 | 0 | 0 | 755 | 729 | 265 | 713 | 713 | 234 |
| Stage 1 | - | - | - | - | - | - | 465 | 465 | - | 242 | 242 | - |
| Stage 2 | - | - | - | - | - | - | 290 | 264 | - | 471 | 471 | - |
| Critical Hdwy | 4.11 | - | - | 4.1 | - | - | 7.1 | 6.5 | 6.2 | 7.14 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Follow-up Hdwy | 2.209 | - | - | 2.2 | - | - | 3.5 | 4 | 3.3 | 3.536 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1315 | - | - | 1304 | - | - | 328 | 352 | 779 | 344 | 360 | 810 |
| Stage 1 | - | - | - | - | - | - | 581 | 566 | - | 757 | 709 | - |
| Stage 2 | - | - | - | - | - | - | 722 | 694 | - | 570 | 563 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1315 | - | - | 1304 | - | - | 264 | 319 | 779 | 312 | 326 | 810 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 264 | 319 | - | 312 | 326 | - |
| Stage 1 | - | - | - | - | - | - | 529 | 515 | - | 689 | 706 | - |
| Stage 2 | - | - | - | - | - | - | 633 | 691 | - | 508 | 512 | - |

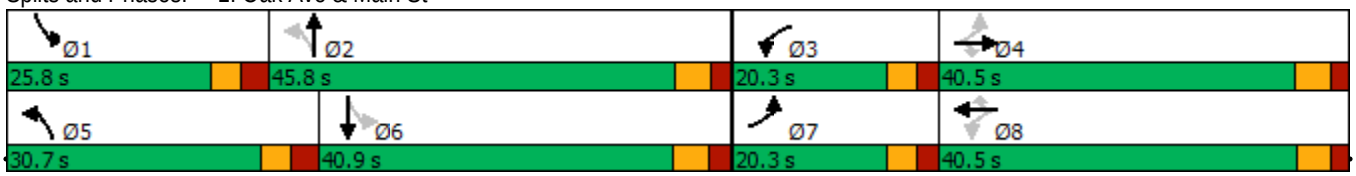
| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.1 | 0.1 | 17.3 | 14 |
| HCM LOS | | | C | B |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 317 | 1315 | - | - | 1304 | - | - | 523 |
| HCM Lane V/C Ratio | 0.076 | 0.076 | - | - | 0.003 | - | - | 0.237 |
| HCM Control Delay (s) | 17.3 | 8 | 0 | - | 7.8 | 0 | - | 14 |
| HCM Lane LOS | C | A | A | - | A | A | - | B |
| HCM 95th %tile Q(veh) | 0.2 | 0.2 | - | - | 0 | - | - | 0.9 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 56 | 221 | 203 | 51 | 304 | 81 | 238 | 258 | 43 | 52 | 224 | 20 |
| Future Volume (vph) | 56 | 221 | 203 | 51 | 304 | 81 | 238 | 258 | 43 | 52 | 224 | 20 |
| Satd. Flow (prot) | 1770 | 1827 | 1599 | 1687 | 1863 | 1538 | 1770 | 1814 | 0 | 1641 | 1783 | 0 |
| Flt Permitted | 0.285 | | | 0.471 | | | 0.312 | | | 0.537 | | |
| Satd. Flow (perm) | 531 | 1827 | 1599 | 836 | 1863 | 1538 | 581 | 1814 | 0 | 928 | 1783 | 0 |
| Satd. Flow (RTOR) | | | 236 | | | 115 | | 10 | | | 4 | |
| Peak Hour Factor | 0.64 | 0.85 | 0.86 | 0.75 | 0.92 | 0.92 | 0.88 | 0.85 | 0.57 | 0.65 | 0.85 | 0.71 |
| Heavy Vehicles (%) | 2% | 4% | 1% | 7% | 2% | 5% | 2% | 2% | 0% | 10% | 5% | 6% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 88 | 260 | 236 | 68 | 330 | 88 | 270 | 379 | 0 | 80 | 292 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 29.2 | 22.2 | 22.2 | 26.8 | 21.1 | 21.1 | 42.8 | 32.2 | | 27.7 | 19.8 | |
| Actuated g/C Ratio | 0.34 | 0.26 | 0.26 | 0.31 | 0.24 | 0.24 | 0.49 | 0.37 | | 0.32 | 0.23 | |
| v/c Ratio | 0.29 | 0.56 | 0.40 | 0.21 | 0.73 | 0.19 | 0.53 | 0.56 | | 0.22 | 0.71 | |
| Control Delay | 21.4 | 35.2 | 6.4 | 20.5 | 42.8 | 4.2 | 19.3 | 29.2 | | 17.8 | 44.6 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 21.4 | 35.2 | 6.4 | 20.5 | 42.8 | 4.2 | 19.3 | 29.2 | | 17.8 | 44.6 | |
| LOS | C | D | A | C | D | A | B | C | | B | D | |
| Approach Delay | | 21.5 | | | 32.7 | | | 25.1 | | | 38.8 | |
| Approach LOS | | C | | | C | | | C | | | D | |
| Queue Length 50th (ft) | 28 | 118 | 0 | 22 | 160 | 0 | 86 | 168 | | 23 | 145 | |
| Queue Length 95th (ft) | 53 | 239 | 51 | 52 | 335 | 23 | 182 | 315 | | 44 | 287 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 100 | | | 150 | | | 225 | | |
| Base Capacity (vph) | 431 | 797 | 830 | 472 | 812 | 735 | 656 | 918 | | 605 | 777 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.20 | 0.33 | 0.28 | 0.14 | 0.41 | 0.12 | 0.41 | 0.41 | | 0.13 | 0.38 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 86.7 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.73 | |
| Intersection Signal Delay: 28.3 | Intersection LOS: C |
| Intersection Capacity Utilization 64.9% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 1: Oak Ave & Main St

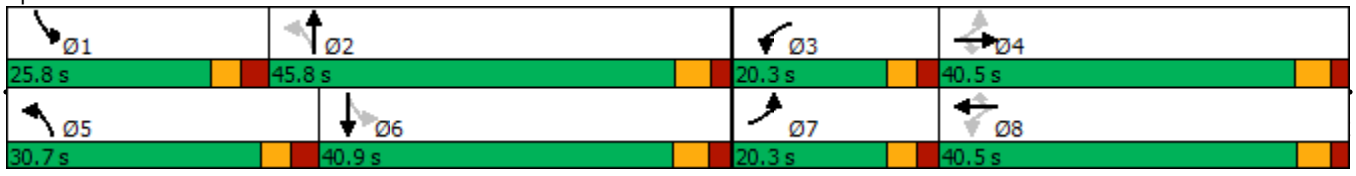


| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 109 | 352 | 307 | 97 | 298 | 126 | 248 | 351 | 37 | 143 | 400 | 39 |
| Future Volume (vph) | 109 | 352 | 307 | 97 | 298 | 126 | 248 | 351 | 37 | 143 | 400 | 39 |
| Satd. Flow (prot) | 1805 | 1881 | 1615 | 1805 | 1863 | 1583 | 1770 | 1870 | 0 | 1787 | 1835 | 0 |
| Flt Permitted | 0.311 | | | 0.167 | | | 0.127 | | | 0.283 | | |
| Satd. Flow (perm) | 591 | 1881 | 1615 | 317 | 1863 | 1583 | 237 | 1870 | 0 | 532 | 1835 | 0 |
| Satd. Flow (RTOR) | | | 302 | | | 143 | | 5 | | | 4 | |
| Peak Hour Factor | 0.85 | 0.81 | 0.95 | 0.81 | 0.92 | 0.88 | 0.98 | 0.85 | 0.77 | 0.76 | 0.93 | 0.89 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 2% | 2% | 0% | 0% | 1% | 2% | 3% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 128 | 435 | 323 | 120 | 324 | 143 | 253 | 461 | 0 | 188 | 474 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 41.0 | 30.4 | 30.4 | 39.5 | 29.8 | 29.8 | 56.0 | 38.6 | | 44.9 | 32.7 | |
| Actuated g/C Ratio | 0.36 | 0.27 | 0.27 | 0.35 | 0.26 | 0.26 | 0.49 | 0.34 | | 0.39 | 0.29 | |
| v/c Ratio | 0.40 | 0.87 | 0.50 | 0.51 | 0.67 | 0.28 | 0.70 | 0.72 | | 0.55 | 0.89 | |
| Control Delay | 26.9 | 59.3 | 8.2 | 31.0 | 46.4 | 7.3 | 34.0 | 41.7 | | 24.4 | 60.8 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 26.9 | 59.3 | 8.2 | 31.0 | 46.4 | 7.3 | 34.0 | 41.7 | | 24.4 | 60.8 | |
| LOS | C | E | A | C | D | A | C | D | | C | E | |
| Approach Delay | | 36.0 | | | 33.8 | | | 39.0 | | | 50.5 | |
| Approach LOS | | D | | | C | | | D | | | D | |
| Queue Length 50th (ft) | 62 | 313 | 12 | 58 | 219 | 0 | 116 | 301 | | 79 | 344 | |
| Queue Length 95th (ft) | 105 | 424 | 92 | 94 | 354 | 48 | 223 | 448 | | 112 | #624 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 100 | | | 150 | | | 225 | | |
| Base Capacity (vph) | 396 | 595 | 717 | 324 | 589 | 598 | 463 | 696 | | 471 | 581 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.32 | 0.73 | 0.45 | 0.37 | 0.55 | 0.24 | 0.55 | 0.66 | | 0.40 | 0.82 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 113.7 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.89 | |
| Intersection Signal Delay: 39.6 | Intersection LOS: D |
| Intersection Capacity Utilization 79.7% | ICU Level of Service D |
| Analysis Period (min) 15 | |

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

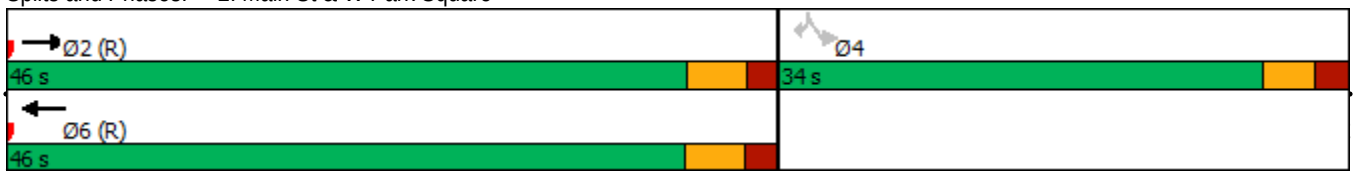
Splits and Phases: 1: Oak Ave & Main St



| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 315 | 363 | 0 | 100 | 73 |
| Future Volume (vph) | 0 | 315 | 363 | 0 | 100 | 73 |
| Satd. Flow (prot) | 0 | 3298 | 3330 | 0 | 1787 | 1583 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 3298 | 3330 | 0 | 1787 | 1583 |
| Satd. Flow (RTOR) | | | | | | 80 |
| Peak Hour Factor | 1.00 | 0.76 | 0.94 | 1.00 | 0.83 | 0.91 |
| Heavy Vehicles (%) | 0% | 4% | 3% | 0% | 1% | 2% |
| Parking (#/hr) | | 0 | 0 | | | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 414 | 386 | 0 | 120 | 80 |
| Turn Type | | NA | NA | | Perm | Perm |
| Protected Phases | | 2 | 6 | | | |
| Permitted Phases | | | | | 4 | 4 |
| Total Split (s) | | 46.0 | 46.0 | | 34.0 | 34.0 |
| Total Lost Time (s) | | 5.5 | 5.6 | | 5.2 | 5.2 |
| Act Effct Green (s) | | 61.3 | 61.2 | | 11.7 | 11.7 |
| Actuated g/C Ratio | | 0.77 | 0.76 | | 0.15 | 0.15 |
| v/c Ratio | | 0.16 | 0.15 | | 0.46 | 0.27 |
| Control Delay | | 3.9 | 2.8 | | 36.3 | 9.6 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 3.9 | 2.8 | | 36.3 | 9.6 |
| LOS | | A | A | | D | A |
| Approach Delay | | 3.9 | 2.8 | | 25.7 | |
| Approach LOS | | A | A | | C | |
| Queue Length 50th (ft) | | 28 | 18 | | 56 | 0 |
| Queue Length 95th (ft) | | 42 | 33 | | 91 | 35 |
| Internal Link Dist (ft) | | 459 | 42 | | 556 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 2527 | 2548 | | 643 | 621 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.16 | 0.15 | | 0.19 | 0.13 |

| Intersection Summary | |
|---|---|
| Cycle Length: 80 | |
| Actuated Cycle Length: 80 | |
| Offset: 2 (3%), Referenced to phase 2:EBT and 6:WBT, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.46 | |
| Intersection Signal Delay: 7.8 | Intersection LOS: A |
| Intersection Capacity Utilization 27.3% | ICU Level of Service A |
| Analysis Period (min) 15 | |

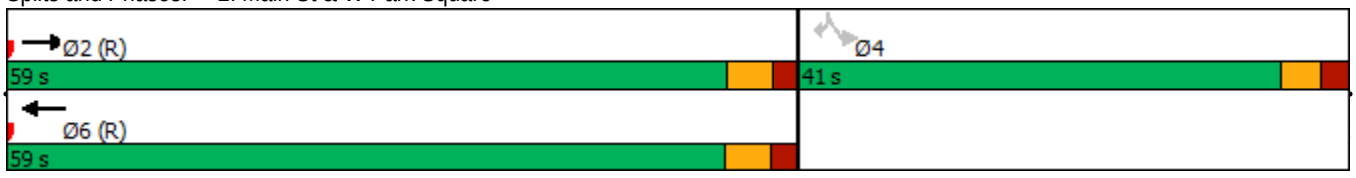
Splits and Phases: 2: Main St & W Park Square



| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 534 | 397 | 0 | 133 | 125 |
| Future Volume (vph) | 0 | 534 | 397 | 0 | 133 | 125 |
| Satd. Flow (prot) | 0 | 3396 | 3396 | 0 | 1805 | 1615 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 3396 | 3396 | 0 | 1805 | 1615 |
| Satd. Flow (RTOR) | | | | | | 144 |
| Peak Hour Factor | 1.00 | 0.86 | 0.88 | 1.00 | 0.79 | 0.87 |
| Heavy Vehicles (%) | 0% | 1% | 1% | 0% | 0% | 0% |
| Parking (#/hr) | | 0 | 0 | | | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 621 | 451 | 0 | 168 | 144 |
| Turn Type | | NA | NA | | Perm | Perm |
| Protected Phases | | 2 | 6 | | | |
| Permitted Phases | | | | | 4 | 4 |
| Total Split (s) | | 59.0 | 59.0 | | 41.0 | 41.0 |
| Total Lost Time (s) | | 5.5 | 5.6 | | 5.2 | 5.2 |
| Act Effct Green (s) | | 73.7 | 73.6 | | 15.6 | 15.6 |
| Actuated g/C Ratio | | 0.74 | 0.74 | | 0.16 | 0.16 |
| v/c Ratio | | 0.25 | 0.18 | | 0.60 | 0.39 |
| Control Delay | | 4.9 | 2.5 | | 47.5 | 9.0 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 4.9 | 2.5 | | 47.5 | 9.0 |
| LOS | | A | A | | D | A |
| Approach Delay | | 4.9 | 2.5 | | 29.7 | |
| Approach LOS | | A | A | | C | |
| Queue Length 50th (ft) | | 56 | 25 | | 101 | 0 |
| Queue Length 95th (ft) | | 90 | 37 | | 136 | 45 |
| Internal Link Dist (ft) | | 459 | 42 | | 556 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 2501 | 2498 | | 646 | 670 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.25 | 0.18 | | 0.26 | 0.21 |

| Intersection Summary | |
|---|---|
| Cycle Length: 100 | |
| Actuated Cycle Length: 100 | |
| Offset: 69 (69%), Referenced to phase 2:EBT and 6:WBT, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.60 | |
| Intersection Signal Delay: 9.7 | Intersection LOS: A |
| Intersection Capacity Utilization 31.0% | ICU Level of Service A |
| Analysis Period (min) 15 | |

Splits and Phases: 2: Main St & W Park Square



| Intersection | |
|---|---|
| Int Delay, s/veh | 2.6 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 332 | 83 | 81 | 349 | 15 | 78 |
| Future Vol, veh/h | 332 | 83 | 81 | 349 | 15 | 78 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 77 | 83 | 70 | 91 | 47 | 81 |
| Heavy Vehicles, % | 4 | 3 | 3 | 3 | 8 | 5 |
| Mvmt Flow | 431 | 100 | 116 | 384 | 32 | 96 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 531 | 0 | 905 | 266 |
| Stage 1 | - | - | - | - | 481 | - |
| Stage 2 | - | - | - | - | 424 | - |
| Critical Hdwy | - | - | 4.16 | - | 6.96 | 7 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.96 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.96 | - |
| Follow-up Hdwy | - | - | 2.23 | - | 3.58 | 3.35 |
| Pot Cap-1 Maneuver | - | - | 1026 | - | 265 | 723 |
| Stage 1 | - | - | - | - | 571 | - |
| Stage 2 | - | - | - | - | 611 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1026 | - | 227 | 723 |
| Mov Cap-2 Maneuver | - | - | - | - | 227 | - |
| Stage 1 | - | - | - | - | 571 | - |
| Stage 2 | - | - | - | - | 523 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 2.4 | 13.9 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 227 | 723 | - | - | 1026 | - |
| HCM Lane V/C Ratio | 0.141 | 0.133 | - | - | 0.113 | - |
| HCM Control Delay (s) | 23.4 | 10.7 | - | - | 9 | 0.4 |
| HCM Lane LOS | C | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.5 | 0.5 | - | - | 0.4 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 3.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 599 | 67 | 57 | 368 | 29 | 144 |
| Future Vol, veh/h | 599 | 67 | 57 | 368 | 29 | 144 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 88 | 76 | 84 | 85 | 66 | 78 |
| Heavy Vehicles, % | 1 | 0 | 2 | 1 | 0 | 0 |
| Mvmt Flow | 681 | 88 | 68 | 433 | 44 | 185 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 769 | 0 | 1078 | 385 |
| Stage 1 | - | - | - | - | 725 | - |
| Stage 2 | - | - | - | - | 353 | - |
| Critical Hdwy | - | - | 4.14 | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | - | - | 2.22 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 841 | - | 217 | 619 |
| Stage 1 | - | - | - | - | 446 | - |
| Stage 2 | - | - | - | - | 688 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 841 | - | 194 | 619 |
| Mov Cap-2 Maneuver | - | - | - | - | 194 | - |
| Stage 1 | - | - | - | - | 446 | - |
| Stage 2 | - | - | - | - | 615 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 1.7 | 16.3 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 194 | 619 | - | - | 841 | - |
| HCM Lane V/C Ratio | 0.226 | 0.298 | - | - | 0.081 | - |
| HCM Control Delay (s) | 28.9 | 13.3 | - | - | 9.7 | 0.4 |
| HCM Lane LOS | D | B | - | - | A | A |
| HCM 95th %tile Q(veh) | 0.8 | 1.2 | - | - | 0.3 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 86 | 324 | 430 | 29 | 0 | 0 |
| Future Vol, veh/h | 86 | 324 | 430 | 29 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 86 | 76 | 96 | 66 | 100 | 100 |
| Heavy Vehicles, % | 1 | 5 | 3 | 4 | 0 | 0 |
| Mvmt Flow | 100 | 426 | 448 | 44 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 492 | 0 | - | 0 | 883 | 246 |
| Stage 1 | - | - | - | - | 470 | - |
| Stage 2 | - | - | - | - | 413 | - |
| Critical Hdwy | 4.12 | - | - | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | 2.21 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1075 | - | - | - | 289 | 760 |
| Stage 1 | - | - | - | - | 601 | - |
| Stage 2 | - | - | - | - | 642 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1075 | - | - | - | 254 | 760 |
| Mov Cap-2 Maneuver | - | - | - | - | 254 | - |
| Stage 1 | - | - | - | - | 528 | - |
| Stage 2 | - | - | - | - | 642 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 2 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1075 | - | - | - | - |
| HCM Lane V/C Ratio | 0.093 | - | - | - | - |
| HCM Control Delay (s) | 8.7 | 0.4 | - | - | 0 |
| HCM Lane LOS | A | A | - | - | A |
| HCM 95th %tile Q(veh) | 0.3 | - | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 1.3 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 125 | 617 | 425 | 61 | 0 | 0 |
| Future Vol, veh/h | 125 | 617 | 425 | 61 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 89 | 92 | 86 | 80 | 100 | 100 |
| Heavy Vehicles, % | 0 | 0 | 1 | 0 | 0 | 0 |
| Mvmt Flow | 140 | 671 | 494 | 76 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 570 | 0 | - | 0 | 1148 | 285 |
| Stage 1 | - | - | - | - | 532 | - |
| Stage 2 | - | - | - | - | 616 | - |
| Critical Hdwy | 4.1 | - | - | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | 2.2 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1013 | - | - | - | 195 | 718 |
| Stage 1 | - | - | - | - | 559 | - |
| Stage 2 | - | - | - | - | 507 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1013 | - | - | - | 152 | 718 |
| Mov Cap-2 Maneuver | - | - | - | - | 152 | - |
| Stage 1 | - | - | - | - | 436 | - |
| Stage 2 | - | - | - | - | 507 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 2.2 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1013 | - | - | - | - |
| HCM Lane V/C Ratio | 0.139 | - | - | - | - |
| HCM Control Delay (s) | 9.1 | 0.7 | - | - | 0 |
| HCM Lane LOS | A | A | - | - | A |
| HCM 95th %tile Q(veh) | 0.5 | - | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 323 | 1 | 2 | 458 | 0 | 0 |
| Future Vol, veh/h | 323 | 1 | 2 | 458 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 50 | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 76 | 25 | 50 | 93 | 100 | 100 |
| Heavy Vehicles, % | 5 | 0 | 0 | 3 | 0 | 0 |
| Mvmt Flow | 425 | 4 | 4 | 492 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 429 | 0 | 681 | 215 |
| Stage 1 | - | - | - | - | 427 | - |
| Stage 2 | - | - | - | - | 254 | - |
| Critical Hdwy | - | - | 4.1 | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | - | - | 2.2 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 1141 | - | 389 | 796 |
| Stage 1 | - | - | - | - | 632 | - |
| Stage 2 | - | - | - | - | 771 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1141 | - | 387 | 796 |
| Mov Cap-2 Maneuver | - | - | - | - | 387 | - |
| Stage 1 | - | - | - | - | 632 | - |
| Stage 2 | - | - | - | - | 767 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0.1 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | - | 1141 | - |
| HCM Lane V/C Ratio | - | - | - | 0.004 | - |
| HCM Control Delay (s) | 0 | - | - | 8.2 | 0 |
| HCM Lane LOS | A | - | - | A | A |
| HCM 95th %tile Q(veh) | - | - | - | 0 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 614 | 2 | 4 | 487 | 0 | 0 |
| Future Vol, veh/h | 614 | 2 | 4 | 487 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 50 | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 50 | 33 | 87 | 100 | 100 |
| Heavy Vehicles, % | 1 | 0 | 0 | 1 | 0 | 0 |
| Mvmt Flow | 667 | 4 | 12 | 560 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 671 | 0 | 973 | 336 |
| Stage 1 | - | - | - | - | 669 | - |
| Stage 2 | - | - | - | - | 304 | - |
| Critical Hdwy | - | - | 4.1 | - | 6.8 | 6.9 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.8 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.8 | - |
| Follow-up Hdwy | - | - | 2.2 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 929 | - | 253 | 666 |
| Stage 1 | - | - | - | - | 476 | - |
| Stage 2 | - | - | - | - | 728 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 929 | - | 248 | 666 |
| Mov Cap-2 Maneuver | - | - | - | - | 248 | - |
| Stage 1 | - | - | - | - | 476 | - |
| Stage 2 | - | - | - | - | 714 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0.3 | 0 |
| HCM LOS | | | A |

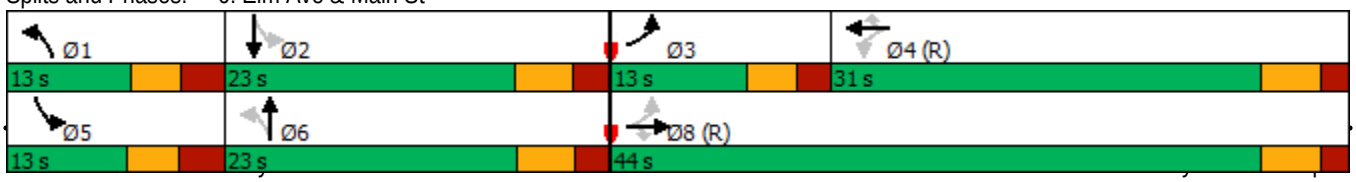
| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | - | 929 | - |
| HCM Lane V/C Ratio | - | - | - | 0.013 | - |
| HCM Control Delay (s) | 0 | - | - | 8.9 | 0.1 |
| HCM Lane LOS | A | - | - | A | A |
| HCM 95th %tile Q(veh) | - | - | - | 0 | - |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Future Volume (vph) | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Satd. Flow (prot) | 1736 | 1845 | 1468 | 1805 | 1845 | 1568 | 1805 | 1778 | 0 | 1805 | 1792 | 0 |
| Flt Permitted | 0.363 | | | 0.584 | | | 0.401 | | | 0.581 | | |
| Satd. Flow (perm) | 663 | 1845 | 1468 | 1110 | 1845 | 1568 | 762 | 1778 | 0 | 1104 | 1792 | 0 |
| Satd. Flow (RTOR) | | | 117 | | | 185 | | 24 | | | 19 | |
| Peak Hour Factor | 0.96 | 0.77 | 0.51 | 0.79 | 0.94 | 0.72 | 0.74 | 0.85 | 0.75 | 0.58 | 0.86 | 0.94 |
| Heavy Vehicles (%) | 4% | 3% | 10% | 0% | 3% | 3% | 0% | 1% | 5% | 0% | 2% | 2% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 68 | 287 | 69 | 52 | 351 | 60 | 96 | 220 | 0 | 36 | 256 | 0 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | 8 | 4 | | 4 | 6 | | | 2 | | |
| Total Split (s) | 13.0 | 44.0 | 44.0 | 31.0 | 31.0 | 31.0 | 13.0 | 23.0 | | 13.0 | 23.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 42.9 | 42.6 | 42.6 | 33.1 | 33.1 | 33.1 | 23.5 | 19.0 | | 20.9 | 16.0 | |
| Actuated g/C Ratio | 0.54 | 0.53 | 0.53 | 0.41 | 0.41 | 0.41 | 0.29 | 0.24 | | 0.26 | 0.20 | |
| v/c Ratio | 0.15 | 0.29 | 0.08 | 0.11 | 0.46 | 0.08 | 0.30 | 0.50 | | 0.11 | 0.69 | |
| Control Delay | 9.4 | 10.1 | 0.2 | 15.8 | 17.5 | 0.5 | 19.9 | 28.3 | | 17.3 | 37.7 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 9.4 | 10.1 | 0.2 | 15.8 | 17.5 | 0.5 | 19.9 | 28.3 | | 17.3 | 37.7 | |
| LOS | A | B | A | B | B | A | B | C | | B | D | |
| Approach Delay | | 8.4 | | | 15.1 | | | 25.8 | | | 35.2 | |
| Approach LOS | | A | | | B | | | C | | | D | |
| Queue Length 50th (ft) | 13 | 58 | 0 | 14 | 102 | 1 | 32 | 88 | | 12 | 112 | |
| Queue Length 95th (ft) | 29 | 82 | 0 | 30 | 158 | 0 | 50 | 145 | | 19 | 175 | |
| Internal Link Dist (ft) | | 301 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 115 | | | 65 | | 65 | 65 | | | 60 | | |
| Base Capacity (vph) | 463 | 983 | 836 | 459 | 764 | 757 | 320 | 452 | | 362 | 400 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.15 | 0.29 | 0.08 | 0.11 | 0.46 | 0.08 | 0.30 | 0.49 | | 0.10 | 0.64 | |

**Intersection Summary**

Cycle Length: 80
Actuated Cycle Length: 80
Offset: 67 (84%), Referenced to phase 4:WBTL and 8:EBTL, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.69
Intersection Signal Delay: 19.4 — Intersection LOS: B
Intersection Capacity Utilization 58.0% — ICU Level of Service B
Analysis Period (min) 15

Splits and Phases: 6: Elm Ave & Main St

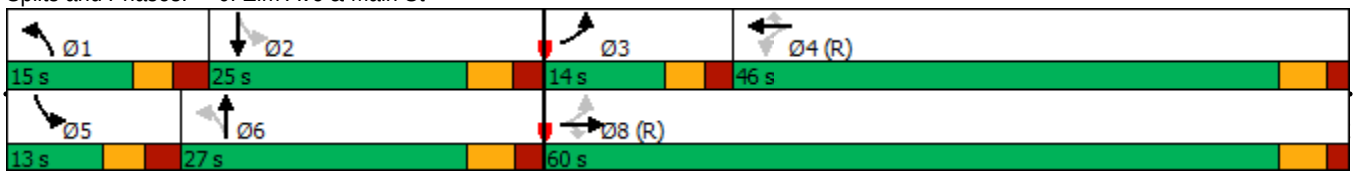



AM Peak Hour

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Future Volume (vph) | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Satd. Flow (prot) | 1805 | 1881 | 1615 | 1805 | 1863 | 1615 | 1805 | 1797 | 0 | 1805 | 1770 | 0 |
| Flt Permitted | 0.341 | | | 0.495 | | | 0.447 | | | 0.398 | | |
| Satd. Flow (perm) | 648 | 1881 | 1615 | 940 | 1863 | 1615 | 849 | 1797 | 0 | 756 | 1770 | 0 |
| Satd. Flow (RTOR) | | | 94 | | | 148 | | 26 | | | 33 | |
| Peak Hour Factor | 0.87 | 0.89 | 0.71 | 0.75 | 0.83 | 0.62 | 0.88 | 0.83 | 0.87 | 0.64 | 0.84 | 0.83 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 0% | 0% | 0% | 0% | 0% | 1% | 0% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 160 | 466 | 85 | 28 | 441 | 60 | 60 | 232 | 0 | 56 | 199 | 0 |
| Turn Type | pm+pt | NA | Perm | Perm | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | 8 | 4 | | 4 | 6 | | | 2 | | |
| Total Split (s) | 14.0 | 60.0 | 60.0 | 46.0 | 46.0 | 46.0 | 15.0 | 27.0 | | 13.0 | 25.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 61.6 | 61.3 | 61.3 | 48.0 | 48.0 | 48.0 | 24.0 | 17.5 | | 22.3 | 16.7 | |
| Actuated g/C Ratio | 0.62 | 0.61 | 0.61 | 0.48 | 0.48 | 0.48 | 0.24 | 0.18 | | 0.22 | 0.17 | |
| v/c Ratio | 0.32 | 0.40 | 0.08 | 0.06 | 0.49 | 0.07 | 0.22 | 0.69 | | 0.24 | 0.62 | |
| Control Delay | 9.7 | 10.1 | 1.1 | 14.7 | 18.4 | 0.8 | 26.2 | 45.3 | | 27.0 | 40.6 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 9.7 | 10.1 | 1.1 | 14.7 | 18.4 | 0.8 | 26.2 | 45.3 | | 27.0 | 40.6 | |
| LOS | A | B | A | B | B | A | C | D | | C | D | |
| Approach Delay | | 8.9 | | | 16.2 | | | 41.4 | | | 37.6 | |
| Approach LOS | | A | | | B | | | D | | | D | |
| Queue Length 50th (ft) | 35 | 119 | 0 | 9 | 168 | 0 | 28 | 126 | | 26 | 99 | |
| Queue Length 95th (ft) | 64 | 178 | 3 | m20 | 219 | m1 | 53 | 177 | | 36 | 154 | |
| Internal Link Dist (ft) | | 301 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 115 | | | 65 | | 65 | 65 | | | 60 | | |
| Base Capacity (vph) | 506 | 1153 | 1026 | 451 | 894 | 852 | 302 | 403 | | 245 | 366 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.32 | 0.40 | 0.08 | 0.06 | 0.49 | 0.07 | 0.20 | 0.58 | | 0.23 | 0.54 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 100 | |
| Actuated Cycle Length: 100 | |
| Offset: 40 (40%), Referenced to phase 4:WBTL and 8:EBTL, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.69 | |
| Intersection Signal Delay: 20.5 | Intersection LOS: C |
| Intersection Capacity Utilization 64.3% | ICU Level of Service C |
| Analysis Period (min) 15 | |
| m Volume for 95th percentile queue is metered by upstream signal. | |

