Intersection Control Evaluation

11th Ave SE at E Center St

City of Rochester, Olmsted County, Minnesota

City of Rochester

December 2018

SRF No. 018 11822

Intersection Control Evaluation

11th Ave SE at
E Center St

Proposed Letting Date: TBD

Report Certification:

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

Adrian S. Potter — Print Name

42785 — Reg. No.

Adrian S. Potter — Signature

12/21/18 — Date

Reviewed:

Dustin S. Dahl. — City of Rochester City Engineer

12/28/18 — Date

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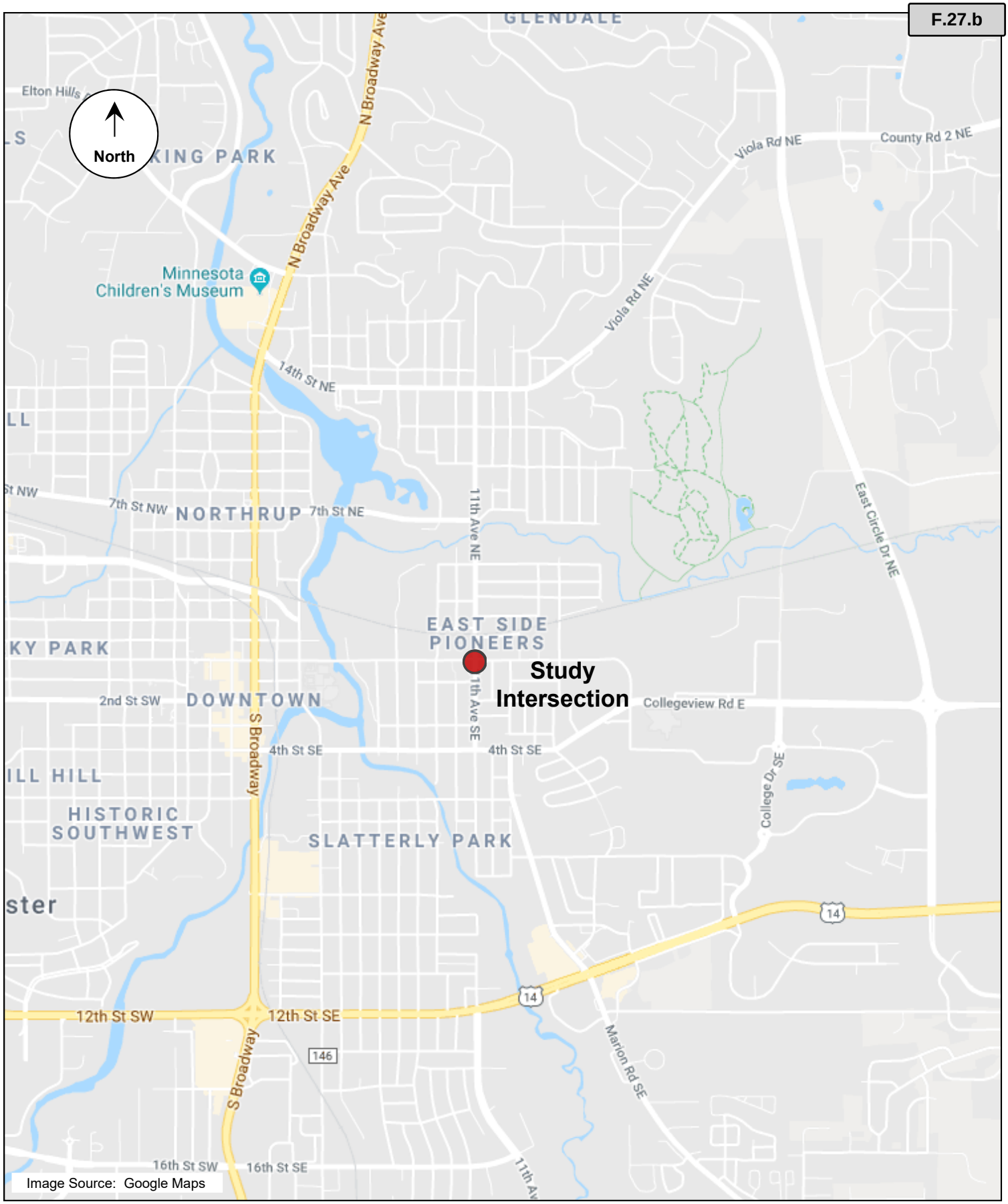
Introduction

This report comprises the intersection control evaluation results for the 11th Avenue SE at E Center Street intersection in the City of Rochester, Olmsted County, Minnesota (see Figure 1). The purpose of this evaluation was to analyze various intersection control alternatives under existing and future conditions to identify a preferred intersection control alternative. The intersection currently has a traffic signal that was installed in 1965. Since this signal is approximately 53 years old, it is likely nearing the end of its useful life. Therefore, the City determined there was a need to study this intersection in order to determine which form of intersection control would be best in the future. The following intersection control alternatives were considered applicable:

- Side-Street Stop Control
- All-Way Stop Control
- Traffic Signal Control
- Mini-Roundabout Control

Due to the age of the existing signal system, the traffic signal control alternative is defined as the replacement of the existing systems with a new system. Detailed warrants, operations, safety, and high-level cost analyses were performed to determine a preferred intersection control alternative. In addition to the above analyses, other factors considered applicable to determining the long-term preferred intersection control included:

- Right-of-Way Considerations
- Transportation System Considerations
- Pedestrian Considerations



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Intersection Location

Figure 1

Intersection Control Evaluation
11th Avenue SE at E Center Street
Rochester, Minnesota

2018 11822
December 2018

Intersection Characteristics

Existing Conditions

The 11th Avenue SE at E Center Street intersection is currently under traffic signal control. 11th Avenue SE and E Center Street are both two-lane undivided roadways with statutory speed limits of 30 mph (no posted speed limits). The adjacent area is comprised primarily of residential homes. The Boys and Girls Club of Rochester is located in the southwest quadrant of the intersection. The St. Francis of Assisi Church and School are located approximately four blocks south of the intersection. There is also an at-grade railroad crossing approximately 450 feet north of the intersection. Current intersection geometrics are listed below in Table 1 and shown in Figure 2.

Table 1. Existing Conditions

Approach	Lane Configurations
Northbound 11th Ave SE	One left-turn lane, one shared thru/right-turn lane
Southbound 11th Ave SE	One left-turn lane, one shared thru/right-turn lane
Eastbound E Center St	One left-turn lane, one shared thru/right-turn lane
Westbound E Center St	One left-turn lane, one shared thru/right-turn lane

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Existing Conditions

Figure 2

Intersection Control Evaluation
11th Avenue SE at E Center Street
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Crash History

Crash data from 2006 through 2015 were obtained from the MnDOT Crash Mapping Analysis Tool (MnCMAT). When measuring crash data, the critical crash rate is a rate determined by MnDOT that is defined as statewide average rate adjusted for the specific volume of the subject intersection. If a crash rate exceeds the critical rate, it is highly recommended that action be taken to improve the safety at that intersection. 43 total crashes were reported at the study intersection during the ten-year analysis period. This results in a crash rate of 0.77 crashes per million entering vehicles, which is above the statewide average of 0.54 but below the critical value of 0.80 for similar intersections. The fatal and serious injury crash rate for the intersection was 1.80 crashes per 100 million entering vehicles. This is above the statewide average of 0.62 but below the critical rate of 2.87. A summary of the crash data is shown below and in Table 1:

- Crash Severity:
  - 32 – Property Damage Only Crashes
  - 6 – Possible Injury (Type C) Crashes
  - 4 – Non-incapacitating Injury (Type B) Crashes
  - 1 – Fatal (Type K) Crash
- Crash Type:
  - 5 – Rear End Crashes
  - 3 – Overtaking Sideswipe Crashes
  - 2 – Left-Turn Crashes
  - 4 – Lost Control Crashes
  - 27 – Right-Angle Crashes
  - 2 – Right-Turn Crashes

Table 2. Crash History Summary

Location	Number of Crashes	Daily Entering Volume	Total Crash Rate (1)			Fatal & Serious Injury Crash Rate (2)		
			Calculated	Average	Critical	Calculated	Average	Critical
11th Ave SE at E Center St	43	15,250	**0.77**	0.54	0.80	**1.80**	0.62	2.87

(1) Intersection crash rates are expressed in crashes per million entering vehicles.
(2) Intersection crash rates are expressed in crashes per 100 million entering vehicles.

Although the crash rate for the subject intersection is not above the critical rates, it is higher than the statewide average rates. This indicates there is a safety concern at this intersection. Based on these factors, it is desired that the proposed traffic control alternative at the intersection addresses the safety issues.

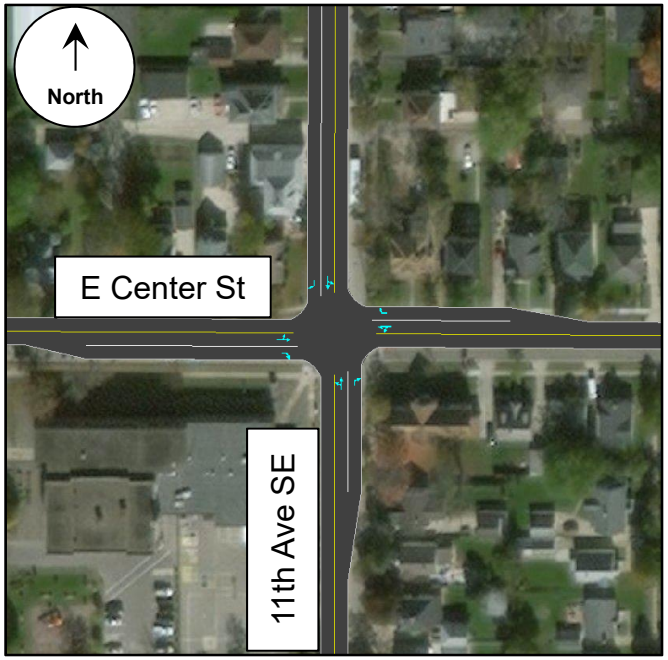
It should be noted that the crash data contains a high frequency of right-angle crashes and zero pedestrian crashes. These characteristics indicate that the existing pedestrian facilities are not a contributing factor the safety problem at the intersection. A high number of right-angle crashes is an uncommon characteristic for low-speed intersections and may help inform the recommendation of this report based on which alternative is expected to reduce that type of crash.

Future Conditions

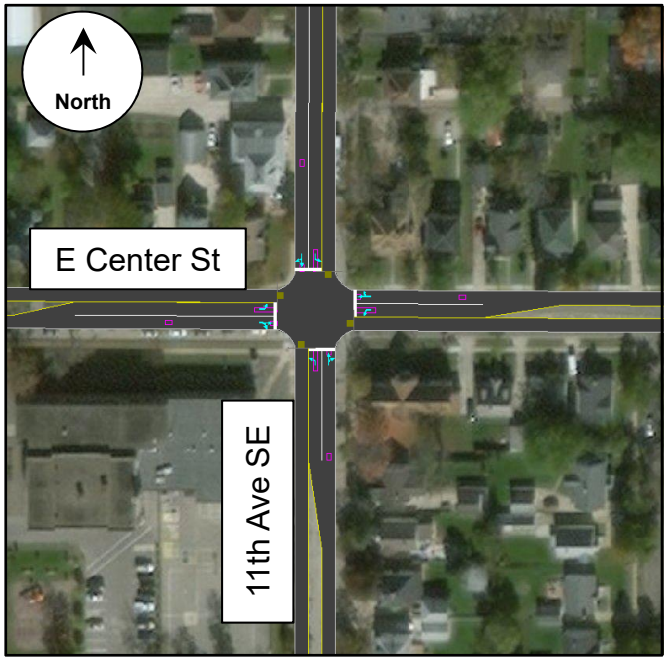
Future lane configurations were developed to accommodate projected traffic volumes. For the side-street stop control and all-way stop control alternatives, all legs of the intersection were assumed to be given a dedicated right-turn lane. For the traffic signal control alternative, the existing lane configuration was assumed to remain. For the roundabout control alternative, a single-lane mini-roundabout was assumed. The assumed lane configurations for all alternatives are shown in Table 3. The assumed layouts for all alternatives are shown in Figure 3. A detailed concept drawing of the mini-roundabout alternative can be found in the Appendix.

