
To: James Merten, P.E., City of Neenah

From: Kenneth H. Voigt, P.E., Transportation Engineer

Date: February 12, 2021 Project No.: 49-0123.00

Re: Final Report on Roundabout Concept Design: Main Street Intersection with Green Bay Road

Study Background

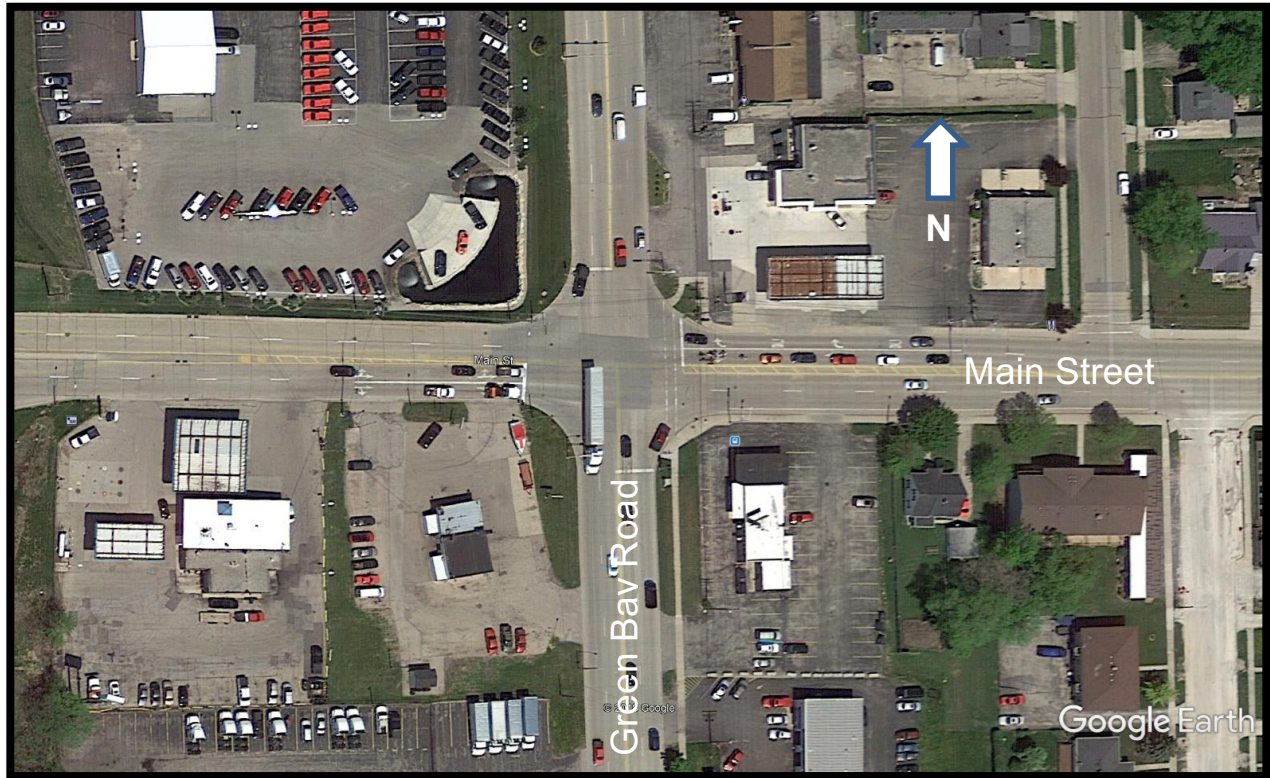
The City of Neenah has retained Ayres Associates to conduct a technical feasibility analysis for construction of a roundabout at the Main Street intersection with Green Bay Road. This Technical Memorandum evaluates existing 2018 and year 2040 operation of the existing intersection traffic signal control and year 2040 operation of a conceptual roundabout design.

The existing signal-controlled intersection was analyzed using the Synchro and SimTraffic software with the conceptual roundabout design analyzed using SIDRA software in HCM 6 mode. WisDOT critical and follow-up headway factors were used to in accordance with the Wisconsin Department of Transportation (WisDOT) *Facilities Development Manual*. A conceptual roundabout design is included in this Technical Memorandum and illustrates potential right-of-way impacts and utility conflicts. The operational worksheets for this analysis are contained in a Technical Supplement to this memorandum.