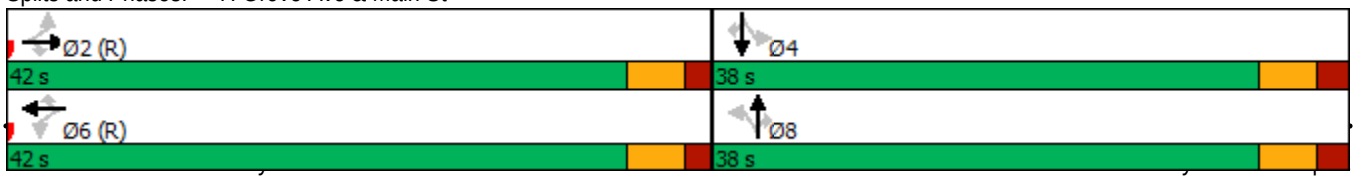
Splits and Phases: 6: Elm Ave & Main St



| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Future Volume (vph) | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Satd. Flow (prot) | 0 | 1808 | 1615 | 0 | 1818 | 1524 | 0 | 1865 | 1615 | 0 | 1816 | 1568 |
| Flt Permitted | | 0.762 | | | 0.976 | | | 0.766 | | | 0.943 | |
| Satd. Flow (perm) | 0 | 1406 | 1615 | 0 | 1780 | 1524 | 0 | 1444 | 1615 | 0 | 1723 | 1568 |
| Satd. Flow (RTOR) | | | 56 | | | 133 | | | 36 | | | 104 |
| Peak Hour Factor | 0.67 | 0.93 | 0.45 | 0.88 | 0.96 | 0.86 | 0.66 | 0.84 | 0.44 | 0.90 | 0.85 | 0.84 |
| Heavy Vehicles (%) | 3% | 3% | 0% | 7% | 4% | 6% | 0% | 1% | 0% | 4% | 4% | 3% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 318 | 56 | 0 | 275 | 133 | 0 | 200 | 36 | 0 | 352 | 161 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | |
| Permitted Phases | 2 | | 2 | 6 | | 6 | 8 | | 8 | 4 | | 4 |
| Total Split (s) | 42.0 | 42.0 | 42.0 | 42.0 | 42.0 | 42.0 | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 |
| Total Lost Time (s) | | 5.1 | 5.1 | | 5.1 | 5.1 | | 5.5 | 5.5 | | 5.5 | 5.5 |
| Act Effct Green (s) | | 44.6 | 44.6 | | 44.6 | 44.6 | | 24.8 | 24.8 | | 24.8 | 24.8 |
| Actuated g/C Ratio | | 0.56 | 0.56 | | 0.56 | 0.56 | | 0.31 | 0.31 | | 0.31 | 0.31 |
| v/c Ratio | | 0.41 | 0.06 | | 0.28 | 0.15 | | 0.45 | 0.07 | | 0.66 | 0.29 |
| Control Delay | | 8.0 | 1.0 | | 11.7 | 2.8 | | 24.0 | 5.9 | | 29.2 | 8.5 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 8.0 | 1.0 | | 11.7 | 2.8 | | 24.0 | 5.9 | | 29.2 | 8.5 |
| LOS | | A | A | | B | A | | C | A | | C | A |
| Approach Delay | | 7.0 | | | 8.8 | | | 21.2 | | | 22.7 | |
| Approach LOS | | A | | | A | | | C | | | C | |
| Queue Length 50th (ft) | | 51 | 1 | | 68 | 0 | | 78 | 0 | | 149 | 20 |
| Queue Length 95th (ft) | | 81 | 1 | | 138 | 25 | | 109 | 3 | | 189 | 47 |
| Internal Link Dist (ft) | | 581 | | | 1203 | | | 622 | | | 478 | |
| Turn Bay Length (ft) | | | 100 | | | 185 | | | 50 | | | 50 |
| Base Capacity (vph) | | 783 | 924 | | 991 | 907 | | 586 | 677 | | 699 | 698 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.41 | 0.06 | | 0.28 | 0.15 | | 0.34 | 0.05 | | 0.50 | 0.23 |

| Intersection Summary | |
|---|---|
| Cycle Length: 80 | |
| Actuated Cycle Length: 80 | |
| Offset: 76 (95%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.66 | |
| Intersection Signal Delay: 14.9 | Intersection LOS: B |
| Intersection Capacity Utilization 70.0% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 7: Grove Ave & Main St

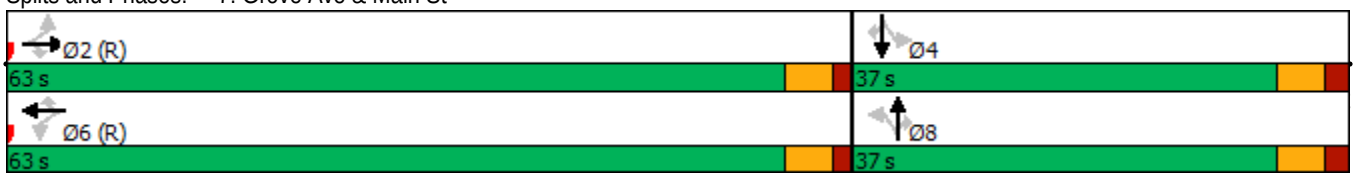


| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Future Volume (vph) | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Satd. Flow (prot) | 0 | 1857 | 1568 | 0 | 1877 | 1615 | 0 | 1858 | 1615 | 0 | 1883 | 1599 |
| Flt Permitted | | 0.772 | | | 0.966 | | | 0.571 | | | 0.795 | |
| Satd. Flow (perm) | 0 | 1457 | 1568 | 0 | 1818 | 1615 | 0 | 1078 | 1615 | 0 | 1510 | 1599 |
| Satd. Flow (RTOR) | | | 57 | | | 79 | | | 23 | | | 86 |
| Peak Hour Factor | 0.79 | 0.92 | 0.67 | 0.44 | 0.91 | 0.78 | 0.69 | 0.86 | 0.63 | 0.90 | 0.84 | 0.76 |
| Heavy Vehicles (%) | 0% | 1% | 3% | 0% | 1% | 0% | 2% | 0% | 0% | 0% | 0% | 1% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 543 | 72 | 0 | 296 | 79 | 0 | 249 | 32 | 0 | 273 | 149 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | |
| Permitted Phases | 2 | | 2 | 6 | | 6 | 8 | | 8 | 4 | | 4 |
| Total Split (s) | 63.0 | 63.0 | 63.0 | 63.0 | 63.0 | 63.0 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 |
| Total Lost Time (s) | | 5.1 | 5.1 | | 5.1 | 5.1 | | 5.5 | 5.5 | | 5.5 | 5.5 |
| Act Effct Green (s) | | 64.0 | 64.0 | | 64.0 | 64.0 | | 25.4 | 25.4 | | 25.4 | 25.4 |
| Actuated g/C Ratio | | 0.64 | 0.64 | | 0.64 | 0.64 | | 0.25 | 0.25 | | 0.25 | 0.25 |
| v/c Ratio | | 0.58 | 0.07 | | 0.25 | 0.07 | | 0.91 | 0.07 | | 0.71 | 0.32 |
| Control Delay | | 10.2 | 1.3 | | 9.4 | 2.3 | | 71.4 | 13.2 | | 43.9 | 14.2 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 10.2 | 1.3 | | 9.4 | 2.3 | | 71.4 | 13.2 | | 43.9 | 14.2 |
| LOS | | B | A | | A | A | | E | B | | D | B |
| Approach Delay | | 9.1 | | | 7.9 | | | 64.8 | | | 33.5 | |
| Approach LOS | | A | | | A | | | E | | | C | |
| Queue Length 50th (ft) | | 87 | 1 | | 75 | 0 | | 153 | 4 | | 158 | 31 |
| Queue Length 95th (ft) | | 334 | 3 | | 137 | 13 | | #238 | 14 | | 210 | 55 |
| Internal Link Dist (ft) | | 581 | | | 1203 | | | 622 | | | 478 | |
| Turn Bay Length (ft) | | | 100 | | | 185 | | | 50 | | | 50 |
| Base Capacity (vph) | | 932 | 1023 | | 1163 | 1061 | | 339 | 524 | | 475 | 562 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.58 | 0.07 | | 0.25 | 0.07 | | 0.73 | 0.06 | | 0.57 | 0.27 |

**Intersection Summary**

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 51 (51%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.91
Intersection Signal Delay: 24.2 — Intersection LOS: C
Intersection Capacity Utilization 79.9% — ICU Level of Service D
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Grove Ave & Main St



| Intersection | |
|---|---|
| Intersection Delay, s/veh | 58.6 |
| Intersection LOS | F |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 11 | 102 | 55 | 74 | 278 | 81 | 115 | 109 | 22 | 55 | 199 | 21 |
| Future Vol, veh/h | 11 | 102 | 55 | 74 | 278 | 81 | 115 | 109 | 22 | 55 | 199 | 21 |
| Peak Hour Factor | 0.69 | 0.73 | 0.92 | 0.60 | 0.79 | 0.84 | 0.85 | 0.85 | 0.55 | 0.69 | 0.84 | 0.53 |
| Heavy Vehicles, % | 13 | 5 | 0 | 1 | 3 | 2 | 8 | 10 | 9 | 2 | 1 | 0 |
| Mvmt Flow | 16 | 140 | 60 | 123 | 352 | 96 | 135 | 128 | 40 | 80 | 237 | 40 |
| Number of Lanes | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 1 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 1 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 1 | 2 |
| HCM Control Delay | 15.7 | 109.3 | 26.1 | 31 |
| HCM LOS | C | F | D | D |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | SBLn1 |
|---|---|---|---|---|---|
| Vol Left, % | 47% | 10% | 0% | 17% | 20% |
| Vol Thru, % | 44% | 90% | 0% | 64% | 72% |
| Vol Right, % | 9% | 0% | 100% | 19% | 8% |
| Sign Control | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 246 | 113 | 55 | 433 | 275 |
| LT Vol | 115 | 11 | 0 | 74 | 55 |
| Through Vol | 109 | 102 | 0 | 278 | 199 |
| RT Vol | 22 | 0 | 55 | 81 | 21 |
| Lane Flow Rate | 304 | 156 | 60 | 572 | 356 |
| Geometry Grp | 2 | 7 | 7 | 5 | 2 |
| Degree of Util (X) | 0.66 | 0.373 | 0.128 | 1.137 | 0.745 |
| Departure Headway (Hd) | 8.348 | 9.088 | 8.168 | 7.16 | 8.022 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes |
| Cap | 437 | 399 | 442 | 503 | 452 |
| Service Time | 6.348 | 6.788 | 5.868 | 5.241 | 6.022 |
| HCM Lane V/C Ratio | 0.696 | 0.391 | 0.136 | 1.137 | 0.788 |
| HCM Control Delay | 26.1 | 17.1 | 12.1 | 109.3 | 31 |
| HCM Lane LOS | D | C | B | F | D |
| HCM 95th-tile Q | 4.6 | 1.7 | 0.4 | 19.4 | 6.1 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 26.8 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 9 | 289 | 122 | 31 | 201 | 63 | 74 | 112 | 46 | 81 | 114 | 11 |
| Future Vol, veh/h | 9 | 289 | 122 | 31 | 201 | 63 | 74 | 112 | 46 | 81 | 114 | 11 |
| Peak Hour Factor | 0.45 | 0.91 | 0.78 | 0.70 | 0.85 | 0.68 | 0.69 | 0.76 | 0.64 | 0.75 | 0.84 | 0.69 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 20 | 318 | 156 | 44 | 236 | 93 | 107 | 147 | 72 | 108 | 136 | 16 |
| Number of Lanes | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 1 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 1 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 1 | 2 |
| HCM Control Delay | 24.7 | 32.7 | 27.3 | 21.8 |
| HCM LOS | C | D | D | C |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | SBLn1 |
|---|---|---|---|---|---|
| Vol Left, % | 32% | 3% | 0% | 11% | 39% |
| Vol Thru, % | 48% | 97% | 0% | 68% | 55% |
| Vol Right, % | 20% | 0% | 100% | 21% | 5% |
| Sign Control | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 232 | 298 | 122 | 295 | 206 |
| LT Vol | 74 | 9 | 0 | 31 | 81 |
| Through Vol | 112 | 289 | 0 | 201 | 114 |
| RT Vol | 46 | 0 | 122 | 63 | 11 |
| Lane Flow Rate | 326 | 338 | 156 | 373 | 260 |
| Geometry Grp | 2 | 7 | 7 | 5 | 2 |
| Degree of Util (X) | 0.702 | 0.739 | 0.311 | 0.78 | 0.581 |
| Departure Headway (Hd) | 7.746 | 7.883 | 7.163 | 7.518 | 8.051 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes |
| Cap | 464 | 456 | 499 | 478 | 447 |
| Service Time | 5.836 | 5.67 | 4.949 | 5.607 | 6.15 |
| HCM Lane V/C Ratio | 0.703 | 0.741 | 0.313 | 0.78 | 0.582 |
| HCM Control Delay | 27.3 | 30 | 13.2 | 32.7 | 21.8 |
| HCM Lane LOS | D | D | B | D | C |
| HCM 95th-tile Q | 5.4 | 6 | 1.3 | 6.9 | 3.6 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 7.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ↕ | | | ↕ | | | ↕ | | | ↕ | |
| Traffic Vol, veh/h | 51 | 128 | 5 | 6 | 295 | 48 | 6 | 4 | 1 | 36 | 20 | 140 |
| Future Vol, veh/h | 51 | 128 | 5 | 6 | 295 | 48 | 6 | 4 | 1 | 36 | 20 | 140 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 64 | 84 | 42 | 50 | 86 | 86 | 38 | 33 | 25 | 60 | 63 | 85 |
| Heavy Vehicles, % | 5 | 5 | 25 | 25 | 3 | 0 | 0 | 0 | 100 | 3 | 6 | 2 |
| Mvmt Flow | 80 | 152 | 12 | 12 | 343 | 56 | 16 | 12 | 4 | 60 | 32 | 165 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 399 | 0 | 0 | 164 | 0 | 0 | 812 | 741 | 158 | 721 | 719 | 371 |
| Stage 1 | - | - | - | - | - | - | 318 | 318 | - | 395 | 395 | - |
| Stage 2 | - | - | - | - | - | - | 494 | 423 | - | 326 | 324 | - |
| Critical Hdwy | 4.15 | - | - | 4.35 | - | - | 7.1 | 6.5 | 7.2 | 7.13 | 6.56 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.425 | - | - | 3.5 | 4 | 4.2 | 3.527 | 4.054 | 3.318 |
| Pot Cap-1 Maneuver | 1144 | - | - | 1286 | - | - | 300 | 347 | 684 | 341 | 349 | 675 |
| Stage 1 | - | - | - | - | - | - | 698 | 657 | - | 628 | 598 | - |
| Stage 2 | - | - | - | - | - | - | 561 | 591 | - | 684 | 643 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1144 | - | - | 1286 | - | - | 196 | 316 | 684 | 307 | 318 | 675 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 196 | 316 | - | 307 | 318 | - |
| Stage 1 | - | - | - | - | - | - | 644 | 606 | - | 580 | 591 | - |
| Stage 2 | - | - | - | - | - | - | 397 | 584 | - | 615 | 593 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.7 | 0.2 | 21.1 | 21.1 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 256 | 1144 | - | - | 1286 | - | - | 476 |
| HCM Lane V/C Ratio | 0.125 | 0.07 | - | - | 0.009 | - | - | 0.539 |
| HCM Control Delay (s) | 21.1 | 8.4 | 0 | - | 7.8 | 0 | - | 21.1 |
| HCM Lane LOS | C | A | A | - | A | A | - | C |
| HCM 95th %tile Q(veh) | 0.4 | 0.2 | - | - | 0 | - | - | 3.1 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 4.7 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ⇕ | | | ⇕ | | | ⇕ | | | ⇕ | |
| Traffic Vol, veh/h | 120 | 284 | 9 | 3 | 213 | 42 | 5 | 5 | 1 | 30 | 17 | 76 |
| Future Vol, veh/h | 120 | 284 | 9 | 3 | 213 | 42 | 5 | 5 | 1 | 30 | 17 | 76 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 97 | 88 | 56 | 75 | 81 | 75 | 31 | 63 | 25 | 83 | 85 | 76 |
| Heavy Vehicles, % | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 4 | 0 | 0 |
| Mvmt Flow | 124 | 323 | 16 | 4 | 263 | 56 | 16 | 8 | 4 | 36 | 20 | 100 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 319 | 0 | 0 | 339 | 0 | 0 | 938 | 906 | 331 | 884 | 886 | 291 |
| Stage 1 | - | - | - | - | - | - | 579 | 579 | - | 299 | 299 | - |
| Stage 2 | - | - | - | - | - | - | 359 | 327 | - | 585 | 587 | - |
| Critical Hdwy | 4.11 | - | - | 4.1 | - | - | 7.1 | 6.5 | 6.2 | 7.14 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Follow-up Hdwy | 2.209 | - | - | 2.2 | - | - | 3.5 | 4 | 3.3 | 3.536 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1247 | - | - | 1231 | - | - | 247 | 278 | 715 | 264 | 286 | 753 |
| Stage 1 | - | - | - | - | - | - | 504 | 504 | - | 706 | 670 | - |
| Stage 2 | - | - | - | - | - | - | 663 | 651 | - | 494 | 500 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1247 | - | - | 1231 | - | - | 182 | 243 | 715 | 231 | 250 | 753 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 182 | 243 | - | 231 | 250 | - |
| Stage 1 | - | - | - | - | - | - | 442 | 442 | - | 619 | 667 | - |
| Stage 2 | - | - | - | - | - | - | 555 | 648 | - | 423 | 439 | - |

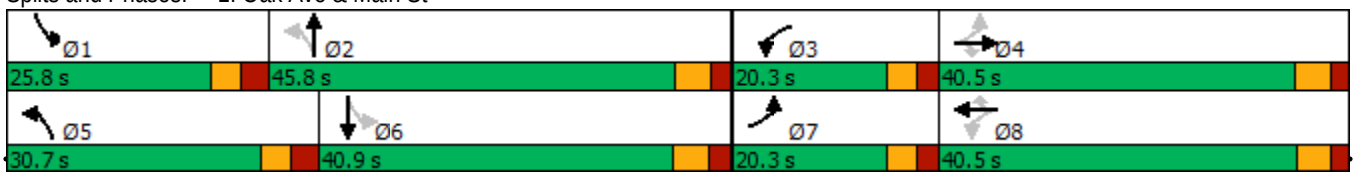
| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.2 | 0.1 | 23.6 | 18.4 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 221 | 1247 | - | - | 1231 | - | - | 423 |
| HCM Lane V/C Ratio | 0.127 | 0.099 | - | - | 0.003 | - | - | 0.369 |
| HCM Control Delay (s) | 23.6 | 8.2 | 0 | - | 7.9 | 0 | - | 18.4 |
| HCM Lane LOS | C | A | A | - | A | A | - | C |
| HCM 95th %tile Q(veh) | 0.4 | 0.3 | - | - | 0 | - | - | 1.7 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 56 | 221 | 203 | 51 | 304 | 81 | 238 | 258 | 43 | 52 | 224 | 20 |
| Future Volume (vph) | 56 | 221 | 203 | 51 | 304 | 81 | 238 | 258 | 43 | 52 | 224 | 20 |
| Satd. Flow (prot) | 1770 | 1827 | 1599 | 1687 | 1863 | 1538 | 1770 | 1814 | 0 | 1641 | 1783 | 0 |
| Flt Permitted | 0.285 | | | 0.471 | | | 0.312 | | | 0.537 | | |
| Satd. Flow (perm) | 531 | 1827 | 1599 | 836 | 1863 | 1538 | 581 | 1814 | 0 | 928 | 1783 | 0 |
| Satd. Flow (RTOR) | | | 236 | | | 115 | | 10 | | | 4 | |
| Peak Hour Factor | 0.64 | 0.85 | 0.86 | 0.75 | 0.92 | 0.92 | 0.88 | 0.85 | 0.57 | 0.65 | 0.85 | 0.71 |
| Heavy Vehicles (%) | 2% | 4% | 1% | 7% | 2% | 5% | 2% | 2% | 0% | 10% | 5% | 6% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 88 | 260 | 236 | 68 | 330 | 88 | 270 | 379 | 0 | 80 | 292 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 29.2 | 22.2 | 22.2 | 26.8 | 21.1 | 21.1 | 42.8 | 32.2 | | 27.7 | 19.8 | |
| Actuated g/C Ratio | 0.34 | 0.26 | 0.26 | 0.31 | 0.24 | 0.24 | 0.49 | 0.37 | | 0.32 | 0.23 | |
| v/c Ratio | 0.29 | 0.56 | 0.40 | 0.21 | 0.73 | 0.19 | 0.53 | 0.56 | | 0.22 | 0.71 | |
| Control Delay | 21.4 | 35.2 | 6.4 | 20.5 | 42.8 | 4.2 | 19.3 | 29.2 | | 17.8 | 44.6 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 21.4 | 35.2 | 6.4 | 20.5 | 42.8 | 4.2 | 19.3 | 29.2 | | 17.8 | 44.6 | |
| LOS | C | D | A | C | D | A | B | C | | B | D | |
| Approach Delay | | 21.5 | | | 32.7 | | | 25.1 | | | 38.8 | |
| Approach LOS | | C | | | C | | | C | | | D | |
| Queue Length 50th (ft) | 28 | 118 | 0 | 22 | 160 | 0 | 86 | 168 | | 23 | 145 | |
| Queue Length 95th (ft) | 53 | 239 | 51 | 52 | 335 | 23 | 182 | 315 | | 44 | 287 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 300 | | 100 | 150 | | | 225 | | |
| Base Capacity (vph) | 431 | 797 | 830 | 472 | 812 | 735 | 656 | 918 | | 605 | 777 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.20 | 0.33 | 0.28 | 0.14 | 0.41 | 0.12 | 0.41 | 0.41 | | 0.13 | 0.38 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 86.7 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.73 | |
| Intersection Signal Delay: 28.3 | Intersection LOS: C |
| Intersection Capacity Utilization 64.9% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 1: Oak Ave & Main St

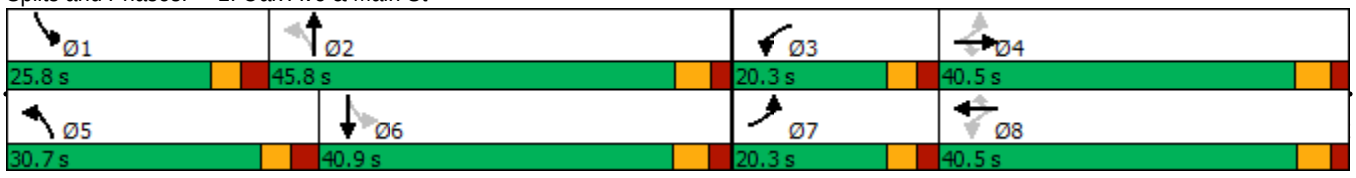


| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 109 | 352 | 307 | 97 | 298 | 126 | 248 | 351 | 37 | 143 | 400 | 39 |
| Future Volume (vph) | 109 | 352 | 307 | 97 | 298 | 126 | 248 | 351 | 37 | 143 | 400 | 39 |
| Satd. Flow (prot) | 1805 | 1881 | 1615 | 1805 | 1863 | 1583 | 1770 | 1870 | 0 | 1787 | 1835 | 0 |
| Flt Permitted | 0.311 | | | 0.167 | | | 0.127 | | | 0.283 | | |
| Satd. Flow (perm) | 591 | 1881 | 1615 | 317 | 1863 | 1583 | 237 | 1870 | 0 | 532 | 1835 | 0 |
| Satd. Flow (RTOR) | | | 302 | | | 115 | | 5 | | | 4 | |
| Peak Hour Factor | 0.85 | 0.81 | 0.95 | 0.81 | 0.92 | 0.88 | 0.98 | 0.85 | 0.77 | 0.76 | 0.93 | 0.89 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 2% | 2% | 0% | 0% | 1% | 2% | 3% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 128 | 435 | 323 | 120 | 324 | 143 | 253 | 461 | 0 | 188 | 474 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 41.0 | 30.4 | 30.4 | 39.5 | 29.8 | 29.8 | 56.0 | 38.6 | | 44.9 | 32.7 | |
| Actuated g/C Ratio | 0.36 | 0.27 | 0.27 | 0.35 | 0.26 | 0.26 | 0.49 | 0.34 | | 0.39 | 0.29 | |
| v/c Ratio | 0.40 | 0.87 | 0.50 | 0.51 | 0.67 | 0.29 | 0.70 | 0.72 | | 0.55 | 0.89 | |
| Control Delay | 26.9 | 59.3 | 8.2 | 31.0 | 46.4 | 11.8 | 34.0 | 41.7 | | 24.4 | 60.8 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 26.9 | 59.3 | 8.2 | 31.0 | 46.4 | 11.8 | 34.0 | 41.7 | | 24.4 | 60.8 | |
| LOS | C | E | A | C | D | B | C | D | | C | E | |
| Approach Delay | | 36.0 | | | 34.9 | | | 39.0 | | | 50.5 | |
| Approach LOS | | D | | | C | | | D | | | D | |
| Queue Length 50th (ft) | 62 | 313 | 12 | 58 | 219 | 16 | 116 | 301 | | 79 | 344 | |
| Queue Length 95th (ft) | 105 | 424 | 92 | 94 | 354 | 68 | 223 | 448 | | 112 | #624 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 300 | | 100 | 150 | | | 225 | | |
| Base Capacity (vph) | 396 | 595 | 717 | 324 | 589 | 579 | 463 | 696 | | 471 | 581 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.32 | 0.73 | 0.45 | 0.37 | 0.55 | 0.25 | 0.55 | 0.66 | | 0.40 | 0.82 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 113.7 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.89 | |
| Intersection Signal Delay: 39.9 | Intersection LOS: D |
| Intersection Capacity Utilization 79.7% | ICU Level of Service D |
| Analysis Period (min) 15 | |

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Oak Ave & Main St



# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | AM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Oak Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Oak Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.85 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 57 | 221 | 203 | 0 | 51 | 304 | 81 | 0 | 237 | 258 | 42 | 0 | 52 | 224 | 21 |
| Percent Heavy Vehicles, % | 3 | 2 | 4 | 1 | 0 | 7 | 2 | 5 | 3 | 2 | 2 | 0 | 3 | 10 | 5 | 6 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 68 | 270 | 241 | 0 | 64 | 365 | 100 | 0 | 284 | 310 | 49 | 0 | 67 | 277 | 26 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 579 | | | 529 | | | 643 | | | 370 | |
| Entry Volume, veh/h | | 565 | | | 513 | | | 631 | | | 349 | |
| Circulating Flow ($v_c$), pc/h | 408 | | | 662 | | | 405 | | | 713 | | |
| Exiting Flow ($v_{ex}$), pc/h | 386 | | | 675 | | | 478 | | | 582 | | |
| Capacity ($c_{pce}$), pc/h | | 910 | | | 702 | | | 913 | | | 667 | |
| Capacity (c), veh/h | | 888 | | | 681 | | | 896 | | | 629 | |
| v/c Ratio (x) | | 0.64 | | | 0.75 | | | 0.70 | | | 0.55 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 14.0 | | | 23.3 | | | 16.5 | | | 15.4 | |
| Lane LOS | | B | | | C | | | C | | | C | |
| 95% Queue, veh | | 4.7 | | | 6.9 | | | 6.0 | | | 3.4 | |
| Approach Delay, s/veh | 14.0 | | | 23.3 | | | 16.5 | | | 15.4 | | |
| Approach LOS | B | | | C | | | C | | | C | | |
| Intersection Delay, s/veh \| LOS | 17.3 | | | | | | C | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | PM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Oak Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Oak Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.95 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 109 | 353 | 306 | 0 | 97 | 299 | 126 | 0 | 248 | 351 | 38 | 0 | 143 | 399 | 38 |
| Percent Heavy Vehicles, % | 3 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 0 | 0 | 3 | 1 | 2 | 3 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 115 | 375 | 322 | 0 | 102 | 321 | 135 | 0 | 266 | 369 | 40 | 0 | 152 | 428 | 41 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 812 | | | 558 | | | 675 | | | 621 | |
| Entry Volume, veh/h | | 808 | | | 549 | | | 670 | | | 610 | |
| Circulating Flow ($v_c$), pc/h | 682 | | | 750 | | | 642 | | | 689 | | |
| Exiting Flow ($v_{ex}$), pc/h | 567 | | | 628 | | | 619 | | | 852 | | |
| Capacity ($c_{pce}$), pc/h | | 688 | | | 642 | | | 717 | | | 683 | |
| Capacity (c), veh/h | | 685 | | | 632 | | | 711 | | | 671 | |
| v/c Ratio (x) | | 1.18 | | | 0.87 | | | 0.94 | | | 0.91 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 117.2 | | | 36.2 | | | 44.7 | | | 40.5 | |
| Lane LOS | | F | | | E | | | E | | | E | |
| 95% Queue, veh | | 26.7 | | | 10.1 | | | 13.5 | | | 11.8 | |
| Approach Delay, s/veh | 117.2 | | | 36.2 | | | 44.7 | | | 40.5 | | |
| Approach LOS | F | | | E | | | E | | | E | | |
| Intersection Delay, s/veh \| LOS | 64.2 | | | | | | F | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | AM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Oak Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Oak Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.85 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | LT | | TR | | LT | | TR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 57 | 221 | 203 | 0 | 51 | 304 | 81 | 0 | 237 | 258 | 42 | 0 | 52 | 224 | 21 |
| Percent Heavy Vehicles, % | 3 | 2 | 4 | 1 | 0 | 7 | 2 | 5 | 3 | 2 | 2 | 0 | 3 | 10 | 5 | 6 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 68 | 270 | 241 | 0 | 64 | 365 | 100 | 0 | 284 | 310 | 49 | 0 | 67 | 277 | 26 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 2 | | | | 2 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | 4.5436 | 4.5436 | | 4.5436 | 4.5436 | | | 4.3276 | | | 4.3276 | |
| Follow-Up Headway, s | 2.5352 | 2.5352 | | 2.5352 | 2.5352 | | | 2.5352 | | | 2.5352 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | 272 | 307 | | 249 | 280 | | | 643 | | | 370 | |
| Entry Volume, veh/h | 266 | 299 | | 241 | 272 | | | 631 | | | 349 | |
| Circulating Flow ($v_c$), pc/h | 408 | | | 662 | | | 405 | | | 713 | | |
| Exiting Flow ($v_{ex}$), pc/h | 386 | | | 675 | | | 478 | | | 582 | | |
| Capacity ($c_{pce}$), pc/h | 980 | 980 | | 777 | 777 | | | 1006 | | | 775 | |
| Capacity (c), veh/h | 956 | 956 | | 754 | 754 | | | 988 | | | 731 | |
| v/c Ratio (x) | 0.28 | 0.31 | | 0.32 | 0.36 | | | 0.64 | | | 0.48 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | 6.6 | 7.0 | | 8.6 | 9.2 | | | 13.0 | | | 11.7 | |
| Lane LOS | A | A | | A | A | | | B | | | B | |
| 95% Queue, veh | 1.1 | 1.3 | | 1.4 | 1.6 | | | 4.8 | | | 2.6 | |
| Approach Delay, s/veh | 6.8 | | | 8.9 | | | 13.0 | | | 11.7 | | |
| Approach LOS | A | | | A | | | B | | | B | | |
| Intersection Delay, s/veh \| LOS | 10.1 | | | | | | B | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | PM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Oak Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Oak Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.95 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | LT | | TR | | LT | | TR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 109 | 353 | 306 | 0 | 97 | 299 | 126 | 0 | 248 | 351 | 38 | 0 | 143 | 399 | 38 |
| Percent Heavy Vehicles, % | 3 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 0 | 0 | 3 | 1 | 2 | 3 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 115 | 375 | 322 | 0 | 102 | 321 | 135 | 0 | 266 | 369 | 40 | 0 | 152 | 428 | 41 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 2 | | | | 2 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | 4.5436 | 4.5436 | | 4.5436 | 4.5436 | | | 4.3276 | | | 4.3276 | |
| Follow-Up Headway, s | 2.5352 | 2.5352 | | 2.5352 | 2.5352 | | | 2.5352 | | | 2.5352 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | 382 | 430 | | 262 | 296 | | | 675 | | | 621 | |
| Entry Volume, veh/h | 380 | 428 | | 258 | 291 | | | 670 | | | 610 | |
| Circulating Flow ($v_c$), pc/h | 682 | | | 750 | | | 642 | | | 689 | | |
| Exiting Flow ($v_{ex}$), pc/h | 567 | | | 628 | | | 619 | | | 852 | | |
| Capacity ($c_{pce}$), pc/h | 763 | 763 | | 718 | 718 | | | 823 | | | 791 | |
| Capacity (c), veh/h | 760 | 760 | | 706 | 706 | | | 816 | | | 776 | |
| v/c Ratio (x) | 0.50 | 0.56 | | 0.37 | 0.41 | | | 0.82 | | | 0.79 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | 11.9 | 13.5 | | 9.8 | 10.7 | | | 25.2 | | | 23.3 | |
| Lane LOS | B | B | | A | B | | | D | | | C | |
| 95% Queue, veh | 2.8 | 3.6 | | 1.7 | 2.0 | | | 9.1 | | | 8.0 | |
| Approach Delay, s/veh | 12.7 | | | 10.3 | | | 25.2 | | | 23.3 | | |
| Approach LOS | B | | | B | | | D | | | C | | |
| Intersection Delay, s/veh \| LOS | 17.8 | | | | | | C | | | | | |