Table 3. Future Intersection Lane Configurations

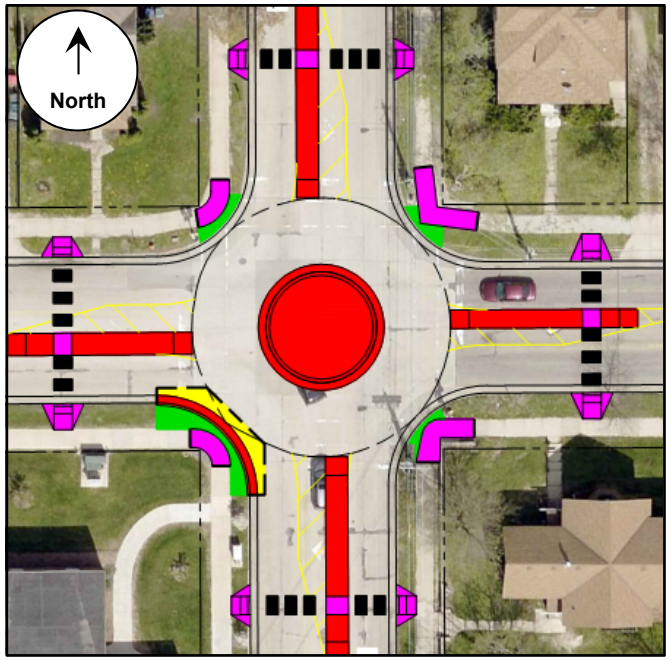
Approach	Side-Street Stop and All-Way Stop Control	Traffic Signal Control	Roundabout Control
Northbound 11th Ave SE	• One shared left-turn/thru lane • One right-turn lane	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru/right-turn lane
Southbound 11th Ave SE	• One shared left-turn/thru lane • One right-turn lane	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru/right-turn lane
Eastbound E Center St	• One shared left-turn/thru lane • One right-turn lane	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru/right-turn lane
Westbound E Center St	• One shared left-turn/thru lane • One right-turn lane	• One left-turn lane • One shared thru/right-turn lane	• One shared left-turn/thru/right-turn lane



Side-Street Stop and All-Way Stop Alternatives



Traffic Signal Alternative



Mini-Roundabout Alternative

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December 2018

Proposed Lane Configurations

Intersection Control Evaluation
11th Avenue SE at E Center Street
Rochester, Minnesota

Figure 3

Traffic Volumes

Existing peak hour approach volumes at the study intersection were collected in October 2018 by SRF Consulting Group and are summarized in Figure 4. The existing turning movement counts are shown in the Appendix.

Forecast Year 2040 AM and PM peak hour turning movement volumes used in the analysis were based on existing hourly counts and further adjusted using historical AADT data to project future growth. Forecast Year 2040 turning movement volumes are shown in Figure 5.

Consulting Group, Inc.

Existing Volumes

Figure 4

Intersection Control Evaluation
11th Avenue SE at E Center Street
Rochester, Minnesota

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SRF Consulting Group, Inc.

Forecast Year 2040 Volumes

Figure 5

Intersection Control Evaluation
11th Avenue SE at E Center Street
Rochester, Minnesota

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Analysis of Alternatives

Warrants Analysis

A warrants analysis was performed for the traffic signal control alternative as outlined in the February 2018 *Minnesota Manual on Uniform Traffic Control Devices* (MnMUTCD). Analysis of signal warrants 1-3 was performed utilizing existing volumes. Signal warrants 6-8 were investigated and were determined to be not applicable to the study due to the lack of coordinated signal systems or roadway network concerns at the intersection.

Warrants 4, 5, and 9 were investigated further. Warrant 4 (Pedestrian Volume) was investigated due to the intersection's location within a residential area. Warrant 5 (School Crossing) was investigated due to the location of the Boys and Girls Club of Rochester in the southwest quadrant of the intersection as well as the St. Francis of Assisi School to the south. This facility was assumed to generate pedestrian behavior similar to that of a school. Warrant 9 (Intersection Near a Grade Crossing) was also investigated due to the railroad crossing approximately 450 feet north of the intersection.

Due to low pedestrian volumes recorded along with the turning movement counts, warrants 4 and 5 were not met by the intersection. Within the MnMUTCD, the figures relating to warrant 9 only contain data for grade crossings up to 130 feet from the subject intersection. Since the grade crossing is much farther away from the intersection than the MnMUTCD addresses, engineering judgement was used to determine that warrant 9 is also not met by the intersection. The lane geometry and approach speeds assumed for the warrant analysis are shown in Table 4.

Table 4. Warrants Analysis Assumptions

Approach	Geometry	Speed Limit
Northbound 11th Ave SE	Two or more approach lanes	30 mph
Southbound 11th Ave SE	Two or more approach lanes	30 mph
Eastbound E Center St	Two or more approach lanes	30 mph
Westbound E Center St	Two or more approach lanes	30 mph

For the analysis, right turns on the minor approach were included as these turns are not given a dedicated lane and thus significantly impact the thru-movement on both minor approaches.

The 70 percent traffic volume factor was not used for the warrants analysis, as proposed conditions did not meet the necessary criteria (i.e. mainline roadway speed limits exceed 40 mph and the city population is less than 10,000). Table 5 provides a summary of the warrants analysis results, while the detailed volume-based warrants analysis is included in the Appendix.

In addition to the signal warrants, Multiway Stop Applications Warrant Condition C (MWSA C) was also evaluated as outlined in the MnMUTCD. The results of the MWSA warrants analysis are also shown in Table 5.

Table 5. Warrants Analysis Summary

MnMUTCD Warrant	Hours Required	Existing Volumes		2040 Volumes	
		Hours Met	Warrant Met?	Hours Met	Warrant Met?
MWSA C: Minimum Volumes	8	13	Yes	14	Yes
Warrant 1A: Minimum Vehicular Volume	8	4	No	6	No
Warrant 1B: Interruption of Continuous Traffic	8	0	No	0	No
Warrant 1C: Combination of Warrants	8	1	No	4	No
Warrant 2: Four-Hour Volume	4	1	No	4	Yes
Warrant 3B: Peak Hour Volume	1	0	No	1	Yes
Warrants 4, 5, 9	Not Met				
Warrants 6-8	Not Applicable				

The results of the warrants analysis indicate the intersection meets MnMUTCD MWSA warrant C under existing conditions. However, the intersection does not meet any signal warrants under existing conditions. However, the results of the warrants analysis also indicate the intersection meets MnMUTCD MWSA warrant C and signal warrants 2 and 3B under 2040 conditions.

Based on guidance from Chapter 9 of MnDOT's Traffic Engineering Manual and references to Part 4 of MnDOT's Manual on Uniform Traffic Control Devices, signal removal analysis was conducted. Due to the intersection's failure to meet any signal warrants under existing conditions, a traffic signal removal analysis was conducted using 80% and 60% removal criteria. The volumes present within the intersection were first compared to 80% of the minimum warrant volumes. The results can be seen in Table 6.

Table 6. Signal Removal Analysis – 80% Removal Criteria

MnMUTCD Warrant	Hours Required	80% of Existing Requirements	
		Hours Met	Warrant Met?
Warrant 1A: Minimum Vehicular Volume	8	9	Yes
Warrant 1B: Interruption of Continuous Traffic	8	1	No
Warrant 1C: Combination of Warrants	8	6	No

Note: Only signal warrant 1 is examined for signal removal analysis.

The results of the 80% removal criteria analysis indicate that the signal is warranted under 80% conditions. This result indicates that the signal likely should not be removed as it is functioning close to the signal warrant minimum volumes. Due to the signal satisfying the 80% warrant conditions, a 60% removal criteria analysis was not conducted.

Operations Analysis

Operational analysis of the side-street stop, all-way stop, and traffic signal control alternatives was performed using Synchro/SimTraffic. SimTraffic is a microscopic simulation software program that interfaces with Synchro and is used in this analysis. Traffic operations analysis of the roundabout alternative was conducted using RODEL and HCS software. RODEL is a software program that is based on existing roundabout operational research and uses an empirical formula method to determine roundabout delay based on geometric features and traffic flows. HCS is a software program that is based on equations and identities from the Highway Capacity Manual (HCM).

The operations analysis identifies a Level of Service (LOS) which indicates how well an intersection is operating based on delay per vehicle. Delay is calculated based on procedures outlined in the HCM. Intersections are given a ranking from LOS A to LOS F. LOS A indicates the best traffic operation and LOS F indicates an intersection where demand exceeds capacity. LOS A through LOS D are considered acceptable because the intersection would be operating under capacity. RODEL results for a Confidence Level (CL) of 50 percent and 85 percent were determined. 50 percent CL results are typically used for roundabout analysis while the 85 percent CL results indicate the sensitivity of the roundabout design. When a substantial degradation in LOS is expected from 50 percent CL to 85 percent CL, designers should exercise caution in the design of the roundabout to ensure adequate capacity is provided. A summary of the operational analysis under existing and 2040 conditions can be seen in Table 7 and Table 8, respectively. The detailed operational analysis results are shown in the Appendix.

Table 7. Operations Analysis Results – 2018 Conditions

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control	SimTraffic	9 / 20	A / C	12 / 31	B / C
All-Way Stop Control	SimTraffic	13 / 17	B / C	16 / 23	C / C
Traffic Signal Control	SimTraffic	9 / 10	A / A	10 / 11	A / B
Roundabout Control	HCS 7	8 / 9	A / A	9 / 10	A / A
	RODEL 50% CL	7 / 8	A / A	7 / 8	A / A
	RODEL 85% CL	11 / 15	B / B	13 / 16	B / C

Note: Overall results are followed by the worst approach results.

Table 8. Operations Analysis Results – 2040 Conditions

Alternative	Analysis Tool	AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Side-Street Stop Control	SimTraffic	22 / 52	C / F	34 / 99	D / F
All-Way Stop Control	SimTraffic	22 / 37	C / E	38 / 77	D / F
Traffic Signal Control	SimTraffic	10 / 11	A / B	11 / 11	B / B
Roundabout Control	HCS 7	10 / 12	A / B	11 / 12	B / B
	RODEL 50% CL	8 / 11	A / B	9 / 10	A / A
	RODEL 85% CL	17 / 26	C / D	19 / 24	C / C

Note: Overall results are followed by the worst approach results.

Operational analysis results of existing conditions indicate that all alternatives are expected to perform with acceptable levels of service under proposed lane conditions. The side-street stop control alternative is expected to offer low average delays but higher minor-approach delays. The all-way stop control alternative is expected to operate with higher average delays but more evenly distributed delays than the side-street stop alternative. Both the traffic signal and roundabout control alternatives are expected to operate with low average and worst-approach delays. There is a significant difference between the RODEL 50% and 85% confidence level results. This indicates that the RODEL analysis is more susceptible to fluctuations in traffic volumes and could operate with less stability.

Operational analysis results of projected 2040 conditions indicate that both the side-street and all-way stop alternatives are expected to fail under future volumes. Both the traffic signal and roundabout control alternatives are still expected to operate with low average and worst-approach delays. There is still a significant difference between the RODEL 50% and 85% confidence level results under future conditions. This indicates that the RODEL analysis is more susceptible to fluctuations in traffic volumes and could operate with less stability.

It should be noted that operational analysis of the traffic signal alternative was conducted under the assumption that the existing signal phasing would remain. Due to low delay results for the traffic signal alternative under the existing phasing, models with alternative phasing were not considered. However, alternative signal phasing could potentially further improve operations under traffic signal control.

Safety Analysis

A safety analysis was performed to estimate the number of crashes per year for each traffic control alternative under current and 2040 conditions for the study intersection. For the traffic signal control alternative, the existing crash rate was assumed to remain. To analyze the crash rates for the side-street stop, all-way stop, and roundabout alternatives, the expected crash rates were assumed to be equal to the statewide average crash rates for similar intersections. A summary of the projected crashes per intersection alternative is shown in Table 9.

Table 9. Projected Crashes per Intersection Alternative

Alternative	Intersection ADT		Average Crash Rate (1)	Projected Crashes/Year	
	Existing Year 2018	Forecast Year 2040		Existing Year 2018	Forecast Year 2040
Side-Street Stop Control	15,250	17,000	0.19 (3)	1.1	1.2
All-Way Stop Control			0.35 (4)	1.9	2.2
Traffic Signal Control			0.77 (2)	4.3	4.8
Roundabout Control			0.32 (5)	1.8	2.0

(1) Per million entering vehicles (2008-2017 data).
(2) Assumed to match the current crash rate at the intersection.
(3) Based on MnDOT Green Sheets average crash rate for urban thru/stop intersections.
(4) Based on MnDOT Green Sheets average crash rate for all-way stop intersections.
(5) Based on *A Study of the Traffic Safety at Roundabouts in Minnesota* (MnDOT – Office of Traffic, Safety, and Technology).

Due to the presence of one fatal and four non-incapacitating injury crashes in the data, a fatal and serious injury crash analysis was also conducted.

Table 10. Projected Fatal & Serious Injury Crashes per Intersection Alternative

Alternative	Intersection ADT		Average Crash Rate (1)	Projected Crashes/Year	
	Existing Year 2018	Forecast Year 2040		Existing Year 2018	Forecast Year 2040
Side-Street Stop Control	15,250	17,000	0.35 (3)	0.02	0.02
All-Way Stop Control			0.60 (4)	0.03	0.04
Traffic Signal Control			1.80 (2)	0.10	0.11
Roundabout Control			0.31 (5)	0.02	0.02

(1) Per 100 million entering vehicles (2008-2017 data).
(2) Assumed to match the current fatal and serious injury crash rate at the intersection.
(3) Based on MnDOT Green Sheets average fatal and serious injury crash rate for urban thru/stop intersections.
(4) Based on MnDOT Green Sheets average fatal and serious injury crash rate for all-way stop intersections.
(5) Based on *A Study of the Traffic Safety at Roundabouts in Minnesota* (MnDOT – Office of Traffic, Safety, and Technology).

