Grand Rapids Signal Optimization Project

FINAL REPORT | JUNE 28, 2019

Prepared for:

DEPARTMENT OF TRANSPORTATION

Prepared by:

ALLIANT

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Executive Summary

The Grand Rapids Traffic Signal Optimization Project, referred to in the following as Signal Optimization Project, includes the evaluation and optimization of 19 traffic signals located in Grand Rapids, Minnesota.

Project Objectives

The objectives of the Signal Optimization project are to review the existing conditions, optimize the signal system timing, and implement and fine-tune the new timing plans within the project. Specific goals of the project include:

1. Review and update the pedestrian and signal controller timing parameters to be in accordance with the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD).
2. Performing a comprehensive network analysis to determine the appropriate grouping of signal systems and determining cycle length ranges for peak and off-peak timing plans appropriate for the daily volume variations along the corridors.
3. Improve the overall intersection traffic signal efficiency by:
    - Improving traffic flow progression and reducing delays for the major vehicle movements.
    - Providing flexibility in the cross-street and left turn movement green times to account for demand variability and to minimize adverse impacts (reduce delay where possible).
4. Evaluate and determine flashing yellow arrow (FYA) operation by time of day.
4. Identify potential low cost operational and intersection safety improvements to address high crash type occurrences and to improve traffic flow along the corridor

Elements of Study

An evaluation of the existing conditions was completed. Key components of the existing conditions include collection of intersection and traffic volume characteristics, safety analysis, signal timing characteristics, development and calibration of the traffic model and collection/evaluation of current measures of effectiveness. The traffic signal optimization included developing timing plans consisting of new cycle lengths, intersection splits, and offsets for each of the signalized corridors and intersections.

The optimized coordinated signal timing plans were implemented by Alliant Engineering June 6-8, 2019. A benefit/cost analysis was also completed to evaluate the overall cost-effectiveness of the implemented signal timing plans.

The purpose of this document is to present the results of the Signal Optimization project, which will be discussed in the following sections:

- Introduction (Section 1.0)
- Existing Conditions (Section 2.0)
- Signal Timing Optimization (Section 3.0)

- Project Benefit Analysis (Section 4.0)
- Potential Improvement Measures (Section 5.0)

Project Benefit

A project benefit analysis was completed that determines how well the project goals are met by comparing key measures of effectiveness against the existing conditions.

Economics

A benefit/cost analysis was completed to establish the annual economic savings incurred as a result of the Signal Optimization project. Typical Measures of Effectiveness (MOEs) used in estimating the benefit of signal optimization projects include total intersection delay, vehicle stops, fuel consumption, and air quality emissions (CO, NOx, and VOC). Table ES-1 illustrates the overall daily and annual "before" and "after" network MOE comparison and percent improvement.

Table ES - 1. Measures of Effectiveness – Network Performance Comparison

	Aggregate Timing Plans	Value of Time Benefit ($) (Cross Street)	Value of Time Benefit ($) (Mainline)	Stops Reduction Benefit ($)	Fuel Reduction Benefit ($)	Emission Reduction Benefit ($)	Total Benefit ($)
Total Project Signals	AM PEAK (715-0830)	-$114,757	$208,788	$58,405	$30,308	$2,083	$184,828
	MID-DAY PEAK (1045-1400)	-$415,220	$755,395	$157,166	$103,568	$6,874	$607,783
	PM PEAK(1545-1745)	-$418,282	$553,034	$104,464	$53,689	$3,560	$296,465
	OFF PERIODS(Remaining Hours)	-$744,929	$964,693	$263,727	$117,076	$7,882	$608,449
	Total System	**-$1,693,188**	**$2,481,910**	**$583,763**	**$304,641**	**$20,399**	**$1,697,525**

Based on the study results, an annual benefit is estimated at approximately 1.7 million dollars, which includes an estimated annual savings of 110,400 gallons of gasoline, 37,200 hours of delay, and 12.3 million stopped vehicles.

The benefit/cost ratio is computed based on the comparison between the annual net benefit and the total project cost. As shown in Table ES-2, the Signal Optimization project resulted in a benefit/cost ratio of approximately **26:1** considering only one year of benefit.

Table ES - 2. Benefit-Cost Ratio

Segment	Number of Intersections	Cost ($)	Benefit ($)	Benefit-Cost Ratio
Total Project - 1 Year Benefit	19	$64,597	$1,697,525	**26**
Total Project - 3 Year Benefit	19	$93,097	$5,092,576	**55**

Project Conclusions

The implementation of new signal timing throughout the Grand Rapids signal network achieved the key project goals:

Goal 1: Perform network evaluation

- Optimized yellow, all red and pedestrian clearance intervals (YARP) were developed and implemented in accordance with the MnMUTCD and MnDOT District 1 standards.
- A comprehensive network signal optimization analysis was conducted, six groups were identified, and coordination plan/time of day plan strategies were implemented to best operate the overall system as a network.
- A range of off-peak period cycle lengths were identified to best fit with the corridor progression and daily traffic volume levels, while minimizing motorist delay.
- Coordination between groups was provided for under all common cycle length timing plans.

Goal 2: Improve intersection traffic signal efficiency.

- The overall network intersection delay, fuel consumed, and total stops were reduced by 8 percent, 5 percent, and 21 percent, respectively.
- Simulated travel times found that the AM peak, mid-day peak, and PM peak periods had reductions in travel time up to 13%. This is an average that reflects delay on all mainline approaches, it is expected that floating car travel time studies would find much greater travel time saving.

Goal 3: Determine FYA operation by time of day.

- The FYA operation was reviewed at three study intersections and a daily schedule for left turn operation was developed for three locations.
- The left turn operation was optimized to balance reduction in motorist delay, while maintaining a conservative approach to intersection safety.

Goal 4: Identify potential low-cost operation and safety improvement measures

- A schedule of intersection geometric, signing and lane configuration improvements has been developed (Section 5.0).
- A FYA retrofit assessment was completed to help prioritize potential future installations.

1.0 Introduction

The Grand Rapids Traffic Signal Optimization project includes the re-timing of traffic signals along Trunk Highway (TH) 169 and TH 2 in the City of Grand Rapids, Minnesota. The optimization includes 19 intersections, as illustrated in Figure 1.

- TH 169: Glenwood Drive to 29th Street S
- TH 2: 7th Avenue East to County State Highway (CSAH) 63
- TH 38 at 14th Street NW

1.1 Project Description and Considerations

TH 169 and TH 2 are major commercial corridors in Grand Rapids and provide regional connectivity to north central Minnesota. The corridor features an array of land uses, namely a combination of commercial, residential, and tourism/hospitality. Weekend traffic is largely dictated by shopping traffic and heavy recreational traffic patterns.

Three intersections utilize Flashing Yellow Arrow (FYA) indications, which require evaluation and assessment for appropriate operation by time of day. Signal cross-coordination for the downtown area along TH 169 and TH 2 should be considered.

The objectives of the Signal Optimization project are to review the existing conditions, optimize the signal system timing in accounting for key land use, infrastructure and operational considerations, and implement and fine-tune the new timing plans. Specific goals of the project include:

1. Review and update the pedestrian and signal controller timing parameters to be in accordance with the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD).
2. Performing a comprehensive network analysis to determine the appropriate grouping of signal systems and determining cycle length ranges for peak and off-peak timing plans appropriate for the daily volume variations along the corridors.
3. Improve the overall intersection traffic signal efficiency by:
    - Improving traffic flow progression and reducing delays for the major vehicle movements.
    - Providing flexibility in the cross-street and left turn movement green times to account for demand variability and to minimize adverse impacts (reduce delay where possible).
4. Evaluate and determine flashing yellow arrow (FYA) operation by time of day.
5. Identify potential low cost operational and intersection safety improvements to address high crash type occurrences and to improve traffic flow along the corridor.

1.2 Elements of Study and Purpose

An evaluation of the existing conditions was completed. Key components of the existing conditions include collection of intersection and traffic volume characteristics, safety analysis, signal timing characteristics, development and calibration of the traffic model and collection/evaluation of current measures of effectiveness. The traffic signal optimization included developing timing plans consisting of new cycle lengths, intersection splits, and offsets for each of the signalized corridors and intersections.

The optimized coordinated signal timing plans were implemented by Alliant Engineering June 6-8, 2019. A benefit/cost analysis was also completed to evaluate the overall cost-effectiveness of the implemented signal timing plans.

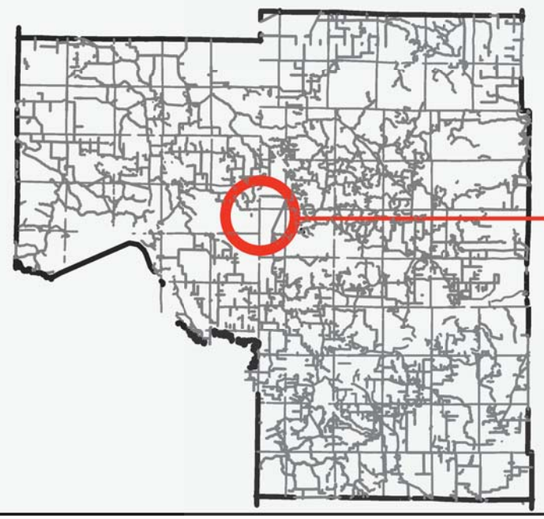
The purpose of this document is to present the results of the Signal Optimization project, which will be discussed in the following sections:

- Existing Conditions (Section 2.0)
- Signal Timing Optimization (Section 3.0)
- Project Benefit Analysis (Section 4.0)
- Potential Improvement Measures (Section 5.0)

PROJECT LOCATION:

COUNTY: ITASCA
CITY: GRAND RAPIDS

MINNESOTA DISTRICT 1 - ITASACA



PROJECT LOCATION

ITASCA 63 COUNTY

MINNESOTA 38

2

169

N Pokegama Ave

8th Ave E

NE 13th Ave

Glerwood Dr

801 NW 14th St
802 NW 3rd St
803
804
806
807
808
809
810
818 NW 2nd St
817
820
SE 1st St Co Highways
816 SW 4th St
815 SE 10th St
814 SE 13th St
813 SE 21st St
812 25th St
811 SE 29th St

Legend
Project Location

Grand Rapids Signal Optimization

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Figure 1 - Project Location Map

2.0 Existing Conditions

An evaluation of the existing conditions was completed. Key components of the existing conditions include collection of corridor intersection and traffic volume characteristics, signal timing characteristics, development and validation of the traffic model, and collection/evaluation of current measures of effectiveness.

2.1 Existing Roadway and Signal Timing Characteristics

The following sections document the key characteristics of the existing conditions.

2.1.1 Key Intersections

The Signal Optimization project included developing an existing condition traffic model for all intersections. Table 1 summarizes the signalized intersections and existing operation characteristics. Nine project intersections are interconnected and communicate to the master controller at the TH 169 and TH 2 West Junction. All intersections were setup in Aries Zone Monitoring traffic management software for use on the project.

2.1.2 Lane Geometries

Google Earth and field reviews of each of the intersections were conducted to establish lane geometry for each of the project intersections included in Table 1. MnDOT District 1 supplemented this data with layouts to confirm any geometric changes incurred from recent construction projects.

2.1.3 Signal Phasing and Signal Timing

Existing traffic signal timings for each intersection and Time-of-Day (TOD) plans were obtained from the Direct Connect System, or directly from MnDOT District 1. Key parameters include; minimum green times, clearance intervals, pedestrian intervals and coordination data (cycle length, offset, splits), detection settings, flashing yellow arrow (FYA) operation and TOD settings. Figure 2 summarizes the key intersection equipment, interconnect type, special operation, and FYA operation for all corridors. Figure 3 illustrates the existing timing plans and time of day schedule. The study network has one nine-intersection closed loop interconnected zone. Under the closed loop master-local zone configuration, signal coordination plan and inter-zone coordination can be limited (or more complicated) by the configuration of the interconnect cable and master controller communication.

Table 1. Intersection Summary and Operation Characteristics

Synchro Node	Intersection	FYA	Controller	Operation Notes
801	TH 2 at CSAH 63		ASC2	-Direct Connect -RR Preempt Logic
802	TH 2 at TH 38		ASC2	
803	TH 2 at 1st Avenue W		ASC2	
804	TH 2 at TH 169 W Junction		ASC2	-RR Preempt Logic -Fixed barrier for northbound lagging operation (alternate sequence prohibited)
806	TH 2 at 1st Avenue E		ASC2	
807	TH 2 at TH 169 E Junction		ASC2	
808	TH 169 at 8th Avenue E		ASC2	
809	TH 169 at 13th Avenue E		ASC2	Direct Connect
810	TH 169 at Glenwood Drive	Eastbound/Westbound (Mainline)	ASC 3	Direct Connect
811	TH 169 at 29th Street S		ASC2	Direct Connect
812	TH 169 at 25th Street S		ASC2	Direct Connect
813	TH 169 at 21st Street S		ASC2	-Direct Connect -RR Preempt Logic
814	TH 169 at 13th Street S		ASC2	Direct Connect
815	TH 169 at 10th Street N		ASC2	Direct Connect
816	TH 169 at 4th Street S	Northbound/Southbound (Mainline)	ASC 3	Direct Connect
817	TH 169 at 2nd Street N		ASC2	
818	TH 169 at 3rd Street N		ASC2	
819	TH 38 at 14th Street N	Northbound/Southbound (Mainline)	ASC3	Direct Connect
820	TH 2 at 7th Avenue E		ASC2	-RR Preempt Logic

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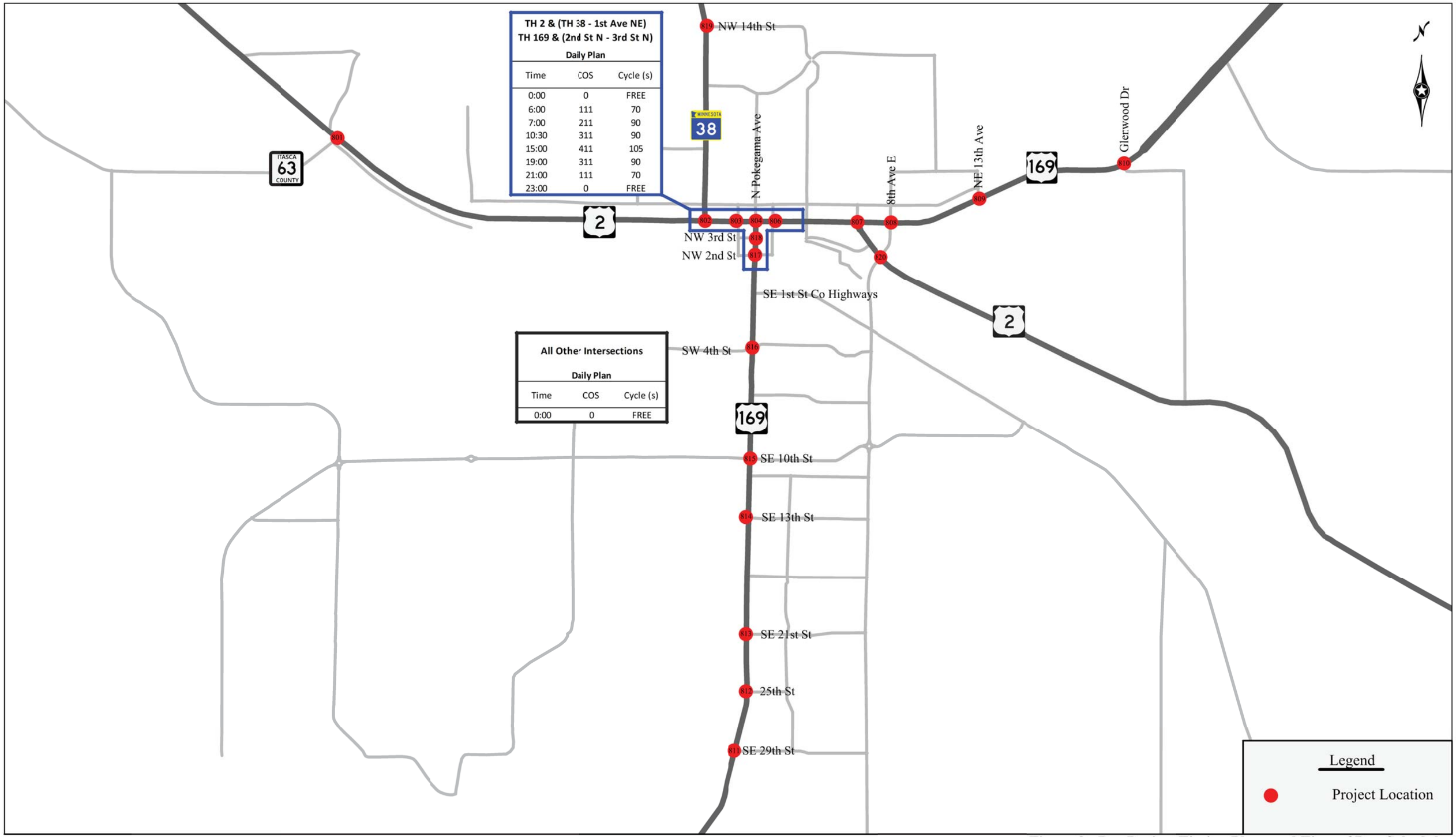
Figure 2 - Existing Signal System Characteristics



Grand Rapids Signal Optimization

Figure 3 - Pre-Project Timing Plans and Time of Day Schedules

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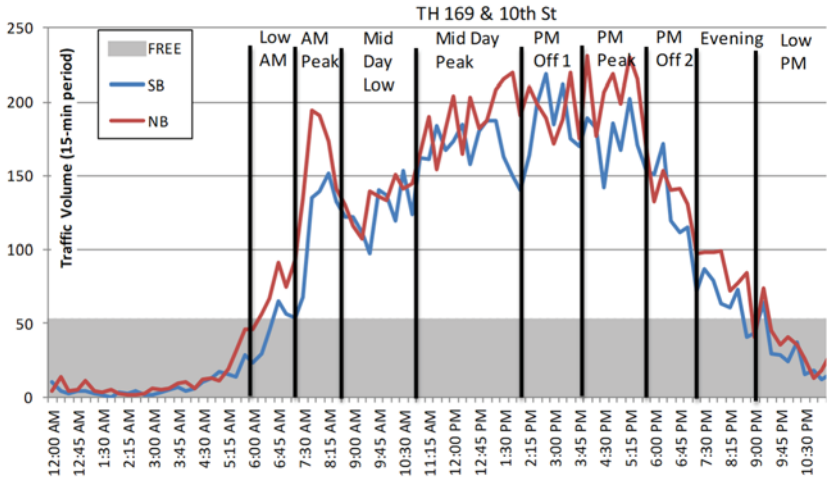
2.1.4 Traffic Volumes

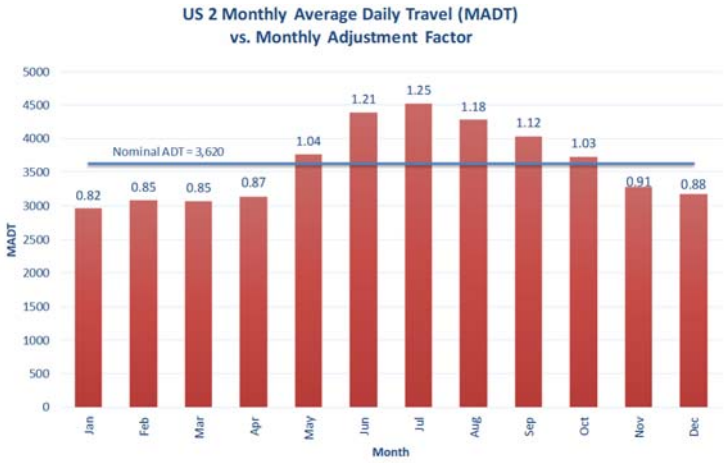
Turning movement volume counts were conducted at each of the 19 signals using data collected in January/February 2019. Turning movement counts were collected at every intersection from 6:00 AM to 9:30 AM, 10:30 AM to 1:30 PM, and 2:30 PM to 6:00 PM. In addition, 24-hour traffic counts were collected the intersections of TH 169 and TH 2 and TH 169 and 10th Street to determine average daily traffic levels and daily volume profiles to assist with TOD schedule development. Based on the daily volume characteristics, the turning movement counts were used to develop key volume level scenarios, as follows:

- Low AM
- AM peak
- AM off (post-peak)
- Mid-day low
- Mid-day peak (balanced peak)
- PM off-peak 1 (Pre-PM peak)
- PM peak
- PM off-peak 2 (Post-PM peak)
- Evening
- Low PM (overnight)



The peak hour was identified for each of the three peak time periods (AM, mid-day, and PM). The AM, mid-day, and PM peak hour traffic volumes used in the Synchro model were developed by multiplying the highest 15-minute interval within the respective intersections' peak hour for each movement by four. The turning movement volumes collected during the off-peak periods were used to estimate representative volume levels (i.e., using either the average or the maximum multiplied by four for the volume scenario case). The volume level scenarios are instrumental in determining the appropriate range in cycle lengths and number of timing plans needed throughout a typical weekday and weekend.

Due to expedited scheduling, data collection was collected in the winter off-season months. Understanding Grand Rapids is a heavy summer recreational traffic city, summer traffic volume levels were estimated. Alliant evaluated MnDOT ATR volume detector data during both the winter and summer months as shown to the right. The winter collected volume data was then factored to reach an estimated summer-oriented data set for analysis of the mid-day peak, PM off-peak 1, PM peak, and PM off-peak 2 periods.



2.1.5 Heavy Commercial Vehicle Percentage

Existing heavy commercial vehicle volumes were field collected at each intersection as part of the intersection turning movement counts. The heavy vehicles were classified as single-unit, those consisting of more than three axles, or being a truck and tractor trailer. The field collected data was utilized to estimate heavy vehicle percentages for the mainline and cross streets under each traffic volume scenario. Trucks represented about 5 percent of the total traffic volume. In addition, the commercial truck percentages are used to estimate the time value of vehicle delay as part of the benefit/cost analysis. Heavy vehicle percentages varied across the day due to unique traffic patterns and characteristics.

2.2 Base Model Validation

The roadway geometrics, traffic volume, and signal timing information were utilized to create a study area model using the Synchro modeling software. The model was calibrated by adjusting the turning speeds, lane utilization, and vehicle positioning characteristics in locations where unique traffic characteristics were evident.

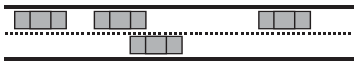
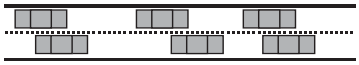
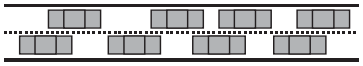
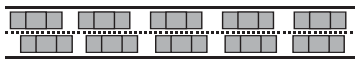
2.3 Existing Performance Measures

The following sections document the AM, mid-day, and PM peak hour traffic operation analysis under the existing conditions.

2.3.1 Intersection Level of Service

The existing condition traffic models were calibrated to existing signal timing parameters, lane geometrics (operation), lane utilization, and observed saturation flow rates. Using the calibrated models and the field collected data, an operations analysis was conducted. The analysis included an intersection capacity, intersection delay and LOS. The methods of the Highway Capacity Manual (HCM), 2010 Edition and the Synchro/SimTraffic software model were used to conduct the analysis. LOS criteria as defined by the HCM for signalized intersections is illustrated in Table 2. The approach and overall intersection level of service analysis for the AM, mid-day, and PM peak hours for all project corridors are documented in Table 3.

Table 2. LOS Criteria

Level of Service		Description	Delay per Vehicle (Seconds) Signalized Intersection
A		**Free Flow.** Low volumes and no delays.	0 - 10
B		**Stable Flow.** Speeds restricted by travel conditions, minor delays.	>10 - 20
C		**Stable Flow.** Speeds and maneuverability closely controlled due to higher volumes.	>20 - 35
D		**Stable Flow.** Speeds considerably affected by change in operating conditions. High density traffic restricts maneuverability, volume near capacity.	>35 - 55
E		**Unstable Flow.** Low speeds, considerable delay, volume at or slightly over capacity.	>55 - 80
F		**Forced Flow.** Very low speeds, volumes exceed capacity, long delays with stop and go traffic.	> 80

Source: Highway Capacity Manual, 2010 Edition, Transportation Research Board, Exhibit 18-4 for Signalized Intersections and Exhibit 19-1 for Unsignalized Intersections.

Table 3. Existing Intersection Level of Service

Node	Intersection	AM Peak Hour						MID Peak Hour						PM Peak Hour					
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS
801	TH 2 at CSAH 63	15	7	9	0	11	B	17	9	15	0	13	B	17	11	19	0	14	B
802	TH 2 at TH 38	12	13	31	29	17	B	13	15	33	30	18	B	18	20	51	26	22	C
803	TH 2 at 1st Avenue W	4	4	41	35	7	A	9	5	35	34	11	B	9	3	41	30	9	A
804	TH 2 at TH 169 W Junction	31	24	17	42	27	C	32	24	30	41	31	C	39	21	34	50	35	C
806	TH 2 at 1st Avenue E	4	6	31	34	7	A	4	8	32	26	10	A	3	8	40	31	10	A
807	TH 2 at TH 169 E Junction	21	31	14	33	24	C	24	23	12	30	22	C	27	30	14	36	26	C
808	TH 169 at 8th Avenue E	17	9	16	21	13	B	17	9	11	18	12	B	24	14	19	21	18	B
809	TH 169 at 13th Avenue E	9	11	14	17	11	B	8	10	17	14	10	A	13	15	15	23	16	B
810	TH 169 at Glenwood Drive	6	15	25	11	13	B	8	13	20	12	11	B	9	10	22	16	11	B
811	TH 169 at 29th Street S	0	20	9	4	8	A	0	13	14	7	10	A	0	15	17	9	13	B
812	TH 169 at 25th Street S	0	16	6	2	5	A	0	15	12	6	9	A	0	16	11	5	8	A
813	TH 169 at 21st Street S	24	14	12	11	14	B	24	18	12	9	12	B	23	23	13	11	14	B
814	TH 169 at 13th Street S	21	15	7	5	7	A	25	28	16	16	18	B	26	28	16	17	19	B
815	TH 169 at 10th Street N	20	31	19	22	22	C	31	40	26	33	31	C	37	42	28	35	34	C
816	TH 169 at 4th Street S	19	16	10	8	10	A	31	33	15	15	17	B	32	32	13	16	17	B
817	TH 169 at 2nd Street N	6	38	4	1	4	A	14	39	8	5	9	A	13	49	11	3	11	B
818	TH 169 at 3rd Street N	21	32	1	1	2	A	17	31	3	2	5	A	20	43	1	2	4	A
819	TH 38 at 14th Street N	12	20	9	17	14	B	9	15	9	13	11	B	11	16	11	16	13	B
820	TH 2 at 7th Avenue E	13	35	20	23	23	C	20	39	25	23	25	C	21	37	30	26	27	C

3.0 Signal Timing Optimization

Optimization of a signalized network is often subjective, and evaluation of performance is based on both qualitative and quantitative metrics. A discussion of key priorities and objectives, optimization strategy and conclusions, and performance assessment of the proposed timing plans was completed.

3.1 Base Timing Parameters

As part of the signal optimization process, the existing local controller timing parameters were reviewed and updated to be in accordance with the latest requirements of the Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD) and MnDOT District 1. Crosswalk measurements and red clearance interval measurements were collected, and the following key local controller settings were developed and implemented as part of this project (Refer to Appendix A).

- Flashing Don't Walk (FDW) Time
- Walk Time
- Yellow Clearance
- All Red Clearance
- Minimum Initial Time (Minimum Green)
- Maximum Initial Time

The FDW utilizes a 3.0 feet per second walking speed at the nine downtown intersections (US 2 between TH 38 and 8th Avenue NE and TH 169 between 3rd Street S and US 2). All other intersections utilize a 3.5 feet per second walking speed.

3.2 Train Preemption

Four intersections within the project area operate with special train preemption programs. The train preemption interfaces with the railroad track switches and may include advanced preemption timing sequences for gate down clearance. Changes to the vehicle or pedestrian clearance intervals may affect the operation of the preemption. In a worst-case pedestrian interval activated scenario, lengthening of the clearance intervals could result in the controller not being able to time out the active intervals and finish the track clearance preemption sequence prior to the train arriving at the intersection. MnDOT reviewed the train preemption calculations previously completed in coordination with BNSF Railroad. MnDOT indicated that the new vehicle and pedestrian clearance intervals at the CSAH 63, TH 169/TH 2 West Junction and TH 169 3rd Street S intersections were less than the required time allotment provided by BNSF; therefore, were implemented. At the TH 2/7th Avenue E intersection, the reduction in Minimum Green (15 seconds to 12 seconds) gained enough time to allow for the new yellow and red clearance intervals. The existing pedestrian intervals (new MUTCD compliant pedestrian intervals were not implemented) were maintained until MnDOT can completed further coordination with BNSF to determine the final advanced preemption time needs.

3.3 Optimization Objectives and Goals

The study area consists of 19 signalized intersections. The intersections have varying traffic characteristics, ranging from heavy Trunk Highway to Trunk Highway movements during the peak periods to serving residential neighborhoods, area schools, and local commercial retail. The primary high-level goal of the signal timing plans is to first provide for safe, and efficient movement of traffic at each intersection, then to provide for orderly movement of traffic between successive intersections. The development of optimized timing plans must balance many considerations, and may not always improve every motorists' travel time, delay or travel route. The key objectives, goals and considerations for the signal timing optimization process included:

- **Network Operation**
  Development of the most optimum network operation and/or assignment of coordination groups. Signal coordination requires a common cycle length to maintain vehicle progression through successive intersections. The overall network needs to prioritize mobility to meet the District's goals; however, it is not anticipated that all signal systems should operate on the same cycle length under every timing plan.

- **Commercial and Residential Areas**
  Consider the varying traffic characteristics at residential neighborhood traffic signals versus traffic signals primarily servicing heavy commercial developments. Residential traffic signals tend to generate more sensitivity to cycle length (i.e., shorter is better) and cross-street delay, whereas commercial based traffic signals tend to have high volume and variable turn movement volumes, generally requiring a longer cycle length.

- **Flexibility**
  The range in cycle lengths should provide for flexibility to accommodate the daily volume levels, high turning volumes, and the variable volume demand on left turn and cross-street movements.

- **Performance Measurement**
  Key MOE's include motorist delay, fuel consumption, stops, and travel time. All measures were considered and balanced through the optimization process. Each measure was reviewed on a network wide level, and no one measure was more important than another. When considering the optimization of the corridors as a system, it was expected that some intersections may experience MOE increases, while the overall system as a whole is decreased.

- **Flashing Yellow Arrow (FYA) Operation**
  Intersections equipped with FYA indications offer the flexibility to control the left turn operation (protected, protected/permissive or permissive only) by time of day. The appropriate operation by timing plan was determined through observation, volume analysis, and the optimization process.

3.4 Network Signal Optimization Evaluation

A comprehensive evaluation of the study area intersections was completed to determine the best overall network operation, to determine the coordination groups (i.e., locations where cycle length changes can occur between adjacent signals), and to assess the optimum range of cycle lengths. Key considerations include:

- **Pedestrian Intervals:** The pedestrian interval was either accommodated or very nearly accommodated at the six downtown Grand Rapids intersections in the vicinity of the TH 169 at TH 2 West Junction. At the remaining locations, pedestrian clearance intervals do not specifically need to fit within the movement split allocation; therefore, were not considered in determining the minimum cycle length or network optimization. In most cases, the pedestrian interval timing would otherwise require a much longer cycle length than desired. In the instance of a pedestrian actuation, the traffic signal will serve the full pedestrian interval, but may cause the signal system to lose sync.

- **Left Turn Arrows:** Left turn arrow phase order sequencing is optimized as a lead/lead, lead/lag or lag/lag (for 3-section, t-configuration 5-section or FYA indications) to optimize two-way vehicle progression and minimize left turn motorist delay. Five-section protected/permissive indications at four-legged intersections (which is most intersections in Grand Rapids) are required to lead/lead to avoid yellow ball trap safety issue.

- **Split Allocation:** Splits are developed to minimize delay for the intersection. Initially the minimum required split time (accounting for lost time, number of lanes, traffic demand and other factors) is assigned to non-coordinated phases (2n+3 formula) and any extra time given to the coordinated phases. After the initial splits are developed, the offsets and phase orders are optimized. Split time is then increased on the non-coordinated movements where possible to increase flexibility without unduly impacting the mainline progression.

