Intersection Control Evaluation Report

STH 23 & Wisconsin American Drive

Project ID 1440-15-01
Fond du Lac County, WI

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PROJECT DESCRIPTION

WisDOT is planning a roadway improvement project (I.D. 1440-15-01) for State Trunk Highway (STH) 23 in Fond du Lac County. This project is planned for construction starting in 2015 and includes the intersection of STH 23 and Wisconsin American Drive. The existing intersection of STH 23 and Wisconsin American Drive is located approximately 800 feet east of the northbound USH 151 ramp terminal with STH 23.

Currently, STH 23 is a four-lane divided highway at this intersection with a 130-foot left-turn (westbound) and 130-foot right turn (eastbound) lane onto Wisconsin American Drive. Wisconsin American Drive is a stop-controlled approach from the south which serves as the sole access point for an isolated residential and commercial area. The posted speed limit on STH 23 is 45 mph east of the intersection and 35 mph west of the intersection; Wisconsin American Drive is posted at 25 mph. The proposed project design speed on STH 23 is 50 mph.

This report will analyze and contrast three potential intersection reconfiguration alternatives in accordance with the criteria outlined in FDM chapter 11-25-3 (project development). The intersection alternatives to be analyzed are as follows:

1. No-build, with no change to existing geometry, using maintaining stop control on Wisconsin American Drive.
2. Reconstructed intersection with two travel lanes in each direction on STH 23, using traffic signal control.
3. Reconstructed roundabout-control intersection.

A project location map is included in **Appendix A.**

	ALTERNATIVE 1 TWO WAY STOP CONTROL	ALTERNATIVE 2 TRAFFIC SIGNAL	ALTERNATIVE 3 ROUNDABOUT
SAFETY CONSIDERATIONS	Existing Crash Patterns A crash report for the project area including this intersection was completed by KL Engineering in 2007. Crash data for this intersection was updated to include crashes that occurred through 2011. Crashes that occurred at this intersection between 2003 and 2011 were evaluated for this report. During this time period, there were twelve non-deer-related crashes reported at this intersection, eight of which occurred in the past six years. This represents an average of approximately 1.3 crashes per year. The resulting crash rate of approximately 0.3 crashes per million entering vehicles (MEV) is below the threshold of concern for a standard intersection (1.5 crashes per MEV). Three of the crashes in the past six years have been angle crashes with a vehicle from Wisconsin American Drive failing to yield the right-of-way to a vehicle on STH 23. Three of the remaining crashes were rear-end crashes. There was one run-off-the-road crash and one crash involving a westbound-to-southbound left-turning vehicle failing to yield the right-of-way to an eastbound vehicle. A collision diagram is included in **Appendix B.** Alternative 1 Analysis This intersection control alternative does not improve upon the existing conditions, so future crash patterns are expected to follow the existing crash pattern. Increased traffic volume will likely result in increased crash frequency.	This intersection control alternative includes reconstruction of the existing condition to a channelized intersection with traffic signal control. The reconstruction of the intersection to current standards under signal control will likely result in a generally safer intersection; however, signalized intersections on high-speed roadways have been known to create an environment for more serious crashes. High speed rural signalized intersections have been shown to experience more serious crashes between drivers having a false sense of security when crossing the intersection obeying a green signal indication, and other drivers deliberately or inattentively disobey signal indications. These crashes result in serious injury given the high rates of speed. Additionally, signalizing intersections can often increase the number of rear-end collisions from vehicles slowing down to a stop compared to a previously free-flowing condition. There are safety features that can be implemented to decrease the potential for high-speed crashes. These features may include advance warning signs, high-speed vehicle detection and careful phasing/timing design for minimizing the chance for crashes to occur. A typical signalized T-intersection has 9 conflict points.	This intersection control alternative includes reconstruction of the existing intersection to a roundabout. It is unlikely that a roundabout would result in a reduction in the number of crashes given the low existing rate. However, roundabout crashes are typically less severe than those occurring at other types of intersections due to lower vehicle operating speeds and smaller impact angles. When compared to a two-way stop-controlled (TWSC) or a signalized intersection, roundabouts reduce the number of conflict points for a T-intersection to 6 (3 diverge and 3 merge, 0 crossing) and reduce the opportunity for high speed and angle crashes. .

Intersection Control Evaluation
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TRAFFIC VOLUMES & OPERATIONAL ANALYSIS

ALTERNATIVE 1
TWO WAY STOP CONTROL

Traffic Volume Background

Hourly traffic counts on STH 23 just east of this intersection show annual average daily traffic (AADT) of 10,800 vehicles per day (vpd) in a 2012. Traffic volumes are projected to reach 13,200 vpd in the construction year (2015), and 17,600 vpd in the design year (2035).

A design year (2035) projection from turning movement count forecasts indicated an AADT on Wisconsin American Drive of 4,550 vpd.

The highest volume of traffic at the intersection occurs during the PM peak hour with the total intersection traffic of approximately 1,865 in the AM and 2,050 in the PM peak hour. The PM peak hour approach volumes projected for the design year (2035) is approximately:
- 1,010 vehicles eastbound STH 23
- 710 vehicles westbound on STH 23
- 330 vehicles northbound on Wisconsin American Drive

In general terms, the vast majority of total traffic using the intersection is through volume on the mainline, with low turning movement volume to or from the side road. STH 23 through volume consists of 76% to 85% of peak hour traffic. Traffic volume on Wisconsin American Drive accounts for 3% to 16% of peak hour traffic. The remaining 8% to 12% is comprised of turning traffic off STH 23.

Truck volume accounts for approximately 12% of total traffic on STH 23 and 2% on Wisconsin American Drive.

Alternative 1 Analysis

A highway capacity analysis using Synchro Software was completed to model this alternative under existing conditions and stop control for the 2015 and 2035 AM and PM peak hour periods.

The Wisconsin American Drive (NB) approach to this intersection would be anticipated to operate at LOS C during the AM peak and LOS F during the PM peak with existing conditions under 2015 projected traffic volumes. The northbound queue on Wisconsin American Drive during the PM peak hour is expected to be approximately 200 feet. The westbound left turn from STH 23 to Wisconsin American Drive is expected to operate at LOS A during both peak hours. See below for a summary of results.

2015 Highway Capacity Results

Existing Conditions Stop Control	Delay Per Vehicle/LOS (Seconds)	
	2015 AM	2015 PM
NB Approach	21/C	79/F
EB Approach	Free Flow	Free Flow
WB LT	9/A	10/A
Intersection	1/A	12/B

ALTERNATIVE 2
TRAFFIC SIGNAL

A traffic signal warrant analysis check (70% volume criteria) was completed for the intersection of STH 23 and Wisconsin American Drive using 2012 traffic volumes. Warrant 1A (eight-hour vehicular volume) & 2 (four-hour vehicular volume) were met using 0 percent right-turns. Refer to **Appendix D** for traffic signal warrant analysis results.

Synchro Software was used to model this alternative, the reconstruction of the intersection to current standards with traffic signal control for the design year (2035) peak hour periods. The modeling assumed two through travel lanes in each direction on STH 23, a 350-foot eastbound right-turn lane, a 450-foot left-turn lane, and two approach lanes on Wisconsin American Drive. The signal control assumed protected/permitted (flashing yellow arrow) phasing for the westbound left turns from STH 23.

The USH 151 northbound ramp intersection is located approximately 800-feet west of the Wisconsin American Drive intersection, while the southbound ramp intersection is approximately 500-feet west of the northbound ramp. These intersections are currently signalized and operated together using diamond interchange type traffic signal phasing. The modeling indicated that traffic progression along STH 23 would benefit from operating the signal at Wisconsin American Drive as part of a coordinated network including the interchange ramps. All results shown in this report are from modeling in coordination with the USH 151 interchange.

The tables below summarize the intersection modeling results in 2035. The HCM results from Synchro software indicate that the intersection and all approaches would operate at a LOS C or better during both peak hours in the design year (2035). No queuing issues are anticipated. See below for a summary of results.

2035 Highway Capacity Results

Traffic Signal	Delay Per Vehicle/LOS (Seconds) HCM	
	2035 AM	2035 PM
NB Left	21/C	20/B
NB Right	19/B	14/B
EB Approach	1/A	8/A
WB Thru	4/A	9/A
WB LT	3/A	7/A
Intersection	3/A	10/A

2035 Synchro Queues

Traffic Signal	95th% Queue Length (Feet) Synchro	
	2035 AM	2035 PM
NB Left	28	124
NB Right	25	25
EB Approach	32	152
WB Thru	115	109
WB LT	25	25

This alternative can provide excess capacity to deal with fluctuations in future traffic volumes.

Refer to **Appendix E** for modeling output data for this alternative.

ALTERNATIVE 3
ROUNDABOUT

RODEL roundabout analysis software was used to model this alternative, the reconstruction of the intersection as a dual-lane roundabout for the design year (2035) peak hour periods. The modeling assumed two through travel lanes in each direction on STH 23 and a single approach lane on Wisconsin American Drive.

The results indicate the intersection will maintain acceptable operations for all approaches during both peak hours in the design year (2035). This alternative has higher average overall intersection delay when compared to the signalized alternative. This is due to the roundabout creating an environment where all traffic has to slow to enter the intersection. No queuing issues are anticipated.

Two additional factors regarding the traffic operations under this alternative were considered:
- Interaction with the signalized USH 151 ramp intersections
- Imbalance of movements at the roundabout

The interaction with the signalized USH 151 ramps is expected to create a platoon type arrival pattern at the eastbound approach to the roundabout. The distance between the northbound ramp and Wisconsin American Drive is 800 feet (1,350 feet from the southbound ramp), which is a short distance that won't allow for significant dispersion of traffic.

The imbalance of traffic volume at the roundabout is also a concern. This location has a low percentage of traffic turning left through the intersection. The potential for high entry speeds and failing to yield may result when through traffic becomes accustomed to rarely yielding to certain movements. This issue may be exacerbated by the platoon arrival of traffic from the USH 151 traffic signal.

The tables below summarize the intersection modeling results in 2035. The RODEL results indicate that the intersection and all approaches would operate at a LOS B or better during both peak hours in the design year (2035). No queuing issues were indicated. RODEL results do not account for any additional delay and queuing from the issues noted above. See below for a summary of results.

2035 RODEL Capacity Results

Roundabout	Delay Per Vehicle/LOS (Seconds)	
	2035 AM	2035 PM
NB Approach	13/B	17/B
EB Approach	16/B	17/B
WB Approach	17/B	17/B
Intersection	17/B	18/B

2035 RODEL Queues

Roundabout	Queue Length (Feet)	
	2035 AM	2035 PM
NB Approach	50	75
EB Approach	25	75
WB Approach	75	50

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Factors to Analyze (Intersection of STH 23 and Wisconsin American Drive)

	ALTERNATIVE 1 TWO WAY STOP CONTROL	ALTERNATIVE 2 TRAFFIC SIGNAL	ALTERNATIVE 3 ROUNDABOUT
TRAFFIC VOLUMES & OPERATIONAL ANALYSIS (CONTINUED)	**2015 Synchro Queues** **Existing Conditions** / **95th % Queue Length (Feet)** **Stop Control** / **2015 AM** / **2015 PM** NB Approach: 25 / 200 EB Approach: 0 / 0 WB LT: 0 / 0 **2035 Highway Capacity Results** **No-Build Conditions** / **Delay Per Vehicle/LOS (Seconds)** **Stop Control** / **2035 AM** / **2035 PM** NB Approach: 33/D / 398/F EB Approach: Free Flow / Free Flow WB LT: 10/B / 11/B Intersection: 1/A / 63/F **2035 Synchro Queues** **No-Build Conditions** / **95th % Queue Length (Feet)** **Stop Control** / **2035 AM** / **2035 PM** NB Approach: 25 / 535 EB Approach: 0 / 0 WB LT: 0 / 0 In 2035, the modeling indicated that the Wisconsin American Drive approach is expected to operate at LOS D during the AM peak and LOS F during the PM peak hour. Queues over 500 feet would be expected on the northbound approach during the PM hour. This alternative does not maintain an acceptable level of service for Wisconsin American Drive traffic beyond 2015. Refer to **Appendix E** for modeling output data for this alternative.		This alternative will provide excess capacity to deal with fluctuations in future traffic volumes. Refer to **Appendix E** for modeling output data for this alternative.

Intersection Control Evaluation
Factors to Analyze (Intersection of STH 23 and Wisconsin American Drive)

	ALTERNATIVE 1 TWO WAY STOP CONTROL	ALTERNATIVE 2 TRAFFIC SIGNAL	ALTERNATIVE 3 ROUNDABOUT
CONSTRUCTION COSTS	General Comments The costs listed for each alternative are specific to the limits of work required for the alternative. The reconstruction areas covered by the estimated costs are measured from the point where the alignment of either alternative deviated from the planned typical section of the STH 23 corridor reconstruction. Refer to the sketch of alternatives in **Appendix G** for a graphical depiction of the areas represented in the estimates.	The total construction cost for this alternative includes an estimate of items required for grading, pavement, and incidentals to construct an intersection to current standards under signal control. A total construction cost of **$1,750,000** includes a 15% contingency and does not include right-of-way or utility costs. This estimate assumes a full reconstruction within the footprint of the intersection expansion of the STH 23 roadway. Refer to **Appendix F** for additional estimate detail.	The total construction cost for this alternative includes an estimate of items required for grading, pavement, and incidentals to construct an intersection to current standards under roundabout control. A total construction cost of **$1,250,000** includes a 15% contingency and does not include right-of-way or utility costs. This estimate assumes a full reconstruction within the footprint of the intersection expansion of the STH 23 roadway. Refer to **Appendix F** for additional estimate detail.
RIGHT-OF-WAY IMPACTS	General Comments The right-of-way impacts listed for each alternative are specific to the limits of work required for the alternative. The reconstruction areas covered by the estimated impacts are measured from the point where the alignment of either alternative deviated from the planned typical section of the STH 23 corridor reconstruction. Refer to the sketch of alternatives in **Appendix G** for right-of-way impacts.	An estimate for right-of-way acquisition required for this alternative assumes an additional 12 feet of right-of-way from the parcel on the north side of STH 23 for the length of the westbound left-turn lane. An additional corner of right-of-way is required for the addition of the eastbound right-turn lane. There will be additional right-of-way required for the overall STH 23 corridor expansion. This amount will be determined with higher precision as design progresses. A total of **2.37 Acres** of new right-of-way will be required to construct an intersection to current standards under signal control. No relocations are needed with this alternative.	An estimate for right-of-way acquisition required for this alternative includes a larger area of right-of-way from the parcel on the north side of STH 23 to accommodate the offset of the circulatory roadway. There will be additional right-of-way required for the overall STH 23 corridor expansion. This amount will be determined with higher precision as design progresses. A total of **2.71 Acres** of new right-of-way will be required to construct an intersection to current standards under roundabout control. No relocations are needed with this alternative.

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	ALTERNATIVE 1 TWO WAY STOP CONTROL	ALTERNATIVE 2 TRAFFIC SIGNAL	ALTERNATIVE 3 ROUNDABOUT
PRACTICAL FEASIBILITY	N/A	This intersection alternative may be considered as feasible for the following reasons: • The intersections are in proximity to be coordinated with the traffic signals at USH 151 during peak periods, and may run independently during off peak periods. • Does not create major impediments for use as an OSOW use. • This alternative can be built under traffic without requiring significant cost or impacts to traffic.	This intersection alternative may be considered as feasible for the following reasons: • Vehicles operate at lower speeds through roundabouts, providing for safer pedestrian and bicycle access. This intersection alternative may be considered as impractical for the following reasons: • This alternative would require significantly more complex and costly construction staging methods to build under traffic.
OPERATIONS & MAINTENANCE COSTS	N/A	In addition to periodic pavement rehabilitation this alternative will require continued operation and maintenance costs incurred for maintenance of the traffic signal and for energy cost. A summary of probable energy usage for the traffic signal is as follows: <u>Traffic signal (LED)</u> 11 – 16 kWH LED signal heads 176 kWH/month = 2,112 kWH/year Yearly Cost @ $0.11/kWH = $232/year <u>Street Lighting</u> 6 – 250 Watt HPS Fixtures: 114 kWH/month/fixture = 684 kWH/month = 8,208 kWH/year Yearly Cost @ $0.11/kWH= $903/year **Total Energy Cost = $232 + $903 = $1,135/year** There would also be an additional cost of maintenance for of a traffic signal and repairing knock-downs and equipment failures. This cost will be variable and difficult to estimate accurately. <u>Traffic Signal Timing</u> – Traffic signals will require ongoing periodic evaluation and maintenance to maintain efficient traffic flow and to keep current with updated equipment needs. The cost for this is not easily estimated; however a long term commitment to engineering and maintenance will be required for any new traffic signal.	In addition to periodic pavement rehabilitation this alternative will require unique operation and maintenance costs incurred for maintenance of 16 new street lights and for energy cost. A summary of probable energy usage for the street lighting is as follows: 10 – 250 Watt HPS Fixtures: 114 kWH/month/fixture =1,140 kWH/month = 13,680 kWH/year Yearly Cost @ $0.11/kWH= **$1505/year** There would also be an additional cost of maintenance for the street lighting for repairing knock-downs and equipment failures. This cost will be variable and difficult to estimate accurately. Additional maintenance concerns with this alternative should be considered given the following roadway design features specific to this alternative. <u>Drainage</u> – It is reasonable to expect that a considerable amount of curb and gutter will require a storm sewer drainage system. Any drainage system will require period cleaning. A specific cost is not easily attributed without determining the exact design of the roundabout. <u>Central Island Landscaping</u> – It is reasonable to expect that a greenscaped central island will require routine maintenance by the local authority. A specific cost is not easily attributed without determining the exact design of the roundabout and landscaping items. <u>Pavement Marking</u> – Roundabouts will generally require more pavement marking than traditional intersections. A specific cost is not easily attributed without determining the exact design of the roundabout.

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	ALTERNATIVE 1 TWO WAY STOP CONTROL	ALTERNATIVE 2 TRAFFIC SIGNAL	ALTERNATIVE 3 ROUNDABOUT
ENVIRONMENTAL IMPACTS	N/A	There are no environmental impacts identified for this alternative.	There are no environmental impacts identified for this alternative.
PEDESTRIAN/BICYCLE ACCOMMODATIONS	Complete Streets (Trans 75) will apply to this project. The corridor expansion project will include a pedestrian and bicycle path along the north side of STH 23.	This alternative will include curb cuts for future cross walks and traversable channelizing islands. The signal could include pedestrian signals if sidewalks are included in the future. This alternative will provide gaps for pedestrians crossing STH 23 and Wisconsin American Drive. Bicycles can use the shoulder or the off-road path.	This alternative will include curb cuts for future cross walks, paved median crossings and off street paths around the roundabout. This alternative will provide gaps for pedestrians crossing STH 23 and Wisconsin American Drive. Bicycles can use the off road path or may travel through the roundabout.
OSOW VEHICLES	General Information STH 23 is a designated long truck route. STH 23 is also considered a primary route for Oversize/Overweight (OSOW) vehicles in the Northeast Region.	This alternative would require removing or raising monotube signal mast arms for loads in excess of 18 feet in height. If turning movements are required, the raised curb may be a barrier for left-turns.	Specific features including mountable curb, increased truck apron size and large offsets to light poles can be designed if it is determined that OSOW vehicles will need to be accommodated.