Based on the crash analysis, the side-street stop control alternative is expected to have the lowest crash rate while the roundabout control alternative is expected to have the lowest fatal and serious injury crash rate. The existing traffic signal control alternative is expected to have the least safety benefits for both rates. It should be noted that the majority of the crashes experienced at this intersection were right-angle/right-turn/left-turn crashes. These crashes are often caused by drivers not obeying or ignoring the existing signal system. Due to this behavioral trend at the intersection, it is reasonable to expect drivers to also ignore or fail to notice future stop signs. Thus, allowing drivers to decide their own right-of-way within a side-street or all-way stop design would likely lead to an increased number of right-angle crashes. It should also be noted that roundabouts typically have fewer conflict points than conventional intersections and that the geometry of a roundabout induces lower speeds for vehicles approaching and traversing an intersection. With lower speeds, the severity of the crashes is decreased. A roundabout should also eliminate almost all right-angle and left-turn type crashes as these movements are not possible within the geometry of a roundabout. Studies have shown the frequency of injury crashes is reduced more than property damage only crashes and that roundabout control significantly reduces the frequency of severe and fatal crashes.

Right-of-Way Considerations

No alternative would require additional right-of-way. Due to the lack of available right-of-way adjacent to the intersection, all alternatives must be able to fit within the existing right-of-way. The side-street stop, all-way stop, and traffic signal alternatives will not add any additional lanes in order to meet this requirement. The roundabout alternative was designed as a mini-roundabout capable of being constructed within the existing intersection footprint.

Transportation System Considerations

Currently, intersections in the area operate under either stop or signal control. However, there are roundabouts located within the City of Rochester and in Olmsted County, so traffic would likely be familiar with roundabout control.

The subject intersection is located between the bulk of downtown Rochester and a handful of large trip generating locations including the Olmsted Medical Center, Faud Mansour Sports Complex, and Rochester Community and Technical College campus. Due to this, the intersection is a contributing factor to the overall mobility to and from the eastern side of downtown Rochester.

Pedestrian Considerations

Based on the pedestrian volume data gathered with the turning movement counts, the subject intersection does not satisfy the pedestrian-based signal warrants. However, due to the intersection's location in urban Rochester, pedestrian volumes do exist and should be considered as part of the alternatives evaluation. Pedestrian movements would be difficult to accommodate under side-street stop conditions as pedestrians would be forced to wait for a gap in the 11th Avenue SE traffic in order to cross. Pedestrian movements would easily be accommodated under the all-way stop or traffic signal conditions as vehicles on all approaches are required to come to a stop fairly regularly. The traffic signal control alternative could offer increased pedestrian safety with dedicated pedestrian phasing. Pedestrian accommodations under roundabout control would operate similarly to the all-way stop control. There were no pedestrian-related crashes reported at the intersection within the last ten years. Thus, it can be assumed that pedestrian safety is not a significant issue under the current traffic signal control.

High-Level Cost Analysis

A high-level cost analysis was conducted for all alternatives. The results of this analysis can be seen in Table 11.

Table 11. High-Level Cost Analysis

Alternative	Estimated Cost
Side-Street / All-Way Stop Control (1)	$38,271
Traffic Signal Control	$284,000
Roundabout Control	$155,355

(1) Construction prices for the side-street and all-way stop control alternatives will vary by roughly $2000 due to the difference in the number of stop and stop ahead signs between the alternatives.

This analysis indicates that the side-street/all-way stop alternatives would be significantly less expensive than the other two alternatives and that the traffic signal alternative would be significantly more expensive. It should be noted that the traffic signal alternative is not a "no-build" alternative but instead assumes a replacement of the existing system. A breakdown of the high-level cost analysis for all alternatives can be seen in the Appendix.

Conclusions

The following intersection control evaluation (ICE) conclusions and recommendations are provided for the 11th Avenue at E Center Street intersection in Rochester, Olmsted County, Minnesota:

- *Warrants Analysis*
  The results of the warrant analysis under existing conditions indicate that while the intersection does satisfy the MWSA warrant. No signal warrants are met under existing volumes including the warrant for pedestrian volumes. However, the intersection does meet the 80% removal criteria for signals. This indicates that the signal could be retained since it is near the warrant minimums.

  The results of the warrant analysis under 2040 conditions indicate that while the intersection does satisfy the MWSA warrant. Signal warrants 2 and 3B are met under 2040 volumes.

- *Operations Analysis*
  Operational analysis results indicate that all alternatives are expected to perform with acceptable levels of service under existing conditions. Both the traffic signal and mini-roundabout alternatives are expected to operate with low overall and worst-approach delays.

  Operational analysis results indicate that both the side-street and all-way stop control alternatives are expected to fail under 2040 conditions. Both the traffic signal and mini-roundabout alternatives are expected to operate with low overall and worst-approach delays.

- *Safety Analysis*
  Based on the crash analysis, the roundabout control alternative is expected to provide the lowest crash rate and fatal and serious injury crash rate. Both the side-street and all-way stop control alternatives are expected to significantly increase both the crash rate and the fatal and serious injury crash rate. Additionally, roundabouts all but eliminate right-angle crashes which comprise approximately 63% of the crashes reported at the subject intersection over the past ten years.

- *High-Level Cost Analysis*
  The side-street/all-way stop control alternative is estimated to cost $38,271. The traffic signal control alternative is expected to cost $284,000. The roundabout control alternative is expected to cost $155,355. This makes the side-street/all-way stop alternative the least expensive by a significant margin. However, both stop-controlled alternatives come with notable drawbacks in other areas.

- *Right-of-Way Considerations*
  All alternatives are not expected to require additional right-of-way.

- *Transportation System Considerations*
  Currently, there are a number of roundabouts located in Rochester. Traffic is expected to be familiar with the traversal of roundabouts. The subject intersection is a contributing factor to the mobility of the area between eastern and downtown Rochester.

- *Pedestrian Considerations*
  Pedestrian accommodations would be difficult to include under side-street stop control conditions. Pedestrians would be afforded greater safety within the all-way stop, traffic signal, or mini-roundabout alternatives.

Recommended Intersection Control

A decision matrix was developed to help evaluate the key factors and is provided in Table 12.

A mini-roundabout design is recommended for the subject intersection. This recommendation is primarily based on the safety benefits afforded by a roundabout design. Due to the high frequency of right-angle crashes, a roundabout design should significantly reduce crashes overall at the intersection. Additionally, the roundabout alternative is expected to operate with similar delay values to the existing traffic signal alternative.

However, if the City of Rochester would rather not invest the amount of capital necessary to construct a roundabout, the conversion of the intersection to all-way stop control is also expected increase intersection safety. However, the all-way stop alternative should not be considered as a long-term solution due to its anticipated operational failure by 2040.

Table 12. Alternative Decision Matrix

Factor		Side-Street Stop Control	All-Way Stop Control	Traffic Signal Control	Roundabout Control	Recommended Alternative(s) Based on Factor
Warrant Analysis	2018	• N/A	• AWSC warrant met under existing conditions	• Signal warrants not met under existing conditions	• N/A	Side-Street Stop Control All-Way Stop Control Roundabout Control
	2040	• N/A	• AWSC warrant met under 2040 conditions	• Signal warrants met under existing conditions	• N/A	All Alternatives
Operational Analysis	2018	• Acceptable LOS	• Acceptable LOS	• Acceptable LOS	• Acceptable LOS	All Alternatives
	2040	• Unacceptable LOS	• Unacceptable LOS	• Acceptable LOS	• Acceptable LOS	Traffic Signal Control Roundabout Control
Safety Analysis	Pro(s):	• N/A	• Lower vehicle speeds	• Lower vehicle speeds	• Lower vehicle speeds • Eliminates right-angle crashes	All-Way Stop Control Roundabout Control
	Con(s):	• Higher mainline vehicle speeds • Lowest pedestrian safety	• Drivers decide right-of-way	• High existing crash rate	• Drivers decide right-of-way	
High-Level Cost Analysis	Pro(s):	• Least expensive	• Least expensive	• N/A	• Less expensive than signal	Side-Street Stop Control
	Con(s):	• N/A	• N/A	• Most expensive	• Significantly expensive	All-Way Stop Control
Right-of-Way Considerations	Pro(s):	• No additional right-of-way required	• No additional right-of-way required	• No additional right-of-way required	• No additional right-of-way required	All Alternatives
	Con(s):	• N/A	• N/A	• N/A	• N/A	
Pedestrian Considerations	Pro(s):	• N/A	• Capable of providing pedestrian accommodations	• Capable of dedicated pedestrian phasing	• Capable of providing pedestrian accommodations	All-Way Stop Control Roundabout Control
	Con(s):	• Pedestrians must find gaps in E Center St traffic	• N/A	• N/A	• N/A	

Appendix

- Year 2018 Intersection Turning Movement Data
- 2006-2015 Crash Data
- 2018 Warrant Analysis
- 2040 Warrant Analysis
- Signal Warrant Analysis – 80% Removal Criteria
- Detailed 2018 Operations Analysis
- Detailed 2040 Operations Analysis
- Mini-Roundabout Alternative Layout
- High-Level Cost Estimates

Year 2018 Intersection Turning Movement Data

11th Ave NE /
E Center St

SRF Consulting Group
Turning Movement Count

Count Date: 1[illegible]

Start Time	11th Ave NE EB				11th Ave NE WB				E Center St NB				E Center St SB				15 min Veh. Total	15 min Ped Total
	L	T	R	Ped	L	T	R	Ped	L	T	R	Ped	L	T	R	Ped		
600	-	14	2	-	1	19	7	-	3	10	-	-	7	24	5	-	92	-
615	-	16	2	-	1	29	4	-	6	25	-	-	3	28	4	-	118	-
630	-	18	2	2	-	52	11	-	14	16	-	-	14	35	6	-	168	2
645	5	28	4	-	-	47	13	-	18	30	1	-	20	37	12	-	215	-
700	3	34	8	-	5	45	14	-	17	44	-	-	13	40	4	-	227	-
715	4	33	3	-	3	52	11	-	11	54	2	-	32	56	13	1	274	1
730	5	51	3	-	1	63	14	-	18	63	2	-	41	69	14	2	344	2
745	5	63	4	1	3	42	17	-	10	47	-	-	41	76	11	1	319	2
800	2	42	9	-	3	33	15	-	10	44	5	-	31	46	7	-	247	-
815	3	31	7	-	-	26	16	-	14	31	-	-	21	65	10	-	224	-
830	4	30	11	-	3	23	14	1	21	45	-	-	13	67	5	-	236	1
845	2	23	4	-	1	30	10	1	11	49	2	-	20	59	4	-	215	1
900	8	23	5	1	3	27	15	-	12	43	4	-	25	48	9	-	222	1
915	2	45	2	-	3	10	12	-	6	48	3	-	26	54	7	-	218	-
930	4	31	8	-	2	15	15	1	8	36	1	-	20	43	9	-	192	1
945	1	23	12	-	1	26	16	2	4	40	-	-	13	37	3	-	176	2
1000	3	23	9	-	3	20	10	-	6	32	1	-	11	36	4	-	158	-
1015	2	21	9	-	1	18	13	-	8	38	1	-	11	40	8	-	170	-
1030	6	27	8	-	2	22	16	-	7	38	-	-	16	43	8	-	193	-
1045	5	37	6	1	-	17	20	-	5	45	2	-	22	47	10	-	216	1
1100	4	12	12	4	3	26	8	-	5	46	2	-	10	51	5	-	184	4
1115	-	15	10	1	3	26	12	-	10	47	2	-	10	49	3	1	187	2
1130	4	20	5	-	1	23	18	1	8	37	4	-	18	45	3	-	186	1
1145	4	28	12	1	1	30	27	-	6	48	4	-	29	36	7	-	232	1
1200	8	27	6	-	2	39	34	-	4	49	1	-	22	51	7	-	250	-
1215	1	21	11	-	1	46	29	1	7	40	-	-	19	39	8	1	222	2
1230	3	25	9	1	1	16	23	-	7	31	3	-	18	45	6	-	187	1
1245	6	26	8	-	1	27	18	-	10	50	3	-	29	51	8	-	237	-
1300	7	20	7	1	5	28	25	-	9	41	-	-	19	36	7	-	204	1
1315	2	18	13	2	2	25	16	-	8	53	2	2	17	38	4	-	198	4
1330	7	26	7	-	2	41	13	-	9	39	1	-	16	40	5	-	206	-
1345	3	24	8	-	2	49	22	-	11	41	2	-	16	46	7	-	231	-
1400	3	25	5	-	3	45	22	-	7	56	6	-	11	39	8	-	230	-
1415	9	29	11	-	1	28	20	-	6	53	-	-	24	58	7	-	246	-
1430	9	22	11	1	3	29	17	1	5	51	-	-	16	65	6	1	234	3
1445	5	30	15	4	2	39	22	-	9	66	1	1	16	70	5	-	280	5
1500	5	30	15	1	2	34	16	1	6	58	2	-	26	70	11	1	275	3
1515	9	38	31	1	5	29	22	-	10	56	-	-	26	97	11	1	334	2
1530	15	53	27	-	2	49	27	-	20	81	5	1	21	67	13	-	380	1
1545	10	47	14	1	1	40	19	-	12	66	1	-	34	71	9	-	324	1
1600	10	35	19	-	3	41	28	1	9	58	-	1	20	66	6	-	295	2
1615	10	51	16	-	2	29	20	1	10	72	2	-	27	76	4	-	319	1
1630	11	52	23	-	3	36	30	2	9	64	4	1	24	64	7	2	327	5
1645	7	47	16	1	5	37	23	-	8	61	-	-	16	67	4	-	291	1
1700	8	48	17	-	2	43	27	-	12	72	3	1	31	69	5	-	337	1
1715	16	51	13	-	2	36	19	2	5	77	4	2	21	73	5	2	322	6
1730	10	37	14	-	3	32	12	1	8	61	-	-	15	53	5	-	250	1
1745	7	31	14	-	3	14	11	-	3	66	4	1	15	67	10	1	245	2
1800	5	17	9	-	1	47	19	-	9	46	1	-	10	51	11	-	226	-
1815	7	16	11	1	4	21	11	-	8	53	1	-	11	47	8	-	198	1
1830	6	17	9	-	2	11	13	-	3	71	1	1	6	62	2	2	203	3
1845	8	17	8	-	2	18	5	-	5	49	2	-	11	52	4	-	181	-