- **Offsets:** Optimization of the offsets and phase orders was completed manually within Synchro to provide the optimum two-way travel time-space diagram for progression and corridor drivability. A key goal in the offset optimization was to provide as smooth flow as possible on the front end of the platoon, reduce potential for platoons to arrive on the yellow change, and minimizing the instances of double stops (stopping at two traffic signals in a row).

- **Minimum and Optimum Cycle Length**: The minimum cycle length (time required to service the minimum green and clearance intervals for all phases) at a typical 8-phase intersection is between 80 and 90 seconds and can be shorter for intersection with less phases or if phases are omitted. The optimum cycle length is often much longer than the minimum to provide for intersection flexibility and to accommodate the volume demands within the system. General cycle length considerations are illustrated in Figure 4.

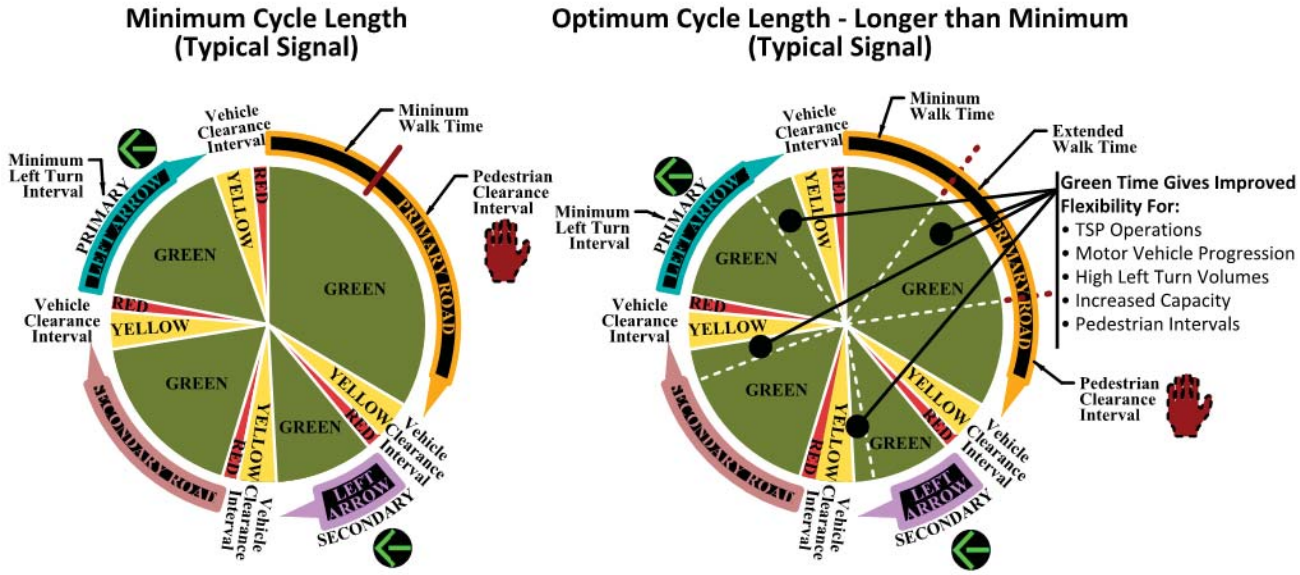


Figure 4. Minimum and Optimum Cycle Length Considerations

A network optimization evaluation was initially completed for the AM, mid-day and PM peak periods. The optimization process involves both a qualitative and quantitative evaluation. For each time period, a "screening" analysis that evaluates multiple iterations of cycle lengths and phasing sequences was conducted. A combination of factors is considered in determining an ideal cycle, including but not limited to delay, stops, emissions, fuel, travel time, arterial bandwidth, and qualitative "feel" of progression. Time-space diagrams that show too many instances of large queues at the start of the green time, or large number of motorists arriving on yellow (or after the yellow change) are generally indications of a cycle length that is too short. Conversely, time-space diagrams with long periods of time with no platoons indicate a cycle length that is too long. The iteration analysis is a subjective assessment of the time-space diagram relationship and key performance measures.

In consideration of key project objectives and key traffic patterns, the network optimization analysis makes the following network operation conclusions for the system groups.

Downtown (Group 1):

- Maintaining a common cycle length for this group of nine intersections was vital to optimal operation, as the close proximity of signals may yield queueing issues if not addressed properly. Six of the nine signals in this group were running coordination prior to optimization. Cycles were kept low to proactively alleviate minor phase wait times while still serving volume needs and stop reduction. Traffic volumes were heavy throughout most of the day, especially at the TH 169 and TH 2 West Junction intersection.
- The major traffic flow occurs on northbound TH 169 and all the coordinated timing plans allow for progressing traffic through the two signals leading to the TH 2 intersection.

TH 169 (4th Street to 21st Street) (Group 2):

- This group serves the busy local commercial retail area with many retail stores and fast food restaurants. Intersecting cross streets provide access to nearby residential areas. These signals were running free prior to optimization.

TH 169 (25th Street to 29th Street) (Group 2a):

- This group is comprised of two "T" intersections that serve major big box retail stores. Because activity at these locations picks up later in the morning, they were split into a separate group to allow free operation for a longer period in the morning. The rest of the schedule mirrors Group 2. These signals were running free prior to optimization.

TH 169 between 13th Avenue and Glenwood Drive (Group 3):

- This group is comprised of two intersections on the east end of the study area. Itasca Community College is served by Glenwood Drive. Coordinated operation is very valuable through this segment with predominate through traffic volume levels. These signals were running free prior to optimization.

TH 38 and 14th Street (Group 4):

- This intersection is north of TH 2 and serves the IRA Civic Center and Grand Rapids High School. Coordinated signal operation provides little value at this location and is recommended to run free. This signal was running free prior to optimization.

TH 2 and CSAH 63 (Group 5):

- This "T" intersection is on the west end of the study area. CSAH 63 provides access to the north and west side of Pokegama Lake. Coordinated operation is very valuable through this segment with predominate through traffic volume levels is. This signal was running free prior to optimization.

3.5 Optimized Timing Plans

The network signal optimization evaluation sets the framework for the development of each individual coordination timing plan. Development of the optimized timing plans include creating weekday and weekend time of day (TOD) timing plans consisting of new cycle lengths, intersection splits, and offsets for each group.

3.5.1 Timing Plan Convention

Based on a review of turning movement count data, field observations of the corridors and evaluation of the daily volume levels, a menu of timing plans was devised for each group to handle the typical range of traffic patterns experienced. In general, approximately two to seven timing plans were developed for each group using the following standard pattern numbering convention. The plan numbering conventions are denoted in Table 4.

Table 4. Standard Timing Plan Numbering Convention

Pattern	Timing Plan
1	AM Peak
2	MID Peak
3	PM Peak
4	Overnight (FREE if no cycle length)
5	--
6	PM OFF
7	--
8	Evening
9	OFF Low AM

3.5.2 Timing Plans and Cycle Lengths

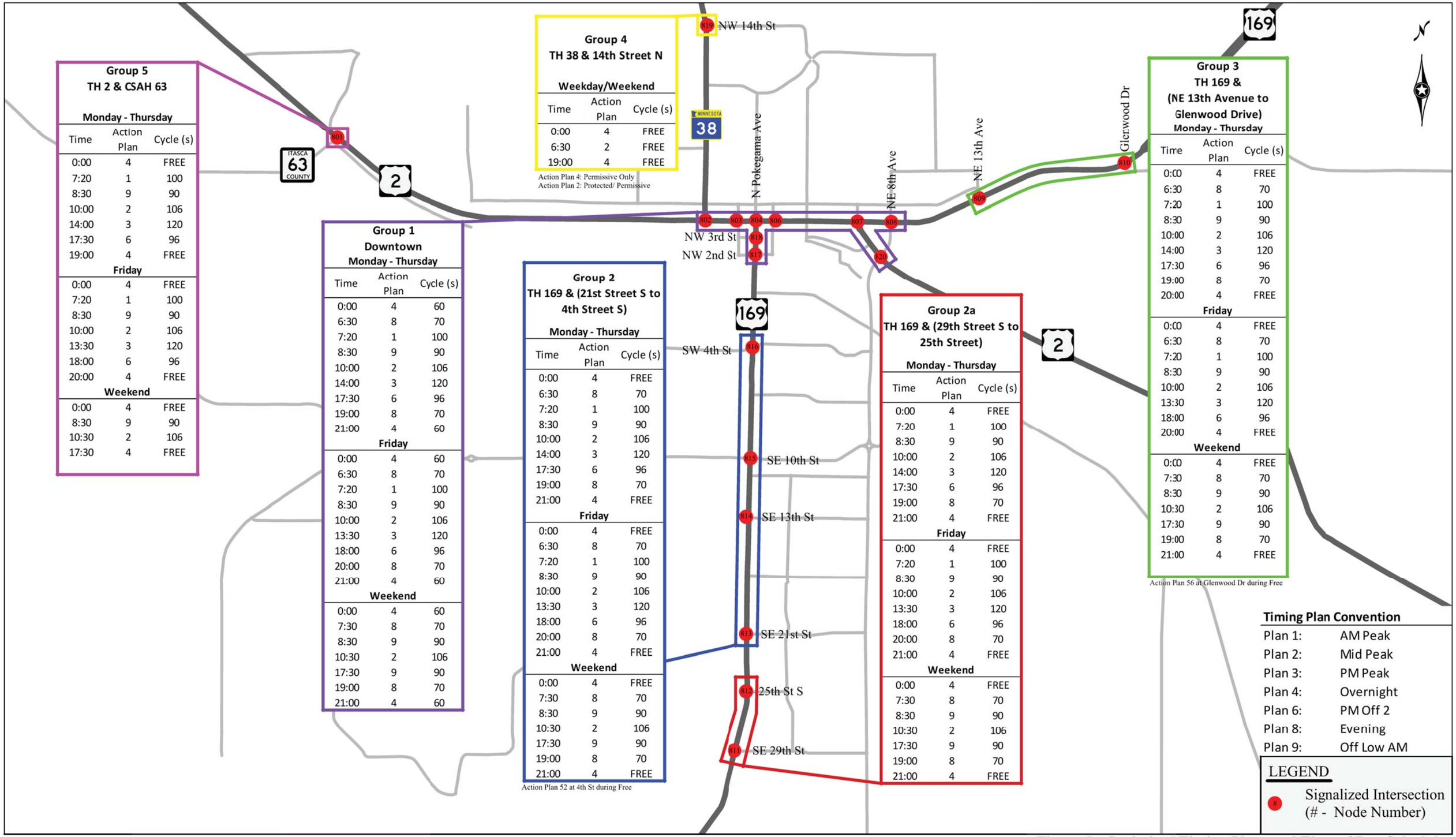
Selecting the appropriate array of cycle lengths was based on the varying traffic volume demands over the course of a day for each group, the network optimization analysis considerations noted previously, and on the following key strategies:

- Long enough to accommodate the mainline traffic volume demand.
- Flexibility to provide added green time to high volume left turn or cross-street traffic movements.
- Best optimizes two-way vehicle progression, given the existing signal spacing, signal phasing, vehicle speeds and traffic volume relationship.
- Ability to allow half cycle operation (i.e., even cycles) at low phase or low volume intersections.
- Provide cycle length changes no greater than 20-30 seconds to help with faster plan transition.

Figure 5 summarizes the signal zone groups, timing plans, and cycle lengths. It should be noted that any group or pattern with matching cycle lengths will operate in coordination together. The timing plan summary, which documents cycle lengths, split times, offsets, and recall data by intersection is provided in Appendix B.

3.5.3 Time of Day Schedules

Time of day (TOD) schedules were developed for each signal group based on the 24-hour turn movement counts collected along the corridors. The detailed TOD schedule, including weekends and holidays for each group is provided for reference in Appendix B. To help illustrate the relationship between the optimized cycle lengths and traffic volumes along the corridor, color coded graphs illustrating the typical weekday TOD schedule for each zone was completed, as shown in Figure 5.



2019 Grand Rapids Signal Optimization

Figure 5 - Optimized Timing Plans and Time of Day Schedules

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3.5.4 Holiday Schedules

Table 5 shows the standard day schedule and day plan convention used by MnDOT District 1. Holidays may affect the traffic patterns and traffic volumes in the study area differently. Therefore, it is important to select the appropriate day plan to be active as it may uniquely apply for each group, corridor or intersection. The specific controller day plan, holiday, and group assignment for the various index networks is shown in Table 6.

Table 5. Day Plan Convention

Day Plan Schedule	Event Description
1	Weekday - Monday to Friday (Typical)
2	Weekend - Saturday to Sunday
4	Weekday - Friday (If Applicable)

Table 6. Holiday Day Plan Assignment

Schedule	Holiday	Day Plan (DP)	Month	Day	Date	Applicable Network Index
Schedule 1	Weekday (Mon-Fri, Mon-Thu)	DP 1	all	Mon-Fri	all	**All**
Schedule 2	Saturday	DP 2	all	Sat/Sun	all	**All**
Schedule 3	Sunday	DP 3	all	or Sun if Applicable	all	--
Schedule 4	Friday	DP 4	all	Fri	all	--
Schedule 5	New Year's Day	DP 2	January	Mon-Fri	1	**All**
Schedule 6	New Year's Day on Sunday	DP 2	January	Mon	2	**All**
Schedule 7	Memorial Day	DP 2	May	Mon	25,26,27,28,29,30,31	**All**
Schedule 8	4th of July on Saturday	DP 2	July	Fri	3	**All**
Schedule 9	4th of July	DP 2	July	Mon-Fri	4	**All**
Schedule 10	4th of July on Sunday	DP 2	July	Mon	5	**All**
Schedule 11	Labor Day	DP 2	September	Mon	1,2,3,4,5,6,7	**All**
Schedule 12	Thanksgiving Day	DP 2	November	Thursday	22,23,24,25,26,27,28	**All**
Schedule 13	Black Friday	DP 2	November	Friday	23,24,25,26,27,28,29	**All**
Schedule 14	Christmas Day on Saturday	DP 2	December	Friday	24	**All**
Schedule 15	Christmas Day	DP 2	December	Mon-Fri	25	**All**
Schedule 16	Christmas Day on Sunday	DP 2	December	Mon	26	**All**
Schedule 17	New Year's Day on Saturday	DP 2	December	Fri	31	**All**

3.5.5 Free vs. Coordinated Operation

Due to the high variability of free operation, it is favorable to operate the coordinated timing plans along a signalized arterial for as long as possible. This reduces the number potential stops along a corridor. Theoretically, a vehicle could stop at every signal if the whole corridor is operating free. Determination of when to run free over coordination lies with a combination of volume analysis and observation of conditions. A general rule of thumb for the initial TOD schedule is to operate coordination when there are approximately 300-400 vehicle per hour on the mainline. Psychologically, motorists tend not to notice the cycle length or be bothered by stopped delay if there are vehicles being

served by the mainline phases. However, once there are long gaps between mainline traffic, the likelihood of a citizen complaint increases. This psychological observation often serves as the threshold for running coordination vs free. When there is noticeable mainline traffic flow it is beneficial to run in coordination, and when traffic is light such that there are frequent cycles with little or no vehicle platoons, it is beneficial to run free operation. Free mode operation is case by case for each corridor and final determination of TOD observed in the field.

3.5.6 Volume to Cycle Comparison

Figure 6 qualitatively illustrates the relationship between the cycle length and traffic volumes at strategic locations on the east, west, and south parts of the study area. Ideally, the cycle lengths and associated timing plans will match with the change in traffic volume and various traffic volume levels that occur throughout the day. Generally, this is the case to provide the time of day transition points for the correct cycle lengths at the appropriate volume level.

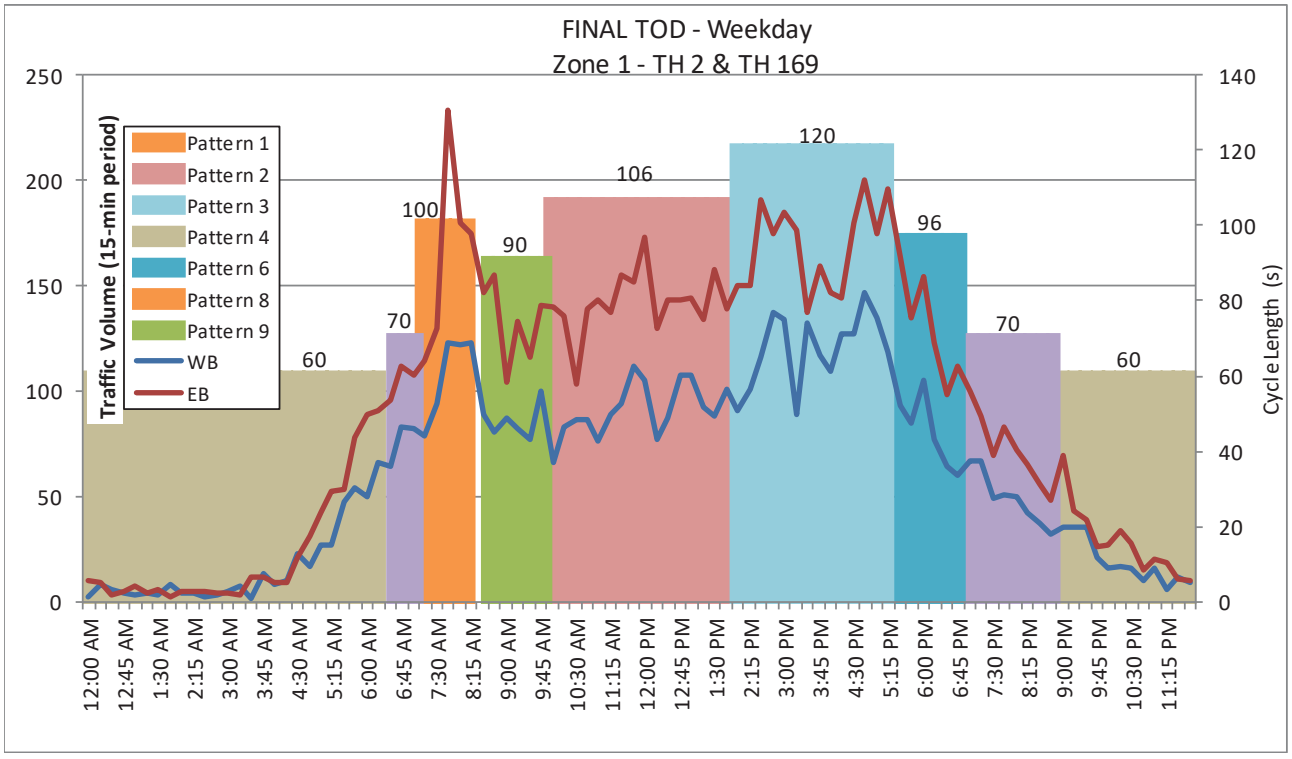


Figure 6. Optimized Cycle vs Volume Profile Diagram

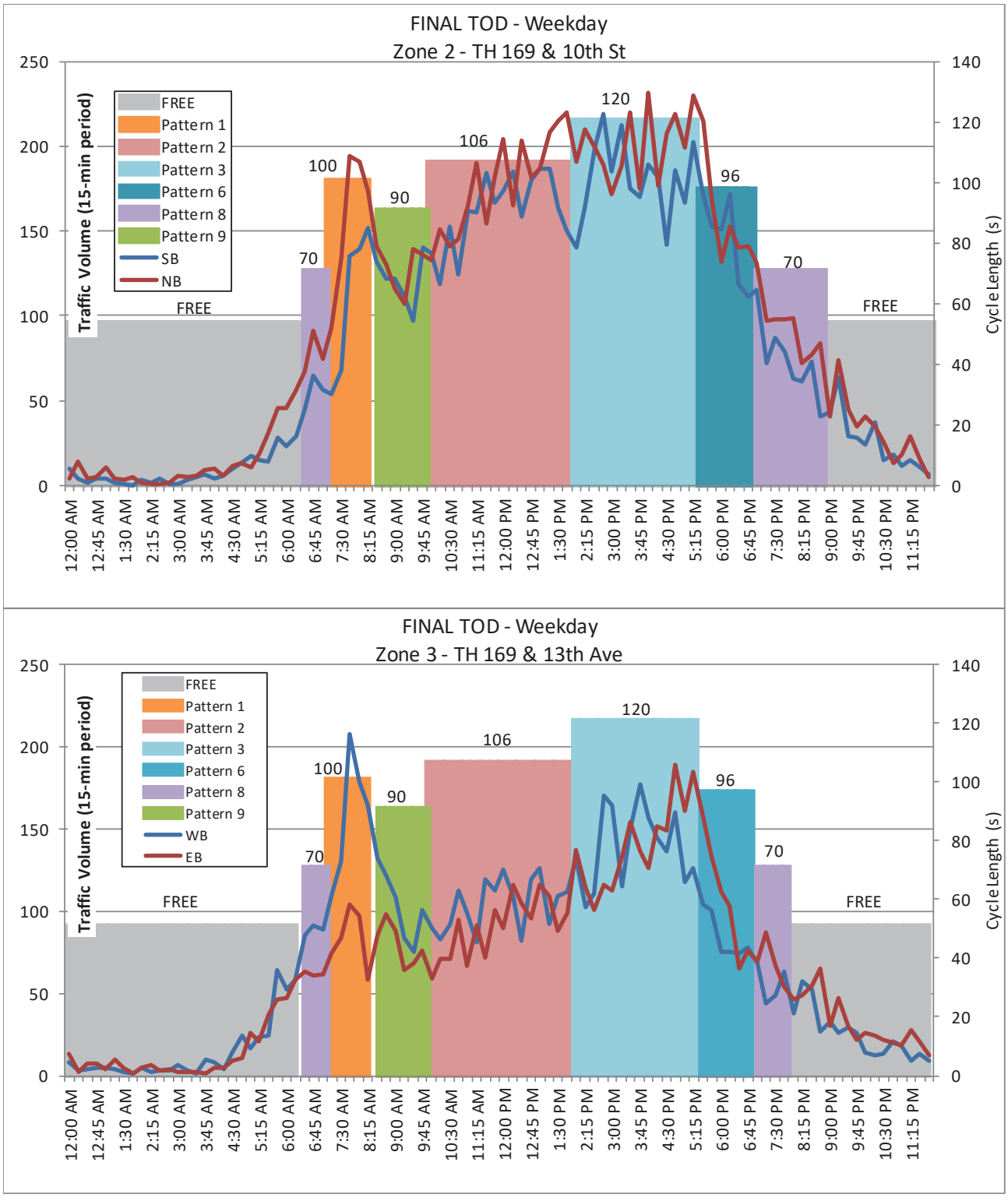


Figure 6. Optimized Cycle vs Volume Profile Diagram, Cont.

3.6 Flashing Yellow Arrow Operation

The project network has three intersections with one or more approaches having flashing yellow arrow (FYA) indications in operation. As part of the signal optimization and coordination plan development, decisions were made regarding the type of left turn phasing used throughout the day (protected vs. protected/permissive vs. permissive only). Considerations include left turn versus opposing though movement volume (cross-product), left turn sight lines, opposing left turn movement traffic volume (i.e., probability of sightline being blocked), left turn lane offsets, mainline vehicle progression, intersection efficiency, engineering judgement, and community expectations. Based on this analysis and discussion with MnDOT District 1, the operation strategy was determined for each intersection and timing plan. Intersections with FYA indications are shown in Figure 2. A summary of the FYA assessment and detailed schedule for left turn arrow operation by time of day for each intersection is included in Appendix C. The FYA operation was field validated during the implementation and revisions made as appropriate.

3.7 Signal Timing Implementation and Fine-Tuning

MnDOT is planning for the installation of Cell Modem communication and associated network hardware to provide integration with their Advanced Traffic Management System (ATMS) MaxView. Associated with the MaxView integration is the upgrading of ASC2 controllers to ASC3/Cobalt controllers. All project signals will receive controller upgrades and communication, with exception to four locations – TH 169/Glenwood Drive, TH 169/13 Avenue NE, TH 2/CSAH 63 and TH 38/14th Street. The controller upgrades and MaxView integration did not occur prior to implementation; therefore, the optimized timing plans were implemented on the existing traffic signal equipment. It is expected that MnDOT will convert the optimized timing plans to the new equipment once installed later in 2019.

The optimized timing plans were implemented June 6-8, 2019. The implementation process included the programming of ASC3/ASC2 databases for download into the local controllers. Each timing plan was then field validated to verify correct intersection operation and that the intended splits, offsets, and phase orders were occurring. After the timing plans were determined to be operating correctly, specific field observations were made over the course of a couple days (each timing plan) to fine-tune splits, offsets, left turn operation and the TOD schedule to observed traffic conditions. Due to the high level of summer recreation traffic, Friday and Saturday plans were validated on a typical summer Friday and Saturday to best manage the movement splits and traffic demands.

3.8 Performance Measurement

The following section presents the traffic operation analysis results for the optimized signal coordination plans.

3.8.1 Timing Plan Network Analysis

A network operational analysis using Synchro/SimTraffic was performed for the optimized timing plans and compared against the equivalent existing condition timing plan. The performance metrics used for this analysis are total delay (hours), vehicle stops, and fuel consumption (gallons). Figures 7 and Figure 8 summarize the expected delay, vehicle stops and fuel consumption improvement by timing plan.

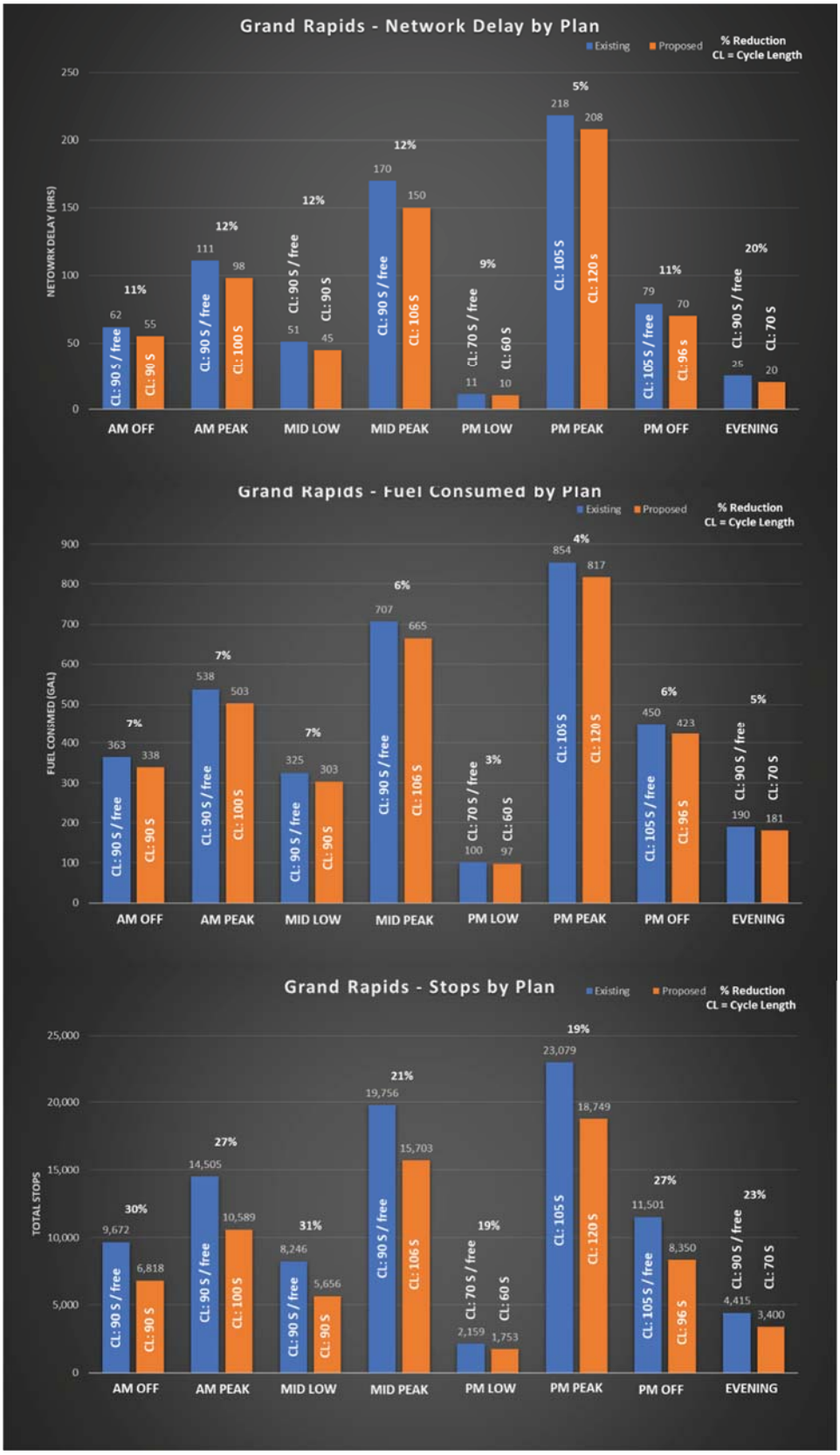


Figure 7. Total Network MOE Comparison by Timing Plan

3.8.2 Total Daily Network Analysis

The optimized total network performance was aggregated for the AM peak period, mid-day peak period, PM peak period, and the remaining off peak periods. Key MOE's include overall delay (hours), vehicle stops, fuel consumption, and air quality emissions (CO, NOx, and VOC). Table 7 compares the network performance measures for the optimized coordination plans, and Figure 8 summarizes the total aggregated daily performance for the key metrics.

Table 7. Optimized Timing Plans Network Performance Summary

		Existing ("Before")				Optimized ("After")				Percent Reduction			
	MOE	AM Peak	Mid-Day Peak	PM Peak	Off Peak Hours	AM Peak	Mid-Day Peak	PM Peak	Off Peak Hours	AM Peak	Mid-Day Peak	PM Peak	Off Peak Hours
Total Project Signals	Stops (no. of veh)	18,131	64,207	46,158	99,732	13,236	51,035	37,403	77,629	**27.0%**	**20.5%**	**19.0%**	**22.2%**
	Delay (hr)	139	552	437	721	122	490	409	680	**12.3%**	**11.2%**	**6.5%**	**5.7%**
	Fuel Consumption (gal)	673	2,304	1,704	3,897	629	2,155	1,627	3,728	**6.5%**	**6.5%**	**4.5%**	**4.3%**
	Emission (CO) (kg)	47	161	119	272	44	151	114	261	**6.6%**	**6.5%**	**4.5%**	**4.3%**
	Emission (NOx) (kg)	9	31	23	53	9	29	22	51	**6.7%**	**6.4%**	**4.5%**	**4.3%**
	Emission (VOC) (kg)	11	37	28	63	10	35	26	60	**6.7%**	**6.5%**	**4.5%**	**4.4%**

AM PEAK (715-0830)
MID-DAY PEAK (1045-1400)
PM PEAK(1545-1745)
OFF PERIODS(Remaining Hours)

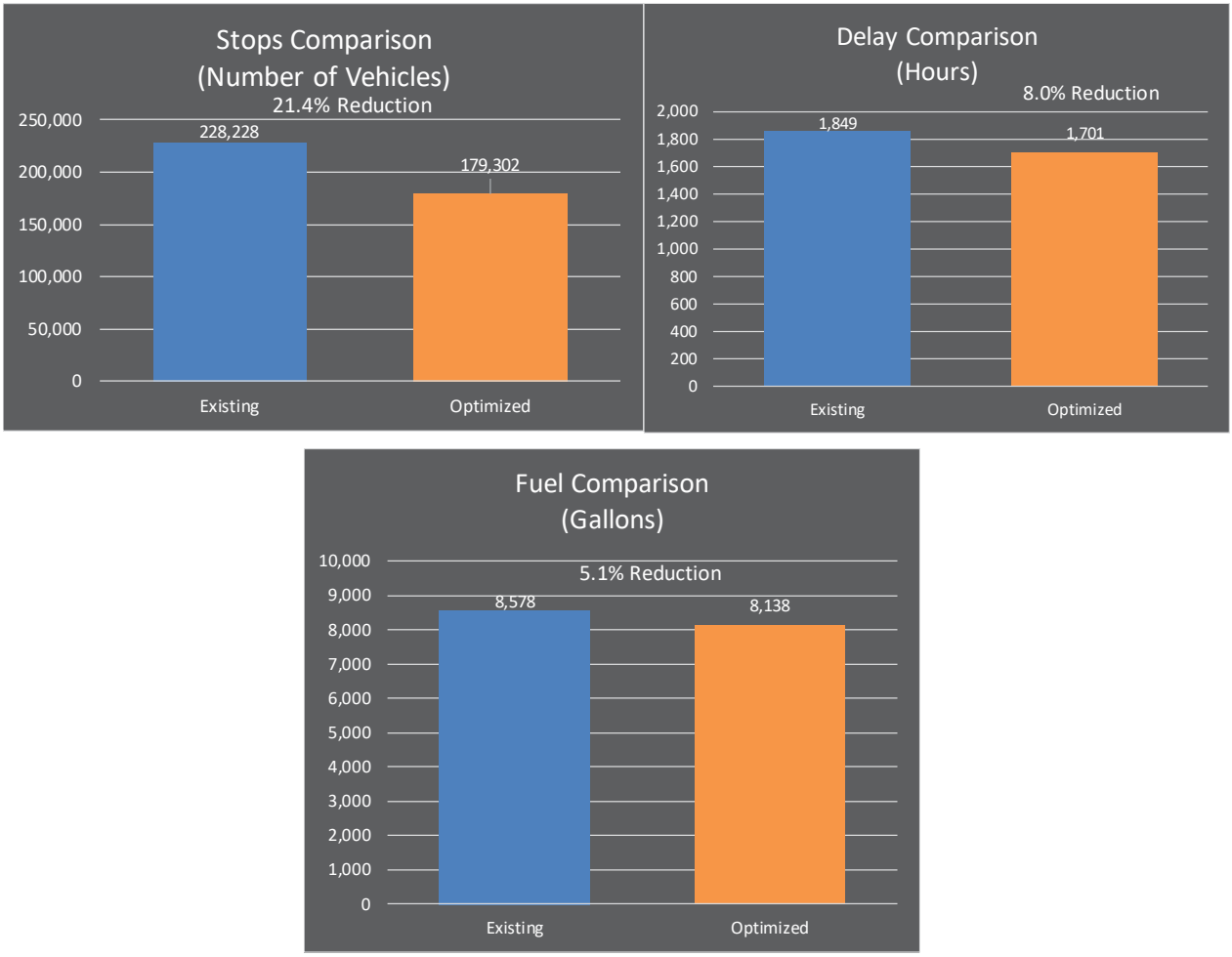


Figure 8. Total System Network Comparisons

3.8.3 Intersection Level of Service

The approach and overall intersection level of service analysis for the AM, mid-day and PM peak periods are documented in Table 8.