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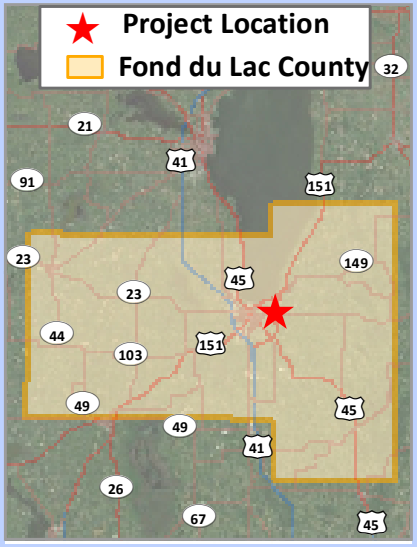
	ALTERNATIVE 1 TWO WAY STOP CONTROL	ALTERNATIVE 2 TRAFFIC SIGNAL	ALTERNATIVE 3 ROUNDABOUT
RECOMMENDATION	Alternative 1: The no-build alternative is not recommended because it does not include safety and operational improvements.	Alternative 2: The signalized alternative would include an intersection design which includes desirable geometric features such as long stopping and intersection sight lines and channelized turn lanes. This alternative has the following preferred criteria when compared to the remaining alternatives: • Lower delay per vehicle without any major queuing issues. • Practical aspect of constructability while maintaining traffic movements. • Lower amount of right-of-way required • Lower operations and maintenance cost	Alternative 3: This alternative would have the lowest potential for crashes, as well as lower crash severity; in addition to having a lower construction cost than the signalized alternative. The Wisconsin Department of Transportation recommends constructing the intersection as a dual-lane roundabout for the following reasons: • Lower cost • A roundabout will fit in with the long range plans for STH 23 and result in continuous travel along STH 23 between USH 151 and Plymouth to the east.

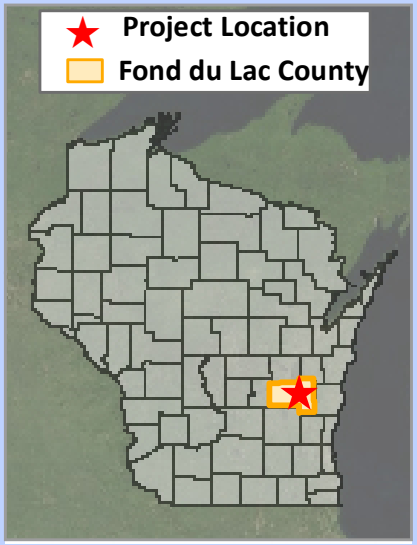
Appendix A

Project Location Map

Project Location Map

WisDOT ID 1440-15-01
USH 151 Interchange - Taft Road
Wisconsin-American Drive Intersection
STH 23
Fond du Lac County





N
W
E
S
Prairie Rd
151
Kairis Ct
23
23
Lynn Ave
Wisconsin-American Drive
Meadowcreek Ln
Lynn Ave
Mariean Ln
K
151

Legend

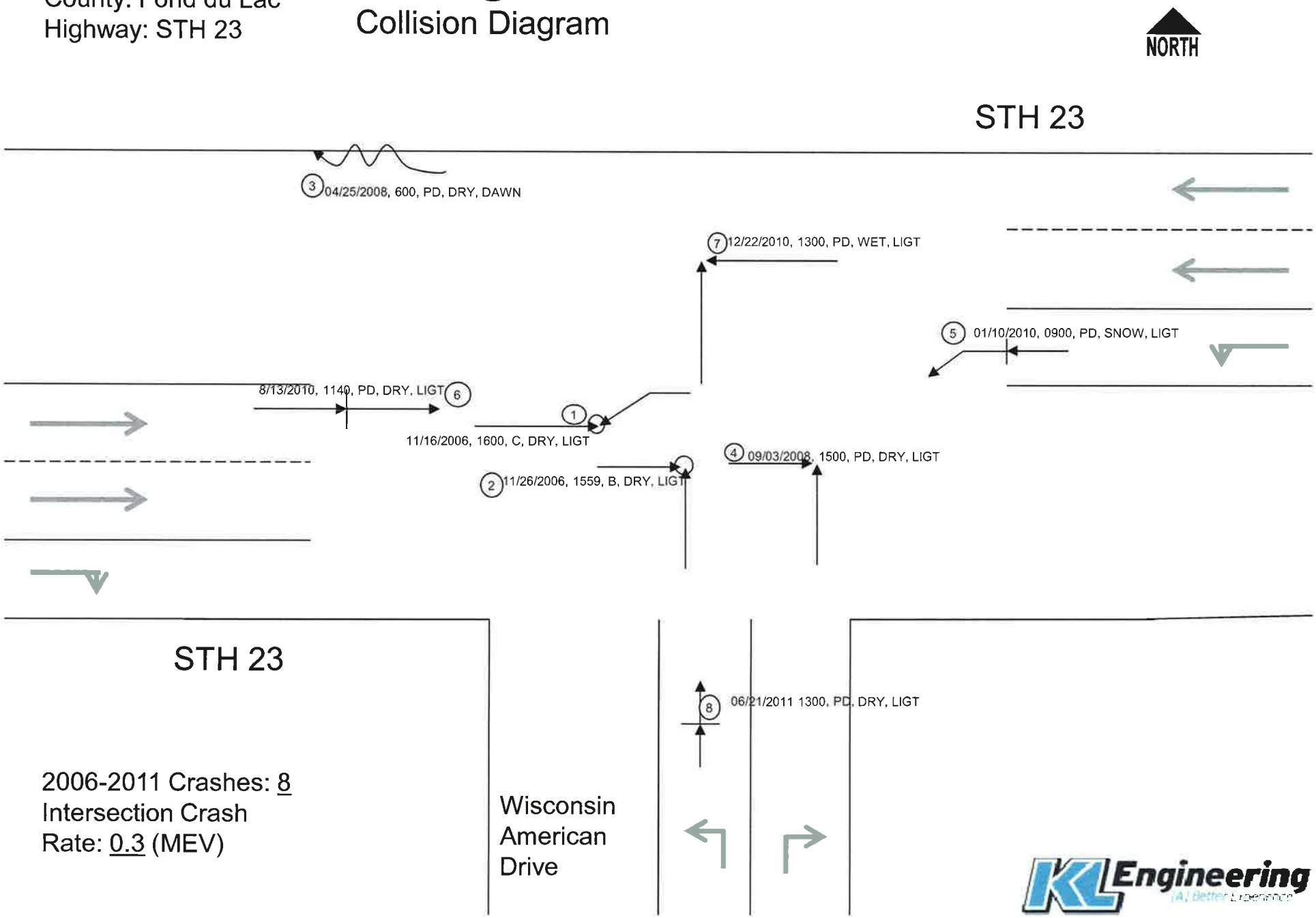
WisDOT ID 1440-15-01

Appendix B

Crash Summary

Project ID: 1440-15-01
County: Fond du Lac
Highway: STH 23

STH 23 @ Wisconsin American Dr.
Collision Diagram



2006-2011 Crashes: 8
Intersection Crash Rate: 0.3 (MEV)

KL Engineering

Appendix C

Traffic Volume Information

Wisconsin Department of Transportation

Daily Volume from 08/22/2011 through 08/24/2011

Site Names: 200219, 1717, NE
County: Fond Du Lac
Funct. Class: U Principal Arterial - Other
Location: STH 23 EAST OF CTH K FOND DU LAC

Seasonal Factor Type: 2
Daily Factor Type: 2
Axle Factor Type: 5
Growth Factor Type: 1

	Sun 08/21/2011			Mon 08/22/2011			Tue 08/23/2011			Wed 08/24/2011			Thu 08/25/2011			Fri 08/26/2011			Sat 08/27/2011		
	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS
00:00							80	43	37	67	28	39									
01:00							39	11	28	66	31	35									
02:00							54	27	27	51	37	14									
03:00							79	52	27	85	57	28									
04:00							157	86	71	154	85	69									
05:00							390	226	164	339	212	127									
06:00							661	401	260	681	407	274									
07:00							893	556	337	911	566	345									
08:00							720	430	290	784	473	311									
09:00							693	393	300	659	375	284									
10:00							789	426	363	736	340	396									
11:00							692	356	336	765	424	341									
12:00							732	364	368	794	423	371									
13:00				813	384	429	798	387	411												
14:00				844	422	422	833	447	386												
15:00				906	444	462	873	415	458												
16:00				1,013	427	586	1,094	481	613												
17:00				992	455	537	1,076	483	593												
18:00				648	265	383	702	301	401												
19:00				507	228	279	530	218	312												
20:00				464	195	269	451	188	263												
21:00				317	111	206	349	165	184												
22:00				206	76	130	197	87	110												
23:00				113	53	60	136	67	69												
Volume				6,823	3,060	3,763	13,018	6,610	6,408	6,092	3,458	2,634									
AM Peak Vol							893	556	363	911	566	396									
AM Peak Fct							1.00	1.00	1.00	1.00	1.00	1.00									
AM Peak Hr							7:00	7:00	10:00	7:00	7:00	10:00									
PM Peak Vol							1,094	483	613												
PM Peak Fct							1.00	1.00	1.00												
PM Peak Hr							16:00	17:00	16:00												
Seasonal Fct				0.930	0.930	0.930	0.930	0.930	0.930	0.930	0.930	0.930									
Daily Fct				0.968	0.968	0.968	0.950	0.950	0.950	0.931	0.931	0.931									
Axle Fct				0.435	0.435	0.435	0.435	0.435	0.435	0.435	0.435	0.435									
Pulse Fct				2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000									

Collected by: WIDOT
Created 04/10/2012 2:12:35PM

ROAD AADT 9,969 **NEG AADT 5,041** **POS AADT 4,928**

Wisconsin Department of Transportation

Daily Volume from 08/22/2011 through 08/24/2011

Site Names: 201185, 8926, NE
County: Fond Du Lac
Funct. Class: U Principal Arterial - Other
Location: STH 23 BTWN WISCONSIN AMERICAN DR & CTH K FOND DU LAC

Seasonal Factor Type: 2
Daily Factor Type: 2
Axle Factor Type: 5
Growth Factor Type: 1

	Sun 08/21/2011			Mon 08/22/2011			Tue 08/23/2011			Wed 08/24/2011			Thu 08/25/2011			Fri 08/26/2011			Sat 08/27/2011		
	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS	ROAD	NEG	POS
00:00							87	42	45	76	30	46									
01:00							39	11	28	66	28	38									
02:00							55	29	26	51	37	14									
03:00							79	51	28	87	58	29									
04:00							157	85	72	155	83	72									
05:00							390	223	167	346	215	131									
06:00							697	415	282	724	430	294									
07:00							980	600	380	961	598	363									
08:00							767	475	292	871	520	351									
09:00							773	432	341	740	423	317									
10:00							850	466	384	811	379	432									
11:00							737	380	357	858	469	389									
12:00							859	426	433	902	474	428									
13:00				885	416	469	912	438	474												
14:00				989	488	501	984	499	485												
15:00				1,055	520	535	1,012	476	536												
16:00				1,154	495	659	1,206	548	658												
17:00				1,148	509	639	1,203	545	658												
18:00				789	364	425	842	385	457												
19:00				608	290	318	612	263	349												
20:00				527	218	309	508	207	301												
21:00				343	127	216	366	168	198												
22:00				217	90	127	231	107	124												
23:00				135	64	71	145	75	70												
Volume				7,850	3,581	4,269	14,491	7,346	7,145	6,648	3,744	2,904									
AM Peak Vol							980	600	384	961	598	432									
AM Peak Fct							1.00	1.00	1.00	1.00	1.00	1.00									
AM Peak Hr							7:00	7:00	10:00	7:00	7:00	10:00									
PM Peak Vol							1,206	548	658												
PM Peak Fct							1.00	1.00	1.00												
PM Peak Hr							16:00	16:00	16:00												
Seasonal Fct				0.930	0.930	0.930	0.930	0.930	0.930	0.930	0.930	0.930									
Daily Fct				0.968	0.968	0.968	0.950	0.950	0.950	0.931	0.931	0.931									
Axle Fct				0.435	0.435	0.435	0.435	0.435	0.435	0.435	0.435	0.435									
Pulse Fct				2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000									

Collected by: WIDOT
Created 04/10/2012 2:12:33PM

ROAD AADT 11,147 **NEG AADT 5,636** **POS AADT 5,511**

KL Engineering, Inc.

5950 Seminole Centre Court, Suite 200
Madison, WI 53711

STH 23 & Wisconsin American Dr.
12 Hour turning movment count
January 10, 2006
Fond du Lac, WI

File Name : 23&WIAM
Site Code : 04210112
Start Date : 1/10/2006
Page No : 1

Groups Printed- CARS - TRUCKS

	From North					STH 23 From East					WISCONSIN AMERICAN DR. From South					STH 23 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	0	0	0	0	0	0	65	0	0	65	0	0	0	0	0	9	39	0	0	48	113
06:15 AM	0	0	0	0	0	0	91	4	0	95	0	0	1	0	1	10	63	0	0	73	169
06:30 AM	0	0	0	0	0	0	119	2	0	121	2	0	0	0	2	12	52	0	0	64	187
06:45 AM	0	0	0	0	0	0	107	2	0	109	2	0	2	0	4	30	73	0	0	103	216
Total	0	0	0	0	0	0	382	8	0	390	4	0	3	0	7	61	227	0	0	288	685
07:00 AM	0	0	0	0	0	0	126	5	0	131	1	0	7	0	8	12	74	0	0	86	225
07:15 AM	0	0	0	0	0	0	168	3	0	171	0	0	7	0	7	22	78	0	0	100	278
07:30 AM	0	0	0	0	0	0	180	4	0	184	0	0	1	0	1	13	87	1	0	101	286
07:45 AM	0	0	0	0	0	0	171	4	0	175	1	0	7	0	8	49	134	0	0	183	366
Total	0	0	0	0	0	0	645	16	0	661	2	0	22	0	24	96	373	1	0	470	1155
08:00 AM	0	0	0	0	0	0	103	4	0	107	2	0	8	0	10	30	85	0	0	115	232
08:15 AM	0	0	0	0	0	0	95	7	0	102	1	0	9	0	10	43	61	0	0	104	216
08:30 AM	0	0	0	0	0	0	90	1	0	91	4	0	15	0	19	24	55	0	0	79	189
08:45 AM	0	0	0	0	0	0	86	4	0	90	3	0	15	0	18	45	56	0	0	101	209
Total	0	0	0	0	0	0	374	16	0	390	10	0	47	0	57	142	257	0	0	399	846
09:00 AM	0	0	0	0	0	0	68	3	0	71	1	0	8	0	9	33	55	0	0	88	168
09:15 AM	0	0	0	0	0	0	73	6	0	79	3	0	18	0	21	31	49	0	0	80	180
09:30 AM	0	0	0	0	0	0	75	7	0	82	5	0	21	0	26	33	65	0	0	98	206
09:45 AM	0	0	0	0	0	0	79	3	0	82	3	0	27	0	30	28	66	0	0	94	206
Total	0	0	0	0	0	0	295	19	0	314	12	0	74	0	86	125	235	0	0	360	760
10:00 AM	0	0	0	0	0	0	76	2	0	78	1	0	29	0	30	17	50	0	0	67	175
10:15 AM	0	0	0	0	0	0	68	4	0	72	4	0	30	0	34	48	56	0	0	104	210
10:30 AM	0	0	0	0	0	0	60	5	0	65	3	0	37	0	40	23	56	0	0	79	184
10:45 AM	0	0	0	0	0	0	69	3	0	72	2	0	33	0	35	36	56	0	0	92	199
Total	0	0	0	0	0	0	273	14	0	287	10	0	129	0	139	124	218	0	0	342	768
11:00 AM	0	0	0	0	0	0	76	4	0	80	4	0	31	0	35	38	74	0	0	112	227
11:15 AM	0	0	0	0	0	0	78	2	0	80	4	0	32	0	36	20	66	0	0	86	202
11:30 AM	0	0	0	0	0	0	63	3	0	66	7	0	41	0	48	26	78	0	0	104	218
11:45 AM	0	0	0	0	0	0	80	4	0	84	3	0	38	0	41	17	59	0	0	76	201
Total	0	0	0	0	0	0	297	13	0	310	18	0	142	0	160	101	277	0	0	378	848
12:00 PM	0	0	0	0	0	0	75	3	0	78	5	0	36	0	41	23	77	0	0	100	219
12:15 PM	0	0	0	0	0	0	83	2	0	85	2	0	14	0	16	21	79	0	0	100	201
12:30 PM	0	0	0	0	0	0	76	2	0	78	6	0	30	0	36	38	71	0	0	109	223
12:45 PM	0	0	0	0	0	0	96	2	0	98	6	0	22	0	28	38	80	0	0	118	244
Total	0	0	0	0	0	0	330	9	0	339	19	0	102	0	121	120	307	0	0	427	887
01:00 PM	0	0	0	0	0	0	76	3	0	79	3	0	23	0	26	31	82	0	0	113	218
01:15 PM	0	0	0	0	0	0	80	4	0	84	7	0	27	0	34	34	92	0	0	126	244
01:30 PM	0	0	0	0	0	0	77	2	0	79	5	0	35	0	40	35	89	0	0	124	243
01:45 PM	0	0	0	0	0	0	84	6	0	90	3	0	17	0	20	30	94	0	0	124	234
Total	0	0	0	0	0	0	317	15	0	332	18	0	102	0	120	130	357	0	0	487	939
02:00 PM	0	0	0	0	0	0	71	1	0	72	4	0	23	0	27	29	66	0	0	95	194
02:15 PM	0	0	0	0	0	0	97	6	0	103	1	0	27	0	28	29	61	0	0	90	221
02:30 PM	0	0	0	0	0	0	85	4	0	89	4	0	41	0	45	23	88	0	0	111	245
02:45 PM	0	0	0	0	0	0	99	4	0	103	4	0	33	0	37	23	93	0	0	116	256
Total	0	0	0	0	0	0	352	15	0	367	13	0	124	0	137	104	308	0	0	412	916
03:00 PM	0	0	0	0	0	0	131	1	0	132	4	0	27	0	31	25	101	0	0	126	289
03:15 PM	0	0	0	0	0	0	126	3	0	129	6	0	27	0	33	30	115	0	0	145	307
03:30 PM	0	0	0	0	0	0	107	2	0	109	5	0	43	0	48	18	137	0	0	155	312

KL Engineering, Inc.