Counted By: KO

11th Ave NE /
E Center St

SRF Consulting Group
Turning Movement Count

Count Date: 1[illegible]

Start Time	11th Ave NE EB L	T	R	Ped	11th Ave NE WB L	T	R	Ped	E Center St NB L	T	R	Ped	E Center St SB L	T	R	Ped	**15 min Veh. Total**	**15 min Ped Total**
Peak 1	0000	to	1000															
715	4	33	3	-	**3**	52	11	**-**	11	54	2	**-**	32	56	13	1	274	-
730	**5**	51	3	-	1	**63**	14	**-**	**18**	**63**	2	**-**	**41**	69	**14**	**2**	344	1
745	**5**	**63**	4	**1**	**3**	42	**17**	**-**	10	47	-	**-**	**41**	**76**	11	1	319	2
800	2	42	**9**	-	**3**	33	15	**-**	10	44	**5**	**-**	31	46	7	-	247	-
Total	**16**	**189**	**19**	**1**	**10**	**190**	**57**	**-**	**49**	**208**	**9**	**-**	**145**	**247**	**45**	**4**	**1,184**	**3**
PHF	0.80	0.75	0.53		0.83	0.75	0.84		0.68	0.83	0.45		0.88	0.81	0.80		0.86	
Trucks	-	1%	-	-	10%	2%	-	-	-	2%	11%	-	1%	3%	-	-	2%	
Peak 2	1000	to	1400															
1400	3	25	5	-	**3**	**45**	**22**	-	7	56	**6**	-	11	39	**8**	-	230	-
1415	**9**	29	11	-	1	28	20	-	6	53	-	-	**24**	58	7	-	246	-
1430	**9**	22	11	1	**3**	29	17	**1**	5	51	-	-	16	65	6	**1**	234	1
1445	5	**30**	**15**	**4**	2	39	**22**	-	**9**	**66**	1	**1**	16	**70**	5	-	280	5
Total	**26**	**106**	**42**	**5**	**9**	**141**	**81**	**1**	**27**	**226**	**7**	**1**	**67**	**232**	**26**	**1**	**990**	**6**
PHF	0.72	0.88	0.70		0.75	0.78	0.92		0.75	0.86	0.29		0.70	0.83	0.81		0.88	
Trucks	8%	5%	2%	-	-	2%	2%	-	-	4%	-	-	1%	4%	4%	-	3%	
Peak 3	1400	to	2400															
1515	9	38	**31**	**1**	**5**	29	22	-	10	56	-	-	26	**97**	11	**1**	334	2
1530	**15**	**53**	27	-	2	**49**	27	-	**20**	**81**	**5**	**1**	21	67	**13**	-	380	1
1545	10	47	14	**1**	1	40	19	-	12	66	1	-	**34**	71	9	-	324	1
1600	10	35	19	-	3	41	**28**	**1**	9	58	-	**1**	20	66	6	-	295	2
Total	**44**	**173**	**91**	**2**	**11**	**159**	**96**	**1**	**51**	**261**	**6**	**2**	**101**	**301**	**39**	**1**	**1,333**	**6**
PHF	0.73	0.82	0.73		0.55	0.81	0.86		0.64	0.81	0.30		0.74	0.78	0.75		0.88	
Trucks	7%	2%	1%	-	27%	1%	-	-	-	4%	-	-	3%	3%	3%	-	3%	

Counted By: KO

2006-2015 Crash Data

Intersection Safety Screening

Intersection: 11th Avenue SE at E Center Street

Crash Data, 2006-2015.

Crashes by Crash Severity	
Fatal	1
Incapacitating Injury	0
Non-incapacitating Injury	4
Possible Injury	6
Property Damage	32
Total Crashes	43

Intersection Characteristics	
Entering Volume	15,250
Traffic Control	Signals
Environment	Urban
Speed Limit	30 mph

Annual crash cost = $256,120

Statewide Comparison

Signals: low volume, low speed

Total Crash Rate	
Observed	0.77
Statewide Average	0.54
Critical Rate	0.80
Critical Index	**0.96**

Fatal & Serious Injury Crash Rate	
Observed	1.80
Statewide Average	0.62
Critical Rate	2.87
Critical Index	**0.63**

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

The observed total crash rate for this period is 0.77 per MEV; this is 4% below the critical rate. Based on similar statewide intersections, an additional 2 crashes over the ten years would indicate this intersection operaters outside the normal range.

The observed fatal and serious injury crash rate for this period is 1.80 per 100 MEV; this is 37% below the critical rate. The intersection operates within the normal range.

2018 Warrant Analysis

Consulting Group, Inc.

WARRANTS ANALYSIS

Existing Year 2018

11th Ave SE at E Center St
Intersection Control Evaluation
City of Rochester, Olmstead County

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Rochester, Olmstead County	30	2 or more	Major Approach 1:	Northbound 11th Ave SE
Date:	10/17/2018	30	2 or more	Major Approach 3:	Southbound 11th Ave SE
Analysis Prepared By:	Kevin Olm	30	2 or more	Minor Approach 2:	Eastbound E Center St
Population Less than 10,000:	No	30	2 or more	Minor Approach 4:	Westbound E Center St
Seventy Percent Factor Used:	No	30	2 or more		

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

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 600	Warrant Met 900	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 200	Warrant Met 100	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 300	MWSA (C) 200
6 - 7 AM	123	195	318			91	184	184		X					X	X
7 - 8 AM	268	410	678	X		216	270	270	X	X	X		X		X	X
8 - 9 AM	232	348	580			168	174	174		X			X		X	X
9 - 10 AM	205	294	499			164	145	164		X			X		X	X
10 - 11 AM	183	256	439			156	142	156		X					X	X
11 - 12 AM	219	266	485			126	178	178		X			X		X	X
12 - 1 PM	205	303	508			151	237	237	X	X			X		X	X
1 - 2 PM	216	251	467			142	230	230	X	X					X	X
2 - 3 PM	260	325	585			174	231	231	X	X			X		X	X
3 - 4 PM	317	456	773	X		294	246	294	X	X	X		X	X	X	X
4 - 5 PM	297	381	678	X		297	257	297	X	X	X		X		X	X
5 - 6 PM	315	369	684	X		266	204	266	X	X	X		X		X	X
6 - 7 PM	249	275	524			130	154	154		X					X	X
7 - 8 PM	172	203	375			84	69	84							X	
8 - 9 PM	173	154	327			74	60	74							X	
9 - 10 PM	113	109	222			56	44	56								
10 - 11 PM	0	0	0			0	0	0								
											4	0	9	1	13	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
MWSA (C):	Multiway Stop Applications Condition C	13	8	Met - Multiway Stop Applications
Warrant 1A:	Minimum Vehicular Volume	4	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	0	8	Not Met
Warrant 1C:	Combination of Warrants	1	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	1	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met

Consulting Group, Inc.

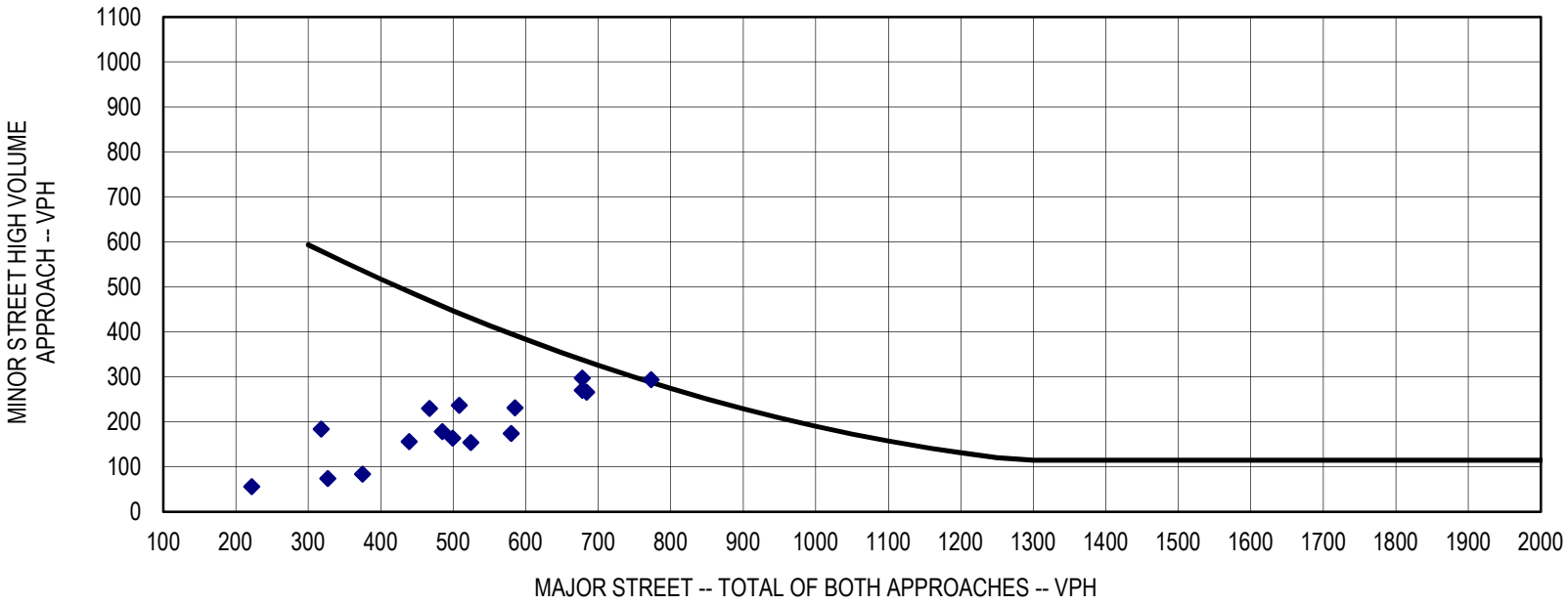
WARRANTS ANALYSIS

Existing Year 2018

11th Ave SE at E Center St
Intersection Control Evaluation
City of Rochester, Olmstead County

Warrants Analysis: Warrant 2

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME



Number of Hours Satisfying Requirements:	1

Notes: 1. 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Consulting Group, Inc.

