



Real People. Real Solutions.

111 Washington Avenue S
Suite 650
Minneapolis, MN 55401

Ph: (612) 416-0220
Fax: (612) 416-0222
Bolton-Menk.com

MEMORANDUM

Date: December 5, 2023
To: Victor Lund, P.E., PTOE
From: Kelsey Larsen, P.E., PTOE
Subject: Intersection Review of Martin Road (CSAH 9) at Stebner Road
St Louis County, MN
Project No.: OT4.126863

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

By: Kelsey Larsen
Kelsey E. Larsen, P.E.
License No. 57829

Date: December 5, 2023

Introduction

This memorandum analyzes the in-place traffic control and lane configuration of the intersection of Martin Road (CSAH 9) at Stebner Road considering the impact of potential commercial development along Stebner Rd. The intersection is located in the City of Rice Lake within St Louis County, MN.

Existing Conditions

The intersection is currently side street stop controlled with Martin Rd having the right of way. Martin Rd runs east-west and Stebner Rd runs north-south. The intersection is a T-intersection with the Stebner Rd access to the south of Martin Rd. Martin Rd has a left-turn lane on the east leg and a right-turn lane on the west leg. Stebner Rd has two approach lanes comprised of a dedicated left-turn and right-turn lane. Martin Rd is classified as a Minor Arterial and Stebner Rd is classified as a Local Roadway according to MnDOT functional classification designations. The speed limit along both roadways is 55 MPH. The intersection does not include roadway lighting. See **Figure 1** below for the intersection location and **Figure 2** for the existing intersection geometry.

Name: Intersection Review of Martin Road (CSAH 9) at Stebner Road

Date: December 5, 2023

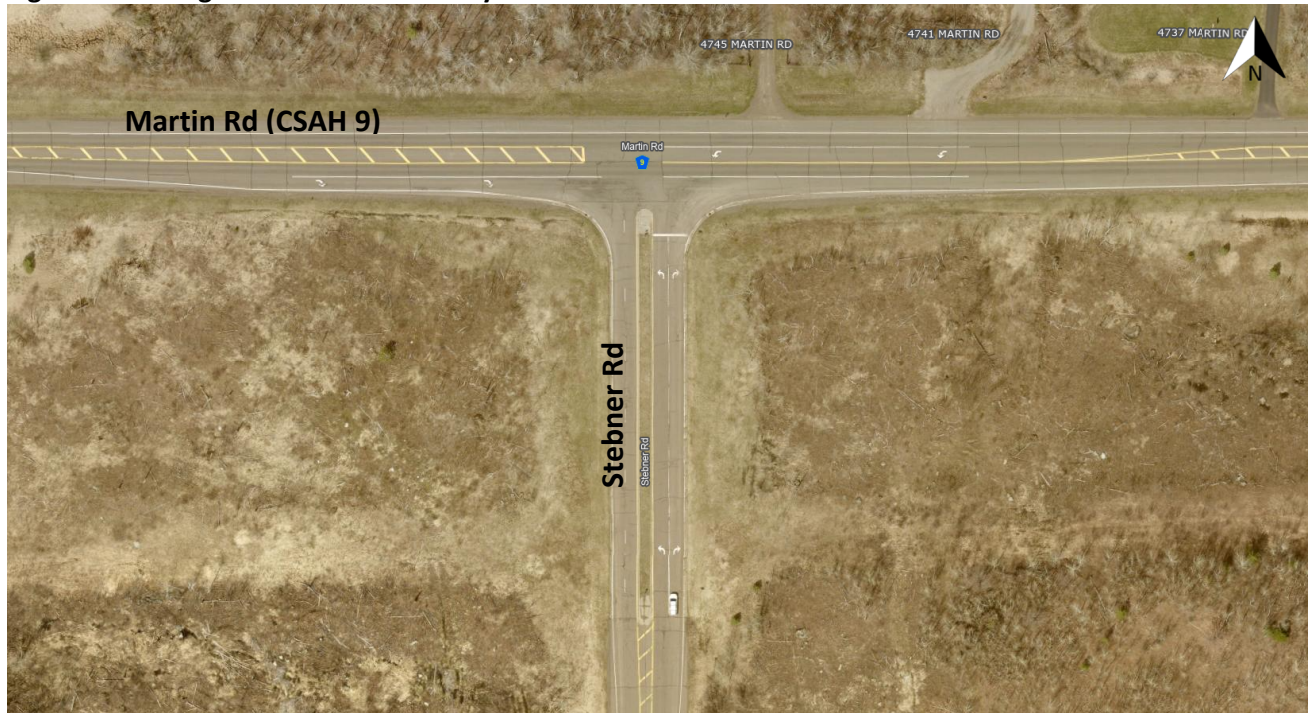
Page: 2

Figure 1. Intersection Location



Source: Google Maps

Figure 2. Existing Intersection Geometry



Source: 2023 Aerial Imagery from County Land Explorer

Stebner Rd currently provides access to Cirrus Aircraft and the 148th Air National Guard Fire Department within Duluth International Airport. Cirrus is an aircraft manufacturer that currently employs over 300 full-time employees supporting the companies engineering, experimental flight testing, airworthiness, and manufacturing design and development.

The existing (2019) annual average daily traffic (AADT) along Martin Rd according to the MnDOT Traffic Mapping Application is 4,950 and the 2023 draft AADT is 5,100. The MnDOT Traffic Mapping Application does not provide traffic count data for Stebner Rd.