5950 Seminole Centre Court, Suite 200
Madison, WI 53711

File Name : 23&WIAM
Site Code : 04210112
Start Date : 1/10/2006
Page No : 2

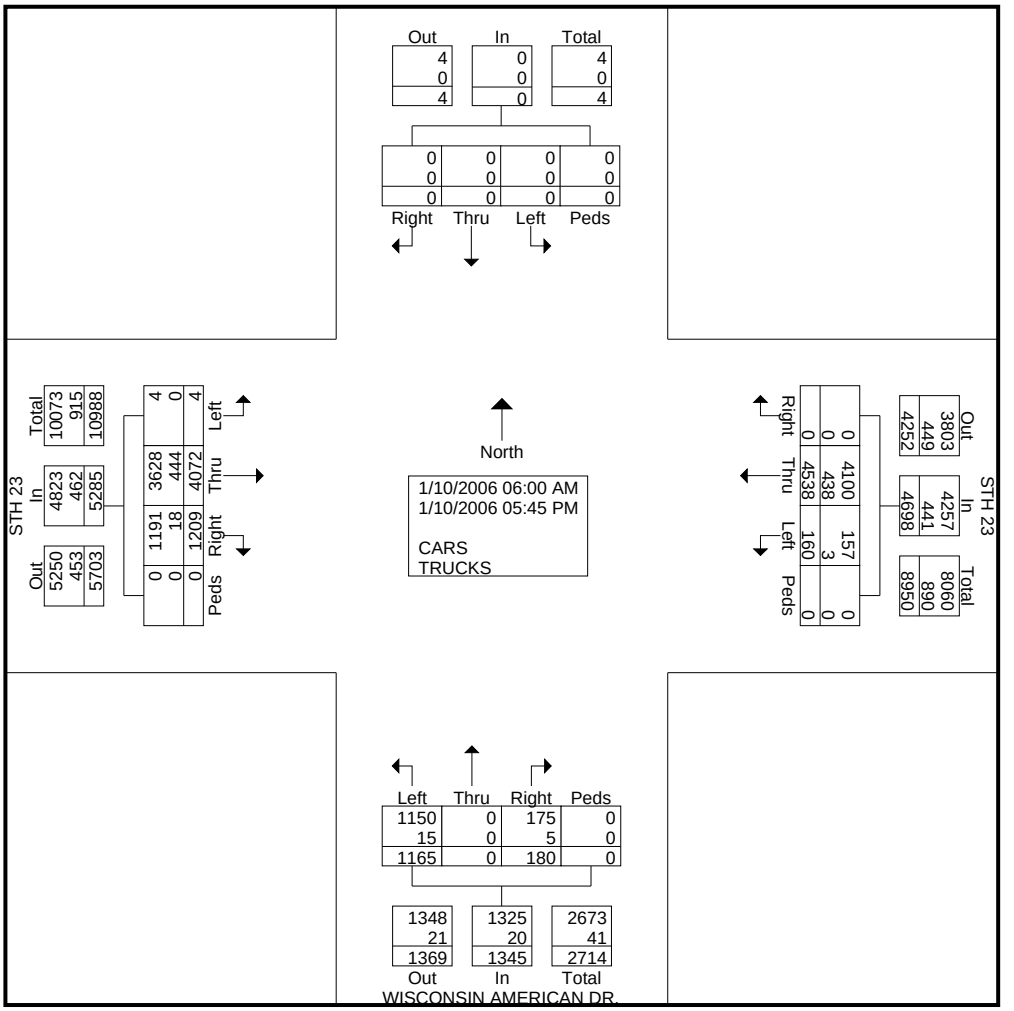
Groups Printed- CARS - TRUCKS

	From North					STH 23 From East					WISCONSIN AMERICAN DR. From South					STH 23 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
03:45 PM	0	0	0	0	0	0	99	3	0	102	5	0	35	0	40	30	124	3	0	157	299
Total	0	0	0	0	0	0	463	9	0	472	20	0	132	0	152	103	477	3	0	583	1207
04:00 PM	0	0	0	0	0	0	118	4	0	122	7	0	45	0	52	28	115	0	0	143	317
04:15 PM	0	0	0	0	0	0	114	8	0	122	9	0	43	0	52	10	144	0	0	154	328
04:30 PM	0	0	0	0	0	0	104	3	0	107	8	0	49	0	57	20	141	0	0	161	325
04:45 PM	0	0	0	0	0	0	105	2	0	107	2	0	36	0	38	18	125	0	0	143	288
Total	0	0	0	0	0	0	441	17	0	458	26	0	173	0	199	76	525	0	0	601	1258
05:00 PM	0	0	0	0	0	0	99	5	0	104	13	0	57	0	70	10	143	0	0	153	327
05:15 PM	0	0	0	0	0	0	81	4	0	85	8	0	20	0	28	11	117	0	0	128	241
05:30 PM	0	0	0	0	0	0	85	0	0	85	6	0	29	0	35	4	134	0	0	138	258
05:45 PM	0	0	0	0	0	0	104	0	0	104	1	0	9	0	10	2	117	0	0	119	233
Total	0	0	0	0	0	0	369	9	0	378	28	0	115	0	143	27	511	0	0	538	1059
Grand Total	0	0	0	0	0	0	4538	160	0	4698	180	0	1165	0	1345	1209	4072	4	0	5285	11328
Apprch %	0	0	0	0		0	96.6	3.4	0		13.4	0	86.6	0		22.9	77	0.1	0		
Total %	0	0	0	0	0	0	40.1	1.4	0	41.5	1.6	0	10.3	0	11.9	10.7	35.9	0	0	46.7	
CARS	0	0	0	0	0	0	4100	157	0	4257	175	0	1150	0	1325	1191	3628	4	0	4823	10405
% CARS	0	0	0	0	0	0	90.3	98.1	0	90.6	97.2	0	98.7	0	98.5	98.5	89.1	100	0	91.3	91.9
TRUCKS	0	0	0	0	0	0	438	3	0	441	5	0	15	0	20	18	444	0	0	462	923
% TRUCKS	0	0	0	0	0	0	9.7	1.9	0	9.4	2.8	0	1.3	0	1.5	1.5	10.9	0	0	8.7	8.1

KL Engineering, Inc.

5950 Seminole Centre Court, Suite 200
Madison, WI 53711

File Name : 23&WIAM
Site Code : 04210112
Start Date : 1/10/2006
Page No : 3

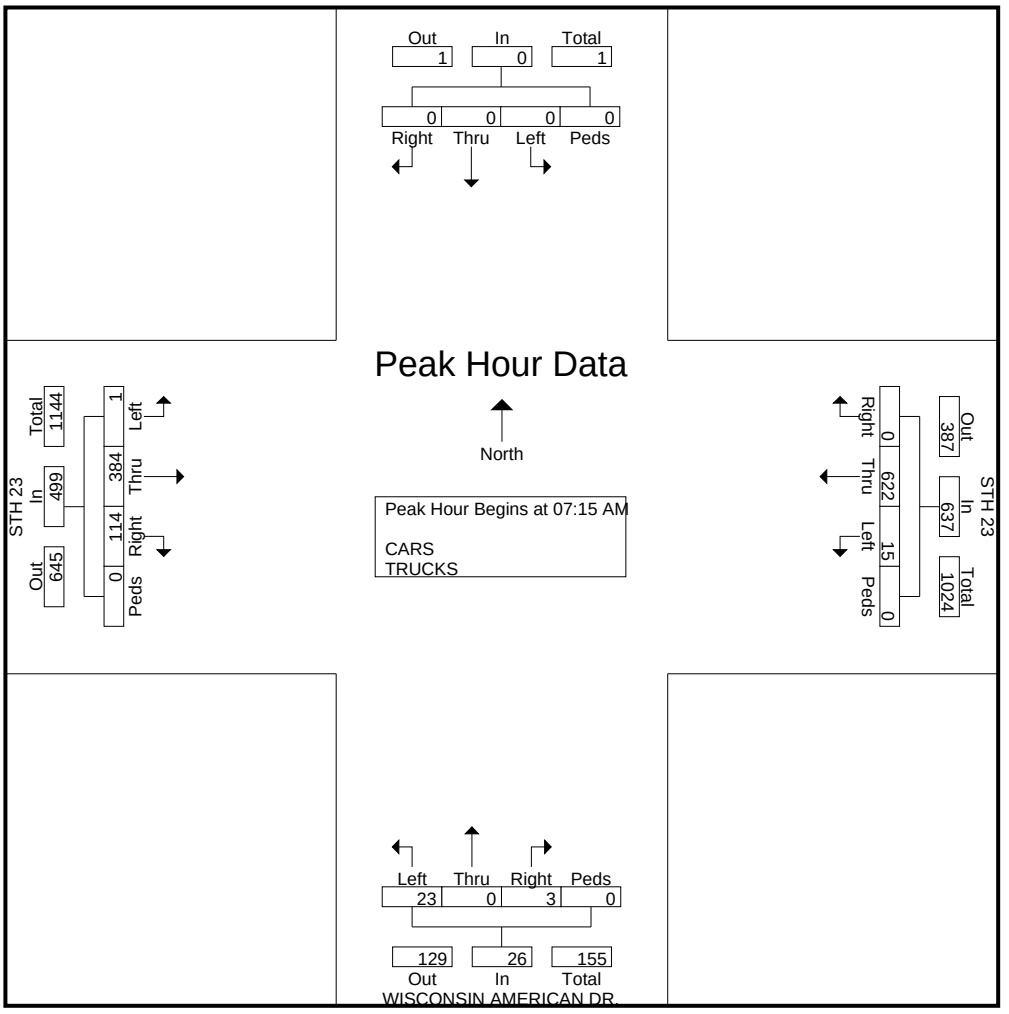


KL Engineering, Inc.

5950 Seminole Centre Court, Suite 200
Madison, WI 53711

File Name : 23&WIAM
Site Code : 04210112
Start Date : 1/10/2006
Page No : 4

	From North					STH 23 From East					WISCONSIN AMERICAN DR. From South					STH 23 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 09:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	0	0	0	0	0	0	168	3	0	171	0	0	7	0	7	22	78	0	0	100	278
07:30 AM	0	0	0	0	0	0	**180**	**4**		**184**	0	0	1	0	1	13	87	**1**			
07:45 AM	**0**	**0**	**0**	**0**	**0**	**0**	**171**	**4**	**0**	**175**	**1**	**0**	**7**	**0**	**8**	**49**	**134**	0	0	**183**	**366**
08:00 AM	0	0	0	0	0	0	103	4	0	107	**2**		**8**	0	**10**	30	85	0	0	115	232
Total Volume	0	0	0	0	0	0	622	15	0	637	3	0	23	0	26	114	384	1	0	499	1162
% App. Total	0	0	0	0		0	97.6	2.4	0		11.5	0	88.5	0		22.8	77	0.2	0		
PHF	.000	.000	.000	.000	.000	.000	.864	.938	.000	.865	.375	.000	.719	.000	.650	.582	.716	.250	.000	.682	.794

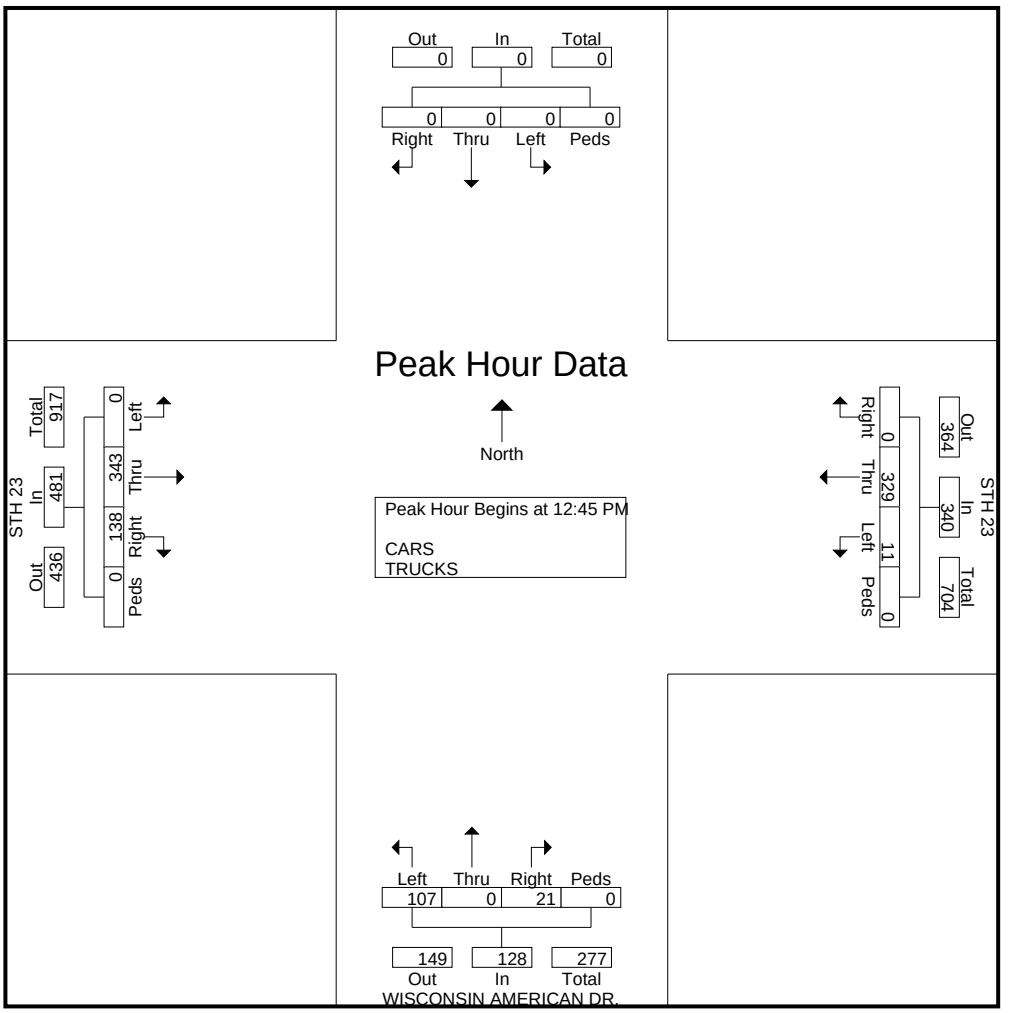


KL Engineering, Inc.

5950 Seminole Centre Court, Suite 200
Madison, WI 53711

File Name : 23&WIAM
Site Code : 04210112
Start Date : 1/10/2006
Page No : 5

	From North					STH 23 From East					WISCONSIN AMERICAN DR. From South					STH 23 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 10:00 AM to 01:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 12:45 PM																					
12:45 PM	0	0	0	0	0	0	**96**			**98**	6	0	22	0	28	**38**					**244**
01:00 PM	0	0	0	0	0	0	76	3	0	79	3	0	23	0	26	31	82	0	0	113	218
01:15 PM	0	0	0	0	0	0	80	**4**			**7**						**92**	0	0	**126**	244
01:30 PM	0	0	0	0	0	0	77	2	0	79	5	0	**35**	0	**40**	35	89	0	0	124	243
Total Volume	0	0	0	0	0	0	329	11	0	340	21	0	107	0	128	138	343	0	0	481	949
% App. Total	0	0	0	0		0	96.8	3.2	0		16.4	0	83.6	0		28.7	71.3	0	0		
PHF	.000	.000	.000	.000	.000	.000	.857	.688	.000	.867	.750	.000	.764	.000	.800	.908	.932	.000	.000	.954	.972

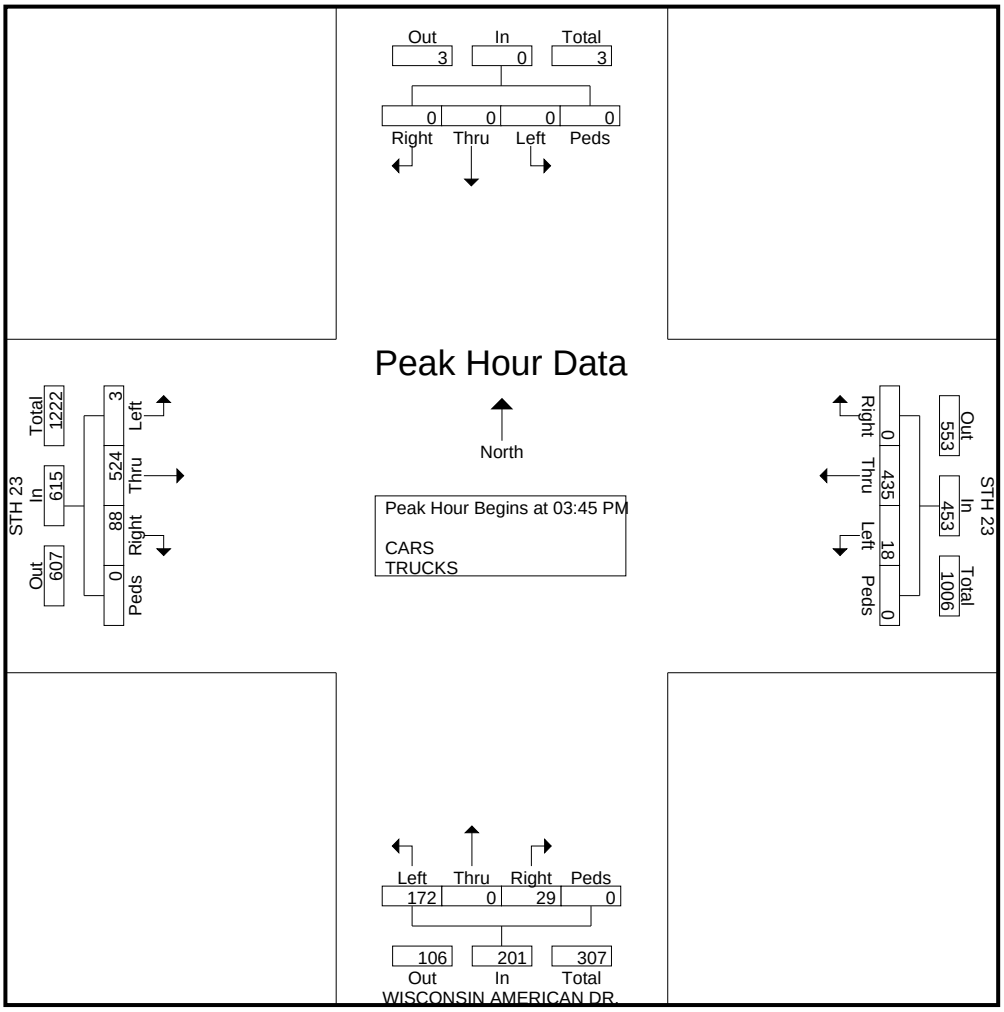


KL Engineering, Inc.