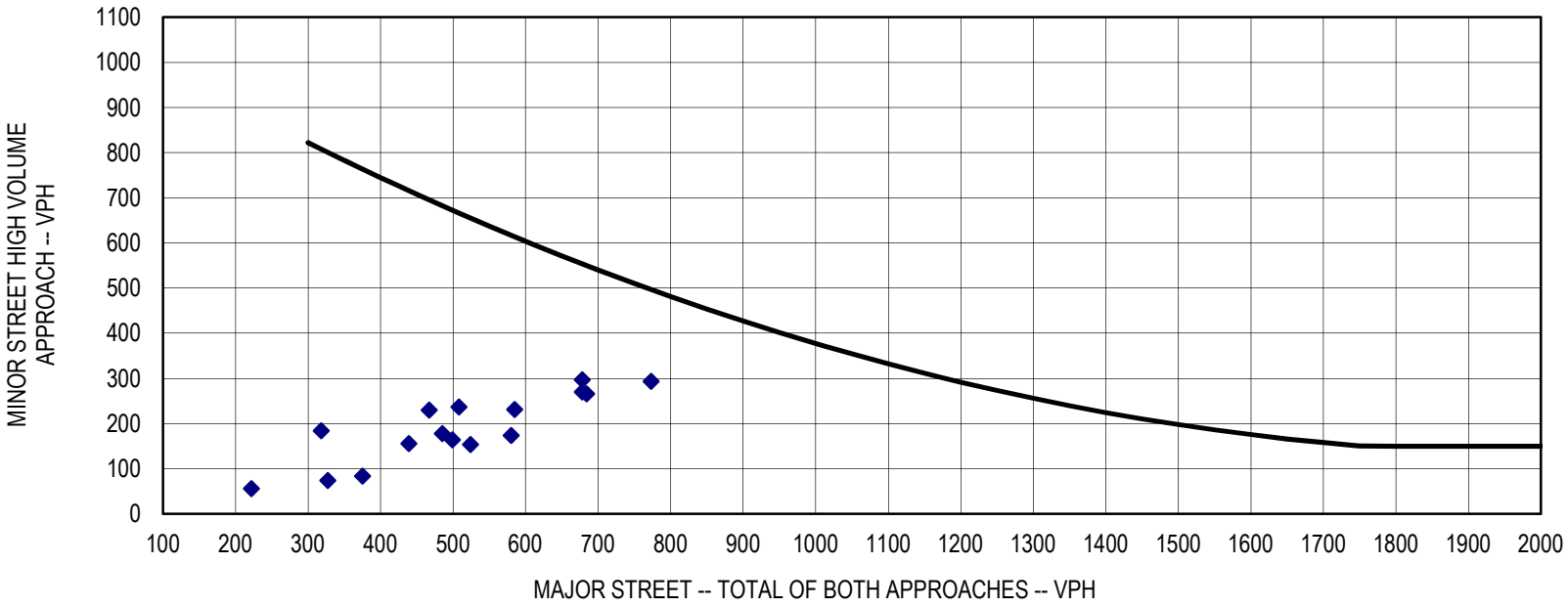
WARRANTS ANALYSIS

Existing Year 2018

11th Ave SE at E Center St
Intersection Control Evaluation
City of Rochester, Olmstead County

Warrants Analysis: Warrant 3

WARRANT 3 - PEAK HOUR



Number of Hours Satisfying Requirements:	0

Notes: 1. 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

2040 Warrant Analysis

Consulting Group, Inc.

WARRANTS ANALYSIS

Forecasted Year 2040

11th Ave SE at E Center St
Intersection Control Evaluation
City of Rochester, Olmstead County

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Rochester, Olmstead County	30	2 or more	Major Approach 1:	Northbound 11th Ave SE
Date:	10/25/2018	30	2 or more	Major Approach 3:	Southbound 11th Ave SE
Analysis Prepared By:	Kevin Olm	30	2 or more	Minor Approach 2:	Eastbound E Center St
Population Less than 10,000:	No	30	2 or more	Minor Approach 4:	Westbound E Center St
Seventy Percent Factor Used:	No	30	2 or more		

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

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 600	Warrant Met 900	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 200	Warrant Met 100	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 300	MWSA (C) 200
6 - 7 AM	133	247	380			147	211	211	X	X					X	X
7 - 8 AM	290	520	810	X		350	310	350	X	X	X		X	X	X	X
8 - 9 AM	251	441	692	X		272	200	272	X	X	X		X		X	X
9 - 10 AM	222	373	595			266	166	266	X	X			X		X	X
10 - 11 AM	198	325	523			253	163	253	X	X			X		X	X
11 - 12 AM	237	337	574			204	204	204	X	X			X		X	X
12 - 1 PM	226	342	568			236	300	300	X	X			X		X	X
1 - 2 PM	238	283	521			222	291	291	X	X			X		X	X
2 - 3 PM	287	367	654	X		272	292	292	X	X	X		X		X	X
3 - 4 PM	350	515	865	X		460	311	460	X	X	X		X	X	X	X
4 - 5 PM	328	430	758	X		465	325	465	X	X	X		X	X	X	X
5 - 6 PM	348	417	765	X		416	258	416	X	X	X		X	X	X	X
6 - 7 PM	275	311	586			204	195	204	X	X			X		X	X
7 - 8 PM	190	229	419			132	87	132		X					X	X
8 - 9 PM	191	174	365			116	76	116		X					X	
9 - 10 PM	125	123	248			88	56	88								
10 - 11 PM	0	0	0			0	0	0								
											6	0	12	4	14	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
MWSA (C):	Multiway Stop Applications Condition C	14	8	Met - Multiway Stop Applications
Warrant 1A:	Minimum Vehicular Volume	6	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	0	8	Not Met
Warrant 1C:	Combination of Warrants	4	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	4	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	1	1	Met - Warrant 3B Satisfied

Consulting Group, Inc.

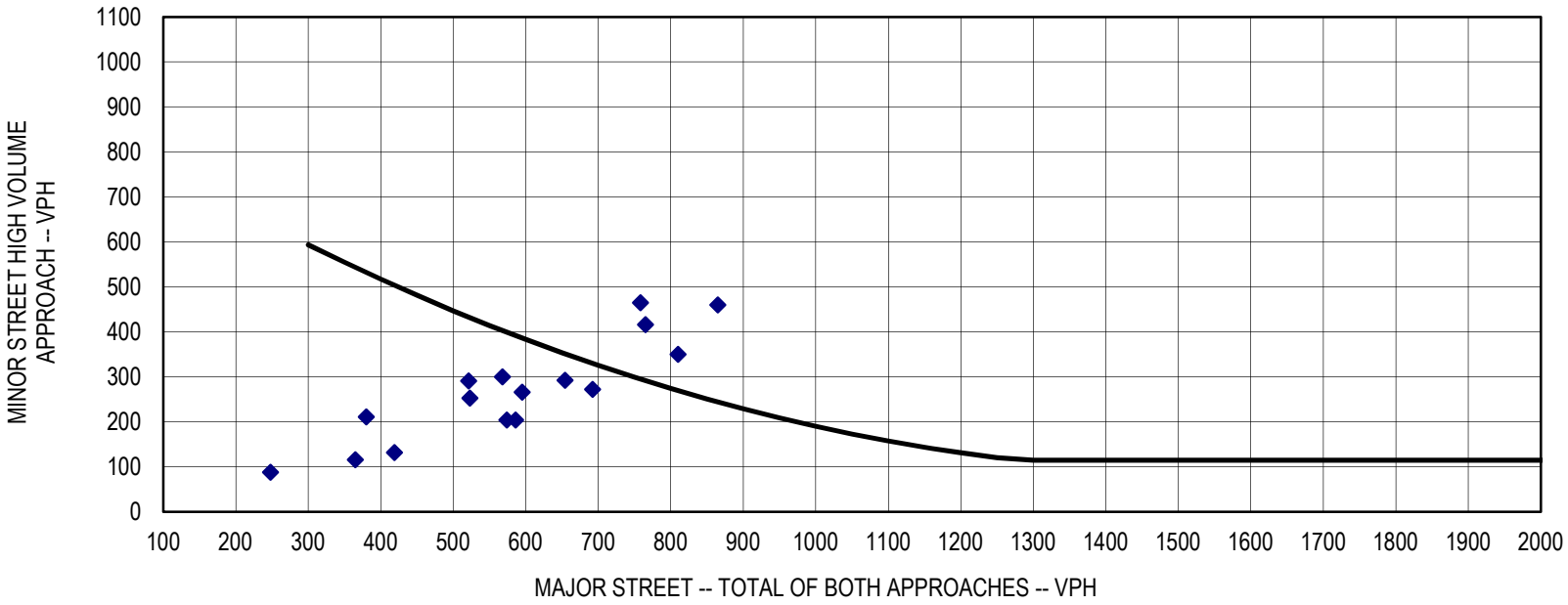
WARRANTS ANALYSIS

Forecasted Year 2040

11th Ave SE at E Center St
Intersection Control Evaluation
City of Rochester, Olmstead County

Warrants Analysis: Warrant 2

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME



Number of Hours Satisfying Requirements:	4

Notes: 1. 115 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 80 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Consulting Group, Inc.

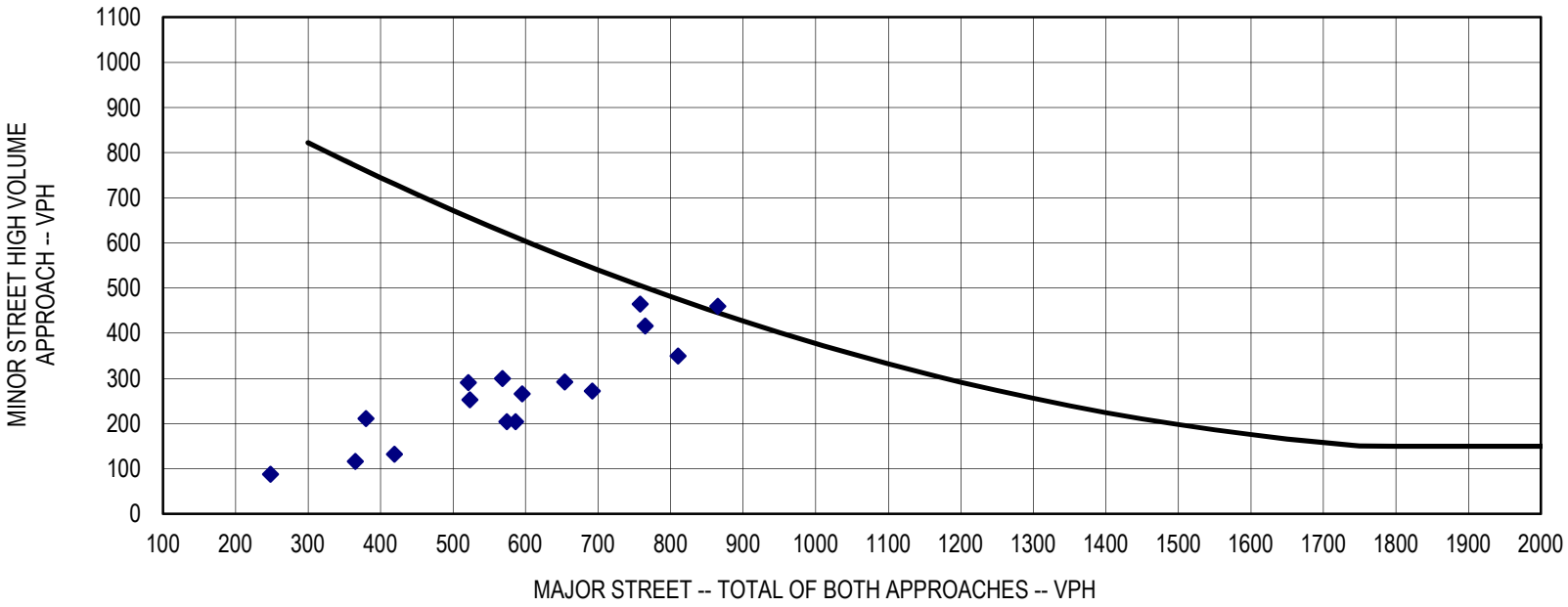
WARRANTS ANALYSIS

Forecasted Year 2040

11th Ave SE at E Center St
Intersection Control Evaluation
City of Rochester, Olmstead County

Warrants Analysis: Warrant 3

WARRANT 3 - PEAK HOUR



Number of Hours Satisfying Requirements:	1

Notes: 1. 150 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACH WITH TWO OR MORE LANES AND 100 VPH APPLIES AS THE LOWER THRESHOLD VOLUME FOR A MINOR STREET APPROACHING WITH ONE LANE.

Signal Warrant Analysis – 80% Removal Criteria

Consulting Group, Inc.