Existing Intersection Geometrics and Study Roadway

Green Bay Road is a north/south, four-lane, undivided arterial roadway with a posted speed limit of 35 miles per hour. Main Street is an east/west, four-lane, undivided arterial roadway which also has a posted speed limit of 30 mph. The Main Street intersection with Green Bay Road is a four-leg signalized intersection. The western and eastern legs of the intersection operate as a split-phase condition with the northern and southern legs operating under standard permissive left-turn/through condition. The existing intersection is shown in Figure 1

Figure 1: Main Street Intersection with Green Bay Road



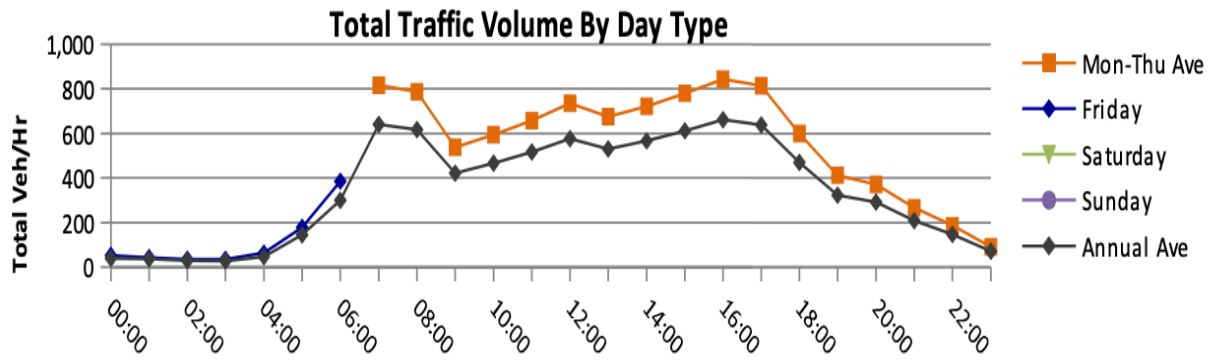
. The intersection lane geometrics include:

- Eastbound Approach
 - Shared left-turn/through lane
 - Shared through/right-turn lane
- Westbound Approach
 - Shared left-turn/through lane
 - Right-turn lane
- Northbound Approach
 - Shared left-turn/through lane
 - Shared through/right-turn lane
- Southbound Approach
 - Shared left-turn/through lane
 - Shared through/right-turn lane

Intersection Traffic

Existing Traffic Volume: According to traffic data collected by the WisDOT, the hourly distribution of traffic at the Main Street intersection with Green Bay Road peaks during the 7:00 to 8:00 A.M. morning and 4:00 to 5:00 P.M. evening time periods as shown on Figure 2. These two time periods were used to analyze intersection peak traffic operating conditions.