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| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 315 | 363 | 0 | 100 | 73 |
| Future Volume (vph) | 0 | 315 | 363 | 0 | 100 | 73 |
| Satd. Flow (prot) | 0 | 1644 | 1660 | 0 | 1787 | 1583 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1644 | 1660 | 0 | 1787 | 1583 |
| Satd. Flow (RTOR) | | | | | | 80 |
| Peak Hour Factor | 1.00 | 0.76 | 0.94 | 1.00 | 0.83 | 0.91 |
| Heavy Vehicles (%) | 0% | 4% | 3% | 0% | 1% | 2% |
| Parking (#/hr) | | 0 | 0 | | | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 414 | 386 | 0 | 120 | 80 |
| Turn Type | | NA | NA | | Perm | Perm |
| Protected Phases | | 2 | 6 | | | |
| Permitted Phases | | | | | 4 | 4 |
| Total Split (s) | | 55.0 | 55.0 | | 25.0 | 25.0 |
| Total Lost Time (s) | | 5.5 | 5.6 | | 5.2 | 5.2 |
| Act Effct Green (s) | | 61.4 | 61.3 | | 11.6 | 11.6 |
| Actuated g/C Ratio | | 0.77 | 0.77 | | 0.14 | 0.14 |
| v/c Ratio | | 0.33 | 0.30 | | 0.46 | 0.27 |
| Control Delay | | 5.2 | 4.8 | | 36.5 | 9.7 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 5.2 | 4.8 | | 36.5 | 9.7 |
| LOS | | A | A | | D | A |
| Approach Delay | | 5.2 | 4.8 | | 25.8 | |
| Approach LOS | | A | A | | C | |
| Queue Length 50th (ft) | | 63 | 45 | | 56 | 0 |
| Queue Length 95th (ft) | | 97 | 123 | | 91 | 35 |
| Internal Link Dist (ft) | | 459 | 42 | | 556 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 1260 | 1271 | | 442 | 451 |
| Starvation Cap Reductn | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.33 | 0.30 | | 0.27 | 0.18 |

| Intersection Summary | |
|---|---|
| Cycle Length: 80 | |
| Actuated Cycle Length: 80 | |
| Offset: 70 (88%), Referenced to phase 2:EBT and 6:WBT, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.46 | |
| Intersection Signal Delay: 9.2 | Intersection LOS: A |
| Intersection Capacity Utilization 33.9% | ICU Level of Service A |
| Analysis Period (min) 15 | |

Splits and Phases: 2: Main St & W Park Square



| Lane Group | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 0 | 534 | 397 | 0 | 133 | 125 |
| Future Volume (vph) | 0 | 534 | 397 | 0 | 133 | 125 |
| Satd. Flow (prot) | 0 | 1693 | 1693 | 0 | 1805 | 1615 |
| Flt Permitted | | | | | 0.950 | |
| Satd. Flow (perm) | 0 | 1693 | 1693 | 0 | 1805 | 1615 |
| Satd. Flow (RTOR) | | | | | | 144 |
| Peak Hour Factor | 1.00 | 0.86 | 0.88 | 1.00 | 0.79 | 0.87 |
| Heavy Vehicles (%) | 0% | 1% | 1% | 0% | 0% | 0% |
| Parking (#/hr) | | 0 | 0 | | | |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 0 | 621 | 451 | 0 | 168 | 144 |
| Turn Type | | NA | NA | | Perm | Perm |
| Protected Phases | | 2 | 6 | | | |
| Permitted Phases | | | | | 4 | 4 |
| Total Split (s) | | 73.0 | 73.0 | | 27.0 | 27.0 |
| Total Lost Time (s) | | 5.5 | 5.6 | | 5.2 | 5.2 |
| Act Effct Green (s) | | 73.9 | 73.8 | | 15.4 | 15.4 |
| Actuated g/C Ratio | | 0.74 | 0.74 | | 0.15 | 0.15 |
| v/c Ratio | | 0.50 | 0.36 | | 0.60 | 0.39 |
| Control Delay | | 7.7 | 3.9 | | 48.1 | 9.2 |
| Queue Delay | | 0.9 | 0.0 | | 0.0 | 0.0 |
| Total Delay | | 8.5 | 3.9 | | 48.1 | 9.2 |
| LOS | | A | A | | D | A |
| Approach Delay | | 8.5 | 3.9 | | 30.1 | |
| Approach LOS | | A | A | | C | |
| Queue Length 50th (ft) | | 138 | 63 | | 101 | 0 |
| Queue Length 95th (ft) | | 235 | 91 | | 137 | 45 |
| Internal Link Dist (ft) | | 459 | 42 | | 556 | |
| Turn Bay Length (ft) | | | | | | |
| Base Capacity (vph) | | 1250 | 1248 | | 393 | 464 |
| Starvation Cap Reductn | | 342 | 0 | | 0 | 0 |
| Spillback Cap Reductn | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | | 0.68 | 0.36 | | 0.43 | 0.31 |

**Intersection Summary**

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 38 (38%), Referenced to phase 2:EBT and 6:WBT, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.60
Intersection Signal Delay: 11.9 — Intersection LOS: B
Intersection Capacity Utilization 44.4% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 2: Main St & W Park Square



| Intersection | |
|---|---|
| Int Delay, s/veh | 2.7 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↑ | | ↰ | ↱ |
| Traffic Vol, veh/h | 0 | 315 | 363 | 0 | 100 | 73 |
| Future Vol, veh/h | 0 | 315 | 363 | 0 | 100 | 73 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 100 | 76 | 94 | 100 | 83 | 91 |
| Heavy Vehicles, % | 0 | 4 | 3 | 0 | 1 | 2 |
| Mvmt Flow | 0 | 414 | 386 | 0 | 120 | 80 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | - | 0 | - | 0 | 800 | 386 |
| Stage 1 | - | - | - | - | 386 | - |
| Stage 2 | - | - | - | - | 414 | - |
| Critical Hdwy | - | - | - | - | 6.41 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.41 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.41 | - |
| Follow-up Hdwy | - | - | - | - | 3.509 | 3.318 |
| Pot Cap-1 Maneuver | 0 | - | - | 0 | 356 | 662 |
| Stage 1 | 0 | - | - | 0 | 689 | - |
| Stage 2 | 0 | - | - | 0 | 669 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | - | - | - | - | 356 | 662 |
| Mov Cap-2 Maneuver | - | - | - | - | 472 | - |
| Stage 1 | - | - | - | - | 689 | - |
| Stage 2 | - | - | - | - | 669 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0 | 13.6 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|
| Capacity (veh/h) | - | - | 472 | 662 |
| HCM Lane V/C Ratio | - | - | 0.255 | 0.121 |
| HCM Control Delay (s) | - | - | 15.2 | 11.2 |
| HCM Lane LOS | - | - | C | B |
| HCM 95th %tile Q(veh) | - | - | 1 | 0.4 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 4 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↑ | | ↰ | ↱ |
| Traffic Vol, veh/h | 0 | 534 | 397 | 0 | 133 | 125 |
| Future Vol, veh/h | 0 | 534 | 397 | 0 | 133 | 125 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 100 | 86 | 88 | 100 | 79 | 87 |
| Heavy Vehicles, % | 0 | 1 | 1 | 0 | 0 | 0 |
| Mvmt Flow | 0 | 621 | 451 | 0 | 168 | 144 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | - | 0 | - | 0 | 1072 | 451 |
| Stage 1 | - | - | - | - | 451 | - |
| Stage 2 | - | - | - | - | 621 | - |
| Critical Hdwy | - | - | - | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | - | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 0 | - | - | 0 | 246 | 613 |
| Stage 1 | 0 | - | - | 0 | 646 | - |
| Stage 2 | 0 | - | - | 0 | 540 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | - | - | - | - | 246 | 613 |
| Mov Cap-2 Maneuver | - | - | - | - | 379 | - |
| Stage 1 | - | - | - | - | 646 | - |
| Stage 2 | - | - | - | - | 540 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0 | 17.7 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|
| Capacity (veh/h) | - | - | 379 | 613 |
| HCM Lane V/C Ratio | - | - | 0.444 | 0.234 |
| HCM Control Delay (s) | - | - | 21.9 | 12.7 |
| HCM Lane LOS | - | - | C | B |
| HCM 95th %tile Q(veh) | - | - | 2.2 | 0.9 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.4 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 332 | 83 | 81 | 349 | 15 | 78 |
| Future Vol, veh/h | 332 | 83 | 81 | 349 | 15 | 78 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 25 | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 77 | 83 | 70 | 91 | 47 | 81 |
| Heavy Vehicles, % | 4 | 3 | 3 | 3 | 8 | 5 |
| Mvmt Flow | 431 | 100 | 116 | 384 | 32 | 96 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 531 | 0 | 1097 | 481 |
| Stage 1 | - | - | - | - | 481 | - |
| Stage 2 | - | - | - | - | 616 | - |
| Critical Hdwy | - | - | 4.13 | - | 6.48 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.48 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.48 | - |
| Follow-up Hdwy | - | - | 2.227 | - | 3.572 | 3.345 |
| Pot Cap-1 Maneuver | - | - | 1031 | - | 230 | 579 |
| Stage 1 | - | - | - | - | 609 | - |
| Stage 2 | - | - | - | - | 527 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1031 | - | 204 | 579 |
| Mov Cap-2 Maneuver | - | - | - | - | 332 | - |
| Stage 1 | - | - | - | - | 609 | - |
| Stage 2 | - | - | - | - | 467 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 2.1 | 13.6 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 332 | 579 | - | - | 1031 | - |
| HCM Lane V/C Ratio | 0.096 | 0.166 | - | - | 0.112 | - |
| HCM Control Delay (s) | 17 | 12.5 | - | - | 8.9 | - |
| HCM Lane LOS | C | B | - | - | A | - |
| HCM 95th %tile Q(veh) | 0.3 | 0.6 | - | - | 0.4 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 3.4 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 599 | 67 | 57 | 368 | 29 | 144 |
| Future Vol, veh/h | 599 | 67 | 57 | 368 | 29 | 144 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 25 | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 88 | 76 | 84 | 85 | 66 | 78 |
| Heavy Vehicles, % | 1 | 0 | 2 | 1 | 0 | 0 |
| Mvmt Flow | 681 | 88 | 68 | 433 | 44 | 185 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 769 | 0 | 1294 | 725 |
| Stage 1 | - | - | - | - | 725 | - |
| Stage 2 | - | - | - | - | 569 | - |
| Critical Hdwy | - | - | 4.12 | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | - | - | 2.218 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 845 | - | 181 | 428 |
| Stage 1 | - | - | - | - | 483 | - |
| Stage 2 | - | - | - | - | 570 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 845 | - | 167 | 428 |
| Mov Cap-2 Maneuver | - | - | - | - | 305 | - |
| Stage 1 | - | - | - | - | 483 | - |
| Stage 2 | - | - | - | - | 524 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 1.3 | 19.4 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 305 | 428 | - | - | 845 | - |
| HCM Lane V/C Ratio | 0.144 | 0.431 | - | - | 0.08 | - |
| HCM Control Delay (s) | 18.8 | 19.6 | - | - | 9.6 | - |
| HCM Lane LOS | C | C | - | - | A | - |
| HCM 95th %tile Q(veh) | 0.5 | 2.1 | - | - | 0.3 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.8 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 86 | 324 | 430 | 29 | 0 | 0 |
| Future Vol, veh/h | 86 | 324 | 430 | 29 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 25 | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 86 | 76 | 96 | 66 | 100 | 100 |
| Heavy Vehicles, % | 1 | 5 | 3 | 4 | 0 | 0 |
| Mvmt Flow | 100 | 426 | 448 | 44 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 492 | 0 | - | 0 | 1096 | 470 |
| Stage 1 | - | - | - | - | 470 | - |
| Stage 2 | - | - | - | - | 626 | - |
| Critical Hdwy | 4.11 | - | - | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | 2.209 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1077 | - | - | - | 238 | 598 |
| Stage 1 | - | - | - | - | 633 | - |
| Stage 2 | - | - | - | - | 537 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1077 | - | - | - | 216 | 598 |
| Mov Cap-2 Maneuver | - | - | - | - | 352 | - |
| Stage 1 | - | - | - | - | 574 | - |
| Stage 2 | - | - | - | - | 537 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 1.6 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1077 | - | - | - | - |
| HCM Lane V/C Ratio | 0.093 | - | - | - | - |
| HCM Control Delay (s) | 8.7 | - | - | - | 0 |
| HCM Lane LOS | A | - | - | - | A |
| HCM 95th %tile Q(veh) | 0.3 | - | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.9 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 125 | 617 | 425 | 61 | 0 | 0 |
| Future Vol, veh/h | 125 | 617 | 425 | 61 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 25 | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 89 | 92 | 86 | 80 | 100 | 100 |
| Heavy Vehicles, % | 0 | 0 | 1 | 0 | 0 | 0 |
| Mvmt Flow | 140 | 671 | 494 | 76 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 570 | 0 | - | 0 | 1483 | 532 |
| Stage 1 | - | - | - | - | 532 | - |
| Stage 2 | - | - | - | - | 951 | - |
| Critical Hdwy | 4.1 | - | - | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | 2.2 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1013 | - | - | - | 139 | 551 |
| Stage 1 | - | - | - | - | 593 | - |
| Stage 2 | - | - | - | - | 379 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1013 | - | - | - | 120 | 551 |
| Mov Cap-2 Maneuver | - | - | - | - | 252 | - |
| Stage 1 | - | - | - | - | 511 | - |
| Stage 2 | - | - | - | - | 379 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 1.6 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1013 | - | - | - | - |
| HCM Lane V/C Ratio | 0.139 | - | - | - | - |
| HCM Control Delay (s) | 9.1 | - | - | - | 0 |
| HCM Lane LOS | A | - | - | - | A |
| HCM 95th %tile Q(veh) | 0.5 | - | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 323 | 1 | 2 | 458 | 0 | 0 |
| Future Vol, veh/h | 323 | 1 | 2 | 458 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 50 | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 76 | 25 | 50 | 93 | 100 | 100 |
| Heavy Vehicles, % | 5 | 0 | 0 | 3 | 0 | 0 |
| Mvmt Flow | 425 | 4 | 4 | 492 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 429 | 0 | 927 | 427 |
| Stage 1 | - | - | - | - | 427 | - |
| Stage 2 | - | - | - | - | 500 | - |
| Critical Hdwy | - | - | 4.1 | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | - | - | 2.2 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 1141 | - | 300 | 632 |
| Stage 1 | - | - | - | - | 662 | - |
| Stage 2 | - | - | - | - | 613 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1141 | - | 299 | 632 |
| Mov Cap-2 Maneuver | - | - | - | - | 426 | - |
| Stage 1 | - | - | - | - | 662 | - |
| Stage 2 | - | - | - | - | 611 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0.1 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | - | 1141 | - |
| HCM Lane V/C Ratio | - | - | - | 0.004 | - |
| HCM Control Delay (s) | 0 | - | - | 8.2 | - |
| HCM Lane LOS | A | - | - | A | - |
| HCM 95th %tile Q(veh) | - | - | - | 0 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.1 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 614 | 2 | 4 | 487 | 0 | 0 |
| Future Vol, veh/h | 614 | 2 | 4 | 487 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 50 | - | 0 | - |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 50 | 33 | 87 | 100 | 100 |
| Heavy Vehicles, % | 1 | 0 | 0 | 1 | 0 | 0 |
| Mvmt Flow | 667 | 4 | 12 | 560 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 671 | 0 | 1253 | 669 |
| Stage 1 | - | - | - | - | 669 | - |
| Stage 2 | - | - | - | - | 584 | - |
| Critical Hdwy | - | - | 4.1 | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | - | - | 2.2 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 929 | - | 192 | 461 |
| Stage 1 | - | - | - | - | 513 | - |
| Stage 2 | - | - | - | - | 561 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 929 | - | 190 | 461 |
| Mov Cap-2 Maneuver | - | - | - | - | 330 | - |
| Stage 1 | - | - | - | - | 513 | - |
| Stage 2 | - | - | - | - | 554 | - |

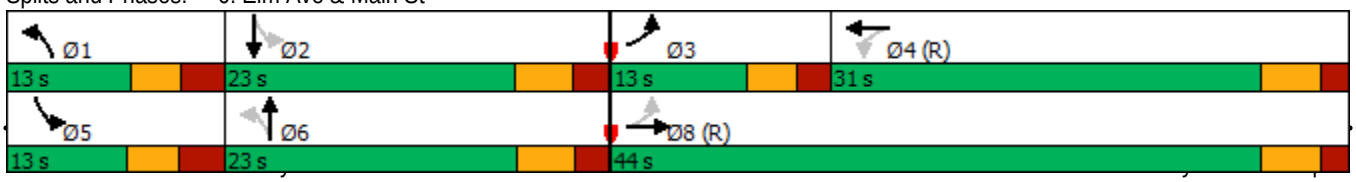
| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0.2 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | NBLn1 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|
| Capacity (veh/h) | - | - | - | 929 | - |
| HCM Lane V/C Ratio | - | - | - | 0.013 | - |
| HCM Control Delay (s) | 0 | - | - | 8.9 | - |
| HCM Lane LOS | A | - | - | A | - |
| HCM 95th %tile Q(veh) | - | - | - | 0 | - |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Future Volume (vph) | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Satd. Flow (prot) | 1736 | 1768 | 0 | 1805 | 1804 | 0 | 1805 | 1778 | 0 | 1805 | 1792 | 0 |
| Flt Permitted | 0.303 | | | 0.548 | | | 0.401 | | | 0.581 | | |
| Satd. Flow (perm) | 554 | 1768 | 0 | 1041 | 1804 | 0 | 762 | 1778 | 0 | 1104 | 1792 | 0 |
| Satd. Flow (RTOR) | | 21 | | | 11 | | | 24 | | | 19 | |
| Peak Hour Factor | 0.96 | 0.77 | 0.51 | 0.79 | 0.94 | 0.72 | 0.74 | 0.85 | 0.75 | 0.58 | 0.86 | 0.94 |
| Heavy Vehicles (%) | 4% | 3% | 10% | 0% | 3% | 3% | 0% | 1% | 5% | 0% | 2% | 2% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 68 | 356 | 0 | 52 | 411 | 0 | 96 | 220 | 0 | 36 | 256 | 0 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | | 4 | | | 6 | | | 2 | | |
| Total Split (s) | 13.0 | 44.0 | | 31.0 | 31.0 | | 13.0 | 23.0 | | 13.0 | 23.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | | 5.3 | 5.3 | | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 42.9 | 42.6 | | 33.1 | 33.1 | | 23.5 | 19.0 | | 20.9 | 16.0 | |
| Actuated g/C Ratio | 0.54 | 0.53 | | 0.41 | 0.41 | | 0.29 | 0.24 | | 0.26 | 0.20 | |
| v/c Ratio | 0.17 | 0.37 | | 0.12 | 0.55 | | 0.30 | 0.50 | | 0.11 | 0.69 | |
| Control Delay | 9.9 | 10.4 | | 16.6 | 19.8 | | 19.9 | 28.3 | | 17.3 | 37.7 | |
| Queue Delay | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 9.9 | 10.4 | | 16.6 | 19.8 | | 19.9 | 28.3 | | 17.3 | 37.7 | |
| LOS | A | B | | B | B | | B | C | | B | D | |
| Approach Delay | | 10.3 | | | 19.5 | | | 25.8 | | | 35.2 | |
| Approach LOS | | B | | | B | | | C | | | D | |
| Queue Length 50th (ft) | 13 | 91 | | 14 | 117 | | 32 | 88 | | 12 | 112 | |
| Queue Length 95th (ft) | 31 | 114 | | 31 | 196 | | 50 | 145 | | 19 | 175 | |
| Internal Link Dist (ft) | | 301 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 175 | | | 150 | | | 65 | | | 60 | | |
| Base Capacity (vph) | 415 | 951 | | 431 | 753 | | 320 | 452 | | 362 | 400 | |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.16 | 0.37 | | 0.12 | 0.55 | | 0.30 | 0.49 | | 0.10 | 0.64 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 80 | |
| Actuated Cycle Length: 80 | |
| Offset: 71 (89%), Referenced to phase 4:WBTL and 8:EBTL, Start of 1st Green | |
| Control Type: Actuated-Coordinated | |
| Maximum v/c Ratio: 0.69 | |
| Intersection Signal Delay: 21.3 | Intersection LOS: C |
| Intersection Capacity Utilization 60.6% | ICU Level of Service B |
| Analysis Period (min) 15 | |

Splits and Phases: 6: Elm Ave & Main St



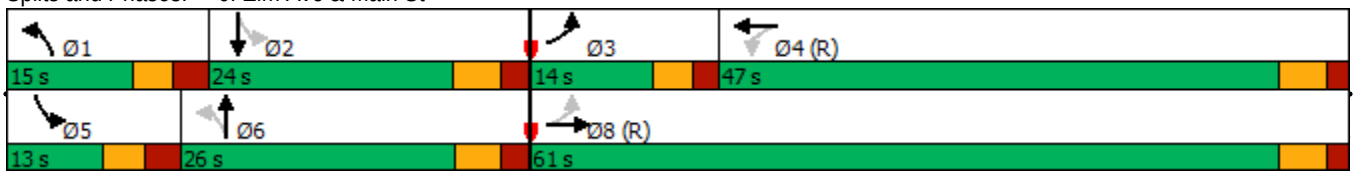

AM Peak Hour

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Future Volume (vph) | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Satd. Flow (prot) | 1805 | 1841 | 0 | 1805 | 1834 | 0 | 1805 | 1797 | 0 | 1805 | 1770 | 0 |
| Flt Permitted | 0.294 | | | 0.458 | | | 0.444 | | | 0.394 | | |
| Satd. Flow (perm) | 559 | 1841 | 0 | 870 | 1834 | 0 | 844 | 1797 | 0 | 749 | 1770 | 0 |
| Satd. Flow (RTOR) | | 15 | | | 8 | | | 26 | | | 32 | |
| Peak Hour Factor | 0.87 | 0.89 | 0.71 | 0.75 | 0.83 | 0.62 | 0.88 | 0.83 | 0.87 | 0.64 | 0.84 | 0.83 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 0% | 0% | 0% | 0% | 0% | 1% | 0% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 160 | 551 | 0 | 28 | 501 | 0 | 60 | 232 | 0 | 56 | 199 | 0 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | | 4 | | | 6 | | | 2 | | |
| Total Split (s) | 14.0 | 61.0 | | 47.0 | 47.0 | | 15.0 | 26.0 | | 13.0 | 24.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | | 5.3 | 5.3 | | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 61.8 | 61.5 | | 48.2 | 48.2 | | 23.8 | 17.3 | | 22.1 | 16.5 | |
| Actuated g/C Ratio | 0.62 | 0.62 | | 0.48 | 0.48 | | 0.24 | 0.17 | | 0.22 | 0.16 | |
| v/c Ratio | 0.36 | 0.48 | | 0.07 | 0.56 | | 0.22 | 0.70 | | 0.24 | 0.62 | |
| Control Delay | 9.8 | 10.7 | | 13.7 | 17.9 | | 26.5 | 46.0 | | 27.3 | 41.5 | |
| Queue Delay | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 9.8 | 10.7 | | 13.7 | 17.9 | | 26.5 | 46.0 | | 27.3 | 41.5 | |
| LOS | A | B | | B | B | | C | D | | C | D | |
| Approach Delay | | 10.5 | | | 17.7 | | | 42.0 | | | 38.4 | |
| Approach LOS | | B | | | B | | | D | | | D | |
| Queue Length 50th (ft) | 34 | 159 | | 8 | 198 | | 28 | 126 | | 26 | 100 | |
| Queue Length 95th (ft) | 58 | 241 | | m19 | 250 | | 54 | 179 | | 37 | 156 | |
| Internal Link Dist (ft) | | 301 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 175 | | | 150 | | | 65 | | | 60 | | |
| Base Capacity (vph) | 460 | 1138 | | 419 | 888 | | 300 | 385 | | 243 | 348 | |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.35 | 0.48 | | 0.07 | 0.56 | | 0.20 | 0.60 | | 0.23 | 0.57 | |

**Intersection Summary**

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 32 (32%), Referenced to phase 4:WBTL and 8:EBTL, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.70
Intersection Signal Delay: 21.8 — Intersection LOS: C
Intersection Capacity Utilization 68.0% — ICU Level of Service C
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 6: Elm Ave & Main St



| Intersection | |
|---|---|
| Int Delay, s/veh | 65.8 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Future Vol, veh/h | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 175 | - | - | 150 | - | - | 65 | - | - | 60 | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 96 | 77 | 51 | 79 | 94 | 72 | 74 | 85 | 75 | 58 | 86 | 94 |
| Heavy Vehicles, % | 4 | 3 | 10 | 0 | 3 | 3 | 0 | 1 | 5 | 0 | 2 | 2 |
| Mvmt Flow | 68 | 287 | 69 | 52 | 351 | 60 | 96 | 156 | 64 | 36 | 192 | 64 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 411 | 0 | 0 | 356 | 0 | 0 | 1071 | 973 | 322 | 1053 | 977 | 381 |
| Stage 1 | - | - | - | - | - | - | 458 | 458 | - | 485 | 485 | - |
| Stage 2 | - | - | - | - | - | - | 613 | 515 | - | 568 | 492 | - |
| Critical Hdwy | 4.14 | - | - | 4.1 | - | - | 7.1 | 6.51 | 6.25 | 7.1 | 6.52 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.51 | - | 6.1 | 5.52 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.51 | - | 6.1 | 5.52 | - |
| Follow-up Hdwy | 2.236 | - | - | 2.2 | - | - | 3.5 | 4.009 | 3.345 | 3.5 | 4.018 | 3.318 |
| Pot Cap-1 Maneuver | 1137 | - | - | 1214 | - | - | 200 | 253 | 712 | 206 | 251 | 666 |
| Stage 1 | - | - | - | - | - | - | 587 | 569 | - | 567 | 552 | - |
| Stage 2 | - | - | - | - | - | - | 483 | 536 | - | 511 | 548 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1137 | - | - | 1214 | - | - | ~ 48 | 228 | 712 | 78 | 226 | 666 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | ~ 48 | 228 | - | 78 | 226 | - |
| Stage 1 | - | - | - | - | - | - | 552 | 535 | - | 533 | 528 | - |
| Stage 2 | - | - | - | - | - | - | 266 | 513 | - | 309 | 515 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 1.3 | 0.9 | 231.9 | 82.2 |
| HCM LOS | | | F | F |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 48 | 284 | 1137 | - | - | 1214 | - | - | 78 | 271 |
| HCM Lane V/C Ratio | 1.999 | 0.776 | 0.06 | - | - | 0.043 | - | - | 0.464 | 0.944 |
| HCM Control Delay (s) | $ 648.2 | 50.8 | 8.4 | - | - | 8.1 | - | - | 86.1 | 81.7 |
| HCM Lane LOS | F | F | A | - | - | A | - | - | F | F |
| HCM 95th %tile Q(veh) | 9.7 | 6 | 0.2 | - | - | 0.1 | - | - | 1.9 | 8.9 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

| Intersection | |
|---|---|
| Int Delay, s/veh | 211.7 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Future Vol, veh/h | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 175 | - | - | 150 | - | - | 65 | - | - | 60 | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 87 | 89 | 71 | 75 | 83 | 62 | 88 | 83 | 87 | 64 | 84 | 83 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Mvmt Flow | 160 | 466 | 85 | 28 | 441 | 60 | 60 | 148 | 84 | 56 | 115 | 84 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 501 | 0 | 0 | 551 | 0 | 0 | 1456 | 1386 | 509 | 1472 | 1398 | 471 |
| Stage 1 | - | - | - | - | - | - | 829 | 829 | - | 527 | 527 | - |
| Stage 2 | - | - | - | - | - | - | 627 | 557 | - | 945 | 871 | - |
| Critical Hdwy | 4.1 | - | - | 4.1 | - | - | 7.1 | 6.5 | 6.2 | 7.1 | 6.51 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.51 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.1 | 5.51 | - |
| Follow-up Hdwy | 2.2 | - | - | 2.2 | - | - | 3.5 | 4 | 3.3 | 3.5 | 4.009 | 3.3 |
| Pot Cap-1 Maneuver | 1074 | - | - | 1029 | - | - | 109 | ~ 144 | 568 | 106 | 141 | 597 |
| Stage 1 | - | - | - | - | - | - | 368 | 388 | - | 538 | 530 | - |
| Stage 2 | - | - | - | - | - | - | 475 | 515 | - | 317 | 370 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1074 | - | - | 1029 | - | - | ~ 6 | ~ 119 | 568 | - | 117 | 597 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | ~ 6 | ~ 119 | - | - | 117 | - |
| Stage 1 | - | - | - | - | - | - | 313 | 330 | - | 458 | 516 | - |
| Stage 2 | - | - | - | - | - | - | 308 | 501 | - | 127 | 315 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2 | 0.5 | $ 1288.9 | |
| HCM LOS | | | F | - |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 6 | 167 | 1074 | - | - | 1029 | - | - | - | 177 |
| HCM Lane V/C Ratio | 10.038 | 1.39 | 0.149 | - | - | 0.027 | - | - | - | 1.129 |
| HCM Control Delay (s) | $ 5254.9 | 259.8 | 8.9 | - | - | 8.6 | - | - | - | 160 |
| HCM Lane LOS | F | F | A | - | - | A | - | - | - | F |
| HCM 95th %tile Q(veh) | 9.2 | 14.2 | 0.5 | - | - | 0.1 | - | - | - | 10.2 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 32.3 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Future Vol, veh/h | 65 | 221 | 35 | 41 | 330 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Peak Hour Factor | 0.96 | 0.77 | 0.51 | 0.79 | 0.94 | 0.72 | 0.74 | 0.85 | 0.75 | 0.58 | 0.86 | 0.94 |
| Heavy Vehicles, % | 4 | 3 | 10 | 0 | 3 | 3 | 0 | 1 | 5 | 0 | 2 | 2 |
| Mvmt Flow | 68 | 287 | 69 | 52 | 351 | 60 | 96 | 156 | 64 | 36 | 192 | 64 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 2 | 2 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 2 | 2 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 2 | 2 | 2 | 2 |
| HCM Control Delay | 32.8 | 47.6 | 18.5 | 22.2 |
| HCM LOS | D | E | C | C |

| Lane | NBLn1 | NBLn2 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|
| Vol Left, % | 100% | 0% | 100% | 0% | 100% | 0% | 100% | 0% |
| Vol Thru, % | 0% | 73% | 0% | 86% | 0% | 88% | 0% | 73% |
| Vol Right, % | 0% | 27% | 0% | 14% | 0% | 12% | 0% | 27% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 71 | 181 | 65 | 256 | 41 | 373 | 21 | 225 |
| LT Vol | 71 | 0 | 65 | 0 | 41 | 0 | 21 | 0 |
| Through Vol | 0 | 133 | 0 | 221 | 0 | 330 | 0 | 165 |
| RT Vol | 0 | 48 | 0 | 35 | 0 | 43 | 0 | 60 |
| Lane Flow Rate | 96 | 220 | 68 | 356 | 52 | 411 | 36 | 256 |
| Geometry Grp | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Degree of Util (X) | 0.245 | 0.52 | 0.164 | 0.801 | 0.123 | 0.913 | 0.092 | 0.604 |
| Departure Headway (Hd) | 9.179 | 8.483 | 8.744 | 8.109 | 8.548 | 8 | 9.187 | 8.507 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 391 | 426 | 410 | 445 | 419 | 452 | 390 | 424 |
| Service Time | 6.946 | 6.249 | 6.507 | 5.872 | 6.307 | 5.759 | 6.952 | 6.272 |
| HCM Lane V/C Ratio | 0.246 | 0.516 | 0.166 | 0.8 | 0.124 | 0.909 | 0.092 | 0.604 |
| HCM Control Delay | 14.9 | 20.1 | 13.2 | 36.5 | 12.5 | 52 | 12.9 | 23.5 |
| HCM Lane LOS | B | C | B | E | B | F | B | C |
| HCM 95th-tile Q | 0.9 | 2.9 | 0.6 | 7.3 | 0.4 | 10.2 | 0.3 | 3.9 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 79.1 |
| Intersection LOS | F |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Future Vol, veh/h | 139 | 415 | 60 | 21 | 366 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Peak Hour Factor | 0.87 | 0.89 | 0.71 | 0.75 | 0.83 | 0.62 | 0.88 | 0.83 | 0.87 | 0.64 | 0.84 | 0.83 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Mvmt Flow | 160 | 466 | 85 | 28 | 441 | 60 | 60 | 148 | 84 | 56 | 115 | 84 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 2 | 2 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 2 | 2 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 2 | 2 | 2 | 2 |
| HCM Control Delay | 108.8 | 100.7 | 20.7 | 18.9 |
| HCM LOS | F | F | C | C |

| Lane | NBLn1 | NBLn2 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|
| Vol Left, % | 100% | 0% | 100% | 0% | 100% | 0% | 100% | 0% |
| Vol Thru, % | 0% | 63% | 0% | 87% | 0% | 91% | 0% | 58% |
| Vol Right, % | 0% | 37% | 0% | 13% | 0% | 9% | 0% | 42% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 53 | 196 | 139 | 475 | 21 | 403 | 36 | 167 |
| LT Vol | 53 | 0 | 139 | 0 | 21 | 0 | 36 | 0 |
| Through Vol | 0 | 123 | 0 | 415 | 0 | 366 | 0 | 97 |
| RT Vol | 0 | 73 | 0 | 60 | 0 | 37 | 0 | 70 |
| Lane Flow Rate | 60 | 232 | 160 | 551 | 28 | 501 | 56 | 200 |
| Geometry Grp | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Degree of Util (X) | 0.155 | 0.547 | 0.373 | 1.199 | 0.066 | 1.112 | 0.146 | 0.477 |
| Departure Headway (Hd) | 9.938 | 9.139 | 8.731 | 8.138 | 8.909 | 8.359 | 10.089 | 9.272 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 363 | 397 | 415 | 452 | 405 | 441 | 358 | 392 |
| Service Time | 7.638 | 6.839 | 6.431 | 5.838 | 6.609 | 6.059 | 7.789 | 6.972 |
| HCM Lane V/C Ratio | 0.165 | 0.584 | 0.386 | 1.219 | 0.069 | 1.136 | 0.156 | 0.51 |
| HCM Control Delay | 14.5 | 22.3 | 16.5 | 135.6 | 12.2 | 105.7 | 14.5 | 20.1 |
| HCM Lane LOS | B | C | C | F | B | F | B | C |
| HCM 95th-tile Q | 0.5 | 3.2 | 1.7 | 20.6 | 0.2 | 16.8 | 0.5 | 2.5 |

# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | AM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Elm Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Elm Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.86 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 66 | 221 | 36 | 0 | 40 | 330 | 43 | 0 | 71 | 133 | 47 | 0 | 20 | 165 | 60 |
| Percent Heavy Vehicles, % | 3 | 4 | 3 | 10 | 0 | 0 | 3 | 3 | 3 | 0 | 1 | 5 | 3 | 0 | 2 | 2 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 80 | 265 | 46 | 0 | 47 | 395 | 52 | 0 | 83 | 156 | 57 | 0 | 23 | 196 | 71 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 31 | | | | 2 | | | | 7 | | | | 5 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 391 | | | 494 | | | 296 | | | 290 | |
| Entry Volume, veh/h | | 376 | | | 481 | | | 292 | | | 285 | |
| Circulating Flow ($v_c$), pc/h | 266 | | | 319 | | | 368 | | | 525 | | |
| Exiting Flow ($v_{ex}$), pc/h | 345 | | | 549 | | | 288 | | | 289 | | |
| Capacity ($c_{pce}$), pc/h | | 1052 | | | 997 | | | 948 | | | 808 | |
| Capacity (c), veh/h | | 1007 | | | 970 | | | 934 | | | 793 | |
| v/c Ratio (x) | | 0.37 | | | 0.50 | | | 0.31 | | | 0.36 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 7.6 | | | 9.8 | | | 7.2 | | | 8.9 | |
| Lane LOS | | A | | | A | | | A | | | A | |
| 95% Queue, veh | | 1.7 | | | 2.8 | | | 1.3 | | | 1.6 | |
| Approach Delay, s/veh | 7.6 | | | 9.8 | | | 7.2 | | | 8.9 | | |
| Approach LOS | A | | | A | | | A | | | A | | |
| Intersection Delay, s/veh \| LOS | 8.5 | | | | | | A | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | PM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Elm Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Elm Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.95 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 139 | 415 | 61 | 0 | 21 | 366 | 37 | 0 | 53 | 123 | 73 | 0 | 36 | 97 | 71 |
| Percent Heavy Vehicles, % | 3 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 1 | 0 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 146 | 441 | 64 | 0 | 22 | 393 | 39 | 0 | 56 | 129 | 77 | 0 | 38 | 103 | 75 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 28 | | | | 3 | | | | 7 | | | | 5 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 651 | | | 454 | | | 262 | | | 216 | |
| Entry Volume, veh/h | | 647 | | | 446 | | | 262 | | | 215 | |
| Circulating Flow ($v_c$), pc/h | 163 | | | 331 | | | 625 | | | 471 | | |
| Exiting Flow ($v_{ex}$), pc/h | 556 | | | 524 | | | 314 | | | 189 | | |
| Capacity ($c_{pce}$), pc/h | | 1169 | | | 985 | | | 729 | | | 854 | |
| Capacity (c), veh/h | | 1156 | | | 967 | | | 729 | | | 849 | |
| v/c Ratio (x) | | 0.56 | | | 0.46 | | | 0.36 | | | 0.25 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 9.8 | | | 9.2 | | | 9.5 | | | 6.9 | |
| Lane LOS | | A | | | A | | | A | | | A | |
| 95% Queue, veh | | 3.6 | | | 2.5 | | | 1.6 | | | 1.0 | |
| Approach Delay, s/veh | 9.8 | | | 9.2 | | | 9.5 | | | 6.9 | | |
| Approach LOS | A | | | A | | | A | | | A | | |
| Intersection Delay, s/veh \| LOS | 9.2 | | | | | | A | | | | | |

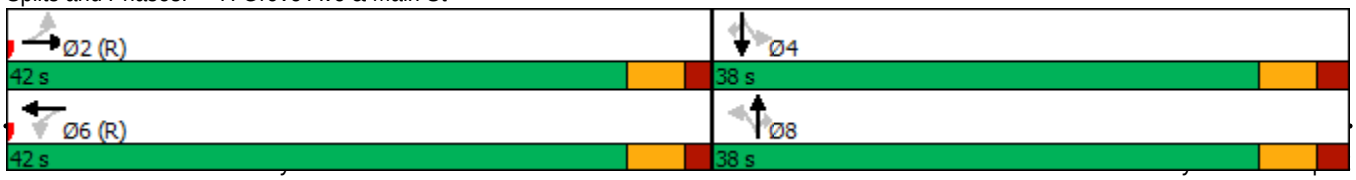
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| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Future Volume (vph) | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Satd. Flow (prot) | 1752 | 1792 | 0 | 1687 | 1723 | 0 | 0 | 1865 | 1615 | 0 | 1816 | 1568 |
| Flt Permitted | 0.474 | | | 0.602 | | | | 0.766 | | | 0.943 | |
| Satd. Flow (perm) | 874 | 1792 | 0 | 1069 | 1723 | 0 | 0 | 1444 | 1615 | 0 | 1723 | 1568 |
| Satd. Flow (RTOR) | | 25 | | | 43 | | | | 36 | | | 104 |
| Peak Hour Factor | 0.67 | 0.93 | 0.45 | 0.88 | 0.96 | 0.86 | 0.66 | 0.84 | 0.44 | 0.90 | 0.85 | 0.84 |
| Heavy Vehicles (%) | 3% | 3% | 0% | 7% | 4% | 6% | 0% | 1% | 0% | 4% | 4% | 3% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 131 | 243 | 0 | 16 | 392 | 0 | 0 | 200 | 36 | 0 | 352 | 161 |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | Perm | Perm | NA | Perm |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | |
| Permitted Phases | 2 | | | 6 | | | 8 | | 8 | 4 | | 4 |
| Total Split (s) | 42.0 | 42.0 | | 42.0 | 42.0 | | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 | 38.0 |
| Total Lost Time (s) | 5.1 | 5.1 | | 5.1 | 5.1 | | | 5.5 | 5.5 | | 5.5 | 5.5 |
| Act Effct Green (s) | 44.6 | 44.6 | | 44.6 | 44.6 | | | 24.8 | 24.8 | | 24.8 | 24.8 |
| Actuated g/C Ratio | 0.56 | 0.56 | | 0.56 | 0.56 | | | 0.31 | 0.31 | | 0.31 | 0.31 |
| v/c Ratio | 0.27 | 0.24 | | 0.03 | 0.40 | | | 0.45 | 0.07 | | 0.66 | 0.29 |
| Control Delay | 7.8 | 5.7 | | 10.9 | 11.8 | | | 24.0 | 5.9 | | 29.2 | 8.5 |
| Queue Delay | 0.0 | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | 7.8 | 5.7 | | 10.9 | 11.8 | | | 24.0 | 5.9 | | 29.2 | 8.5 |
| LOS | A | A | | B | B | | | C | A | | C | A |
| Approach Delay | | 6.4 | | | 11.8 | | | 21.2 | | | 22.7 | |
| Approach LOS | | A | | | B | | | C | | | C | |
| Queue Length 50th (ft) | 19 | 28 | | 3 | 93 | | | 78 | 0 | | 149 | 20 |
| Queue Length 95th (ft) | 31 | 59 | | 14 | 189 | | | 109 | 3 | | 189 | 47 |
| Internal Link Dist (ft) | | 581 | | | 1203 | | | 622 | | | 478 | |
| Turn Bay Length (ft) | 300 | | | 150 | | | | | 50 | | | 50 |
| Base Capacity (vph) | 486 | 1009 | | 595 | 978 | | | 586 | 677 | | 699 | 698 |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | 0.27 | 0.24 | | 0.03 | 0.40 | | | 0.34 | 0.05 | | 0.50 | 0.23 |

**Intersection Summary**

Cycle Length: 80
Actuated Cycle Length: 80
Offset: 76 (95%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.66
Intersection Signal Delay: 15.6 — Intersection LOS: B
Intersection Capacity Utilization 74.7% — ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 7: Grove Ave & Main St

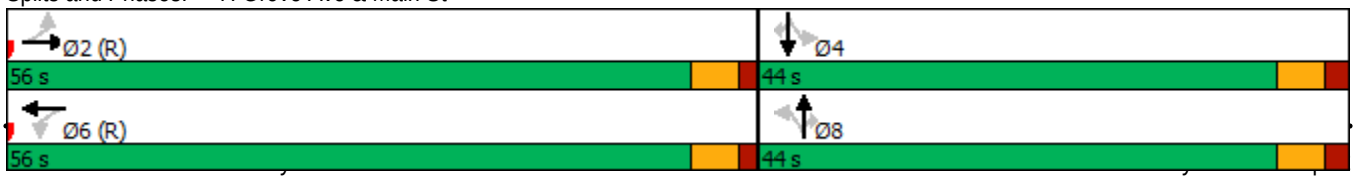


| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Future Volume (vph) | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Satd. Flow (prot) | 1805 | 1828 | 0 | 1805 | 1823 | 0 | 0 | 1858 | 1615 | 0 | 1883 | 1599 |
| Flt Permitted | 0.515 | | | 0.459 | | | | 0.554 | | | 0.778 | |
| Satd. Flow (perm) | 978 | 1828 | 0 | 872 | 1823 | 0 | 0 | 1046 | 1615 | 0 | 1478 | 1599 |
| Satd. Flow (RTOR) | | 14 | | | 21 | | | | 23 | | | 96 |
| Peak Hour Factor | 0.79 | 0.92 | 0.67 | 0.44 | 0.91 | 0.78 | 0.69 | 0.86 | 0.63 | 0.90 | 0.84 | 0.76 |
| Heavy Vehicles (%) | 0% | 1% | 3% | 0% | 1% | 0% | 2% | 0% | 0% | 0% | 0% | 1% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 176 | 439 | 0 | 16 | 359 | 0 | 0 | 249 | 32 | 0 | 273 | 149 |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | Perm | Perm | NA | Perm |
| Protected Phases | | 2 | | | 6 | | | 8 | | | 4 | |
| Permitted Phases | 2 | | | 6 | | | 8 | | 8 | 4 | | 4 |
| Total Split (s) | 56.0 | 56.0 | | 56.0 | 56.0 | | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 |
| Total Lost Time (s) | 5.1 | 5.1 | | 5.1 | 5.1 | | | 5.5 | 5.5 | | 5.5 | 5.5 |
| Act Effct Green (s) | 64.7 | 64.7 | | 64.7 | 64.7 | | | 24.7 | 24.7 | | 24.7 | 24.7 |
| Actuated g/C Ratio | 0.65 | 0.65 | | 0.65 | 0.65 | | | 0.25 | 0.25 | | 0.25 | 0.25 |
| v/c Ratio | 0.28 | 0.37 | | 0.03 | 0.30 | | | 0.97 | 0.08 | | 0.75 | 0.32 |
| Control Delay | 7.0 | 6.8 | | 8.9 | 9.2 | | | 84.2 | 12.9 | | 46.9 | 12.7 |
| Queue Delay | 0.0 | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 | | 0.0 | 0.0 |
| Total Delay | 7.0 | 6.8 | | 8.9 | 9.2 | | | 84.2 | 12.9 | | 46.9 | 12.7 |
| LOS | A | A | | A | A | | | F | B | | D | B |
| Approach Delay | | 6.9 | | | 9.2 | | | 76.1 | | | 34.8 | |
| Approach LOS | | A | | | A | | | E | | | C | |
| Queue Length 50th (ft) | 21 | 61 | | 3 | 85 | | | 157 | 4 | | 161 | 26 |
| Queue Length 95th (ft) | 76 | 229 | | 7 | 169 | | | 219 | 14 | | 204 | 49 |
| Internal Link Dist (ft) | | 581 | | | 1203 | | | 622 | | | 478 | |
| Turn Bay Length (ft) | 300 | | | 150 | | | | | 50 | | | 50 |
| Base Capacity (vph) | 632 | 1187 | | 564 | 1186 | | | 402 | 635 | | 569 | 674 |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | | 0 | 0 | | 0 | 0 |
| Reduced v/c Ratio | 0.28 | 0.37 | | 0.03 | 0.30 | | | 0.62 | 0.05 | | 0.48 | 0.22 |

**Intersection Summary**

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 60 (60%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.97
Intersection Signal Delay: 25.8 — Intersection LOS: C
Intersection Capacity Utilization 73.9% — ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 7: Grove Ave & Main St



| Intersection | |
|---|---|
| Int Delay, s/veh | 78.4 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Future Vol, veh/h | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 300 | - | - | 150 | - | - | - | - | 50 | - | - | 50 |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 67 | 93 | 45 | 88 | 96 | 86 | 66 | 84 | 44 | 90 | 85 | 84 |
| Heavy Vehicles, % | 3 | 3 | 0 | 7 | 4 | 6 | 0 | 1 | 0 | 4 | 4 | 3 |
| Mvmt Flow | 131 | 187 | 56 | 16 | 259 | 133 | 44 | 156 | 36 | 40 | 312 | 161 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 392 | 0 | 0 | 243 | 0 | 0 | 1071 | 901 | 215 | 931 | 863 | 326 |
| Stage 1 | - | - | - | - | - | - | 477 | 477 | - | 358 | 358 | - |
| Stage 2 | - | - | - | - | - | - | 594 | 424 | - | 573 | 505 | - |
| Critical Hdwy | 4.13 | - | - | 4.17 | - | - | 7.1 | 6.51 | 6.2 | 7.14 | 6.54 | 6.23 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.51 | - | 6.14 | 5.54 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.51 | - | 6.14 | 5.54 | - |
| Follow-up Hdwy | 2.227 | - | - | 2.263 | - | - | 3.5 | 4.009 | 3.3 | 3.536 | 4.036 | 3.327 |
| Pot Cap-1 Maneuver | 1161 | - | - | 1295 | - | - | 200 | 279 | 830 | 245 | ~ 290 | 713 |
| Stage 1 | - | - | - | - | - | - | 573 | 558 | - | 656 | 624 | - |
| Stage 2 | - | - | - | - | - | - | 495 | 589 | - | 501 | 537 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1161 | - | - | 1295 | - | - | - | 244 | 830 | 105 | ~ 254 | 713 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | - | 244 | - | 105 | ~ 254 | - |
| Stage 1 | - | - | - | - | - | - | 508 | 495 | - | 582 | 617 | - |
| Stage 2 | - | - | - | - | - | - | 187 | 582 | - | 291 | 476 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 3 | 0.3 | | 231.8 |
| HCM LOS | | | - | F |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | - | 830 | 1161 | - | - | 1295 | - | - | 219 | 713 |
| HCM Lane V/C Ratio | - | 0.044 | 0.113 | - | - | 0.012 | - | - | 1.606 | 0.225 |
| HCM Control Delay (s) | - | 9.5 | 8.5 | - | - | 7.8 | - | - | $ 332.4 | 11.5 |
| HCM Lane LOS | - | A | A | - | - | A | - | - | F | B |
| HCM 95th %tile Q(veh) | - | 0.1 | 0.4 | - | - | 0 | - | - | 22.5 | 0.9 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

| Intersection | |
|---|---|
| Int Delay, s/veh | 929.1 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Future Vol, veh/h | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 300 | - | - | 150 | - | - | - | - | 50 | - | - | 50 |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 79 | 92 | 67 | 44 | 91 | 78 | 69 | 86 | 63 | 90 | 84 | 76 |
| Heavy Vehicles, % | 0 | 1 | 3 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 |
| Mvmt Flow | 176 | 367 | 72 | 16 | 280 | 79 | 80 | 169 | 32 | 48 | 225 | 149 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 359 | 0 | 0 | 439 | 0 | 0 | 1294 | 1146 | 403 | 1208 | 1143 | 320 |
| Stage 1 | - | - | - | - | - | - | 755 | 755 | - | 352 | 352 | - |
| Stage 2 | - | - | - | - | - | - | 539 | 391 | - | 856 | 791 | - |
| Critical Hdwy | 4.1 | - | - | 4.1 | - | - | 7.12 | 6.5 | 6.2 | 7.1 | 6.5 | 6.21 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.12 | 5.5 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.12 | 5.5 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.2 | - | - | 2.2 | - | - | 3.518 | 4 | 3.3 | 3.5 | 4 | 3.309 |
| Pot Cap-1 Maneuver | 1211 | - | - | 1132 | - | - | 139 | 201 | 652 | 161 | ~ 202 | 723 |
| Stage 1 | - | - | - | - | - | - | 401 | 420 | - | 669 | 635 | - |
| Stage 2 | - | - | - | - | - | - | 527 | 611 | - | 355 | 404 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1211 | - | - | 1132 | - | - | - | 169 | 652 | ~ 4 | ~ 170 | 723 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | - | 169 | - | ~ 4 | ~ 170 | - |
| Stage 1 | - | - | - | - | - | - | 343 | 359 | - | 572 | 626 | - |
| Stage 2 | - | - | - | - | - | - | 264 | 602 | - | 153 | 345 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.4 | 0.3 | | $ 3726.4 |
| HCM LOS | | | - | F |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | - | 652 | 1211 | - | - | 1132 | - | - | 21 | 723 |
| HCM Lane V/C Ratio | - | 0.049 | 0.145 | - | - | 0.014 | - | - | 12.989 | 0.206 |
| HCM Control Delay (s) | - | 10.8 | 8.5 | - | - | 8.2 | - | - | $ 5751.4 | 11.3 |
| HCM Lane LOS | - | B | A | - | - | A | - | - | F | B |
| HCM 95th %tile Q(veh) | - | 0.2 | 0.5 | - | - | 0 | - | - | 34.4 | 0.8 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 29.6 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Future Vol, veh/h | 88 | 174 | 25 | 14 | 249 | 114 | 29 | 131 | 16 | 36 | 265 | 135 |
| Peak Hour Factor | 0.67 | 0.93 | 0.45 | 0.88 | 0.96 | 0.86 | 0.66 | 0.84 | 0.44 | 0.90 | 0.85 | 0.84 |
| Heavy Vehicles, % | 3 | 3 | 0 | 7 | 4 | 6 | 0 | 1 | 0 | 4 | 4 | 3 |
| Mvmt Flow | 131 | 187 | 56 | 16 | 259 | 133 | 44 | 156 | 36 | 40 | 312 | 161 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 2 | 2 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 2 | 2 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 2 | 2 | 2 | 2 |
| HCM Control Delay | 19.5 | 44.2 | 18.7 | 30.4 |
| HCM LOS | C | E | C | D |

| Lane | NBLn1 | NBLn2 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|
| Vol Left, % | 18% | 0% | 100% | 0% | 100% | 0% | 12% | 0% |
| Vol Thru, % | 82% | 0% | 0% | 87% | 0% | 69% | 88% | 0% |
| Vol Right, % | 0% | 100% | 0% | 13% | 0% | 31% | 0% | 100% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 160 | 16 | 88 | 199 | 14 | 363 | 301 | 135 |
| LT Vol | 29 | 0 | 88 | 0 | 14 | 0 | 36 | 0 |
| Through Vol | 131 | 0 | 0 | 174 | 0 | 249 | 265 | 0 |
| RT Vol | 0 | 16 | 0 | 25 | 0 | 114 | 0 | 135 |
| Lane Flow Rate | 200 | 36 | 131 | 243 | 16 | 392 | 352 | 161 |
| Geometry Grp | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Degree of Util (X) | 0.493 | 0.082 | 0.327 | 0.563 | 0.039 | 0.874 | 0.809 | 0.334 |
| Departure Headway (Hd) | 8.879 | 8.073 | 8.968 | 8.358 | 8.828 | 8.031 | 8.276 | 7.489 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 406 | 443 | 401 | 432 | 406 | 451 | 436 | 481 |
| Service Time | 6.636 | 5.83 | 6.725 | 6.114 | 6.577 | 5.779 | 6.025 | 5.238 |
| HCM Lane V/C Ratio | 0.493 | 0.081 | 0.327 | 0.563 | 0.039 | 0.869 | 0.807 | 0.335 |
| HCM Control Delay | 20 | 11.6 | 16 | 21.4 | 11.9 | 45.5 | 37.9 | 14 |
| HCM Lane LOS | C | B | C | C | B | E | E | B |
| HCM 95th-tile Q | 2.6 | 0.3 | 1.4 | 3.4 | 0.1 | 9.1 | 7.4 | 1.5 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 43.2 |
| Intersection LOS | E |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Future Vol, veh/h | 139 | 338 | 48 | 7 | 255 | 62 | 55 | 145 | 20 | 43 | 189 | 113 |
| Peak Hour Factor | 0.79 | 0.92 | 0.67 | 0.44 | 0.91 | 0.78 | 0.69 | 0.86 | 0.63 | 0.90 | 0.84 | 0.76 |
| Heavy Vehicles, % | 0 | 1 | 3 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 |
| Mvmt Flow | 176 | 367 | 72 | 16 | 280 | 79 | 80 | 169 | 32 | 48 | 225 | 149 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 2 | 2 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 2 | 2 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 2 | 2 | 2 | 2 |
| HCM Control Delay | 63 | 44.7 | 26 | 24.3 |
| HCM LOS | F | E | D | C |

| Lane | NBLn1 | NBLn2 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 | SBLn2 |
|---|---|---|---|---|---|---|---|---|
| Vol Left, % | 28% | 0% | 100% | 0% | 100% | 0% | 19% | 0% |
| Vol Thru, % | 72% | 0% | 0% | 88% | 0% | 80% | 81% | 0% |
| Vol Right, % | 0% | 100% | 0% | 12% | 0% | 20% | 0% | 100% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 200 | 20 | 139 | 386 | 7 | 317 | 232 | 113 |
| LT Vol | 55 | 0 | 139 | 0 | 7 | 0 | 43 | 0 |
| Through Vol | 145 | 0 | 0 | 338 | 0 | 255 | 189 | 0 |
| RT Vol | 0 | 20 | 0 | 48 | 0 | 62 | 0 | 113 |
| Lane Flow Rate | 248 | 32 | 176 | 439 | 16 | 360 | 273 | 149 |
| Geometry Grp | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Degree of Util (X) | 0.643 | 0.074 | 0.442 | 1.03 | 0.041 | 0.859 | 0.68 | 0.336 |
| Departure Headway (Hd) | 9.51 | 8.597 | 9.035 | 8.442 | 9.418 | 8.771 | 9.153 | 8.324 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 382 | 419 | 401 | 435 | 382 | 417 | 398 | 434 |
| Service Time | 7.21 | 6.297 | 6.735 | 6.142 | 7.118 | 6.471 | 6.853 | 6.024 |
| HCM Lane V/C Ratio | 0.649 | 0.076 | 0.439 | 1.009 | 0.042 | 0.863 | 0.686 | 0.343 |
| HCM Control Delay | 27.8 | 12 | 18.7 | 80.8 | 12.5 | 46.1 | 29.2 | 15.2 |
| HCM Lane LOS | D | B | C | F | B | E | D | C |
| HCM 95th-tile Q | 4.3 | 0.2 | 2.2 | 13.7 | 0.1 | 8.4 | 4.9 | 1.5 |

# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | AM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Grove Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Grove Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.86 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 89 | 174 | 25 | 0 | 14 | 249 | 115 | 0 | 29 | 131 | 16 | 0 | 35 | 265 | 135 |
| Percent Heavy Vehicles, % | 3 | 3 | 3 | 0 | 0 | 7 | 4 | 6 | 3 | 0 | 1 | 0 | 3 | 4 | 4 | 3 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 107 | 208 | 29 | 0 | 17 | 301 | 142 | 0 | 34 | 154 | 19 | 0 | 42 | 320 | 162 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 344 | | | 460 | | | 207 | | | 524 | |
| Entry Volume, veh/h | | 335 | | | 439 | | | 205 | | | 505 | |
| Circulating Flow ($v_c$), pc/h | 379 | | | 295 | | | 357 | | | 352 | | |
| Exiting Flow ($v_{ex}$), pc/h | 269 | | | 497 | | | 403 | | | 366 | | |
| Capacity ($c_{pce}$), pc/h | | 938 | | | 1021 | | | 959 | | | 964 | |
| Capacity (c), veh/h | | 913 | | | 975 | | | 952 | | | 929 | |
| v/c Ratio (x) | | 0.37 | | | 0.45 | | | 0.22 | | | 0.54 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 8.0 | | | 8.9 | | | 5.9 | | | 11.1 | |
| Lane LOS | | A | | | A | | | A | | | B | |
| 95% Queue, veh | | 1.7 | | | 2.4 | | | 0.8 | | | 3.4 | |
| Approach Delay, s/veh | 8.0 | | | 8.9 | | | 5.9 | | | 11.1 | | |
| Approach LOS | A | | | A | | | A | | | B | | |
| Intersection Delay, s/veh \| LOS | 9.1 | | | | | | A | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | PM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Grove Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Grove Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.96 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 138 | 338 | 48 | 0 | 7 | 256 | 62 | 0 | 55 | 146 | 19 | 0 | 43 | 188 | 113 |
| Percent Heavy Vehicles, % | 3 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 144 | 356 | 52 | 0 | 7 | 269 | 65 | 0 | 58 | 152 | 20 | 0 | 45 | 196 | 119 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 552 | | | 341 | | | 230 | | | 360 | |
| Entry Volume, veh/h | | 547 | | | 338 | | | 229 | | | 359 | |
| Circulating Flow ($v_c$), pc/h | 248 | | | 354 | | | 545 | | | 334 | | |
| Exiting Flow ($v_{ex}$), pc/h | 421 | | | 446 | | | 361 | | | 255 | | |
| Capacity ($c_{pce}$), pc/h | | 1072 | | | 962 | | | 792 | | | 982 | |
| Capacity (c), veh/h | | 1062 | | | 954 | | | 788 | | | 978 | |
| v/c Ratio (x) | | 0.52 | | | 0.35 | | | 0.29 | | | 0.37 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 9.5 | | | 7.6 | | | 7.9 | | | 7.6 | |
| Lane LOS | | A | | | A | | | A | | | A | |
| 95% Queue, veh | | 3.0 | | | 1.6 | | | 1.2 | | | 1.7 | |
| Approach Delay, s/veh | 9.5 | | | 7.6 | | | 7.9 | | | 7.6 | | |
| Approach LOS | A | | | A | | | A | | | A | | |
| Intersection Delay, s/veh \| LOS | 8.4 | | | | | | A | | | | | |

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| Intersection | |
|---|---|
| Intersection Delay, s/veh | 34.9 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 11 | 102 | 55 | 74 | 278 | 81 | 115 | 109 | 22 | 55 | 199 | 21 |
| Future Vol, veh/h | 11 | 102 | 55 | 74 | 278 | 81 | 115 | 109 | 22 | 55 | 199 | 21 |
| Peak Hour Factor | 0.69 | 0.73 | 0.92 | 0.60 | 0.79 | 0.84 | 0.85 | 0.85 | 0.55 | 0.69 | 0.84 | 0.53 |
| Heavy Vehicles, % | 13 | 5 | 0 | 1 | 3 | 2 | 8 | 10 | 9 | 2 | 1 | 0 |
| Mvmt Flow | 16 | 140 | 60 | 123 | 352 | 96 | 135 | 128 | 40 | 80 | 237 | 40 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 18 | 48.3 | 26 | 31.1 |
| HCM LOS | C | E | D | D |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 47% | 100% | 0% | 100% | 0% | 20% |
| Vol Thru, % | 44% | 0% | 65% | 0% | 77% | 72% |
| Vol Right, % | 9% | 0% | 35% | 0% | 23% | 8% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 246 | 11 | 157 | 74 | 359 | 275 |
| LT Vol | 115 | 11 | 0 | 74 | 0 | 55 |
| Through Vol | 109 | 0 | 102 | 0 | 278 | 199 |
| RT Vol | 22 | 0 | 55 | 0 | 81 | 21 |
| Lane Flow Rate | 304 | 16 | 200 | 123 | 448 | 356 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.672 | 0.041 | 0.466 | 0.284 | 0.95 | 0.758 |
| Departure Headway (Hd) | 7.972 | 9.326 | 8.408 | 8.277 | 7.631 | 7.656 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 452 | 383 | 427 | 433 | 475 | 470 |
| Service Time | 6.047 | 7.108 | 6.189 | 6.043 | 5.397 | 5.727 |
| HCM Lane V/C Ratio | 0.673 | 0.042 | 0.468 | 0.284 | 0.943 | 0.757 |
| HCM Control Delay | 26 | 12.5 | 18.4 | 14.3 | 57.6 | 31.1 |
| HCM Lane LOS | D | B | C | B | F | D |
| HCM 95th-tile Q | 4.9 | 0.1 | 2.4 | 1.2 | 11.5 | 6.4 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 44.6 |
| Intersection LOS | E |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 9 | 289 | 122 | 31 | 201 | 63 | 74 | 112 | 46 | 81 | 114 | 11 |
| Future Vol, veh/h | 9 | 289 | 122 | 31 | 201 | 63 | 74 | 112 | 46 | 81 | 114 | 11 |
| Peak Hour Factor | 0.45 | 0.91 | 0.78 | 0.70 | 0.85 | 0.68 | 0.69 | 0.76 | 0.64 | 0.75 | 0.84 | 0.69 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 20 | 318 | 156 | 44 | 236 | 93 | 107 | 147 | 72 | 108 | 136 | 16 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 77 | 28.7 | 30.3 | 23.8 |
| HCM LOS | F | D | D | C |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 32% | 100% | 0% | 100% | 0% | 39% |
| Vol Thru, % | 48% | 0% | 70% | 0% | 76% | 55% |
| Vol Right, % | 20% | 0% | 30% | 0% | 24% | 5% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 232 | 9 | 411 | 31 | 264 | 206 |
| LT Vol | 74 | 9 | 0 | 31 | 0 | 81 |
| Through Vol | 112 | 0 | 289 | 0 | 201 | 114 |
| RT Vol | 46 | 0 | 122 | 0 | 63 | 11 |
| Lane Flow Rate | 326 | 20 | 474 | 44 | 329 | 260 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.726 | 0.048 | 1.036 | 0.107 | 0.735 | 0.601 |
| Departure Headway (Hd) | 8.295 | 8.584 | 7.867 | 9.013 | 8.317 | 8.649 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 437 | 420 | 465 | 400 | 438 | 421 |
| Service Time | 6.295 | 6.284 | 5.567 | 6.713 | 6.017 | 6.649 |
| HCM Lane V/C Ratio | 0.746 | 0.048 | 1.019 | 0.11 | 0.751 | 0.618 |
| HCM Control Delay | 30.3 | 11.7 | 79.8 | 12.8 | 30.8 | 23.8 |
| HCM Lane LOS | D | B | F | B | D | C |
| HCM 95th-tile Q | 5.7 | 0.2 | 14.4 | 0.4 | 5.9 | 3.8 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 393.9 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 11 | 102 | 55 | 74 | 278 | 81 | 115 | 109 | 22 | 55 | 199 | 21 |
| Future Vol, veh/h | 11 | 102 | 55 | 74 | 278 | 81 | 115 | 109 | 22 | 55 | 199 | 21 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 150 | - | - | 150 | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 69 | 73 | 92 | 60 | 79 | 84 | 85 | 85 | 55 | 69 | 84 | 53 |
| Heavy Vehicles, % | 13 | 5 | 0 | 1 | 3 | 2 | 8 | 10 | 9 | 2 | 1 | 0 |
| Mvmt Flow | 16 | 140 | 60 | 123 | 352 | 96 | 135 | 128 | 40 | 80 | 237 | 40 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 448 | 0 | 0 | 200 | 0 | 0 | 987 | 896 | 170 | 932 | 878 | 400 |
| Stage 1 | - | - | - | - | - | - | 202 | 202 | - | 646 | 646 | - |
| Stage 2 | - | - | - | - | - | - | 785 | 694 | - | 286 | 232 | - |
| Critical Hdwy | 4.23 | - | - | 4.11 | - | - | 7.18 | 6.6 | 6.29 | 7.12 | 6.51 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.18 | 5.6 | - | 6.12 | 5.51 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.18 | 5.6 | - | 6.12 | 5.51 | - |
| Follow-up Hdwy | 2.317 | - | - | 2.209 | - | - | 3.572 | 4.09 | 3.381 | 3.518 | 4.009 | 3.3 |
| Pot Cap-1 Maneuver | 1057 | - | - | 1378 | - | - | 221 | 271 | 856 | 247 | 288 | 654 |
| Stage 1 | - | - | - | - | - | - | 786 | 719 | - | 460 | 469 | - |
| Stage 2 | - | - | - | - | - | - | 377 | 432 | - | 721 | 714 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1057 | - | - | 1378 | - | - | ~ 39 | 243 | 856 | 128 | 258 | 654 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | ~ 39 | 243 | - | 128 | 258 | - |
| Stage 1 | - | - | - | - | - | - | 774 | 708 | - | 453 | 427 | - |
| Stage 2 | - | - | - | - | - | - | 144 | 394 | - | 554 | 703 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.6 | 1.7 | $ 1485.2 | $ 331.1 |
| HCM LOS | | | F | F |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 75 | 1057 | - | - | 1378 | - | - | 222 |
| HCM Lane V/C Ratio | 4.047 | 0.015 | - | - | 0.09 | - | - | 1.605 |
| HCM Control Delay (s) | $ 1485.2 | 8.5 | - | - | 7.9 | - | - | $ 331.1 |
| HCM Lane LOS | F | A | - | - | A | - | - | F |
| HCM 95th %tile Q(veh) | 32.1 | 0 | - | - | 0.3 | - | - | 22.7 |

| Notes | | | |
|---|---|---|---|
| ~: Volume exceeds capacity | $: Delay exceeds 300s | +: Computation Not Defined | *: All major volume in platoon |

| Intersection | |
|---|---|
| Int Delay, s/veh | 91.8 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 9 | 289 | 122 | 31 | 201 | 63 | 74 | 112 | 46 | 81 | 114 | 11 |
| Future Vol, veh/h | 9 | 289 | 122 | 31 | 201 | 63 | 74 | 112 | 46 | 81 | 114 | 11 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 150 | - | - | 150 | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 45 | 91 | 78 | 70 | 85 | 68 | 69 | 76 | 64 | 75 | 84 | 69 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 20 | 318 | 156 | 44 | 236 | 93 | 107 | 147 | 72 | 108 | 136 | 16 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 329 | 0 | 0 | 474 | 0 | 0 | 883 | 853 | 396 | 917 | 885 | 283 |
| Stage 1 | - | - | - | - | - | - | 436 | 436 | - | 371 | 371 | - |
| Stage 2 | - | - | - | - | - | - | 447 | 417 | - | 546 | 514 | - |
| Critical Hdwy | 4.1 | - | - | 4.1 | - | - | 7.13 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.13 | 5.5 | - | 6.1 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.13 | 5.5 | - | 6.1 | 5.5 | - |
| Follow-up Hdwy | 2.2 | - | - | 2.2 | - | - | 3.527 | 4 | 3.3 | 3.5 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1242 | - | - | 1099 | - | - | 265 | 299 | 658 | 255 | 286 | 761 |
| Stage 1 | - | - | - | - | - | - | 597 | 583 | - | 653 | 623 | - |
| Stage 2 | - | - | - | - | - | - | 589 | 595 | - | 526 | 539 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1242 | - | - | 1099 | - | - | 151 | 283 | 658 | 129 | 270 | 761 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 151 | 283 | - | 129 | 270 | - |
| Stage 1 | - | - | - | - | - | - | 587 | 574 | - | 643 | 598 | - |
| Stage 2 | - | - | - | - | - | - | 428 | 571 | - | 343 | 530 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 0.3 | 1 | 216.9 | 239.2 |
| HCM LOS | | | F | F |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 244 | 1242 | - | - | 1099 | - | - | 191 |
| HCM Lane V/C Ratio | 1.338 | 0.016 | - | - | 0.04 | - | - | 1.359 |
| HCM Control Delay (s) | 216.9 | 7.9 | - | - | 8.4 | - | - | 239.2 |
| HCM Lane LOS | F | A | - | - | A | - | - | F |
| HCM 95th %tile Q(veh) | 17.4 | 0 | - | - | 0.1 | - | - | 15.1 |

# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | AM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Lincoln Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Lincoln Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.86 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 10 | 102 | 55 | 0 | 74 | 278 | 81 | 0 | 115 | 109 | 22 | 0 | 55 | 199 | 21 |
| Percent Heavy Vehicles, % | 3 | 13 | 5 | 0 | 0 | 1 | 3 | 2 | 3 | 8 | 10 | 9 | 0 | 2 | 1 | 0 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 13 | 125 | 64 | 0 | 87 | 333 | 96 | 0 | 144 | 139 | 28 | 0 | 65 | 234 | 24 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 202 | | | 516 | | | 311 | | | 323 | |
| Entry Volume, veh/h | | 195 | | | 504 | | | 285 | | | 319 | |
| Circulating Flow ($v_c$), pc/h | 386 | | | 296 | | | 203 | | | 564 | | |
| Exiting Flow ($v_{ex}$), pc/h | 218 | | | 501 | | | 248 | | | 385 | | |
| Capacity ($c_{pce}$), pc/h | | 931 | | | 1020 | | | 1122 | | | 776 | |
| Capacity (c), veh/h | | 897 | | | 996 | | | 1029 | | | 768 | |
| v/c Ratio (x) | | 0.22 | | | 0.51 | | | 0.28 | | | 0.42 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 6.2 | | | 9.8 | | | 6.2 | | | 10.1 | |
| Lane LOS | | A | | | A | | | A | | | B | |
| 95% Queue, veh | | 0.8 | | | 2.9 | | | 1.1 | | | 2.1 | |
| Approach Delay, s/veh | 6.2 | | | 9.8 | | | 6.2 | | | 10.1 | | |
| Approach LOS | A | | | A | | | A | | | B | | |
| Intersection Delay, s/veh \| LOS | 8.5 | | | | | | A | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | PM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Lincoln Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Lincoln Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.92 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 9 | 289 | 122 | 0 | 31 | 202 | 63 | 0 | 74 | 112 | 45 | 0 | 82 | 113 | 11 |
| Percent Heavy Vehicles, % | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 10 | 317 | 133 | 0 | 34 | 220 | 68 | 0 | 83 | 122 | 49 | 0 | 89 | 123 | 12 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 460 | | | 322 | | | 254 | | | 224 | |
| Entry Volume, veh/h | | 457 | | | 322 | | | 252 | | | 224 | |
| Circulating Flow ($v_c$), pc/h | 246 | | | 215 | | | 416 | | | 337 | | |
| Exiting Flow ($v_{ex}$), pc/h | 455 | | | 315 | | | 200 | | | 290 | | |
| Capacity ($c_{pce}$), pc/h | | 1074 | | | 1108 | | | 903 | | | 979 | |
| Capacity (c), veh/h | | 1066 | | | 1108 | | | 894 | | | 979 | |
| v/c Ratio (x) | | 0.43 | | | 0.29 | | | 0.28 | | | 0.23 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 8.0 | | | 6.0 | | | 7.0 | | | 5.9 | |
| Lane LOS | | A | | | A | | | A | | | A | |
| 95% Queue, veh | | 2.2 | | | 1.2 | | | 1.2 | | | 0.9 | |
| Approach Delay, s/veh | 8.0 | | | 6.0 | | | 7.0 | | | 5.9 | | |
| Approach LOS | A | | | A | | | A | | | A | | |
| Intersection Delay, s/veh \| LOS | 6.9 | | | | | | A | | | | | |

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| Intersection | |
|---|---|
| Intersection Delay, s/veh | 22 |
| Intersection LOS | C |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 8 | 85 | 55 | 74 | 233 | 68 | 115 | 109 | 22 | 46 | 199 | 18 |
| Future Vol, veh/h | 8 | 85 | 55 | 74 | 233 | 68 | 115 | 109 | 22 | 46 | 199 | 18 |
| Peak Hour Factor | 0.69 | 0.73 | 0.92 | 0.60 | 0.79 | 0.84 | 0.85 | 0.85 | 0.55 | 0.69 | 0.84 | 0.53 |
| Heavy Vehicles, % | 13 | 5 | 0 | 1 | 3 | 2 | 8 | 10 | 9 | 2 | 1 | 0 |
| Mvmt Flow | 12 | 116 | 60 | 123 | 295 | 81 | 135 | 128 | 40 | 67 | 237 | 34 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 15.2 | 24.6 | 21.4 | 22.6 |
| HCM LOS | C | C | C | C |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 47% | 100% | 0% | 100% | 0% | 17% |
| Vol Thru, % | 44% | 0% | 61% | 0% | 77% | 76% |
| Vol Right, % | 9% | 0% | 39% | 0% | 23% | 7% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 246 | 8 | 140 | 74 | 301 | 263 |
| LT Vol | 115 | 8 | 0 | 74 | 0 | 46 |
| Through Vol | 109 | 0 | 85 | 0 | 233 | 199 |
| RT Vol | 22 | 0 | 55 | 0 | 68 | 18 |
| Lane Flow Rate | 304 | 12 | 176 | 123 | 376 | 338 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.617 | 0.028 | 0.384 | 0.267 | 0.746 | 0.655 |
| Departure Headway (Hd) | 7.32 | 8.782 | 7.838 | 7.9 | 7.256 | 7.103 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 498 | 409 | 462 | 458 | 500 | 513 |
| Service Time | 5.32 | 6.502 | 5.557 | 5.6 | 4.956 | 5.103 |
| HCM Lane V/C Ratio | 0.61 | 0.029 | 0.381 | 0.269 | 0.752 | 0.659 |
| HCM Control Delay | 21.4 | 11.8 | 15.4 | 13.5 | 28.3 | 22.6 |
| HCM Lane LOS | C | B | C | B | D | C |
| HCM 95th-tile Q | 4.1 | 0.1 | 1.8 | 1.1 | 6.3 | 4.7 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 19.6 |
| Intersection LOS | C |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 7 | 242 | 102 | 26 | 170 | 53 | 62 | 94 | 37 | 69 | 95 | 9 |
| Future Vol, veh/h | 7 | 242 | 102 | 26 | 170 | 53 | 62 | 94 | 37 | 69 | 95 | 9 |
| Peak Hour Factor | 0.45 | 0.91 | 0.78 | 0.70 | 0.85 | 0.68 | 0.69 | 0.76 | 0.64 | 0.75 | 0.84 | 0.69 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 16 | 266 | 131 | 37 | 200 | 78 | 90 | 124 | 58 | 92 | 113 | 13 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 25.7 | 16.7 | 17.2 | 15.4 |
| HCM LOS | D | C | C | C |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 32% | 100% | 0% | 100% | 0% | 40% |
| Vol Thru, % | 49% | 0% | 70% | 0% | 76% | 55% |
| Vol Right, % | 19% | 0% | 30% | 0% | 24% | 5% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 193 | 7 | 344 | 26 | 223 | 173 |
| LT Vol | 62 | 7 | 0 | 26 | 0 | 69 |
| Through Vol | 94 | 0 | 242 | 0 | 170 | 95 |
| RT Vol | 37 | 0 | 102 | 0 | 53 | 9 |
| Lane Flow Rate | 271 | 16 | 397 | 37 | 278 | 218 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.518 | 0.032 | 0.739 | 0.079 | 0.535 | 0.429 |
| Departure Headway (Hd) | 6.87 | 7.413 | 6.705 | 7.62 | 6.935 | 7.078 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 521 | 481 | 536 | 468 | 517 | 506 |
| Service Time | 4.952 | 5.185 | 4.476 | 5.403 | 4.717 | 5.166 |
| HCM Lane V/C Ratio | 0.52 | 0.033 | 0.741 | 0.079 | 0.538 | 0.431 |
| HCM Control Delay | 17.2 | 10.4 | 26.3 | 11.1 | 17.5 | 15.4 |
| HCM Lane LOS | C | B | D | B | C | C |
| HCM 95th-tile Q | 2.9 | 0.1 | 6.2 | 0.3 | 3.1 | 2.1 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 25.4 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 9 | 91 | 55 | 74 | 249 | 72 | 115 | 109 | 22 | 49 | 199 | 19 |
| Future Vol, veh/h | 9 | 91 | 55 | 74 | 249 | 72 | 115 | 109 | 22 | 49 | 199 | 19 |
| Peak Hour Factor | 0.69 | 0.73 | 0.92 | 0.60 | 0.79 | 0.84 | 0.85 | 0.85 | 0.55 | 0.69 | 0.84 | 0.53 |
| Heavy Vehicles, % | 13 | 5 | 0 | 1 | 3 | 2 | 8 | 10 | 9 | 2 | 1 | 0 |
| Mvmt Flow | 13 | 125 | 60 | 123 | 315 | 86 | 135 | 128 | 40 | 71 | 237 | 36 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 16 | 30.6 | 22.8 | 25.3 |
| HCM LOS | C | D | C | D |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 47% | 100% | 0% | 100% | 0% | 18% |
| Vol Thru, % | 44% | 0% | 62% | 0% | 78% | 75% |
| Vol Right, % | 9% | 0% | 38% | 0% | 22% | 7% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 246 | 9 | 146 | 74 | 321 | 267 |
| LT Vol | 115 | 9 | 0 | 74 | 0 | 49 |
| Through Vol | 109 | 0 | 91 | 0 | 249 | 199 |
| RT Vol | 22 | 0 | 55 | 0 | 72 | 19 |
| Lane Flow Rate | 304 | 13 | 184 | 123 | 401 | 344 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.635 | 0.032 | 0.411 | 0.274 | 0.82 | 0.694 |
| Departure Headway (Hd) | 7.526 | 8.961 | 8.026 | 8.006 | 7.363 | 7.269 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 480 | 399 | 448 | 449 | 493 | 498 |
| Service Time | 5.576 | 6.719 | 5.784 | 5.753 | 5.11 | 5.319 |
| HCM Lane V/C Ratio | 0.633 | 0.033 | 0.411 | 0.274 | 0.813 | 0.691 |
| HCM Control Delay | 22.8 | 12 | 16.3 | 13.8 | 35.8 | 25.3 |
| HCM Lane LOS | C | B | C | B | E | D |
| HCM 95th-tile Q | 4.3 | 0.1 | 2 | 1.1 | 7.9 | 5.3 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 25.2 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 8 | 259 | 109 | 28 | 181 | 57 | 67 | 100 | 40 | 73 | 101 | 10 |
| Future Vol, veh/h | 8 | 259 | 109 | 28 | 181 | 57 | 67 | 100 | 40 | 73 | 101 | 10 |
| Peak Hour Factor | 0.45 | 0.91 | 0.78 | 0.70 | 0.85 | 0.68 | 0.69 | 0.76 | 0.64 | 0.75 | 0.84 | 0.69 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 18 | 285 | 140 | 40 | 213 | 84 | 97 | 132 | 63 | 97 | 120 | 14 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 36 | 20.1 | 20.7 | 17.9 |
| HCM LOS | E | C | C | C |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 32% | 100% | 0% | 100% | 0% | 40% |
| Vol Thru, % | 48% | 0% | 70% | 0% | 76% | 55% |
| Vol Right, % | 19% | 0% | 30% | 0% | 24% | 5% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 207 | 8 | 368 | 28 | 238 | 184 |
| LT Vol | 67 | 8 | 0 | 28 | 0 | 73 |
| Through Vol | 100 | 0 | 259 | 0 | 181 | 101 |
| RT Vol | 40 | 0 | 109 | 0 | 57 | 10 |
| Lane Flow Rate | 291 | 18 | 424 | 40 | 297 | 232 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.595 | 0.039 | 0.839 | 0.09 | 0.611 | 0.491 |
| Departure Headway (Hd) | 7.356 | 7.831 | 7.12 | 8.096 | 7.406 | 7.611 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 489 | 457 | 509 | 442 | 487 | 473 |
| Service Time | 5.417 | 5.585 | 4.874 | 5.856 | 5.166 | 5.677 |
| HCM Lane V/C Ratio | 0.595 | 0.039 | 0.833 | 0.09 | 0.61 | 0.49 |
| HCM Control Delay | 20.7 | 10.9 | 37.1 | 11.7 | 21.2 | 17.9 |
| HCM Lane LOS | C | B | E | B | C | C |
| HCM 95th-tile Q | 3.8 | 0.1 | 8.5 | 0.3 | 4 | 2.7 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 28.8 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 9 | 96 | 55 | 74 | 262 | 76 | 115 | 109 | 22 | 51 | 199 | 20 |
| Future Vol, veh/h | 9 | 96 | 55 | 74 | 262 | 76 | 115 | 109 | 22 | 51 | 199 | 20 |
| Peak Hour Factor | 0.69 | 0.73 | 0.92 | 0.60 | 0.79 | 0.84 | 0.85 | 0.85 | 0.55 | 0.69 | 0.84 | 0.53 |
| Heavy Vehicles, % | 13 | 5 | 0 | 1 | 3 | 2 | 8 | 10 | 9 | 2 | 1 | 0 |
| Mvmt Flow | 13 | 132 | 60 | 123 | 332 | 90 | 135 | 128 | 40 | 74 | 237 | 38 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 16.9 | 36.8 | 24.1 | 27.4 |
| HCM LOS | C | E | C | D |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 47% | 100% | 0% | 100% | 0% | 19% |
| Vol Thru, % | 44% | 0% | 64% | 0% | 78% | 74% |
| Vol Right, % | 9% | 0% | 36% | 0% | 22% | 7% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 246 | 9 | 151 | 74 | 338 | 270 |
| LT Vol | 115 | 9 | 0 | 74 | 0 | 51 |
| Through Vol | 109 | 0 | 96 | 0 | 262 | 199 |
| RT Vol | 22 | 0 | 55 | 0 | 76 | 20 |
| Lane Flow Rate | 304 | 13 | 191 | 123 | 422 | 349 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.65 | 0.033 | 0.435 | 0.278 | 0.876 | 0.719 |
| Departure Headway (Hd) | 7.711 | 9.112 | 8.185 | 8.116 | 7.472 | 7.431 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 467 | 392 | 440 | 443 | 485 | 484 |
| Service Time | 5.77 | 6.878 | 5.951 | 5.868 | 5.224 | 5.488 |
| HCM Lane V/C Ratio | 0.651 | 0.033 | 0.434 | 0.278 | 0.87 | 0.721 |
| HCM Control Delay | 24.1 | 12.2 | 17.2 | 14 | 43.5 | 27.4 |
| HCM Lane LOS | C | B | C | B | E | D |
| HCM 95th-tile Q | 4.6 | 0.1 | 2.2 | 1.1 | 9.4 | 5.7 |

| Intersection | |
|---|---|
| Intersection Delay, s/veh | 32.3 |
| Intersection LOS | D |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 8 | 273 | 115 | 29 | 191 | 60 | 70 | 105 | 42 | 77 | 106 | 11 |
| Future Vol, veh/h | 8 | 273 | 115 | 29 | 191 | 60 | 70 | 105 | 42 | 77 | 106 | 11 |
| Peak Hour Factor | 0.45 | 0.91 | 0.78 | 0.70 | 0.85 | 0.68 | 0.69 | 0.76 | 0.64 | 0.75 | 0.84 | 0.69 |
| Heavy Vehicles, % | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 18 | 300 | 147 | 41 | 225 | 88 | 101 | 138 | 66 | 103 | 126 | 16 |
| Number of Lanes | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| Opposing Approach | WB | EB | SB | NB |
| Opposing Lanes | 2 | 2 | 1 | 1 |
| Conflicting Approach Left | SB | NB | EB | WB |
| Conflicting Lanes Left | 1 | 1 | 2 | 2 |
| Conflicting Approach Right | NB | SB | WB | EB |
| Conflicting Lanes Right | 1 | 1 | 2 | 2 |
| HCM Control Delay | 50 | 23.9 | 24.5 | 20.4 |
| HCM LOS | E | C | C | C |

| Lane | NBLn1 | EBLn1 | EBLn2 | WBLn1 | WBLn2 | SBLn1 |
|---|---|---|---|---|---|---|
| Vol Left, % | 32% | 100% | 0% | 100% | 0% | 40% |
| Vol Thru, % | 48% | 0% | 70% | 0% | 76% | 55% |
| Vol Right, % | 19% | 0% | 30% | 0% | 24% | 6% |
| Sign Control | Stop | Stop | Stop | Stop | Stop | Stop |
| Traffic Vol by Lane | 217 | 8 | 388 | 29 | 251 | 194 |
| LT Vol | 70 | 8 | 0 | 29 | 0 | 77 |
| Through Vol | 105 | 0 | 273 | 0 | 191 | 106 |
| RT Vol | 42 | 0 | 115 | 0 | 60 | 11 |
| Lane Flow Rate | 305 | 18 | 447 | 41 | 313 | 245 |
| Geometry Grp | 2 | 7 | 7 | 7 | 7 | 2 |
| Degree of Util (X) | 0.656 | 0.04 | 0.924 | 0.097 | 0.675 | 0.545 |
| Departure Headway (Hd) | 7.733 | 8.145 | 7.432 | 8.457 | 7.765 | 8.017 |
| Convergence, Y/N | Yes | Yes | Yes | Yes | Yes | Yes |
| Cap | 464 | 438 | 488 | 422 | 463 | 448 |
| Service Time | 5.823 | 5.922 | 5.208 | 6.244 | 5.551 | 6.115 |
| HCM Lane V/C Ratio | 0.657 | 0.041 | 0.916 | 0.097 | 0.676 | 0.547 |
| HCM Control Delay | 24.5 | 11.3 | 51.5 | 12.2 | 25.4 | 20.4 |
| HCM Lane LOS | C | B | F | B | D | C |
| HCM 95th-tile Q | 4.6 | 0.1 | 10.8 | 0.3 | 4.9 | 3.2 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 7.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 51 | 128 | 5 | 6 | 295 | 48 | 6 | 4 | 1 | 36 | 20 | 140 |
| Future Vol, veh/h | 51 | 128 | 5 | 6 | 295 | 48 | 6 | 4 | 1 | 36 | 20 | 140 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 150 | - | - | 150 | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 64 | 84 | 42 | 50 | 86 | 86 | 38 | 33 | 25 | 60 | 63 | 85 |
| Heavy Vehicles, % | 5 | 5 | 25 | 25 | 3 | 0 | 0 | 0 | 100 | 3 | 6 | 2 |
| Mvmt Flow | 80 | 152 | 12 | 12 | 343 | 56 | 16 | 12 | 4 | 60 | 32 | 165 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 399 | 0 | 0 | 164 | 0 | 0 | 812 | 741 | 158 | 721 | 719 | 371 |
| Stage 1 | - | - | - | - | - | - | 318 | 318 | - | 395 | 395 | - |
| Stage 2 | - | - | - | - | - | - | 494 | 423 | - | 326 | 324 | - |
| Critical Hdwy | 4.15 | - | - | 4.35 | - | - | 7.1 | 6.5 | 7.2 | 7.13 | 6.56 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.425 | - | - | 3.5 | 4 | 4.2 | 3.527 | 4.054 | 3.318 |
| Pot Cap-1 Maneuver | 1144 | - | - | 1286 | - | - | 300 | 347 | 684 | 341 | 349 | 675 |
| Stage 1 | - | - | - | - | - | - | 698 | 657 | - | 628 | 598 | - |
| Stage 2 | - | - | - | - | - | - | 561 | 591 | - | 684 | 643 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1144 | - | - | 1286 | - | - | 197 | 320 | 684 | 310 | 322 | 675 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 197 | 320 | - | 310 | 322 | - |
| Stage 1 | - | - | - | - | - | - | 649 | 611 | - | 584 | 593 | - |
| Stage 2 | - | - | - | - | - | - | 398 | 586 | - | 620 | 598 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.7 | 0.2 | 20.9 | 20.9 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 258 | 1144 | - | - | 1286 | - | - | 478 |
| HCM Lane V/C Ratio | 0.124 | 0.07 | - | - | 0.009 | - | - | 0.537 |
| HCM Control Delay (s) | 20.9 | 8.4 | - | - | 7.8 | - | - | 20.9 |
| HCM Lane LOS | C | A | - | - | A | - | - | C |
| HCM 95th %tile Q(veh) | 0.4 | 0.2 | - | - | 0 | - | - | 3.1 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 4.7 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 120 | 284 | 9 | 3 | 213 | 42 | 5 | 5 | 1 | 30 | 17 | 76 |
| Future Vol, veh/h | 120 | 284 | 9 | 3 | 213 | 42 | 5 | 5 | 1 | 30 | 17 | 76 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 150 | - | - | 150 | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 97 | 88 | 56 | 75 | 81 | 75 | 31 | 63 | 25 | 83 | 85 | 76 |
| Heavy Vehicles, % | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 4 | 0 | 0 |
| Mvmt Flow | 124 | 323 | 16 | 4 | 263 | 56 | 16 | 8 | 4 | 36 | 20 | 100 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 319 | 0 | 0 | 339 | 0 | 0 | 938 | 906 | 331 | 884 | 886 | 291 |
| Stage 1 | - | - | - | - | - | - | 579 | 579 | - | 299 | 299 | - |
| Stage 2 | - | - | - | - | - | - | 359 | 327 | - | 585 | 587 | - |
| Critical Hdwy | 4.11 | - | - | 4.1 | - | - | 7.1 | 6.5 | 6.2 | 7.14 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Follow-up Hdwy | 2.209 | - | - | 2.2 | - | - | 3.5 | 4 | 3.3 | 3.536 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1247 | - | - | 1231 | - | - | 247 | 278 | 715 | 264 | 286 | 753 |
| Stage 1 | - | - | - | - | - | - | 504 | 504 | - | 706 | 670 | - |
| Stage 2 | - | - | - | - | - | - | 663 | 651 | - | 494 | 500 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1247 | - | - | 1231 | - | - | 186 | 250 | 715 | 236 | 257 | 753 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 186 | 250 | - | 236 | 257 | - |
| Stage 1 | - | - | - | - | - | - | 454 | 454 | - | 636 | 668 | - |
| Stage 2 | - | - | - | - | - | - | 556 | 649 | - | 435 | 451 | - |

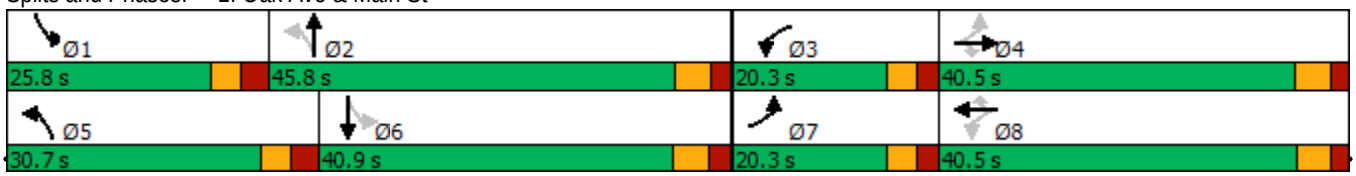
| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.2 | 0.1 | 23.2 | 18.1 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 226 | 1247 | - | - | 1231 | - | - | 429 |
| HCM Lane V/C Ratio | 0.124 | 0.099 | - | - | 0.003 | - | - | 0.364 |
| HCM Control Delay (s) | 23.2 | 8.2 | - | - | 7.9 | - | - | 18.1 |
| HCM Lane LOS | C | A | - | - | A | - | - | C |
| HCM 95th %tile Q(veh) | 0.4 | 0.3 | - | - | 0 | - | - | 1.6 |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 56 | 221 | 203 | 51 | 304 | 81 | 238 | 258 | 43 | 52 | 224 | 20 |
| Future Volume (vph) | 56 | 221 | 203 | 51 | 304 | 81 | 238 | 258 | 43 | 52 | 224 | 20 |
| Satd. Flow (prot) | 1770 | 1827 | 1599 | 1687 | 1863 | 1538 | 1770 | 1814 | 0 | 1641 | 1783 | 0 |
| Flt Permitted | 0.285 | | | 0.471 | | | 0.312 | | | 0.537 | | |
| Satd. Flow (perm) | 531 | 1827 | 1599 | 836 | 1863 | 1538 | 581 | 1814 | 0 | 928 | 1783 | 0 |
| Satd. Flow (RTOR) | | | 236 | | | 115 | | 10 | | | 4 | |
| Peak Hour Factor | 0.64 | 0.85 | 0.86 | 0.75 | 0.92 | 0.92 | 0.88 | 0.85 | 0.57 | 0.65 | 0.85 | 0.71 |
| Heavy Vehicles (%) | 2% | 4% | 1% | 7% | 2% | 5% | 2% | 2% | 0% | 10% | 5% | 6% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 88 | 260 | 236 | 68 | 330 | 88 | 270 | 379 | 0 | 80 | 292 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 29.2 | 22.2 | 22.2 | 26.8 | 21.1 | 21.1 | 42.8 | 32.2 | | 27.7 | 19.8 | |
| Actuated g/C Ratio | 0.34 | 0.26 | 0.26 | 0.31 | 0.24 | 0.24 | 0.49 | 0.37 | | 0.32 | 0.23 | |
| v/c Ratio | 0.29 | 0.56 | 0.40 | 0.21 | 0.73 | 0.19 | 0.53 | 0.56 | | 0.22 | 0.71 | |
| Control Delay | 21.4 | 35.2 | 6.4 | 20.5 | 42.8 | 4.2 | 19.3 | 29.2 | | 17.8 | 44.6 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 21.4 | 35.2 | 6.4 | 20.5 | 42.8 | 4.2 | 19.3 | 29.2 | | 17.8 | 44.6 | |
| LOS | C | D | A | C | D | A | B | C | | B | D | |
| Approach Delay | | 21.5 | | | 32.7 | | | 25.1 | | | 38.8 | |
| Approach LOS | | C | | | C | | | C | | | D | |
| Queue Length 50th (ft) | 28 | 118 | 0 | 22 | 160 | 0 | 86 | 168 | | 23 | 145 | |
| Queue Length 95th (ft) | 53 | 239 | 51 | 52 | 335 | 23 | 182 | 315 | | 44 | 287 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 300 | | 100 | 150 | | | 225 | | |
| Base Capacity (vph) | 431 | 797 | 830 | 472 | 812 | 735 | 656 | 918 | | 605 | 777 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.20 | 0.33 | 0.28 | 0.14 | 0.41 | 0.12 | 0.41 | 0.41 | | 0.13 | 0.38 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 86.7 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.73 | |
| Intersection Signal Delay: 28.3 | Intersection LOS: C |
| Intersection Capacity Utilization 64.9% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 1: Oak Ave & Main St