WARRANTS ANALYSIS

80% Signal Removal Criteria

11th Ave SE at E Center St
Intersection Control Evaluation
City of Rochester, Olmstead County

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Rochester, Olmstead County	30	2	Major Approach 1:	Northbound 11th Ave SE
Date:	10/24/2018	30	2	Major Approach 3:	Southbound 11th Ave SE
Analysis Prepared By:	Kevin Olm	30	2 or more	Minor Approach 2:	Eastbound E Center St
Population Less than 10,000:	No	30	2 or more	Minor Approach 4:	Westbound E Center St
Seventy Percent Factor Used:	No				

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

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 480	Warrant Met 720	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 160	Warrant Met 80	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 300	MWSA (C) 200
6 - 7 AM	123	195	318			91	184	184	X	X					X	X
7 - 8 AM	268	410	678	X		216	270	270	X	X	X		X	X	X	X
8 - 9 AM	232	348	580	X		168	174	174	X	X	X		X	X	X	X
9 - 10 AM	205	294	499	X		164	145	164	X	X	X		X		X	X
10 - 11 AM	183	256	439			156	142	156		X			X		X	X
11 - 12 AM	219	266	485	X		126	178	178	X	X	X		X		X	X
12 - 1 PM	205	303	508	X		151	237	237	X	X	X		X		X	X
1 - 2 PM	216	251	467			142	230	230	X	X			X		X	X
2 - 3 PM	260	325	585	X		174	231	231	X	X	X		X	X	X	X
3 - 4 PM	317	456	773	X	X	294	246	294	X	X	X	X	X	X	X	X
4 - 5 PM	297	381	678	X		297	257	297	X	X	X		X	X	X	X
5 - 6 PM	315	369	684	X		266	204	266	X	X	X		X	X	X	X
6 - 7 PM	249	275	524	X		130	154	154		X			X		X	X
7 - 8 PM	172	203	375			84	69	84		X					X	
8 - 9 PM	173	154	327			74	60	74							X	
9 - 10 PM	113	109	222			56	44	56								
10 - 11 PM																
											9	1	12	6	13	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	9	8	Met - Warrant 1A Satisfied
Warrant 1B:	Interruption of Continuous Traffic	1	8	Not Met
Warrant 1C:	Combination of Warrants	6	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	1	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met
MWSA (C):	Multiway Stop Applications Condition C	13	8	Met - Multiway Stop Applications

Detailed 2018 Operations Analysis

SimTraffic Performance Report
TWSC_AM
10/17/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.1	0.0	0.1	0.2
Denied Del/Veh (s)	0.6	1.1	0.4	0.8	0.7
Total Delay (hr)	1.3	1.4	0.1	0.3	3.1
Total Del/Veh (s)	19.8	19.1	1.5	2.7	9.3

Total Network Performance

Denied Delay (hr)	0.2
Denied Del/Veh (s)	0.7
Total Delay (hr)	3.6
Total Del/Veh (s)	10.6

SimTraffic Performance Report
TWSC_PM
10/17/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.1	0.0	0.1	0.3
Denied Del/Veh (s)	1.2	1.6	0.3	0.6	0.9
Total Delay (hr)	2.6	1.6	0.2	0.3	4.6
Total Del/Veh (s)	31.3	20.4	1.8	2.2	12.3

Total Network Performance

Denied Delay (hr)	0.3
Denied Del/Veh (s)	0.9
Total Delay (hr)	5.1
Total Del/Veh (s)	13.5

SimTraffic Performance Report
AWSC_AM 10/17/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.1	0.0	0.1	0.2
Denied Del/Veh (s)	0.6	1.1	0.4	0.8	0.7
Total Delay (hr)	0.7	0.7	0.9	2.1	4.3
Total Del/Veh (s)	10.6	9.7	11.8	16.7	12.9

Total Network Performance

Denied Delay (hr)	0.2
Denied Del/Veh (s)	0.7
Total Delay (hr)	5.0
Total Del/Veh (s)	15.0

SimTraffic Performance Report
AWSC_PM 10/17/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.1	0.0	0.1	0.3
Denied Del/Veh (s)	1.2	1.6	0.4	0.7	0.9
Total Delay (hr)	0.9	0.7	1.5	2.9	5.9
Total Del/Veh (s)	10.3	9.2	16.1	22.6	15.6

Total Network Performance

Denied Delay (hr)	0.3
Denied Del/Veh (s)	0.9
Total Delay (hr)	6.7
Total Del/Veh (s)	17.6

SimTraffic Performance Report
Signal_AM 10/17/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.0	0.1	0.2	0.3
Denied Del/Veh (s)	0.5	0.4	0.9	1.6	1.0
Total Delay (hr)	0.7	0.7	0.6	1.1	3.0
Total Del/Veh (s)	10.4	9.4	7.5	8.7	8.9

Total Network Performance

Denied Delay (hr)	0.3
Denied Del/Veh (s)	1.0
Total Delay (hr)	3.5
Total Del/Veh (s)	10.5

SimTraffic Performance Report
Signal_PM 10/17/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.0	0.1	0.2	0.3
Denied Del/Veh (s)	0.7	0.4	0.9	1.2	0.9
Total Delay (hr)	0.9	0.7	0.8	1.1	3.6
Total Del/Veh (s)	10.5	9.7	9.1	9.0	9.5

Total Network Performance

Denied Delay (hr)	0.3
Denied Del/Veh (s)	0.9
Total Delay (hr)	4.2
Total Del/Veh (s)	11.1

HCS7 Roundabouts Report

General Information

Analyst	Kevin Olm
Agency or Co.	SRF Consulting
Date Performed	10/16/2018
Analysis Year	2018
Time Analyzed	AM
Project Description	ICE Report

Site Information

Intersection	11th Ave at E Center St
E/W Street Name	E Center Street
N/S Street Name	11th Avenue SE
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.88
Jurisdiction	

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	16	189	19	0	10	190	57	0	49	208	9	0	145	247	45
Percent Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flow Rate (v_{PCE}), pc/h	0	19	219	22	0	12	220	66	0	57	241	10	0	168	286	52
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		260			298			308			506	
Entry Volume veh/h		255			292			302			496	
Circulating Flow (v_c), pc/h		466			317			406			289	
Exiting Flow (v_{ex}), pc/h		397			329			326			320	
Capacity (c_{pce}), pc/h		858			999			912			1028	
Capacity (c), veh/h		841			979			894			1008	
v/c Ratio (x)		0.30			0.30			0.34			0.49	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		7.6			6.7			7.8			9.4	
Lane LOS		A			A			A			A	
95% Queue, veh		1.3			1.3			1.5			2.8	
Approach Delay, s/veh	7.6			6.7			7.8			9.4		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	8.1						A					

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HCS7 Roundabouts Report

General Information

Analyst	Kevin Olm
Agency or Co.	SRF Consulting
Date Performed	10/16/2018
Analysis Year	2018
Time Analyzed	PM
Project Description	ICE Report

Site Information

Intersection	11th Ave at E Center St
E/W Street Name	E Center Street
N/S Street Name	11th Avenue SE
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.88
Jurisdiction	

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	44	173	91	0	11	159	96	0	51	261	6	0	101	301	39
Percent Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flow Rate (v_{PCE}), pc/h	0	51	201	105	0	13	184	111	0	59	303	7	0	117	349	45
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		357			308			369			511	
Entry Volume veh/h		350			302			362			501	
Circulating Flow (v_c), pc/h		479			413			369			256	
Exiting Flow (v_{ex}), pc/h		325			288			465			467	
Capacity (c_{pce}), pc/h		847			906			947			1063	
Capacity (c), veh/h		830			888			929			1042	
v/c Ratio (x)		0.42			0.34			0.39			0.48	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		9.6			7.8			8.3			9.0	
Lane LOS		A			A			A			A	
95% Queue, veh		2.1			1.5			1.9			2.7	
Approach Delay, s/veh	9.6			7.8			8.3			9.0		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh | LOS	8.7						A					

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Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2020 AM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	49	208	9	0	2.0	1.00	0.880
2	WB E Center St	0	10	190	57	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	145	247	45	0	2.0	1.00	0.880
4	EB E Center St	0	16	189	19	0	2.0	1.00	0.880

Operational Results

2020 AM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	6.22		6.22	1.51		A		A
2	WB E Center St	None	5.75		5.75	1.33		A		A
3	SB 11th Ave SE	None	7.93		7.93	3.30		A		A
4	EB E Center St	None	6.04		6.04	1.23		A		A

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2020 PM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	51	261	6	0	2.0	1.00	0.880
2	WB E Center St	0	11	159	96	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	101	301	39	0	2.0	1.00	0.880
4	EB E Center St	0	44	173	91	0	2.0	1.00	0.880

Operational Results

2020 PM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	6.65		6.65	1.95		A		A
2	WB E Center St	None	6.25		6.25	1.52		A		A
3	SB 11th Ave SE	None	7.76		7.76	3.24		A		A
4	EB E Center St	None	7.13		7.13	2.07		A		A

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2020 AM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	49	208	9	0	2.0	1.00	0.880
2	WB E Center St	0	10	190	57	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	145	247	45	0	2.0	1.00	0.880
4	EB E Center St	0	16	189	19	0	2.0	1.00	0.880

Operational Results

2020 AM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	9.64		9.64	2.45		A		A
2	WB E Center St	None	8.55		8.55	2.04		A		A
3	SB 11th Ave SE	None	14.52		14.52	6.57		B		B
4	EB E Center St	None	9.22		9.22	1.96		A		A

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2020 PM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	51	261	6	0	2.0	1.00	0.880
2	WB E Center St	0	11	159	96	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	101	301	39	0	2.0	1.00	0.880
4	EB E Center St	0	44	173	91	0	2.0	1.00	0.880

Operational Results

2020 PM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	10.71		10.71	3.31		B		B
2	WB E Center St	None	9.72		9.72	2.47		A		A
3	SB 11th Ave SE	None	13.95		13.95	6.29		B		B
4	EB E Center St	None	12.05		12.05	3.72		B		B

Detailed 2040 Operations Analysis

SimTraffic Performance Report
TWSC_2040_AM 10/26/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.1	0.0	0.1	0.3
Denied Del/Veh (s)	0.6	1.1	0.4	0.8	0.7
Total Delay (hr)	3.5	4.3	0.2	0.4	8.4
Total Del/Veh (s)	46.4	51.7	1.8	3.1	22.0

Total Network Performance

Denied Delay (hr)	0.3
Denied Del/Veh (s)	0.7
Total Delay (hr)	9.0
Total Del/Veh (s)	23.3

SimTraffic Performance Report
TWSC_2040_PM
10/26/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.2	0.1	0.0	0.1	0.5
Denied Del/Veh (s)	2.0	1.5	0.4	0.8	1.1
Total Delay (hr)	10.0	3.8	0.2	0.4	14.4
Total Del/Veh (s)	98.8	45.9	2.1	2.8	33.8

Total Network Performance

Denied Delay (hr)	0.5
Denied Del/Veh (s)	1.1
Total Delay (hr)	15.0
Total Del/Veh (s)	34.9

SimTraffic Performance Report
AWSC_2040_AM 10/26/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.1	0.0	0.1	0.3
Denied Del/Veh (s)	0.6	1.1	0.4	0.8	0.8
Total Delay (hr)	1.0	1.0	1.3	5.1	8.4
Total Del/Veh (s)	13.1	11.6	15.8	36.6	22.0

Total Network Performance

Denied Delay (hr)	0.3
Denied Del/Veh (s)	0.8
Total Delay (hr)	9.2
Total Del/Veh (s)	24.1

SimTraffic Performance Report
AWSC_2040_PM 10/26/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.1	0.0	0.4	0.7
Denied Del/Veh (s)	1.3	1.5	0.4	2.6	1.6
Total Delay (hr)	1.3	0.9	2.7	11.2	16.0
Total Del/Veh (s)	12.7	11.0	27.3	77.1	37.6

Total Network Performance

Denied Delay (hr)	0.7
Denied Del/Veh (s)	1.6
Total Delay (hr)	17.0
Total Del/Veh (s)	39.5

SimTraffic Performance Report
Signal_2040_AM 10/26/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.0	0.0	0.1	0.2	0.4
Denied Del/Veh (s)	0.5	0.4	1.0	1.7	1.0
Total Delay (hr)	0.8	0.9	0.8	1.4	4.0
Total Del/Veh (s)	11.0	11.0	9.2	10.3	10.3

Total Network Performance

Denied Delay (hr)	0.4
Denied Del/Veh (s)	1.0
Total Delay (hr)	4.6
Total Del/Veh (s)	12.1

SimTraffic Performance Report
Signal_2040_PM 10/26/2018

3: 11th Ave SE & E Center St Performance by approach

Approach	EB	WB	NB	SB	All
Denied Delay (hr)	0.1	0.0	0.1	0.2	0.4
Denied Del/Veh (s)	0.8	0.4	0.9	1.3	0.9
Total Delay (hr)	1.1	0.8	1.0	1.6	4.5
Total Del/Veh (s)	11.1	9.8	10.0	11.3	10.7

Total Network Performance

Denied Delay (hr)	0.4
Denied Del/Veh (s)	0.9
Total Delay (hr)	5.3
Total Del/Veh (s)	12.3

HCS7 Roundabouts Report

General Information

Analyst	Kevin Olm
Agency or Co.	SRF Consulting
Date Performed	10/16/2018
Analysis Year	2040
Time Analyzed	AM
Project Description	ICE Report

Site Information

Intersection	11th Ave at E Center St
E/W Street Name	E Center Street
N/S Street Name	11th Avenue SE
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.88
Jurisdiction	

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	20	215	25	0	15	215	65	0	55	235	10	0	165	280	50
Percent Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flow Rate (v_{PCE}), pc/h	0	23	249	29	0	17	249	75	0	64	272	12	0	191	325	58
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		301			341			348			574	
Entry Volume veh/h		295			334			341			563	
Circulating Flow (v_c), pc/h		533			359			463			330	
Exiting Flow (v_{ex}), pc/h		452			371			370			371	
Capacity (c_{pce}), pc/h		801			957			861			986	
Capacity (c), veh/h		786			938			844			966	
v/c Ratio (x)		0.38			0.36			0.40			0.58	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		9.2			7.7			9.2			11.7	
Lane LOS		A			A			A			B	
95% Queue, veh		1.8			1.6			2.0			3.9	
Approach Delay, s/veh	9.2			7.7			9.2			11.7		
Approach LOS	A			A			A			B		
Intersection Delay, s/veh | LOS	9.8						A					

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HCS7 Roundabouts Report

General Information		Site Information	
Analyst	Kevin Olm	Intersection	11th Ave at E Center St
Agency or Co.	SRF Consulting	E/W Street Name	E Center Street
Date Performed	10/16/2018	N/S Street Name	11th Avenue SE
Analysis Year	2040	Analysis Time Period (hrs)	0.25
Time Analyzed	PM	Peak Hour Factor	0.88
Project Description	ICE Report	Jurisdiction	