Table 8. Intersection Level of Service – Optimized Timing Plans

Node	Intersection	AM Peak Hour								MID Peak Hour								PM Peak Hour							
		EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	Existing Int. Delay (s/v)	Existing LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	Existing Int. Delay (s/v)	Existing LOS	EB Delay (s/v)	WB Delay (s/v)	NB Delay (s/v)	SB Delay (s/v)	Int. Delay (s/v)	LOS	Existing Int. Delay (s/v)	Existing LOS
801	TH 2 at CSAH 63	7	1	20	0	8	A	11	B	8	2	33	0	9	A	13	B	9	3	33	0	9	A	14	B
802	TH 2 at TH 38	17	5	47	34	17	B	17	B	10	5	53	45	16	B	18	B	7	10	**80**	**59**	20	B	22	C
803	TH 2 at 1st Avenue W	3	4	47	40	6	A	7	A	12	6	43	41	14	B	11	B	5	3	48	37	9	A	9	A
804	TH 2 at TH 169 W Junction	13	16	27	48	22	C	27	C	25	27	24	**76**	33	C	31	C	39	29	27	**75**	37	D	35	C
806	TH 2 at 1st Avenue E	3	2	35	39	6	A	7	A	5	4	39	31	10	A	10	A	6	3	47	36	10	A	10	A
807	TH 2 at TH 169 E Junction	6	11	29	54	19	B	24	C	8	11	28	50	17	B	22	C	10	15	33	**57**	21	C	26	C
808	TH 169 at 8th Avenue E	3	2	44	44	15	B	13	B	1	3	36	39	11	B	12	B	2	5	49	39	18	B	18	B
809	TH 169 at 13th Avenue E	5	1	27	40	7	A	11	B	5	3	36	36	8	A	10	A	5	9	28	55	13	B	16	B
810	TH 169 at Glenwood Drive	7	11	30	12	11	B	13	B	4	10	42	21	12	B	11	B	4	7	40	25	9	A	11	B
811	TH 169 at 29th Street S	0	31	6	1	6	A	8	A	0	23	8	3	10	A	10	A	0	33	12	4	15	B	13	B
812	TH 169 at 25th Street S	0	24	3	2	3	A	5	A	0	25	9	2	7	A	9	A	0	31	6	1	6	A	8	A
813	TH 169 at 21st Street S	46	22	1	5	9	A	14	B	42	30	3	3	9	A	12	B	44	46	5	3	11	B	14	B
814	TH 169 at 13th Street S	37	23	3	3	5	A	7	A	40	39	7	6	13	B	18	B	54	55	10	7	18	B	19	B
815	TH 169 at 10th Street N	25	41	20	7	21	C	22	C	33	41	22	10	22	C	31	C	45	52	15	15	27	C	34	C
816	TH 169 at 4th Street S	47	34	6	2	10	A	10	A	52	54	9	8	14	B	17	B	**68**	**70**	9	4	16	B	17	B
817	TH 169 at 2nd Street N	10	43	2	1	3	A	4	A	17	48	3	3	7	A	9	A	18	**58**	7	3	10	A	11	B
818	TH 169 at 3rd Street N	23	36	1	1	2	A	2	A	23	38	1	5	6	A	5	A	16	29	5	19	13	B	4	A
819	TH 38 at 14th Street N	12	20	9	17	14	B	14	B	9	15	9	13	11	B	11	B	15	24	5	4	9	A	13	B
820	TH 2 at 7th Avenue E	17	50	18	15	26	C	23	C	24	41	22	24	27	C	25	C	28	48	25	33	33	C	27	C

4.0 Project Benefit Analysis

The purpose of this section is to document the benefit of the Signal Optimization project. A benefit/cost analysis was completed to evaluate the overall cost-effectiveness of the optimized signal timing plans through the evaluation of key performance measures.

4.1 Benefit/Cost Analysis

A cost benefit analysis was completed to establish the annual economic savings incurred as a result of the Signal Optimization project. Typical measures of effectiveness (MOE) used in estimating the benefit of signal optimization projects include approach vehicle delay, vehicle stops, fuel consumption, and air quality emissions (CO, NOx, and VOC). The detailed analysis is provided in Appendix D.

4.1.1 Traffic Volume Cases

In order to compute the daily "before" and "after" MOE's for the Signal Optimization project, general traffic volume cases were developed (discussed in Section 2.1.4). Because the time of day schedules between the existing conditions and the implemented optimized conditions differ, a matrix of Synchro files was developed for each combination of timing plan/volume case and evaluated over the network to develop hourly traffic volumes for every hour of the day. Each volume case is assigned and assumed to be applicable for a certain number of hours of the day as previously discussed in Section 2.1.4. Each volume case was developed specifically for the corridor. In order to make an accurate "apples-to-apples" comparison, the traffic volumes used in the "before" condition (and number of hours) has to equal the volumes used in the "after" condition (and number of hours) analysis. The benefit/cost analysis includes the daily volume cases for a Monday to Friday.

4.1.2 Project Benefit

The project benefit measures of effectiveness are measured through the reduction in mainline and cross-street delay (total intersection delay-hour), reduction in vehicle stops, reduction in fuel consumption, and reduction of air quality emissions. To determine the annual economic benefit of the Signal Optimization project, the daily estimated reductions (or increases) in MOE's are calculated and are then multiplied by the unit benefit.

Net Average Daily MOE

The daily savings for each MOE was determined by multiplying the number of hours each optimized timing plan is in effect and comparing against the corresponding existing timing plan and traffic volume conditions. It should be noted that the overall net benefit of these measures' accounts for any impacts (i.e., typically an increase in vehicle delay) to cross-street or mainline MOE's. Table 9 illustrates the overall daily and annual "before" and "after" network performance comparison and percent improvement the corridor and documents the net reduction in vehicle delay, vehicle stops, and fuel

consumption for the total system. A positive value shown in Table 9 is a benefit (i.e., reduction) and a negative value shown is an impact (i.e., increase).

Table 9. Measures of Effectiveness – Daily Network Performance Comparison

MOE - Net Reduction from Existing to Proposed Condition							
Aggregate Timing Plans	Stops (no. of veh) (All Approaches)	Delay (veh-hr) (Cross Street)	Delay (veh-hr) (Mainline)	Fuel Consumption (gal) (All Approaches)	Emissions CO (kg) (All Approaches)	Emissions NOx (kg) (All Approaches)	Emissions VOC (kg) (All Approaches)
AM PEAK (715-0830)	4895.00	-21.76	39.87	44	3.12	1	0.73
MID-DAY PEAK (1045-1400)	13172.25	-79.45	144.41	150	10.45	2	2.42
PM PEAK(1545-1745)	8825.25	-80.59	107.39	78	5.41	1	1.24
OFF PERIODS(Remaining Hours)	22159.25	-141.71	184.62	169	11.72	2	2.77
Total System	**49,051.8**	**-323.5**	**476.3**	**439.8**	**30.7**	**6.0**	**7.2**

Unit Benefit

Table 10 provides a summary of unit dollar values for each measure of effectiveness. The unit values are based on standard economic variables established by the MnDOT Office of Investment for Transportation projects and Federal Highway Administration (FHWA).

Table 10. Unit Benefit

Motorist User Costs

MOE	Unit Price
Value of Time - Truck[1]	$30.30
Value of Time - Auto[1]	$18.90
Vehicle Stop[2]	$0.048
Fuel Cost[3]	$2.76

[1] Mn/DOT Office of Investment Management Benefit-Cost Analysis for Transportation Projects, Appendix A, Table A.1, SFY2019 Recommended Standard Values

[2] Life-Cycle Cost Analysis in Pavement Design, US Dept of Transportation, FHWA, Table 2.3 (Vehicle Cost per Stop), September 1998 (Refer to Appendix D for calculations)

[3] US Department of Energy, Energy Information Administration, Average Fuel Prices 6/03/18 to 6/4/19

Air Pollutant Damage Costs and Adjustment Factors Used in HERS

Pollutant	Damage Costs ($/ton)	Urban Adjustment Factor
Carbon Monoxide (CO)	125	1
Volatile Organic Compounds (VOC)	3437.5	1.5
Nitrogen Oxides (NOx)	4531.25	1.5

HERS-ST 2.0 (Highway Economic Requirements System – State Version) Technical Reports, U.S. Department of Transportation/Federal Highway Administration, 2002.
Table E5 - "Air Pollution Damage Costs and Adjustment Factors Used in HERS."
Costs converted from Year 2000 to Year 2018 by Consumer Price Index of 1.25.

Annual Economic Benefit

The net annual economic benefit is based upon 251 Mondays to Thursdays. Applying the number of days and the unit savings to each computed daily MOE, the annual net benefit

(or economic savings) can be computed. Table 11 documents the overall annual net benefit estimated because of the Signal Optimization project. Based on the results, the total estimated annual benefit is estimated at approximately 1.7 million dollars.

Costs for most roadway improvement projects are associated with capital costs, future costs, and operations and maintenance costs. At the end of the analysis period, there would also be a remaining capital value. For this Signal Optimization project, there is not a capital or future cost. The only cost is an "operations" cost and includes the labor required to develop and implement the new signal timing plans. The estimated project cost was $64,597 and includes consulting fees.

Table 11. Measures of Effectiveness – Net Average Daily MOE Reductions

Total Project Signals	Aggregate Timing Plans	Value of Time Benefit ($) (Cross Street)	Value of Time Benefit ($) (Mainline)	Stops Reduction Benefit ($)	Fuel Reduction Benefit ($)	Emission Reduction Benefit ($)	Total Benefit ($)
	AM PEAK (715-0830)	-$114,757	$208,788	$58,405	$30,308	$2,083	$184,828
	MID-DAY PEAK (1045-1400)	-$415,220	$755,395	$157,166	$103,568	$6,874	$607,783
	PM PEAK(1545-1745)	-$418,282	$553,034	$104,464	$53,689	$3,560	$296,465
	OFF PERIODS(Remaining Hours)	-$744,929	$964,693	$263,727	$117,076	$7,882	$608,449
	Total System	**-$1,693,188**	**$2,481,910**	**$583,763**	**$304,641**	**$20,399**	**$1,697,525**

4.1.3 Project Benefit/Cost Ratio

The benefit/cost ratio is computed based on the comparison between the annual net benefit and total project cost. Table 12 documents the estimated benefit/cost ratio for each corridor and the total project.

As shown, the Signal Optimization project resulted in a benefit/cost ratio of approximately **26:1,** considering only one year of benefit. Signal timing plans are typically used for three to five years; therefore, assuming $500 per year per intersection timing plan maintenance cost, the estimated three-year benefit/cost ratio is 55:1.

Table 12. Project Benefit to Cost Ratio

Segment	Number of Intersections	Cost ($)	Benefit ($)	Benefit-Cost Ratio
Total Project - 1 Year Benefit	19	$64,597	$1,697,525	**26**
Total Project - 3 Year Benefit	19	$93,097	$5,092,576	**55**

4.2 Before and After Travel Times

Before and after travel time studies were estimated using Synchro 9 for the TH 2/TH 169 east (eastbound and westbound movements) and TH 169 south of TH 2 (northbound and southbound movements). The travel times comparison was completed for key segments of travel and/or major commuter routes. Comparisons of the before and after travel time

analysis estimate for each direction are illustrated in Figure 9. It should be noted that traffic model travel time is not specifically equivalent to traditional floating car studies. The model output reflects an average delay for all mainline approaches (delay from cross street turn in traffic plus mainline through traffic). It is expected that floating car travel time studies would find much greater travel time saving.

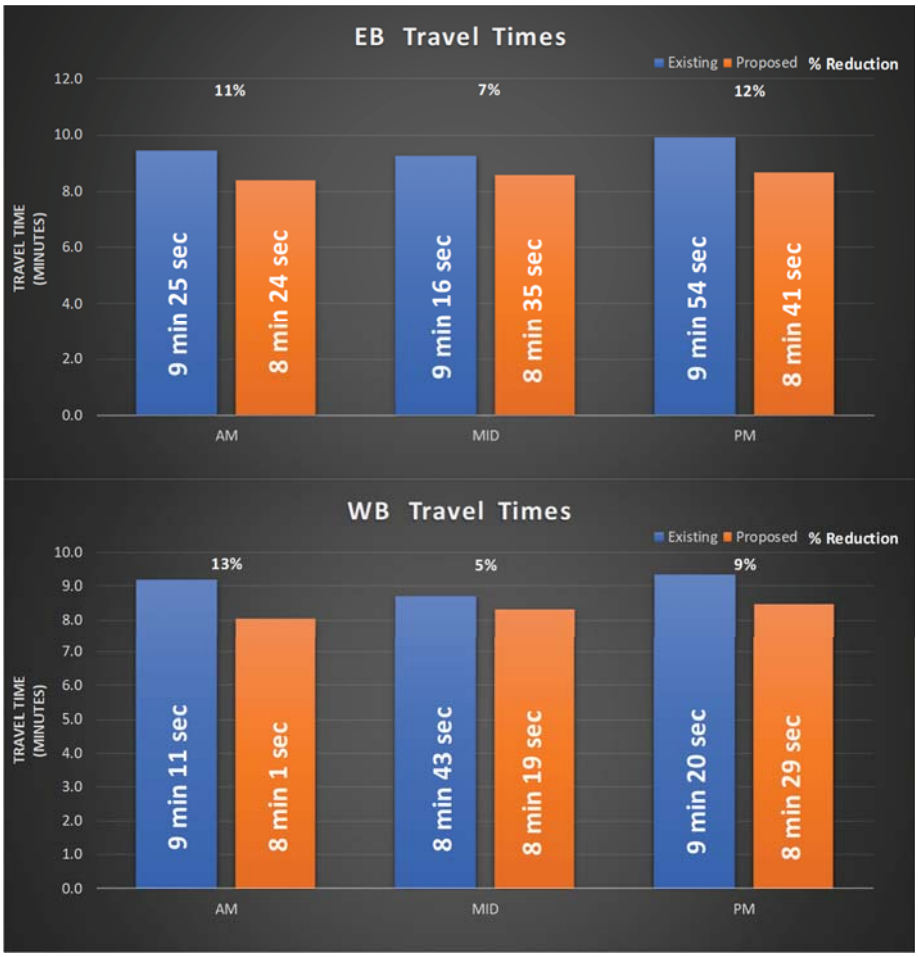


Figure 9. Before and After Travel Time Summary

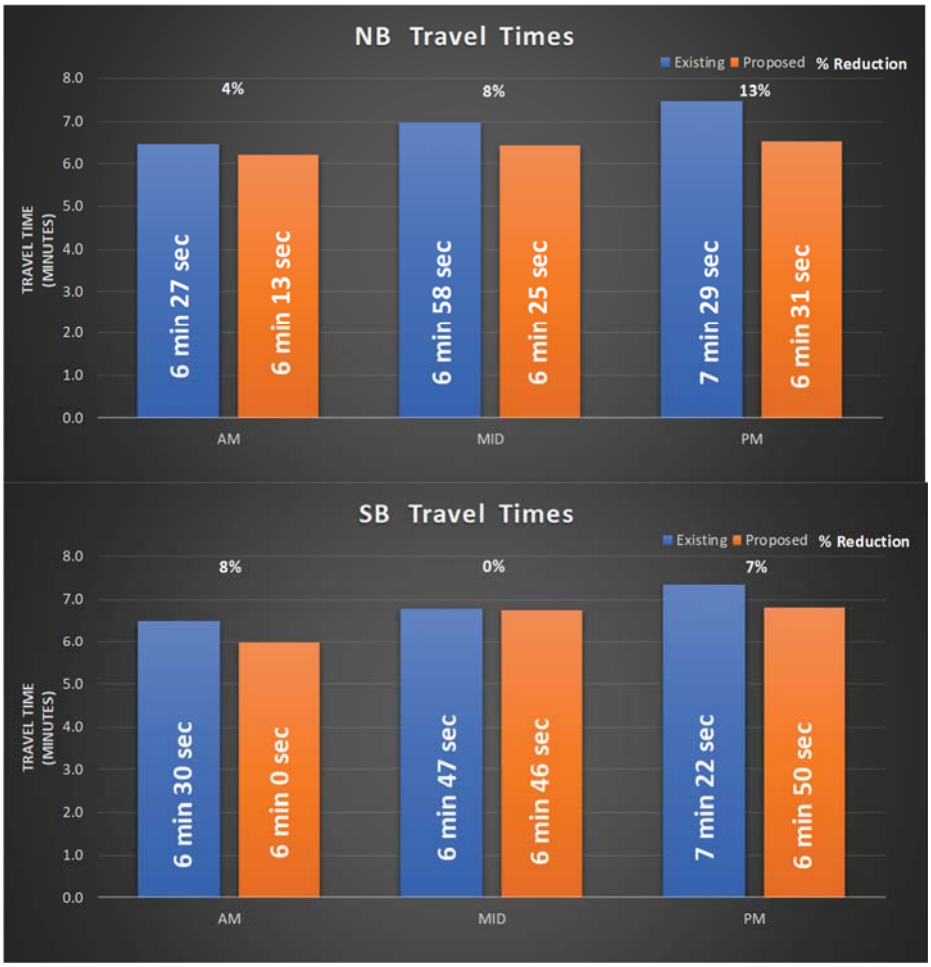


Figure 9. Before and After Travel Time Summary, Cont.

4.4 Key Project Highlights

The project benefit analysis estimates the Signal Optimization project resulted in a **26:1** benefit/cost ratio and an estimated annual economic savings of 1.7 million dollars. Several factors contribute to the project benefit:

Goal 1: Perform network evaluation

- Optimized yellow, all red and pedestrian clearance intervals (YARP) were developed and implemented in accordance with the MnMUTCD and MnDOT District 1 standards.
- A comprehensive network signal optimization analysis was conducted, six groups were identified, and coordination plan/time of day plan strategies were implemented to best operate the overall system as a network.
- A range of off-peak period cycle lengths were identified to best fit with the corridor progression and daily traffic volume levels, while minimizing motorist delay.

- Coordination between groups was provided for under all common cycle length timing plans.

Goal 2: Improve intersection traffic signal efficiency.

- The overall network intersection delay, fuel consumed, and total stops were reduced by 8 percent, 5 percent, and 21 percent, respectively.
- Simulated travel times found that the AM peak, mid-day peak, and PM peak periods had reductions in travel time up to 13%. This is an average that reflects delay on all mainline approaches, it is expected that floating car travel time studies would find much greater travel time saving.

Goal 3: Determine FYA operation by time of day.

- The FYA operation was reviewed at three study intersections and a daily schedule for left turn operation was developed for three locations.
- The left turn operation was optimized to balance reduction in motorist delay, while maintaining a conservative approach to intersection safety.

Goal 4: Identify potential low-cost operation and safety improvement measures

- A schedule of intersection geometric, signing and lane configuration improvements has been developed (Section 5.0).
- A FYA retrofit assessment was completed to help prioritize potential future installations.

5.0 Potential Improvement Measures

As part of the Signal Optimization process, a review of the operations at each of the 19 intersections was completed to determine whether any improvements beyond signal timing changes could be made that further enhance the safety/or efficiency of the intersections. Recommendations are low cost signal operation or geometric modifications based upon field observations and the network optimization analysis.

5.1 Recommended Future Improvements

Table 13 documents a few potential future improvement measures, which range from signal operation efficiency measures to moderate geometric revisions. During field implementation, poor northbound left turn lane utilization was observed at the TH 169/TH 2 West Junction intersection. Most of the northbound TH 169 traffic turns left at TH 2. However, the left-most northbound left turn lane is infrequently used resulting in essentially single traffic lane operation, with left turn queues that occasionally spill back to the Mississippi river bridge. Figure 10 identifies an improvement concept to realign the northbound TH 169 travel lanes directly into the left turn lanes and require a single lane shift for through and right turning vehicles. This concept requires only a minimal 3-foot lane shift for northbound thru vehicles across the intersection and accomplishes this by reducing southbound thru and northbound left turn lanes to be between 10-11 feet. Further feasibility review and engineering design is necessary, but it is expected this concept could be implemented by revising existing pavement markings and deploying tubular delineators or curb reconstruction. An associated overhead or advanced lane use designation sign will also be necessary to communicate to motorists. Should better northbound lane utilization be achieved, then this movement green time could be reduced to increase the eastbound approach green time, which also has poor lane utilization due to the heavy right turn movement. Overall, a significant intersection efficiency improvement is expected.

5.2 Flashing Yellow Arrow Assessment

Flashing yellow arrow (FYA) traffic signals feature a flashing yellow arrow along with the standard red, yellow and green indications. The operation is similar to a standard permissive left turn on green ball. However, FYA offers several operational and safety benefits:

- Studies have shown that FYA results in fewer motorist mistakes. The FYA has been found to be more understandable by the motoring public than the traditional left turn on green ball.
- Reduces motorist delay by providing the flexibility to change left turn phasing operation by time of day (i.e. protected only, protected/permissive or permissive only).

Each intersection was evaluated for its suitability for FYA retrofit implementation and given a priority ranking of High, Medium or Low. Factors used in determining the priority of each intersection included the following:

- **Existing signal phasing.** Intersections with existing protected only phasing (no situations exist in Grand Rapids) have the most potential benefit to be gained from FYA retrofit. While protected only phasing may still be needed during peak periods, protected-permissive or permissive only phasing can often be used during off peak times.
- **Sight distance.** Intersections with good sight distance for left turn movements are better candidates for FYA retrofits. Skewed intersections, intersections with vertical or horizontal curvature on the approach, and intersections with other non-standard geometry warrant an in-depth review of sight distance before adding FYA.
- **Need for Lead/Lag phasing**. One strategy that FYA indications make possible is the use of lead/lag protected/permissive left turn phasing. This type of operation can be used to improve two-way progression while minimizing delay for left turn movements. Intersections with 5-section protected-permissive left turn indications may benefit from conversion to FYA depending on a number of factors including traffic volumes and spacing from adjacent intersections.
- **Number of turn lanes**. Intersections with dual turn lanes on one or more legs have traditionally been operated with protected only phasing by the County. Protected-permissive or permissive only phasing can be used for such situations, but deeper consideration of other factors including traffic volumes and available sight distance is warranted.
- **Number of opposing through lanes**. Similar to the number of turn lanes, approaches having three or more opposing through lanes have been traditionally operated with protected only phasing. Protected-permissive or permissive only operation is possible for these cases but warrants a deeper consideration of other factors including traffic volumes and sight distance.

The FYA evaluation resulted in two intersections being ranked as high-priority and one ranked as medium-priority candidates for implementation of flashing yellow arrow indications. It was determined these locations would benefit from lead/lag left-turn phasing in several of the coordinated timing plans. In deciding the order in which to implement FYA at these intersections, consideration should be given to whether signal controller or other equipment upgrades would be required, whether mast arm extensions would be needed, and whether wiring or conduit upgrades would be required to complete a flashing yellow arrow retrofit project.

Table 13. Recommendations for Future Intersection Improvements

Node #	Intersection	Potential Geometric Improvements	Lane Use/Pavement Marking or Signing Improvements	Signal Phasing or Signal Operation Improvements	Flashing Yellow Arrow Operation Priority (Determine Left Turn Operation by TOD)
801	TH 2 at CSAH 63			-Upgrade controller to ASC3/Cobalt -Install cell modem and integrate into MaxView	Low
802	TH 2 at TH 38				Low
803	TH 2 at 1st Avenue W				Low
804	TH 2 at TH 169 W Junction	(1)	-Install advanced lane use designation signing for northbound approach (consider overhead for greater visibility)		Low
806	TH 2 at 1st Avenue E				Low
807	TH 2 at TH 169 E Junction				Low
808	TH 169 at 8th Avenue E		-Reconfigure pavement markings to provide 1-Thru/Left and 1-right turn lane on the northbbound approach. -Provide northbound lane use designation sign	-Consider a northbound right turn overlap, concurrent with westbound left turn (phase 8 +phase 1)	Low
809	TH 169 at 13th Avenue E			-Upgrade controller to ASC3/Cobalt -Install cell modem and integrate into MaxView	Low
810	TH 169 at Glenwood Drive			-Upgrade controller to ASC3/Cobalt -Install cell modem and integrate into MaxView	--
811	TH 169 at 29th Street S				Low
812	TH 169 at 25th Street S		-Add lane striping for westbound approach		Low
813	TH 169 at 21st Street S				Low
814	TH 169 at 13th Street S		-Add lane striping for westbound approach to designate it as 1-Through/left and 1-right turn lane and provide lane use designation sign		High
815	TH 169 at 10th Street N				High
816	TH 169 at 4th Street S				--
817	TH 169 at 2nd Street N	-Consider reconstructing the southwest and southeast corners to remove pork chop right turn design to improve pedestrian crossing comfort and ADA (vision impaired) accessibility			Low
818	TH 169 at 3rd Street N	(1)	-Consider removing SBL storage lane to accommodate storage for W Junction		Low
819	TH 38 at 14th Street N				--
820	TH 2 at 7th Avenue E				Medium

(1) Refer to Concept Sketch Figure 10

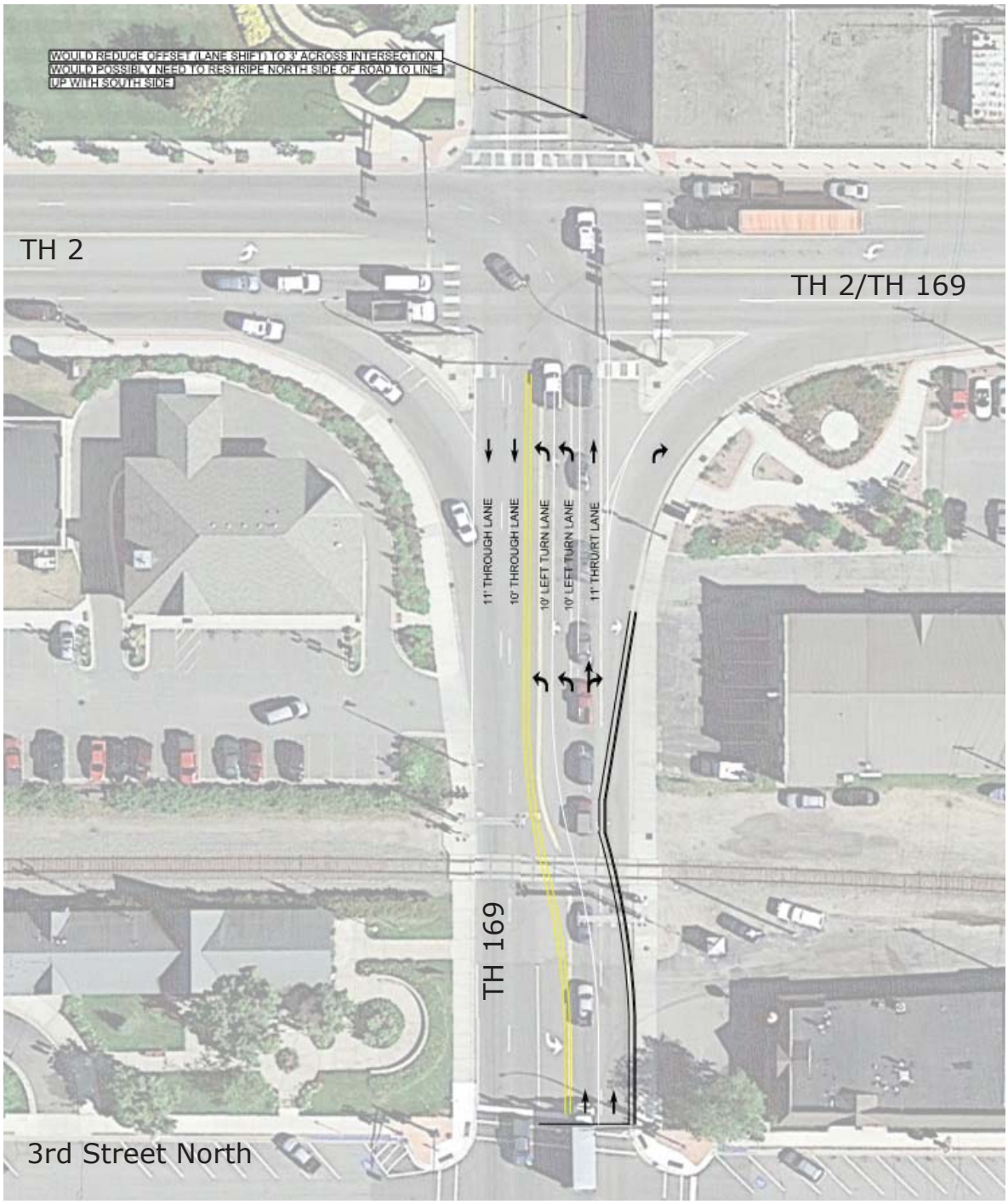


Figure 10. TH 169 at TH 2 West Junction Intersection Improvement Concept

Appendix A:

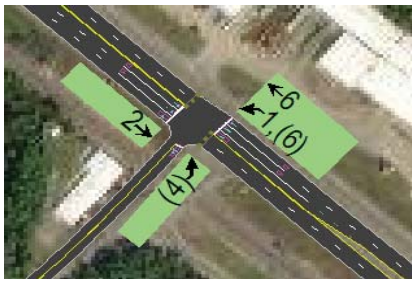
Yellow, All Red and Pedestrian Intervals (YARP)

Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	0	12	0	0
Yellow	3	4.5		5		4.5		0
Proposed All Red	**3**	**1.5**	**0**	**1.5**	**0**	**1.5**	**0**	**0**
Calculated All Red	2.8	1.1	0.0	1.0	0.0	1.3	0.0	0.0
Walk								
FDW								
Max INI								

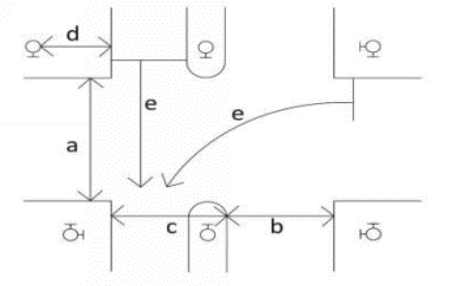
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)								
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)								
"e" (Distance from stop bar to farthest side of conflicting lane)	82	51		57		63		