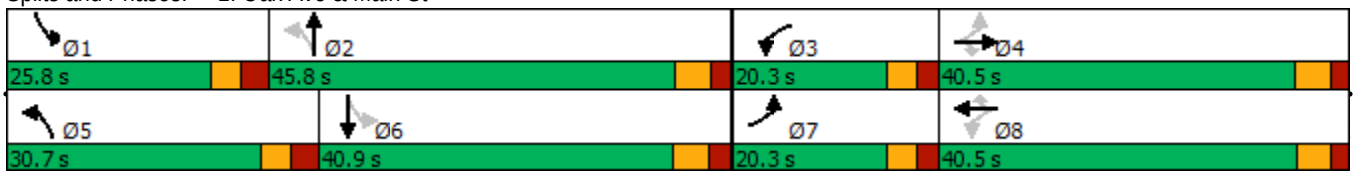


| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 109 | 352 | 307 | 97 | 298 | 126 | 248 | 351 | 37 | 143 | 400 | 39 |
| Future Volume (vph) | 109 | 352 | 307 | 97 | 298 | 126 | 248 | 351 | 37 | 143 | 400 | 39 |
| Satd. Flow (prot) | 1805 | 1881 | 1615 | 1805 | 1863 | 1583 | 1770 | 1870 | 0 | 1787 | 1835 | 0 |
| Flt Permitted | 0.311 | | | 0.167 | | | 0.127 | | | 0.283 | | |
| Satd. Flow (perm) | 591 | 1881 | 1615 | 317 | 1863 | 1583 | 237 | 1870 | 0 | 532 | 1835 | 0 |
| Satd. Flow (RTOR) | | | 302 | | | 115 | | 5 | | | 4 | |
| Peak Hour Factor | 0.85 | 0.81 | 0.95 | 0.81 | 0.92 | 0.88 | 0.98 | 0.85 | 0.77 | 0.76 | 0.93 | 0.89 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 2% | 2% | 0% | 0% | 1% | 2% | 3% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 128 | 435 | 323 | 120 | 324 | 143 | 253 | 461 | 0 | 188 | 474 | 0 |
| Turn Type | pm+pt | NA | Perm | pm+pt | NA | Perm | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | | 6 | | |
| Total Split (s) | 20.3 | 40.5 | 40.5 | 20.3 | 40.5 | 40.5 | 30.7 | 45.8 | | 25.8 | 40.9 | |
| Total Lost Time (s) | 5.3 | 5.5 | 5.5 | 5.3 | 5.4 | 5.4 | 5.7 | 5.8 | | 5.8 | 5.9 | |
| Act Effct Green (s) | 41.0 | 30.4 | 30.4 | 39.5 | 29.8 | 29.8 | 56.0 | 38.6 | | 44.9 | 32.7 | |
| Actuated g/C Ratio | 0.36 | 0.27 | 0.27 | 0.35 | 0.26 | 0.26 | 0.49 | 0.34 | | 0.39 | 0.29 | |
| v/c Ratio | 0.40 | 0.87 | 0.50 | 0.51 | 0.67 | 0.29 | 0.70 | 0.72 | | 0.55 | 0.89 | |
| Control Delay | 26.9 | 59.3 | 8.2 | 31.0 | 46.4 | 11.8 | 34.0 | 41.7 | | 24.4 | 60.8 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 26.9 | 59.3 | 8.2 | 31.0 | 46.4 | 11.8 | 34.0 | 41.7 | | 24.4 | 60.8 | |
| LOS | C | E | A | C | D | B | C | D | | C | E | |
| Approach Delay | | 36.0 | | | 34.9 | | | 39.0 | | | 50.5 | |
| Approach LOS | | D | | | C | | | D | | | D | |
| Queue Length 50th (ft) | 62 | 313 | 12 | 58 | 219 | 16 | 116 | 301 | | 79 | 344 | |
| Queue Length 95th (ft) | 105 | 424 | 92 | 94 | 354 | 68 | 223 | 448 | | 112 | #624 | |
| Internal Link Dist (ft) | | 987 | | | 459 | | | 665 | | | 1008 | |
| Turn Bay Length (ft) | 100 | | | 300 | | 100 | 150 | | | 225 | | |
| Base Capacity (vph) | 396 | 595 | 717 | 324 | 589 | 579 | 463 | 696 | | 471 | 581 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.32 | 0.73 | 0.45 | 0.37 | 0.55 | 0.25 | 0.55 | 0.66 | | 0.40 | 0.82 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 132.4 | |
| Actuated Cycle Length: 113.7 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.89 | |
| Intersection Signal Delay: 39.9 | Intersection LOS: D |
| Intersection Capacity Utilization 79.7% | ICU Level of Service D |
| Analysis Period (min) 15 | |

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 1: Oak Ave & Main St



| Intersection | |
|---|---|
| Int Delay, s/veh | 2.7 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↑ | | ↰ | ↱ |
| Traffic Vol, veh/h | 0 | 315 | 363 | 0 | 100 | 73 |
| Future Vol, veh/h | 0 | 315 | 363 | 0 | 100 | 73 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 100 | 76 | 94 | 100 | 83 | 91 |
| Heavy Vehicles, % | 0 | 4 | 3 | 0 | 1 | 2 |
| Mvmt Flow | 0 | 414 | 386 | 0 | 120 | 80 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | - | 0 | - | 0 | 800 | 386 |
| Stage 1 | - | - | - | - | 386 | - |
| Stage 2 | - | - | - | - | 414 | - |
| Critical Hdwy | - | - | - | - | 6.41 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.41 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.41 | - |
| Follow-up Hdwy | - | - | - | - | 3.509 | 3.318 |
| Pot Cap-1 Maneuver | 0 | - | - | 0 | 356 | 662 |
| Stage 1 | 0 | - | - | 0 | 689 | - |
| Stage 2 | 0 | - | - | 0 | 669 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | - | - | - | - | 356 | 662 |
| Mov Cap-2 Maneuver | - | - | - | - | 472 | - |
| Stage 1 | - | - | - | - | 689 | - |
| Stage 2 | - | - | - | - | 669 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0 | 13.6 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|
| Capacity (veh/h) | - | - | 472 | 662 |
| HCM Lane V/C Ratio | - | - | 0.255 | 0.121 |
| HCM Control Delay (s) | - | - | 15.2 | 11.2 |
| HCM Lane LOS | - | - | C | B |
| HCM 95th %tile Q(veh) | - | - | 1 | 0.4 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 4 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↑ | | ↰ | ↱ |
| Traffic Vol, veh/h | 0 | 534 | 397 | 0 | 133 | 125 |
| Future Vol, veh/h | 0 | 534 | 397 | 0 | 133 | 125 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | - | - | 0 | 0 |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 100 | 86 | 88 | 100 | 79 | 87 |
| Heavy Vehicles, % | 0 | 1 | 1 | 0 | 0 | 0 |
| Mvmt Flow | 0 | 621 | 451 | 0 | 168 | 144 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | - | 0 | - | 0 | 1072 | 451 |
| Stage 1 | - | - | - | - | 451 | - |
| Stage 2 | - | - | - | - | 621 | - |
| Critical Hdwy | - | - | - | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | - | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 0 | - | - | 0 | 246 | 613 |
| Stage 1 | 0 | - | - | 0 | 646 | - |
| Stage 2 | 0 | - | - | 0 | 540 | - |
| Platoon blocked, % | | - | - | | | |
| Mov Cap-1 Maneuver | - | - | - | - | 246 | 613 |
| Mov Cap-2 Maneuver | - | - | - | - | 379 | - |
| Stage 1 | - | - | - | - | 646 | - |
| Stage 2 | - | - | - | - | 540 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 0 | 17.7 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | EBT | WBT | SBLn1 | SBLn2 |
|---|---|---|---|---|
| Capacity (veh/h) | - | - | 379 | 613 |
| HCM Lane V/C Ratio | - | - | 0.444 | 0.234 |
| HCM Control Delay (s) | - | - | 21.9 | 12.7 |
| HCM Lane LOS | - | - | C | B |
| HCM 95th %tile Q(veh) | - | - | 2.2 | 0.9 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 2.4 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 330 | 84 | 81 | 349 | 15 | 78 |
| Future Vol, veh/h | 330 | 84 | 81 | 349 | 15 | 78 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 25 | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 77 | 84 | 70 | 91 | 47 | 81 |
| Heavy Vehicles, % | 4 | 3 | 3 | 3 | 8 | 5 |
| Mvmt Flow | 429 | 100 | 116 | 384 | 32 | 96 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 529 | 0 | 1095 | 479 |
| Stage 1 | - | - | - | - | 479 | - |
| Stage 2 | - | - | - | - | 616 | - |
| Critical Hdwy | - | - | 4.13 | - | 6.48 | 6.25 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.48 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.48 | - |
| Follow-up Hdwy | - | - | 2.227 | - | 3.572 | 3.345 |
| Pot Cap-1 Maneuver | - | - | 1033 | - | 230 | 581 |
| Stage 1 | - | - | - | - | 611 | - |
| Stage 2 | - | - | - | - | 527 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 1033 | - | 204 | 581 |
| Mov Cap-2 Maneuver | - | - | - | - | 332 | - |
| Stage 1 | - | - | - | - | 611 | - |
| Stage 2 | - | - | - | - | 468 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 2.1 | 13.5 |
| HCM LOS | | | B |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 332 | 581 | - | - | 1033 | - |
| HCM Lane V/C Ratio | 0.096 | 0.166 | - | - | 0.112 | - |
| HCM Control Delay (s) | 17 | 12.4 | - | - | 8.9 | - |
| HCM Lane LOS | C | B | - | - | A | - |
| HCM 95th %tile Q(veh) | 0.3 | 0.6 | - | - | 0.4 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 3.4 |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 598 | 70 | 57 | 368 | 29 | 144 |
| Future Vol, veh/h | 598 | 70 | 57 | 368 | 29 | 144 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 25 | - | 0 | 50 |
| Veh in Median Storage, # | 0 | - | - | 0 | 0 | - |
| Grade, % | 0 | - | - | 0 | 0 | - |
| Peak Hour Factor | 87 | 76 | 84 | 85 | 66 | 78 |
| Heavy Vehicles, % | 1 | 0 | 2 | 1 | 0 | 0 |
| Mvmt Flow | 687 | 92 | 68 | 433 | 44 | 185 |

| Major/Minor | Major1 | | Major2 | | Minor1 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 0 | 0 | 779 | 0 | 1302 | 733 |
| Stage 1 | - | - | - | - | 733 | - |
| Stage 2 | - | - | - | - | 569 | - |
| Critical Hdwy | - | - | 4.12 | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | - | - | 2.218 | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | - | - | 838 | - | 179 | 424 |
| Stage 1 | - | - | - | - | 479 | - |
| Stage 2 | - | - | - | - | 570 | - |
| Platoon blocked, % | - | - | | - | | |
| Mov Cap-1 Maneuver | - | - | 838 | - | 165 | 424 |
| Mov Cap-2 Maneuver | - | - | - | - | 304 | - |
| Stage 1 | - | - | - | - | 479 | - |
| Stage 2 | - | - | - | - | 524 | - |

| Approach | EB | WB | NB |
|---|---|---|---|
| HCM Control Delay, s | 0 | 1.3 | 19.7 |
| HCM LOS | | | C |

| Minor Lane/Major Mvmt | NBLn1 | NBLn2 | EBT | EBR | WBL | WBT |
|---|---|---|---|---|---|---|
| Capacity (veh/h) | 304 | 424 | - | - | 838 | - |
| HCM Lane V/C Ratio | 0.145 | 0.435 | - | - | 0.081 | - |
| HCM Control Delay (s) | 18.8 | 19.9 | - | - | 9.7 | - |
| HCM Lane LOS | C | C | - | - | A | - |
| HCM 95th %tile Q(veh) | 0.5 | 2.2 | - | - | 0.3 | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.8 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 86 | 324 | 430 | 29 | 0 | 0 |
| Future Vol, veh/h | 86 | 324 | 430 | 29 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 25 | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 86 | 76 | 96 | 66 | 100 | 100 |
| Heavy Vehicles, % | 1 | 5 | 3 | 4 | 0 | 0 |
| Mvmt Flow | 100 | 426 | 448 | 44 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 492 | 0 | - | 0 | 1096 | 470 |
| Stage 1 | - | - | - | - | 470 | - |
| Stage 2 | - | - | - | - | 626 | - |
| Critical Hdwy | 4.11 | - | - | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | 2.209 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1077 | - | - | - | 238 | 598 |
| Stage 1 | - | - | - | - | 633 | - |
| Stage 2 | - | - | - | - | 537 | - |
| Platoon blocked, % | | - | - | - | | |
| Mov Cap-1 Maneuver | 1077 | - | - | - | 216 | 598 |
| Mov Cap-2 Maneuver | - | - | - | - | 352 | - |
| Stage 1 | - | - | - | - | 574 | - |
| Stage 2 | - | - | - | - | 537 | - |

| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 1.6 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1077 | - | - | - | - |
| HCM Lane V/C Ratio | 0.093 | - | - | - | - |
| HCM Control Delay (s) | 8.7 | - | - | - | 0 |
| HCM Lane LOS | A | - | - | - | A |
| HCM 95th %tile Q(veh) | 0.3 | - | - | - | - |

| Intersection | |
|---|---|
| Int Delay, s/veh | 0.9 |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Vol, veh/h | 125 | 615 | 425 | 61 | 0 | 0 |
| Future Vol, veh/h | 125 | 615 | 425 | 61 | 0 | 0 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 25 | - | - | - | 0 | - |
| Veh in Median Storage, # | - | 0 | 0 | - | 0 | - |
| Grade, % | - | 0 | 0 | - | 0 | - |
| Peak Hour Factor | 89 | 92 | 86 | 80 | 100 | 100 |
| Heavy Vehicles, % | 0 | 0 | 1 | 0 | 0 | 0 |
| Mvmt Flow | 140 | 668 | 494 | 76 | 0 | 0 |

| Major/Minor | Major1 | | Major2 | | Minor2 | |
|---|---|---|---|---|---|---|
| Conflicting Flow All | 570 | 0 | - | 0 | 1480 | 532 |
| Stage 1 | - | - | - | - | 532 | - |
| Stage 2 | - | - | - | - | 948 | - |
| Critical Hdwy | 4.1 | - | - | - | 6.4 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | 5.4 | - |
| Critical Hdwy Stg 2 | - | - | - | - | 5.4 | - |
| Follow-up Hdwy | 2.2 | - | - | - | 3.5 | 3.3 |
| Pot Cap-1 Maneuver | 1013 | - | - | - | 140 | 551 |
| Stage 1 | - | - | - | - | 593 | - |
| Stage 2 | - | - | - | - | 380 | - |
| Platoon blocked, % | | | - | - | - | |
| Mov Cap-1 Maneuver | 1013 | - | - | - | 121 | 551 |
| Mov Cap-2 Maneuver | - | - | - | - | 253 | - |
| Stage 1 | - | - | - | - | 511 | - |
| Stage 2 | - | - | - | - | 380 | - |

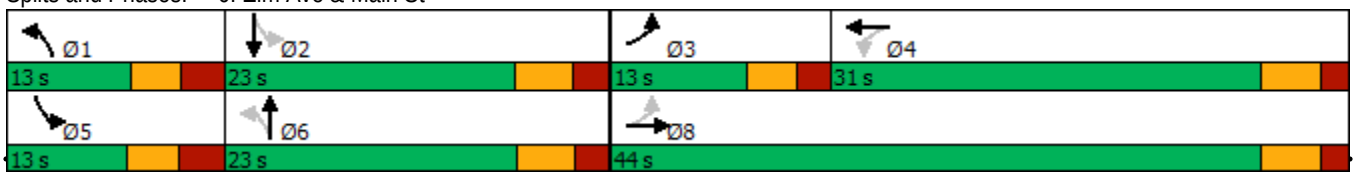
| Approach | EB | WB | SB |
|---|---|---|---|
| HCM Control Delay, s | 1.6 | 0 | 0 |
| HCM LOS | | | A |

| Minor Lane/Major Mvmt | EBL | EBT | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|
| Capacity (veh/h) | 1013 | - | - | - | - |
| HCM Lane V/C Ratio | 0.139 | - | - | - | - |
| HCM Control Delay (s) | 9.1 | - | - | - | 0 |
| HCM Lane LOS | A | - | - | - | A |
| HCM 95th %tile Q(veh) | 0.5 | - | - | - | - |

| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 65 | 221 | 35 | 42 | 328 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Future Volume (vph) | 65 | 221 | 35 | 42 | 328 | 43 | 71 | 133 | 48 | 21 | 165 | 60 |
| Satd. Flow (prot) | 1736 | 1768 | 0 | 1805 | 1804 | 0 | 1805 | 1778 | 0 | 1805 | 1792 | 0 |
| Flt Permitted | 0.206 | | | 0.548 | | | 0.459 | | | 0.621 | | |
| Satd. Flow (perm) | 376 | 1768 | 0 | 1041 | 1804 | 0 | 872 | 1778 | 0 | 1180 | 1792 | 0 |
| Satd. Flow (RTOR) | | 21 | | | 11 | | | 24 | | | 19 | |
| Peak Hour Factor | 0.96 | 0.77 | 0.51 | 0.81 | 0.93 | 0.72 | 0.74 | 0.85 | 0.75 | 0.58 | 0.86 | 0.94 |
| Heavy Vehicles (%) | 4% | 3% | 10% | 0% | 3% | 3% | 0% | 1% | 5% | 0% | 2% | 2% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 68 | 356 | 0 | 52 | 413 | 0 | 96 | 220 | 0 | 36 | 256 | 0 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | | 4 | | | 6 | | | 2 | | |
| Total Split (s) | 13.0 | 44.0 | | 31.0 | 31.0 | | 13.0 | 23.0 | | 13.0 | 23.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | | 5.3 | 5.3 | | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 25.8 | 25.4 | | 19.3 | 19.3 | | 25.2 | 22.7 | | 21.7 | 17.2 | |
| Actuated g/C Ratio | 0.40 | 0.40 | | 0.30 | 0.30 | | 0.39 | 0.35 | | 0.34 | 0.27 | |
| v/c Ratio | 0.23 | 0.50 | | 0.17 | 0.75 | | 0.21 | 0.34 | | 0.08 | 0.52 | |
| Control Delay | 13.3 | 15.8 | | 20.5 | 31.1 | | 16.2 | 21.3 | | 15.7 | 28.1 | |
| Queue Delay | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 13.3 | 15.8 | | 20.5 | 31.1 | | 16.2 | 21.3 | | 15.7 | 28.1 | |
| LOS | B | B | | C | C | | B | C | | B | C | |
| Approach Delay | | 15.4 | | | 29.9 | | | 19.8 | | | 26.6 | |
| Approach LOS | | B | | | C | | | B | | | C | |
| Queue Length 50th (ft) | 16 | 95 | | 17 | 160 | | 27 | 58 | | 10 | 97 | |
| Queue Length 95th (ft) | 38 | 133 | | 40 | 275 | | 50 | 145 | | 19 | 175 | |
| Internal Link Dist (ft) | | 446 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 175 | | | 150 | | | 65 | | | 60 | | |
| Base Capacity (vph) | 336 | 1142 | | 457 | 799 | | 459 | 664 | | 489 | 540 | |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.20 | 0.31 | | 0.11 | 0.52 | | 0.21 | 0.33 | | 0.07 | 0.47 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 80 | |
| Actuated Cycle Length: 64.3 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.75 | |
| Intersection Signal Delay: 23.0 | Intersection LOS: C |
| Intersection Capacity Utilization 60.5% | ICU Level of Service B |
| Analysis Period (min) 15 | |

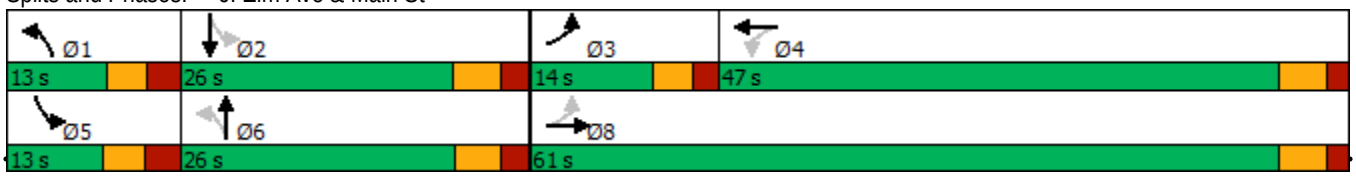
Splits and Phases: 6: Elm Ave & Main St



| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Volume (vph) | 139 | 415 | 60 | 25 | 362 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Future Volume (vph) | 139 | 415 | 60 | 25 | 362 | 37 | 53 | 123 | 73 | 36 | 97 | 70 |
| Satd. Flow (prot) | 1805 | 1841 | 0 | 1805 | 1834 | 0 | 1805 | 1797 | 0 | 1805 | 1770 | 0 |
| Flt Permitted | 0.191 | | | 0.458 | | | 0.576 | | | 0.498 | | |
| Satd. Flow (perm) | 363 | 1841 | 0 | 870 | 1834 | 0 | 1094 | 1797 | 0 | 946 | 1770 | 0 |
| Satd. Flow (RTOR) | | 15 | | | 8 | | | 26 | | | 33 | |
| Peak Hour Factor | 0.87 | 0.89 | 0.71 | 0.69 | 0.83 | 0.62 | 0.88 | 0.83 | 0.87 | 0.64 | 0.84 | 0.83 |
| Heavy Vehicles (%) | 0% | 1% | 0% | 0% | 2% | 0% | 0% | 0% | 0% | 0% | 1% | 0% |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 160 | 551 | 0 | 36 | 496 | 0 | 60 | 232 | 0 | 56 | 199 | 0 |
| Turn Type | pm+pt | NA | | Perm | NA | | pm+pt | NA | | pm+pt | NA | |
| Protected Phases | 3 | 8 | | | 4 | | 1 | 6 | | 5 | 2 | |
| Permitted Phases | 8 | | | 4 | | | 6 | | | 2 | | |
| Total Split (s) | 14.0 | 61.0 | | 47.0 | 47.0 | | 13.0 | 26.0 | | 13.0 | 26.0 | |
| Total Lost Time (s) | 5.0 | 5.3 | | 5.3 | 5.3 | | 5.6 | 5.7 | | 5.8 | 5.8 | |
| Act Effct Green (s) | 39.8 | 39.5 | | 26.2 | 26.2 | | 21.1 | 17.3 | | 20.8 | 17.2 | |
| Actuated g/C Ratio | 0.53 | 0.53 | | 0.35 | 0.35 | | 0.28 | 0.23 | | 0.28 | 0.23 | |
| v/c Ratio | 0.46 | 0.57 | | 0.12 | 0.77 | | 0.16 | 0.53 | | 0.17 | 0.46 | |
| Control Delay | 14.5 | 14.9 | | 19.0 | 30.9 | | 21.5 | 31.9 | | 21.8 | 29.1 | |
| Queue Delay | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Delay | 14.5 | 14.9 | | 19.0 | 30.9 | | 21.5 | 31.9 | | 21.8 | 29.1 | |
| LOS | B | B | | B | C | | C | C | | C | C | |
| Approach Delay | | 14.8 | | | 30.1 | | | 29.8 | | | 27.5 | |
| Approach LOS | | B | | | C | | | C | | | C | |
| Queue Length 50th (ft) | 40 | 173 | | 12 | 215 | | 19 | 93 | | 18 | 73 | |
| Queue Length 95th (ft) | 76 | 291 | | 26 | 315 | | 54 | 179 | | 37 | 152 | |
| Internal Link Dist (ft) | | 446 | | | 581 | | | 629 | | | 535 | |
| Turn Bay Length (ft) | 175 | | | 150 | | | 65 | | | 60 | | |
| Base Capacity (vph) | 376 | 1419 | | 515 | 1090 | | 383 | 536 | | 350 | 531 | |
| Starvation Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Reduced v/c Ratio | 0.43 | 0.39 | | 0.07 | 0.46 | | 0.16 | 0.43 | | 0.16 | 0.37 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 100 | |
| Actuated Cycle Length: 75.1 | |
| Control Type: Actuated-Uncoordinated | |
| Maximum v/c Ratio: 0.77 | |
| Intersection Signal Delay: 23.6 | Intersection LOS: C |
| Intersection Capacity Utilization 68.0% | ICU Level of Service C |
| Analysis Period (min) 15 | |

Splits and Phases: 6: Elm Ave & Main St



# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | AM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Grove Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Grove Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.86 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 89 | 174 | 25 | 0 | 14 | 249 | 115 | 0 | 29 | 131 | 16 | 0 | 35 | 265 | 135 |
| Percent Heavy Vehicles, % | 3 | 3 | 3 | 0 | 0 | 7 | 4 | 6 | 3 | 0 | 1 | 0 | 3 | 4 | 4 | 3 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 107 | 208 | 29 | 0 | 17 | 301 | 142 | 0 | 34 | 154 | 19 | 0 | 42 | 320 | 162 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 344 | | | 460 | | | 207 | | | 524 | |
| Entry Volume, veh/h | | 335 | | | 439 | | | 205 | | | 505 | |
| Circulating Flow ($v_c$), pc/h | 379 | | | 295 | | | 357 | | | 352 | | |
| Exiting Flow ($v_{ex}$), pc/h | 269 | | | 497 | | | 403 | | | 366 | | |
| Capacity ($c_{pce}$), pc/h | | 938 | | | 1021 | | | 959 | | | 964 | |
| Capacity (c), veh/h | | 913 | | | 975 | | | 952 | | | 929 | |
| v/c Ratio (x) | | 0.37 | | | 0.45 | | | 0.22 | | | 0.54 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 8.0 | | | 8.9 | | | 5.9 | | | 11.1 | |
| Lane LOS | | A | | | A | | | A | | | B | |
| 95% Queue, veh | | 1.7 | | | 2.4 | | | 0.8 | | | 3.4 | |
| Approach Delay, s/veh | 8.0 | | | 8.9 | | | 5.9 | | | 11.1 | | |
| Approach LOS | A | | | A | | | A | | | B | | |
| Intersection Delay, s/veh \| LOS | 9.1 | | | | | | A | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | PM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Grove Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Grove Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.96 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 138 | 338 | 48 | 0 | 7 | 256 | 62 | 0 | 55 | 146 | 19 | 0 | 43 | 188 | 113 |
| Percent Heavy Vehicles, % | 3 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 144 | 356 | 52 | 0 | 7 | 269 | 65 | 0 | 58 | 152 | 20 | 0 | 45 | 196 | 119 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 552 | | | 341 | | | 230 | | | 360 | |
| Entry Volume, veh/h | | 547 | | | 338 | | | 229 | | | 359 | |
| Circulating Flow ($v_c$), pc/h | 248 | | | 354 | | | 545 | | | 334 | | |
| Exiting Flow ($v_{ex}$), pc/h | 421 | | | 446 | | | 361 | | | 255 | | |
| Capacity ($c_{pce}$), pc/h | | 1072 | | | 962 | | | 792 | | | 982 | |
| Capacity (c), veh/h | | 1062 | | | 954 | | | 788 | | | 978 | |
| v/c Ratio (x) | | 0.52 | | | 0.35 | | | 0.29 | | | 0.37 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 9.5 | | | 7.6 | | | 7.9 | | | 7.6 | |
| Lane LOS | | A | | | A | | | A | | | A | |
| 95% Queue, veh | | 3.0 | | | 1.6 | | | 1.2 | | | 1.7 | |
| Approach Delay, s/veh | 9.5 | | | 7.6 | | | 7.9 | | | 7.6 | | |
| Approach LOS | A | | | A | | | A | | | A | | |
| Intersection Delay, s/veh \| LOS | 8.4 | | | | | | A | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | AM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Lincoln Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Lincoln Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.86 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 10 | 102 | 55 | 0 | 74 | 278 | 81 | 0 | 115 | 109 | 22 | 0 | 55 | 199 | 21 |
| Percent Heavy Vehicles, % | 3 | 13 | 5 | 0 | 0 | 1 | 3 | 2 | 3 | 8 | 10 | 9 | 0 | 2 | 1 | 0 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 13 | 125 | 64 | 0 | 87 | 333 | 96 | 0 | 144 | 139 | 28 | 0 | 65 | 234 | 24 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 202 | | | 516 | | | 311 | | | 323 | |
| Entry Volume, veh/h | | 195 | | | 504 | | | 285 | | | 319 | |
| Circulating Flow ($v_c$), pc/h | 386 | | | 296 | | | 203 | | | 564 | | |
| Exiting Flow ($v_{ex}$), pc/h | 218 | | | 501 | | | 248 | | | 385 | | |
| Capacity ($c_{pce}$), pc/h | | 931 | | | 1020 | | | 1122 | | | 776 | |
| Capacity (c), veh/h | | 897 | | | 996 | | | 1029 | | | 768 | |
| v/c Ratio (x) | | 0.22 | | | 0.51 | | | 0.28 | | | 0.42 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 6.2 | | | 9.8 | | | 6.2 | | | 10.1 | |
| Lane LOS | | A | | | A | | | A | | | B | |
| 95% Queue, veh | | 0.8 | | | 2.9 | | | 1.1 | | | 2.1 | |
| Approach Delay, s/veh | 6.2 | | | 9.8 | | | 6.2 | | | 10.1 | | |
| Approach LOS | A | | | A | | | A | | | B | | |
| Intersection Delay, s/veh \| LOS | 8.5 | | | | | | A | | | | | |

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# HCS Roundabouts Report

## General Information

| | |
|---|---|
| Analyst | Blake Andert |
| Agency or Co. | SEH |
| Date Performed | 2/10/2022 |
| Analysis Year | 2045 |
| Time Analyzed | PM Peak Hour |
| Project Description | CSAH 48 (Main St) Corridor... |




## Site Information

| | |
|---|---|
| Intersection | CSAH 48 at Lincoln Ave |
| E/W Street Name | CSAH 48 (Main St) |
| N/S Street Name | Lincoln Ave |
| Analysis Time Period, hrs | 0.25 |
| Peak Hour Factor | 0.92 |
| Jurisdiction | Steele County |

## Volume Adjustments and Site Characteristics

| Approach | EB | | | | WB | | | | NB | | | | SB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Number of Lanes (N) | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Lane Assignment | | | LTR | | | | LTR | | | | LTR | | | | LTR | |
| Volume (V), veh/h | 0 | 9 | 289 | 122 | 0 | 31 | 202 | 63 | 0 | 74 | 112 | 45 | 0 | 82 | 113 | 11 |
| Percent Heavy Vehicles, % | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Flow Rate ($v_{PCE}$), pc/h | 0 | 10 | 317 | 133 | 0 | 34 | 220 | 68 | 0 | 83 | 122 | 49 | 0 | 89 | 123 | 12 |
| Right-Turn Bypass | None | | | | None | | | | None | | | | None | | | |
| Conflicting Lanes | 1 | | | | 1 | | | | 1 | | | | 1 | | | |
| Pedestrians Crossing, p/h | 0 | | | | 0 | | | | 0 | | | | 0 | | | |
| Proportion of CAVs | 0 | | | | | | | | | | | | | | | |

## Critical and Follow-Up Headway Adjustment

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Critical Headway, s | | 4.9763 | | | 4.9763 | | | 4.9763 | | | 4.9763 | |
| Follow-Up Headway, s | | 2.6087 | | | 2.6087 | | | 2.6087 | | | 2.6087 | |

## Flow Computations, Capacity and v/c Ratios

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Entry Flow ($v_e$), pc/h | | 460 | | | 322 | | | 254 | | | 224 | |
| Entry Volume, veh/h | | 457 | | | 322 | | | 252 | | | 224 | |
| Circulating Flow ($v_c$), pc/h | 246 | | | 215 | | | 416 | | | 337 | | |
| Exiting Flow ($v_{ex}$), pc/h | 455 | | | 315 | | | 200 | | | 290 | | |
| Capacity ($c_{pce}$), pc/h | | 1074 | | | 1108 | | | 903 | | | 979 | |
| Capacity (c), veh/h | | 1066 | | | 1108 | | | 894 | | | 979 | |
| v/c Ratio (x) | | 0.43 | | | 0.29 | | | 0.28 | | | 0.23 | |

## Delay and Level of Service

| Approach | EB | | | WB | | | NB | | | SB | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass | Left | Right | Bypass |
| Lane Control Delay (d), s/veh | | 8.0 | | | 6.0 | | | 7.0 | | | 5.9 | |
| Lane LOS | | A | | | A | | | A | | | A | |
| 95% Queue, veh | | 2.2 | | | 1.2 | | | 1.2 | | | 0.9 | |
| Approach Delay, s/veh | 8.0 | | | 6.0 | | | 7.0 | | | 5.9 | | |
| Approach LOS | A | | | A | | | A | | | A | | |
| Intersection Delay, s/veh \| LOS | 6.9 | | | | | | A | | | | | |

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| Intersection | |
|---|---|
| Int Delay, s/veh | 7.2 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 51 | 128 | 5 | 6 | 295 | 48 | 6 | 4 | 1 | 36 | 20 | 140 |
| Future Vol, veh/h | 51 | 128 | 5 | 6 | 295 | 48 | 6 | 4 | 1 | 36 | 20 | 140 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 150 | - | - | 150 | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 64 | 84 | 42 | 50 | 86 | 86 | 38 | 33 | 25 | 60 | 63 | 85 |
| Heavy Vehicles, % | 5 | 5 | 25 | 25 | 3 | 0 | 0 | 0 | 100 | 3 | 6 | 2 |
| Mvmt Flow | 80 | 152 | 12 | 12 | 343 | 56 | 16 | 12 | 4 | 60 | 32 | 165 |

| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 399 | 0 | 0 | 164 | 0 | 0 | 812 | 741 | 158 | 721 | 719 | 371 |
| Stage 1 | - | - | - | - | - | - | 318 | 318 | - | 395 | 395 | - |
| Stage 2 | - | - | - | - | - | - | 494 | 423 | - | 326 | 324 | - |
| Critical Hdwy | 4.15 | - | - | 4.35 | - | - | 7.1 | 6.5 | 7.2 | 7.13 | 6.56 | 6.22 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.13 | 5.56 | - |
| Follow-up Hdwy | 2.245 | - | - | 2.425 | - | - | 3.5 | 4 | 4.2 | 3.527 | 4.054 | 3.318 |
| Pot Cap-1 Maneuver | 1144 | - | - | 1286 | - | - | 300 | 347 | 684 | 341 | 349 | 675 |
| Stage 1 | - | - | - | - | - | - | 698 | 657 | - | 628 | 598 | - |
| Stage 2 | - | - | - | - | - | - | 561 | 591 | - | 684 | 643 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1144 | - | - | 1286 | - | - | 197 | 320 | 684 | 310 | 322 | 675 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 197 | 320 | - | 310 | 322 | - |
| Stage 1 | - | - | - | - | - | - | 649 | 611 | - | 584 | 593 | - |
| Stage 2 | - | - | - | - | - | - | 398 | 586 | - | 620 | 598 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.7 | 0.2 | 20.9 | 20.9 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 258 | 1144 | - | - | 1286 | - | - | 478 |
| HCM Lane V/C Ratio | 0.124 | 0.07 | - | - | 0.009 | - | - | 0.537 |
| HCM Control Delay (s) | 20.9 | 8.4 | - | - | 7.8 | - | - | 20.9 |
| HCM Lane LOS | C | A | - | - | A | - | - | C |
| HCM 95th %tile Q(veh) | 0.4 | 0.2 | - | - | 0 | - | - | 3.1 |

| Intersection | |
|---|---|
| Int Delay, s/veh | 4.7 |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Traffic Vol, veh/h | 120 | 284 | 9 | 3 | 213 | 42 | 5 | 5 | 1 | 30 | 17 | 76 |
| Future Vol, veh/h | 120 | 284 | 9 | 3 | 213 | 42 | 5 | 5 | 1 | 30 | 17 | 76 |
| Conflicting Peds, #/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | 150 | - | - | 150 | - | - | - | - | - | - | - | - |
| Veh in Median Storage, # | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, % | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Peak Hour Factor | 97 | 88 | 56 | 75 | 81 | 75 | 31 | 63 | 25 | 83 | 85 | 76 |
| Heavy Vehicles, % | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 4 | 0 | 0 |
| Mvmt Flow | 124 | 323 | 16 | 4 | 263 | 56 | 16 | 8 | 4 | 36 | 20 | 100 |