5950 Seminole Centre Court, Suite 200
Madison, WI 53711

File Name : 23&WIAM
Site Code : 04210112
Start Date : 1/10/2006
Page No : 6

	From North					STH 23 From East					WISCONSIN AMERICAN DR. From South					STH 23 From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 02:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 03:45 PM																					
03:45 PM	0	0	0	0	0	0	99	3	0	102	5	0	35	0	40	**30**		**3**			
04:00 PM	**0**	**0**	**0**	**0**	**0**	**0**	**118**	**4**	**0**	**122**	7	0	45	0	52	28	115	0	0	143	317
04:15 PM	0	0	0	0	0	0	114	**8**			**9**						**144**	0	0	154	**328**
04:30 PM	0	0	0	0	0	0	104	3	0	107	8	0	**49**	0	**57**	20	141	0	0	**161**	325
Total Volume	0	0	0	0	0	0	435	18	0	453	29	0	172	0	201	88	524	3	0	615	1269
% App. Total	0	0	0	0		0	96	4	0		14.4	0	85.6	0		14.3	85.2	0.5	0		
PHF	.000	.000	.000	.000	.000	.000	.922	.563	.000	.928	.806	.000	.878	.000	.882	.733	.910	.250	.000	.955	.967



WisDot Bureau of State Highway Programs
Traffic Forecasting Section
Analyst: Bill Gavinski
Phone: (608) 266-3976
Email: william.gavinski@dot.state.wi.us

Projected AADT Traffic Volumes

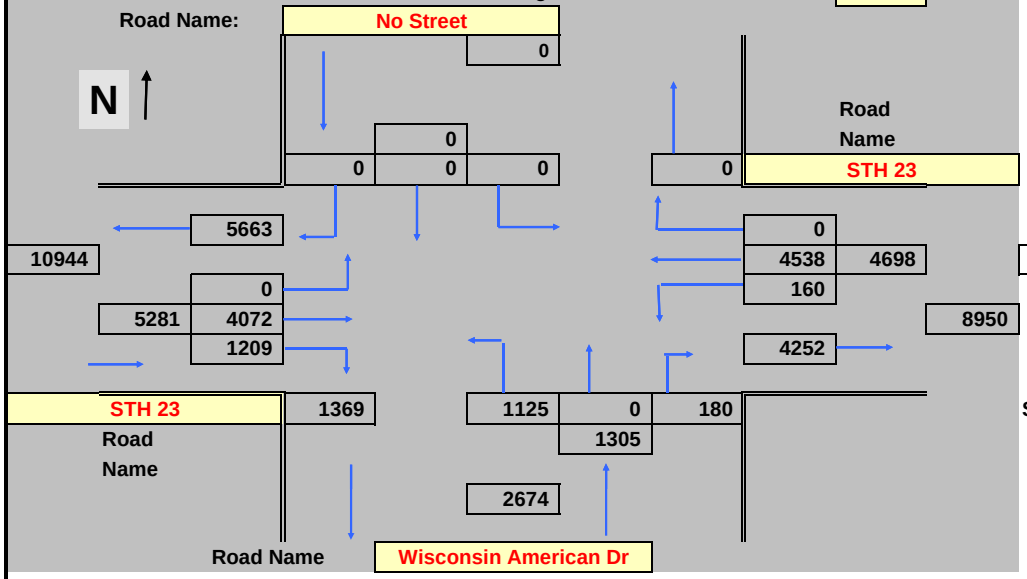
Project Description

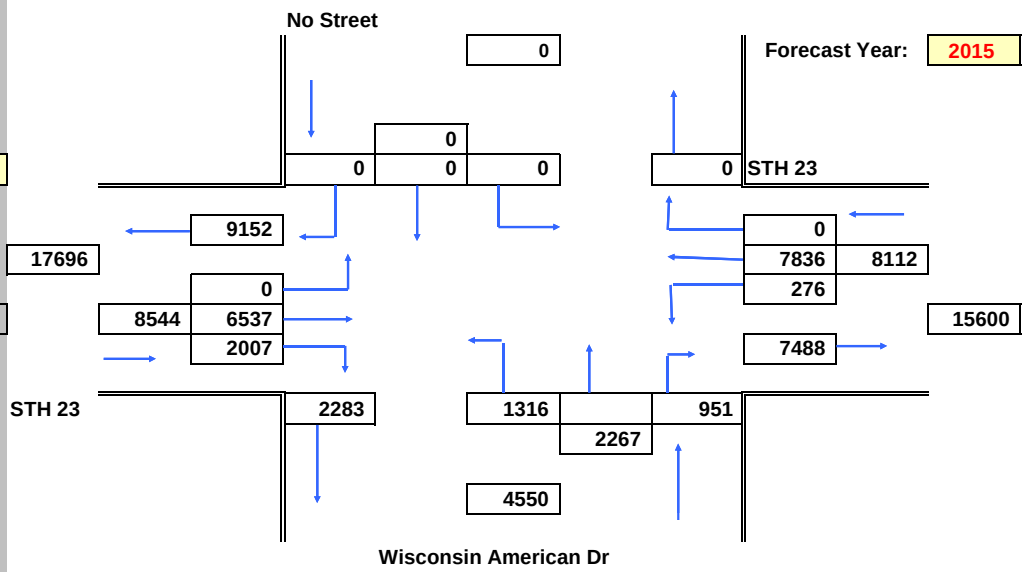
Project ID: 1440-13-00
Location: USH 151 to CTH "UU"

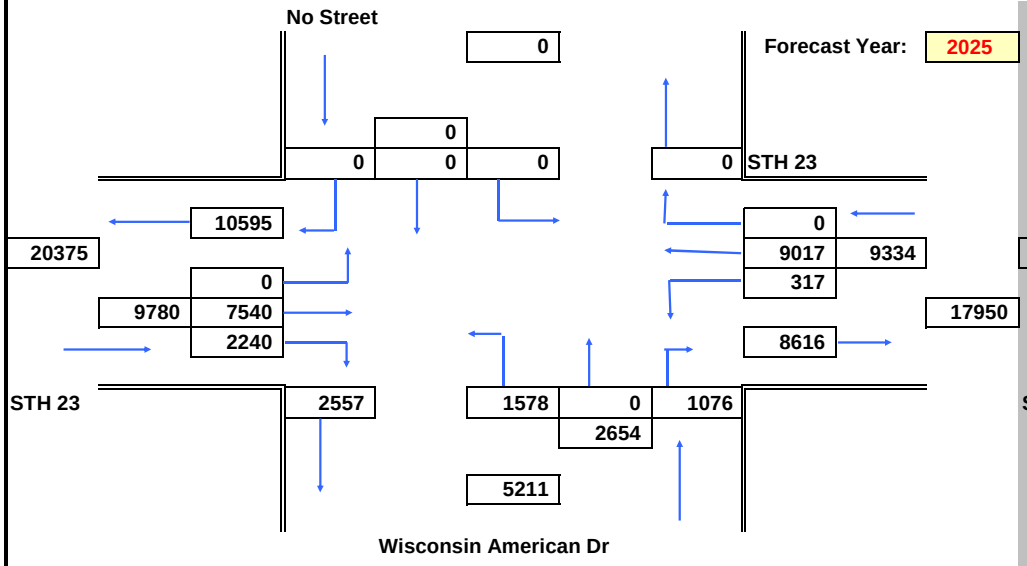
Route: STH 23
County: Fond du Lac

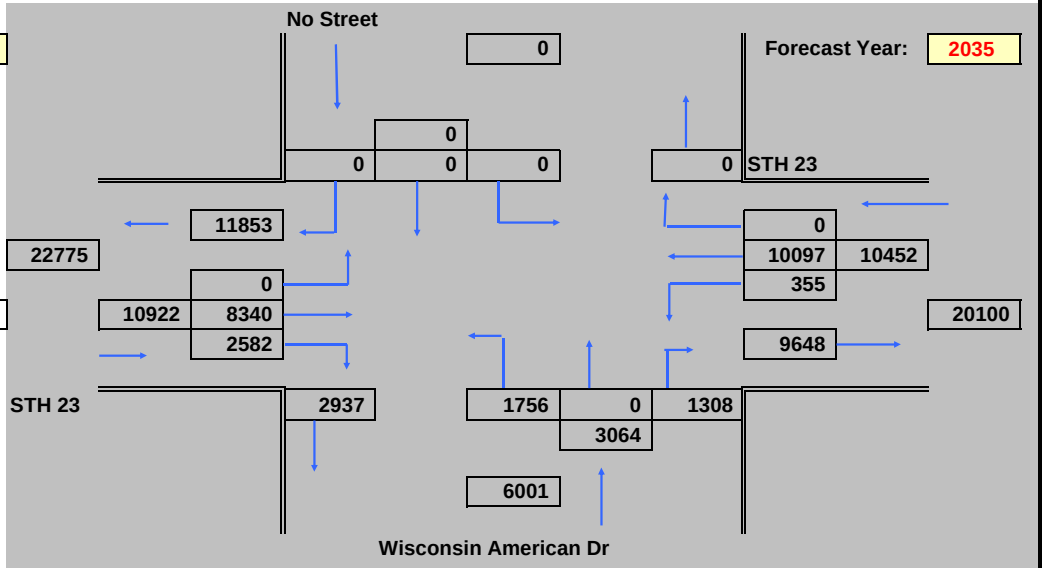
Forecast Completed: 02-20-06

Turning Movement Data - Year: 2004









WisDot Bureau of State Highway Programs
Traffic Forecasting Section
Developed by Bill Gavinski
Phone: (608) 266-3976
Email: william.gavinski@dot.state.wi.us

Projected PM Design Hour Traffic Volumes

Design Hour: 4 - 5 p.m.

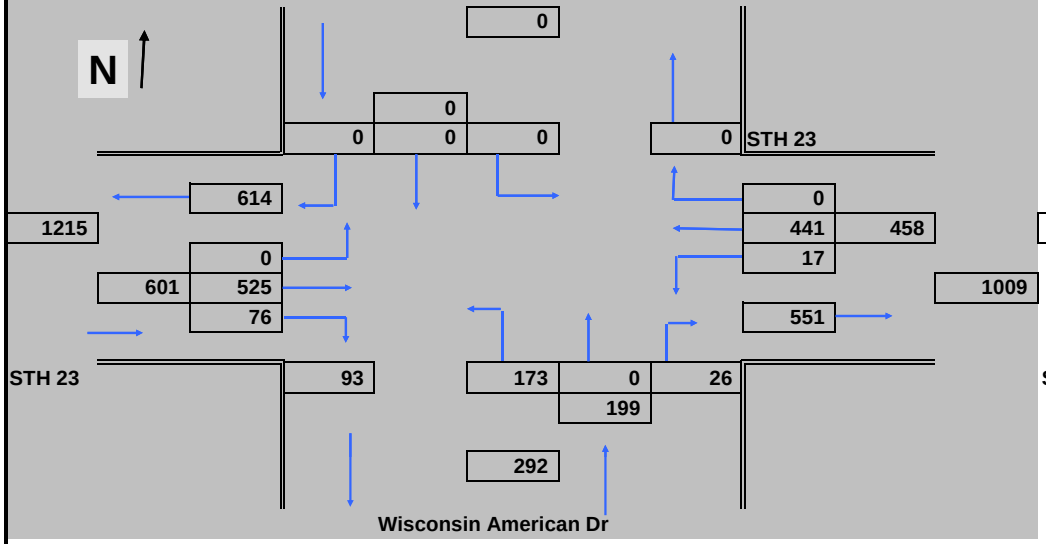
Forecast Completed: 02-15-06

Project Description

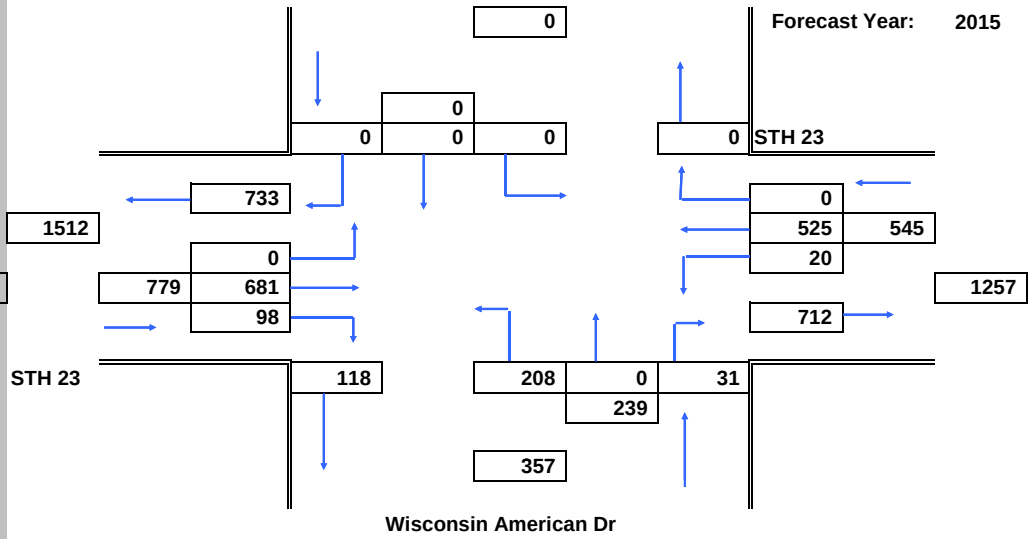
Project ID: 1440-13-00
Location: USH 151 to CTH "UU"

Route: STH 23
County: Fond du Lac

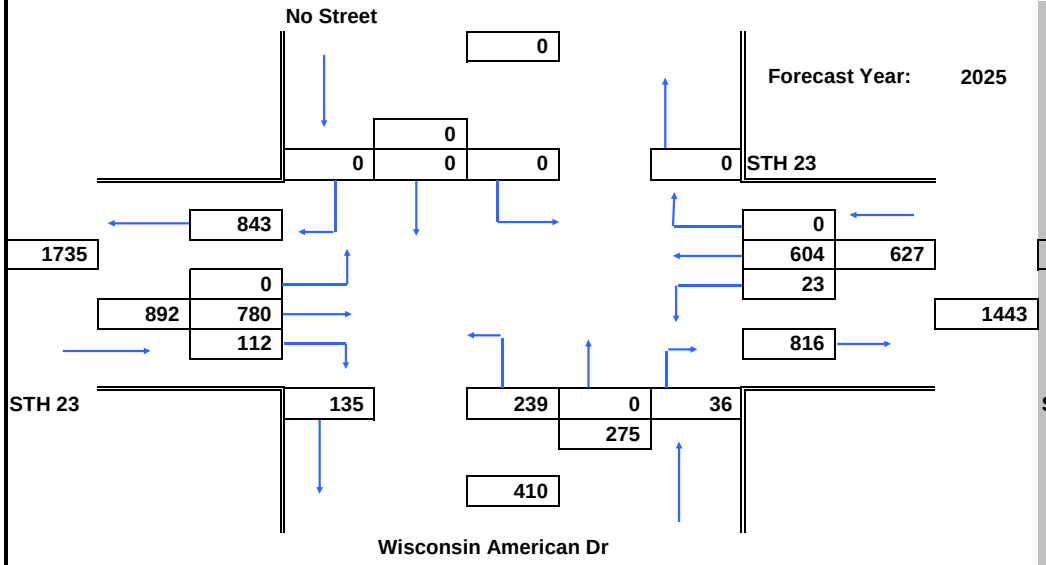
Design Hour Turning Movement Data — Year: 2006



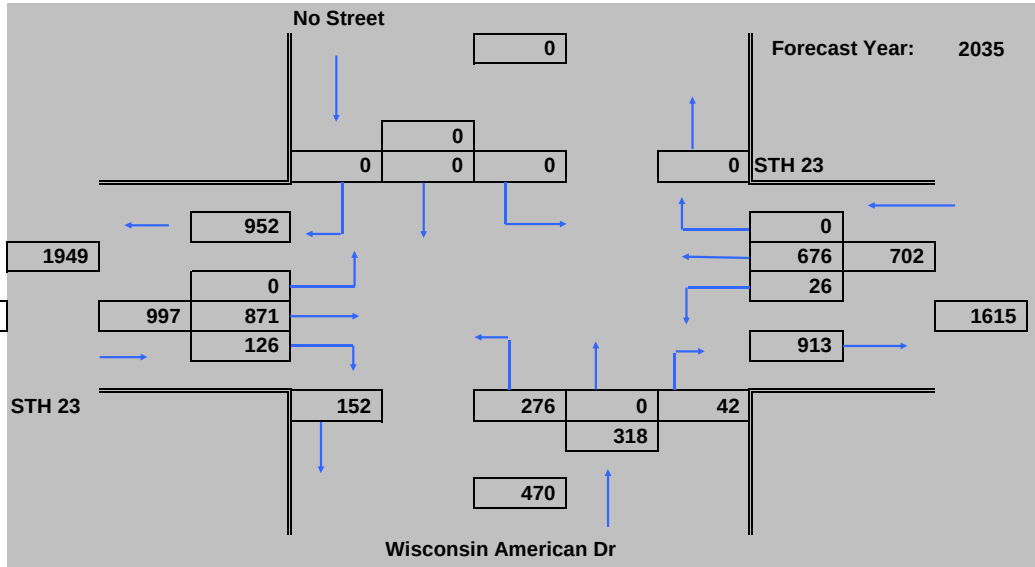
Forecast Year: 2015



Forecast Year: 2025



Forecast Year: 2035



2035 Projected AM Design Hour Traffic Volumes

Mary Greuel
KL Engineering

Design Hour: 7:15 - 8:15 AM

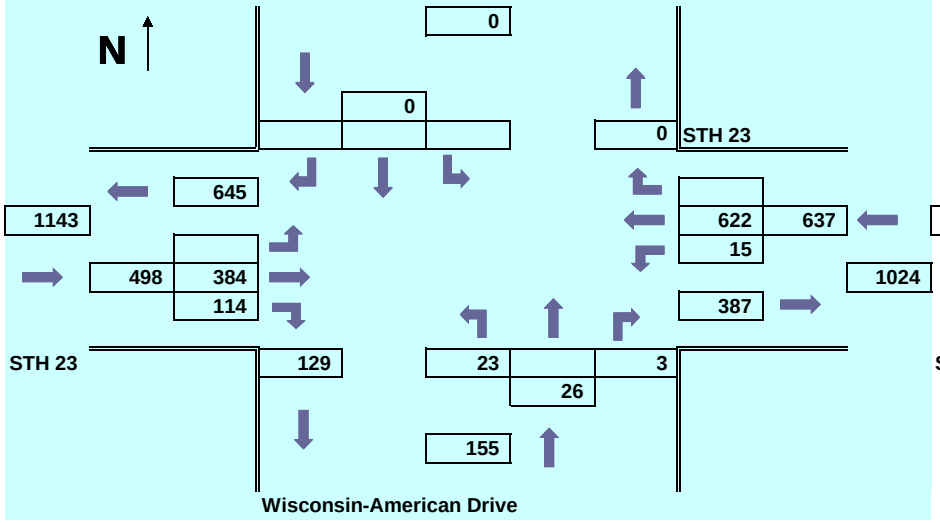
Project Description

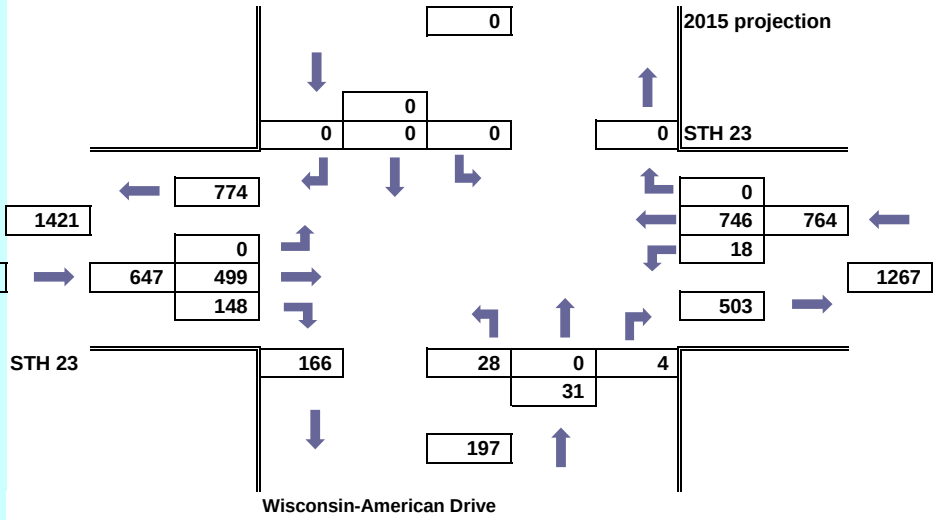
STH 23 and Wisconsin-American Drive
Location: Fond du Lac