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	45	0	50	0	45	0	0

Phasing Diagram



Lengths and Distances Key



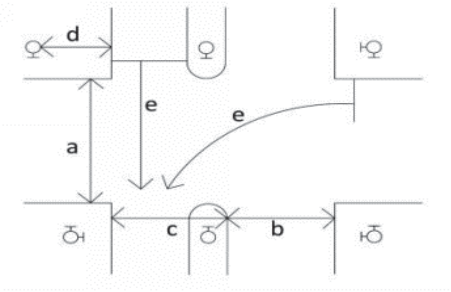
Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	5	7
Yellow	3	3.5		3.5	3	3.5	3	3.5
Proposed All Red	**2.5**	**2**	**0**	**2.5**	**2.5**	**2**	**2.5**	**2.5**
Calculated All Red	2.3	1.9	0.0	2.3	2.4	1.8	2.1	2.3
Walk		7		7		7		7
FDW		19		32		28		31
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		62		104		89		102
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		12		22		22		12
"e" (Distance from stop bar to farthest side of conflicting lane)	66	64		83	68	61	58	82

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	25	30

Phasing Diagram

Lengths and Distances Key

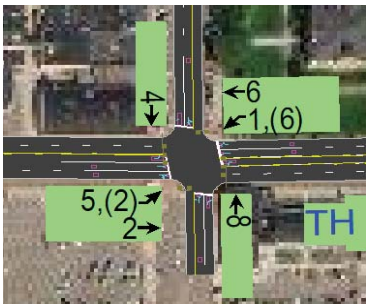


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2.5**	**0**	**2.5**	**2.5**	**2.5**	**0**	**2.5**
Calculated All Red	2.4	2.0	0.0	2.1	2.3	2.0	0.0	2.2
Walk		7		7		7		7
FDW		22		26		22		25
Max INI								

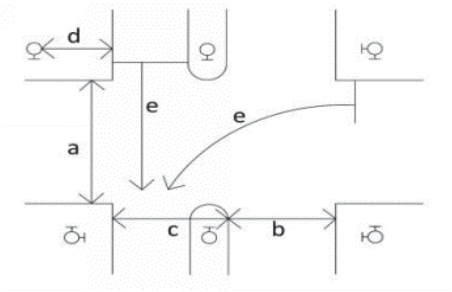
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		73		85		74		83
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		11		12		12		11
"e" (Distance from stop bar to farthest side of conflicting lane)	68	66		74	65	70		76

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



Lengths and Distances Key

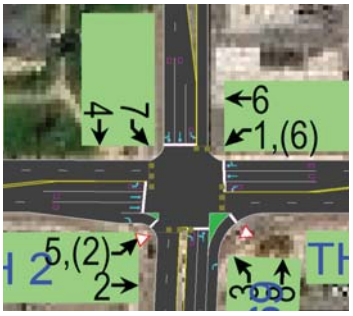


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	7	7	5	12	7	7
Yellow	3	3.5	3	3.5	3	3.5	3	3.5
Proposed All Red	**2.5**	**2.5**	**3**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**
Calculated All Red	2.34	1.95	2.70	2.11	2.13	2.18	2.13	2.32
Walk		7		7		7		7
FDW		22		22		25		21
Max INI								

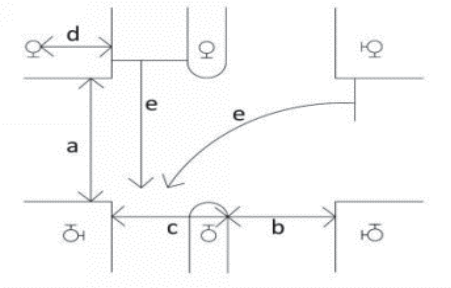
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		75		75		84		72
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		11		7		12		8
"e" (Distance from stop bar to farthest side of conflicting lane)	66	66	79	73	58	76	58	82

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	25	30	25	30	25	30

Phasing Diagram



Lengths and Distances Key

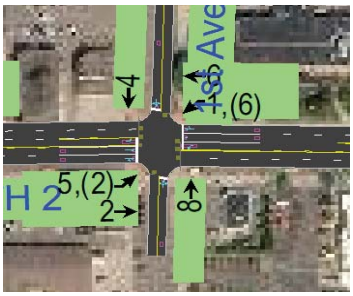


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2**	**0**	**2.5**	**2.5**	**2**	**0**	**2.5**
Calculated All Red	2.3	1.9	0.0	2.4	2.4	1.9	0.0	2.2
Walk		7		7		7		7
FDW		23		26		22		28
Max INI								

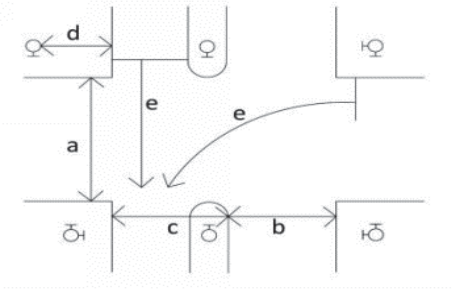
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		76		86		71		91
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		9		12		15		14
"e" (Distance from stop bar to farthest side of conflicting lane)	65	63		84	67	63		78

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



Lengths and Distances Key



Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	5	7	5	12	0	7
Yellow	3	3.5	3	3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**0**	**2.5**
Calculated All Red	2.4	2.2	2.1	2.2	2.3	1.8	0.0	2.1
Walk		7				7		7
FDW		24				20		27
Max INI								

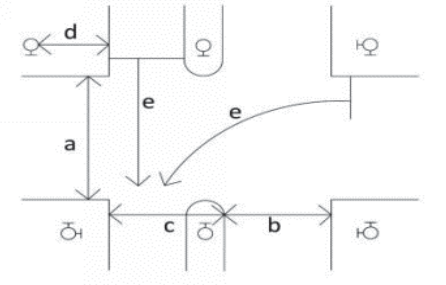
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		81				67		89
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		12		0		16		20
"e" (Distance from stop bar to farthest side of conflicting lane)	68	75	56	76	66	59		72

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	25	30	25	30	0	30

Phasing Diagram

Phase 7 exists only on the layout.

Lengths and Distances Key

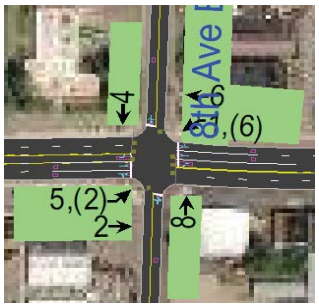


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2**	**0**	**2.5**	**2.5**	**2**	**0**	**2.5**
Calculated All Red	2.2	1.9	0.0	2.2	2.2	1.8	0.0	2.0
Walk		7		7		7		7
FDW		24		28		28		26
Max INI								

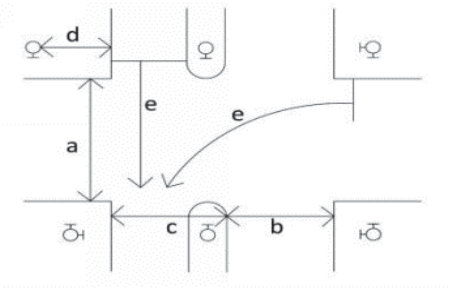
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		77		92		90		86
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		17		16		17		13
"e" (Distance from stop bar to farthest side of conflicting lane)	61	64		79	61	61		68

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



Lengths and Distances Key

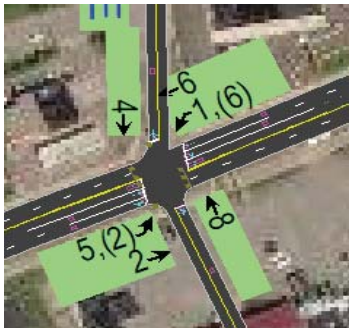


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2**	**0**	**2.5**	**2**	**2**	**0**	**2.5**
Calculated All Red	2.1	1.7	0.0	2.4	2.0	1.8	0.0	2.5
Walk		7		7		7		7
FDW		16		31		24		30
Max INI								

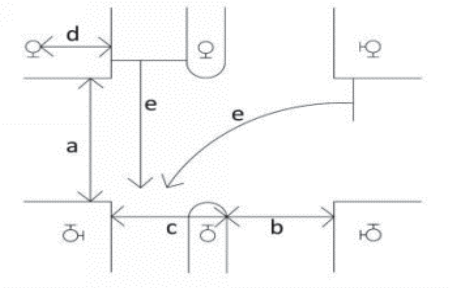
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		53		100		77		97
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		11		16		19		13
"e" (Distance from stop bar to farthest side of conflicting lane)	57	53		87	53	61		90

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



Lengths and Distances Key

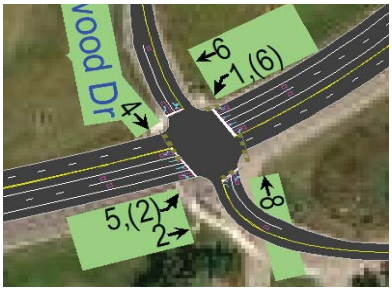


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	4		3.5	3	4		3.5
Proposed All Red	**3.5**	**2**	**0**	**3.5**	**3**	**2**	**0**	**3.5**
Calculated All Red	3.1	1.8	0.0	3.2	2.9	1.5	0.0	3.2
Walk				7		7		
FDW				29		15		
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)				111		60		
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)				10		10		
"e" (Distance from stop bar to farthest side of conflicting lane)	94	87		123	87	66		119

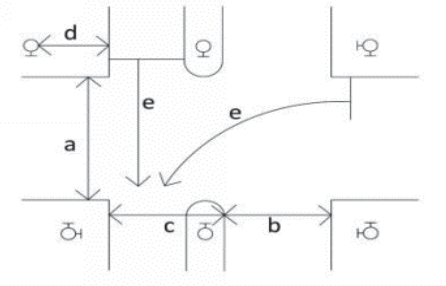
Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	40	0	30	25	40	0	30

Phasing Diagram



FYA on mainline

Lengths and Distances Key

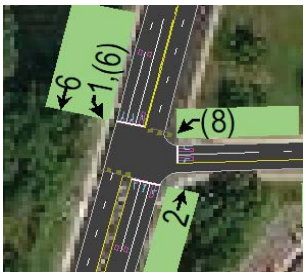


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	1	0	12	0	7
Yellow	3	4		3		4		3.5
Proposed All Red	**3**	**2.5**	**0**	**0**	**0**	**2.5**	**0**	**2.5**
Calculated All Red	2.7	2.0	0.0	0.0	0.0	1.5	0.0	2.3
Walk		7		7				
FDW		20		29				
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		81		99				
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		11		11				
"e" (Distance from stop bar to farthest side of conflicting lane)	80	98				70		80

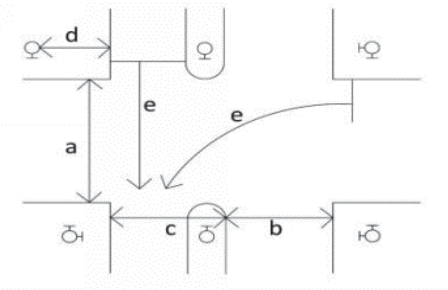
Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	40	0	0	0	40	0	30

Phasing Diagram



Note: Phase 4 is Ped Phase Crossing South Leg. Operates Concurrent with Phase 8. No Phase 8 Ped Interval

Lengths and Distances Key

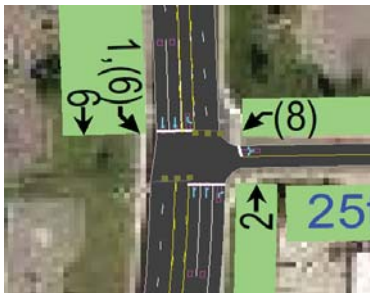


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	1	0	12	0	7
Yellow	3	4		3		4		3.5
Proposed All Red	**3**	**2**	**0**	**0**	**0**	**2**	**0**	**2.5**
Calculated All Red	2.9	1.6	0.0	0.0	0.0	1.6	0.0	2.2
Walk		7		7				7
FDW		23		27				24
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		89		94				94
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		15						10
"e" (Distance from stop bar to farthest side of conflicting lane)	85	72				71		76

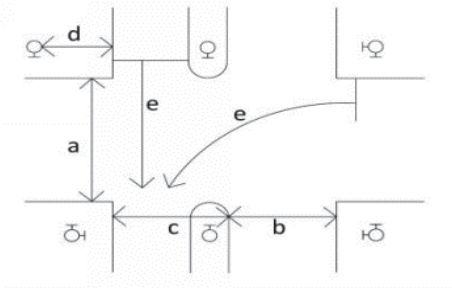
Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	40	0	0	0	40	0	30

Phasing Diagram



Note: Phase 4 Ped is Exclusive Phase (Crossing South Leg). No Ped Crossing with Phase 8

Lengths and Distances Key

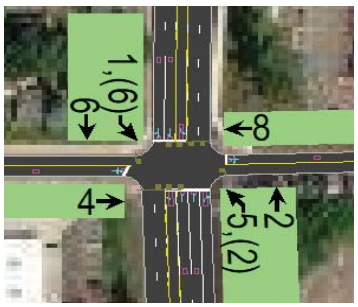


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	4		3.5	3	4		3.5
Proposed All Red	**2.5**	**2**	**0**	**3**	**2.5**	**2**	**0**	**3**
Calculated All Red	2.4	2.0	0.0	2.6	2.4	1.3	0.0	2.8
Walk		7		7		7		7
FDW		20		24		13		26
Max INI								

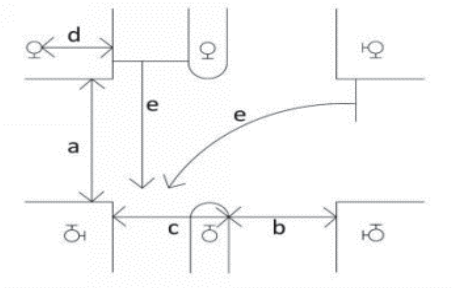
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		80		93		53		101
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		11		9		8		11
"e" (Distance from stop bar to farthest side of conflicting lane)	69	68		94	68	59		103

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	40	0	30

Phasing Diagram



Lengths and Distances Key

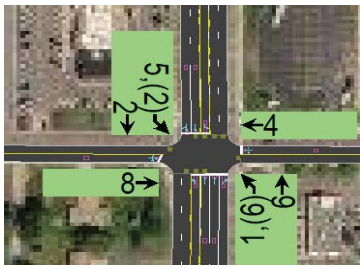


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2.5**	**0**	**2.5**	**3**	**2.5**	**0**	**2.5**
Calculated All Red	2.4	2.2	0.0	2.4	2.8	1.9	0.0	2.5
Walk		7		7		7		7
FDW		13		20		14		21
Max INI								

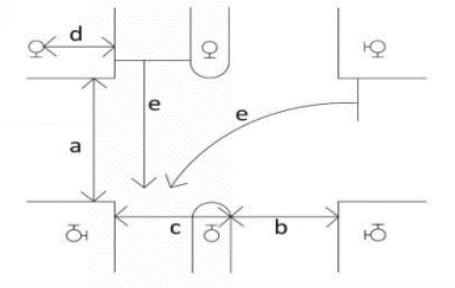
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		55		78		58		84
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		4		4		4		4
"e" (Distance from stop bar to farthest side of conflicting lane)	67	76		86	83	65		88

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



Lengths and Distances Key



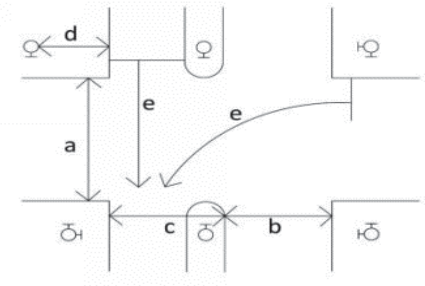
Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	5	7	5	12	5	7
Yellow	3	3.5	3	3.5	3	3.5	3	3.5
Proposed All Red	**3**	**2.5**	**3**	**3**	**3**	**2.5**	**3**	**3**
Calculated All Red	2.7	2.2	2.9	2.7	2.9	2.3	2.6	2.9
Walk		7		7		7		7
FDW		19		26		20		27
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		76		101		79		106
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		7		9		6		6
"e" (Distance from stop bar to farthest side of conflicting lane)	78	79	85	100	87	81	76	108

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	25	30	25	30	25	30

Phasing Diagram

Lengths and Distances Key

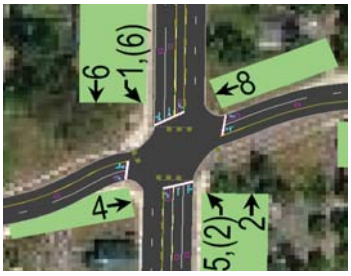


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2.5**	**0**	**2.5**	**2.5**	**2.5**	**0**	**2.5**
Calculated All Red	2.2	2.1	0.0	2.4	2.2	2.1	0.0	2.4
Walk		7		7		7		7
FDW		14		17		13		18
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		57		70		54		71
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		4		4		4		4
"e" (Distance from stop bar to farthest side of conflicting lane)	59	73		85	61	71		84

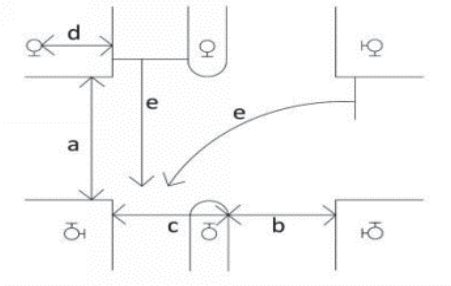
Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



FYA on mainline

Lengths and Distances Key

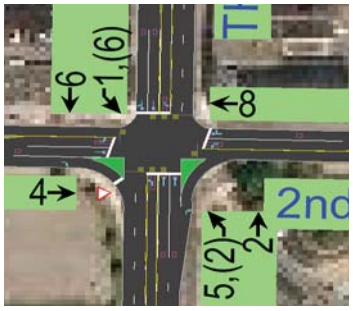


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2.5**	**0**	**2.5**	**2.5**	**2.5**	**0**	**2.5**
Calculated All Red	2.2	2.1	0.0	2.4	2.2	2.1	0.0	2.4
Walk		7		7		7		7
FDW		14		19		15		19
Max INI								

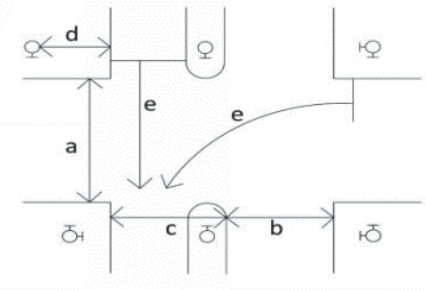
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		50		65		54		65
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		4		4		4		4
"e" (Distance from stop bar to farthest side of conflicting lane)	59	73		85	61	71		84

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



Lengths and Distances Key

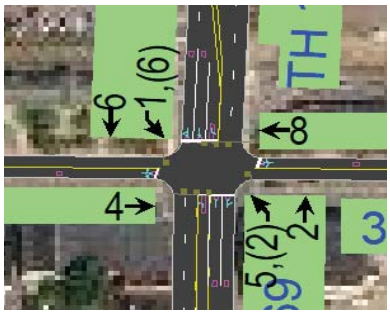


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2**	**0**	**2.5**	**2.5**	**2**	**0**	**2.5**
Calculated All Red	2.3	1.7	0.0	2.2	2.2	1.8	0.0	2.3
Walk		7		7		7		7
FDW		14		22		14		21
Max INI								

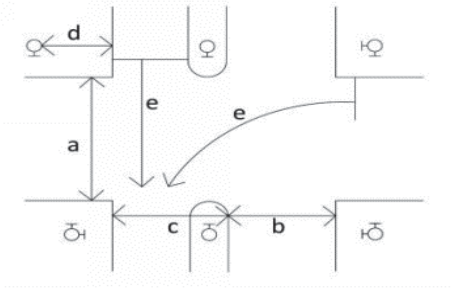
Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		47		74		48		70
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		8		8		7		7
"e" (Distance from stop bar to farthest side of conflicting lane)	63	57		76	59	60		83

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	30	25	30	0	30

Phasing Diagram



Lengths and Distances Key

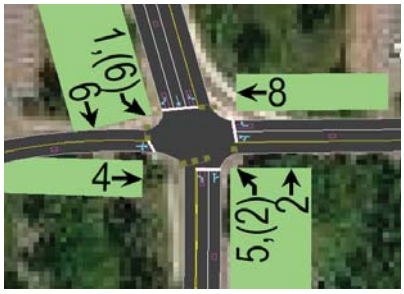


Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	0	7	5	12	0	7
Yellow	3	3.5		3.5	3	3.5		3.5
Proposed All Red	**2.5**	**2**	**0**	**3**	**2.5**	**2**	**0**	**3**
Calculated All Red	2.0	1.6	0.0	2.9	2.0	1.7	0.0	2.3
Walk		7		7		7		7
FDW		14		20		16		19
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		57		79		63		77
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		9		8		8		9
"e" (Distance from stop bar to farthest side of conflicting lane)	55	50		65	55	53		82

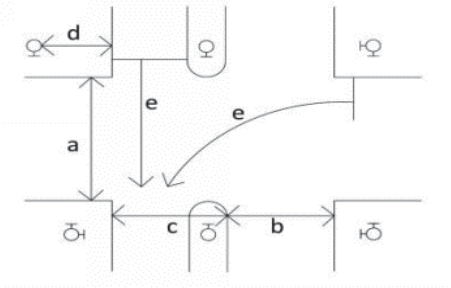
Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	0	20	25	30	0	30

Phasing Diagram



FYA on mainline

Lengths and Distances Key



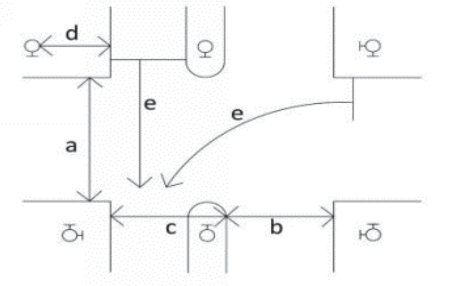
Controller Timing Values (s)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Min Green	5	12	5	7	5	12	5	7
Yellow	3	3.5	3	3.5	3	3.5	3	3.5
Proposed All Red	**2.5**	**2.5**	**3**	**3**	**2.5**	**2.5**	**3**	**3**
Calculated All Red	2.3	1.8	2.7	2.6	2.5	2.1	2.8	2.4
Walk		7		7		7		7
FDW		15		28		23		26
Max INI								

Ped Crosswalk Lengths, Push buttons, and Red Clearance Distances (ft)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
"a+d" (Curb to curb cross walk distance without median push button Plus longest pushbutton to curb distance)		52		93		77		87
"b" (Longest curb to median push button distance)								
"c" (Shortest curb to median push button distance+Median length)								
"d" (Longest distance from push button to curb)		8		15		10		8
"e" (Distance from stop bar to farthest side of conflicting lane)	65	60	80	94	71	72	81	84

Design Speeds (mph)								
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**
Posted Speed Limit/Vehicle Turning Speed	25	30	25	30	25	30	25	30

Phasing Diagram

Lengths and Distances Key



Appendix B:

Coordination Timing Plan Summary

Cycle Length and Timing Plan Summary
Grand Rapids

	Synchro Node No.	Intersection	Controller Type	FYA Capable?	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6	Plan 7	Plan 8	Plan 9
	801	TH 2 & CSAH 63	ASC2	No	100	106	120	--	--	96	--	--	90
	802	TH 2 & TH 38	ASC2	No	100	106	120	60	--	96	--	70	90
	803	TH 2 & 1st Avenue W	ASC2	No	100	106	120	60	--	96	--	70	90
	804	TH 2 & TH 169 W Junction	ASC2	No	100	106	120	60	--	96	--	70	90
	806	TH 2 & 1st Avenue E	ASC2	No	100	106	120	60	--	96	--	70	90
	807	TH 2 & TH 169 E Junction	ASC2	No	100	106	120	60	--	96	--	70	90
	808	TH 169 & 8th Avenue E	ASC2	No	100	106	120	60	--	96	--	70	90
	809	TH 169 & 13th Avenue E	ASC2	No	100	106	120	--	--	96	--	70	90
	810	TH 169 & Glenwood Drive	ASC 3	EB/WB	100	106	120	--	--	96	--	70	90
	811	TH 169 & 29th Street S	ASC2	No	100	106	120	--	--	96	--	70	90
	812	TH 169 & 25th Street S	ASC2	No	100	106	120	--	--	96	--	70	90
	813	TH 169 & 21st Street S	ASC2	No	100	106	120	--	--	96	--	70	90
	814	TH 169 & 13th Street S	ASC2	No	100	106	120	--	--	96	--	70	90
	815	TH 169 & 10th Street N	ASC2	No	100	106	120	--	--	96	--	70	90
	816	TH 169 & 4th Street S	ASC 3	NB/SB	100	106	120	--	--	96	--	70	90
	817	TH 169 & 2nd Street N	ASC2	No	100	106	120	60	--	96	--	70	90
	818	TH 169 & 3rd Street N	ASC2	No	100	106	120	60	--	96	--	70	90
	819	TH 38 & 14th Street N	ASC3	NB/SB	--	--	--	--	--	--	--	--	--
	820	TH 2 & 7th Avenue E	ASC2	No	100	106	120	60	--	96	--	70	90

Local Pattern and Cycle Length Identification

Local Controller Pattern No.	CSAH 47 Signal Optimization			
	COS SUMMARY			
	COS	Cycle	Volume Case	Notes
Plan 1	522	100	AM PEAK	
Plan 2	611	106	MID PEAK	
Plan 3	633	120	PM PEAK	
Plan 4	111	60	LOW	Also Free AP
Plan 5	--			
Plan 6	411	96	PM OFF	
Plan 7	--			
Plan 8	211	70	EVENING	
Plan 9	311	90	OFF LOW AM	
Plan 10	--		--	
Plan 11	--		--	
Plan 12	--		--	
Plan 13	--		--	
Plan 14	--		--	

254 = FREE

Coordination Operation Notes:

1. Splits and Offsets in Seconds
2. Smooth Transition
3. Leading Offset Reference
4. Inhibit Max Green
5. Force Off Added Initial Green
6. Fixed Force Off
7. SYS System Source in Standard Format

TOD and Local Controller Timebase Schedule
Grand Rapids

		Grand Rapids																										
		Group 1: TH 2 and TH 169 802-808, 817, 818, 820					Group 2: TH 169 813-816					Group 2a: TH 169 811-812					Group 3: TH 169 809-810					Group 4: TH 38/14th St N 819					Group 5: US 2/CR 63 801				
Type	Operation	Timebase Start Time	COS	Action Plan	Coord Pattern	Cycle Length (s)	Timebase Start Time	COS	Action Plan	Coord Pattern	Cycle Length (s)	Timebase Start Time	COS	Action Plan	Coord Pattern	Cycle Length (s)	Timebase Start Time	COS	Action Plan	Coord Pattern	Cycle Length (s)	Timebase Start Time	Action Plan	Coord Pattern	Cycle Length (s)	Timebase Start Time	COS	Action Plan	Coord Pattern	Cycle Length (s)
Weekday (Mon-Thurs) (Prog 1)	TOD	0:00:00	111	4	4	60	0:00:00	111	4	254	Free	0:00:00	111	4	254	Free	0:00:00	111	4	254	Free	0:00:00	4	254	Free	0:00:00	111	4	254	Free
		6:30:00	211	8	8	70	5:30:00	111	4	254	Free	5:30:00	111	4	254	Free	5:30:00	111	4	254	Free	6:30:00	2	254	Free	5:30:00	111	4	254	Free
		7:20:00	522	1	1	100	6:30:00	211	8	8	70	6:30:00	111	4	254	Free	6:30:00	211	8	8	70	19:00:00	4	254	Free	6:30:00	111	4	254	Free
		8:30:00	311	9	9	90	7:20:00	522	1	1	100	7:20:00	522	1	1	100	7:20:00	522	1	1	100					7:20:00	522	1	1	100
		10:00:00	611	2	2	106	8:30:00	311	9	9	90	8:30:00	311	9	9	90	8:30:00	311	9	9	90					8:30:00	311	9	9	90
		14:00:00	633	3	3	120	10:00:00	611	2	2	106	10:00:00	611	2	2	106	10:00:00	611	2	2	106					10:00:00	611	2	2	106
		17:30:00	411	6	6	96	14:00:00	633	3	3	120	14:00:00	633	3	3	120	14:00:00	633	3	3	120					14:00:00	633	3	3	120
		19:00:00	211	8	8	70	17:30:00	411	6	6	96	17:30:00	411	6	6	96	17:30:00	411	6	6	96					17:30:00	411	6	6	96
		21:00:00	111	4	4	60	19:00:00	211	8	8	70	19:00:00	211	8	8	70	19:00:00	211	8	8	70					19:00:00	111	4	254	Free
							21:00:00	111	4	254	Free	21:00:00	111	4	254	Free	20:00:00	111	4	254	Free					21:00:00	111	4	254	Free
							23:00:00	111	4	254	Free	23:00:00	111	4	254	Free	23:00:00	111	4	254	Free					23:00:00	111	4	254	Free
Weekend (Prog 2)	TOD	0:00:00	111	4	4	60	0:00:00	111	4	254	Free	0:00:00	111	4	254	Free	0:00:00	111	4	254	Free	0:00:00	4	254	Free	0:00:00	111	4	254	Free
		7:30:00	211	8	8	70	6:30:00	111	4	254	Free	6:30:00	111	4	254	Free	6:30:00	111	4	254	Free	6:30:00	2	254	Free	6:30:00	111	4	254	Free
		8:30:00	311	9	9	90	7:30:00	211	8	8	70	7:30:00	211	8	8	70	7:30:00	211	8	8	70	19:00:00	4	254	Free	7:30:00	111	4	254	Free
		10:30:00	611	2	2	106	8:30:00	311	9	9	90	8:30:00	311	9	9	90	8:30:00	311	9	9	90					8:30:00	311	9	9	90
		17:30:00	311	9	9	90	10:30:00	611	2	2	106	10:30:00	611	2	2	106	10:30:00	611	2	2	106					10:30:00	611	2	2	106
		19:00:00	211	8	8	70	17:30:00	311	9	9	90	17:30:00	311	9	9	90	17:30:00	311	9	9	90					17:30:00	111	4	254	Free
		21:00:00	111	4	4	60	19:00:00	211	8	8	70	19:00:00	211	8	8	70	19:00:00	211	8	8	70					19:00:00	111	4	254	Free
							21:00:00	111	4	254	Free	21:00:00	111	4	254	Free	21:00:00	111	4	254	Free					21:00:00	111	4	254	Free
							23:00:00	111	4	254	Free	23:00:00	111	4	254	Free	23:00:00	111	4	254	Free					23:00:00	111	4	254	Free
Weekday (Friday) (Prog 4)	TOD	0:00:00	111	4	4	60	0:00:00	111	4	254	Free	0:00:00	111	4	254	Free	0:00:00	111	4	254	Free	0:00:00	4	254	Free	0:00:00	111	4	254	Free
		6:30:00	211	8	8	70	5:30:00	111	4	254	Free	5:30:00	111	4	254	Free	5:30:00	111	4	254	Free	6:30:00	2	254	Free	5:30:00	111	4	254	Free
		7:20:00	522	1	1	100	6:30:00	211	8	8	70	6:30:00	111	4	254	Free	6:30:00	211	8	8	70	19:00:00	4	254	Free	6:30:00	111	4	254	Free
		8:30:00	311	9	9	90	7:20:00	522	1	1	100	7:20:00	522	1	1	100	7:20:00	522	1	1	100					7:20:00	522	1	1	100
		10:00:00	611	2	2	106	8:30:00	311	9	9	90	8:30:00	311	9	9	90	8:30:00	311	9	9	90					8:30:00	311	9	9	90
		13:30:00	633	3	3	120	10:00:00	611	2	2	106	10:00:00	611	2	2	106	10:00:00	611	2	2	106					10:00:00	611	2	2	106
		18:00:00	411	6	6	96	13:30:00	633	3	3	120	13:30:00	633	3	3	120	13:30:00	633	3	3	120					13:30:00	633	3	3	120
		20:00:00	211	8	8	70	18:00:00	411	6	6	96	18:00:00	411	6	6	96	18:00:00	411	6	6	96					18:00:00	411	6	6	96
		21:00:00	111	4	4	60	20:00:00	211	8	8	70	20:00:00	211	8	8	70	20:00:00	111	4	4	Free					20:00:00	111	4	254	Free
							21:00:00	111	4	254	Free	21:00:00	111	4	254	Free	21:00:00	111	4	254	Free					21:00:00	111	4	254	Free
							23:00:00	111	4	254	Free	23:00:00	111	4	254	Free	23:00:00	111	4	254	Free					23:00:00	111	4	254	Free