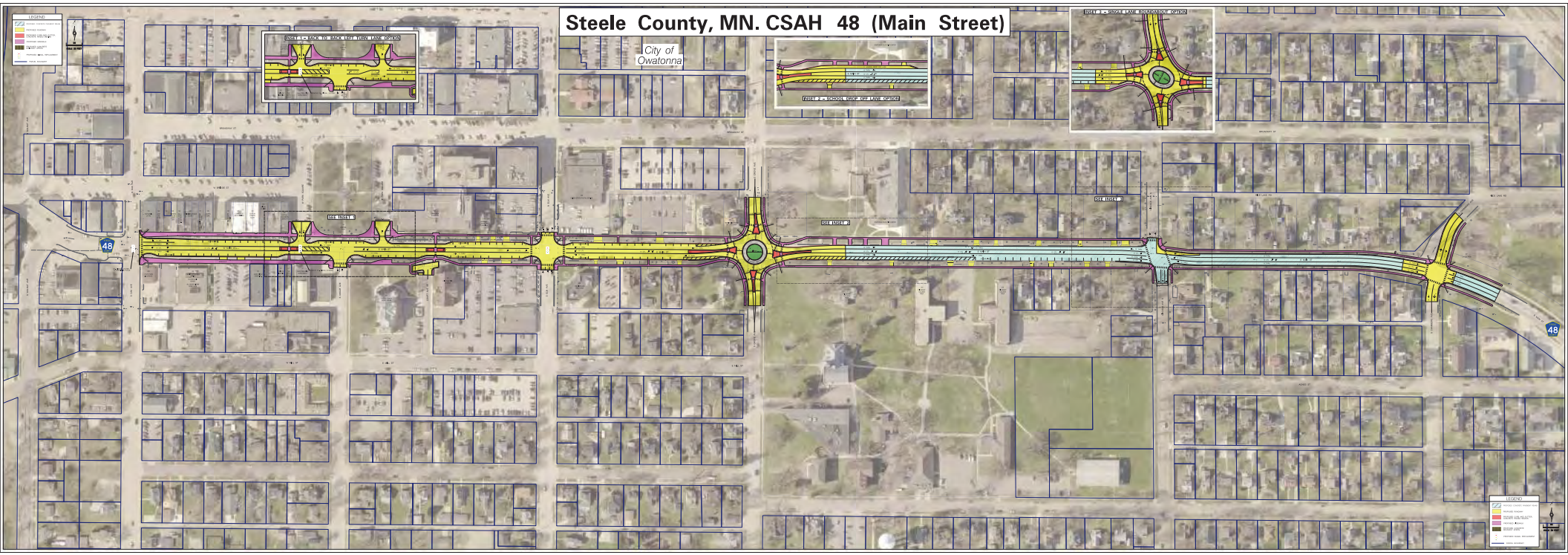
| Major/Minor | Major1 | | | Major2 | | | Minor1 | | | Minor2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conflicting Flow All | 319 | 0 | 0 | 339 | 0 | 0 | 938 | 906 | 331 | 884 | 886 | 291 |
| Stage 1 | - | - | - | - | - | - | 579 | 579 | - | 299 | 299 | - |
| Stage 2 | - | - | - | - | - | - | 359 | 327 | - | 585 | 587 | - |
| Critical Hdwy | 4.11 | - | - | 4.1 | - | - | 7.1 | 6.5 | 6.2 | 7.14 | 6.5 | 6.2 |
| Critical Hdwy Stg 1 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Critical Hdwy Stg 2 | - | - | - | - | - | - | 6.1 | 5.5 | - | 6.14 | 5.5 | - |
| Follow-up Hdwy | 2.209 | - | - | 2.2 | - | - | 3.5 | 4 | 3.3 | 3.536 | 4 | 3.3 |
| Pot Cap-1 Maneuver | 1247 | - | - | 1231 | - | - | 247 | 278 | 715 | 264 | 286 | 753 |
| Stage 1 | - | - | - | - | - | - | 504 | 504 | - | 706 | 670 | - |
| Stage 2 | - | - | - | - | - | - | 663 | 651 | - | 494 | 500 | - |
| Platoon blocked, % | | - | - | | - | - | | | | | | |
| Mov Cap-1 Maneuver | 1247 | - | - | 1231 | - | - | 186 | 250 | 715 | 236 | 257 | 753 |
| Mov Cap-2 Maneuver | - | - | - | - | - | - | 186 | 250 | - | 236 | 257 | - |
| Stage 1 | - | - | - | - | - | - | 454 | 454 | - | 636 | 668 | - |
| Stage 2 | - | - | - | - | - | - | 556 | 649 | - | 435 | 451 | - |

| Approach | EB | WB | NB | SB |
|---|---|---|---|---|
| HCM Control Delay, s | 2.2 | 0.1 | 23.2 | 18.1 |
| HCM LOS | | | C | C |

| Minor Lane/Major Mvmt | NBLn1 | EBL | EBT | EBR | WBL | WBT | WBR | SBLn1 |
|---|---|---|---|---|---|---|---|---|
| Capacity (veh/h) | 226 | 1247 | - | - | 1231 | - | - | 429 |
| HCM Lane V/C Ratio | 0.124 | 0.099 | - | - | 0.003 | - | - | 0.364 |
| HCM Control Delay (s) | 23.2 | 8.2 | - | - | 7.9 | - | - | 18.1 |
| HCM Lane LOS | C | A | - | - | A | - | - | C |
| HCM 95th %tile Q(veh) | 0.4 | 0.3 | - | - | 0 | - | - | 1.6 |

# Appendix C

Preliminary Layout


Steele County, MN. CSAH 48 (Main Street)
City of Owatonna
INSET 1 - MOVE TO BACK OF CURB LANE OPTION
INSET 2 - SCHOOL DROP OFF LANE OPTION
INSET 3 - STOP LANE INTERSECTION OPTION
SEE INSET 1
SEE INSET 2
SEE INSET 3
48
LEGEND

# Building a Better World for All of Us®

Sustainable buildings, sound infrastructure, safe transportation systems, clean water, renewable energy and a balanced environment. Building a Better World for All of Us communicates a company-wide commitment to act in the best interests of our clients and the world around us.

We're confident in our ability to balance these requirements.

Join Our Social Communities

# Appendix C

Public Open House Summaries

Building a Better World for All of Us®

# MEMORANDUM

TO: Kyle Skov (Owatonna), Andrew Sorenson (Owatonna), Greg Ilkka (Steele County), Paul Sponholz (Steele County)

FROM: Kristin Petersen (SEH), Chad Jorgenson (SEH)

RE: Summary of **Open House 1 – February 17, 2022**

This memo documents the details and comments received during the in-person open house for the **Steele County – CSAH 48 (Owatonna, MN - Main St) Public Open House #1** that took place on Thursday, February 17, 2022.

## Meeting Information

- Audience: Adjacent property owners, commuters, and residents surrounding the project area
- Date of event: Thursday, February 17, 2022, from 4:00 pm to 6:00 pm at Owatonna Fire Station
- Format: In-person open house style meeting with staff available to discuss the project 1-on-1 with attendees. Presentation boards included background information, schedule, and project goals. A large plot of the corridor was also available for attendees to view and provide comments about issues and opportunities.
- Comment cards were provided.

## Meeting Notifications

- Postcard/flier invitations were mailed directly to properties surrounding the project area.
- Meeting information was posted on the County and City website
- Meeting announced in Owatonna People's Press on February 15, 2022:

> *Steele County and the City of Owatonna are holding an open house meeting to gather public input on a proposed project that will rehabilitate and make improvements on Main Street from Oak Avenue to Chambers Avenue. Construction is currently scheduled for 2023.*
>
> *The meeting will take place Thursday, February 17, 4–6 p.m. at the Owatonna Fire Department, 107 W Main Street Owatonna, MN 55060.*
>
> *For more information about the project, or if you are unable to make the open house, check out the following webpage: www.bit.ly/OwatonnaMainSt. Also available at that web page is an interactive map you may provide comments about the project.*
>
> *Steele County advises motorists to drive with caution and slow down through work zones for their safety and for the safety of the construction crews. For updates on this or other Steele County Highway construction projects or to sign up for project email updates, visit: https://www.co.steele.mn.us/highway/index.php*

**Attendance**

- A total of 21 attendees signed in, a couple of attendees did not sign in.
- The following staff members/elected officials were present to facilitate the event and address questions and comments:

    1) Kyle Skov - Owatonna
    2) Andrew Sorenson - Owatonna
    3) Greg Ilkka - Steele County
    4) Paul Sponholz - Steele County
    5) Chad Jorgenson - SEH
    6) Kristin Petersen – SEH
    7) Doug Voss – Councilmember

**Comments**

The following (4) written comments were received during the open house:

Comment Cards

1. Gary Moore, 10236 610 St Claremont

   *I see problems with the curb extensions already at Cedar and Rose St and in Waseca. Many people are driving over the corner and snow removal is difficult. Raised islands at key intersections seem like a more viable means for pedestrians and traffic safety. I don't like roundabouts in restricted area city streets.*

   *Thank you*

2. Scott Tuchtenhagen, 626 12th St SE

   *Requesting roundabout @ Lincoln*

3. Randy Moore, 140 W. School St. Apt. 1.

   *The pedestrian crosswalk (Fire Station side) – push button so far from crossing, walk light sometimes already on and I don't get across before red. Can it include a post with button next to entry point. Concrete is also rough – needs better cut-out.*

   *Thanks*

4. Myrtle Schnader, 578 E. Main St

   I've been a resident of E. Main for 60 years! Rented 300 block, owner 54 years. Don't cut down our existing trees! Building bypass on S. edge of town was greatest improvement. Removing semaphores at Lincoln/Main big mistake. Put them back. Reroute the canning company trucks so they don't use Main St. June-October! Creates excessive weight and speed. Regular maintenance would take care of most cosmetic problems. Curb, sidewalk repair.

   Every time I receive one of these cards/letters, it results in a raise in my taxes (assessments) why does the city continue to spend money they don't have.

Please enforce the rules we already have. Speed. Clean up your property, eliminate junk cars/cars that don't run and have outdated licenses. Main St. can be attractive, without city involvement.

No roundabouts!!

The last major construction resulted in moving the nice street lite at the end of my driveway to the south side of the street. In fact, all street lites moved to S. side.

Please have next meeting at place for better parking – time so people can attend after they finish work.

Staff Comments

- Lighting – one-sided, dark on the other
- Lincoln and Main traffic back ups

Emailed Comment

3-3-22

Greetings!

Being as the website didn't work on the potential upcoming Main St. project from Oak to Chambers, I am responding by mail. I do agree that Main St. needs fixing, but then I think about how street repairs went last year! Truman Ave and downtown Cedar are still not complete, as you know. Hopefully this Main St. project will work out better.

I do want to comment on roundabouts. I do NOT think that there is enough room to do a proper roundabout within the city. My biggest concern on a roundabout is that it is very dangerous for pedestrians, especially handicapped, to use safely. Grove Ave. is a very busy intersection, as are most intersections downtown. Think about it!

Please make well thought out decisions for every ones benefit! Thank you!

Sincerely,

Karen La Fond

Email Sign Ups

1. kastenzel@fedins.com
2. bprick@frontier.com
3. Tmcmanimon72@gmail.com
4. Gary.deb.moore@gmail.com
5. Joshua.prokopec@owatonnautilities.com
6. carver@owatonnaleouyers.com
7. Kory.koziolek@owatonnautilities.com
8. Kyle.skov@ci.owatonna.mn.us
9. Dsch255@aol.com
10. 19ed@live.com
11. deorcomactuary@gmail.com
12. Jvogt830@gmail.com

## Steel County Times 2/25/2022 Article:



*Council member Doug Voss of Owatonna, right, makes a point on illustrations of Main Street to Greg Ikka, Steele County engineer, left, and Chad Jorgenson, traffic engineer with SEH in St. Paul, center, at an open house last Thursday. Dozens of people attended the open house to learn more about what the city and county are planning to do to improve Main Street in Owatonna. Staff photo*

### Officials Seek Input On Main In Owatonna

Wed, 02/23/2022 - 5:23pm admin

SHARE

**BY: RICK BUSSLER, PUBLISHER**

Officials couldn't have picked a better spot to illustrate the need for improvements to Main Street in Owatonna.

From the third floor window of the Owatonna Fire Station, which overlooks West Main Street at Central Park, it's apparent why something needs to be done to the roadway. There are many cracks and holes in the pavement on one of the city's busiest corridors.

Inside, officials made a pitch by showing diagrams, illustrations and charts to residents during an open house last week..

"The pavement is in pretty bad shape," said Paul Sponholz, assistant engineer for Steele County. "If we don't address it soon, it's really going to start falling apart."

Sponholz said officials are looking to do a full reconstruction or overall. However, he added, to do the latter would be just a Band-Aid.

Steele County and the City of Owatonna are teaming up on the project to repair Main Street from Oak Avenue to Chambers Avenue, which is a .79-mile stretch. About 10,000 vehicles travel on the roadway in the downtown area each day, according to Sponholz.

The project is expected to cost $2.4 million with the largest portion, $1.3 million, coming from sales tax revenue, Sponholz said. Other funding sources include local and state aid. Steele County will be providing 75% of the funding while Owatonna will kick in the rest. Utilities and streetscape would be covered by the city.

The most recent repairs to the roadway took place in 2005 when a mill and resurface happened from Oak to Elm Avenue. Prior to that, the curb and gutter was replaced in 1984 along with storm sewer repairs and existing concrete overlayed with bituminous asphalt.

In 1998, Elm Avenue to Chambers Avenue received reconstructed concrete pavement.

The city and county are currently conducting a feasibility study, which includes a thorough review of the corridor's pavement conditions. Officials are also utilizing the study to identify opportunities to improve walking, biking and rolling as well as a traffic and safety analysis of the entire corridor.

Sponholz said officials want feedback from the public to understand the issues of the roadway and potential problems. Citizens have until March 10 to share comments at www.bit.ly/OwatonnaMainSt.

Citizens at last week's open house shared how they want additional lighting in the neighborhoods while others were concerned about trees along the corridor.

Officials are also seeking to improve the pedestrian crosswalk by Federated Insurance. Chad Jorgenson, traffic engineer with SEH in St. Paul hired to help with the project, said one idea being tossed around is constructing bump-outs to cut down on the crosswalk, which would allow pedestrians to cross the street quicker in a shorter distance.

Engineers are considering roundabouts at two locations: Grove and Main and Lincoln and Main.

Crash statistics from 2017 to 2021 show there have been 86 crashes long the nearly one-mile stretch of Main Street. Of those crashes, one was a fatal pedestrian crash in December 2020. The worst areas along the corridor are Oak with 35 crashes, Grove with 22 and Elm with 6.

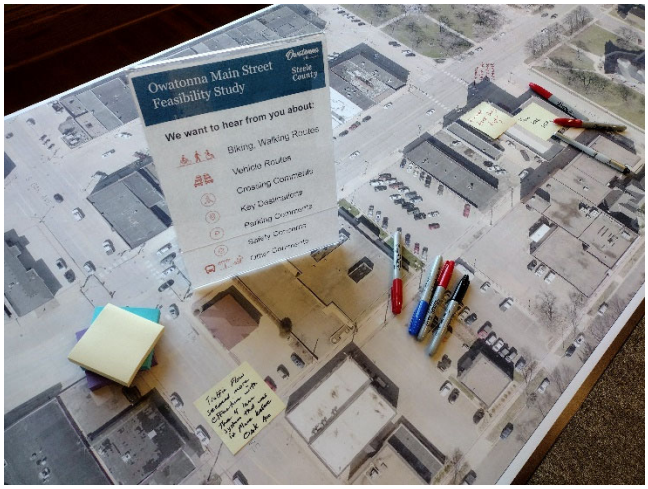
A second open house is planned for August when officials will present alternatives.

**Owatonna Main Street Project**

- Project involves E. Main Street from Oak to Chambers Avenue
- Feasibility Study soliciting comments from public
- Deadline: March 10
- Provide input at www.bit.ly/OwatonnaMainSt.

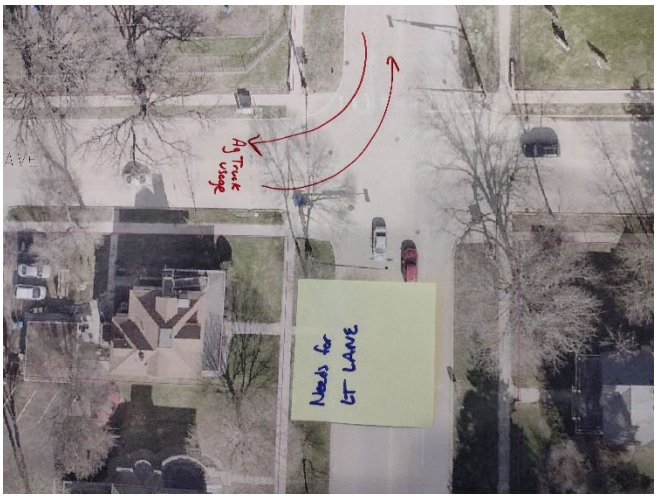
## Event Photos




Owatonna Main Street Feasibility Study
We want to hear from you about:
Biking, Walking Routes
Vehicle Routes
Crossing Comments
Key Destinations
Parking Comments
Safety Comments
Other Comments






AJ Truck
Needs for
LT LANE


Welcome!
Please Sign In
PUBLIC WORKS / UTILITIES

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# MEMORANDUM

TO: Kyle Skov (Owatonna), Andrew Sorenson (Owatonna), Greg Ilkka (Steele County), Paul Sponholz (Steele County)

FROM: Kristin Petersen (SEH), Chad Jorgenson (SEH)

RE: Summary of **Open House 2 – August 25, 2022**

This memo documents the details and comments received during the in-person open house for the **Steele County – CSAH 48 (Owatonna, MN - Main St) Public Open House #2** that took place on Thursday, August 25, 2022.

**Meeting Information**

- Audience: Adjacent property owners, commuters, and residents surrounding the project area
- Event Date: Thursday, August 25, 2022, 4:00 pm to 6:00 pm at the Steele County Community Center
- Format: In-person open house style meeting with staff available to discuss the project 1-on-1 with attendees. Presentation boards included background information, schedule, and project goals. A large plot of the preliminary design was displayed on a table.
- Comment cards were provided.

**Meeting Notifications**

- Postcard/flier invitations were mailed directly to properties surrounding the project area.
- Meeting information was posted on the County and City website
- Posted on Social Media and Chamber of Commerce
- Meeting announced in Owatonna People's Press on August 18, 2022:

  *Steele County and the City of Owatonna are holding a second open house meeting to gather public input on plan alternatives for a proposed project that will make improvements on Main Street from Oak Avenue to Chambers Avenue. Construction is currently scheduled within the next five years.*

  *The meeting date, time and location is: Thursday, Aug. 25, 4 – 6 p.m. at the Steele County Community Center 1380 S. Elm Avenue Owatonna, MN 55060*

  *For more information about the project, or if you are unable to make the open house, check out the following webpage: www.bit.ly/OwatonnaMainStreetStudy. Also available at that web page is an interactive map you may provide comments about the project.*

  *Steele County advises motorists to drive with caution and slow down through work zones for their safety and for the safety of the construction crews.*

  *For updates on this or other Steele County Highway construction projects or to sign up for project email updates, visit: co.steele.mn.us/highway/index.php*

**Attendance & Website Traffic**

- A total of 18 attendees signed in, and approximately 5 attendees did not sign in.
- The following staff members/elected officials were present to facilitate the event and address questions and comments:

1) Kyle Skov - Owatonna
2) Andrew Sorenson – Owatonna
3) Sean Murphy – Owatonna
4) Greg Ilkka - Steele County
5) Paul Sponholz - Steele County
6) Chad Jorgenson – SEH
7) Jenna Obernolte – SEH
8) Kristin Petersen – SEH
9) Connor Burke – SEH
10) Doug Voss – Councilmember

- The StoryMap online open house has had 336 views between April – September 2022.

**Comments**

The following (6) written comments were received during the open house:

Comment Cards

1. Myrtle Schrader (578 E. Main St for over 50 years)
   1st – Nothing needs to be done from Grove St to the east. No roundabout!
   2nd – We need parking in front of our houses
   3rd -We need traffic enforcement of this street
   4th – City is so far into debt, why do we have to do anything that isn't absolutely necessary. Taxes going sky high, inflation (gas-groceries). Somehow the money drain needs to stop!

2. Machelle Drivdahl (546 E. Main St.)
   The manhole is making my house shake because its raised and trucks go by and jar it w/ rear axel and house shakes 100 times a day 24/7.

3. Andi Arnold (914 Saint Andrews Place)
   I think the safety aspect is important and if we are improving the streets please take this as an opportunity to improve the beauty – more green space, native plants and gardens.

4. Ryan Stensvold (537 E Main)
   Not being able to park in front of my home will not help me with a single lane driveway. Also the roundabout proposed at Lincoln in a horrible idea for my family.

5. Paula Even Tranda (121 W Main St)
   Not a big fan of green space along Main – hard to keep alive w/ salt from snow removal. Not a fan of raised center islands. Need to address turning lane from Elm to Oak and looking to improve traffic. Concern over tax assessments raising my rent when sales are low due to current economy.

6. Jon Foley (914 St. Andrews Place)
   I would love to see much more GREEN SPACE – especially near the park. This would greatly enhance the space downtown.
   Nice design being proposed. This looks promising!

Mailed Comment (1)

I, resident of 530 East Main Street, have concerns of the new street project, projected to be conducted in the near future. My concerns are as follows: and would like action to be taken due to the influx cars, big semi's and other large vehicle's and speeding motorcycles and trucks revving engine at all times of the day and night it is very upsetting for this loud noise's happening all day can a camera speeding trailer be set up on East Main street between Lincoln and Grove street to help this major issue for the residents of this area of street, this has been a problem since I have live at this resident for over 20 years and with more influx of traffic too that this new project could cause drivers using our back alley as new traffic flow and speeding. Which could be very dangerous due to kids that play in this alley and a day-care that is located in this alley too. I have stop on occasions drivers speeding down this alley with no regards of these kids playing in this area something Needs to be done! it should be for resident only traffic not to all drivers and my fear that this new road project could cause more traffic flow in this alley. Could a sign be erected to state this for resident only? and could speed bumps be put in place to for any speeders in this alley too? I hope you actually read this and understand our point of view as if this was in your own home area. I do understand that improving road ways need to be done but please consider these facts that have been already occurring and that a solution be put in place for us residents that will have to endure this new road project and with the New High School to start soon it will cause more traffic and H/S Kids to speed to class which can be another issue too. I plead to whom this concerns, please have some road ethics in place so the residents can enjoy just to be able to sit outside our front porches and not see and hear the speeding traffic roaring past our homes and in the our back alley too PLEASE!!!!

Thank-you for your time

Resident on East Main Street

Staff Comments (1)

Paul Sponholz:  I spoke with Candace Smith at 554 Main St regarding her business Critter Comforts at 560 Main Street.  She confirmed what her neighbors were saying last night that she has lots of customers using the parking lane to drop off and pick up pets.  She was very concerned about losing parking.

Online Comments (3)

1) 8/26/2022

My name is Candace Smith 554 and 560 East Main Street. 507-451-7577: This is in response to the proposed changes of Main Street. I own a very busy business at 560 East Main that requires access daily to this property. Eliminating parking will eliminate access to my approximately 60 to 70 weekly customers which will effectively put me out of business. A business I have spent building for nearly 30 years. These changes will also decrease the value of my homes. Therefore, I will need to change the trajectory of my life and make some unexpected major life changes. The original proposal was to begin work next summer. At that time it appeared to me that the project was to re- do the existing road and curbs and that project would go May to October of 2023. I could work with that. My customers were willing to park at Jaycee Park and walk their dogs to the business. But this proposal does not allow me any alternatives. If construction is to begin next May I need to inform my customers of my immediate closing so they can make other arrangements for their dogs. I also need to put my properties on the market before construction begins. Is it the intention of the City of Owatonna to begin construction on the same timeline as earlier proposed? I would greatly appreciate a quick response by either email at crittercomforts@charter.net or by phone at 507-451-7577.  In closing I would have very much enjoyed being at both meetings, however, both were held on a weekday during business hours which prevented my attendance. Thank you, Candace L. smith

2) 8/28/2022

Feedback for Study  A 6th goal should have been considered in this feasibility study:  Whatever work considered for  East Main Street in the residential areas from Elm to Chambers Avenues should not have a significant negative impact to the taxpayers/property owners, which would include restrictions of  property access, safety of

property owners and decreased property market valuation. We concur with repairing cracked, broken and buckled concrete on the sidewalks and pavement on East Main Street. We concur with the addition of updates to make the sidewalks accessible to those requiring mobility aids. We also concur that there is a need to update the utilities that run underground in the downtown area from Oak to Elm Avenues (because we understand that these have not been touched for over a century). We have concerns about the bump-outs that are being considered from Oak to Elm Avenues (the downtown area) as we have already seen that the snow plows cannot fully clean a bump-out area which causes a problem with vehicles and pedestrians crossing these areas. Additionally, bump-outs are causing near misses as larger vehicles try to navigate the Cedar corridor as we have personally witnessed. However, the most concerning is the consideration of constructing any roundabout on Main Street (in this 2nd session we understand a roundabout at Main Street and Grove Avenue is being presented to proceed and the roundabout potential on Main and Lincoln has been tabled for future consideration). Our country is currently facing the largest inflation rate that has been seen in over 40 years. Prices are skyrocketing, taxes increasing and wages not keeping up with the either. Owatonna has a huge debt load that is increasing significantly, especially increasing with the addition of a new high school. There are many areas in Owatonna that have extremely poor pavement conditions, huge potholes, and crumbling sidewalks that need to be repaired. This is not the time to spend money on construction like roundabouts, which are unnecessary expenses and will destroy the East Main Street neighborhoods. "Streetscaping" is an expense that the city and county should postpone and use taxpayer dollars on critical needs of the city (street/sidewalk maintenance and repair). Main and Grove Original point for study (#5): We will review pedestrian crossings of side streets for improvement opportunitites. How did this feasibility directive go from "pedestrian crossings" to removing the traffic signals and replacing with a roundabout? In the first 8 months of the Rose Street and Grove Avenue roundabout there 13 vehicle crashes and the source of many traffic stops by officers. There is more traffic on Main Street and the number of crashes and traffic stops at this location will be far larger. As much as we like to think we are Owatonna or Minnesota "nice", the majority of vehicles do not slow or stop to allow vehicles onto the street and a roundabout will intensify that problem. There are a few who do not know the mechanics of driving roundabouts. However, most drivers know the rules of driving roundabouts, which results in drivers speeding up to be first into the roundabout and beat others coming into the intersection. Even though pedestrians have the right of way, drivers get focused on getting through the roundabout first and fast, putting pedestrians and bikers at dangerous risk. The paraphernalia required for the roundabout (speed signs, direction signs, pedestrian crossing signs, stakes/markers to keep vehicles in the correct lane, stakes/markers to keep vehicles from driving over the top of the roundabout) are all ugly. Signs and stakes are knocked over and not fixed/replaced which impacts safety. But overall a roundabout will take this pretty and safe area of Main Street and make it ugly and dangerous. Main and Lincoln Original point of study (#6): The study will look at street alignments and may suggest ways to make intersections more easy to navigate. Original point of study (#7): Safety and access are primary concerns. We want to make Main Street accessible to all users including people who require mobility aids such as walkers, canes, and wheelchairs. We are very happy that the original prospect of a roundabout at Main and Lincoln has been moved to future consideration and will not happen at this time. And that the four-way stop remains. We still are unsure of the reasons why changes are needed between from Lincoln Avenue to Chambers Avenue (repainting the street to include a center turn lane). An explanation was that the center lane is to protect homeowners making left hand turn into their driveway, so their vehicles won't be rear-ended. In the more than 50 years that my family has lived on Main Street, none of my family or neighbors have had a vehicle rear-ended getting into or out of the driveway. This is a residential section and a center lane for left turns is unnecessary and solves no existing traffic problem. Additionally, with the center line street parking will be completely prohibited in this area between Lincoln and Chambers. We have need of street parking. There are delivery trucks of all kinds stopping along Main Street (with the pandemic we have seen many more deliveries in the neighborhood with all of the online ordering). The US Postal truck stops on Main Street to bring mail to this area. SMART buses pick up passengers in front of their homes (they are not allowed to pick up or drop off in alleys). Family and visitors park in the street, especially visiting those homeowners who do not have driveways onto Main Street. And those who have driveways on Main Street typically do not have alley parking for visitors. Because of fencing or houses in their backyards, they have no access from the back to get to their home. There are also school buses that let the kids off on Main Street. People pull over to park when their cars are in distress or they need to check directions. We and our neighbors hold rummage sales, those who stop in park in the street. There are many reasons that we have cars that park on Main. With this center turn lane, the two main traffic lanes (the through lanes) will be on the outside (closer to the curbs) of Main and will be an issue for bikers who use the street. There are also many small vehicles (not sure if they are street legal, but they frequently travel on Main) including 4-wheelers, riding

lawnmowers, golf carts, electric scooters, mini motor bikes, etc which usually travel on the far outside edges of the street which will no longer be available to them and put them directly in the main traffic lanes. This area does not have a traffic flow problem. There is a small window of time in the morning and afternoon when there are backups, but this is not a traffic flow problem. Those of us who live on Main Street are proud of how beautiful Main Street looks and is a reflection of who we are as people drive into Owatonna. We see many pedestrians including families walking together, baby carriages, children on trikes and bikes (not large enough to be safe in the street they pedal on the sidewalk), families walking their dogs. The four-way stop is critical for these pedestrians in crossing Main and Lincoln. There is no need to repaint this street into 3 lanes from the current 2 lanes. Main and Chambers Original point of study (#8): There are several corridor amenities that generate pedestrian and bicycle activity along Main Street, such as Jaycee Park. We are unsure of how point #8 of the study leads to the straightening out Chambers Avenue, especially concerning is taking land from Jaycee park. It would be interesting to know how many vehicle crashes have been caused in the last 10 years because this road is not considered "straight). Conclusion Our conclusion is that we ask Steele County and the City of Owatonna to be more judicious in the spending of taxpayers' dollars on street construction. Only those projects critical in nature such as repairing century old utilities in the downtown area (which requires street construction to access) or the maintenance/repair of cracked, broken and buckled concrete on the sidewalks and street pavement (which is dangerous to pedestrians and bikers or destructive to vehicles). Thank you.

3) 8/28/2022

We attended both open houses. Can you please document on this website what the next steps are? Thank you!