Safety Analysis

A crash review was completed for the intersection analyzing the last five years of available crash data (2018-2022) using MnCMAT2. There have been no reported crashes at the intersection for this time period. Crash data was also analyzed for the last ten years (2013-2022). There have been no crashes at the intersection, however, there was one crash along Stebner Rd near Martin Rd. The crash involved one vehicle that spun out due to snow on the road and a second vehicle that ran into the spun-out vehicle. The crash resulted in property damage.

Existing Operations

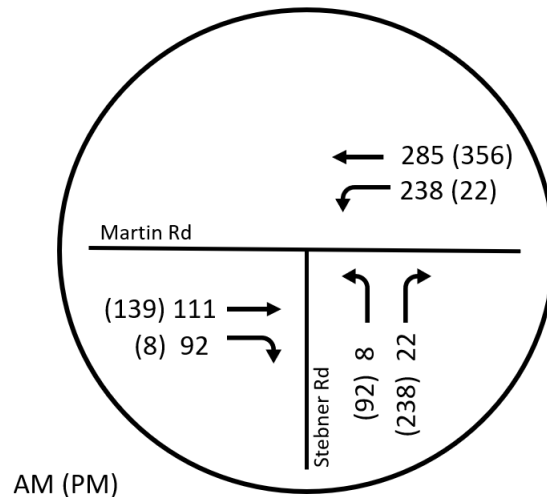
Although traffic count data was not collected at the intersection, peak hour traffic volumes were estimated based on the existing count information available along Martin Rd and the existing development along Stebner Rd. Currently only Cirrus Aircraft and the 148th Air National Guard Fire Department are accessed via Stebner Rd. During the morning peak hour 300 vehicles are estimated to arrive at Cirrus Aircraft based on the existing employee count. The number of employees is unknown at the Fire Department so 30 vehicles were assumed.

The volumes at Martin Rd and Stebner Rd were estimated as turning movement counts based on the existing volumes at the intersections of Lavaque Rd at Martin Rd to the west and Rice Lake Rd at Martin Rd to the east. The nearby volumes are shown below.

Volume to the East			Volume to the West		
Location	Volume	Percent of All Traffic	Location	Volume	Percent of All Traffic
Rice Lake Rd N of Martin	5,900	18%	Lavaque N of Martin	3,300	10%
Rice Lake Rd S of Martin	10,600	33%	Lavaque S of Martin	3,300	10%
Martin E of Rice Lake Rd	6,600	21%	Martin E of Rice Lake Rd	2,450	8%
Total to/from the East	23,100	72%	Total to/from the West	9,050	28%

From the existing volumes at the two nearby intersections, the volume coming from and destined for each direction was determined. The existing volumes showed 72% of traffic destined for/coming from the east and 28% destined for/coming from the west. Mainline volumes along Martin Rd were estimated assuming 8% of traffic is present during the AM peak hour and 10% during the PM peak hour.

The estimated existing peak hour turning movement counts are shown below.



The traffic operation analysis for the intersection included an evaluation of existing intersection delay and Level of Service (LOS). LOS results are described using letters ranging from A to F. These letters serve to describe a range of operating conditions for different types of facilities. Levels of Service are calculated based on the Highway Capacity Manual (HCM) 6th Edition, which defines the LOS, based on control delay. Control delay is the delay experienced by vehicles slowing down as they are approaching the intersection, the wait time at the intersection, and the time for the vehicle to speed up through the intersection and enter into the traffic stream. The average intersection control delay is a volume-weighted average of delay experienced by all motorists entering the intersection on all intersection approaches. LOS D is commonly taken to be acceptable. The control delay was modeled within the analysis software Synchro. The exiting peak hour operations are shown in **Table 1** below. The default peak hour factor (0.92) and heavy vehicle percent (2%) values within Synchro were not changed for the operational analysis.

Table 1. Existing Traffic Operations

		Existing Condition								
		Traffic Delay (sec/veh)				Traffic Queuing (feet)				
Peak Hour	Approach	Movement (Delay - LOS)			Approach (Delay - LOS)	Intersection (Delay - LOS)	Left Turn		Right Turn	
		L	T	R			Storage	95th Percentile Queue	Storage	95th Percentile Queue
AM	EB	-	0 - A	0 - A	0 - A	3 - A	-	-	-	-
	WB	8 - A	0 - A	-	4 - A		325	25	-	-
	NB	21 - C	-	9 - A	12 - B		315	25	315	25
	SB	-	-	-	-		-	-	-	-
PM	EB	-	0 - A	0 - A	0 - A	5 - A	-	-	-	-
	WB	8 - A	0 - A	-	0 - A		325	25	-	-
	NB	15 - C	-	11 - B	12 - B		315	25	315	50
	SB	-	-	-	-		-	-	-	-

Table 1 shows that all movements are currently estimated to operate with acceptable delay. The northbound left operates with LOS C during both peak hours. All other movements operate with LOS A or B. The 95th percentile queue is the queue length that only has a 5% probability of being exceeded. Table 1 shows all 95th percentile queues 50 ft or less during both peak hours.