AP 4 Free. Refer to FYA Operation Standards

Coordination Pattern 4 = FREE (if not operated with cycle length)

AP 2 (Phase 1 and 5 - protected/permissive): TH 38/14th Street (#819)

AP 4 (Phase 1/3/5/7 - Permissive): TH 169/4th Street (#816) and TH 38/14th Street (#819), (Phase 1/5 - Prot/Perm Mainline, Phase 3/7- Permissive): TH 169/Glenwood (#810)

FYA Action Plan Summary - Optimization

810 TH 2 and Glenwood

Action Plan	COS	Scenario	Coord Pattern	Special Function	Phase Omit	Proposed FYA Operation	Det. Plan	LP Enabled	Notes
Plan 1		AM PEAK	1			1,5 - P/P	1		
Plan 2		MID PEAK	2			1,5 - P/P	1		
Plan 3		PM PEAK	3			1,5 - P/P	1		
Plan 4		FREE	254			1,5 - P/P	1		
Plan 5									
Plan 6		PM OFF	6			1,5 - P/P	1		
Plan 7									
Plan 8		EVENING	8			1,5 - P/P	1		
Plan 9		OFF LOW AM	9			1,5 - P/P	1		

819 TH 38 and 14th

Action Plan	COS	Scenario	Coord Pattern	Special Function	Phase Omit	Proposed FYA Operation	Det. Plan	LP Enabled	Notes
Plan 4		FREE	254		1,5	1,5 - Perm	1		
Plan 2		FREE	254			1,5 - P/P	1		

816 TH 169 and 4th

Action Plan	COS	Scenario	Coord Pattern	Special Function	Phase Omit	Proposed FYA Operation	Det. Plan	LP Enabled	Notes
Plan 1		AM PEAK	1			1,5 - P/P	1		
Plan 2		MID PEAK	2			1,5 - P/P	1		
Plan 3		PM PEAK	3			1,5 - P/P	1		
Plan 4		FREE	254		1,5	1,5 - Perm	1		
Plan 5									
Plan 6		PM OFF	6			1,5 - P/P	1		
Plan 7									
Plan 8		EVENING	8			1,5 - P/P	1		
Plan 9		OFF LOW AM	9			1,5 - P/P	1		

801 TH 2 & CSAH 63

Controller Type: ASC2 — TH 2 & CSAH 63

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	0	12	0	0				
Yellow	3	4.5		5		4.5		0				
Proposed All Red	3	1.5	0	1.5	0	1.5	0	0				
Walk												
FDW												
Max INI		30				30						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	15	62	--	23	--	77	--	--	--	--	--	--	100	43	--	1	26+		
Plan 2	**611**	MID PEAK	13	72	--	21	--	85	--	--	--	--	--	--	106	33	--	1	26+		
Plan 3	**633**	PM PEAK	20	68	--	32	--	88	--	--	--	--	--	--	120	47	--	1	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	17	55	--	24	--	72	--	--	--	--	--	--	96	61	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 9	**311**	OFF LOW AM	17	48	--	25	--	65	--	--	--	--	--	--	90	62	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	36	--	--	--	36	--	--	--	--	--	--							
		Min Split Check	11	18	--	13.5	--	18	--	0	--	--	--	--							
		Coord/Ped Split Check	--	--	--	--	--	--	--	--	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) Railroad Preemption
2) Phase 1 (det 17) add phase 6 cross swithc
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

802 **TH 2 & TH 38**

Controller Type: ASC2 **TH 2 & TH 38**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	5	7				
Yellow	3	3.5		3.5	3	3.5	3	3.5				
Proposed All Red	2.5	2	0	2.5	2.5	2	2.5	2.5				
Walk		7		7		7		7				
FDW		19		32		28		31				
Max INI		0				0						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	49	--	38	13	49	22	16	--	--	--	--	100	82	--	1	26+		
Plan 2	**611**	MID PEAK	13	59	--	34	13	59	18	16	--	--	--	--	106	88	--	1	26+		
Plan 3	**633**	PM PEAK	13	70	--	37	13	70	19	18	--	--	--	--	120	116	--	1	26+		
Plan 4	**111**	LOW	Omit	41	--	19	Omit	41	Omit	19	--	--	--	--	60	7	--	1	26+		Φ1 Φ5 Φ7
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	50	--	33	13	50	16	17	--	--	--	--	96	80	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	50	--	20	Omit	50	Omit	20	--	--	--	--	70	12	--	1	26+		Φ1 Φ5 Φ7
Plan 9	**311**	OFF LOW AM	13	42	--	35	13	42	18	17	--	--	--	--	90	79	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	17.5	--	13	10.5	17.5	10.5	13	--	--	--	--							
		Coord/Ped Split Check	--	31.5	--	45	--	40.5	--	44	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1)
2) phase 1 and 5 cross switching
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

803 TH 2 & 1st Avenue W

Controller Type: ASC2 — **TH 2 & 1st Avenue W**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2.5	0	2.5	2.5	2.5	0	2.5				
Walk		7		7		7		7				
FDW		22		26		22		25				
Max INI		0				0						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	12	49	--	39	12	49	--	39	--	--	--	--	100	85	--	1	26+		
Plan 2	**611**	MID PEAK	12	55	--	39	12	55	--	39	--	--	--	--	106	88	--	1	26+		
Plan 3	**633**	PM PEAK	12	69	--	39	12	69	--	39	--	--	--	--	120	107	--	1	26+		
Plan 4	**111**	LOW	Omit	35	--	25	Omit	35	--	25	--	--	--	--	60	7	--	1	26+		Φ1 Φ5
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	12	45	--	39	12	45	--	39	--	--	--	--	96	89	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	35	--	35	Omit	35	--	35	--	--	--	--	70	23	--	1	26+		Φ1 Φ5
Plan 9	**311**	OFF LOW AM	12	39	--	39	12	39	--	39	--	--	--	--	90	81	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	18	--	13	10.5	18	--	13	--	--	--	--							
		Coord/Ped Split Check	--	35	--	39	--	35	--	38	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1)
2) phase 1 and 5 cross switching
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

804 TH 2 & TH 169 W Junction

Controller Type: ASC2

FYA Capable? No

TH 2 & TH 169 W Junction

Controller Timing Values (s)

Phase	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12
Min Green	5	12	7	7	5	12	7	7				
Yellow	3	3.5	3	3.5	3	3.5	3	3.5				
Proposed All Red	2.5	2.5	3	2.5	2.5	2.5	2.5	2.5				
Walk		7		7		7		7				
FDW		22		22		25		21				
Max INI		0				0						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	15	37	25	23	12	40	23	25	--	--	--	--	100	82	--	1	26+		
Plan 2	**611**	MID PEAK	15	35	38	18	12	38	18	38	--	--	--	--	106	95	--	1	26+		
Plan 3	**633**	PM PEAK	18	36	45	21	12	42	21	45	--	--	--	--	120	7	--	1	26+		
Plan 4	**111**	LOW	Omit	30	15	15	Omit	30	15	15	--	--	--	--	60	3	--	1	26+		Φ1 Φ5
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	14	36	29	17	11	39	17	29	--	--	--	--	96	82	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	38	17	15	Omit	38	15	17	--	--	--	--	70	17	--	1	26+		Φ1 Φ5
Plan 9	**311**	OFF LOW AM	15	32	26	17	12	35	17	26	--	--	--	--	90	77	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	18	13	13	10.5	18	12.5	13	--	--	--	--							
		Coord/Ped Split Check	--	35	--	35	--	38	--	34	--	--	--	--							

FYA Left Turning Operations

	Φ1	Φ3	Φ5	Φ7
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) NBL lag - fixed barrier
2) Railroad Preemption
3) phase 1 and 5 cross switching
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

806 TH 2 & 1st Avenue E

Controller Type: ASC2 — **TH 2 & 1st Avenue E**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2	0	2.5	2.5	2	0	2.5				
Walk		7		7		7		7				
FDW		23		26		22		28				
Max INI		0				0						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	46	--	41	13	46	--	41	--	--	--	--	100	94	--	1	26+		
Plan 2	**611**	MID PEAK	13	52	--	41	13	52	--	41	--	--	--	--	106	90	--	1	26+		
Plan 3	**633**	PM PEAK	13	66	--	41	13	66	--	41	--	--	--	--	120	117	--	1	26+		
Plan 4	**111**	LOW	Omit	40	--	20	Omit	40	--	20	--	--	--	--	60	3	--	1	26+		Φ1 Φ5
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	42	--	41	13	42	--	41	--	--	--	--	96	92	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	36	--	34	Omit	36	--	34	--	--	--	--	70	27	--	1	26+		Φ1 Φ5
Plan 9	**311**	OFF LOW AM	13	36	--	41	13	36	--	41	--	--	--	--	90	86	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	17.5	--	13	10.5	17.5	--	13	--	--	--	--							
		Coord/Ped Split Check	--	35.5	--	39	--	34.5	--	41	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1)
2) phase 1 and 5 cross switching
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

807 TH 2 & TH 169 E Junction

Controller Type: ASC2 — **TH 2 & TH 169 E Junction**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	5	7	5	12	0	7				
Yellow	3	3.5	3	3.5	3	3.5		3.5				
Proposed All Red	2.5	2.5	2.5	2.5	2.5	2.5	0	2.5				
Walk		7				7		7				
FDW		24				20		27				
Max INI		20				20						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	45	20	22	13	45	--	42	--	--	--	--	100	31	--	1	26+		
Plan 2	**611**	MID PEAK	13	48	22	23	13	48	--	45	--	--	--	--	106	31	--	1	26+		
Plan 3	**633**	PM PEAK	13	55	30	22	13	55	--	52	--	--	--	--	120	54	--	1	26+		
Plan 4	**111**	LOW	Omit	37	Omit	23	Omit	37	--	23	--	--	--	--	60	45	--	1	26+		Φ1 Φ3 Φ5
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	49	16	18	13	49	--	34	--	--	--	--	96	29	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	37	Omit	33	Omit	37	--	33	--	--	--	--	70	63	--	1	26+		Φ1 Φ3 Φ5
Plan 9	**311**	OFF LOW AM	13	39	18	20	13	39	--	38	--	--	--	--	90	34	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	26	--	--	--	26	--	--	--	--	--	--							
		Min Split Check	10.5	18	10.5	13	10.5	18	--	13	--	--	--	--							
		Coord/Ped Split Check	--	37	--	--	--	33	--	40	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) phase 1 and 5 cross switching
2) Dual assign phase 3 detectors with phase 8
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

808 TH 169 & 8th Avenue E

Controller Type: ASC2 — **TH 169 & 8th Avenue E**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2	0	2.5	2.5	2	0	2.5				
Walk		7		7		7		7				
FDW		24		28		28		26				
Max INI		20				20						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	25	45	--	30	13	57	--	30	--	--	--	--	100	29	--	1	26+		
Plan 2	**611**	MID PEAK	20	61	--	25	13	68	--	25	--	--	--	--	106	30	--	1	26+		
Plan 3	**633**	PM PEAK	25	62	--	33	13	74	--	33	--	--	--	--	120	51	--	1	26+		
Plan 4	**111**	LOW	Omit	41	--	19	Omit	41	--	19	--	--	--	--	60	52	--	1	26+		Φ1 Φ5
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	23	53	--	20	13	63	--	20	--	--	--	--	96	29	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	37	--	33	Omit	37	--	33	--	--	--	--	70	8	--	1	26+		Φ1 Φ5
Plan 9	**311**	OFF LOW AM	23	37	--	30	13	47	--	30	--	--	--	--	90	41	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	25.5	--	--	--	25.5	--	--	--	--	--	--							
		Min Split Check	10.5	17.5	--	13	10.5	17.5	--	13	--	--	--	--							
		Coord/Ped Split Check	--	36.5	--	41	--	40.5	--	39	--	--	--	--							

FYA Left Turning Operations				
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) phase 1 and 5 cross switching
2)
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

809 TH 169 & 13th Avenue E

Controller Type: ASC2 — **TH 169 & 13th Avenue E**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2	0	2.5	2	2	0	2.5				
Walk		7		7		7		7				
FDW		16		31		24		30				
Max INI		20				20						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	59	--	28	13	59	--	28	--	--	--	--	100	74	--	1	26+		
Plan 2	**611**	MID PEAK	13	60	--	33	13	60	--	33	--	--	--	--	106	86	--	1	26+		
Plan 3	**633**	PM PEAK	13	72	--	35	13	72	--	35	--	--	--	--	120	2	--	1	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	C	5	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	59	--	24	13	59	--	24	--	--	--	--	96	86	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	37	--	21	12	37	--	21	--	--	--	--	70	42	--	1	26+		
Plan 9	**311**	OFF LOW AM	13	49	--	28	13	49	--	28	--	--	--	--	90	83	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	25.5	--	--	--	25.5	--	--	--	--	--	--							
		Min Split Check	10.5	17.5	--	13	10	17.5	--	13	--	--	--	--							
		Coord/Ped Split Check	--	28.5	--	44	--	36.5	--	43	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) phase 1 and 5 cross switching
2)
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

810 TH 169 & Glenwood Drive

Controller Type: ASC 3 — TH 169 & Glenwood Drive

FYA Capable? EB/WB

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	4		3.5	3	4		3.5				
Proposed All Red	3.5	2	0	3.5	3	2	0	3.5				
Walk				7		7						
FDW				29		15						
Max INI												

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	60	--	27	18	55	--	27	--	--	--	--	100	13	C	5	26+		
Plan 2	**611**	MID PEAK	13	64	--	29	19	58	--	29	--	--	--	--	106	22	C	5	26+		
Plan 3	**633**	PM PEAK	13	74	--	33	18	69	--	33	--	--	--	--	120	66	--	1	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	60	--	23	15	58	--	23	--	--	--	--	96	28	C	5	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	37	--	21	12	37	--	21	--	--	--	--	70	44	--	1	26+		
Plan 9	**311**	OFF LOW AM	13	54	--	23	18	49	--	23	--	--	--	--	90	21	C	5	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	11.5	18	--	14	11	18	--	14	--	--	--	--							
		Coord/Ped Split Check	--	--	--	43	--	28	--	--	--	--	--	--							

FYA Left Turning Operations				
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	P/P	--	P/P	--
Plan 2	P/P	--	P/P	--
Plan 3	P/P	--	P/P	--
Plan 4	P/P	--	P/P	--
Plan 5	--	--	--	--
Plan 6	P/P	--	P/P	--
Plan 7	--	--	--	--
Plan 8	P/P	--	P/P	--
Plan 9	P/P	--	P/P	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) 3.0s FYA Delay (OVLP E and G)
2) Enable USDLS due to no comm.
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed:

811 TH 169 & 29th Street S

Controller Type: ASC2 — **TH 169 & 29th Street S**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	1	0	12	0	7				
Yellow	3	4		3		4		3.5				
Proposed All Red	3	2.5	0	0	0	2.5	0	2.5				
Walk		7		7								
FDW		20		29								
Max INI		27				27						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	20	58	--	1	--	78	--	21	--	--	--	--	100	48	--	1	26+		
Plan 2	**611**	MID PEAK	28	45	--	1	--	73	--	32	--	--	--	--	106	59	--	1	26+		
Plan 3	**633**	PM PEAK	23	70	--	1	--	93	--	26	--	--	--	--	120	63	A	2	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	21	50	--	1	--	71	--	24	--	--	--	--	96	41	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	40	--	1	--	52	--	17	--	--	--	--	70	29	A	2	26+		
Plan 9	**311**	OFF LOW AM	20	45	--	1	--	65	--	24	--	--	--	--	90	51	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	33.5	--	--	--	33.5	--	--	--	--	--	--							
		Min Split Check	11	18.5	--	4	--	18.5	--	13	--	--	--	--							
		Coord/Ped Split Check	--	33.5	--	39	--	--	--	--	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) Dual assign phase 1 detectors with phase 6
2) Ped Phase 4 and vehicle phase 8 operate concurrent
3) Remove back up prevent
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

812 TH 169 & 25th Street S

Controller Type: ASC2 — **TH 169 & 25th Street S**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	1	0	12	0	7				
Yellow	3	4		3		4		3.5				
Proposed All Red	3	2	0	0	0	2	0	2.5				
Walk		7		7				7				
FDW		23		27				24				
Max INI		26				26						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	20	57	--	1	--	77	--	22	--	--	--	--	100	86	A	2	26+		
Plan 2	**611**	MID PEAK	19	66	--	1	--	85	--	20	--	--	--	--	106	96	A	2	26+		
Plan 3	**633**	PM PEAK	18	82	--	1	--	100	--	19	--	--	--	--	120	85	A	2	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	15	60	--	1	--	75	--	20	--	--	--	--	96	76	A	2	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	37	--	1	--	49	--	20	--	--	--	--	70	31	--	1	26+		
Plan 9	**311**	OFF LOW AM	18	49	--	1	--	67	--	22	--	--	--	--	90	87	A	2	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	32	--	--	--	32	--	--	--	--	--	--							
		Min Split Check	11	18	--	4	--	18	--	13	--	--	--	--							
		Coord/Ped Split Check	--	36	--	37	--	--	--	37	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) Dual assign phase 1 detectors with phase 6
2) Exclusive Ped Phase 4
3) Remove back up prevent
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

813 TH 169 & 21st Street S

Controller Type: ASC2 — **TH 169 & 21st Street S**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	4		3.5	3	4		3.5				
Proposed All Red	2.5	2	0	3	2.5	2	0	3				
Walk		7		7		7		7				
FDW		20		24		13		26				
Max INI		26				26						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	15	62	--	23	13	64	--	23	--	--	--	--	100	0	--	1	26+		
Plan 2	**611**	MID PEAK	15	59	--	32	13	61	--	32	--	--	--	--	106	9	--	1	26+		
Plan 3	**633**	PM PEAK	15	81	--	24	13	83	--	24	--	--	--	--	120	83	--	1	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	15	56	--	25	13	58	--	25	--	--	--	--	96	90	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	38	--	20	12	38	--	20	--	--	--	--	70	69	--	1	26+		
Plan 9	**311**	OFF LOW AM	15	43	--	32	13	45	--	32	--	--	--	--	90	10	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	32	--	--	--	32	--	--	--	--	--	--							
		Min Split Check	10.5	18	--	13.5	10.5	18	--	13.5	--	--	--	--							
		Coord/Ped Split Check	--	33	--	37.5	--	26	--	39.5	--	--	--	--							

FYA Left Turning Operations				
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) phase 1 and 5 detector cross switching
2)
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

814 TH 169 & 13th Street S

Controller Type: ASC2 — **TH 169 & 13th Street S**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2.5	0	2.5	3	2.5	0	2.5				
Walk		7		7		7		7				
FDW		13		20		14		21				
Max INI		22				22						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	15	55	--	30	15	55	--	30	--	--	--	--	100	57	--	1	26+		
Plan 2	**611**	MID PEAK	15	61	--	30	15	61	--	30	--	--	--	--	106	53	--	1	26+		
Plan 3	**633**	PM PEAK	13	79	--	28	13	79	--	28	--	--	--	--	120	38	--	1	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	15	51	--	30	13	53	--	30	--	--	--	--	96	45	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	38	--	20	12	38	--	20	--	--	--	--	70	37	--	1	26+		
Plan 9	**311**	OFF LOW AM	15	45	--	30	15	45	--	30	--	--	--	--	90	52	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	28	--	--	--	28	--	--	--	--	--	--							
		Min Split Check	10.5	18	--	13	11	18	--	13	--	--	--	--							
		Coord/Ped Split Check	--	26	--	33	--	27	--	34	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) phase 1 and 5 detector cross switching
2)
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

815 TH 169 & 10th Street N

Controller Type: ASC2

FYA Capable? No

TH 169 & 10th Street N

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	5	7	5	12	5	7				
Yellow	3	3.5	3	3.5	3	3.5	3	3.5				
Proposed All Red	3	2.5	3	3	3	2.5	3	3				
Walk		7		7		7		7				
FDW		19		26		20		27				
Max INI		22				22						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	15	45	18	22	13	47	15	25	--	--	--	--	100	13	--	1	26+		
Plan 2	**611**	MID PEAK	17	48	20	21	13	52	15	26	--	--	--	--	106	13	--	1	26+		
Plan 3	**633**	PM PEAK	18	58	21	23	13	63	17	27	--	--	--	--	120	43	--	1	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	19	41	17	19	13	47	13	23	--	--	--	--	96	8	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	11	33	11	15	11	33	11	15	--	--	--	--	70	69	--	1	26+		
Plan 9	**311**	OFF LOW AM	17	35	18	20	13	39	13	25	--	--	--	--	90	3	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	28	--	--	--	28	--	--	--	--	--	--							
		Min Split Check	11	18	11	13.5	11	18	11	13.5	--	--	--	--							
		Coord/Ped Split Check	--	32	--	39.5	--	33	--	40.5	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) phase 1 and 5 detector cross switching
2)
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

816 TH 169 & 4th Street S

Controller Type: ASC 3 — TH 169 & 4th Street S

FYA Capable? NB/SB

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2.5	0	2.5	2.5	2.5	0	2.5				
Walk		7		7		7		7				
FDW		14		17		13		18				
Max INI												

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	56	--	31	13	56	--	31	--	--	--	--	100	65	--	1	26+		
Plan 2	**611**	MID PEAK	13	62	--	31	13	62	--	31	--	--	--	--	106	63	--	1	26+		
Plan 3	**633**	PM PEAK	13	72	--	35	13	72	--	35	--	--	--	--	120	95	--	1	26+		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	52	--	31	13	52	--	31	--	--	--	--	96	64	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	38	--	20	12	38	--	20	--	--	--	--	70	2	--	1	26+		
Plan 9	**311**	OFF LOW AM	13	46	--	31	13	46	--	31	--	--	--	--	90	62	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	18	--	13	10.5	18	--	13	--	--	--	--							
		Coord/Ped Split Check	--	27	--	30	--	26	--	31	--	--	--	--							

FYA Left Turning Operations				
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	P/P	--	P/P	--
Plan 2	P/P	--	P/P	--
Plan 3	P/P	--	P/P	--
Plan 4	Perm.	--	Perm.	--
Plan 5	--	--	--	--
Plan 6	P/P	--	P/P	--
Plan 7	--	--	--	--
Plan 8	P/P	--	P/P	--
Plan 9	P/P	--	P/P	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) 3.0s FYA Delay (OVLP E and G)
2) Enable USDLS due to no comm.
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed:

817 TH 169 & 2nd Street N

Controller Type: ASC2 — **TH 169 & 2nd Street N**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2.5	0	2.5	2.5	2.5	0	2.5				
Walk		7		7		7		7				
FDW		14		19		15		19				
Max INI		0				0						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	55	--	32	13	55	--	32	--	--	--	--	100	14	--	1	26+		
Plan 2	**611**	MID PEAK	13	61	--	32	13	61	--	32	--	--	--	--	106	11	--	1	26+		
Plan 3	**633**	PM PEAK	13	75	--	32	13	75	--	32	--	--	--	--	120	28	--	1	26+		
Plan 4	**111**	LOW	Omit	28	--	32	Omit	28	--	32	--	--	--	--	60	38	--	1	26+		Φ1 Φ5
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	51	--	32	13	51	--	32	--	--	--	--	96	13	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	38	--	32	Omit	38	--	32	--	--	--	--	70	51	--	1	26+		Φ1 Φ5
Plan 9	**311**	OFF LOW AM	13	45	--	32	13	45	--	32	--	--	--	--	90	17	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	18	--	13	10.5	18	--	13	--	--	--	--							
		Coord/Ped Split Check	--	27	--	32	--	28	--	32	--	--	--	--							

FYA Left Turning Operations				
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) phase 1 and 5 detector cross switching
2)
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

818 TH 169 & 3rd Street N

Controller Type: ASC2 — **TH 169 & 3rd Street N**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2	0	2.5	2.5	2	0	2.5				
Walk		7		7		7		7				
FDW		14		22		14		21				
Max INI		0				0						

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	13	52	--	35	13	52	--	35	--	--	--	--	100	16	--	1	26+		
Plan 2	**611**	MID PEAK	13	58	--	35	13	58	--	35	--	--	--	--	106	23	--	1	26+		
Plan 3	**633**	PM PEAK	13	72	--	35	13	72	--	35	--	--	--	--	120	41	--	1	26+		
Plan 4	**111**	LOW	Omit	32	--	28	Omit	32	--	28	--	--	--	--	60	30	--	1	26+		Φ1 Φ5
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	48	--	35	13	48	--	35	--	--	--	--	96	19	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	Omit	35	--	35	Omit	35	--	35	--	--	--	--	70	48	--	1	26+		Φ1 Φ5
Plan 9	**311**	OFF LOW AM	13	42	--	35	13	42	--	35	--	--	--	--	90	23	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	17.5	--	13	10.5	17.5	--	13	--	--	--	--							
		Coord/Ped Split Check	--	26.5	--	35	--	26.5	--	34	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) Railroad Preempt
2) phase 1 and 5 detector cross switching
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed: x

819 TH 38 & 14th Street N

Controller Type: ASC3 — TH 38 & 14th Street N

FYA Capable? NB/SB

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	0	7	5	12	0	7				
Yellow	3	3.5		3.5	3	3.5		3.5				
Proposed All Red	2.5	2	0	3	2.5	2	0	3				
Walk		7		7		7		7				
FDW		14		20		16		19				
Max INI												

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 2	**611**	MID PEAK	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 3	**633**	PM PEAK	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 4	**111**	LOW	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 9	**311**	OFF LOW AM	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	1	0		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	--	--	--	--	--	--	--	--	--	--	--							
		Min Split Check	10.5	17.5	--	13.5	10.5	17.5	--	13.5	--	--	--	--							
		Coord/Ped Split Check	--	26.5	--	33.5	--	28.5	--	32.5	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	P/P	--	P/P	--
Plan 3	--	--	--	--
Plan 4	Perm.	--	Perm.	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) 3.0s FYA Delay (OVLP E and G)
2) Enable USDLS due to no comm.
3)
4)
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed:

820 TH 2 & 7th Avenue E

Controller Type: ASC2 — **TH 2 & 7th Avenue E**

FYA Capable? No

Controller Timing Values (s)												
Phase	**Φ1**	**Φ2**	**Φ3**	**Φ4**	**Φ5**	**Φ6**	**Φ7**	**Φ8**	**Φ9**	**Φ10**	**Φ11**	**Φ12**
Min Green	5	12	5	7	5	12	5	7				
Yellow	3	3.5	3	3.5	3	3.5	3	3.5				
Proposed All Red	2.5	2.5	3	3	2.5	2.5	3	3				
Walk		7		7		7		7				
FDW		15		28		23		26				
Max INI		22				22						

Existing FDW is in operation in controller due to railroad preemption. MnDOT coordination with BNSF to occur.

Plan	COS	Plan Type	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7	Φ8	Φ9	Φ10	Φ11	Φ12	Cycle	Offset	Sequence (ASC 2)	Sequence (ASC 3)	COORD Phase	Recalls	Phase Omits
Plan 1	**522**	AM PEAK	15	28	21	36	13	30	15	42	--	--	--	--	100	65	--	1	26+		
Plan 2	**611**	MID PEAK	18	25	31	32	13	30	25	38	--	--	--	--	106	87	--	1	26+		
Plan 3	**633**	PM PEAK	17	38	23	42	13	42	19	46	--	--	--	--	120	115	--	1	26+		
Plan 4	**111**	LOW	Omit	30	Omit	30	Omit	30	Omit	30	--	--	--	--	60	20	--	1	26+		Φ1 Φ3 Φ5 Φ7
Plan 5	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 6	**411**	PM OFF	13	30	17	36	13	30	13	40	--	--	--	--	96	85	--	1	26+		
Plan 7	**--**	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 8	**211**	EVENING	12	25	Omit	33	12	25	Omit	33	--	--	--	--	70	30	--	1	26+		Φ3 Φ7
Plan 9	**311**	OFF LOW AM	13	30	20	27	13	30	17	30	--	--	--	--	90	67	--	1	26+		
Plan 10	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 11	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 13	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
Plan 14	**--**	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--		
		Max INI Split Check	--	28	--	--	--	28	--	--	--	--	--	--							
		Min Split Check	10.5	18	11	13.5	10.5	18	11	13.5	--	--	--	--							
		Coord/Ped Split Check	--	28	--	41.5	--	36	--	39.5	--	--	--	--							

	FYA Left Turning Operations			
	Φ1	**Φ3**	**Φ5**	**Φ7**
Plan 1	--	--	--	--
Plan 2	--	--	--	--
Plan 3	--	--	--	--
Plan 4	--	--	--	--
Plan 5	--	--	--	--
Plan 6	--	--	--	--
Plan 7	--	--	--	--
Plan 8	--	--	--	--
Plan 9	--	--	--	--
Plan 10	--	--	--	--
Plan 11	--	--	--	--
Plan 12	--	--	--	--
Plan 13	--	--	--	--
Plan 14	--	--	--	--

Notes:

1) Railroad Preempt
2) USE NEW YARP (MIN GRN, YEL, RED) and USE EXISTING YARP (PED FDW AND WALK) -- MNDOT TO COORDINATE WITH BNSF
3) phase 1 and 5 detector cross switching
4) phase 3 and 7 detector dual assigment
5)

Download Notes:

Controller

Detector

Coordinator

Nic/TOD

Programmed:

Appendix C:

FYA Operation Assessment

TH 169 & Glenwood Dr

Phase 1 Mainline WBL

Time	Left Turn Volume	U Turn Volume	Adjusted Left Turn Volume	Opposing Thru Volume	Opposing Right Volume	Adjusted Opposing Thru Volume	Opposing Left Turn Volume	Opposing U Turn Volume	Adjusted Opposing Left Turn Volume	Hourly Volumes (15-min x 4) Adj. Left Turn Volume	Adj. Opp. Thru Volume	Adj. Opp. LT Volume	Left Turn Cross Product	Cross Product (ITE)	MnDOT Signal Coordination Manual Speed 45+ and LT Volume >240 vph?	Cross product >80k - 1 opposing	ITE Forum Left turn volume	Cross product	MnDOT Phasing Guidance
000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
515	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
530	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
600	2	0	2	54	1	55	3	0	3	8	220	12	1,760	880	No	No	Perm	Perm	Permissive-Only
615	3	0	3	57	6	63	3	0	3	12	252	12	3,024	1,512	No	No	Perm	Perm	Permissive-Only
630	3	0	3	56	5	61	6	0	6	12	244	24	2,928	1,464	No	No	Perm	Perm	Permissive-Only
645	7	0	7	52	7	59	10	0	10	28	236	40	6,608	3,304	No	No	Perm	Perm	Permissive-Only
700	7	0	7	62	2	64	8	0	8	28	256	32	7,168	3,584	No	No	Perm	Perm	Permissive-Only
715	4	0	4	82	2	84	7	0	7	16	336	28	5,376	2,688	No	No	Perm	Perm	Permissive-Only
730	11	0	11	73	3	76	19	0	19	44	304	76	13,376	6,688	No	No	Perm	Perm	Permissive-Only
745	11	0	11	82	7	89	63	0	63	44	356	252	15,664	7,832	No	No	Perm	Perm	Permissive-Only
800	6	0	6	77	7	84	26	0	26	24	336	104	8,064	4,032	No	No	Perm	Perm	Permissive-Only
815	6	0	6	55	5	60	14	0	14	24	240	56	5,760	2,880	No	No	Perm	Perm	Permissive-Only
830	4	0	4	54	7	61	31	0	31	16	244	124	3,904	1,952	No	No	Perm	Perm	Permissive-Only
845	1	0	1	60	5	65	40	0	40	4	260	160	1,040	520	No	No	Perm	Perm	Permissive-Only
900	0	0	0	58	4	62	16	0	16	0	248	64	0	0	No	No	Perm	Perm	Permissive-Only
915	1	0	1	51	0	51	17	0	17	4	204	68	816	408	No	No	Perm	Perm	Permissive-Only
930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1030	5	0	5	64	4	68	13	0	13	20	272	52	5,440	2,720	No	No	Perm	Perm	Permissive-Only
1045	5	0	5	70	6	76	26	0	26	20	304	104	6,080	3,040	No	No	Perm	Perm	Permissive-Only
1100	1	0	1	83	6	89	8	0	8	4	356	32	1,424	712	No	No	Perm	Perm	Permissive-Only
1115	3	0	3	63	2	65	11	0	11	12	260	44	3,120	1,560	No	No	Perm	Perm	Permissive-Only
1130	3	0	3	67	5	72	13	0	13	12	288	52	3,456	1,728	No	No	Perm	Perm	Permissive-Only
1145	1	0	1	84	10	94	20	0	20	4	376	80	1,504	752	No	No	Perm	Perm	Permissive-Only
1200	1	0	1	79	10	89	15	0	15	4	356	60	1,424	712	No	No	Perm	Perm	Permissive-Only
1215	5	0	5	92	7	99	17	0	17	20	396	68	7,920	3,960	No	No	Perm	Perm	Permissive-Only
1230	3	0	3	72	9	81	18	0	18	12	324	72	3,888	1,944	No	No	Perm	Perm	Permissive-Only
1245	1	1	2	85	10	95	19	0	19	8	380	76	3,040	1,520	No	No	Perm	Perm	Permissive-Only
1300	3	0	3	90	11	101	9	0	9	12	404	36	4,848	2,424	No	No	Perm	Perm	Permissive-Only
1315	1	0	1	101	7	108	14	0	14	4	432	56	1,728	864	No	No	Perm	Perm	Permissive-Only
1330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1430	5	0	5	99	10	109	7	0	7	20	436	28	8,720	4,360	No	No	Perm	Perm	Permissive-Only
1445	5	0	5	115	16	131	12	0	12	20	524	48	10,480	5,240	No	No	Perm	Perm	Permissive-Only
1500	5	0	5	125	8	133	11	0	11	20	532	44	10,640	5,320	No	No	Perm	Perm	Permissive-Only
1515	2	0	2	132	10	142	15	0	15	8	568	60	4,544	2,272	No	No	Perm	Perm	Permissive-Only
1530	7	0	7	125	7	132	14	0	14	28	528	56	14,784	7,392	No	No	Perm	Perm	Permissive-Only
1545	10	0	10	155	8	163	10	0	10	40	652	40	**26,080**	13,040	No	No	Perm	Perm	Protected-Permissive
1600	4	0	4	164	11	175	7	0	7	16	700	28	11,200	5,600	No	No	Perm	Perm	Permissive-Only
1615	7	0	7	132	6	138	13	0	13	28	552	52	15,456	7,728	No	No	Perm	Perm	Permissive-Only
1630	6	0	6	175	15	190	4	0	4	24	760	16	18,240	9,120	No	No	Perm	Perm	Permissive-Only
1645	5	0	5	187	9	196	9	0	9	20	784	36	15,680	7,840	No	No	Perm	Perm	Permissive-Only
1700	6	0	6	160	14	174	14	0	14	24	696	56	16,704	8,352	No	No	Perm	Perm	Permissive-Only
1715	5	0	5	167	10	177	20	0	20	20	708	80	14,160	7,080	No	No	Perm	Perm	Permissive-Only
1730	6	0	6	152	5	157	4	0	4	24	628	16	15,072	7,536	No	No	Perm	Perm	Permissive-Only
1745	4	0	4	117	3	120	2	0	2	16	480	8	7,680	3,840	No	No	Perm	Perm	Permissive-Only
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1815	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1830	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1845	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-

Time	Left Turn Phase Decision-Making: Timing Pattern	Left Turn Phasing
000	4	Protected-Permissive
015	4	Protected-Permissive
030	4	Protected-Permissive
045	4	Protected-Permissive
100	4	Protected-Permissive
115	4	Protected-Permissive
130	4	Protected-Permissive
145	4	Protected-Permissive
200	4	Protected-Permissive
215	4	Protected-Permissive
230	4	Protected-Permissive
245	4	Protected-Permissive
300	4	Protected-Permissive
315	4	Protected-Permissive
330	4	Protected-Permissive
345	4	Protected-Permissive
400	4	Protected-Permissive
415	4	Protected-Permissive
430	4	Protected-Permissive
445	4	Protected-Permissive
500	4	Protected-Permissive
515	4	Protected-Permissive
530	4	Protected-Permissive
545	4	Protected-Permissive
600	4	Protected-Permissive
615	4	Protected-Permissive
630	8	Protected-Permissive
645	8	Protected-Permissive
700	8	Protected-Permissive
715	1	Protected-Permissive
730	1	Protected-Permissive
745	1	Protected-Permissive
800	1	Protected-Permissive
815	1	Protected-Permissive
830	9	Protected-Permissive
845	9	Protected-Permissive
900	9	Protected-Permissive
915	9	Protected-Permissive
930	9	Protected-Permissive
945	9	Protected-Permissive
1000	2	Protected-Permissive
1015	2	Protected-Permissive
1030	2	Protected-Permissive
1045	2	Protected-Permissive
1100	2	Protected-Permissive
1115	2	Protected-Permissive
1130	2	Protected-Permissive
1145	2	Protected-Permissive
1200	2	Protected-Permissive
1215	2	Protected-Permissive
1230	2	Protected-Permissive
1245	2	Protected-Permissive
1300	2	Protected-Permissive
1315	2	Protected-Permissive
1330	2	Protected-Permissive
1345	2	Protected-Permissive
1400	3	Protected-Permissive
1415	3	Protected-Permissive
1430	3	Protected-Permissive
1445	3	Protected-Permissive
1500	3	Protected-Permissive
1515	3	Protected-Permissive
1530	3	Protected-Permissive
1545	3	Protected-Permissive
1600	3	Protected-Permissive
1615	3	Protected-Permissive
1630	3	Protected-Permissive
1645	3	Protected-Permissive
1700	3	Protected-Permissive
1715	3	Protected-Permissive
1730	6	Protected-Permissive
1745	6	Protected-Permissive
1800	6	Protected-Permissive
1815	6	Protected-Permissive
1830	6	Protected-Permissive
1845	6	Protected-Permissive
1900	8	Protected-Permissive
1915	8	Protected-Permissive
1930	8	Protected-Permissive
1945	8	Protected-Permissive
2000	4	Protected-Permissive
2015	4	Protected-Permissive
2030	4	Protected-Permissive
2045	4	Protected-Permissive
2100	4	Protected-Permissive
2115	4	Protected-Permissive
2130	4	Protected-Permissive
2145	4	Protected-Permissive
2200	4	Protected-Permissive
2215	4	Protected-Permissive
2230	4	Protected-Permissive
2245	4	Protected-Permissive
2300	4	Protected-Permissive
2315	4	Protected-Permissive
2330	4	Protected-Permissive
2345	4	Protected-Permissive

Geometric Features	
Number of Left Turn Lanes	1
Number of Opposing Thru Lanes	2
Speed Limit (mph)	40
Lateral Offset (ft)	
Longitudinal Offset (ft)	

Other Factors	
Mainline	x
Cross Street	
Crash History	
High Truck Volume	
Vertical Alignment	
Skewed Intersection	

Protected-Only	
Highest LT Volume	-
Highest Cross Product	-
Protected-Permissive	
Highest LT Volume	11.00
Highest Cross Product	13,040.00
Permissive-Only	
Highest LT Volume	-
Highest Cross Product	-

TH 169 & Glenwood Dr

Phase 5 Mainline EBL

Time	Left Turn Volume	U Turn Volume	Adjusted Left Turn Volume	Opposing Thru Volume	Opposing Right Volume	Adjusted Opposing Thru Volume	Opposing Left Turn Volume	Opposing U Turn Volume	Adjusted Opposing Left Turn Volume	Hourly Volumes (15-min x 4) Adj. Left Turn Volume	Adj. Opp. Thru Volume	Adj. Opp. LT Volume	Left Turn Cross Product	Cross Product (ITE)	MnDOT Signal Coordination Manual Speed 45+ and LT Volume >240 vph?	MnDOT Signal Coordination Manual Cross product >80k - 1 opposing	ITE Forum Left turn volume	ITE Forum Cross product	MnDOT Phasing Guidance
000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
515	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
530	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
600	3	0	3	62	1	63	2	0	2	12	252	8	3,024	1,512	No	No	Perm	Perm	Permissive-Only
615	3	0	3	58	0	58	3	0	3	12	232	12	2,784	1,392	No	No	Perm	Perm	Permissive-Only
630	6	0	6	95	0	95	3	0	3	24	380	12	9,120	4,560	No	No	Perm	Perm	Permissive-Only
645	10	0	10	94	0	94	7	0	7	40	376	28	15,040	7,520	No	No	Perm	Perm	Permissive-Only
700	8	0	8	94	3	97	7	0	7	32	388	28	12,416	6,208	No	No	Perm	Perm	Permissive-Only
715	7	0	7	122	3	125	4	0	4	28	500	16	14,000	7,000	No	No	Perm	Perm	Permissive-Only
730	19	0	19	185	3	188	11	0	11	76	752	44	**57,152**	28,576	No	No	Perm	Perm	Protected-Permissive
745	63	0	63	221	15	236	11	0	11	**252**	944	44	**237,888**	118,944	No	**Yes**	Prot/Perm	Prot/Perm	Protected-Only
800	26	0	26	166	4	170	6	0	6	104	680	24	**70,720**	35,360	No	No	Perm	Perm	Protected-Permissive
815	14	0	14	130	2	132	6	0	6	56	528	24	**29,568**	14,784	No	No	Perm	Perm	Protected-Permissive
830	31	0	31	133	10	143	4	0	4	124	572	16	**70,928**	35,464	No	No	Perm	Perm	Protected-Permissive
845	40	0	40	98	13	111	1	0	1	**160**	444	4	**71,040**	35,520	No	No	Perm	Perm	Protected-Permissive
900	16	0	16	92	1	93	0	0	0	64	372	0	**23,808**	11,904	No	No	Perm	Perm	Protected-Permissive
915	17	0	17	70	3	73	1	0	1	68	292	4	19,856	9,928	No	No	Perm	Perm	Permissive-Only
930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1030	13	0	13	88	6	94	5	0	5	52	376	20	19,552	9,776	No	No	Perm	Perm	Permissive-Only
1045	26	0	26	82	8	90	5	0	5	104	360	20	**37,440**	18,720	No	No	Perm	Perm	Protected-Permissive
1100	8	0	8	74	2	76	1	0	1	32	304	4	9,728	4,864	No	No	Perm	Perm	Permissive-Only
1115	11	0	11	84	1	85	3	0	3	44	340	12	14,960	7,480	No	No	Perm	Perm	Permissive-Only
1130	13	0	13	98	6	104	3	0	3	52	416	12	**21,632**	10,816	No	No	Perm	Perm	Protected-Permissive
1145	20	0	20	82	3	85	1	0	1	80	340	4	**27,200**	13,600	No	No	Perm	Perm	Protected-Permissive
1200	15	0	15	79	0	79	1	0	1	60	316	4	18,960	9,480	No	No	Perm	Perm	Permissive-Only
1215	17	0	17	88	0	88	5	0	5	68	352	20	**23,936**	11,968	No	No	Perm	Perm	Protected-Permissive
1230	18	0	18	79	3	82	3	0	3	72	328	12	**23,616**	11,808	No	No	Perm	Perm	Protected-Permissive
1245	19	0	19	77	7	84	1	1	2	76	336	8	**25,536**	12,768	No	No	Perm	Perm	Protected-Permissive
1300	9	0	9	74	3	77	3	0	3	36	308	12	11,088	5,544	No	No	Perm	Perm	Permissive-Only
1315	14	0	14	74	4	78	1	0	1	56	312	4	17,472	8,736	No	No	Perm	Perm	Permissive-Only
1330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1430	7	0	7	128	1	129	5	0	5	28	516	20	14,448	7,224	No	No	Perm	Perm	Permissive-Only
1445	12	0	12	130	1	131	5	0	5	48	524	20	**25,152**	12,576	No	No	Perm	Perm	Protected-Permissive
1500	11	0	11	92	1	93	5	0	5	44	372	20	16,368	8,184	No	No	Perm	Perm	Permissive-Only
1515	15	0	15	92	1	93	2	0	2	60	372	8	**22,320**	11,160	No	No	Perm	Perm	Protected-Permissive
1530	14	0	14	135	3	138	7	0	7	56	552	28	**30,912**	15,456	No	No	Perm	Perm	Protected-Permissive
1545	10	0	10	144	7	151	10	0	10	40	604	40	**24,160**	12,080	No	No	Perm	Perm	Protected-Permissive
1600	7	0	7	126	1	127	4	0	4	28	508	16	14,224	7,112	No	No	Perm	Perm	Permissive-Only
1615	13	0	13	113	1	114	7	0	7	52	456	28	**23,712**	11,856	No	No	Perm	Perm	Protected-Permissive
1630	4	0	4	133	2	135	6	0	6	16	540	24	8,640	4,320	No	No	Perm	Perm	Permissive-Only
1645	9	0	9	104	1	105	5	0	5	36	420	20	15,120	7,560	No	No	Perm	Perm	Permissive-Only
1700	14	0	14	108	2	110	6	0	6	56	440	24	**24,640**	12,320	No	No	Perm	Perm	Protected-Permissive
1715	20	0	20	93	5	98	5	0	5	80	392	20	**31,360**	15,680	No	No	Perm	Perm	Protected-Permissive
1730	4	0	4	101	0	101	6	0	6	16	404	24	6,464	3,232	No	No	Perm	Perm	Permissive-Only
1745	2	0	2	86	0	86	4	0	4	8	344	16	2,752	1,376	No	No	Perm	Perm	Permissive-Only
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1815	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1830	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1845	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-

Time	Left Turn Phase Decision-Making: Timing Pattern	Left Turn Phasing
000	4	Protected-Permissive
015	4	Protected-Permissive
030	4	Protected-Permissive
045	4	Protected-Permissive
100	4	Protected-Permissive
115	4	Protected-Permissive
130	4	Protected-Permissive
145	4	Protected-Permissive
200	4	Protected-Permissive
215	4	Protected-Permissive
230	4	Protected-Permissive
245	4	Protected-Permissive
300	4	Protected-Permissive
315	4	Protected-Permissive
330	4	Protected-Permissive
345	4	Protected-Permissive
400	4	Protected-Permissive
415	4	Protected-Permissive
430	4	Protected-Permissive
445	4	Protected-Permissive
500	4	Protected-Permissive
515	4	Protected-Permissive
530	4	Protected-Permissive
545	4	Protected-Permissive
600	4	Protected-Permissive
615	4	Protected-Permissive
630	8	Protected-Permissive
645	8	Protected-Permissive
700	8	Protected-Permissive
715	1	Protected-Permissive
730	1	Protected-Permissive
745	1	Protected-Permissive
800	1	Protected-Permissive
815	1	Protected-Permissive
830	9	Protected-Permissive
845	9	Protected-Permissive
900	9	Protected-Permissive
915	9	Protected-Permissive
930	9	Protected-Permissive
945	9	Protected-Permissive
1000	2	Protected-Permissive
1015	2	Protected-Permissive
1030	2	Protected-Permissive
1045	2	Protected-Permissive
1100	2	Protected-Permissive
1115	2	Protected-Permissive
1130	2	Protected-Permissive
1145	2	Protected-Permissive
1200	2	Protected-Permissive
1215	2	Protected-Permissive
1230	2	Protected-Permissive
1245	2	Protected-Permissive
1300	2	Protected-Permissive
1315	2	Protected-Permissive
1330	2	Protected-Permissive
1345	2	Protected-Permissive
1400	3	Protected-Permissive
1415	3	Protected-Permissive
1430	3	Protected-Permissive
1445	3	Protected-Permissive
1500	3	Protected-Permissive
1515	3	Protected-Permissive
1530	3	Protected-Permissive
1545	3	Protected-Permissive
1600	3	Protected-Permissive
1615	3	Protected-Permissive
1630	3	Protected-Permissive
1645	3	Protected-Permissive
1700	3	Protected-Permissive
1715	3	Protected-Permissive
1730	6	Protected-Permissive
1745	6	Protected-Permissive
1800	6	Protected-Permissive
1815	6	Protected-Permissive
1830	6	Protected-Permissive
1845	6	Protected-Permissive
1900	8	Protected-Permissive
1915	8	Protected-Permissive
1930	8	Protected-Permissive
1945	8	Protected-Permissive
2000	4	Protected-Permissive
2015	4	Protected-Permissive
2030	4	Protected-Permissive
2045	4	Protected-Permissive
2100	4	Protected-Permissive
2115	4	Protected-Permissive
2130	4	Protected-Permissive
2145	4	Protected-Permissive
2200	4	Protected-Permissive
2215	4	Protected-Permissive
2230	4	Protected-Permissive
2245	4	Protected-Permissive
2300	4	Protected-Permissive
2315	4	Protected-Permissive
2330	4	Protected-Permissive
2345	4	Protected-Permissive

Geometric Features	
Number of Left Turn Lanes	1
Number of Opposing Thru Lanes	2
Speed Limit (mph)	40
Lateral Offset (ft)	
Longitudinal Offset (ft)	

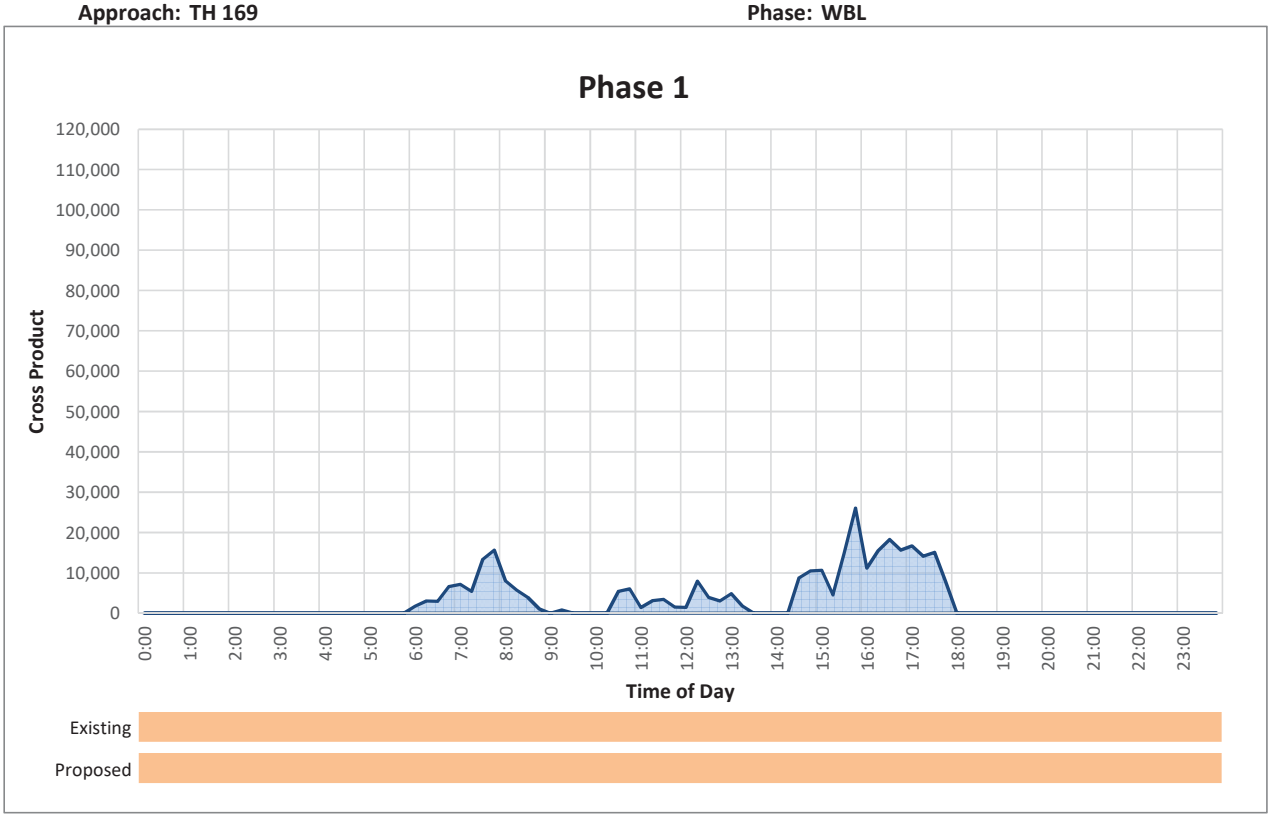
Other Factors	
Mainline	x
Cross Street	
Crash History	
High Truck Volume	
Vertical Alignment	
Skewed Intersection	

Protected-Only	
Highest LT Volume	-
Highest Cross Product	-
Protected-Permissive	
Highest LT Volume	###
Highest Cross Product	###
Permissive-Only	
Highest LT Volume	-
Highest Cross Product	-

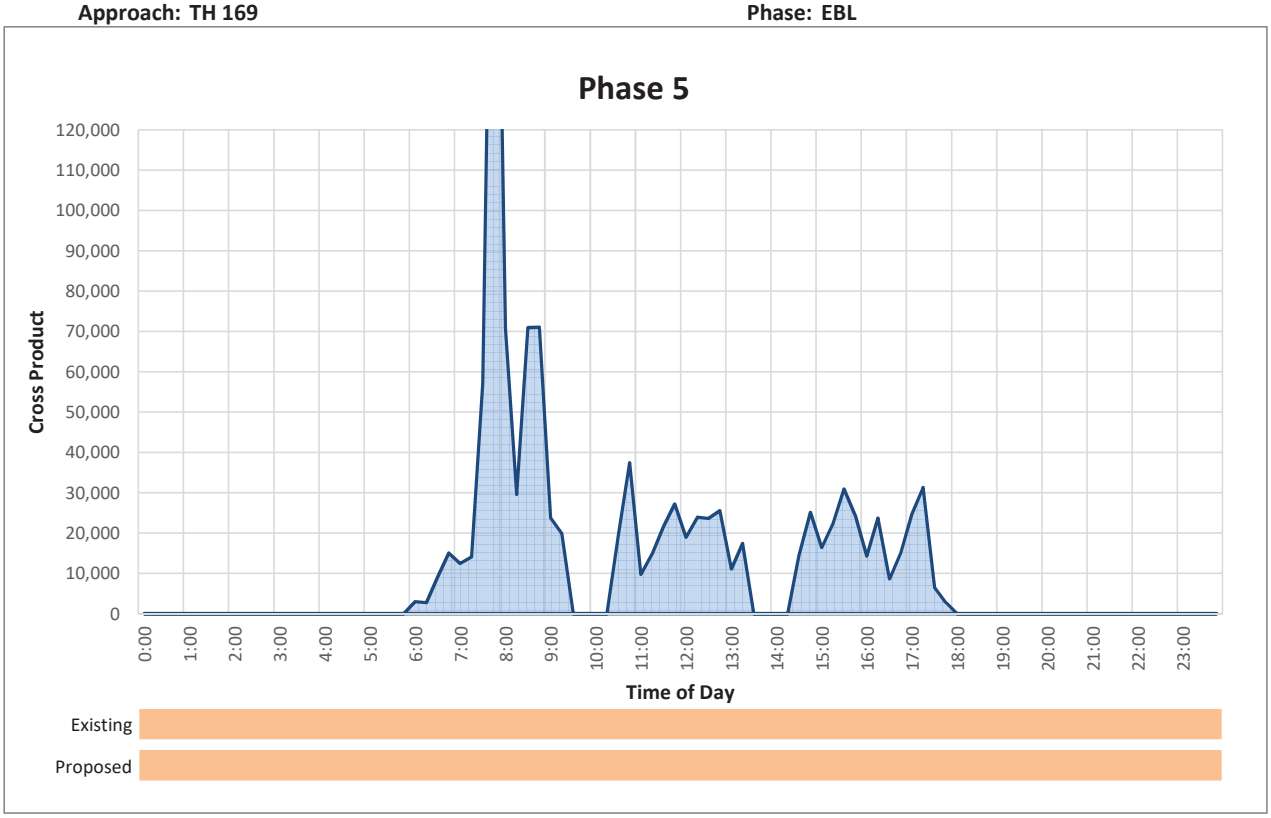
TH 169 & Glenwood Dr

Protected
Protected/Permissive
Permissive

Approach: TH 169 **Phase: WBL**



Approach: TH 169 **Phase: EBL**



TH 169 & Glenwood Dr
System ID: **FYA Time-of-Day Operation as of:**
39595 **June 6, 2019**

Day Plan	Days In Effect	Event	Action Plan	Start Time	Left-Turn FYA Operation	
					TH 169 Phase 1 (WBL)	TH 169 Phase 5 (EBL)
Day Plan 1	(Monday - Thursday)	1	4	0:00	Protected-Permissive	Protected-Permissive
		2	4	5:30	Protected-Permissive	Protected-Permissive
		3	8	6:30	Protected-Permissive	Protected-Permissive
		4	1	7:20	Protected-Permissive	Protected-Permissive
		5	9	8:30	Protected-Permissive	Protected-Permissive
		6	2	10:00	Protected-Permissive	Protected-Permissive
		7	3	14:00	Protected-Permissive	Protected-Permissive
		8	6	17:30	Protected-Permissive	Protected-Permissive
		9	8	19:00	Protected-Permissive	Protected-Permissive
		10	4	20:00	Protected-Permissive	Protected-Permissive
		11	4	23:00	Protected-Permissive	Protected-Permissive
Day Plan 2	Weekend	1	4	0:00	Protected-Permissive	Protected-Permissive
		2	4	6:30	Protected-Permissive	Protected-Permissive
		3	8	7:30	Protected-Permissive	Protected-Permissive
		4	9	8:30	Protected-Permissive	Protected-Permissive
		5	2	10:30	Protected-Permissive	Protected-Permissive
		6	9	17:30	Protected-Permissive	Protected-Permissive
		7	8	19:00	Protected-Permissive	Protected-Permissive
		8	4	21:00	Protected-Permissive	Protected-Permissive
		9	4	23:00	Protected-Permissive	Protected-Permissive
Day Plan 4	(Friday)	1	4	0:00	Protected-Permissive	Protected-Permissive
		2	4	5:30	Protected-Permissive	Protected-Permissive
		3	8	6:30	Protected-Permissive	Protected-Permissive
		4	1	7:20	Protected-Permissive	Protected-Permissive
		5	9	8:30	Protected-Permissive	Protected-Permissive
		6	2	10:00	Protected-Permissive	Protected-Permissive
		7	3	13:30	Protected-Permissive	Protected-Permissive
		8	6	18:00	Protected-Permissive	Protected-Permissive
		9	4	20:00	Protected-Permissive	Protected-Permissive
		10	4	21:00	Protected-Permissive	Protected-Permissive
		11	4	23:00	Protected-Permissive	Protected-Permissive

TH 169 & 4th St S

Phase 1 Mainline NBL

Time	Left Turn Volume	U Turn Volume	Adjusted Left Turn Volume	Opposing Thru Volume	Opposing Right Volume	Adjusted Opposing Thru Volume	Opposing Left Turn Volume	Opposing U Turn Volume	Adjusted Opposing Left Turn Volume	Hourly Volumes (15-min x 4) Adj. Left Turn Volume	Adj. Opp. Thru Volume	Adj. Opp. LT Volume	Left Turn Cross Product	Cross Product (ITE)	MnDOT Signal Coordination Manual Speed 45+ and LT Volume >240 vph?	Cross product >80k - 1 opposing	ITE Forum Left turn volume	Cross product	MnDOT Phasing Guidance
000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
515	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
530	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
600	0	0	0	21	0	21	1	0	1	0	84	4	0	0	No	No	Perm	Perm	Permissive-Only
615	1	0	1	27	0	27	0	0	0	4	108	0	432	216	No	No	Perm	Perm	Permissive-Only
630	0	0	0	39	1	40	8	0	8	0	160	32	0	0	No	No	Perm	Perm	Permissive-Only
645	0	0	0	52	3	55	7	0	7	0	220	28	0	0	No	No	Perm	Perm	Permissive-Only
700	1	0	1	47	0	47	2	0	2	4	188	8	752	376	No	No	Perm	Perm	Permissive-Only
715	0	0	0	64	4	68	2	0	2	0	272	8	0	0	No	No	Perm	Perm	Permissive-Only
730	0	0	0	74	1	75	1	0	1	0	300	4	0	0	No	No	Perm	Perm	Permissive-Only
745	1	0	1	108	2	110	3	0	3	4	440	12	1,760	880	No	No	Perm	Perm	Permissive-Only
800	0	0	0	81	6	87	6	0	6	0	348	24	0	0	No	No	Perm	Perm	Permissive-Only
815	0	0	0	88	2	90	1	0	1	0	360	4	0	0	No	No	Perm	Perm	Permissive-Only
830	1	0	1	104	3	107	1	0	1	4	428	4	1,712	856	No	No	Perm	Perm	Permissive-Only
845	1	0	1	117	1	118	3	0	3	4	472	12	1,888	944	No	No	Perm	Perm	Permissive-Only
900	2	0	2	93	1	94	0	0	0	8	376	0	3,008	1,504	No	No	Perm	Perm	Permissive-Only
915	1	0	1	93	2	95	2	0	2	4	380	8	1,520	760	No	No	Perm	Perm	Permissive-Only
930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1030	1	0	1	131	7	138	0	0	0	4	552	0	2,208	1,104	No	No	Perm	Perm	Permissive-Only
1045	1	0	1	135	7	142	8	0	8	4	568	32	2,272	1,136	No	No	Perm	Perm	Permissive-Only
1100	5	0	5	151	4	155	4	0	4	20	620	16	12,400	6,200	No	No	Perm	Perm	Permissive-Only
1115	2	0	2	151	7	158	3	0	3	8	632	12	5,056	2,528	No	No	Perm	Perm	Permissive-Only
1130	4	0	4	153	1	154	1	0	1	16	616	4	9,856	4,928	No	No	Perm	Perm	Permissive-Only
1145	4	0	4	194	6	200	1	0	1	16	800	4	12,800	6,400	No	No	Perm	Perm	Permissive-Only
1200	6	0	6	147	7	154	5	0	5	24	616	20	14,784	7,392	No	No	Perm	Perm	Permissive-Only
1215	2	0	2	143	5	148	1	0	1	8	592	4	4,736	2,368	No	No	Perm	Perm	Permissive-Only
1230	2	0	2	153	6	159	1	0	1	8	636	4	5,088	2,544	No	No	Perm	Perm	Permissive-Only
1245	4	0	4	134	7	141	4	0	4	16	564	16	9,024	4,512	No	No	Perm	Perm	Permissive-Only
1300	1	0	1	131	2	133	2	0	2	4	532	8	2,128	1,064	No	No	Perm	Perm	Permissive-Only
1315	5	0	5	145	6	151	0	0	0	20	604	0	12,080	6,040	No	No	Perm	Perm	Permissive-Only
1330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1430	4	0	4	133	4	137	2	0	2	16	548	8	8,768	4,384	No	No	Perm	Perm	Permissive-Only
1445	6	0	6	116	7	123	2	0	2	24	492	8	11,808	5,904	No	No	Perm	Perm	Permissive-Only
1500	4	0	4	128	3	131	2	0	2	16	524	8	8,384	4,192	No	No	Perm	Perm	Permissive-Only
1515	4	0	4	142	3	145	1	0	1	16	580	4	9,280	4,640	No	No	Perm	Perm	Permissive-Only
1530	5	0	5	163	7	170	3	0	3	20	680	12	13,600	6,800	No	No	Perm	Perm	Permissive-Only
1545	1	0	1	131	6	137	2	0	2	4	548	8	2,192	1,096	No	No	Perm	Perm	Permissive-Only
1600	5	0	5	125	3	128	2	0	2	20	512	8	10,240	5,120	No	No	Perm	Perm	Permissive-Only
1615	5	0	5	141	3	144	4	0	4	20	576	16	11,520	5,760	No	No	Perm	Perm	Permissive-Only
1630	1	0	1	134	4	138	0	0	0	4	552	0	2,208	1,104	No	No	Perm	Perm	Permissive-Only
1645	3	0	3	133	1	134	2	0	2	12	536	8	6,432	3,216	No	No	Perm	Perm	Permissive-Only
1700	3	0	3	189	3	192	3	0	3	12	768	12	9,216	4,608	No	No	Perm	Perm	Permissive-Only
1715	4	0	4	135	9	144	2	0	2	16	576	8	9,216	4,608	No	No	Perm	Perm	Permissive-Only
1730	4	0	4	138	11	149	0	0	0	16	596	0	9,536	4,768	No	No	Perm	Perm	Permissive-Only
1745	2	0	2	134	7	141	2	0	2	8	564	8	4,512	2,256	No	No	Perm	Perm	Permissive-Only
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1815	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1830	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1845	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-