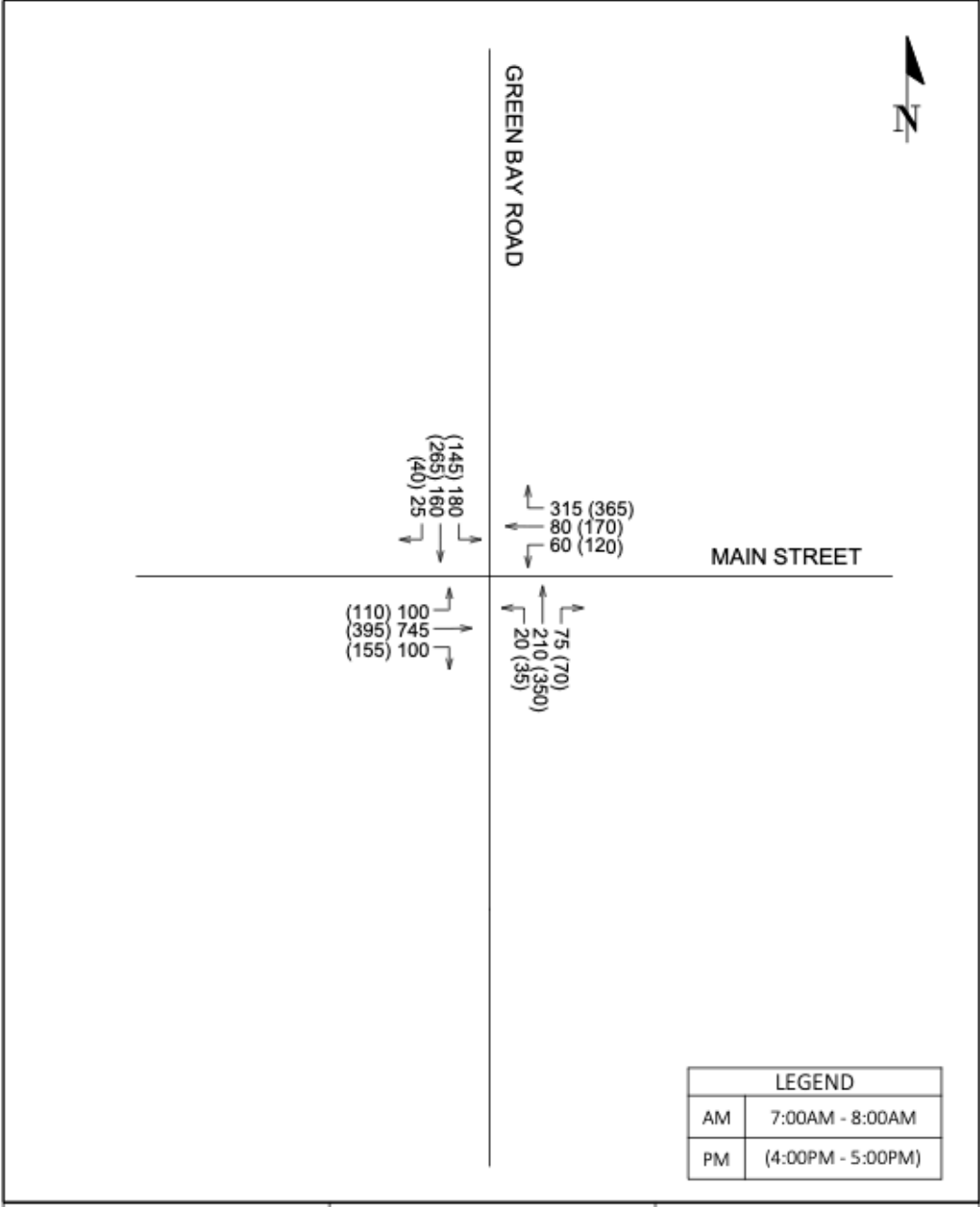
Figure 2: Green Bay Road Hourly Traffic Distribution North of Main Street



Source: Wisconsin Department of Transportation

Year 2018 intersection turning movement counts were obtained from the City of Neenah. The morning and evening peak hour turning movement volumes are shown on Figure 3.

Figure 3: 2018 Peak Hour Traffic Volumes at the Main Street Intersection with Green Bay Road