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment			LTR				LTR				LTR				LTR	
Volume (V), veh/h	0	50	195	105	0	15	180	110	0	60	295	10	0	115	340	45
Percent Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flow Rate (v_{PCE}), pc/h	0	58	226	122	0	17	209	128	0	70	342	12	0	133	394	52
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		406			354			424			579	
Entry Volume veh/h		398			347			416			568	
Circulating Flow (v_c), pc/h	544			470			417			296		
Exiting Flow (v_{ex}), pc/h	371			331			528			533		
Capacity (c_{pce}), pc/h		792			854			902			1020	
Capacity (c), veh/h		777			838			884			1000	
v/c Ratio (x)		0.51			0.41			0.47			0.57	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		12.0			9.4			10.0			11.0	
Lane LOS		B			A			A			B	
95% Queue, veh		3.0			2.1			2.6			3.7	
Approach Delay, s/veh	12.0			9.4			10.0			11.0		
Approach LOS	B			A			A			B		
Intersection Delay, s/veh | LOS	10.7						B					

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Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2040 AM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	55	235	10	0	2.0	1.00	0.880
2	WB E Center St	0	15	215	65	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	165	280	50	0	2.0	1.00	0.880
4	EB E Center St	0	20	215	25	0	2.0	1.00	0.880

Operational Results

2040 AM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	6.93		6.93	1.94		A		A
2	WB E Center St	None	6.33		6.33	1.71		A		A
3	SB 11th Ave SE	None	9.57		9.57	4.70		A		A
4	EB E Center St	None	6.79		6.79	1.65		A		A

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2040 PM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	60	295	10	0	2.0	1.00	0.880
2	WB E Center St	0	15	180	110	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	115	340	45	0	2.0	1.00	0.880
4	EB E Center St	0	50	195	105	0	2.0	1.00	0.880

Operational Results

2040 PM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	7.61		7.61	2.64		A		A
2	WB E Center St	None	7.03		7.03	2.01		A		A
3	SB 11th Ave SE	None	9.32		9.32	4.59		A		A
4	EB E Center St	None	8.31		8.31	2.83		A		A

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2040 AM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	55	235	10	0	2.0	1.00	0.880
2	WB E Center St	0	15	215	65	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	165	280	50	0	2.0	1.00	0.880
4	EB E Center St	0	20	215	25	0	2.0	1.00	0.880

Operational Results

2040 AM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	11.47		11.47	3.41		B		B
2	WB E Center St	None	9.90		9.90	2.79		A		A
3	SB 11th Ave SE	None	21.18		21.18	11.98		C		C
4	EB E Center St	None	11.07		11.07	2.83		B		B

Operational Data

Main Geometry (ft)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	NB 11th Ave SE	0	0	12.00	1	17.00	1	5.00	22.00	40.00
2	WB E Center St	90	0	12.00	1	17.00	1	5.00	22.00	40.00
3	SB 11th Ave SE	180	0	12.00	1	17.00	1	5.00	22.00	40.00
4	EB E Center St	270	0	12.00	1	17.00	1	5.00	22.00	40.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	NB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
2	WB E Center St	70.00	18.00	1	15.00	1	12.00	1
3	SB 11th Ave SE	70.00	18.00	1	15.00	1	12.00	1
4	EB E Center St	70.00	18.00	1	15.00	1	12.00	1

Traffic Flow Data (veh/hr)

2040 PM Peak Peak Hour Flows

Leg	Leg Names	Turning Flows					Flow Modifiers		
		U-Turn	Exit-3	Exit-2	Exit-1	Bypass	Trucks %	Flow Factor	Peak Hour Factor
1	NB 11th Ave SE	0	60	295	10	0	2.0	1.00	0.880
2	WB E Center St	0	15	180	110	0	2.0	1.00	0.880
3	SB 11th Ave SE	0	115	340	45	0	2.0	1.00	0.880
4	EB E Center St	0	50	195	105	0	2.0	1.00	0.880

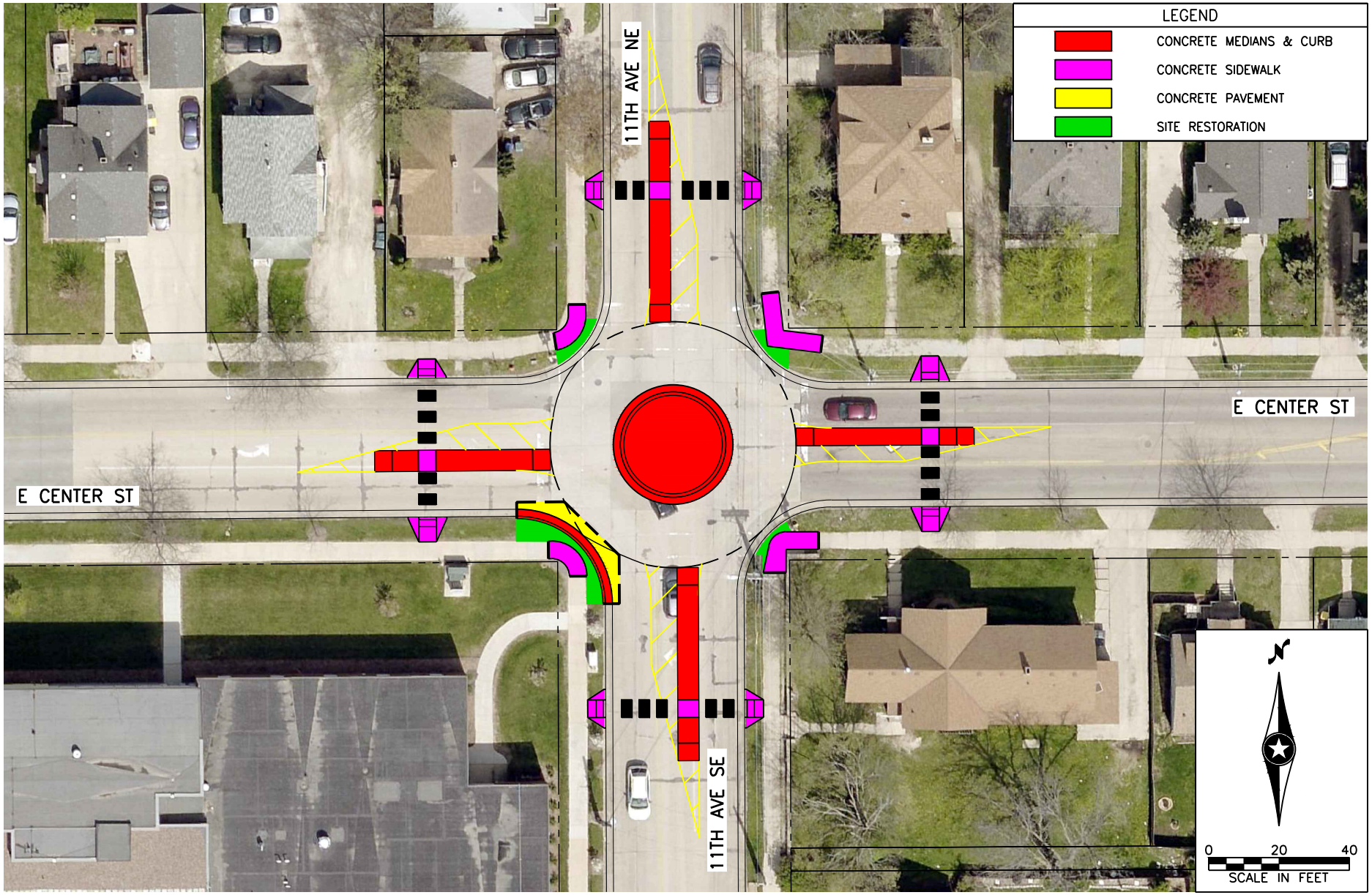
Operational Results

2040 PM Peak - 60 minutes

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	NB 11th Ave SE	None	13.48		13.48	5.04		B		B
2	WB E Center St	None	11.76		11.76	3.58		B		B
3	SB 11th Ave SE	None	19.98		19.98	11.20		C		C
4	EB E Center St	None	15.85		15.85	5.95		C		C

Mini-Roundabout Alternative Layout



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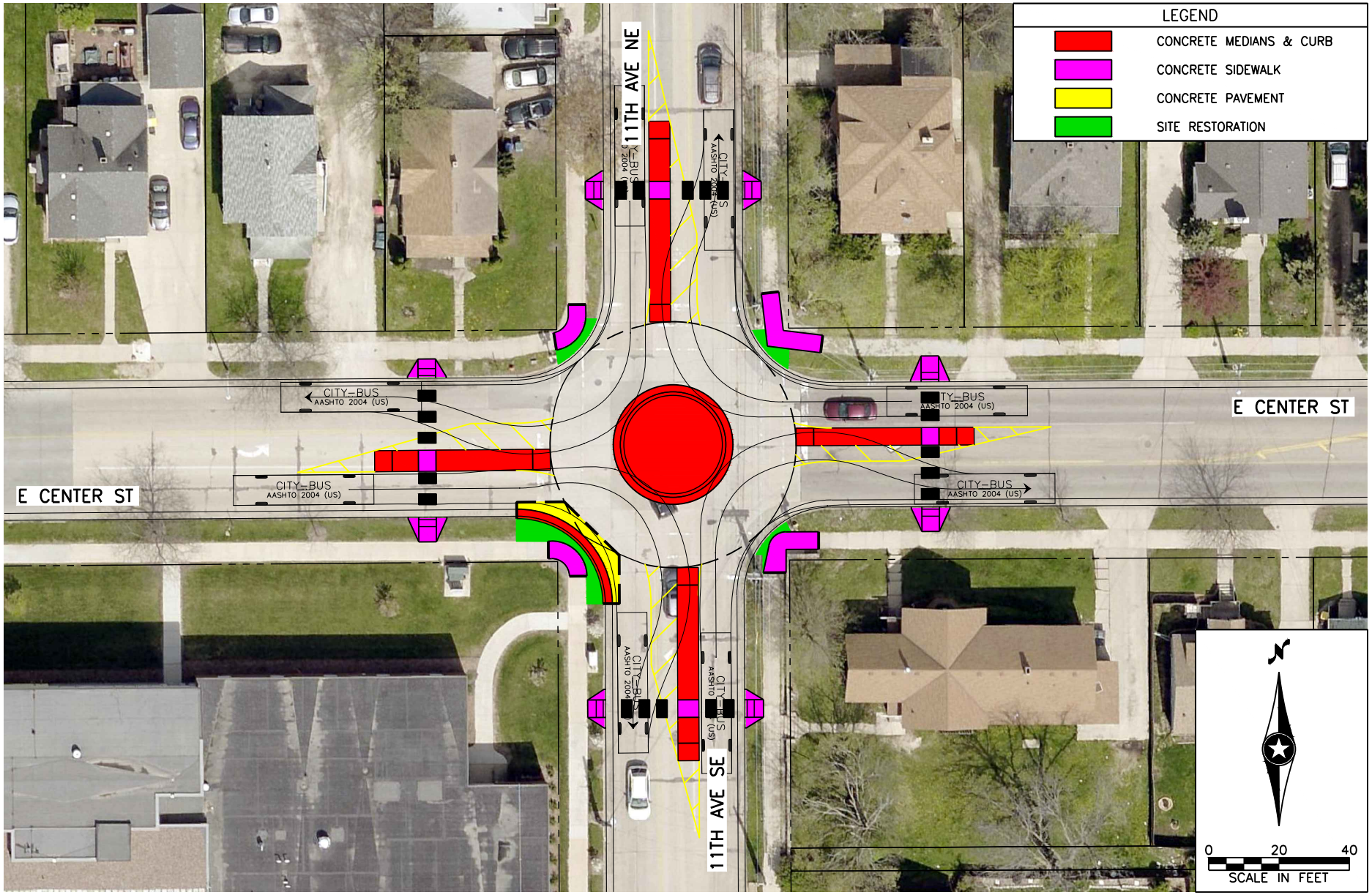
Mini-Roundabout Concept