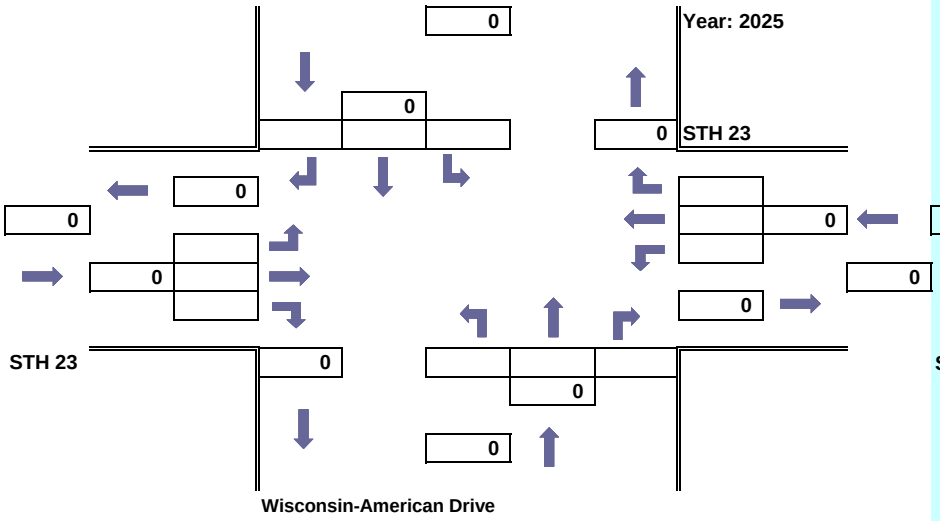
Fond du Lac County, WI

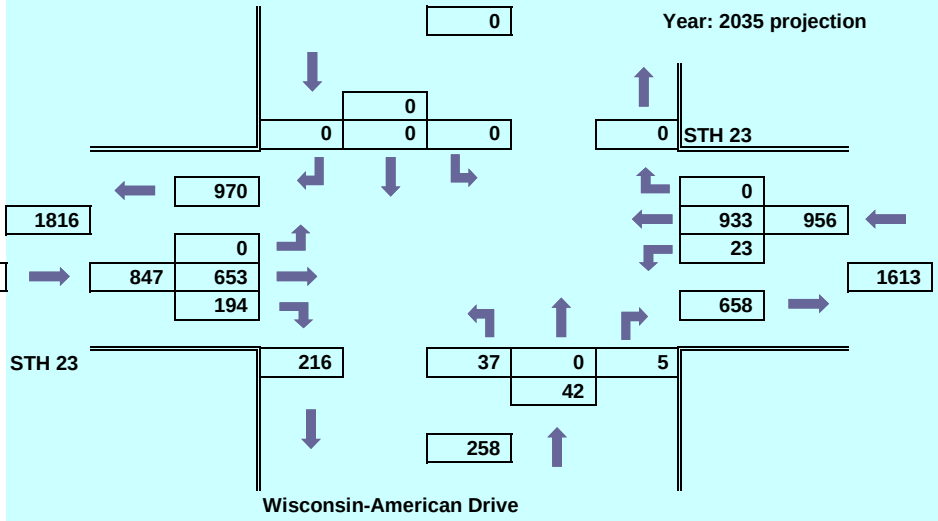
Design Hour Turning Movement Data

Year: 2006 Count









Appendix D

Traffic Signal Warrants

Instructions for Completing Warrant Analysis Worksheets

These worksheets contain several fields. It is important to keep in mind the following when entering information in these fields so as to obtain an easy to read final product.

When entering hours relating to which hour meets warrants or describing which hours are used to compare against the warrants, you should not enter the time as 1-2 pm. Rather, the time should be entered as military time (13:00). The assumption is that the one-hour interval begins at 13:00. The reason for this discussion is that there is limited size in the fields that are needed to put the form together. If you input data into the field and extend it outside the limits of the table cell some of the data will be cut off.

Some portions of the worksheet are set up so that values are filled in automatically. If a field does not update properly when a change is made to the source information, you may need to manually enter the information in that particular field. In addition, the worksheet has been set up to automatically update all fields before printing, so if there are fields that you see not updating, please print the document and it will automatically update all of the fields within the worksheet. You will notice that the Warrant Evaluation Summary on the page immediately following this instruction page appears blank to the right of each warrant. There are imbedded fields located here that will only be visible during a print preview or on a hard copy (printed document). These fields are tied to dropdowns located within the document for each signal warrant.

Adding Hours and Volumes to the 8 Highest Hours Table

When entering data into this table it is critical that it is **NOT** entered chronologically, but rather with the **highest volume hour in the first column, the second highest volume hour in the second column** and so forth across the table. This is because the information entered into the first four columns is then used for the Four Hour Warrant table and the Peak Hour Warrant uses the first column of data.

Plotting data for Four Hour, Peak Hour Volume Pedestrian Volume and Intersection Near Grade Crossing Warrants

Plot the points manually after printing out the Worksheets. Following this process eliminates the need to play with the form protections.

Wisconsin Department of Transportation
Traffic Signal Warrant Summary Worksheet

70% RURAL

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:

Intersection: STH 23 and Wisconsin American Drive Date: 02-23-2012

County: Fond du Lac

Town
Village
City Fond du Lac

Major Street	STH 23	Critical Approach Speed	45	Lanes	2
Minor Street	General American Drive	Critical Approach Speed	25	Lanes	1

Note: The warrants for rural areas (70% of urban warrant) are used when the 85% speed on the major street exceeds 40 m.p.h. or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

THE ANALYSIS IS BASED ON COUNTS CONDUCTED ON 2012 [+] & , 20 , , FROM 6:00 AM PM TO 6:00 AM PM

DATES DAYS

% Right Turns Included

Warrant Evaluation Summary		**YES/NO/NOT EVALUATED**
Warrant 1	**Eight-Hour Vehicular Volume**	Yes
Condition A	Minimum Vehicular Volume	Yes
Condition B	Interruption of Continuous Traffic	No
Condition C	Combination: 80% of A and B	N/A
Warrant 2	**Four-Hour Volume**	Yes
Warrant 3	**Peak Hour Volume**	N/A
Warrant 4	**Pedestrian Volume**	N/A
Criterion A	Four-Hour	N/A
Criterion B	Peak Hour	N/A
Warrant 5	**School Crossing**	N/A
Warrant 6	**Coordinated Signal System**	N/A
Warrant 7	**Crash Experience**	N/A
Warrant 8	**Roadway Network**	N/A
Warrant 9	**Intersection Near A Grade Crossing**	N/A

This analysis was conducted by:

Mary Greuel
(Name)

KL Engineering
(Agency)

02-23-2012
(Date)

TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET

Intersection: STH 23 and Wisconsin American Drive Date: 02-23-2012
County: Fond du Lac

Town
Village
City Fond du Lac

Major Street STH 23 Critical Approach Speed 45 Lanes 2
Minor Street General American Drive Critical Approach Speed 25 Lanes 1

Volume Level

1. Critical speed of major road traffic > 40 mph : Yes ☑ No ☐
2. In built-up area of isolated community of < 10,000 pop.: Yes ☐ No ☑

If Question 1 or 2 above is answered "Yes" then use "70%" volume level: 70% ☑ 100% ☐

WARRANT 1 – Eight-Hour Vehicular Volume

Warrant is satisfied if Condition A or B is "100 % satisfied." Warrant also satisfied if Condition C (80% of A and B) is satisfied.

8 Highest Hours								
Hour	16:00	15:00	1035	13:00	14:00	12:00	11:00	10:00
Major Road Both App. vph	1142	1101	1035	800	781	748	680	584
Minor Road High App. vph	195	149	130	115	140	115	160	146

Record hours where condition is met and the corresponding volumes in boxes provided. Condition is 100% satisfied if the minimum volumes are met for eight hours.

Condition A – Minimum Vehicular Volume

(volumes in veh/h)	Minimum Requirements (80% Shown in Brackets)			
Approach Lanes:	1		2 or more	
Volume Level:	100%	Hours	100%	Hours
Major Road-Both Approaches	**350**		**420**	8
	(280)		**(336)**	8
Minor Road-Highest Approach	**105**	8	**140**	
	(84)	8	**(112)**	

100% Satisfied: Yes
80 % Satisfied: Yes

Condition B – Interruption of Continuous Traffic

(volumes in veh/h)	Minimum Requirements (80% Shown in Brackets)			
Approach Lanes:	1		2 or more	
Volume Level:	100%	Hours	100%	Hours
Major Road-Both Approaches	**525**		**630**	7
	(420)		**(504)**	8
Minor Road-Highest Approach	**53**	8	**70**	
	(42)	8	**(56)**	

100% Satisfied: No
80 % Satisfied: Yes

Condition C – Combination of Condition A and B: Condition A and B Both 80% Satisfied?:

Warrant Satisfied?: Yes

% Right Turns Included: 0%

TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET

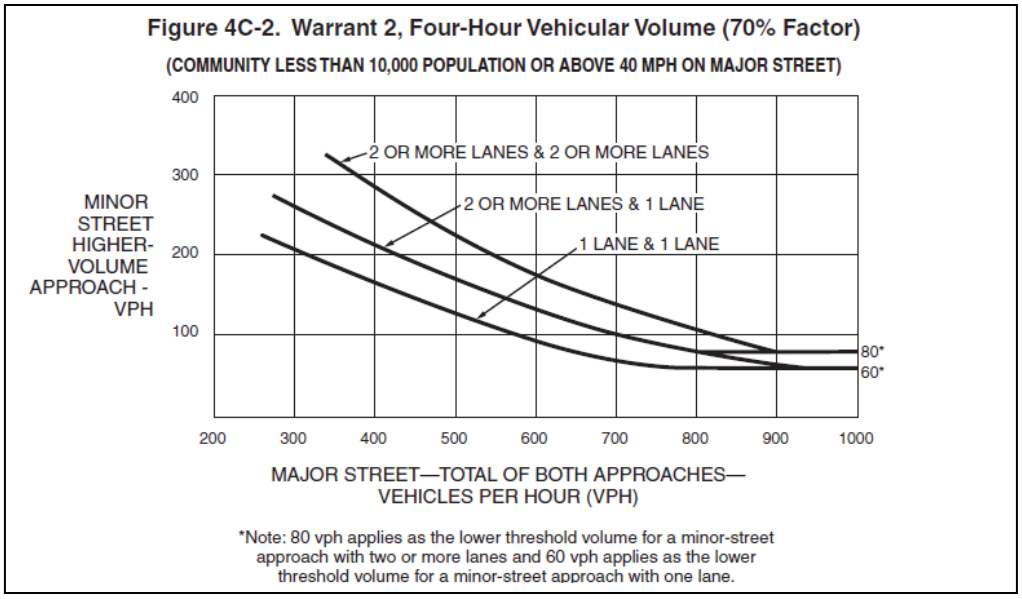
Warrant 2 – Four-Hour Vehicular Volume

Plot four volume combinations on the applicable figure below. If four points lie above the appropriate line, then the warrant is satisfied.

Figure A. Criteria for "70%" volume level.

Hour	16:00	15:00	1035	13:00
Major Vol.	1142	1101	1035	800
Minor Vol.	195	149	130	115

Satisfied?: Yes



Warrant 3 – Peak Hour

Unusual condition justifying use of warrant: _____

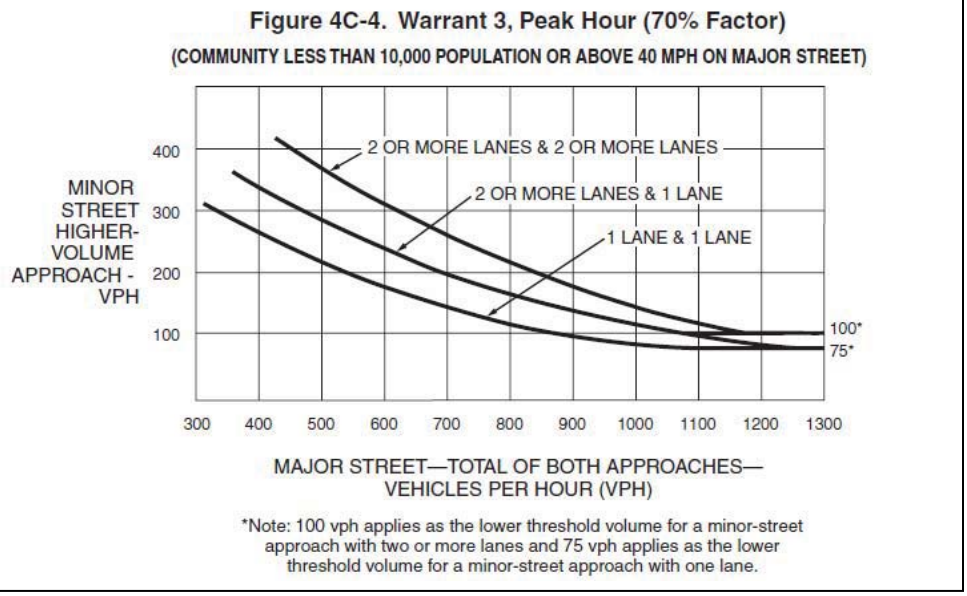
Record hour where criteria are fulfilled and the corresponding delay or volume in boxes provided. Plot the peak hour volume combination on the applicable figure below. If all three criteria are fulfilled or the plotted point lies above the appropriate line, then the warrant is satisfied.

Criteria	Approach Lanes		No. of Approaches		Hour	Fulfilled?	
	1	2	3	4		Yes	No
1. Delay on Minor Approach (veh/h)	4	5				☐	☐
2. Volume on Minor Approach (veh/h)	100	150				☐	☐
3. Total Entering Volume (veh/h)			650	800		☐	☐

Figure A. Criteria for "70%" volume level.

Hour	16:00
Major Vol.	1142
Minor Vol.	195

Satisfied?: N/A



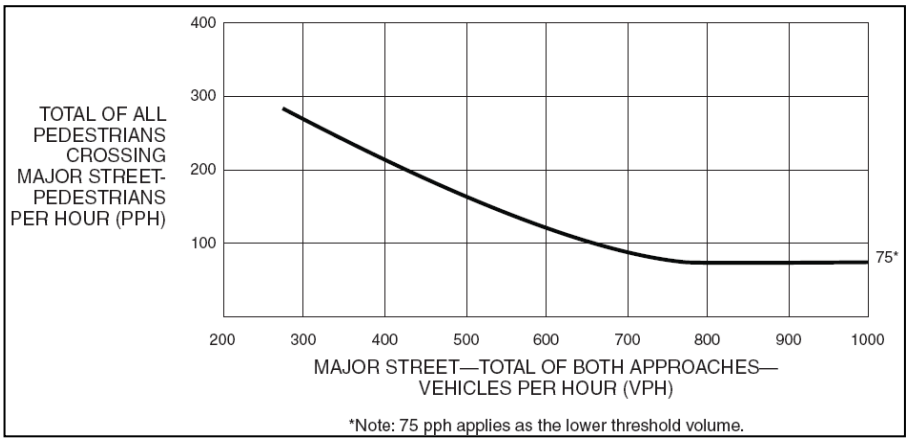
TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET

Warrant 4 – Pedestrian Volume

Plot four volume combinations on the applicable figure below.

Criterion A

Hour				
Major Vol.				
Pedestrian Vol.				

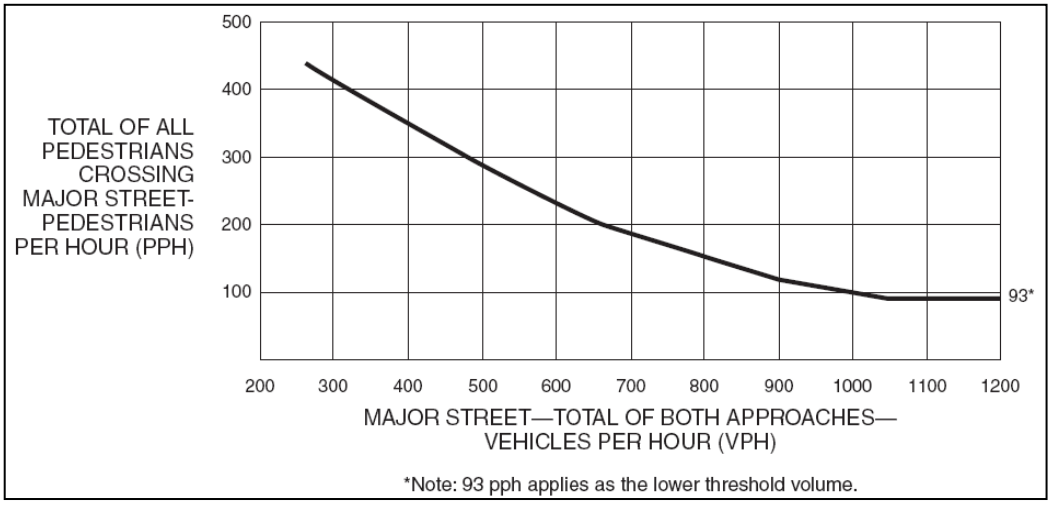


Criterion A Satisfied?: N/A

Criterion B

Plot the peak hour volume combination on the applicable figure below.