Time	Left Turn Phase Decision-Making: Timing Pattern	Left Turn Phasing
000	4	Permissive-Only
015	4	Permissive-Only
030	4	Permissive-Only
045	4	Permissive-Only
100	4	Permissive-Only
115	4	Permissive-Only
130	4	Permissive-Only
145	4	Permissive-Only
200	4	Permissive-Only
215	4	Permissive-Only
230	4	Permissive-Only
245	4	Permissive-Only
300	4	Permissive-Only
315	4	Permissive-Only
330	4	Permissive-Only
345	4	Permissive-Only
400	4	Permissive-Only
415	4	Permissive-Only
430	4	Permissive-Only
445	4	Permissive-Only
500	4	Permissive-Only
515	4	Permissive-Only
530	4	Permissive-Only
545	4	Permissive-Only
600	4	Permissive-Only
615	4	Permissive-Only
630	8	Protected-Permissive
645	8	Protected-Permissive
700	8	Protected-Permissive
715	1	Protected-Permissive
730	1	Protected-Permissive
745	1	Protected-Permissive
800	1	Protected-Permissive
815	1	Protected-Permissive
830	9	Protected-Permissive
845	9	Protected-Permissive
900	9	Protected-Permissive
915	9	Protected-Permissive
930	9	Protected-Permissive
945	9	Protected-Permissive
1000	2	Protected-Permissive
1015	2	Protected-Permissive
1030	2	Protected-Permissive
1045	2	Protected-Permissive
1100	2	Protected-Permissive
1115	2	Protected-Permissive
1130	2	Protected-Permissive
1145	2	Protected-Permissive
1200	2	Protected-Permissive
1215	2	Protected-Permissive
1230	2	Protected-Permissive
1245	2	Protected-Permissive
1300	2	Protected-Permissive
1315	2	Protected-Permissive
1330	2	Protected-Permissive
1345	2	Protected-Permissive
1400	3	Protected-Permissive
1415	3	Protected-Permissive
1430	3	Protected-Permissive
1445	3	Protected-Permissive
1500	3	Protected-Permissive
1515	3	Protected-Permissive
1530	3	Protected-Permissive
1545	3	Protected-Permissive
1600	3	Protected-Permissive
1615	3	Protected-Permissive
1630	3	Protected-Permissive
1645	3	Protected-Permissive
1700	3	Protected-Permissive
1715	3	Protected-Permissive
1730	6	Protected-Permissive
1745	6	Protected-Permissive
1800	6	Protected-Permissive
1815	6	Protected-Permissive
1830	6	Protected-Permissive
1845	6	Protected-Permissive
1900	8	Protected-Permissive
1915	8	Protected-Permissive
1930	8	Protected-Permissive
1945	8	Protected-Permissive
2000	8	Protected-Permissive
2015	8	Protected-Permissive
2030	8	Protected-Permissive
2045	8	Protected-Permissive
2100	4	Permissive-Only
2115	4	Permissive-Only
2130	4	Permissive-Only
2145	4	Permissive-Only
2200	4	Permissive-Only
2215	4	Permissive-Only
2230	4	Permissive-Only
2245	4	Permissive-Only
2300	4	Permissive-Only
2315	4	Permissive-Only
2330	4	Permissive-Only
2345	4	Permissive-Only

Geometric Features	
Number of Left Turn Lanes	1
Number of Opposing Thru Lanes	2
Speed Limit (mph)	30
Lateral Offset (ft)	
Longitudinal Offset (ft)	

Other Factors	
Mainline	x
Cross Street	
Crash History	
High Truck Volume	
Vertical Alignment	
Skewed Intersection	

Protected-Only	
Highest LT Volume	-
Highest Cross Product	-
Protected-Permissive	
Highest LT Volume	6
Highest Cross Product	7392
Permissive-Only	
Highest LT Volume	1.00
Highest Cross Product	216.00

TH 169 & 4th St S
Phase 5 Mainline SBL

Time	Left Turn Volume	U Turn Volume	Adjusted Left Turn Volume	Opposing Thru Volume	Opposing Right Volume	Adjusted Opposing Thru Volume	Opposing Left Turn Volume	Opposing U Turn Volume	Adjusted Opposing Left Turn Volume	Hourly Volumes (15-min x 4) Adj. Left Turn Volume	Adj. Opp. Thru Volume	Adj. Opp. LT Volume	Left Turn Cross Product	Cross Product (ITE)	MnDOT Signal Coordination Manual Speed 45+ and LT Volume >240 vph?	Cross product >80k - 1 opposing	ITE Forum Left turn volume	Cross product	MnDOT Phasing Guidance
000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
515	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
530	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
600	1	0	1	36	3	39	0	0	0	4	156	0	624	312	No	No	Perm	Perm	Permissive-Only
615	0	0	0	30	5	35	1	0	1	0	140	4	0	0	No	No	Perm	Perm	Permissive-Only
630	8	0	8	46	3	49	0	0	0	32	196	0	6,272	3,136	No	No	Perm	Perm	Permissive-Only
645	7	0	7	56	13	69	0	0	0	28	276	0	7,728	3,864	No	No	Perm	Perm	Permissive-Only
700	2	0	2	42	11	53	1	0	1	8	212	4	1,696	848	No	No	Perm	Perm	Permissive-Only
715	2	0	2	54	9	63	0	0	0	8	252	0	2,016	1,008	No	No	Perm	Perm	Permissive-Only
730	1	0	1	59	12	71	0	0	0	4	284	0	1,136	568	No	No	Perm	Perm	Permissive-Only
745	3	0	3	117	12	129	1	0	1	12	516	4	6,192	3,096	No	No	Perm	Perm	Permissive-Only
800	6	0	6	95	11	106	0	0	0	24	424	0	10,176	5,088	No	No	Perm	Perm	Permissive-Only
815	1	0	1	92	13	105	0	0	0	4	420	0	1,680	840	No	No	Perm	Perm	Permissive-Only
830	1	0	1	89	3	92	1	0	1	4	368	4	1,472	736	No	No	Perm	Perm	Permissive-Only
845	3	0	3	88	8	96	1	0	1	12	384	4	4,608	2,304	No	No	Perm	Perm	Permissive-Only
900	0	0	0	85	3	88	2	0	2	0	352	8	0	0	No	No	Perm	Perm	Permissive-Only
915	2	0	2	88	3	91	1	0	1	8	364	4	2,912	1,456	No	No	Perm	Perm	Permissive-Only
930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1030	0	0	0	131	9	140	1	0	1	0	560	4	0	0	No	No	Perm	Perm	Permissive-Only
1045	8	0	8	125	10	135	1	0	1	32	540	4	17,280	8,640	No	No	Perm	Perm	Permissive-Only
1100	4	0	4	142	7	149	5	0	5	16	596	20	9,536	4,768	No	No	Perm	Perm	Permissive-Only
1115	3	0	3	168	5	173	2	0	2	12	692	8	8,304	4,152	No	No	Perm	Perm	Permissive-Only
1130	1	0	1	177	4	181	4	0	4	4	724	16	2,896	1,448	No	No	Perm	Perm	Permissive-Only
1145	1	0	1	168	9	177	4	0	4	4	708	16	2,832	1,416	No	No	Perm	Perm	Permissive-Only
1200	5	0	5	159	8	167	6	0	6	20	668	24	13,360	6,680	No	No	Perm	Perm	Permissive-Only
1215	1	0	1	172	14	186	2	0	2	4	744	8	2,976	1,488	No	No	Perm	Perm	Permissive-Only
1230	1	0	1	181	8	189	2	0	2	4	756	8	3,024	1,512	No	No	Perm	Perm	Permissive-Only
1245	4	0	4	203	15	218	4	0	4	16	872	16	13,952	6,976	No	No	Perm	Perm	Permissive-Only
1300	2	0	2	185	15	200	1	0	1	8	800	4	6,400	3,200	No	No	Perm	Perm	Permissive-Only
1315	0	0	0	166	9	175	5	0	5	0	700	20	0	0	No	No	Perm	Perm	Permissive-Only
1330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1430	2	0	2	160	14	174	4	0	4	8	696	16	5,568	2,784	No	No	Perm	Perm	Permissive-Only
1445	2	0	2	161	11	172	6	0	6	8	688	24	5,504	2,752	No	No	Perm	Perm	Permissive-Only
1500	2	0	2	161	6	167	4	0	4	8	668	16	5,344	2,672	No	No	Perm	Perm	Permissive-Only
1515	1	0	1	160	5	165	4	0	4	4	660	16	2,640	1,320	No	No	Perm	Perm	Permissive-Only
1530	3	0	3	156	5	161	5	0	5	12	644	20	7,728	3,864	No	No	Perm	Perm	Permissive-Only
1545	2	0	2	166	5	171	1	0	1	8	684	4	5,472	2,736	No	No	Perm	Perm	Permissive-Only
1600	2	0	2	174	11	185	5	0	5	8	740	20	5,920	2,960	No	No	Perm	Perm	Permissive-Only
1615	4	0	4	157	12	169	5	0	5	16	676	20	10,816	5,408	No	No	Perm	Perm	Permissive-Only
1630	0	0	0	151	6	157	1	0	1	0	628	4	0	0	No	No	Perm	Perm	Permissive-Only
1645	2	0	2	156	9	165	3	0	3	8	660	12	5,280	2,640	No	No	Perm	Perm	Permissive-Only
1700	3	0	3	151	15	166	3	0	3	12	664	12	7,968	3,984	No	No	Perm	Perm	Permissive-Only
1715	2	0	2	177	11	188	4	0	4	8	752	16	6,016	3,008	No	No	Perm	Perm	Permissive-Only
1730	0	0	0	136	7	143	4	0	4	0	572	16	0	0	No	No	Perm	Perm	Permissive-Only
1745	2	0	2	124	6	130	2	0	2	8	520	8	4,160	2,080	No	No	Perm	Perm	Permissive-Only
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1815	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1830	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1845	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-

Time	Left Turn Phase Decision-Making: Timing Pattern	Left Turn Phasing
000	4	Permissive-Only
015	4	Permissive-Only
030	4	Permissive-Only
045	4	Permissive-Only
100	4	Permissive-Only
115	4	Permissive-Only
130	4	Permissive-Only
145	4	Permissive-Only
200	4	Permissive-Only
215	4	Permissive-Only
230	4	Permissive-Only
245	4	Permissive-Only
300	4	Permissive-Only
315	4	Permissive-Only
330	4	Permissive-Only
345	4	Permissive-Only
400	4	Permissive-Only
415	4	Permissive-Only
430	4	Permissive-Only
445	4	Permissive-Only
500	4	Permissive-Only
515	4	Permissive-Only
530	4	Permissive-Only
545	4	Permissive-Only
600	4	Permissive-Only
615	4	Permissive-Only
630	8	Protected-Permissive
645	8	Protected-Permissive
700	8	Protected-Permissive
715	1	Protected-Permissive
730	1	Protected-Permissive
745	1	Protected-Permissive
800	1	Protected-Permissive
815	1	Protected-Permissive
830	9	Protected-Permissive
845	9	Protected-Permissive
900	9	Protected-Permissive
915	9	Protected-Permissive
930	9	Protected-Permissive
945	9	Protected-Permissive
1000	2	Protected-Permissive
1015	2	Protected-Permissive
1030	2	Protected-Permissive
1045	2	Protected-Permissive
1100	2	Protected-Permissive
1115	2	Protected-Permissive
1130	2	Protected-Permissive
1145	2	Protected-Permissive
1200	2	Protected-Permissive
1215	2	Protected-Permissive
1230	2	Protected-Permissive
1245	2	Protected-Permissive
1300	2	Protected-Permissive
1315	2	Protected-Permissive
1330	2	Protected-Permissive
1345	2	Protected-Permissive
1400	3	Protected-Permissive
1415	3	Protected-Permissive
1430	3	Protected-Permissive
1445	3	Protected-Permissive
1500	3	Protected-Permissive
1515	3	Protected-Permissive
1530	3	Protected-Permissive
1545	3	Protected-Permissive
1600	3	Protected-Permissive
1615	3	Protected-Permissive
1630	3	Protected-Permissive
1645	3	Protected-Permissive
1700	3	Protected-Permissive
1715	3	Protected-Permissive
1730	6	Protected-Permissive
1745	6	Protected-Permissive
1800	6	Protected-Permissive
1815	6	Protected-Permissive
1830	6	Protected-Permissive
1845	6	Protected-Permissive
1900	8	Protected-Permissive
1915	8	Protected-Permissive
1930	8	Protected-Permissive
1945	8	Protected-Permissive
2000	8	Protected-Permissive
2015	8	Protected-Permissive
2030	8	Protected-Permissive
2045	8	Protected-Permissive
2100	4	Permissive-Only
2115	4	Permissive-Only
2130	4	Permissive-Only
2145	4	Permissive-Only
2200	4	Permissive-Only
2215	4	Permissive-Only
2230	4	Permissive-Only
2245	4	Permissive-Only
2300	4	Permissive-Only
2315	4	Permissive-Only
2330	4	Permissive-Only
2345	4	Permissive-Only

Geometric Features	
Number of Left Turn Lanes	1
Number of Opposing Thru Lanes	2
Speed Limit (mph)	30
Lateral Offset (ft)	
Longitudinal Offset (ft)	

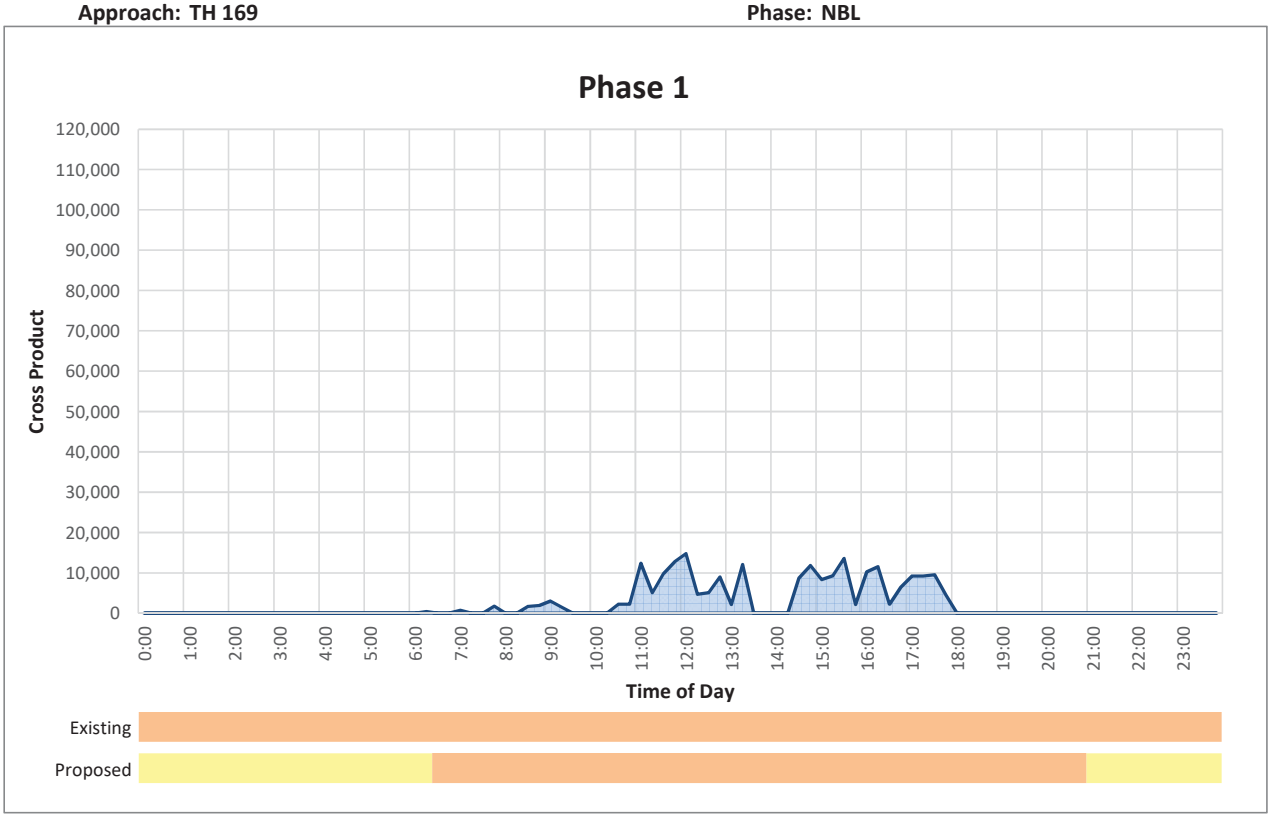
Other Factors	
Mainline	x
Cross Street	
Crash History	
High Truck Volume	
Vertical Alignment	
Skewed Intersection	

Protected-Only	
Highest LT Volume	-
Highest Cross Product	-
Protected-Permissive	
Highest LT Volume	8
Highest Cross Product	8640
Permissive-Only	
Highest LT Volume	1.00
Highest Cross Product	312.00

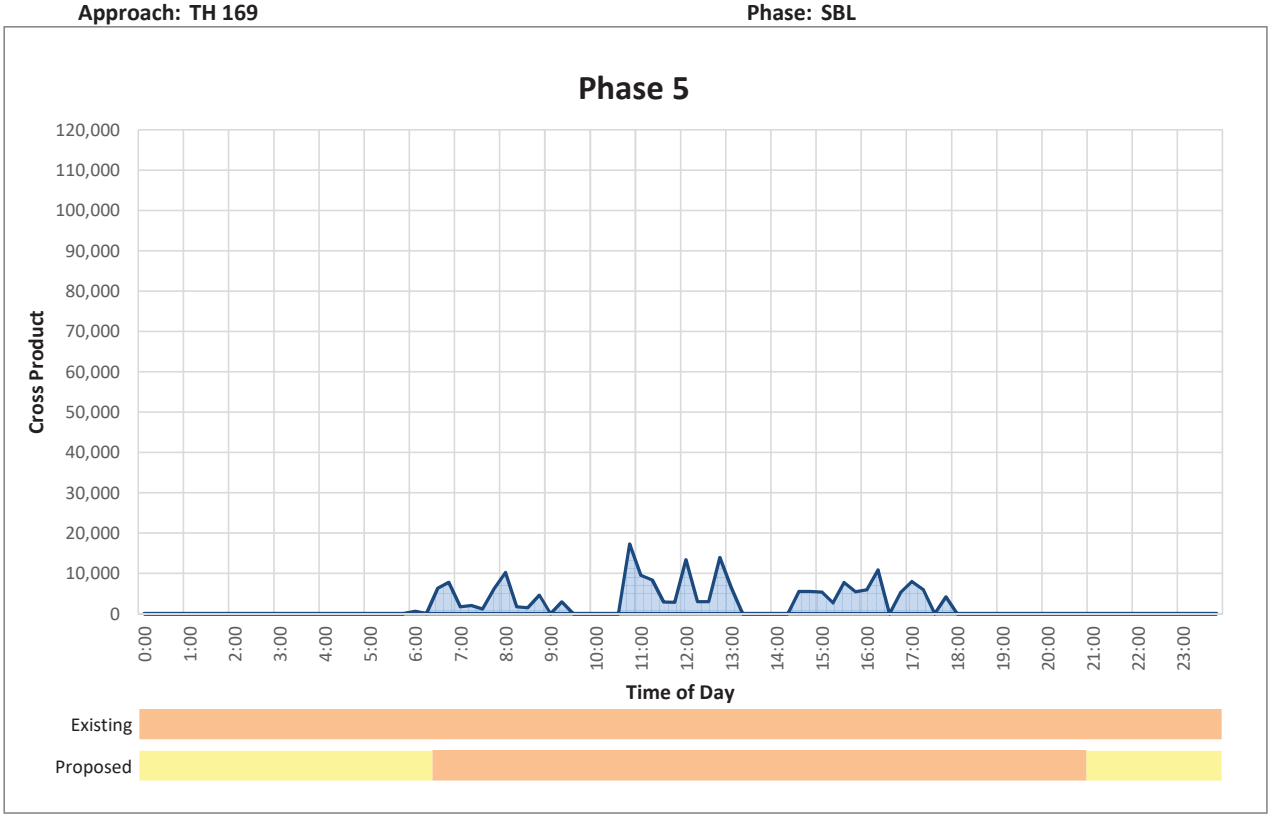
TH 169 & 4th St S

Protected
Protected/Permissive
Permissive

Approach: TH 169 **Phase: NBL**



Approach: TH 169 **Phase: SBL**



TH 169 & 4th St S
System ID: **FYA Time-of-Day Operation as of:**
39417 **June 6, 2019**

Day Plan	Days In Effect	Event	Action Plan	Start Time	Left-Turn FYA Operation	
					TH 169 Phase 1 (NBL)	TH 169 Phase 5 (SBL)
Day Plan 1	(Monday - Thursday)	1	4	0:00	Permissive-Only	Permissive-Only
		2	4	5:30	Permissive-Only	Permissive-Only
		3	8	6:30	Protected-Permissive	Protected-Permissive
		4	1	7:20	Protected-Permissive	Protected-Permissive
		5	9	8:30	Protected-Permissive	Protected-Permissive
		6	2	10:00	Protected-Permissive	Protected-Permissive
		7	3	14:00	Protected-Permissive	Protected-Permissive
		8	6	17:30	Protected-Permissive	Protected-Permissive
		9	8	19:00	Protected-Permissive	Protected-Permissive
		10	4	21:00	Permissive-Only	Permissive-Only
		11	4	23:00	Permissive-Only	Permissive-Only
Day Plan 2	Weekend	1	4	0:00	Permissive-Only	Permissive-Only
		2	4	6:30	Permissive-Only	Permissive-Only
		3	8	7:30	Protected-Permissive	Protected-Permissive
		4	9	8:30	Protected-Permissive	Protected-Permissive
		5	2	10:30	Protected-Permissive	Protected-Permissive
		6	9	17:30	Protected-Permissive	Protected-Permissive
		7	8	19:00	Protected-Permissive	Protected-Permissive
		8	4	21:00	Permissive-Only	Permissive-Only
		9	4	23:00	Permissive-Only	Permissive-Only
Day Plan 4	(Friday)	1	4	0:00	Permissive-Only	Permissive-Only
		2	4	5:30	Permissive-Only	Permissive-Only
		3	8	6:30	Protected-Permissive	Protected-Permissive
		4	1	7:20	Protected-Permissive	Protected-Permissive
		5	9	8:30	Protected-Permissive	Protected-Permissive
		6	2	10:00	Protected-Permissive	Protected-Permissive
		7	3	13:30	Protected-Permissive	Protected-Permissive
		8	6	18:00	Protected-Permissive	Protected-Permissive
		9	8	20:00	Protected-Permissive	Protected-Permissive
		10	4	21:00	Permissive-Only	Permissive-Only
		11	4	23:00	Permissive-Only	Permissive-Only

TH 38 & 14th St N

Phase 1 Mainline NBL

Time	Left Turn Volume	U Turn Volume	Adjusted Left Turn Volume	Opposing Thru Volume	Opposing Right Volume	Adjusted Opposing Thru Volume	Opposing Left Turn Volume	Opposing U Turn Volume	Adjusted Opposing Left Turn Volume	Hourly Volumes (15-min x 4) Adj. Left Turn Volume	Adj. Opp. Thru Volume	Adj. Opp. LT Volume	Left Turn Cross Product	Cross Product (ITE)	MnDOT Signal Coordination Manual Speed 45+ and LT Volume >240 vph?	MnDOT Signal Coordination Manual Cross product >80k - 1 opposing	ITE Forum Left turn volume	ITE Forum Cross product	MnDOT Phasing Guidance
000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
515	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
530	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
600	17	0	17	27	4	31	0	0	0	68	124	0	8,432	8,432	No	No	Perm	Perm	Permissive-Only
615	2	0	2	17	0	17	0	0	0	8	68	0	544	544	No	No	Perm	Perm	Permissive-Only
630	11	0	11	36	1	37	1	0	1	44	148	4	6,512	6,512	No	No	Perm	Perm	Permissive-Only
645	9	0	9	60	1	61	5	0	5	36	244	20	8,784	8,784	No	No	Perm	Perm	Permissive-Only
700	18	0	18	28	1	29	1	0	1	72	116	4	8,352	8,352	No	No	Perm	Perm	Permissive-Only
715	32	0	32	46	0	46	8	0	8	**128**	184	32	**23,552**	23,552	No	No	Perm	Perm	Protected-Permissive
730	46	0	46	67	3	70	17	0	17	**184**	280	68	**51,520**	51,520	No	No	Perm	Prot/Perm	Protected-Permissive
745	86	0	86	89	12	101	28	0	28	**344**	404	112	**138,976**	138,976	No	**Yes**	Prot	Prot/Perm	Protected-Only
800	99	0	99	65	16	81	29	0	29	**396**	324	116	**128,304**	128,304	No	**Yes**	Prot	Prot/Perm	Protected-Only
815	75	0	75	70	1	71	16	0	16	**300**	284	64	**85,200**	85,200	No	**Yes**	Prot/Perm	Prot/Perm	Protected-Only
830	7	0	7	48	5	53	0	0	0	28	212	0	5,936	5,936	No	No	Perm	Perm	Permissive-Only
845	20	0	20	44	1	45	2	0	2	80	180	8	14,400	14,400	No	No	Perm	Perm	Permissive-Only
900	23	0	23	40	0	40	0	0	0	92	160	0	14,720	14,720	No	No	Perm	Perm	Permissive-Only
915	4	0	4	36	0	36	0	0	0	16	144	0	2,304	2,304	No	No	Perm	Perm	Permissive-Only
930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1030	3	0	3	23	0	23	1	0	1	12	92	4	1,104	1,104	No	No	Perm	Perm	Permissive-Only
1045	4	0	4	37	1	38	1	0	1	16	152	4	2,432	2,432	No	No	Perm	Perm	Permissive-Only
1100	10	0	10	41	0	41	2	0	2	40	164	8	6,560	6,560	No	No	Perm	Perm	Permissive-Only
1115	13	0	13	35	0	35	3	0	3	52	140	12	7,280	7,280	No	No	Perm	Perm	Permissive-Only
1130	10	0	10	48	0	48	0	0	0	40	192	0	7,680	7,680	No	No	Perm	Perm	Permissive-Only
1145	10	0	10	38	0	38	1	0	1	40	152	4	6,080	6,080	No	No	Perm	Perm	Permissive-Only
1200	11	0	11	40	0	40	3	0	3	44	160	12	7,040	7,040	No	No	Perm	Perm	Permissive-Only
1215	6	0	6	47	1	48	1	0	1	24	192	4	4,608	4,608	No	No	Perm	Perm	Permissive-Only
1230	7	0	7	49	0	49	5	0	5	28	196	20	5,488	5,488	No	No	Perm	Perm	Permissive-Only
1245	8	0	8	47	0	47	0	0	0	32	188	0	6,016	6,016	No	No	Perm	Perm	Permissive-Only
1300	9	0	9	41	0	41	2	0	2	36	164	8	5,904	5,904	No	No	Perm	Perm	Permissive-Only
1315	6	0	6	52	8	60	4	0	4	24	240	16	5,760	5,760	No	No	Perm	Perm	Permissive-Only
1330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1430	17	0	17	88	0	88	23	0	23	68	352	92	**23,936**	23,936	No	No	Perm	Perm	Protected-Permissive
1445	20	0	20	38	4	42	3	0	3	80	168	12	13,440	13,440	No	No	Perm	Perm	Permissive-Only
1500	13	0	13	35	2	37	2	0	2	52	148	8	7,696	7,696	No	No	Perm	Perm	Permissive-Only
1515	14	0	14	33	0	33	4	0	4	56	132	16	7,392	7,392	No	No	Perm	Perm	Permissive-Only
1530	12	0	12	45	0	45	6	0	6	48	180	24	8,640	8,640	No	No	Perm	Perm	Permissive-Only
1545	12	0	12	27	0	27	0	0	0	48	108	0	5,184	5,184	No	No	Perm	Perm	Permissive-Only
1600	19	0	19	29	0	29	5	0	5	76	116	20	8,816	8,816	No	No	Perm	Perm	Permissive-Only
1615	24	0	24	29	1	30	4	0	4	96	120	16	11,520	11,520	No	No	Perm	Perm	Permissive-Only
1630	28	0	28	47	1	48	7	0	7	112	192	28	**21,504**	21,504	No	No	Perm	Perm	Protected-Permissive
1645	23	0	23	40	3	43	6	0	6	92	172	24	15,824	15,824	No	No	Perm	Perm	Permissive-Only
1700	26	0	26	35	0	35	5	0	5	104	140	20	14,560	14,560	No	No	Perm	Perm	Permissive-Only
1715	40	0	40	35	2	37	5	0	5	**160**	148	20	**23,680**	23,680	No	No	Perm	Perm	Protected-Permissive
1730	38	0	38	31	5	36	5	0	5	**152**	144	20	**21,888**	21,888	No	No	Perm	Perm	Protected-Permissive
1745	30	0	30	39	2	41	8	0	8	120	164	32	19,680	19,680	No	No	Perm	Perm	Permissive-Only
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1815	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1830	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1845	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-
2345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-

Time	Left Turn Phase Decision-Making: Timing Pattern	Left Turn Phasing
000	4	Permissive-Only
015	4	Permissive-Only
030	4	Permissive-Only
045	4	Permissive-Only
100	4	Permissive-Only
115	4	Permissive-Only
130	4	Permissive-Only
145	4	Permissive-Only
200	4	Permissive-Only
215	4	Permissive-Only
230	4	Permissive-Only
245	4	Permissive-Only
300	4	Permissive-Only
315	4	Permissive-Only
330	4	Permissive-Only
345	4	Permissive-Only
400	4	Permissive-Only
415	4	Permissive-Only
430	4	Permissive-Only
445	4	Permissive-Only
500	4	Permissive-Only
515	4	Permissive-Only
530	4	Permissive-Only
545	4	Permissive-Only
600	4	Permissive-Only
615	4	Permissive-Only
630	2	Protected-Permissive
645	2	Protected-Permissive
700	2	Protected-Permissive
715	2	Protected-Permissive
730	2	Protected-Permissive
745	2	Protected-Permissive
800	2	Protected-Permissive
815	2	Protected-Permissive
830	2	Protected-Permissive
845	2	Protected-Permissive
900	2	Protected-Permissive
915	2	Protected-Permissive
930	2	Protected-Permissive
945	2	Protected-Permissive
1000	2	Protected-Permissive
1015	2	Protected-Permissive
1030	2	Protected-Permissive
1045	2	Protected-Permissive
1100	2	Protected-Permissive
1115	2	Protected-Permissive
1130	2	Protected-Permissive
1145	2	Protected-Permissive
1200	2	Protected-Permissive
1215	2	Protected-Permissive
1230	2	Protected-Permissive
1245	2	Protected-Permissive
1300	2	Protected-Permissive
1315	2	Protected-Permissive
1330	2	Protected-Permissive
1345	2	Protected-Permissive
1400	2	Protected-Permissive
1415	2	Protected-Permissive
1430	2	Protected-Permissive
1445	2	Protected-Permissive
1500	2	Protected-Permissive
1515	2	Protected-Permissive
1530	2	Protected-Permissive
1545	2	Protected-Permissive
1600	2	Protected-Permissive
1615	2	Protected-Permissive
1630	2	Protected-Permissive
1645	2	Protected-Permissive
1700	2	Protected-Permissive
1715	2	Protected-Permissive
1730	2	Protected-Permissive
1745	2	Protected-Permissive
1800	2	Protected-Permissive
1815	2	Protected-Permissive
1830	2	Protected-Permissive
1845	2	Protected-Permissive
1900	4	Permissive-Only
1915	4	Permissive-Only
1930	4	Permissive-Only
1945	4	Permissive-Only
2000	4	Permissive-Only
2015	4	Permissive-Only
2030	4	Permissive-Only
2045	4	Permissive-Only
2100	4	Permissive-Only
2115	4	Permissive-Only
2130	4	Permissive-Only
2145	4	Permissive-Only
2200	4	Permissive-Only
2215	4	Permissive-Only
2230	4	Permissive-Only
2245	4	Permissive-Only
2300	4	Permissive-Only
2315	4	Permissive-Only
2330	4	Permissive-Only
2345	4	Permissive-Only

Geometric Features	
Number of Left Turn Lanes	1
Number of Opposing Thru Lanes	1
Speed Limit (mph)	30
Lateral Offset (ft)	
Longitudinal Offset (ft)	