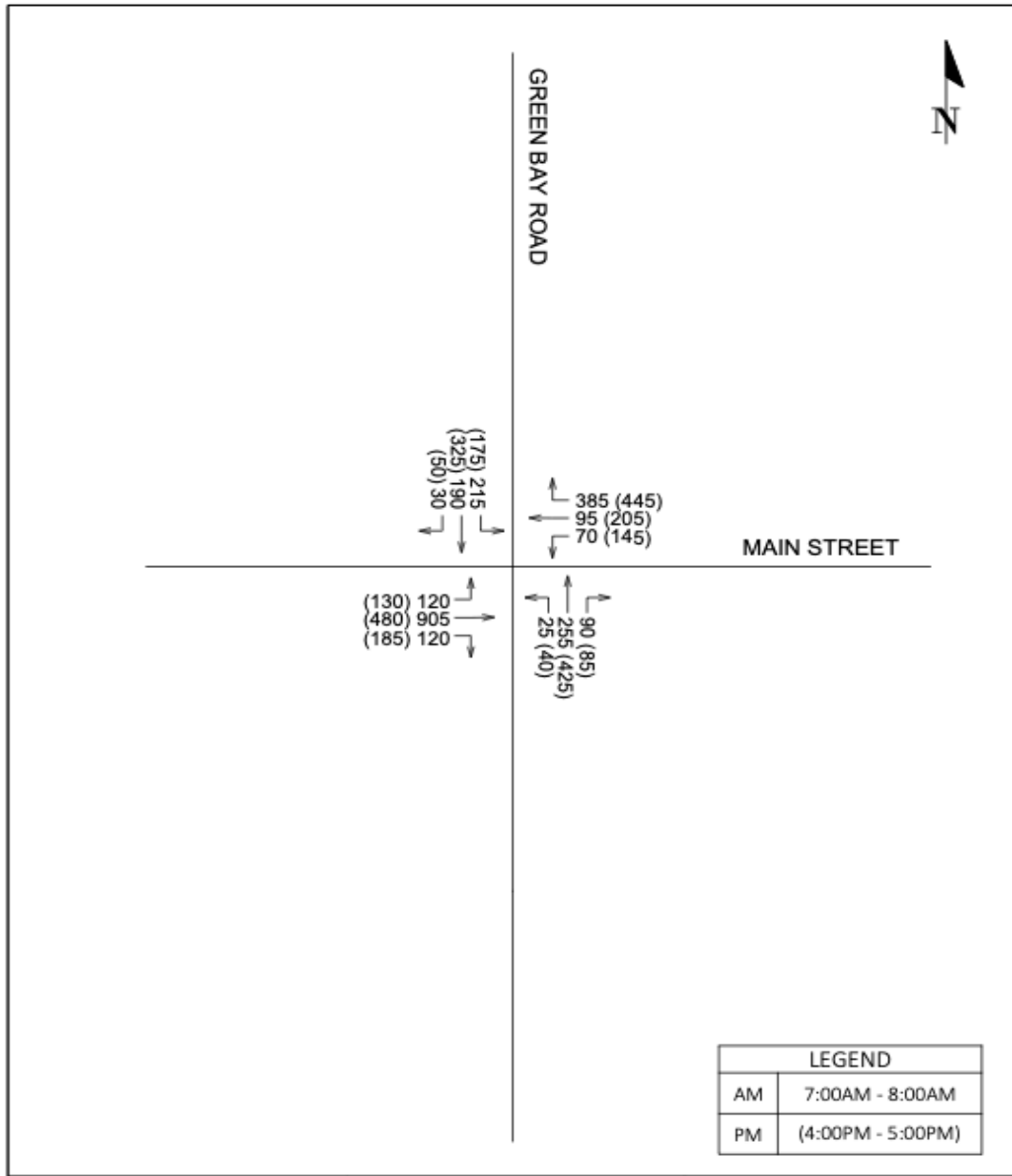
Year 2040 Traffic Volumes: According to historic traffic count data collected by the WisDOT, the daily two-way traffic volumes on the Main Street and Green Bay Road approaches to the study intersection have been fairly consistent with a slight decrease since 2016 as shown on Table 1.

Table 1: 2008 - 2019 Traffic Volumes at the Main Street Intersection with Green Bay Road

<u>Year</u>	<u>Main Street</u>	<u>Green Bay Road</u>	
	<u>West of GB Road</u>	<u>South of Main</u>	<u>North of Main</u>
2008	9,600	9,300	11,000
2010	9,000	7,500	10,500
2013	9,200	8,800	11,300
2016	8,400	6,000	8,700
2019	8,000	6,800	9,100

Based on these historic traffic patterns, year 2040 future traffic levels were assumed to grow at an annual rate of 1 percent per year. Year 2040 peak hour intersection traffic volume projections are shown on Figure 4.

Figure 4: Year 2040 Peak Hour Traffic Volumes at the Main Street Intersection with Green Bay Road



Signalized Intersection Operation

Intersection operation is quantified by Level of Service (LOS) categories. These LOS categories have been defined by the National Academy of Sciences Transportation Research Board and have been adopted by federal, state and local municipalities to analyze intersection operation. Level of Service (LOS) 'D', as defined in the Highway Capacity Manual 6th Edition (HCM), is normally used as the threshold for acceptable peak hour intersection operation in built out urban areas. The LOS is determined based on the average amount of delay experienced by each vehicle entering an intersection during the study period and is categorized by grades of 'A' through 'F'. Table 2 summarizes the different intersection LOS parameters.