Planned Development

Planned development off Stebner Rd includes:

- 35 acres (seven 5-acre lots) for industrial use
 - The Institute of Transportation Engineers (ITE) Trip Generation Manual (11th Edition) was used to estimate the number of peak hour and daily trips anticipated to be generated by the 35 acres of industrial land. Land Use 130 - Industrial Park was used to estimate the trip generation.
 - The peak hour and daily trip generation is shown below:

Time	Entering	Exiting	Total
AM	420	99	519
PM	114	405	519
Daily	1936	1936	3872

- Increased employment to 500 by the end of 2024 at Cirrus Aircraft
 - Two shifts were assumed at Cirrus with 500 employees. Half the employees were assumed to enter during the same hour in the morning and leave the site during the same hour in the evening. The other half was assumed to enter during the same hour the first shift was leaving and exit when the first shift was entering.
 - Additionally, half the employees were assumed to take a break off site increasing the daily trips entering/exiting the development.
- 90 acres for Minnesota Power Relocation
 - The Minnesota Power site will include office space, a warehouse, fleet, and outdoor storage. An estimated 250-300 employees will work at this Minnesota Power site.
 - One shift was assumed for all 300 employees. All employees were assumed to enter during the same hour in the morning and leave the site during the same hour in the evening.
 - Additionally, half the employees were assumed to take a break off site increasing the daily trips entering/exiting the development.

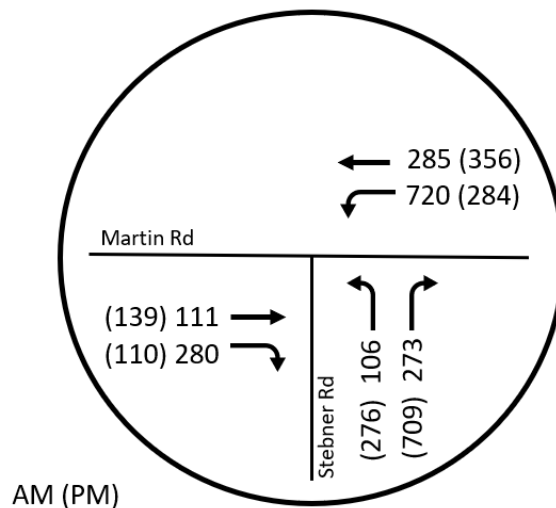
The total peak hour and daily trips assumed for the three developments listed above plus the existing trips assumed for the National Guard Fire Department were determined. **Table 2** shows the total number of trips anticipated at the intersection considering both existing and the planned development.

Table 2. Total Trips with Existing and Planned Development

Time	Entering	Exiting	Total
AM	1000	379	1379
PM	394	985	1379
Daily	3226	3226	6452

Future Operations

Future peak hour turning movement counts were estimated at Martin Rd and Stebner Rd based on the existing volume breakdown and the anticipated peak hour volumes with the planned development. The estimated future peak hour turning movement counts are shown on the following page. The volumes shown assume that the AM and PM peak hours are the same for each development along Stebner Rd to show the worst-case scenario or maximum number of vehicles anticipated in a single hour since the exact hours of operation for each facility is unknown.



The future peak hours were also analyzed in Synchro with the existing side street stop control. The anticipated operations are shown in **Table 3** below.

Table 3. Future Traffic Operations – Existing Side Street Stop Control

		No Build								
		Traffic Delay (sec/veh)				Traffic Queuing (feet)				
Peak Hour	Approach	Movement (Delay - LOS)			Approach (Delay - LOS)	Intersection (Delay - LOS)	Left Turn		Right Turn	
		L	T	R			Storage	95th Percentile Queue	Storage	95th Percentile Queue
AM	EB	-	0 - A	0 - A	0 - A	159 - F	-	-	-	-
	WB	15 - C	0 - A	-	11 - B		325	150	-	-
	NB	2527 - F	-	11 - B	714 - F		315	375	315	50
	SB	-	-	-	-		-	-	-	-
PM	EB	-	0 - A	0 - A	0 - A	77 - F	-	-	-	-
	WB	9 - A	0 - A	-	4 - A		325	25	-	-
	NB	438 - F	-	28 - D	143 - F		315	550	315	275
	SB	-	-	-	-		-	-	-	-

Table 3 shows if no changes are made to the existing intersection, significant delays are anticipated for the northbound left movement with increased volumes from the planned development along Stebner

Rd. The volume to capacity ratio according to Synchro is 5.8 in the AM peak hour and 1.8 in the PM peak hour for the northbound left movement.

An analysis was also conducted keeping the existing side street stop control but restricting the northbound left turn movement out of Steber Rd so that all vehicles have to turn right. The results of this analysis for the future peak hours are shown in **Table 4** below.

Table 4. Future Traffic Operations – Existing Side Street Stop Control with Northbound Right Turn Only

		Existing Traffic Control - Northbound Right Turn Only								
		Traffic Delay (sec/veh)				Traffic Queuing (feet)				
Peak Hour	Approach	Movement (Delay - LOS)			Approach (Delay - LOS)	Intersection (Delay - LOS)	Left Turn		Right Turn	
		L	T	R			Storage	95th Percentile Queue	Storage	95th Percentile Queue
AM	EB	-	0 - A	0 - A	0 - A	9 - A	-	-	-	-
	WB	15 - C	0 - A	-	11 - B		325	150	-	-
	NB	-	-	12 - B	12 - B		-	-	315	75
	SB	-	-	-	-		-	-	-	-
PM	EB	-	0 - A	0 - A	0 - A	63 - F	-	-	-	-
	WB	9 - A	0 - A	-	4 - A		325	25	-	-
	NB	-	-	117 - F	117 - F		-	-	315	850
	SB	-	-	-	-		-	-	-	-

Table 4 shows if the existing intersection were to be restricted to right turns only for vehicles along Stebner Rd, operations would be acceptable in the AM peak hour, but the northbound right turn would operate with failing LOS during the PM peak hour with vehicles anticipated to wait on average for about two minutes per vehicle.