Hour	
Major Vol.	
Pedestrian Vol.	



Criterion B Satisfied?:
N/A

Warrant Satisfied?:
N/A

Warrant 5 – School Crossing

Record hours where criteria are fulfilled and the corresponding volume or gap frequency in the boxes provided.
The warrant is satisfied if all three of the criteria are fulfilled.

Criteria	Fulfilled?	
	Yes	No
1. There are a minimum of **20** school children during the highest crossing hour.	☐	☐
2. There are fewer adequate gaps in the major road traffic stream during the period when the school children are using the crossing than the number of minutes in the same period.	☐	☐
3. The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	☐	☐

Satisfied?: N/A

TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET

Warrant 6 – Coordinated Signal System

Indicate if the criteria are fulfilled in the boxes provided. The warrant is satisfied if either criterion is fulfilled. This warrant should not be applied when the resulting signal spacing would be less than 1000 ft.

Criteria	Fulfilled? Yes	Fulfilled? No
1. On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	☐	☐
2. On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed and adjacent signals will collectively provide a progressive operation.	☐	☐

Satisfied?: N/A

Warrant 7 – Crash Experience

The warrant is satisfied if all three of the criteria are fulfilled.

Criteria (Must use 80% - Urban - Condition Warrant Volume Levels)		Met? Yes	Met? No	Fulfilled? Yes	Fulfilled? No
A. Adequate trial of other remedial measures has failed to reduce crash frequency.	Measures tried:			☐	☐
B. Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12-mo period.	Number of crashes per 12 months:			☐	☐
C. One of the warrants to the right is met.	Warrant 1, Condition A (80% satisfied from Table 1 above)	☐	☐	☐	☐
	Warrant 1, Condition B (80% satisfied from Table 1 above)	☐	☐		
	Warrant 4, Criterion A (80% satisfied above)	☐	☐		
	Warrant 4, Criterion B (80% satisfied above)	☐	☐		

Table 1: 80% Volume Comparison Criteria for Warrant 1

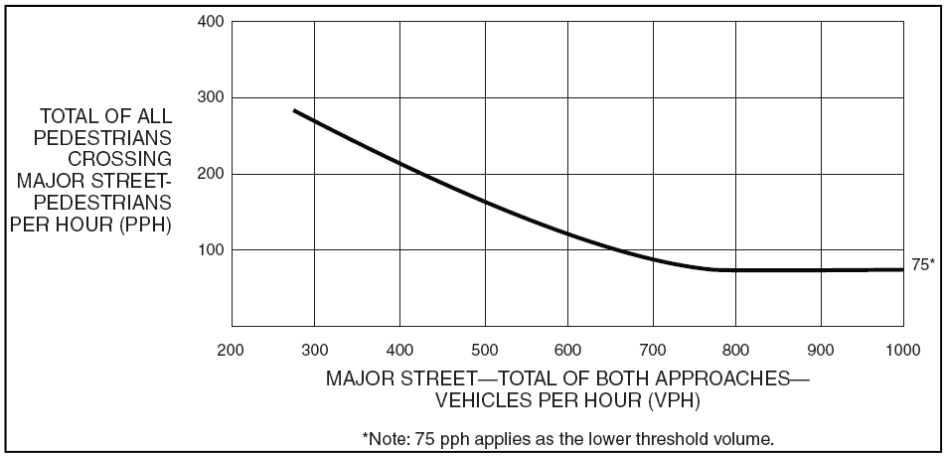
(Volumes in veh/h)		Minimum Requirements			
Approach Lanes:		**1**		**2 or more**	
Volume Level:		80%	Hours	80%	Hours
Major Road Both App. vph	1A	**280**		**336**	
	1B	**420**		**504**	
Minor Road High App. vph	1A	**84**		**112**	
	1B	**42**		**56**	

TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET

Criterion 4A

Plot four volume combinations on the applicable figure below. Draw vertical line for each of the four major road volumes. Where this line meets the graphed line, draw horizontal line to determine the minimum pedestrian volume to meet the warrant for this major road volume. Enter that value as the "Graph Ped. Volume." Multiply the "Graph Ped. Volume" by 0.8. Enter this new value as the "80% of Graphed Ped. Volume." If your actual "Pedestrian Volume" value exceeds the "80% of Graphed Ped. Volume" for each of the four hours, the 80% warrant is met.

Hour				
Major Vol.				
Ped.Vol.				
Graphed Ped. Vol.				
80% of Graphed Ped. Vol.				



Criterion A Satisfied?:

N/A

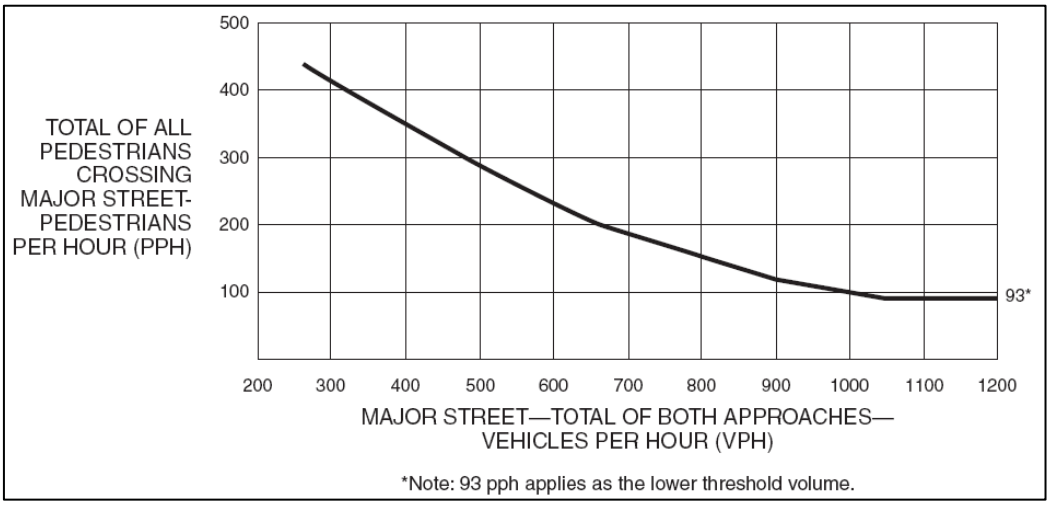
Warrant Satisfied?:

N/A

Criterion 4B

Plot and establish the pedestrian volumes for the peak hour as explained in Criterion 4A.

Hour	
Major Vol.	
Ped.Vol.	
Graph Ped. Volume	
80% of Graphed Ped Volume	



Criterion B Satisfied?:

N/A

Warrant Satisfied?:

N/A

TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET

Warrant 8 – Roadway Network

Record hours where criteria are fulfilled, the corresponding volume, and other information in the boxes provided. The warrant is satisfied if at least one of the criteria is fulfilled and if all intersecting routes have one or more of the characteristics listed.

Criteria			Met? Yes	Met? No	Fulfilled? Yes	Fulfilled? No
1. Both of the criteria to the right are met.	a. Total entering volume of at least **1,000 veh/h** during typical weekday peak hour.	Entering volume:	☐	☐	☐	☐
	b. Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.	Warrant(s) satisfied:	☐	☐		
2. Total entering volume at least **1,000 veh/h** for each of any 5 hrs of a non-normal business day (Sat. or Sun.)					☐	☐

Characteristics of Major Routes	Fulfilled? Yes	Fulfilled? No
1. Part of the road or highway system that serves as the principal roadway network for through traffic flow.	☐	☐
2. Rural or suburban highway outside of, entering, or traversing a city.	☐	☐
3. Appears as a major route on an official plan.	☐	☐

Warrant Satisfied?: N/A

Warrant 9 – Intersection Near a Grade Crossing

Plot the peak hour volume combination on the applicable figure below. Use curve for D (where D = Clear Storage Distance as defined in 1A.13) that is nearest to the actual distance.

Hour	16:00
Major Vol.	1142
Minor Vol.	195
Adjusted Minor Vol.	

Adjustment Factors Applied	
Rail Traffic	
% Buses	
% Trucks	

Adjustment Factor for Daily Frequency of Rail Traffic

Rail Traffic per Day	Adjustment Factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

Adjustment Factor for Percentage of High-Occupancy Buses

% of High-Occupancy Buses* on Minor-Street Approach	Adjustment Factor
0%	1.00
2%	1.09
4%	1.19
6% or more	1.32

* A high-occupancy bus is defined as a bus occupied by at least 20 people.

Adjustment Factor for Percentage of Tractor-Trailer Trucks

% of Tractor-Trailer Trucks on Minor-Street Approach	Adjustment Factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% to 7.5%	0.75	0.75
7.6% to 12.5%	1.00	1.00
12.6% to 17.5%	2.30	1.15
17.6% to 22.5%	2.70	1.35
22.6% to 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

TRAFFIC SIGNAL WARRANT ANALYSIS WORKSHEET

Figure 4C-9 – One Approach Lane at the Track Crossing

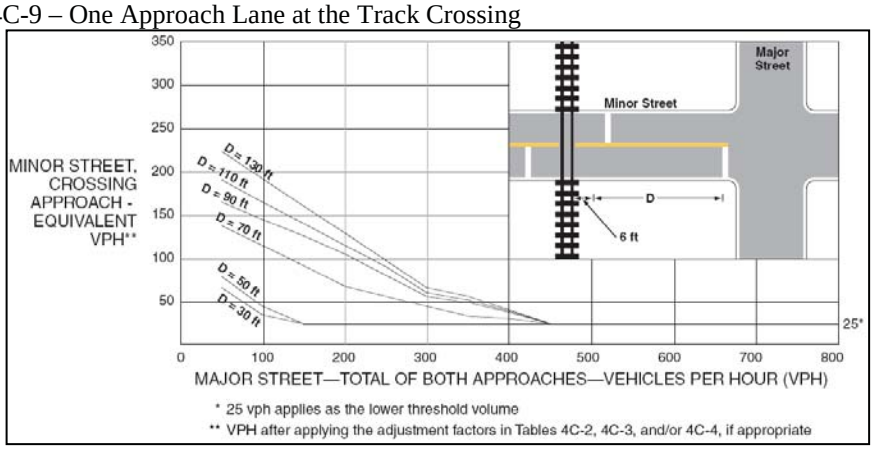
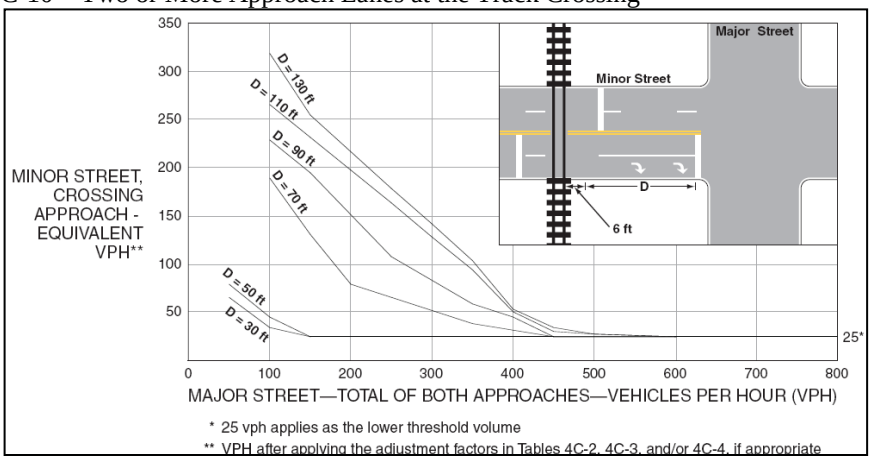


Figure 4C-10 – Two or More Approach Lanes at the Track Crossing



Warrant Satisfied?: N/A

CONCLUSIONS:

Warrant 1A (Minimum Vehicular Volume) and warrant 1C (Combination of condition A and B) as well as Warrant 2 (Four Hour Volume) are met for the installation of a traffic signal. No other warrants were evaluated.

Appendix E

Operational Modeling Output

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	499	148	18	746	28	4
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	542	161	20	811	30	4
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1038					
pX, platoon unblocked						
vC, conflicting volume			703		987	271
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			703		987	271
tC, single (s)			4.3		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			98		87	99
cM capacity (veh/h)			839		239	727

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	271	271	161	20	405	405	30	4
Volume Left	0	0	0	20	0	0	30	0
Volume Right	0	0	161	0	0	0	0	4
cSH	1700	1700	1700	839	1700	1700	239	727
Volume to Capacity	0.16	0.16	0.09	0.02	0.24	0.24	0.13	0.01
Queue Length 95th (ft)	0	0	0	2	0	0	11	0
Control Delay (s)	0.0	0.0	0.0	9.4	0.0	0.0	22.3	10.0
Lane LOS				A			C	A
Approach Delay (s)	0.0			0.2			20.7	
Approach LOS							C	

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	681	98	20	525	208	31
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	702	101	21	541	214	32
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1038					
pX, platoon unblocked						
vC, conflicting volume			803		1014	351
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			803		1014	351
tC, single (s)			4.3		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			97		6	95
cM capacity (veh/h)			767		229	645

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	351	351	101	21	271	271	214	32
Volume Left	0	0	0	21	0	0	214	0
Volume Right	0	0	101	0	0	0	0	32
cSH	1700	1700	1700	767	1700	1700	229	645
Volume to Capacity	0.21	0.21	0.06	0.03	0.16	0.16	0.94	0.05
Queue Length 95th (ft)	0	0	0	2	0	0	203	4
Control Delay (s)	0.0	0.0	0.0	9.8	0.0	0.0	89.6	10.9
Lane LOS				A			F	B
Approach Delay (s)	0.0			0.4			79.4	
Approach LOS							F	

Intersection Summary			
Average Delay	12.3		
Intersection Capacity Utilization	37.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	653	194	23	933	37	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	710	211	25	1014	40	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1038					
pX, platoon unblocked						
vC, conflicting volume			921		1267	355
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			921		1267	355
tC, single (s)			4.3		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			96		74	99
cM capacity (veh/h)			689		155	641

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	355	355	211	25	507	507	40	5
Volume Left	0	0	0	25	0	0	40	0
Volume Right	0	0	211	0	0	0	0	5
cSH	1700	1700	1700	689	1700	1700	155	641
Volume to Capacity	0.21	0.21	0.12	0.04	0.30	0.30	0.26	0.01
Queue Length 95th (ft)	0	0	0	3	0	0	25	1
Control Delay (s)	0.0	0.0	0.0	10.4	0.0	0.0	36.2	10.7
Lane LOS				B			E	B
Approach Delay (s)	0.0			0.3			33.2	
Approach LOS							D	

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	35.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	871	126	26	676	276	42
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	898	130	27	697	285	43
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	1038					
pX, platoon unblocked			0.97		0.97	0.97
vC, conflicting volume			1028		1300	449
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			967		1247	370
tC, single (s)			4.3		6.8	6.9
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			96		0	93
cM capacity (veh/h)			641		154	608

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	WB 3	NB 1	NB 2
Volume Total	449	449	130	27	348	348	285	43
Volume Left	0	0	0	27	0	0	285	0
Volume Right	0	0	130	0	0	0	0	43
cSH	1700	1700	1700	641	1700	1700	154	608
Volume to Capacity	0.26	0.26	0.08	0.04	0.20	0.20	1.85	0.07
Queue Length 95th (ft)	0	0	0	3	0	0	534	6
Control Delay (s)	0.0	0.0	0.0	10.9	0.0	0.0	456.5	11.4
Lane LOS				B			F	B
Approach Delay (s)	0.0			0.4			397.7	
Approach LOS							F	

Intersection Summary			
Average Delay	62.8		
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	499	148	18	746	28	4
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0	7.0	5.0	5.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3282	1468	1641	3282	1770	1583
Flt Permitted	1.00	1.00	0.45	1.00	0.95	1.00
Satd. Flow (perm)	3282	1468	777	3282	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	542	161	20	811	30	4
RTOR Reduction (vph)	0	54	0	0	0	4
Lane Group Flow (vph)	542	107	20	811	30	0
Heavy Vehicles (%)	10%	10%	10%	10%	2%	2%
Turn Type	NA	Perm	Perm	NA	NA	Perm
Protected Phases	2			6	4	
Permitted Phases		2	6			4
Actuated Green, G (s)	29.8	29.8	29.8	29.8	3.2	3.2
Effective Green, g (s)	29.8	29.8	29.8	29.8	3.2	3.2
Actuated g/C Ratio	0.66	0.66	0.66	0.66	0.07	0.07
Clearance Time (s)	7.0	7.0	7.0	7.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	2173	972	515	2173	126	113
v/s Ratio Prot	0.17			c0.25	c0.02	
v/s Ratio Perm		0.07	0.03			0.00
v/c Ratio	0.25	0.11	0.04	0.37	0.24	0.00
Uniform Delay, d1	3.1	2.8	2.6	3.4	19.7	19.4
Progression Factor	0.46	0.16	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.3	0.2	0.0	0.1	1.0	0.0
Delay (s)	1.7	0.7	2.7	3.5	20.7	19.4
Level of Service	A	A	A	A	C	B
Approach Delay (s)	1.4			3.5	20.6	
Approach LOS	A			A	C	

Intersection Summary			
HCM Average Control Delay	2.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	45.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	37.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	871	126	26	676	276	42
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	7.0	7.0	7.0	7.0	5.0	5.0
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	3282	1468	1641	3282	1770	1583
Flt Permitted	1.00	1.00	0.30	1.00	0.95	1.00
Satd. Flow (perm)	3282	1468	510	3282	1770	1583
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	898	130	27	697	285	43
RTOR Reduction (vph)	0	64	0	0	0	32
Lane Group Flow (vph)	898	66	27	697	285	11
Heavy Vehicles (%)	10%	10%	10%	10%	2%	2%
Turn Type	NA	Perm	Perm	NA	NA	Perm
Protected Phases	2			6	4	
Permitted Phases		2	6			4
Actuated Green, G (s)	25.4	25.4	25.4	25.4	12.6	12.6
Effective Green, g (s)	25.4	25.4	25.4	25.4	12.6	12.6
Actuated g/C Ratio	0.51	0.51	0.51	0.51	0.25	0.25
Clearance Time (s)	7.0	7.0	7.0	7.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	1667	746	259	1667	446	399
v/s Ratio Prot	c0.27			0.21	c0.16	
v/s Ratio Perm		0.04	0.05			0.01
v/c Ratio	0.54	0.09	0.10	0.42	0.64	0.03
Uniform Delay, d1	8.3	6.3	6.4	7.7	16.7	14.1
Progression Factor	0.84	1.07	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.2	0.8	0.8	3.0	0.0
Delay (s)	8.2	7.0	7.2	8.5	19.7	14.1
Level of Service	A	A	A	A	B	B
Approach Delay (s)	8.0			8.4	18.9	
Approach LOS	A			A	B	