East Center Street and 11th Avenue Southeast

Rochester, MN

Job #11822
11/15/2018 - 6:04PM

Figure 1



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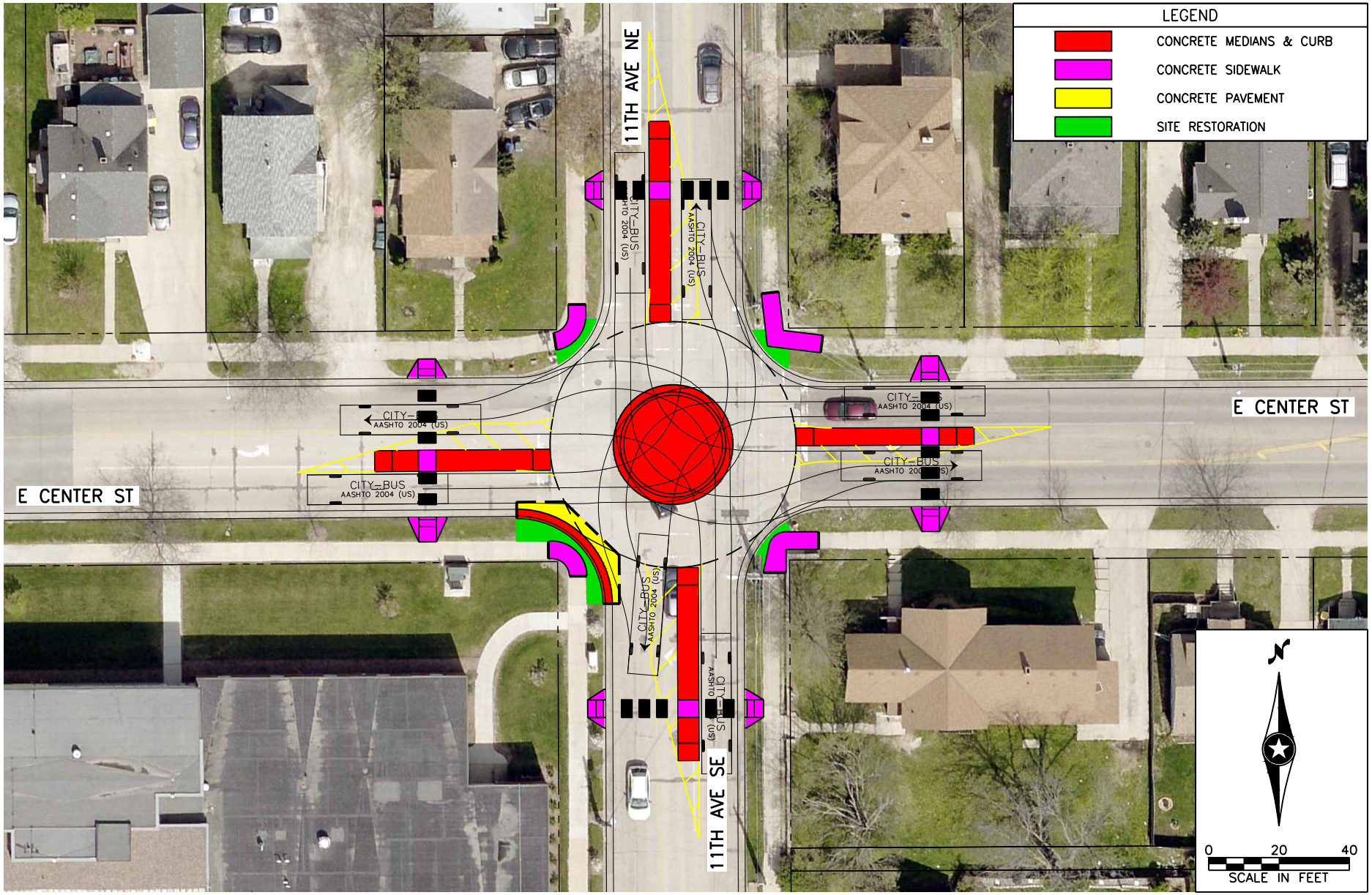
Mini-Roundabout Concept
East Center Street and 11th Avenue Southeast
Rochester, MN

Job #11822
11/15/2018 - 6:04PM

Figure 2



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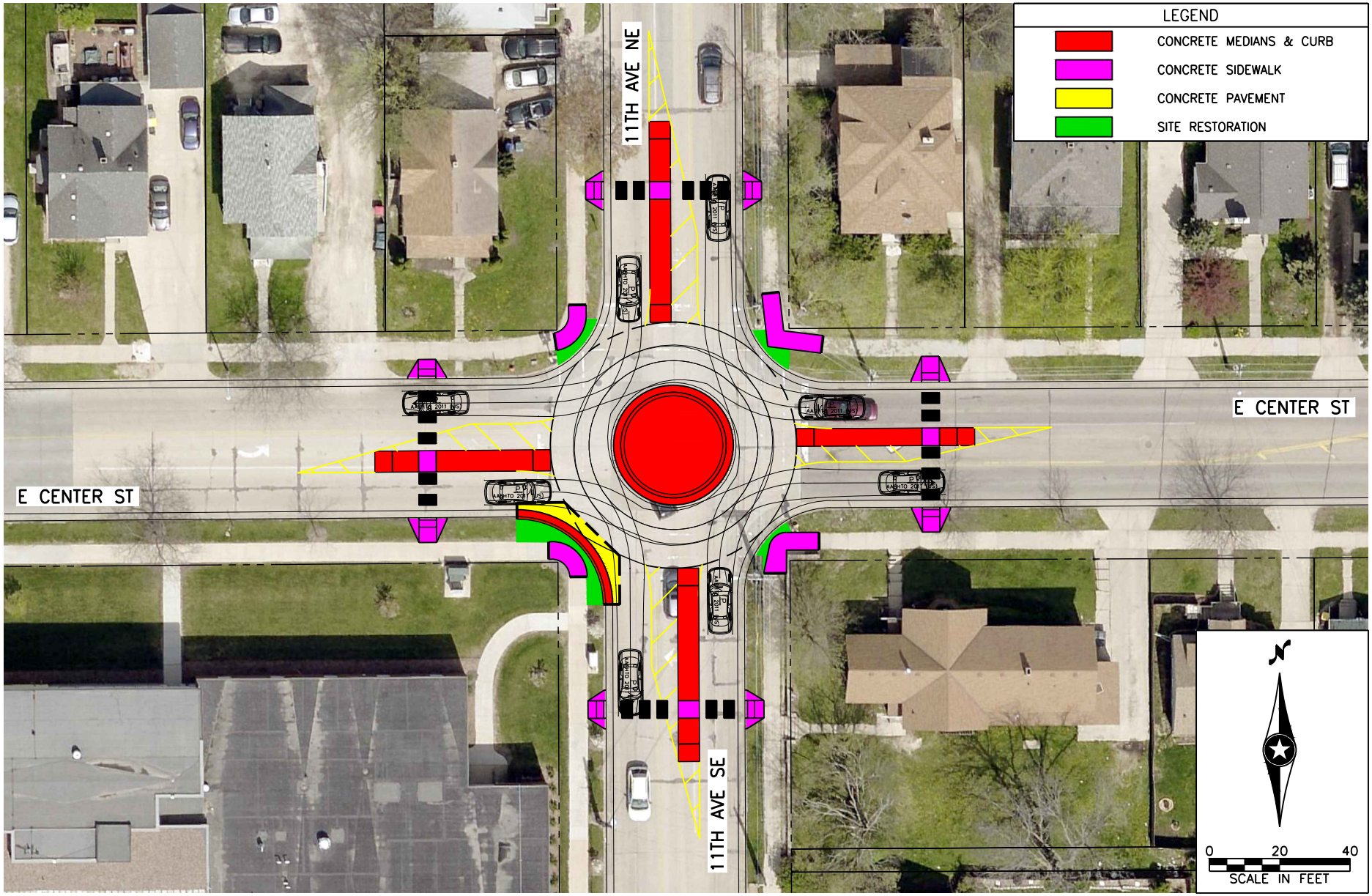
Mini-Roundabout Concept
East Center Street and 11th Avenue Southeast
Rochester, MN

Job #11822
11/15/2018 - 6:04PM

Figure 3



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Mini-Roundabout Concept
East Center Street and 11th Avenue Southeast
Rochester, MN

Job #11822
11/15/2018 - 6:04PM

Figure 4

High-Level Cost Estimates

ALL-WAY STOP, TRAFFIC SIGNAL, AND MINI-ROUNDABOUT ROCHESTER, MN
EAST CENTER STREET AND 11TH AVE SOUTHEAST
SRF PROJECT NO. 11822 FEASIBILITY ESTIMATE
KAO 11/20/2018

ENGINEER'S ESTIMATE

NOTES	ITEM NUMBER	ITEM DESCRIPTION	UNIT	ESTIMATED UNIT PRICE	SIDE-STREET/ALL-WAY STOP		TRAFFIC SIGNAL		MINI-ROUNDABOUT	
					ESTIMATED QUANTITY	ESTIMATED COST	ESTIMATED QUANTITY	ESTIMATED COST	ESTIMATED QUANTITY	ESTIMATED COST
	2021.501	MOBILIZATION	LUMP SUM	$5,000.00	1	$5,000.00	1	$5,000.00	1	$5,000.00
	2102.518	PAVEMENT MARKING REMOVAL	SQ FT	$2.00	200	$400.00	0	$0.00	800	$1,600.00
	2104.503	SAWING CONCRETE PAVEMENT (FULL DEPTH)	LIN FT	$5.00	0	$0.00	0	$0.00	700	$3,500.00
	2104.503	SAWING BITUMINOUS PAVEMENT (FULL DEPTH)	LIN FT	$5.00	0	$0.00	0	$0.00	50	$250.00
	2104.503	REMOVE CURB & GUTTER	LIN FT	$5.00	0	$0.00	0	$0.00	150	$750.00
	2104.509	REMOVE SIGNAL SYSTEM	EACH	$10,000.00	1	$10,000.00	1	$10,000.00	1	$10,000.00
	2104.518	REMOVE CONCRETE WALK	SQ FT	$1.50	0	$0.00	0	$0.00	1300	$1,950.00
	2104.518	REMOVE CONCRETE PAVEMENT	SQ FT	$2.50	0	$0.00	0	$0.00	3150	$7,875.00
	2105.601	MISCELLANEOUS TEMPORARY GRADING	LUMP SUM	$5000.00	1	$5000.00	1	$5000.00	1	$5,000.00
	2106.507	EXCAVATION - COMMON	CU YD	$200.00	0	$0.00	0	$0.00	5	$1,000.00
	2106.507	COMMON EMBANKMENT (CV)	CU YD	$150.00	0	$0.00	0	$0.00	5	$750.00
	2123.610	STREET SWEEPER (WITH PICKUP BROOM)	HOUR	$150.00	0	$0.00	0	$0.00	5	$750.00
	2211.507	AGGREGATE BASE (CV) CLASS 5	CU YD	$40.00	0	$0.00	0	$0.00	60	$2,400.00
	2301.504	CONCRETE PAVEMENT 8.0"	SQ YD	$60.00	0	$0.00	0	$0.00	70	$4,200.00
	2521.518	4" CONCRETE WALK	SQ FT	$10.00	0	$0.00	0	$0.00	1800	$18,000.00
	2521.518	6" CONCRETE WALK	SQ FT	$15.00	0	$0.00	0	$0.00	1350	$20,250.00
	2531.503	CONCRETE CURB & GUTTER DESIGN D412	LIN FT	$30.00	0	$0.00	0	$0.00	360	$10,800.00
	2531.503	CONCRETE CURB & GUTTER DESIGN B624	LIN FT	$40.00	0	$0.00	0	$0.00	130	$5,200.00
	2531.503	CONCRETE CURB & GUTTER DESIGN D424	LIN FT	$40.00	0	$0.00	0	$0.00	100	$4,000.00
	2531.618	TRUNCATED DOMES	SQ FT	$50.00	0	$0.00	0	$0.00	40	$2,000.00
	2563.601	TRAFFIC CONTROL (ALL-WAY STOP)	LUMP SUM	$1,000.00	1	$1,000.00	0	$0.00	0	$0.00
	2563.601	TRAFFIC CONTROL (TRAFFIC SIGNAL AND ROUNDABOUT)	LUMP SUM	$2,500.00	0	$0.00	1	$2,500.00	1	$2,500.00
	2563.601	DETOUR SIGNING	LUMP SUM	$2,500.00	0	$0.00	0	$0.00	1	$2,500.00
	2564.518	SIGN PANELS TYPE C	SQ FT	$75.00	50	$3,750.00	0	$0.00	40	$3,000.00
	2565.516	TRAFFIC CONTROL SIGNAL SYSTEM	SYS	$200,000.00	0	$0.00	1	$200,000.00	0	$0.00
	2573.503	SILT FENCE, TYPE MS	LIN FT	$3.00	0	$0.00	0	$0.00	100	$300.00
	2575.602	SITE RESTORATION	EACH	$250.00	0	$0.00	0	$0.00	4	$1,000.00
	2582.503	4" BROKEN LINE MULTI COMP	LIN FT	$6.00	0	$0.00	0	$0.00	80	$480.00
	2582.503	4" SOLID LINE MULTI COMP	LIN FT	$6.00	0	$0.00	0	$0.00	800	$4,800.00
	2582.503	24" SOLID LINE MULTI COMP	LIN FT	$12.00	50	$600.00	0	$0.00	0	$0.00
	2582.518	CROSSWALK PAINT GR IN	SQ FT	$15.00	300	$4,500.00	300	$4,500.00	300	$4,500.00
	2582.618	PAVEMENT MARKING SPECIAL	SQ FT	$0.30	70	$21.00	0	$0.00	0	$0.00
		+15% CONTINGENCY				$5,000.00		$34,000.00		$19,000.00
		+10% DESIGN				$3,000.00		$23,000.00		$12,000.00
				PROJECT TOTAL	**$38,271.00**		**$284,000.00**		**$155,355.00**	

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