Warrant Analysis

Traffic Control Signal Warrant Analysis

The MnMUTCD (Chapter 4C) states that the investigation of the need for a traffic control signal shall include an analysis of the applicable factors contained in the following traffic signal warrants:

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

A traffic signal should not be installed unless one or more of the warrants can be met. Furthermore, a signal should not be installed unless an engineering study indicates that the signal will improve the

overall safety and operation of the intersection. For the warrant analysis, the right turn volume of the minor street was excluded since the northbound approach has a right turn lane and as the operational analysis indicated, right turning traffic operates acceptably without a signal.

The warrant analysis indicates that Warrant 3, the peak hour warrant is met with the anticipated future volumes at the intersection. Both the AM and the PM peak hour volumes met the volume threshold for Warrant 3. Warrants 1 and 2 were not analyzed as only peak hour volumes were estimated. Warrant 4 was not analyzed as pedestrian count data was not collected at the intersection, however, this warrant was assumed to not be met. Warrants 5, 8 and 9 are not applicable for this intersection and Warrants 6 and 7 are not met. Detailed information used for the warrant analysis can be found in the **Appendix**.

Meeting signal or all way stop warrants are one element among other considerations to justify a roundabout according to the MnDOT Intersection Control Evaluation (ICE) Manual. If the intersection meets warrants for either a traffic signal or an all-way stop, a roundabout should be considered.

Alternative Analysis

Both a traffic signal and roundabout were analyzed in Synchro with the future anticipated peak hour volumes. The operational results are shown in **Tables 5** and **6**.

Table 5. Future Traffic Operations – Traffic Signal

		Traffic Signal									
		Traffic Delay (sec/veh)					Traffic Queuing (feet)				
Peak Hour	Approach	Movement (Delay - LOS)			Approach (Delay - LOS)	Intersection (Delay - LOS)	Left Turn		Through	Right Turn	
		L	T	R			Storage	95th Percentile Queue	95th Percentile Queue	Storage	95th Percentile Queue
AM	EB	-	25 - C	8 - A	13 - B	14 - B	-	-	100	275	75
	WB	18 - B	5 - A	-	14 - B		325	375	75	-	-
	NB	26 - C	-	9 - A	13 - B		315	100	-	315	75
	SB	-	-	-	-		-	-	-	-	-
PM	EB	-	9 - A	3 - A	7 - A	11 - B	-	-	75	275	25
	WB	19 - B	13 - B	-	15 - B		325	150	150	-	-
	NB	12 - B	-	9 - A	10 - B		315	125	-	315	125
	SB	-	-	-	-		-	-	-	-	-

Table 5 shows how a traffic signal would improve operations for the northbound left movement from LOS F to LOS B or C during both peak hours while keeping all other movements operating with acceptable LOS. The intersection overall is anticipated to operate with LOS B during both peak hours. The 95th percentile queue is anticipated to extend beyond the westbound left turn lane storage during the AM peak hour. All other queues are contained within the existing storage area.

Table 6. Future Traffic Operations – Single Lane Roundabout

		Roundabout							
		Traffic Delay (sec/veh)				Traffic Queuing (feet)			
Peak Hour	Approach	Movement (Delay - LOS)			Approach (Delay - LOS)	Intersection (Delay - LOS)	Left Turn	Through	Right Turn
		L	T	R			95th Percentile Queue	95th Percentile Queue	95th Percentile Queue
AM	EB	-	23 - C	23 - C	23 - C	22 - C	-	150	150
	WB	28 - D	28 - D	-	28 - D		375	375	-
	NB	6 - A	-	6 - A	6 - A		50	-	50
	SB	-	-	-	-		-	-	-
PM	EB	-	6 - A	6 - A	6 - A	22 - C	-	25	25
	WB	15 - C	15 - C	-	15 - C		150	150	-
	NB	31 - D	-	31 - D	31 - D		375	-	375
	SB	-	-	-	-		-	-	-

Table 6 shows how a single lane roundabout would improve operations for the northbound left movement from LOS F to LOS A or D during both peak hours while keeping all other movements operating with acceptable LOS. The intersection overall is anticipated to operate with LOS C during both peak hours.

Tables 5 and **6** indicate that either a traffic signal or roundabout are anticipated to mitigate the operational issues shown in the no build condition.

Sensitivity Analysis

A sensitivity analysis was also completed to understand the operations with the existing intersection geometry and traffic control if only 75% or 50% of the volumes destined for the development along Stebner Rd enter/exit at the same time. The operational results with the existing side street stop control are shown in **Tables 7** and **8**.

Table 7. Future Traffic Operations – Existing Side Street Stop Control (75% Peak Hour Volumes)

		No Build - 75% Volumes								
		Traffic Delay (sec/veh)				Traffic Queuing (feet)				
Peak Hour	Approach	Movement (Delay - LOS)			Approach (Delay - LOS)	Intersection (Delay - LOS)	Left Turn		Right Turn	
		L	T	R			Storage	95th Percentile Queue	Storage	95th Percentile Queue
AM	EB	-	0 - A	0 - A	0 - A	27 - D	-	-	-	-
	WB	11 - B	0 - A	-	7 - A		325	75	-	-
	NB	388 - F	-	10 - B	116 - F		315	200	315	25
	SB	-	-	-	-		-	-	-	-
PM	EB	-	0 - A	0 - A	0 - A	22 - C	-	-	-	-
	WB	8 - A	0 - A	-	3 - A		325	25	-	-
	NB	110 - F	-	16 - C	43 - E		315	250	315	125
	SB	-	-	-	-		-	-	-	-

Table 8. Future Traffic Operations – Existing Side Street Stop Control (50% Peak Hour Volumes)