Intersection Summary			
HCM Average Control Delay	9.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		

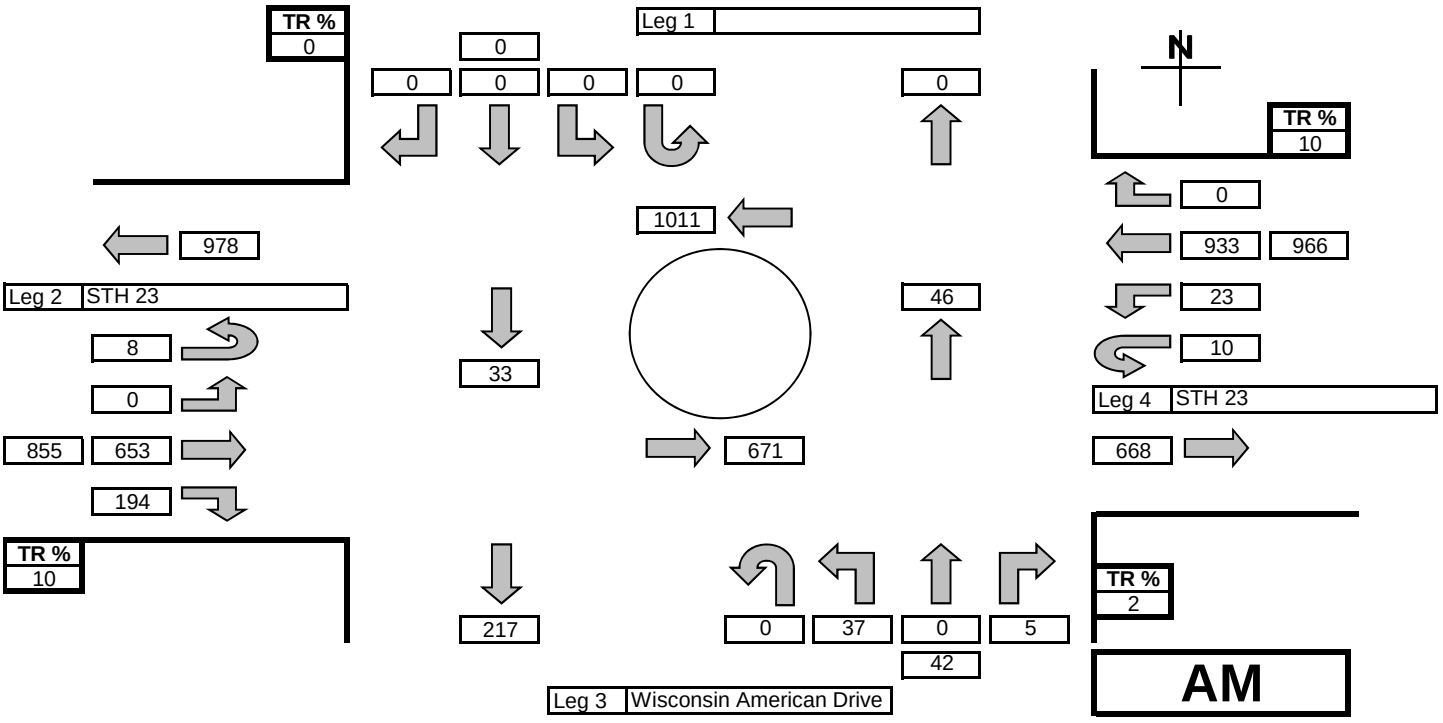
c Critical Lane Group

Project: Wisconsin American Drive
Project No.: 1440-15-01
Intersection: STH 23-Wisconsin American
Time Period: AM Peak

Drawn By:

Sheet **of**

Roundabout Summary



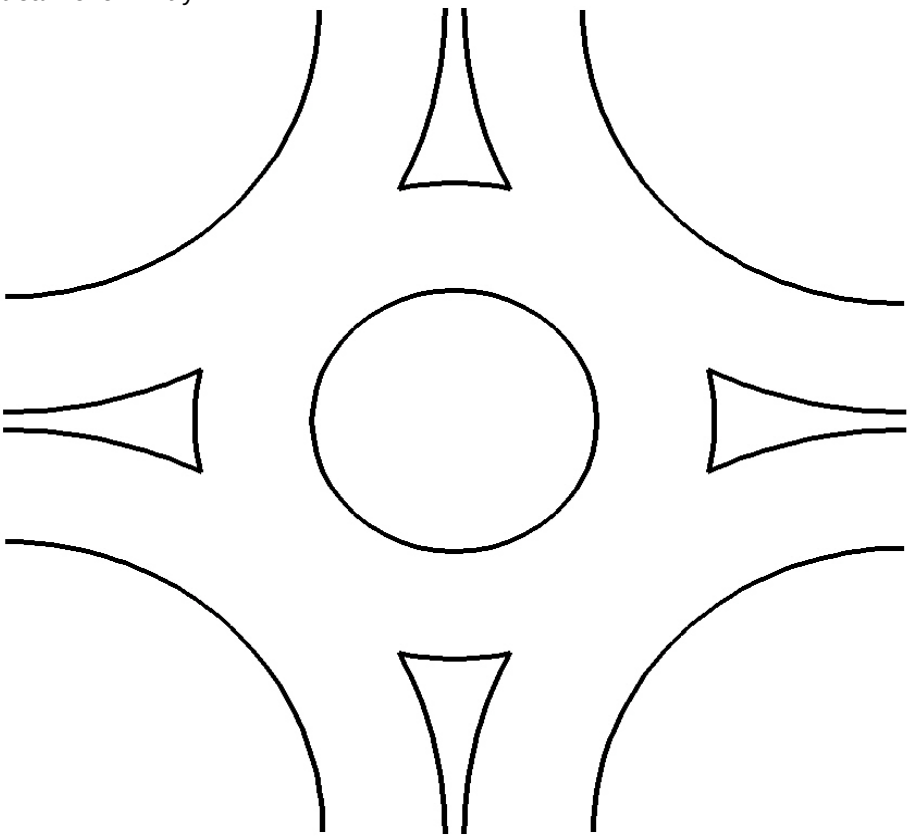
Capacity Guidelines for Single Lane

1. Single lane service volumes
   < 900 vph - 1200 vph
2. Exit Flow < 900 vph - 1200 vph
3. Entry Flow + Circulating Flow
   < 1400 vph - 1800 vph
4. Circulating Flow downstream of on Entry
   1400 vph - 1800 vph
5. V/C > 0.85

Rodel Inputs

Leg	Street Name	PCU	RT	TH	LT	UT
1	0	1.00	0	0	0	0
2	STH 23	1.10	194	653	0	8
3	Wisconsin American Drive	1.02	5	0	37	0
4	STH 23	1.10	0	933	23	10

Right Turn Bypass
None

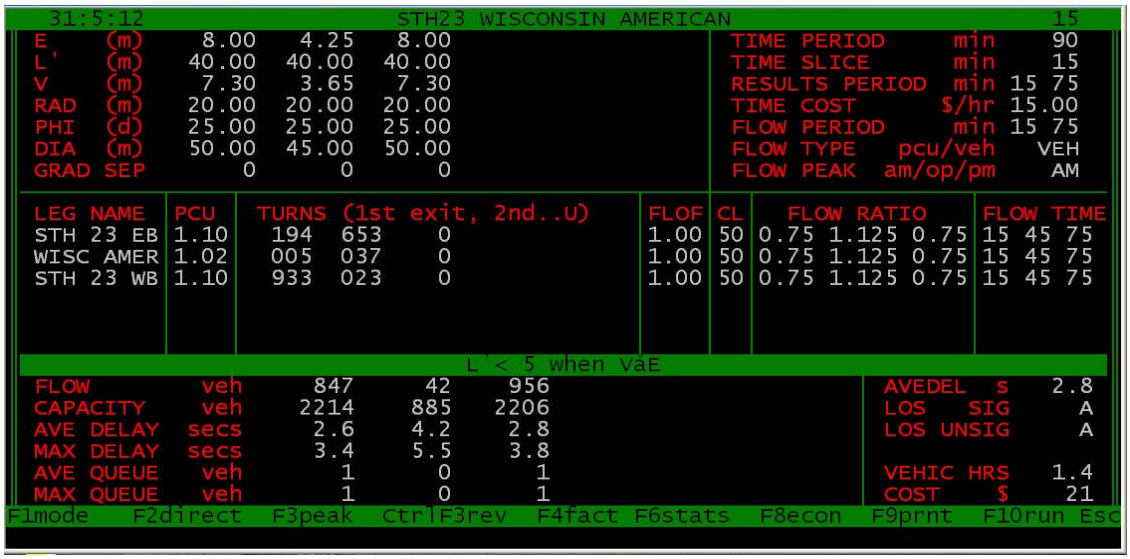


Right Turn Bypass
None

Right Turn Bypass
None

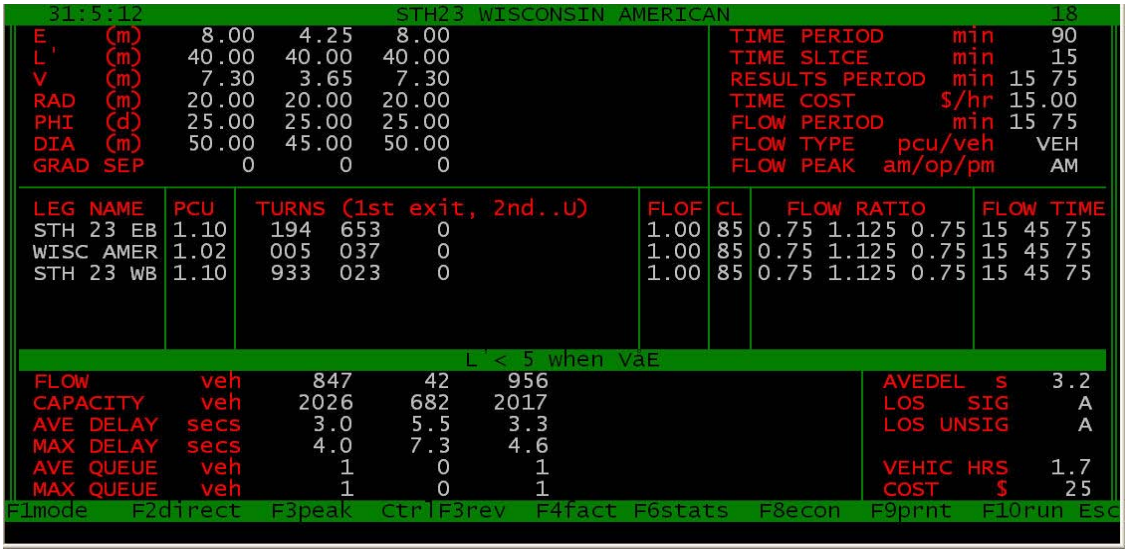
Right Turn Bypass
None

STH 23 and Wisconsin-American Drive Roundabout Analysis
AM Design Year 2035
Dual Lane Eastbound & Westbound STH 23, Single Lane Wisconsin-American
50% Confidence Level



	EB	NB	WB	Intersection
Average Stopped Delay(from above)	2.6	4.2	2.8	2.8
Geometric Delay	14	9	14	14
Total Delay	**16.6**	**13.2**	**16.8**	**16.8**
Level of Service (LOS)	**B**	**B**	**B**	**B**
95% Queue (from next page)	**50**	**50**	**75**	

85% Confidence Level



	EB	NB	WB	Intersection
Average Stopped Delay(from above)	3	5.5	3..3	3.2
Geometric Delay	14	9	14	14
Total Delay	**17**	**14.5**	**14**	**17.2**
Level of Service (LOS)	**B**	**B**	**B**	**B**

STH 23 and Wisconsin-American Drive Roundabout Analysis

AM Design Year 2035

Dual Lane Eastbound & Westbound STH 23, Single Lane Wisconsin-American

Queue Length Outputs

Eastbound STH 23

31:5:12 STH23 WISCONSIN AMERI 15

AM LEG NUMBER 1 STH 23 EB

TIME SLICES		ARR FLOW v/slice	CAP v/slice	CIRC FLOW v/slice	VC RATIO	END QUEUES vehs	95% QUEUES vehs	EXIT FLOW veh/slice
0	15	159.42	554.60	4.32	0.287	0.40	1.05	181.56
15	30	190.36	553.96	5.17	0.344	0.52	1.36	217.24
30	45	233.14	553.08	6.32	0.422	0.72	1.88	265.98
45	60	233.14	553.08	6.33	0.422	0.73	1.88	266.25
60	75	190.36	553.96	5.18	0.344	0.53	1.37	217.68
75	90	159.42	554.59	4.33	0.287	0.40	1.06	182.22

Northbound Wisconsin American Drive

31:5:12 STH23 WISCONSIN AMERI 15

AM LEG NUMBER 2 WISC AMER

TIME SLICES		ARR FLOW v/slice	CAP v/slice	CIRC FLOW v/slice	VC RATIO	END QUEUES vehs	95% QUEUES vehs	EXIT FLOW veh/slice
0	15	7.90	245.63	132.24	0.032	0.03	0.09	43.93
15	30	9.44	231.22	158.18	0.041	0.04	0.11	52.56
30	45	11.56	211.51	193.69	0.055	0.06	0.15	64.36
45	60	11.56	211.41	193.84	0.055	0.06	0.15	64.41
60	75	9.44	231.07	158.42	0.041	0.04	0.11	52.65
75	90	7.90	245.39	132.63	0.032	0.03	0.09	44.08

Westbound STH 23

31:5:12 STH23 WISCONSIN AMERI 15

AM LEG NUMBER 3 STH 23 WB

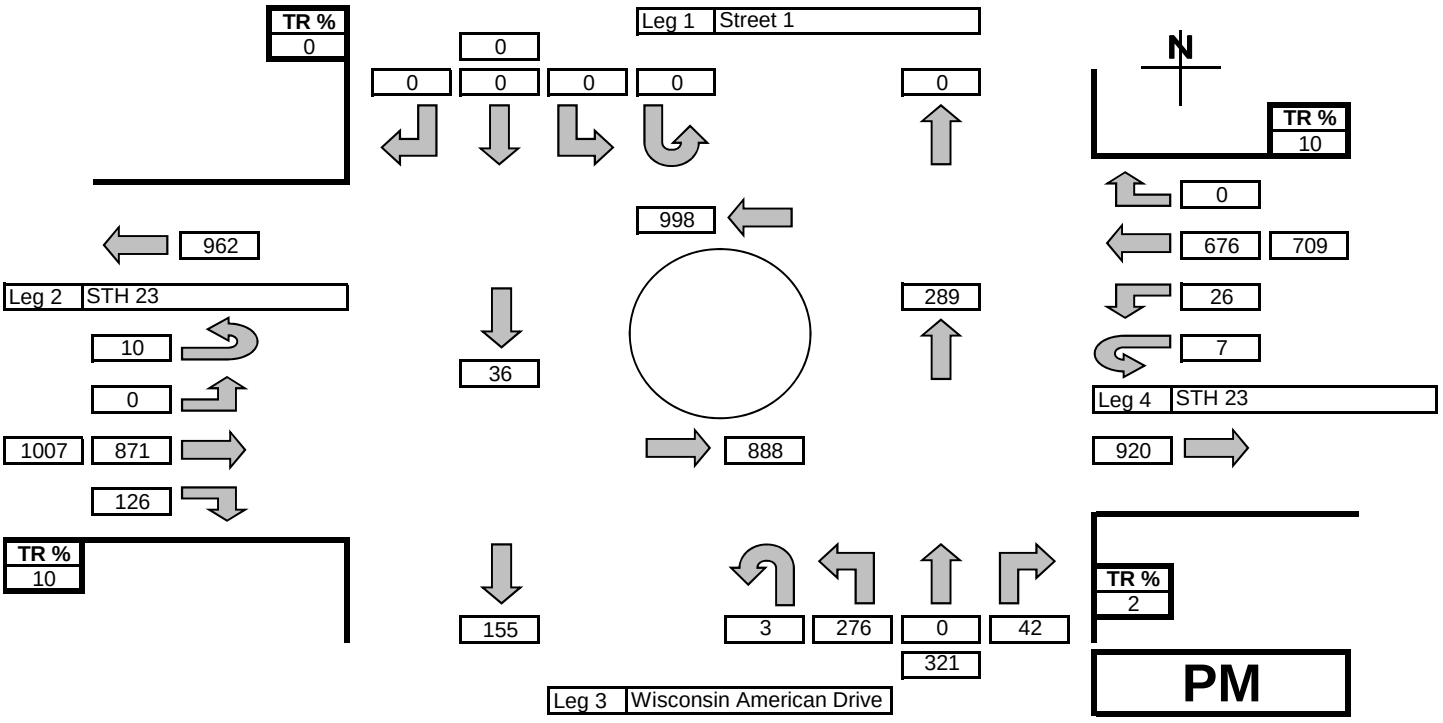
TIME SLICES		ARR FLOW v/slice	CAP v/slice	CIRC FLOW v/slice	VC RATIO	END QUEUES vehs	95% QUEUES vehs	EXIT FLOW veh/slice
0	15	179.93	553.00	6.43	0.325	0.48	1.25	123.46
15	30	214.86	552.04	7.70	0.389	0.63	1.65	147.71
30	45	263.14	550.73	9.43	0.478	0.91	2.34	180.86
45	60	263.14	550.72	9.44	0.478	0.91	2.35	181.02
60	75	214.86	552.03	7.72	0.389	0.64	1.66	147.96
75	90	179.93	552.98	6.46	0.325	0.48	1.26	123.87

Project: Wisconsin American Drive
Project No.: 1440-15-01
Intersection: STH 23-Wisconsin American
Time Period: PM Peak

Drawn By:

Sheet **of**

Roundabout Summary



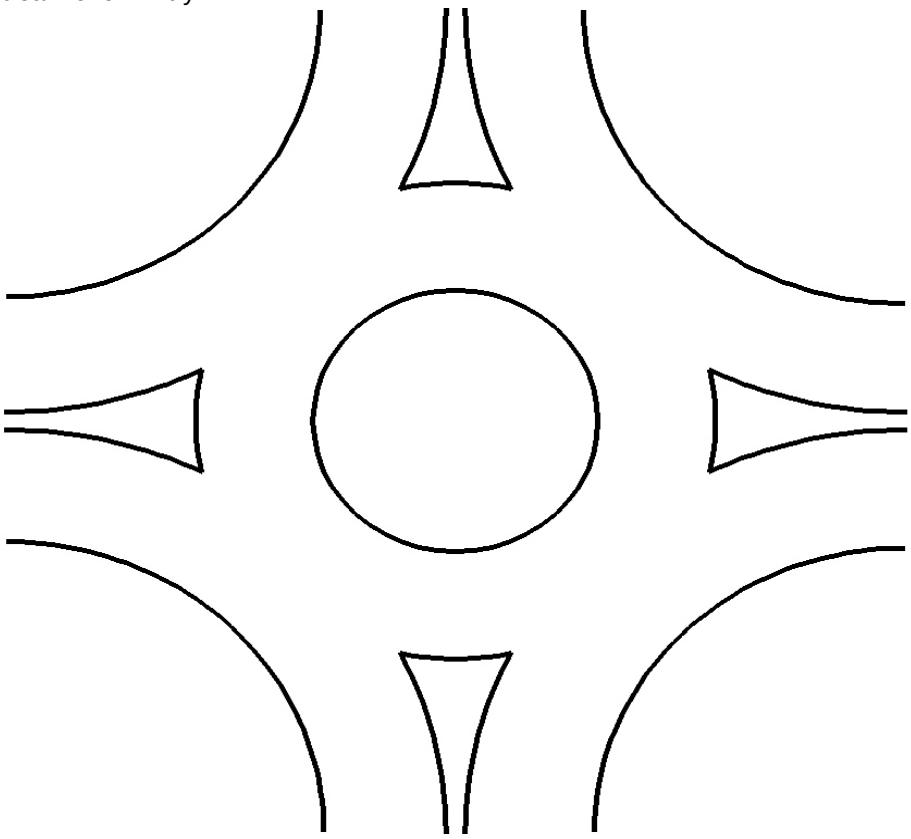
Capacity Guidelines for Single Lane

1. Single lane service volumes
   < 900 vph - 1200 vph
2. Exit Flow < 900 vph - 1200 vph
3. Entry Flow + Circulating Flow
   < 1400 vph - 1800 vph
4. Circulating Flow downstream of on Entry
   1400 vph - 1800 vph
5. V/C > 0.85

Rodel Inputs						
Leg	**Street Name**	**PCU**	**RT**	**TH**	**LT**	**UT**
1	Street 1	1.00	0	0	0	0
2	STH 23	1.10	126	871	0	10
3	Wisconsin American Drive	1.02	42	0	276	3
4	STH 23	1.10	0	676	26	7

Right Turn Bypass
None

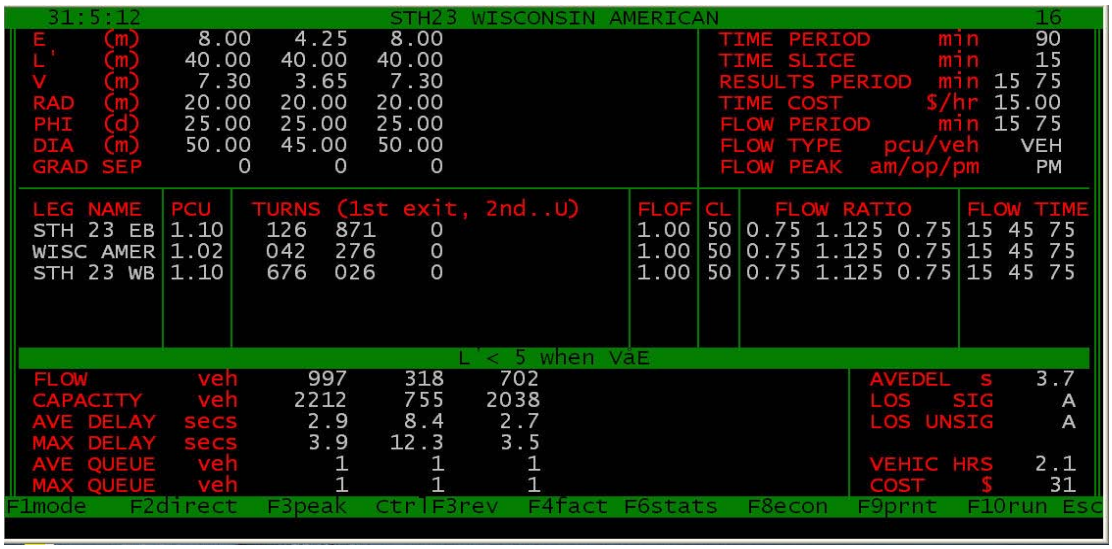
Right Turn Bypass
None



Right Turn Bypass
None

Right Turn Bypass
None

STH 23 and Wisconsin-American Drive Roundabout Analysis
PM Design Year 2035
Dual Lane Eastbound & Westbound STH 23, Single Lane Wisconsin-American
50% Confidence Level



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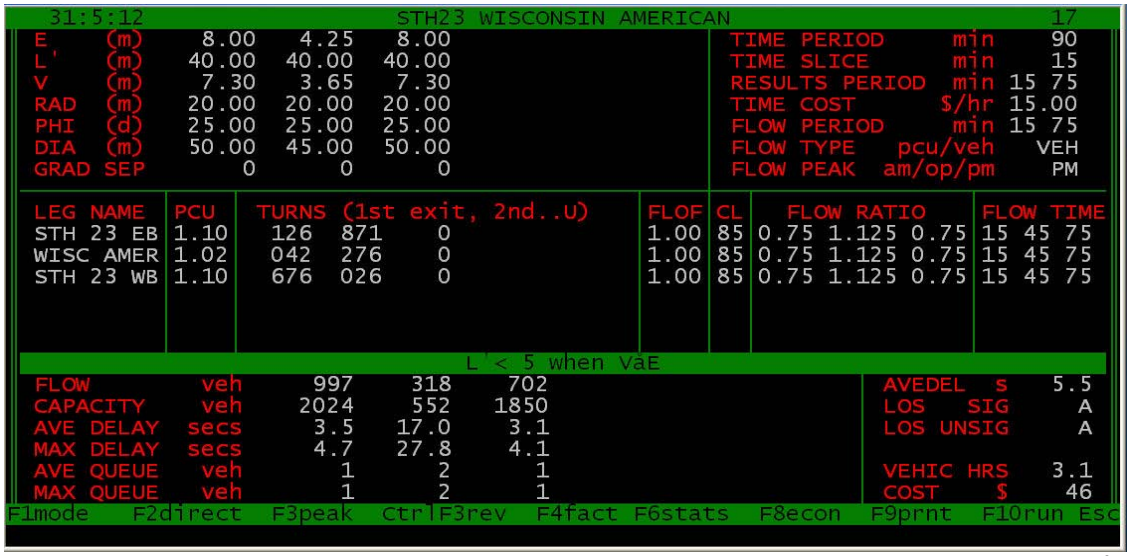
 31:5:12                    STH23 WISCONSIN AMERICAN                      16
 E    (m)    8.00   4.25   8.00          TIME PERIOD      min     90
 L'   (m)   40.00  40.00  40.00          TIME SLICE       min     15
 V    (m)    7.30   3.65   7.30          RESULTS PERIOD   min 15 75
 RAD  (m)   20.00  20.00  20.00          TIME COST        $/hr 15.00
 PHI  (d)   25.00  25.00  25.00          FLOW PERIOD      min 15 75
 DIA  (m)   50.00  45.00  50.00          FLOW TYPE    pcu/veh   VEH
 GRAD SEP       0      0      0          FLOW PEAK    am/op/pm   PM

 LEG NAME  PCU  TURNS (1st exit, 2nd..U)     FLOF CL   FLOW RATIO      FLOW TIME
 STH 23 EB 1.10   126  871    0             1.00 50 0.75 1.125 0.75 15 45 75
 WISC AMER 1.02   042  276    0             1.00 50 0.75 1.125 0.75 15 45 75
 STH 23 WB 1.10   676  026    0             1.00 50 0.75 1.125 0.75 15 45 75

                          L' < 5 when VaE
 FLOW          veh      997    318    702          AVEDEL  s    3.7
 CAPACITY      veh     2212    755   2038          LOS   SIG    A
 AVE DELAY     secs     2.9    8.4    2.7          LOS UNSIG    A
 MAX DELAY     secs     3.9   12.3    3.5
 AVE QUEUE     veh        1      1      1          VEHIC HRS  2.1
 MAX QUEUE     veh        1      1      1          COST   $    31
F1mode  F2direct  F3peak  Ctrl F3rev  F4fact F6stats  F8econ  F9prnt  F10run Esc
```

	EB	NB	WB	Intersection
Average Stopped Delay(from above)	2.9	8.4	2.7	3.7
Geometric Delay	14	9	14	14
Total Delay	**16.9**	**17.4**	**16.7**	**17.7**
Level of Service (LOS)	**B**	**B**	**B**	**B**
95% Queue (from next page)	**75**	**75**	**50**	

85% Confidence Level



```
 31:5:12                    STH23 WISCONSIN AMERICAN                      17
 E    (m)    8.00   4.25   8.00          TIME PERIOD      min     90
 L'   (m)   40.00  40.00  40.00          TIME SLICE       min     15
 V    (m)    7.30   3.65   7.30          RESULTS PERIOD   min 15 75
 RAD  (m)   20.00  20.00  20.00          TIME COST        $/hr 15.00
 PHI  (d)   25.00  25.00  25.00          FLOW PERIOD      min 15 75
 DIA  (m)   50.00  45.00  50.00          FLOW TYPE    pcu/veh   VEH
 GRAD SEP       0      0      0          FLOW PEAK    am/op/pm   PM

 LEG NAME  PCU  TURNS (1st exit, 2nd..U)     FLOF CL   FLOW RATIO      FLOW TIME
 STH 23 EB 1.10   126  871    0             1.00 85 0.75 1.125 0.75 15 45 75
 WISC AMER 1.02   042  276    0             1.00 85 0.75 1.125 0.75 15 45 75
 STH 23 WB 1.10   676  026    0             1.00 85 0.75 1.125 0.75 15 45 75

                          L' < 5 when VaE
 FLOW          veh      997    318    702          AVEDEL  s    5.5
 CAPACITY      veh     2024    552   1850          LOS   SIG    A
 AVE DELAY     secs     3.5   17.0    3.1          LOS UNSIG    A
 MAX DELAY     secs     4.7   27.8    4.1
 AVE QUEUE     veh        1      2      1          VEHIC HRS  3.1
 MAX QUEUE     veh        1      2      1          COST   $    46
F1mode  F2direct  F3peak  Ctrl F3rev  F4fact F6stats  F8econ  F9prnt  F10run Esc
```

	EB	NB	WB	Intersection
Average Stopped Delay(from above)	3.5	17	3.1	5.5
Geometric Delay	14	9	14	14
Total Delay	**17.5**	**26**	**17.1**	**19.5**
Level of Service (LOS)	**B**	**C**	**B**	**C**

STH 23 and Wisconsin-American Drive Roundabout Analysis

PM Design Year 2035

Dual Lane Eastbound & Westbound STH 23, Single Lane Wisconsin-American

Queue Length Outputs

Eastbound STH 23

31:5:12 STH23 WISCONSIN AMERI 19

PM LEG NUMBER 1 STH 23 EB

TIME SLICES	ARR FLOW v/slice	CAP v/slice	CIRC FLOW v/slice	VC RATIO	END QUEUES vehs	95% QUEUES vehs	EXIT FLOW veh/slice
0 15	187.65	554.17	4.88	0.339	0.51	1.33	174.78
15 30	224.07	553.45	5.84	0.405	0.68	1.76	209.21
30 45	274.43	552.46	7.15	0.497	0.98	2.52	256.00
45 60	274.43	552.45	7.16	0.497	0.98	2.53	256.51
60 75	224.07	553.44	5.85	0.405	0.68	1.77	209.96
75 90	187.65	554.17	4.90	0.339	0.51	1.34	175.65

Northbound Wisconsin American Drive

31:5:12 STH23 WISCONSIN AMERI 19

PM LEG NUMBER 2 WISC AMER

TIME SLICES	ARR FLOW v/slice	CAP v/slice	CIRC FLOW v/slice	VC RATIO	END QUEUES vehs	95% QUEUES vehs	EXIT FLOW veh/slice
0 15	59.85	221.14	176.35	0.271	0.37	0.96	30.77
15 30	71.47	201.92	210.96	0.354	0.54	1.41	36.81
30 45	87.53	175.65	258.29	0.498	0.97	2.50	45.07
45 60	87.53	175.49	258.55	0.499	0.98	2.53	45.12
60 75	71.47	201.67	211.36	0.354	0.56	1.45	36.89
75 90	59.85	220.79	176.94	0.271	0.38	0.98	30.88

Westbound STH 23

31:5:12 STH23 WISCONSIN AMERI 19

PM LEG NUMBER 3 STH 23 WB

TIME SLICES	ARR FLOW v/slice	CAP v/slice	CIRC FLOW v/slice	VC RATIO	END QUEUES vehs	95% QUEUES vehs	EXIT FLOW veh/slice
0 15	132.13	521.66	47.88	0.253	0.34	0.89	170.77
15 30	157.77	514.47	57.38	0.307	0.44	1.15	204.34
30 45	193.23	504.85	70.11	0.383	0.62	1.60	250.15
45 60	193.23	504.59	70.44	0.383	0.62	1.61	250.46
60 75	157.77	514.10	57.86	0.307	0.44	1.16	204.82
75 90	132.13	521.32	48.31	0.253	0.34	0.89	171.43

Appendix F

Cost Estimates

Wisconsin Department of Transportation
I.D. 1440-15-71
USH 151 - TAFT ROAD
WISCONSIN AMERICAN DRIVE INTERSECTION
STH 23
Preliminary Cost Estimate Summary

ITEM DESCRIPTION				TOTAL
ITEMS DETAILED	UNIT	QUANTITY	UNIT COST	TOTAL
HMA PAVEMENT	TN	430	$40.00	$17,200.00
CONCRETE PAVEMENT	SY	14550	$30.00	$436,500.00
ASPHALTIC MATERIALS (AC)	TN	26	$375.00	$9,675.00
BASE AGGREGATE DENSE	TN	9160	$10.00	$91,600.00
CURB & GUTTER	LF	5600	$12.00	$67,200.00
		Major Roadway Items Detailed Subtotaled		$622,175.00
	UNIT	***QUANTITY***	***UNIT PRICE***	
SIGNALIZE INTERSECTION	LS	1	$150,000	$150,000.00
DRAINAGE	LS	*% of Major Item $*	20%	$124,000.00
EROSION CONTROL & RESTORATION	LS	*% of Major Item $*	15%	$93,000.00
TRAFFIC CONTROL & STAGING	LS	*% of Major Item $*	40%	$249,000.00
LIGHTING	EACH	*6*	10,000	$60,000.00
SIGNING/MARKING	LS	*% of Major Item $*	6%	$37,000.00
ROADWAY INCIDENTALS	LS	*% of Major Item $*	30%	$187,000.00
			Construction Costs Subtotal	$1,522,175.00
CONSTRUCTION DESIGN CONTINGENCY	LS	% of Constr. Costs	15%	$228,000.00
ESTIMATED CONTRACT LET AMOUNT				**$1,750,000.00**
		TOTAL COST		**$1,750,000**

Wisconsin Department of Transportation
I.D. 1440-15-71
USH 151 - TAFT ROAD
WISCONSIN AMERICAN DRIVE ROUNDABOUT
STH 23
Preliminary Cost Estimate Summary

ITEM DESCRIPTION				TOTAL
ITEMS DETAILED	UNIT	QUANTITY	UNIT COST	TOTAL
HMA PAVEMENT	TN	0	$40.00	$0.00
CONCRETE PAVEMENT	SY	10710	$30.00	$321,300.00
ASPHALTIC MATERIALS (AC)	TN	0	$375.00	$0.00
BASE AGGREGATE DENSE	TN	4900	$10.00	$49,000.00
CURB & GUTTER	LF	8110	$12.00	$97,320.00
			Major Roadway Items Detailed Subtotaled	$467,620.00
	UNIT	***QUANTITY***	***UNIT PRICE***	
SIGNALIZE INTERSECTION	LS	-	$150,000	$0.00
DRAINAGE	LS	*% of Major Item $*	20%	$94,000.00
EROSION CONTROL & RESTORATION	LS	*% of Major Item $*	15%	$70,000.00
TRAFFIC CONTROL & STAGING	LS	*% of Major Item $*	40%	$187,000.00
LIGHTING	EACH	*10*	10,000	$100,000.00
SIGNING/MARKING	LS	*% of Major Item $*	6%	$28,000.00
ROADWAY INCIDENTALS	LS	*% of Major Item $*	30%	$140,000.00
			Construction Costs Subtotal	$1,086,620.00
CONSTRUCTION DESIGN CONTINGENCY	LS	% of Constr. Costs	15%	$163,000.00
ESTIMATED CONTRACT LET AMOUNT				**$1,250,000.00**
			TOTAL COST	**$1,250,000**

Appendix G

Sketch of Alternatives

2

2

N

USH 151

NB TO USH 151

NB TO STH 23

STH 23 WB

STH 23 EB

PROPOSED R/W

PROPOSED R/W

PROPOSED R/W

PROPOSED R/W

EXISTING R/W

EXISTING R/W

MULTI-USE TRAIL

WISCONSIN AMERICAN DRIVE

RIPRAP

BERM

RUINS

SEPTIC

POOL

PROJECT NO:1440-05-01	HWY: STH 23	COUNTY:FOND DU LAC	SIGNALIZED INTERSECTION ALTERNATIVE	SHEET	E

FILE NAME : G:\WDOTCO\10033 (Design Work Orders)\WO 2 STH 23\DGN\EXHIBITS AND MISC\PIM EXHIBIT INTERSECTION.dgn PLOT DATE : 6/20/2012 PLOT BY : KL Engineering PLOT NAME : PLOT SCALE :

WISDOT/CADDS SHEET 42

2

2

N

USH 151

NB TO USH 151

NB TO STH 23

PROPOSED R/W

MULTI-USE TRAIL

EXISTING R/W

STH 23

PROPOSED R/W

PROPOSED R/W

EXISTING R/W

WISCONSIN AMERICAN DRIVE

RIPRAP

BERM

INL

MH

RUINS

SEPTIC

POOL

A/C

PROJECT NO:1440-05-01	HWY: STH 23	COUNTY:FOND DU LAC	ROUNDABOUT ALTERNATIVE	SHEET	E

FILE NAME : \\KL1NAS\Data1\WDOTCO\10033 (Design Work Orders)\WO 2 STH 23\DGN\EXHIBITS AND MISC\PIM EXHIBIT RAB.dgn PLOT DATE : 6/20/2012 PLOT BY : KL Engineering PLOT NAME : PLOT SCALE :