Email Sign Ups (Open House 1, 2, and online combined)

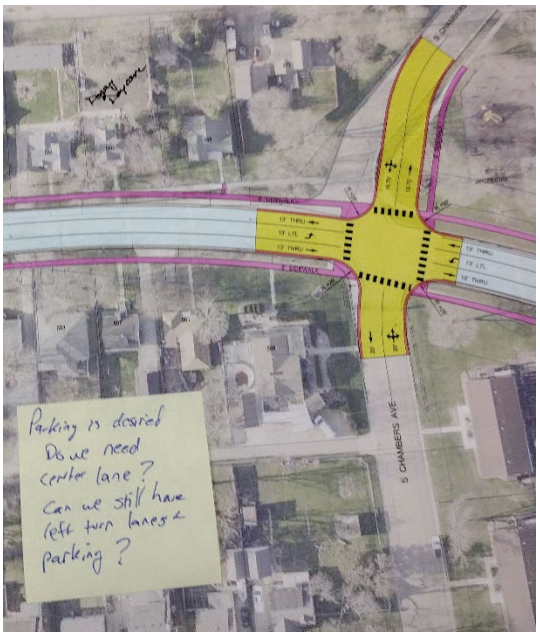
1. kastenzel@fedins.com
2. bprick@frontier.com
3. Tmcmanimon72@gmail.com
4. Gary.deb.moore@gmail.com
5. Joshua.prokopec@owatonnautilities.com
6. carver@owatonnaleouyers.com
7. Kory.koziolek@owatonnautilities.com
8. Kyle.skov@ci.owatonna.mn.us
9. Dsch255@aol.com
10. 19ed@live.com
11. deorcomactuary@gmail.com
12. Jvogt830@gmail.com
13. Drivdahlm@hotmail.com
14. Jfoley68@yahoo.com
15. Alynnarnold83@gmail.com
16. RyanStensvold@gmail.com
17. paula@curlygirlycandy.com
18. crittercomforts@charter.net
19. jjbikervet@hotmail.com
20. larry.brinkman@gmail.com
21. mulitia49@hotmail.com
22. tylerscochran@gmail.com
23. barry.cattadoris@gmail.com
24. kmmkrm@msn.com
25. sescamilla2010@gmail.com
26. tmgrems@yahoo.com
27. robinroseland@yahoo.com
28. sueb0306@gmail.com
29. Mrsarnesen@gmail.com
30. jmdixonp@charter.net
31. jwvogt@fedins.com
32. jenna0723@gmail.com
33. djmadden@fedins.com
34. drivdahlm@hotmail.com
35. tsblaze@q.com
36. mijomill@gmail.com
37. drmeganrogers@gmail.com
38. nednimble@gmail.com
39. jjbikervet@hotmail.com
40. lcochran@owatonna.org

Photos of Event





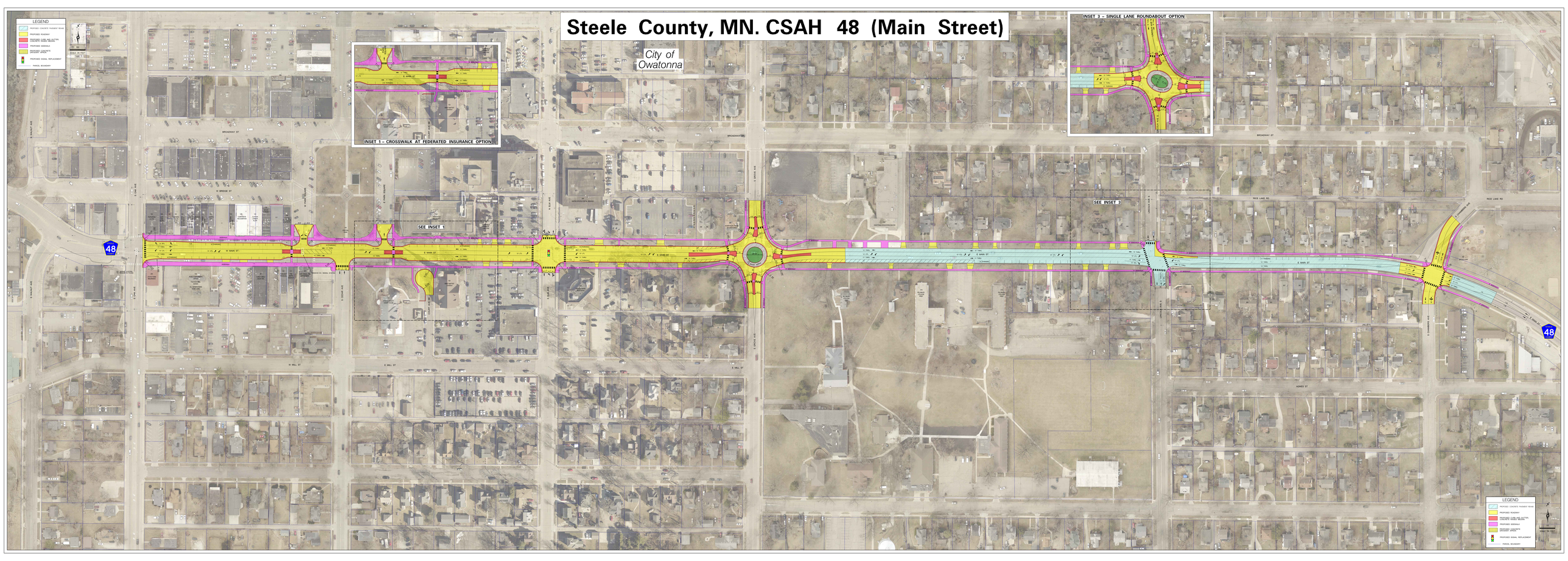



Parking is desired
Do we need
center lane?
Can we still have
left turn lanes +
parking?
S CHAMBERS AVE



# Appendix D

Proposed Corridor Layout


Steele County, MN. CSAH 48 (Main Street)
City of Owatonna
INSET 1 – CROSSWALK AT FEDERATED INSURANCE OPTION
INSET 3 – SINGLE LANE ROUNDABOUT OPTION
SEE INSET 3
SEE INSET 3
LEGEND
PROPOSED CONCRETE PAVEMENT REHAB
PROPOSED ROADWAY
PROPOSED CURB AND GUTTER, CONCRETE MEDIAN
PROPOSED SIDEWALK
PROPOSED CONCRETE DRIVEWAY
PROPOSED SIGNAL REPLACEMENT
PARCEL BOUNDARY
SCALE IN FEET
48
48

# Appendix E

Assessment Role

| PIN | PARCEL ADDRESS | OWNER NAME | OWNER ADDRESS LINE 1 | OWNER ADDRESS LINE 2 | OWNER ADDRESS CITY, STATE, ZIP | ASSESSABLE FOOTAGE | ASSESSABLE NOTES | ESTIMATED ASSESSMENT | Footage 1 | Footage 2 | Footage 3 | LGLDESC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 171000118 | 151 BRIDGE ST W 55060 | REDLINE DEVELOPMENT GROUP LLC | 11401 SW 72ND AVE | | ELLENDALE MN 56026 | 44 | 2.F | $ 2,270 | 43.66 | | | BLK 1 W10 1/2' OF L13 & LOT 14 ORIG TN |
| 171000117 | 149 BRIDGE ST W 55060 | SPIN-TIN, INC | 2523 COUNTY ROAD 45 SOUTH | | OWATONNA MN 55060 | 0 | 2.E | $ - | 22.31 | | | BLK 1 LOT 13 EX W 10 1/2' ORIG TN |
| 171000116 | 148 MAIN ST W 55060 | CITY OF OWATONNA | 540 WEST HILLS CIRCLE | | OWATONNA MN 55060 | 22 | 2.E | $ 1,164 | 22.38 | | | SOUTH 53.59' OF WEST 22' OF LOT 12 BLK 1 ORIGINAL |
| 171000114 | 145 BRIDGE ST W 55060 | TBB INVESTMENTS LLC | 1626 WEDGEWOOD DR NE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 22.06 | | | BLK.1 W 1/3 OF L.11 & E 1/3 OF 12 ORIGINAL TOWN |
| 171000113 | 143 BRIDGE ST W 55060 | HAVELKA ENTERPRISE LLC | 143 BRIDGE STREET W | | OWATONNA MN 55060 | 0 | 2.E | $ - | 21.56 | | | BLK 1 E2/3 OF LOT 11 ORIGINAL TOWN |
| 171000112 | 141 BRIDGE ST W 55060 | D S B M T, LLC | 141 WEST BRIDGE ST | | OWATONNA MN 55060 | 0 | 2.E | $ - | 22.63 | | | BLK 1 W2/3 OF LOT 10 ORIGINAL TOWN |
| 171000111 | 137 BRIDGE ST W 55060 | BURR'S PROPERTY MANAGEMENT LLC | 635 PAMELA PLACE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 43.38 | | | BLK 1 LOT 9 & E 1/3 OF LOT 10 ORIGINAL TOWN |
| 171000109 | 135 BRIDGE ST W 55060 | BURR'S PROPERTY MANAGEMENT LLC | 635 PAMELA PLACE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 22.88 | | | BLK.1 W 2/3 LOT 8 ORIGINAL TOWN |
| 171000108 | 131 BRIDGE ST W 55060 | BURR'S PROPERTY MANAGEMENT LLC | 635 PAMELA PLACE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 43.13 | | | BLK 1 LOT 7 & E1/3 OF 8 ORIG TN |
| 171000107 | 129 BRIDGE ST W 55060 | JOHNSON/BEN/& | MARK J SHERMAN | P O BOX 634 | OWATONNA MN 55060 | 0 | 2.E | $ - | 22.63 | | | BLK.1 SUB L.9 OF LOT 6 ORIGINAL TOWN |
| 171000106 | 125 BRIDGE ST W 55060 | GSO PROPERTIES LLC | 1835 CREEKSIDE DR NE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 44.97 | | | BLK.1 SUB L.8 OF 5 & 6 ORIGINAL TOWN |
| 171000105 | 123 BRIDGE ST W 55060 | DRAEGER/GREGG A & ANNE L | 600 OAKWOOD LANE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 18.28 | | | BLK.1 SUB. L.7 OF 4 & 5 ORIGINAL TOWN |
| 171000104 | 121 BRIDGE ST W 55060 | DRAEGER/GREGG A & ANNE L | 600 OAKWOOD LANE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 21.59 | | | SUB LOT 6 OF LOTS 3 & 4 BLOCK 1 ORIGINAL TOWN |
| 171000103 | 119 BRIDGE ST W 55060 | ONG/MINH H/& | LOAN N TRINH | 625 SOUTH STREET | OWATONNA MN 55060 | 0 | 2.E | $ - | 26.09 | | | BLK.1 SUB L.4 & 5 OF LOT 3 ORIGINAL TOWN |
| 171000102 | 117 BRIDGE ST W 55060 | CITY OF OWATONNA | 540 WEST HILLS CIRCLE | | OWATONNA MN 55060 | 0 | 2.E | $ - | 41.25 | | | BLK.1 LOT 2 & W. 8' OF LOT 1 ORIGINAL TOWN |
| 171000101 | 150 PARK SQUARE W 55060 | PARK SQUARE PROPERTIES, LLC | PO BOX 249 | | WASECA MN 56093 | 25 | 2.F | $ 1,300 | 25.00 | 98.52 | | BLK 1 E25' OF LOT 1 ORIGINAL TOWN |
| 171000001 | 100 MAIN ST E 55060 | CITY OF OWATONNA | 540 WEST HILLS CIRCLE | | OWATONNA MN 55060 | 199 | 2.D | $ 10,330 | 198.66 | 334.51 | 334.50 | BLK 1 CENTRAL PARK ORIGINAL TOWN |
| 171000512 | 121 PARK SQUARE E 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | P O BOX 328 | OWATONNA MN 55060 | 125 | 2.B | $ 6,476 | 264.54 | 76.34 | | BLK 5 LOTS 11, 12, 13 & 14 ORIGINAL TOWN |
| 171000509 | 140 MAIN ST E 55060 | WALBRAN/MARK MOONAN | PO BOX 273 | | OWATONNA MN 55060 | 66 | 2.A | $ 3,439 | 66.13 | | | BLK 5 LOT 10 EX N23' ORIGINAL TOWN |
| 171000506 | MAIN ST E 55060 | FEDERATED MUT IMP | & HDWE INS CO | PO BOX 328 | OWATONNA MN 55060 | 66 | 2.A | $ 3,439 | 66.13 | | | BLK.5 S1/2 OF LOT 9 ORIGINAL TOWN |
| 171000505 | 152 MAIN ST E 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | P O BOX 328 | OWATONNA MN 55060 | 66 | 2.F | $ 3,448 | 66.31 | 66.20 | | BLK.5 S1/2 OF LOT 8 ORIGINAL TOWN |
| 171001301 | 209 BROADWAY E 55060 | MINNESOTA JLS EQUITTIES LLC | C/O NPM | 75 COLUMBIA AVE | CEDARHURST NY 11516 | 0 | 2.E | $ - | 164.88 | 281.24 | | BLK 13 LOTS 1,2,&3 EXCEPT E20' OF LOT 3 AND LOTS |
| 171001315 | 216 MAIN ST E 55060 | PIRKL/KAREN A | 216 E MAIN ST | | OWATONNA MN 55060 | 40 | 2.A | $ 2,080 | 40.00 | | | BLK 13 W 7' OF LOT 15 & E1/2 OF LOT 16 ORIG TWN |
| 171001314 | MAIN ST E 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | | OWATONNA MN 55060 | 59 | 2.A | $ 3,070 | 59.03 | | | BLK 13 E59' OF LOT 15 ORIGINAL TOWN |
| 171001313 | MAIN ST E 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | | OWATONNA MN 55060 | 66 | 2.A | $ 3,432 | 66.00 | | | BLK 13 LOT 14 ORIG TOWN |
| 171001312 | MAIN ST E 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | | OWATONNA MN 55060 | 66 | 2.A | $ 3,434 | 66.03 | | | BLK 13 LOT 13 ORIG TOWN |
| 171001311 | MAIN ST E 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | | OWATONNA MN 55060 | 43 | 2.A | $ 2,236 | 43.00 | | | BLK 13 W43' OF LOT 12 ORIG TOWN |
| 171001310 | 246 MAIN ST E 55060 | PROHASKI/CHRISTOPHER J | & ABRAMS, JAMES A | 430 SOUTH CEDAR | OWATONNA MN 55060 | 89 | 2.A | $ 4,630 | 89.03 | | | BLK 13 LOTS 11 & 12 EX W43' OF LOT 12 ORIGINAL TOWN |
| 171001309 | 250 MAIN ST E 55060 | HOSPITALITY HOUSE | OF OWATONNA INC | 250 MAIN STREET E | OWATONNA MN 55060 | 66 | 2.B | $ 3,434 | 66.03 | 132.36 | | BLK 13 LOT 10 ORIGINAL TOWN |
| 171001407 | 249 MAIN ST E 55060 | JORGENSEN/GALE | 249 E MAIN ST | | OWATONNA MN 55060 | 58 | 2.B | $ 3,013 | 197.94 | 132.49 | | BLK 14 LOTS 7,8&9 ORIG TOWN |
| 171001406 | 233 MAIN ST E 55060 | HINNENKAMP/GEORGE & MELISSA | 233 E MAIN ST | | OWATONNA MN 55060 | 66 | 2.A | $ 3,430 | 65.97 | | | BLK 14 LOT 6 ORIG TOWN |
| 171001405 | 227 MAIN ST E 55060 | KENITA ENTERPRISES, LLC | 3375 E 151ST ST | | FARIBAULT MN 55021 | 66 | 2.A | $ 3,430 | 65.97 | | | BLK 14 LOT 5 ORIG TOWN |
| 171001404 | 221 MAIN ST E 55060 | SMITH VENTURES LLC | 23770 NATCHEZ AVENUE | | LAKEVILLE MN 55044 | 66 | 2.A | $ 3,430 | 65.97 | | | BLK 14 LOT 4 ORIG TOWN |
| 171001403 | 215 MAIN ST E 55060 | PREMIER BANK METRO SOUTH | ATTN CHARLENE NUN | 2866 WHITEBEAR AVE | MAPLEWOOD MN 55109 | 66 | 2.A | $ 3,432 | 66.00 | | | BLK 14 LOT 3 ORIG TWN |
| 171001401 | 209 MAIN ST E 55060 | PREMIER BANK METRO SOUTH | ATTN CHARLENE NUN | 2866 WHITEBEAR AVE | MAPLEWOOD MN 55109 | 132 | 2.B | $ 6,861 | 131.94 | 132.50 | | BLK 14 LOTS 1 & 2 ORIG TOWN |
| 171000608 | 212 ELM AVE S 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | P O BOX 328 | OWATONNA MN 55060 | 132 | 2.B | $ 6,880 | 132.32 | 215.67 | | BLK.6 LOTS 8 & 9 & N1/2 OF LOTS 10 & 11 EX. CITY OF |
| 171000612 | 140 MILL ST E 55060 | FEDERATED MUTUAL INS CO | 121 EAST PARK SQUARE | P O BOX 328 | OWATONNA MN 55060 | 99 | 2.G | $ 5,161 | 99.25 | | | ALL OF L 7 & 12, AND E 2 RDS OF L 6, AND LOTS 13 & 14 EX |
| 171000605 | 123 MAIN ST E 55060 | REDEMPTION CHURCH | 123 E MAIN ST | | OWATONNA MN 55060 | 99 | 2.B | $ 5,160 | 99.22 | 169.35 | | BLK 6 LOT 5 & W33' OF LOT 6 & N20' OF LOT 14 & N20' OF |
| 171000601 | 111 MAIN ST E 55060 | STEELE COUNTY | 630 FLORENCE AVE | PO BOX 890 | OWATONNA MN 55060 | 232 | 2.F | $ 12,042 | 231.57 | 281.64 | 281.94 | BLK 6 LOTS 1,2,3,4,15,16,17,18, & VACATED ALLEY ORIGINAL |
| 171000701 | 107 MAIN ST W 55060 | CITY OF OWATONNA | 540 WEST HILLS CIRCLE | | OWATONNA MN 55060 | 122 | 2.B | $ 6,365 | 122.41 | 133.63 | | BLK 7 LOT 1 & E 55' OF LOT 2 ORIG TOWN |
| 171000702 | 111 MAIN ST W 55060 | ZAPPA/STEVEN M | 111 W MAIN ST | | OWATONNA MN 55060 | 22 | 2.A | $ 1,144 | 22.00 | | | BLK.7 W.11' OF L.2 & E. 11' OF LOT 3 TORRENS PROPERTY |
| 171000703 | 113 MAIN ST W 55060 | NATRLL LLC | 113 W MAIN STREET | | OWATONNA MN 55060 | 22 | 2.A | $ 1,144 | 22.00 | | | BLK 7 W22' LOT 3 AND E2.25' LOT 4 ORIGINAL TOWN |
| 171000704 | MAIN ST W 55060 | T & J EVANS PROPERTIES LLC | 2325 HADDONSTONE LN NE | | OWATONNA MN 55060 | 45 | 2.A | $ 2,330 | 44.81 | | | BLK 7 LOT 4 EXCEPT E2.25' AND E11' LOT 5 ORIGINAL |
| 171000705 | 121 MAIN ST W 55060 | T & J EVANS PROPERTIES LLC | 2325 HADDONSTONE LN NE | | OWATONNA MN 55060 | 44 | 2.A | $ 2,288 | 44.00 | | | BLK.7 E 2/3 OF L.6 & W.2/3 OF LOT 5 ORIGINAL TOWN |
| 171000707 | 135 MAIN ST W 55060 | STENDEL/BRIAN K & SUSAN L | 27568 160TH STREET | | NEW RICHLAND MN 56072 | 286 | 2.A | $ 14,872 | 286.01 | | | BLK 7 W1/3 OF LOT 6 & ALL OF LOTS 7,8,9,10,11 12,13,14, & |
| 171000716 | 203 OAK AVE S 55060 | REGAN,/WILLIAM E/LLC | 1138 IRONWOOD | | OWATONNA MN 55060 | 55 | 2.B | $ 2,860 | 55.00 | | | BLK.7 W. 2/3 OF L.15 & LOT 16 ORIGINAL TOWN |
| | | | | | | **2654** | | **$ 138,025** | **3472.0** | | | |
| | | | | | | | | | | | | |
| | | | | | | **MAX ASSESSMENT RATE** | **$ 52.00** | | | | | |

# Appendix F

Environmental Desktop Review

Building a Better World for All of Us®

June 22, 2022

RE: Environmental Desktop Review
CSAH 48 (Main Street) Feasibility Study
Owatonna, Minnesota
SEH No. STEEL 164362

Paul Sponholz, PE
Steele County Highway Department
PO Box 890
3000 Hoffman Drive Northwest
Owatonna, Minnesota 55060-0890

Dear Mr. Sponholz:

Short Elliott Hendrickson Inc. (SEH) was retained by the Steele County Highway Department complete a preliminary environmental desktop review for the CSAH 48 (Main Street) Feasibility Study project located in Owatonna, Minnesota.

## Project Overview and Scope

The proposed project consists of a rehabilitation of CSAH 48 (Main Street) from Oak Avenue to South Chambers Avenue (**Figure 1**). The project scope of work includes a possible full depth roadway reconstruction and utility improvements from Oak Avenue to Elm Avenue, and possible concrete pavement rehabilitation from Elm Avenue to South Chambers Avenue. This report summarizes the environmental desktop review findings for the CSAH 48 (Main Street) Feasibility Study project.

The purpose of this desktop review was to identify potential soil, groundwater, and soil vapor contaminated sites that pose an environmental risk to the project. The area of interest will herein be referred to as “project corridor” and includes the proposed construction area and adjacent parcels. It was not within the scope of this desktop review to evaluate the level, extent, or confirm contamination. Summary information and conclusions from this report may be used to develop contingency planning for environmental issues associated with proposed construction within the project corridor.

This desktop review was limited to the following research tasks listed below.

- Environmental Database Review of Minnesota Pollution Control Agency (MPCA) What’s in my Neighborhood (WIMN) listings,
- Minnesota Department of Agriculture (MDA) WIMN listings,
- MPCA Spill listings,
- Review of located wells available on the Minnesota Department of Health (MDH) Minnesota Well Index (MWI) website.

A table for each database is included below. Listings were not reviewed to verify correct location data. Additionally, unlocated listings were not included in the following tables.

**MPCA WIMN**

| Site Name | Location | Listing Type | Listing ID |
|---|---|---|---|
| Cashman Fertilizer Plant | Adjacent to the north of 208 Walnut Avenue South | Closed Leak. | LS0009835 |
| Bridge Street Bridge | Intersection of Bridge Street and Main Street | Closed Leak. | LS0004012 |
| Owatonna Public Utilities - Power Plant | 208 Walnut Avenue South | Closed Leaks, active ASTs/USTs/RCRA Generator. | LS0004156<br>LS0008051<br>LS0019210<br>TS0009420<br>TS0051421<br>TS0009420<br>TS0051421<br>MNS000144063 |
| Parts Dept Of Owatonna Inc | 218 West Bridge Street | Inactive RCRA Generator. | MND022984751 |
| Lyles Repair | Adjacent to the south of 218 West Bridge Street | Inactive RCRA Generator. | MND982212474 |
| Printing House Inc | Adjacent to the north of 120 Oak Avenue South | Inactive RCRA Generator. | MND122707367 |
| Rietz Property | 120 Oak Avenue South | Close Leaks/USTs. | LS0013386<br>LS0014232<br>TS0017452 |
| Firestone Complete Auto Care #655392 | Adjacent to the east of 202 West Bridge Street | Active RCRA Generator. | MNS000101899 |
| Central Communications | Adjacent to the east of 120 Oak Avenue North | Inactive RCRA Generator. | 147363832 |
| Benjamin Roger MD | Adjacent to the east of 120 Oak Avenue North | Inactive RCRA Generator. | 147362537 |
| Gilthvedt Eye Care Clinic Inc | Adjacent to the east of 120 Oak Avenue North | Inactive RCRA Generator. | MNS000216697 |
| Harland Tire & Auto | Adjacent to the east of 202 Oak Avenue North | Closed Leak, active RCRA Generator. | LS0000369<br>MND052750411 |
| Motor Supply Co | Adjacent to the West of 151 West Bridge Street | Inactive RCRA Generator. | 147366991 |
| Wayne Mfg Co | Intersection of West Bridge Street and South Oak Avenue | Inactive RCRA Generator. | MNNONGEN91 |
| Andys Conoco Station | 105 Oak Avenue South | Closed USTs | TS0009399 |
| Owatonna Amoco | 203 Oak Avenue South | Inactive RCRA Generator. | MND134128727 |
| Photos Plus | 105 Oak Avenue South | Inactive RCRA Generator. | 713267383 |
| Amoco Service Station #5061 | 135 West Main Street | Closed Leak/USTs. | LS0003845<br>TS0009452 |
| Sears Outlet / Former Sears Owatonna | 146 West Broadway Street | Closed Superfund/CERCLIS/VIC /Leak. | SR0001503<br>MN0001118934<br>VP3620 |

| Site Name | Location | Listing Type | Listing ID |
|---|---|---|---|
| | | | LS0004431 |
| Steele County Jail | 135 West Main Street | Closed Leak/USTs. | LS0012099<br>TS0012769 |
| P & H Auto Service | Adjacent to the north of 135 West Main Street | Inactive RCRA Generator. | 147368104 |
| CenturyLink - Owatonna CO | Adjacent to the south of 220 Cedar Avenue South | Active ASTs/USTs, inactive RCRA Generator. | TS0009455<br>MNS000322264 |
| Nelson Mark DDS | Adjacent to the west of 100 East Main Street | Inactive RCRA Generator. | 147362743 |
| Styles By Sara | Adjacent to the west of 100 East Main Street | Inactive RCRA Generator. | 147369276 |
| REMAX Venture | Adjacent to the east of 104 West Broadway Street | Active RCRA Generator. | MNS000319536 |
| Malm Jewelers Inc | 100 East Main Street | Inactive RCRA Generator. | 147366561 |
| Elwood Star Cleaners | Intersection of North Cedar Street and West Broadway Avenue | Active RCRA Generator. | MND039800388 |
| Norwest Bank Owatonna Na | 100 East Main Street | Inactive RCRA Generator. | MN0000230277 |
| William Kottke | Adjacent to the northeast of 100 East Main Street | Inactive RCRA Generator. | 3334034 |
| Federated Insurance | Adjacent to the east of 100 East Main Street | Inactive RCRA Generator. | MND071341283 |
| Federated Mutual Insurance Co | Adjacent to the east of 100 East Main Street | Closed USTs. | TS0009378 |
| Owatonna National Guard Armory | Adjacent to the north of 101 East Broadway Street | Inactive RCRA Generator. | MND980682462 |
| Jostens Inc - Office Bldg | Adjacent to the north of 129 East Broadway Street | Inactive RCRA Generator. | MND006147136 |
| Stahel Arnold | 209 East Main Street | Inactive RCRA Generator. | 713095610 |
| Smith Dental Care PA | 209 East Main Street | Active RCRA Generator. | MNS000216465 |
| Baker Ronald L Dds | Adjacent to the west of 338 East Main Street | Inactive RCRA Generator. | MND985741230 |
| Pillsbury College Prep & Camp/Pillsbury Baptist Bible College | 315 South Grove Avenue | Closed Leaks/USTs. | LS0011435<br>TS0013533<br>TS0013534<br>TS0013535<br>MND985684711 |
| ISD 761 Owatonna Education Center | 338 East Main Street | Closed Leaks/USTs, active RCRA Generator. | LS0001691<br>TS0009428<br>MNS000125930 |
| TRI-M Graphics | 219 South Chambers Avenue | Active RCRA Generator. | MN0000876854 |
| Flom Plumbing & Heating Inc | 631 Rice Lake Road | Inactive RCRA Generator. | 147364822 |

- A closed or inactive status indicates the MPCA has adequality assessed the extent of a release and does not indicate that remedial activities have occurred. Contamination is often present on sites that received regulatory closure.

## Wells

| Location | Well ID | Well Type | Well Name |
|---|---|---|---|
| Adjacent to the west of 211 West Main Street | 00446086<br>00446087 | 135 West Main Street | MW-2<br>MW-3 |
| 211 West Bridge Street | 00658935 | Monitoring Well | AMW-8 |
| Adjacent to the North of 211 West Bridge Street | 00658901 | 135 West Main Street | AMW-3 |
| 211 West Main Street | 00446085 | 135 West Main Street | MW-1 |
| Adjacent to the North of 209 West Bridge Street | 00658902 | 135 West Main Street | AMW-4 |
| 209 West Bridge Street | 00658933<br>00658934 | 135 West Main Street | AMW-6<br>AMW-7 |
| 214 South Oak Avenue | 00495385 | 135 West Main Street | MW-7 |
| 120 South Oak Avenue | 00655998<br>00656000<br>00715877 | 135 West Main Street135 West Main Street | AMW-1<br>AMW-2<br>AMW-10 |
| 202 South Oak Avenue | 00495384 | 135 West Main Street | MW-6 |
| Adjacent to the south of 120 South Oak Avenue | 00655999 | 135 West Main Street | AMW-5 |
| Adjacent to the east of 202 South Oak Avenue | 00560527 | 135 West Main Street | MW-14 |
| Adjacent to the west of 203 South Oak Avenue | 00476821 | 135 West Main Street | MW-2 |
| Adjacent to the west of 151 West Bridge Street | 00658931 | 135 West Main Street | MW |
| 203 South Oak Avenue | 00544134<br>00476820<br>00476823<br>00476824<br>00544133 | Remediation Well<br>Monitoring Well | RW-1<br>MW-1<br>MW-4<br>MW-5<br>MW12 |
| 103 North Oak Avenue | 00497787<br>00497788<br>00497789 | 135 West Main Street | MW-1<br>MW-2<br>MW-3 |
| 215 South Oak Avenue | 00495383 | 135 West Main Street | MW-8 |
| 135 West Main Street | 00492792<br>00492793 | 135 West Main Street | MW-10<br>MW-11 |
| Adjacent to the north of 135 West Main Street | 00476822 | 135 West Main Street | MW-3 |

## Spills

| Location | Substance | Status | Incident ID |
|---|---|---|---|
| 208 South Walnut Ave MN | unknown units Petroleum Other | Closed or Completed | 88082 |

## MDA WIMN

| Location | Substance | Status | Listing ID |
|---|---|---|---|
| 280 West Bridge Street | - | Closed | FY79I056 |

## Findings and Opinions

Based on the findings of the desktop review, a majority of the listings identified exist within the western portion of the project corridor. These listings include closed Leaks, closed Tank Sites, active and inactive RCRA generators, and wells. A closed listing registered under the Superfund, Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), and Voluntary Investigation and Cleanup (VIC) programs was also identified in the western portion of the project corridor.

Additionally, an abandoned steam pipe was previously identified running along the project corridor and records of the pipe's location were lost in a flood. Municipal steam pipes were commonly insulated with an asbestos containing pipe wrap or the pipe itself is often transite (an asbestos containing material). If encountered during construction the pipe should be tested for asbestos and if it does contain asbestos, an asbestos abatement company will need to be contracted for proper handling/disposal.

SEH recommends at minimum that an Environmental Review be completed that includes Phase I Environmental Site Assessment (ESA) type research or a full Phase I ESA be completed for the project reconstruction corridor. This information would then be used as the basis in which to place Phase II ESA borings. Phase II ESA information would then be used to write special provisions for the project and assist with a cost estimate for properly dealing with contamination during construction.

Please feel free to contact me directly at 651.318.0354 or kaufdencamp@sehinc.com if you have any questions.

Sincerely,

Keri B. Aufdencamp

Keri Aufdencamp
Project Manager

Robert Hawkins

Robert Hawkins, GIT (MN)
Graduate Scientist

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## Attachments

Figure 1 – Project Features

## References

Minnesota Department of Agriculture (MDA), 2011, Steele *County Spill Report*

MDA, What's In My Neighborhood (WIMN) Interactive Map, https://app.gisdata.mn.gov/mda-agchem/

Minnesota Department of Health (MDH), Minnesota Well Index, https://mnwellindex.web.health.state.mn.us/

Minnesota Pollution Control Agency (MPCA) Groundwater Contamination Atlas Interactive Map, 2021, https://webapp.pca.state.mn.us/cleanup/search

MPCA WIMN Interactive Map, https://pca-gis02.pca.state.mn.us/wimn2/index.html

Glendale St
Riverside Ave
Pearl St
Vine St
Bridge St
Walnut Ave NW
W Main St
Oak Ave
Cedar Ave
S Cedar Ave
Elm Ave
Grove Ave
Lincoln Ave
School St
Mosher Ave
8
19
48
45
6

**Legend**

- Project Corridor Buffer
- Feasibility Study Limits
- MPCA WIMN Listing
- MPCA Spill
- MDA WIMN Listing
- MDH MWI Located Well

0 350 700 Feet

Path: X:\PT\S\STEEL\164362\23-env-sht-rpts\010-GIS\STEEL_164362.aprx


SEH

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Project: STEEL 164362
Print Date: 6/7/2022

User Name: rhawkins
Projection: NAD 1983 UTM Zone 15N
Source: ESRI, Steele County, SEH Digi

# *Project Features*

Environmental Desktop Review
CSAH 48 (Main Street) Feasibility Study
Owatonna, Minnesota

Figure 1


This map is neither a legally recorded map nor a survey map and is not intended to be used as one. This map is a compilation of records, information, and data gathered from various sources listed on this map and is to be used for reference purposes only. SEH does not warrant that the Geographic Information System (GIS) Data used to prepare this map are error free, and SEH does not represent that the GIS Data can be used for navigational, tracking, or any other purpose requiring exacting measurement of distance or direction or precision in the depiction of geographic features. The user of this map acknowledges that SEH shall not be liable for any damages which arise out of the user's access or use of data provided.

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