Table 2: Intersection Level of Service Description

Alpha LOS	Signalized (sec/veh)	Unsignalized Delay (sec/veh)	Description
A	≤ 10	≤ 10	No Congestion: Very few vehicles experience delay.
B	> 10 – 20	> 10 – 15	Minimal Congestion: Some vehicles experience delay but many travel through intersection without stopping.
C	> 20 – 35	> 15 – 25	Minor Congestion: Many vehicles experience delay but some travel through intersection without stopping.
D	> 35 – 55	> 25 – 35	Moderate Congestion: Most vehicles experience delay.
E	> 55 – 80	> 35 – 50	Severe Congestion: Most vehicles experience significant delay. Volumes nearing capacity.
F	> 80 Or V/C >1.0	> 50 Or V/C >1.0	Extreme Congestion: Nearly all vehicles experience significant delay. Volume may be higher than capacity. Potential gridlock.

The 95th percentile queue is also included in the operations summary as an additional performance measure. The 95th percentile queue (sometimes referred to as the “maximum probable queue”) represents the distance away from the stop bar of an intersection at which 95% of all queues for a given traffic movement are expected to extend. In other words, there is only a 5% probability that the 95th percentile queue length will be exceeded during the analysis period.

Year 2020 Peak Hour Intersection Operation: As previously shown in Table 1, traffic growth trends have not changed significantly at the study intersection, therefore, for study analysis purposes the 2018 intersection traffic counts obtained from the City of Neenah are referenced as year 2020 in this Technical Memorandum. Table 3 summarizes year 2020 morning and evening peak hour intersection operation.

Table 3: Year 2020 Peak Hour Signalized Operation of the Main Street Intersection with Green Bay Road

TRAFFIC CONTROL	PEAK HOUR	MOE	LANE GROUPS							
			EASTBOUND		WESTBOUND		NORTHBOUND		SOUTHBOUND	
			LT-TH	TH-RT	LT-TH	RT	LT-TH	TH-RT	LT-TH	TH-RT
TRAFFIC SIGNAL	AM	LOS	D	D	F	B	D	D	D	D
		Delay (Sec)	41.4	32.0	28.1	6.2	25.5	50.5	20.3	32.8
		Queue (Ft)	475'	400'	250'	100'	225'	200'	300'	225'
	PM	LOS	D	D	E	A	D	D	D	D
		Delay (Sec)	45.5	26.1	25.7	6.5	42.2	23.6	61.0	19.8
		Queue (Ft)	325'	275'	300'	100'	275'	225'	350'	300'

As shown on Table 3, all intersection traffic movements are currently operating acceptably at LOS ‘D’, except for the westbound ‘shared left turn/through’ traffic movement on Main Street which is operating at LOS ‘F’ during the morning peak hour and at LOS ‘E’ during the evening peak hour.

Table 4 summarizes year 2040 intersection operation at the study intersection.

Table 4: Year 2040 Peak Hour Signalized Operation at the Main Street Intersection with Green Bay Road

TRAFFIC CONTROL	PEAK HOUR	MOE	LANE GROUPS							
			EASTBOUND		WESTBOUND		NORTHBOUND		SOUTHBOUND	
			LT-TH	TH-RT	LT-TH	RT	LT-TH	TH-RT	LT-TH	TH-RT
TRAFFIC SIGNAL	AM	LOS	E	E	F	B	D	D	D	D
		Delay (Sec)	43.0	31.2	30.9	7.2	46.1	23.6	86.5	27.1
		Queue (Ft)	525'	450'	250'	125'	225'	200'	400'	325'
	PM	LOS	F	F	F	A	D	D	D	D
		Delay (Sec)	87.7	69.7	31.2	8.6	42.5	29.8	104.4	22.5
		Queue (Ft)	525'	525'	325'	125'	300'	275'	450'	400'