		No Build - 50% Volumes								
		Traffic Delay (sec/veh)				Traffic Queuing (feet)				
Peak Hour	Approach	Movement (Delay - LOS)			Approach (Delay - LOS)	Intersection (Delay - LOS)	Left Turn		Right Turn	
		L	T	R			Storage	95th Percentile Queue	Storage	95th Percentile Queue
AM	EB	-	0 - A	0 - A	0 - A	7 - A	-	-	-	-
	WB	9 - A	0 - A	-	5 - A		325	50	-	-
	NB	48 - E	-	10 - B	20 - C		315	50	315	25
	SB	-	-	-	-		-	-	-	-
PM	EB	-	0 - A	0 - A	0 - A	8 - A	-	-	-	-
	WB	8 - A	0 - A	-	2 - A		325	25	-	-
	NB	29 - D	-	12 - B	17 - C		315	75	315	75
	SB	-	-	-	-		-	-	-	-

Table 7 shows that with 75% of the development traffic entering/exiting within the same hour, the northbound left movement still operates with LOS F during both peak hours. **Table 8** shows that if only 50% of the development traffic enters/exits at the same time operations are improved with the northbound left anticipated to operate with LOS E during the AM peak hour and LOS D during the PM peak hour.

The warrant analysis was also completed with the 50% and 75% volumes. The analysis indicates that the peak hour warrant is still met with 75% volumes, but not with 50% volumes. However, an additional ten northbound left movements would result in the 50% volumes also meeting the peak hour warrant.

Conclusion

The intersection of Martin Rd at Stebner Rd was found to operate with acceptable delay and does not show safety concerns based on the existing crash data. However, with the proposed development expected off of Stebner Rd in the future there are operational concerns. If all or 75% of the traffic

coming from and destined for the facilities along Stebner Rd enter and exit within the same peak hours, the northbound left turn movement at the intersection is anticipated to operate with failing LOS and several minutes of delay per vehicle. With only half of the development traffic entering and exiting in the same hour the delay is more reasonable with the northbound left movement operating with LOS E during the AM peak hour and LOS D during the PM peak hour. If the existing intersection were to be restricted to right turns only for vehicles along Stebner Rd, operations would be acceptable in the AM peak hour with the planned development, but the northbound right turn would operate with failing LOS during the PM peak hour with vehicles anticipated to wait on average for about two minutes per vehicle.

Peak hour volumes were found to justify a traffic signal if all or 75% of the traffic coming from and destined for the facilities along Stebner Rd enter and exit within the same peak hours. With a traffic signal justified both a signal and single lane roundabout were analyzed. The operational analysis with a signal and roundabout were completed assuming all traffic enters and exits in the same peak hour. With a traffic signal all movements were found to operate with LOS C or better and with a roundabout all movements were found to operate with LOS D or better.

Stebner Rd only extends approximately 1.25 miles south of Martin Rd so off-peak hour volumes are anticipated to be low. Although a traffic signal could be justified based on the peak hour volume analysis, since the volumes during the off-peak hours are anticipated to be low along Stebner Rd a traffic signal is not recommended. Additionally, a traffic signal could be unexpected for a driver as the adjacent intersections along Martin Rd are not signalized.

Since the exact peak hour volumes are unknown and were estimated for this analysis, further detailed shift timing information is recommended to be analyzed associated with each development to better estimate traffic operations. It is recommended that St Louis County monitor the intersection as additional trips are generated with the planned development. If improved traffic control is needed to mitigate traffic operations at this intersection, alternatives such as a single lane roundabout, a single lane roundabout with westbound bypass lane, signalized intersection, and a continuous Green-T intersection should be further analyzed.

Appendix



**BOLTON
& MENK**

Real People. Real Solutions.

LOCATION: Martin Road at Stebner Rd

COUNTY: St Louis

REF. POINT:

DATE: 2023

OPERATOR: KL

SIGNAL WARRANTS ANALYSIS

Martin Road at Stebner Road

Future Volumes with Anticipated Development

Speed	Approach Description		Lanes Entering Intersection
55	Major App1:	Martin Rd EB	1
55	Major App3:	Martin Rd WB	1
55	Minor App2:	Stebner Rd NB	1
	Minor App4:		

0.70 FACTOR USED?

YES

POPULATION < 10,000?

No

EXISTING SIGNAL ?

No

THRESHOLDS 1A/1B:

350/525

105/52

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 1A/1B	MET SAME 1A/1B
0:00 - 1:00			0	/		/			/
1:00 - 2:00			0	/		/			/
2:00 - 3:00			0	/		/			/
3:00 - 4:00			0	/		/			/
4:00 - 5:00			0	/		/			/
5:00 - 6:00			0	/		/			/
6:00 - 7:00			0	/		/			/
7:00 - 8:00	391	1005	1396	X/X	106	X/X			X/X
8:00 - 9:00			0	/		/			/
9:00 - 10:00			0	/		/			/
10:00 - 11:00			0	/		/			/
11:00 - 12:00			0	/		/			/
12:00 - 13:00			0	/		/			/
13:00 - 14:00			0	/		/			/
14:00 - 15:00			0	/		/			/
15:00 - 16:00			0	/		/			/
16:00 - 17:00	249	640	889	X/X	276	X/X			X/X
17:00 - 18:00			0	/		/			/
18:00 - 19:00			0	/		/			/
19:00 - 20:00			0	/		/			/
20:00 - 21:00			0	/		/			/
21:00 - 22:00			0	/		/			/
22:00 - 23:00			0	/		/			/
23:00 - 24:00			0	/		/			/

Met (Hr) Required (Hr)