Other Factors	
Mainline	x
Cross Street	
Crash History	
High Truck Volume	
Vertical Alignment	
Skewed Intersection	

Protected-Only	
Highest LT Volume	-
Highest Cross Product	-
Protected-Permissive	
Highest LT Volume	99.00
Highest Cross Product	138,976.00
Permissive-Only	
Highest LT Volume	17.00
Highest Cross Product	8,432.00

TH 38 & 14th St N
Phase 5 Mainline SBL

Time	Left Turn Volume	U Turn Volume	Adjusted Left Turn Volume	Opposing Thru Volume	Opposing Right Volume	Adjusted Opposing Thru Volume	Opposing Left Turn Volume	Opposing U Turn Volume	Adjusted Opposing Left Turn Volume	Hourly Volumes (15-min x 4) Adj. Left Turn Volume	Adj. Opp. Thru Volume	Adj. Opp. LT Volume	Left Turn Cross Product	Cross Product (ITE)	MnDOT Signal Coordination Manual Speed 45+ and LT Volume >240 vph?	Cross product >80k - 1 opposing	ITE Forum Left turn volume	Cross product	MnDOT Phasing Guidance	Time	Left Turn Phase Decision-Making Timing Pattern	Left Turn Phasing
000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	000	4	Permissive-Only
015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	015	4	Permissive-Only
030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	030	4	Permissive-Only
045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	045	4	Permissive-Only
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	100	4	Permissive-Only
115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	115	4	Permissive-Only
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	130	4	Permissive-Only
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	145	4	Permissive-Only
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	200	4	Permissive-Only
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	215	4	Permissive-Only
230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	230	4	Permissive-Only
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	245	4	Permissive-Only
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	300	4	Permissive-Only
315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	315	4	Permissive-Only
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	330	4	Permissive-Only
345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	345	4	Permissive-Only
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	400	4	Permissive-Only
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	415	4	Permissive-Only
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	430	4	Permissive-Only
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	445	4	Permissive-Only
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	500	4	Permissive-Only
515	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	515	4	Permissive-Only
530	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	530	4	Permissive-Only
545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	545	4	Permissive-Only
600	0	0	0	2	8	10	17	0	17	0	40	68	0	0	No	No	Perm	Perm	Permissive-Only	600	4	Permissive-Only
615	0	0	0	10	8	18	2	0	2	0	72	8	0	0	No	No	Perm	Perm	Permissive-Only	615	4	Permissive-Only
630	1	0	1	10	9	19	11	0	11	4	76	44	304	304	No	No	Perm	Perm	Permissive-Only	630	2	Protected-Permissive
645	5	0	5	8	9	17	9	0	9	20	68	36	1,360	1,360	No	No	Perm	Perm	Permissive-Only	645	2	Protected-Permissive
700	1	0	1	15	8	23	18	0	18	4	92	72	368	368	No	No	Perm	Perm	Permissive-Only	700	2	Protected-Permissive
715	8	0	8	10	8	18	32	0	32	32	72	128	2,304	2,304	No	No	Perm	Perm	Permissive-Only	715	2	Protected-Permissive
730	17	0	17	29	7	36	46	0	46	68	144	184	9,792	9,792	No	No	Perm	Perm	Permissive-Only	730	2	Protected-Permissive
745	28	0	28	31	12	43	86	0	86	112	172	344	19,264	19,264	No	No	Perm	Perm	Permissive-Only	745	2	Protected-Permissive
800	29	0	29	56	6	62	99	0	99	116	248	396	**28,768**	28,768	No	No	Perm	Perm	Protected-Permissive	800	2	Protected-Permissive
815	16	0	16	56	2	58	75	0	75	64	232	300	14,848	14,848	No	No	Perm	Perm	Permissive-Only	815	2	Protected-Permissive
830	0	0	0	25	4	29	7	0	7	0	116	28	0	0	No	No	Perm	Perm	Permissive-Only	830	2	Protected-Permissive
845	2	0	2	25	3	28	20	0	20	8	112	80	896	896	No	No	Perm	Perm	Permissive-Only	845	2	Protected-Permissive
900	0	0	0	35	1	36	23	0	23	0	144	92	0	0	No	No	Perm	Perm	Permissive-Only	900	2	Protected-Permissive
915	0	0	0	18	7	25	4	0	4	0	100	16	0	0	No	No	Perm	Perm	Permissive-Only	915	2	Protected-Permissive
930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	930	2	Protected-Permissive
945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	945	2	Protected-Permissive
1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1000	2	Protected-Permissive
1015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1015	2	Protected-Permissive
1030	1	0	1	32	11	43	3	0	3	4	172	12	688	688	No	No	Perm	Perm	Permissive-Only	1030	2	Protected-Permissive
1045	1	0	1	26	7	33	4	0	4	4	132	16	528	528	No	No	Perm	Perm	Permissive-Only	1045	2	Protected-Permissive
1100	2	0	2	28	1	29	10	0	10	8	116	40	928	928	No	No	Perm	Perm	Permissive-Only	1100	2	Protected-Permissive
1115	3	0	3	44	7	51	13	0	13	12	204	52	2,448	2,448	No	No	Perm	Perm	Permissive-Only	1115	2	Protected-Permissive
1130	0	0	0	43	4	47	10	0	10	0	188	40	0	0	No	No	Perm	Perm	Permissive-Only	1130	2	Protected-Permissive
1145	1	0	1	41	2	43	10	0	10	4	172	40	688	688	No	No	Perm	Perm	Permissive-Only	1145	2	Protected-Permissive
1200	3	0	3	45	0	45	11	0	11	12	180	44	2,160	2,160	No	No	Perm	Perm	Permissive-Only	1200	2	Protected-Permissive
1215	1	0	1	32	3	35	6	0	6	4	140	24	560	560	No	No	Perm	Perm	Permissive-Only	1215	2	Protected-Permissive
1230	5	0	5	36	1	37	7	0	7	20	148	28	2,960	2,960	No	No	Perm	Perm	Permissive-Only	1230	2	Protected-Permissive
1245	0	0	0	38	3	41	8	0	8	0	164	32	0	0	No	No	Perm	Perm	Permissive-Only	1245	2	Protected-Permissive
1300	2	0	2	46	2	48	9	0	9	8	192	36	1,536	1,536	No	No	Perm	Perm	Permissive-Only	1300	2	Protected-Permissive
1315	4	0	4	40	0	40	6	0	6	16	160	24	2,560	2,560	No	No	Perm	Perm	Permissive-Only	1315	2	Protected-Permissive
1330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1330	2	Protected-Permissive
1345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1345	2	Protected-Permissive
1400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1400	2	Protected-Permissive
1415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1415	2	Protected-Permissive
1430	23	0	23	66	5	71	17	0	17	92	284	68	**26,128**	26,128	No	No	Perm	Perm	Protected-Permissive	1430	2	Protected-Permissive
1445	3	0	3	53	5	58	20	0	20	12	232	80	2,784	2,784	No	No	Perm	Perm	Permissive-Only	1445	2	Protected-Permissive
1500	2	0	2	48	2	50	13	0	13	8	200	52	1,600	1,600	No	No	Perm	Perm	Permissive-Only	1500	2	Protected-Permissive
1515	4	0	4	50	4	54	14	0	14	16	216	56	3,456	3,456	No	No	Perm	Perm	Permissive-Only	1515	2	Protected-Permissive
1530	6	0	6	53	4	57	12	0	12	24	228	48	5,472	5,472	No	No	Perm	Perm	Permissive-Only	1530	2	Protected-Permissive
1545	0	0	0	47	4	51	12	0	12	0	204	48	0	0	No	No	Perm	Perm	Permissive-Only	1545	2	Protected-Permissive
1600	5	0	5	55	3	58	19	0	19	20	232	76	4,640	4,640	No	No	Perm	Perm	Permissive-Only	1600	2	Protected-Permissive
1615	4	0	4	63	1	64	24	0	24	16	256	96	4,096	4,096	No	No	Perm	Perm	Permissive-Only	1615	2	Protected-Permissive
1630	7	0	7	71	1	72	28	0	28	28	288	112	8,064	8,064	No	No	Perm	Perm	Permissive-Only	1630	2	Protected-Permissive
1645	6	0	6	61	6	67	23	0	23	24	268	92	6,432	6,432	No	No	Perm	Perm	Permissive-Only	1645	2	Protected-Permissive
1700	5	0	5	66	3	69	26	0	26	20	276	104	5,520	5,520	No	No	Perm	Perm	Permissive-Only	1700	2	Protected-Permissive
1715	5	0	5	75	6	81	40	0	40	20	324	160	6,480	6,480	No	No	Perm	Perm	Permissive-Only	1715	2	Protected-Permissive
1730	5	0	5	80	3	83	38	0	38	20	332	152	6,640	6,640	No	No	Perm	Perm	Permissive-Only	1730	2	Protected-Permissive
1745	8	0	8	72	3	75	30	0	30	32	300	120	9,600	9,600	No	No	Perm	Perm	Permissive-Only	1745	2	Protected-Permissive
1800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1800	2	Protected-Permissive
1815	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1815	2	Protected-Permissive
1830	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1830	2	Protected-Permissive
1845	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1845	2	Protected-Permissive
1900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1900	4	Permissive-Only
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1915	4	Permissive-Only
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1930	4	Permissive-Only
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	1945	4	Permissive-Only
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2000	4	Permissive-Only
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2015	4	Permissive-Only
2030	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2030	4	Permissive-Only
2045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2045	4	Permissive-Only
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2100	4	Permissive-Only
2115	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2115	4	Permissive-Only
2130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2130	4	Permissive-Only
2145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2145	4	Permissive-Only
2200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2200	4	Permissive-Only
2215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2215	4	Permissive-Only
2230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2230	4	Permissive-Only
2245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2245	4	Permissive-Only
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2300	4	Permissive-Only
2315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2315	4	Permissive-Only
2330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2330	4	Permissive-Only
2345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No	No	-	-	-	2345	4	Permissive-Only

Geometric Features	
Number of Left Turn Lanes	1
Number of Opposing Thru Lanes	1
Speed Limit (mph)	30
Lateral Offset (ft)	
Longitudinal Offset (ft)	

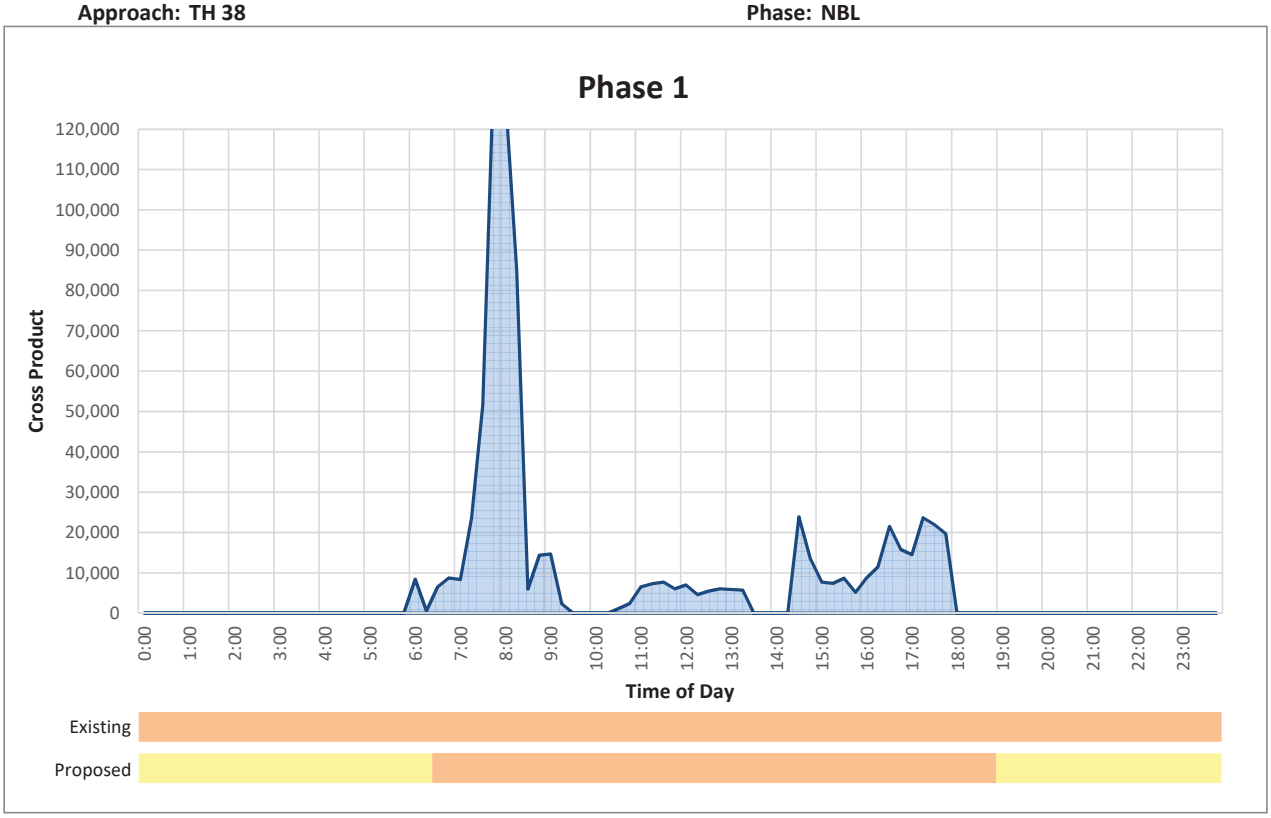
Other Factors	
Mainline	x
Cross Street	
Crash History	
High Truck Volume	
Vertical Alignment	
Skewed Intersection	

Protected-Only	
Highest LT Volume	-
Highest Cross Product	-
Protected-Permissive	
Highest LT Volume	###
Highest Cross Product	###
Permissive-Only	
Highest LT Volume	-
Highest Cross Product	-

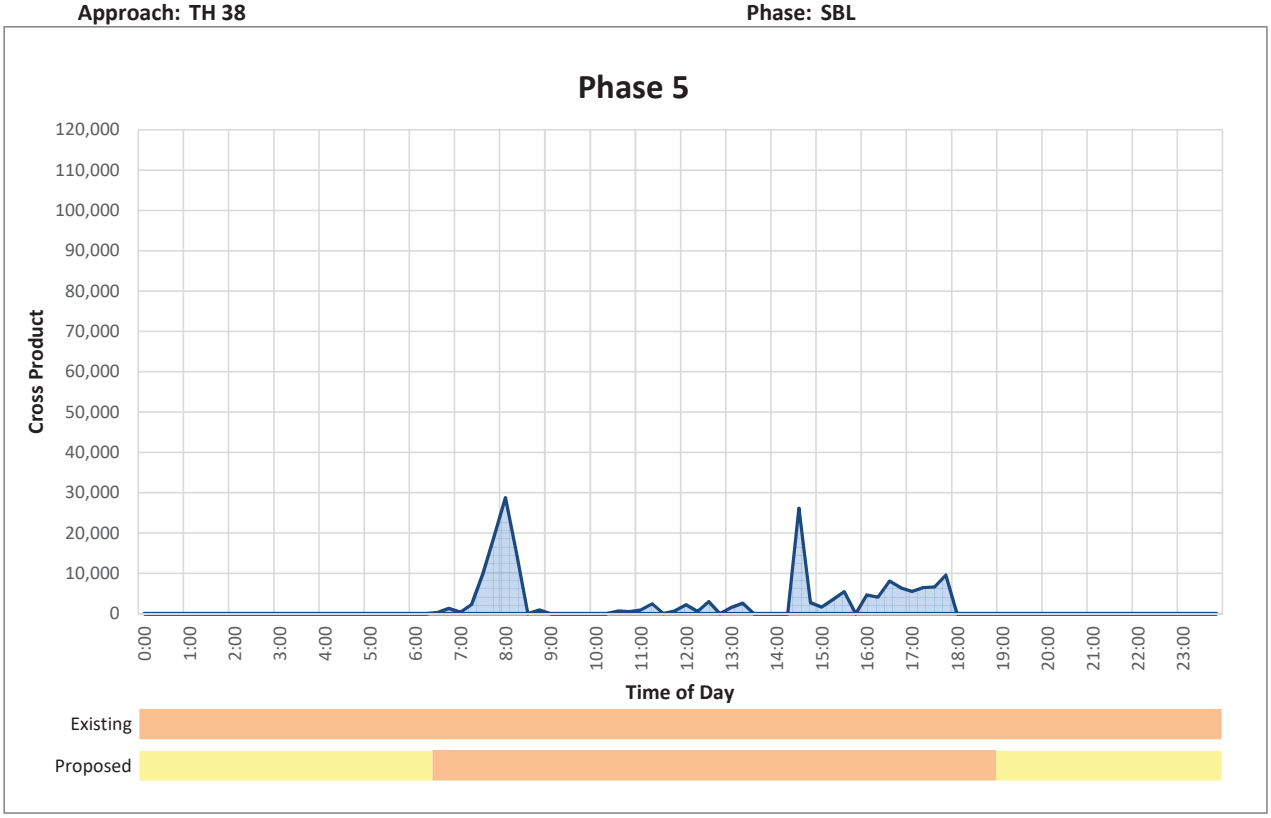
TH 38 & 14th St N

Protected
Protected/Permissive
Permissive

Approach: TH 38 **Phase: NBL**



Approach: TH 38 **Phase: SBL**



TH 38 & 14th St N
System ID: **FYA Time-of-Day Operation as of:**
2E+06 **June 6, 2019**

Day Plan	Days In Effect	Event	Action Plan	Start Time	Left-Turn FYA Operation	
					TH 38 Phase 1 (NBL)	TH 38 Phase 5 (SBL)
Day Plan 1	(Monday - Thursday)	1	4	0:00	Permissive-Only	Permissive-Only
		2	2	6:30	Protected-Permissive	Protected-Permissive
		3	4	19:00	Permissive-Only	Permissive-Only
Day Plan 2	(Weekday)	1	4	0:00	Permissive-Only	Permissive-Only
		2	2	6:30	Protected-Permissive	Protected-Permissive
		3	4	19:00	Permissive-Only	Permissive-Only
Day Plan 3	(Friday)	1	4	0:00	Permissive-Only	Permissive-Only
		2	2	6:30	Protected-Permissive	Protected-Permissive
		3	4	19:00	Permissive-Only	Permissive-Only

Appendix D:

Cost-Benefit Analysis

Zone: **Grand Rapids**

Existing TOD/Volume Case

Tab	Time		Volume Case	Hours/day
1e	445 - 600		LOW AM	1.25
2e	600 - 700		LOW AM	1.00
3e	700 - 715		LOW AM	0.25
4e	**715 - 830**		**AM PEAK**	**1.25**
5e	830 - 930		AM OFF	1.00
6e	930 - 1030		MID LOW	1.00
7e	1030 - 1045		MID LOW	0.25
8e	**1045 - 1400**		**MID PEAK**	**3.25**
9e	1400 - 1500		PM OFF 1	1.00
10e	1500 - 1545		PM OFF 1	0.75
11e	**1545 - 1745**		**PM PEAK**	**2.00**
12e	1745 - 1900		PM OFF 2	1.25
13e	1900 - 2030		EVENING	1.50
14e	2030 - 2100		LOW PM	0.50
15e	2100 - 2300		LOW PM	2.00
16e	2300 - 2345		LOW PM	0.75

Final TOD/Volume Case
Grand Rapids

Tab	Time	Volume Case	Hours/day
1f	445 - 630	LOW AM	1.75
2f	630 - 715	LOW AM	0.75
3f	**715 - 830**	**AM PEAK**	**1.25**
4f	830 - 930	AM OFF	1.00
5f	930 - 1000	MID LOW	0.50
6f	1000 - 1045	MID LOW	0.75
7f	**1045 - 1400**	**MID PEAK**	**3.25**
8f	1400 - 1545	PM OFF 1	1.75
9f	**1545 - 1730**	**PM PEAK**	**1.75**
10f	**1730 - 1745**	**PM PEAK**	**0.25**
11f	1745 - 1900	PM OFF 2	1.25
12f	1900 - 2000	EVENING	1.00
13f	2000 - 2030	EVENING	0.50
14f	2030 - 2100	LOW PM	0.50
15f	2100 - 2345	LOW PM	2.75

Volume/Time Check

Grand Rapids

Vol Case	Final	Existing	OK?
LOW AM	2.5	2.5	OK
AM PEAK	1.25	1.25	OK
AM OFF	1	1	OK
MID LOW	1.25	1.25	OK
MID PEAK	3.25	3.25	OK
PM OFF 1	1.75	1.75	OK
PM PEAK	2	2	OK
PM OFF 2	1.25	1.25	OK
EVENING	1.5	1.5	OK
LOW PM	3.25	3.25	OK
TOTAL	**19**	**19**	**OK**

TRUCK PERCENTAGES

Grand Rapids

Start Time	Main Volume (Total)	Cross Volume (Total)	Main Volume (Trucks)	Cross Volume (Trucks)	Main % Trucks	Cross % Trucks
5:30:00 AM	148	125	12	18		
5:45:00 AM	244	176	15	16		
6:00:00 AM	1612	386	159	52	9.9%	13.5%
6:15:00 AM	1805	440	202	70	11.2%	15.9%
6:30:00 AM	2219	469	172	48	7.8%	10.2%
6:45:00 AM	2510	651	140	58	5.6%	8.9%
7:00:00 AM	2427	649	176	70	7.3%	10.8%
7:15:00 AM	**2707**	**718**	**175**	**55**	**6.5%**	**7.7%**
7:30:00 AM	**3743**	**944**	**199**	**59**	**5.3%**	**6.3%**
7:45:00 AM	**5277**	**1433**	**210**	**53**	**4.0%**	**3.7%**
8:00:00 AM	**4900**	**1310**	**205**	**120**	**4.2%**	**9.2%**
8:15:00 AM	**4449**	**1269**	**177**	**59**	**4.0%**	**4.6%**
8:30:00 AM	3863	1006	185	48	4.8%	4.8%
8:45:00 AM	3901	1054	180	47	4.6%	4.5%
9:00:00 AM	3453	873	179	41	5.2%	4.7%
9:15:00 AM	3411	921	229	61	6.7%	6.6%
9:30:00 AM	520	325	20	18	3.8%	5.5%
9:45:00 AM	600	379	16	28	2.7%	7.4%
10:00:00 AM	563	359	20	24	3.6%	6.7%
10:15:00 AM	574	376	25	12	4.4%	3.2%
10:30:00 AM	3594	935	166	63	4.6%	6.7%
10:45:00 AM	**4013**	**1066**	**186**	**59**	**4.6%**	**5.5%**
11:00:00 AM	**4041**	**1139**	**187**	**48**	**4.6%**	**4.2%**
11:15:00 AM	**4392**	**1134**	**189**	**50**	**4.3%**	**4.4%**
11:30:00 AM	**4431**	**1205**	**202**	**69**	**4.6%**	**5.7%**
11:45:00 AM	**4575**	**1287**	**218**	**55**	**4.8%**	**4.3%**
12:00:00 PM	**4619**	**1418**	**188**	**57**	**4.1%**	**4.0%**
12:15:00 PM	**4513**	**1144**	**200**	**36**	**4.4%**	**3.1%**
12:30:00 PM	**4470**	**1248**	**179**	**40**	**4.0%**	**3.2%**
12:45:00 PM	**4672**	**1362**	**222**	**46**	**4.8%**	**3.4%**
1:00:00 PM	**4673**	**1328**	**197**	**46**	**4.2%**	**3.5%**
1:15:00 PM	**4494**	**1259**	**166**	**51**	**3.7%**	**4.1%**
1:30:00 PM	**749**	**425**	**19**	**16**	**2.5%**	**3.8%**
1:45:00 PM	**748**	**395**	**28**	**22**	**3.7%**	**5.6%**
2:00:00 PM	799	414	30	21	3.8%	5.1%
2:15:00 PM	784	434	27	26	3.4%	6.0%
2:30:00 PM	5143	1577	224	64	4.4%	4.1%
2:45:00 PM	5336	1551	209	76	3.9%	4.9%
3:00:00 PM	4927	1469	183	58	3.7%	3.9%
3:15:00 PM	5194	1427	193	62	3.7%	4.3%
3:30:00 PM	5111	1545	147	39	2.9%	2.5%
3:45:00 PM	**5336**	**1539**	**208**	**52**	**3.9%**	**3.4%**
4:00:00 PM	**5255**	**1404**	**166**	**40**	**3.2%**	**2.8%**
4:15:00 PM	**5299**	**1421**	**144**	**37**	**2.7%**	**2.6%**
4:30:00 PM	**5457**	**1597**	**120**	**39**	**2.2%**	**2.4%**
4:45:00 PM	**5603**	**1605**	**122**	**20**	**2.2%**	**1.2%**
5:00:00 PM	**5646**	**1731**	**91**	**28**	**1.6%**	**1.6%**
5:15:00 PM	**5571**	**1527**	**96**	**27**	**1.7%**	**1.8%**
5:30:00 PM	**5089**	**1339**	**248**	**27**	**4.9%**	**2.0%**
5:45:00 PM	4479	1169	106	29	2.4%	2.5%
6:00:00 PM	599	375	19	11	3.2%	2.9%
6:15:00 PM	652	346	4	5	0.6%	1.4%
6:30:00 PM	551	286	3	6	0.5%	2.1%
6:45:00 PM	536	290	9	5	1.7%	1.7%
AM PEAK (715-0830)	**21076**	**5674**	**966**	**346**	**4.6%**	**6.1%**
MID-DAY PEAK (1045-1400)	**50390**	**14410**	**2181**	**595**	**4.3%**	**4.1%**
PM PEAK (1545-1745)	**43256**	**12163**	**1195**	**270**	**2.8%**	**2.2%**
OFF PERIODS (Remaining Hours)	**65555**	**20007**	**3050**	**1076**	**4.7%**	**5.4%**
Total	**180277**	**52254**	**7392**	**2287**	**4.1%**	**4.4%**

AM PEAK (715-0830)	**5%**
MID-DAY PEAK (1045-1400)	**4%**
PM PEAK (1545-1745)	**3%**
OFF PERIODS (Remaining Hours)	**5%**

Cost per Stop Calculations

Table 2.3. Added time and vehicle running cost/1,000 stops and idling costs

Initial Speed (mph)	Added Cost ($/1,000 Stop) (Excludes idling time)		
	Pass Cars	Single-Unit Trucks	Combination Truck
5	2.70	9.25	33.62
10	8.83	20.72	77.49
15	15.16	33.89	129.97
20	21.74	48.40	190.06
25	28.67	63.97	256.54
30	36.10	80.23	328.21
35	**44.06**	**96.88**	**403.84**
40	52.70	113.97	482.21
45	62.07	130.08	562.14
50	72.31	145.96	642.41
55	83.47	160.89	721.77
60	95.70	178.98	798.99
65	109.02	195.84	NA*
70	123.61	NA*	NA*
75		NA*	NA*
80	156.85	NA*	NA*

Source: Life-Cycle Cost Analysis in Pavement Design, US Dept of Transportation, FHWA, September 1998

Weighted Average Vehicle Fleet Percentages (Total Project)

	Pass Cars (10-Hr Total)	Single-Unit Trucks (10-Hr Total)	Combination Truck (10-Hr Total)	% Pass Cars	% Single-Unit	% Combination Truck
Grand Rapids	222,852	8,711	968	95.8%	3.7%	0.4%
Project Total	**222,852**	**8,711**	**968**	**95.8%**	**3.7%**	**0.4%**

Reference: "Trucks" excel tab
Note: Single Unit Trucks assumed to represent 90% of the Truck Fleet

Weighted Average Free Flow Speed (Network)

		Distance	Free Flow Travel Time (sec)	Speed (mph)
Grand Rapids				
	20 mph	400	9.1	30
	30 mph	66256	1506.5	30
	40 mph	18278	311.7	40
	45 mph	8482	128.6	45
	50 mph	1810	24.7	50
	Total Project	**95,226**	**1,981**	
	Average Free Flow Speed		**33**	

Weighted Average Cost per Stop (Total Project)

Average Cost per Stop - Network Average	**$0.048**

Measures of Effectiveness Summary

	MOE - Net Reduction from Existing to Proposed Condition							
Total Project Signals	Aggregate Timing Plans	Stops (no. of veh) (All Approaches)	Delay (veh-hr) (Cross Street)	Delay (veh-hr) (Mainline)	Fuel Consumption (gal) (All Approaches)	Emissions CO (kg) (All Approaches)	Emissions NOx (kg) (All Approaches)	Emissions VOC (kg) (All Approaches)
	AM PEAK (715-0830)	4895.00	-21.76	39.87	44	3.12	1	0.73
	MID-DAY PEAK (1045-1400)	13172.25	-79.45	144.41	150	10.45	2	2.42
	PM PEAK(1545-1745)	8755.25	-80.77	106.52	78	5.41	1	1.24
	OFF PERIODS(Remaining Hours)	22103.25	-141.71	184.14	169	11.72	2	2.77
	Total System	**48,925.8**	**-323.7**	**474.9**	**439.8**	**30.7**	**6.0**	**7.2**

[1] A positive value equals the net reduction (i.e., benefit) and a negative value equals a net increase (i.e., impact)

[2] Off peak period includes the EARLY AM, AM OFF, BALANCED, PM OFF, EVENING, and OVERNIGHT Plans.

Unit Benefit

Motorist User Costs

MOE	Unit Price
Value of Time - Truck[1]	$30.30
Value of Time - Auto[1]	$18.90
Vehicle Stop[2]	$0.048
Fuel Cost[3]	$2.76

[1] Mn/DOT Office of Investment Management Benefit-Cost Analysis for Transportation Projects, Appendix A, Table A.1, SFY2018 Recommended Standard Values

[2] Life-Cycle Cost Analysis in Pavement Design, US Dept of Transportation, FHWA, Table 2.3 (Vehicle Cost per Stop), September 1998 (Refer to Appendix D for calculations)

[3] US Department of Energy, Energy Information Administration, Average Fuel Prices 6/03/18 to 6/4/19

Air Pollutant Damage Costs and Adjustment Factors Used in HERS

Pollutant	Damage Costs ($/ton)	Urban Adjustment Factor
Carbon Monoxide (CO)	125	1
Volatile Organic Compounds (VOC)	3437.5	1.5
Nitrogen Oxides (NOx)	4531.25	1.5

HERS-ST 2.0 (Highway Economic Requirements System – State Version) Technical Reports, U.S. Department of Transportation/Federal Highway Administration, 2002.
Table E5 - "Air Pollution Damage Costs and Adjustment Factors Used in HERS."
Costs converted from Year 2000 to Year 2018 by Consumer Price Index of 1.25.

Total Project Benefit

	Aggregate Timing Plans	Truck Percent (Cross Street)	Truck Percent (Mainline)	Occ.[1]	Days/ Year[2]	Value of Time Benefit ($) (Cross Street)	Value of Time Benefit ($) (Mainline)	Stops Reduction Benefit ($)	Fuel Reduction Benefit ($)	Emission Reduction Benefit ($)	Total Benefit ($)
Total Project Signals	AM PEAK (715-0830)	6.1%	4.6%	1.08	251	-$114,757	$208,788	$58,405	$30,308	$2,083	$184,828
	MID-DAY PEAK (1045-1400)	4.1%	4.3%	1.08	251	-$415,220	$755,395	$157,166	$103,568	$6,874	$607,783
	PM PEAK(1545-1745)	2.2%	2.8%	1.08	251	-$418,282	$553,034	$104,464	$53,689	$3,560	$296,465
	OFF PERIODS(Remaining Hours)	5.4%	4.7%	1.08	251	-$744,929	$964,693	$263,727	$117,076	$7,882	$608,449
	Total System			**Total Project (Average Annual Benefit)**		**-$1,693,188**	**$2,481,910**	**$583,763**	**$304,641**	**$20,399**	**$1,697,525**

[1] Occupancy Rate used by Mn/DOT Metro Traffic Office

[2] Total weekday days were reduced by 10 to account for Holidays.

[3] Off peak period includes the EARLY AM, AM OFF, BALANCED, PM OFF, EVENING, and OVERNIGHT Plans.

Benefit-Cost Ratio

Segment	Number of Intersections	Cost ($)	Benefit ($)	Benefit-Cost Ratio
Total Project - 1 Year Benefit	19	$64,597	$1,697,525	**26**
Total Project - 3 Year Benefit	19	$93,097	$5,092,576	**55**