As shown on Table 4, during the year 2040 morning peak hour, the westbound 'shared left turn/through' traffic movements on Main Street is expected to continue to operate at LOS 'F', however, all traffic movements on the eastbound approach of Main Street are expected to be degraded to LOS 'E' operation with a maximum queue of 525 feet for the 'shared left turn/through' movement. In comparison, during the evening peak hour the westbound 'shared left turn/through' movements and all movements on the eastbound approach of Main Street are expected to operate at LOS 'F' with a maximum approach queue for both lanes of 525 feet on the eastbound approach. It is noted that the traffic operational findings assume no adjustments are made to the existing traffic signal timings or intersection geometrics to improve intersection operation.

Roundabout Control Analysis

A conceptual roundabout design was prepared for the Main Street intersection with Green Bay Road to identify anticipated geometrics, potential right-of-way impacts, and impacts to utilities at the intersection. The conceptual design geometrics for a roundabout at the Main Street intersection with Green Bay Road are based on the traffic operational analysis results of the existing signalized intersection and consideration of providing a design that is compatible with the existing lane geometrics on each of the intersection approaches. The conceptual roundabout design is shown in Figure 3.

Figure 3: Roundabout Conceptual Design for the Main Street Intersection with Green Bay Road



2040 Roundabout Traffic Operation

Operation of the roundabout with projected year 2040 traffic volumes is summarized in Table 5.

Table 5: Year 2040 Peak Hour Roundabout Operation at the Main Street Intersection with Green Bay Road

MAIN STREET & GREEN BAY ROAD TRAFFIC ANALYSIS (2040 ROUNDABOUT ANALYSIS)										
TRAFFIC CONTROL	PEAK HOUR	MOE	LANE GROUPS							
			EASTBOUND		WESTBOUND		NORTHBOUND		SOUTHBOUND	
			LT-TH	TH-RT	LT-TH	RT	LT-TH	TH-RT	LT-TH	TH-RT
ROUNDABOUT	AM	LOS	C	D	A	B	C	C	A	A
		Delay (Sec)	20.7	28.9	6.8	12.0	20.1	22.8	3.5	9.3
		Queue (Ft)	200'	275'	25'	100'	75'	100'	25'	75'
	PM	LOS	B	B	B	B	B	B	A	A
		Delay (Sec)	13.0	15.0	11.3	14.8	11.2	12.4	7.4	7.9
		Queue (Ft)	100'	125'	75'	125'	75'	75'	50'	50'

As shown on Table 5, during the Year 2040 morning and evening peak hours, all roundabout traffic movements are expected to operate at LOS 'C' or better during the 2040 morning peak hour, all traffic movements are expected to operate at LOS 'C' or better, except for the eastbound 'shared through/right turn' lane which is expected to operate at LOS 'D' with a

maximum queue of 275 feet. It is noted that the USH 41 northbound off-ramp to Main Street is approximately 370 feet from Green Bay Road intersection. During the evening peak hour all traffic movements are expected to operate at LOS 'B' or better with a maximum queue of 125 feet on the eastbound and westbound approaches.

It is planned to construct a new high school northwest of the Green Bay Road/Main Street intersection to serve the entire Neenah area. Much of the traffic generated by the future high school is expected to use Oakridge Road to/from Main Street. Due to the 370 spacing between the US 41 off-ramp and Green Bay Road it is important that a traffic impact assessment conducted for the new school include an analysis of school traffic impacts on the operation of the conceptual roundabout design shown on Figure 14 due to potential queuing concerns on eastbound Main Street and the roundabout spacing to the US 41 ramp system.

Conclusions

The traffic operation analysis indicate that a roundabout will operate at acceptable LOS through the Year 2040 at the Main Street intersection with Green Bay Road under a projected annual traffic growth rate of 1 percent through the year 2040. If the annual traffic growth is less than 1 percent, the roundabout can be expected to operate with an improved LOS and shorter queues than reported in this Technical Memorandum.

It is noted that the traffic Impact assessment prepared for a new Neenah area high school planned for the area northwest of the Green Bay Road/Main Street intersection should include an analysis of its impact on Main Street queuing between US 41 ramps and Green Bay Road intersections.