Warrant 1A	2	8	Not satisfied
Warrant 1B	2	8	Not satisfied
Warrant 2	2	4	Not satisfied
Warrant 3	2	1	Satisfied
Warrant 7	2	8	Not satisfied

LOCATION: Martin Road at Stebner Road

COUNTY: St Louis

REF. POINT:

DATE: 2023

OPERATOR: KL

Speed	Approach Description		Lanes
55	Major App1:	Martin Rd EB	1
55	Major App3:	Martin Rd WB	1
55	Minor App2:	Stebner Rd NB	1
	Minor App4:		

0.70 FACTOR USED? YES
 POPULATION < 10,000? No
 EXISTING SIGNAL ? No

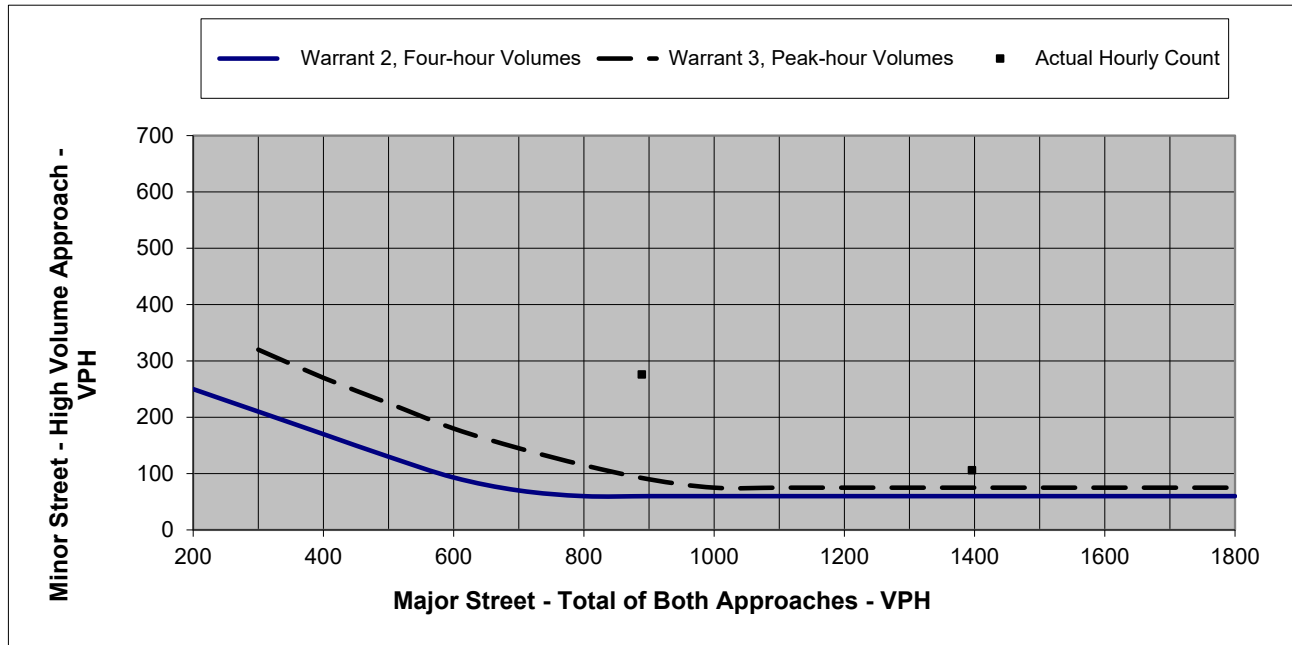


Figure 1. Four Hour and Peak Hour Warrant Analysis

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

Warrant Criteria			Actual Hourly Count	
Major	Warrant 2, Four-hour	Warrant 3, Peak-hour	Major	Actual Hourly Count
200	250		0	0
300	210	320	0	0
400	170	270	0	0
500	130	225	0	0
600	93	180	0	0
700	70	145	0	0
800	60	115	0	0
900	60	90	1396	106
1000	60	75	0	0
1100	60	75	0	0
1200	60	75	0	0
1300	60	75	0	0
1400	60	75	0	0
1500	60	75	0	0
1600	60	75	0	0
1700	60	75	0	0
1800	60	75	889	276
			0	0
			0	0
			0	0
			0	0
			0	0
			0	0
			0	0



Real People. Real Solutions.

LOCATION: Martin Road at Stebner Rd

COUNTY: St Louis

REF. POINT:

DATE: 2023

OPERATOR: KL

SIGNAL WARRANTS ANALYSIS

Martin Road at Stebner Road

Future Volumes with Anticipated Development

75% Development Volumes Enter/Exit in Same Hour

Speed	Approach Description		Lanes Entering Intersection
55	Major App1:	Martin Rd EB	1
55	Major App3:	Martin Rd WB	1
55	Minor App2:	Stebner Rd NB	1
	Minor App4:		

0.70 FACTOR USED?

YES

POPULATION < 10,000?

No

EXISTING SIGNAL ?

No

THRESHOLDS 1A/1B:

350/525

105/52

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 1A/1B	MET SAME 1A/1B
0:00 - 1:00			0	/		/			/
1:00 - 2:00			0	/		/			/
2:00 - 3:00			0	/		/			/
3:00 - 4:00			0	/		/			/
4:00 - 5:00			0	/		/			/
5:00 - 6:00			0	/		/			/
6:00 - 7:00			0	/		/			/
7:00 - 8:00	321	825	1146	X/X	80	/X			/X
8:00 - 9:00			0	/		/			/
9:00 - 10:00			0	/		/			/
10:00 - 11:00			0	/		/			/
11:00 - 12:00			0	/		/			/
12:00 - 13:00			0	/		/			/
13:00 - 14:00			0	/		/			/
14:00 - 15:00			0	/		/			/
15:00 - 16:00			0	/		/			/
16:00 - 17:00	221	569	790	X/X	207	X/X			X/X
17:00 - 18:00			0	/		/			/
18:00 - 19:00			0	/		/			/
19:00 - 20:00			0	/		/			/
20:00 - 21:00			0	/		/			/
21:00 - 22:00			0	/		/			/
22:00 - 23:00			0	/		/			/
23:00 - 24:00			0	/		/			/

Met (Hr) Required (Hr)

Warrant 1A	1	8	Not satisfied
Warrant 1B	2	8	Not satisfied
Warrant 2	2	4	Not satisfied
Warrant 3	2	1	Satisfied
Warrant 7	2	8	Not satisfied

LOCATION: Martin Road at Stebner Road

COUNTY: St Louis

REF. POINT:

DATE: 2023

OPERATOR: KL

Speed	Approach Description		Lanes
55	Major App1:	Martin Rd EB	1
55	Major App3:	Martin Rd WB	1
55	Minor App2:	Stebner Rd NB	1
	Minor App4:		

0.70 FACTOR USED? YES
 POPULATION < 10,000? No
 EXISTING SIGNAL ? No

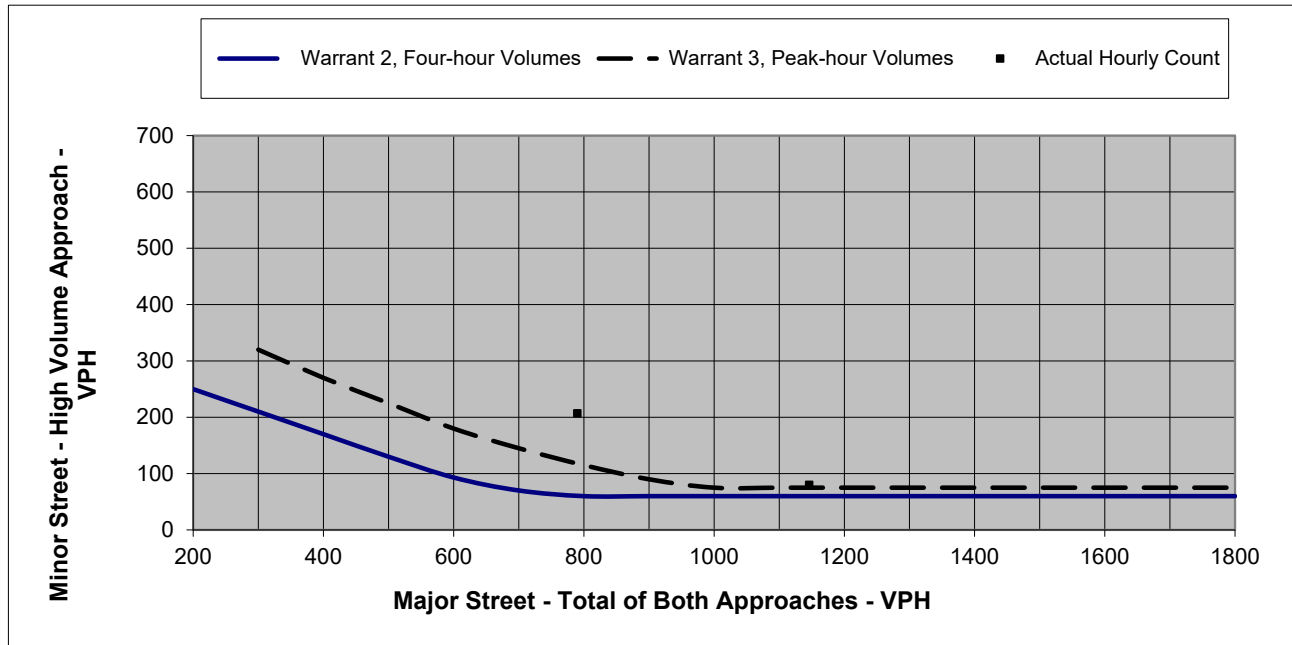


Figure 1. Four Hour and Peak Hour Warrant Analysis

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

Warrant Criteria			Actual Hourly Count	
Major	Warrant 2, Four-hour	Warrant 3, Peak-hour	Major	Actual Hourly Count
200	250		0	0
300	210	320	0	0
400	170	270	0	0
500	130	225	0	0
600	93	180	0	0
700	70	145	0	0
800	60	115	0	0
900	60	90	1146	80
1000	60	75	0	0
1100	60	75	0	0
1200	60	75	0	0
1300	60	75	0	0
1400	60	75	0	0
1500	60	75	0	0
1600	60	75	0	0
1700	60	75	0	0
1800	60	75	790	207
			0	0
			0	0
			0	0
			0	0
			0	0
			0	0
			0	0



**BOLTON
& MENK**

Real People. Real Solutions.

LOCATION: Martin Road at Stebner Rd

COUNTY: St Louis

REF. POINT:

DATE: 2023

OPERATOR: KL

SIGNAL WARRANTS ANALYSIS

Martin Road at Stebner Road

Future Volumes with Anticipated Development

50% Development Volumes Enter/Exit in Same Hour

Speed	Approach Description		Lanes Entering Intersection
55	Major App1:	Martin Rd EB	1
55	Major App3:	Martin Rd WB	1
55	Minor App2:	Stebner Rd NB	1
	Minor App4:		

0.70 FACTOR USED?

YES

POPULATION < 10,000?

No

EXISTING SIGNAL ?

No

THRESHOLDS 1A/1B:

350/525

105/52

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 1A/1B	MET SAME 1A/1B
0:00 - 1:00			0	/		/			/
1:00 - 2:00			0	/		/			/
2:00 - 3:00			0	/		/			/
3:00 - 4:00			0	/		/			/
4:00 - 5:00			0	/		/			/
5:00 - 6:00			0	/		/			/
6:00 - 7:00			0	/		/			/
7:00 - 8:00	251	645	896	X/X	53	/X			/X
8:00 - 9:00			0	/		/			/
9:00 - 10:00			0	/		/			/
10:00 - 11:00			0	/		/			/
11:00 - 12:00			0	/		/			/
12:00 - 13:00			0	/		/			/
13:00 - 14:00			0	/		/			/
14:00 - 15:00			0	/		/			/
15:00 - 16:00			0	/		/			/
16:00 - 17:00	194	498	692	X/X	138	X/X			X/X
17:00 - 18:00			0	/		/			/
18:00 - 19:00			0	/		/			/
19:00 - 20:00			0	/		/			/
20:00 - 21:00			0	/		/			/
21:00 - 22:00			0	/		/			/
22:00 - 23:00			0	/		/			/
23:00 - 24:00			0	/		/			/

Met (Hr) Required (Hr)

Warrant 1A	1	8	Not satisfied
Warrant 1B	2	8	Not satisfied
Warrant 2	1	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	2	8	Not satisfied

LOCATION: Martin Road at Stebner Road

COUNTY: St Louis

REF. POINT:

DATE: 2023

OPERATOR: KL

Speed	Approach Description		Lanes
55	Major App1:	Martin Rd EB	1
55	Major App3:	Martin Rd WB	1
55	Minor App2:	Stebner Rd NB	1
	Minor App4:		

0.70 FACTOR USED? YES
 POPULATION < 10,000? No
 EXISTING SIGNAL ? No

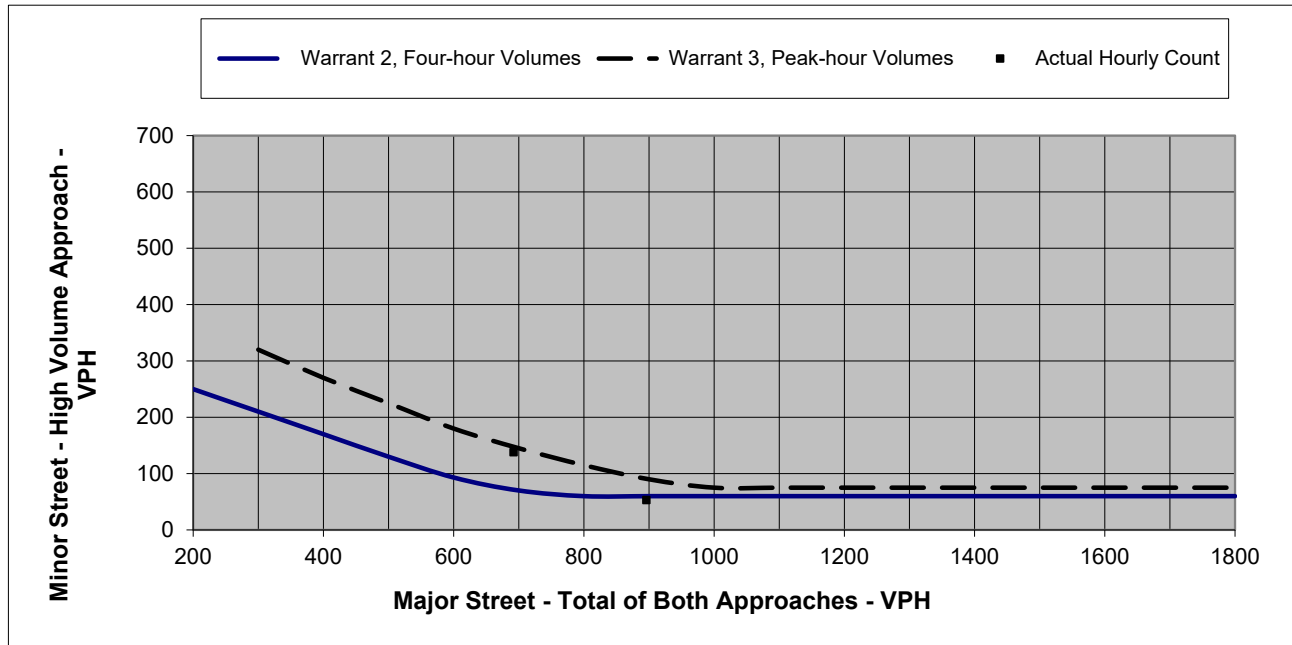


Figure 1. Four Hour and Peak Hour Warrant Analysis

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

Warrant Criteria			Actual Hourly Count	
Major	Warrant 2, Four-hour	Warrant 3, Peak-hour	Major	Actual Hourly Count
200	250		0	0
300	210	320	0	0
400	170	270	0	0
500	130	225	0	0
600	93	180	0	0
700	70	145	0	0
800	60	115	0	0
900	60	90	896	53
1000	60	75	0	0
1100	60	75	0	0
1200	60	75	0	0
1300	60	75	0	0
1400	60	75	0	0
1500	60	75	0	0
1600	60	75	0	0
1700	60	75	0	0
1800	60	75	692	138
			0	0
			0	0
			0	0
			0	0
			0	0
			0	0
			0	0