



**WISCONSIN TRAFFIC OPERATIONS
& SAFETY LABORATORY**
UNIVERSITY OF WISCONSIN-MADISON

Department of Civil and Environmental Engineering

Date: 11/18/2009
To: Marie Treazise, WisDOT Bureau of Highway Operations
From: Amanda Ryadi, Wisconsin TOPS Lab
Subject: Ramp Metering Evaluation – Technical Memo #7
WisDOT and TXDOT Ramp Metering Warrant Assessment

This memorandum summarizes the Wisconsin Department of Transportation (WisDOT) and Texas Department of Transportation (TXDOT) warrant comparison analysis conducted in the context of current ramp metering in Wisconsin. The WisDOT warrants are documented in a March 2006 report by Wilbur Smith Associates¹. The TXDOT warrants are documented by the Texas Transportation Institute in May 2009².

A WisDOT warrant requires at least two out of the four criteria to be met in order for a ramp meter to be installed or to keep operating. The four WisDOT criteria are the following:

1. Mainline flow of at least 1200 vehicles per hour per lane (vphpl) for any hour
2. Ramp flow of at least 240 vehicles per hour (vph) for a one lane ramp, and 400 vph for a two lane ramp for any hour
3. Mainline speeds of less than 30 mph in the peak hour
4. Accident rate in the vicinity of the ramp in excess of 80 per hundred million vehicle miles

TXDOT has seven criteria. A ramp meter installation needs to be considered when all of the first four criteria are met or when one or more of the last three criteria are met. TXDOT criteria are the following:

1. The average traffic flow rate of the two right-most lanes during peak hour periods exceeds 1600 vphpl for entrance ramps with acceleration lanes of 500 feet or less
2. The combined traffic flow rate in the right-most freeway lane plus the flow rate on the entrance ramp during peak periods exceed a minimum of 2300 vphpl for entrance ramps with acceleration lanes of 500 ft or less
3. Traffic flow rate on the entrance ramp during peak periods exceeds 300 vph
4. The freeway regularly operates at speeds less than 50 mph for at least a half-hour period
5. The rate of crashes in the immediate vicinity of the ramp exceeds the mean crash rate for comparable sections of freeway in a metropolitan area
6. The ramp length permits a vehicle starting from a stop at the signal to reach the prevailing speed of the freeway traffic in the merge area so as to prevent an unacceptable speed differential in the merge area
7. Sufficient storage length exists upstream of the ramp control signal to prevent queues from impeding operations on the frontage road or surface street intersection

¹ "Wisconsin Statewide Freeway Ramp Control Plan" available via <http://www.topslab.wisc.edu/workgroups/toip/rampcntrl.html>

² "Warrants for Installing and Operating Ramp Meters" available via http://tti.tamu.edu/publications/catalog/record_detail.htm?id=31032

Wisconsin Ramp Metering Warrant Analysis

An analysis of existing meters using present data was conducted to determine if the ramp meters currently meet the warrant requirements to continue operating. One year of V-SPOC³ data from October 2008 to September 2009 are used.

The peak hour periods that are used for the analysis are 6 – 9 AM and 4 – 8 PM. The percentage of the missing (null or zero) data is also noted in the summary tables to indicate data reliability. Safety (crashes or accidents) was not evaluated as part of this assessment.

Table 1 shows the results of the analysis.

All meters currently meet the WisDOT warrants with the exception of the following:

- RM-40-006 I-94 EB @ 35th St
- RM-40-015 I-43 SB @ Hampton Ave
- RM-40-039 I-894/US 45 NB @ Greenfield Ave WB (Slip Ramp)
- RM-40-089 US 45 SB @ Good Hope Rd WB (Loop Ramp)
- RM-40-095 US 45 NB @ Appleton Ave
- RM-40-100 US 45 SB @ Hampton Ave
- RM-40-108 I-94 SB @ College Ave
- RM-40-109 I-94 SB @ Rawson Ave
- RM-40-124 I-43 NB @ Atkinson Ave
- RM-67-069 I-94 EB @ CTH T
- RM-67-114 US 41/45 NB @ 124th St
- RM-67-123 I-94 WB @ CTH SS

These ramp meters are further evaluated to determine whether they should be turned off. The decision will be mainly influenced by the consideration of safety, corridor operations and consistency with neighboring ramp operations. Figures 1 to 5 show the locations of these ramp meters and show the list of its neighboring ramp meters with the ramp meters that do not meet the warrant marked with a black square.

RM-67-120, RM-67-113 and RM-67-062 have been turned off based for the ramp meter turn-off analysis and have been recommended to stay inactive (refer to Technical Memo #5). Since this list of ramp meters are the neighboring ramp meters to RM-67-123, the evidence suggests the discontinuation of the operation of RM-67-123 as well.

RM-67-069 has been turned off as a part of the ramp meter turn-off analysis as well and has been recommended to stay inactive (refer to Technical Memo #5).

As for the other 10 ramp meters listed, their neighboring ramp meters currently meet the WisDOT warrant. Therefore, considering the location and the operation of the neighboring ramp meters, the 10 ramp meters should keep operating to maintain corridor operation consistency.

³ WisTransPortal Volume, Speed, and Occupancy Application Suite, available via <http://transportal.cee.wisc.edu/applications/vspoc.html>

Figure 1. Location of RM-40-006

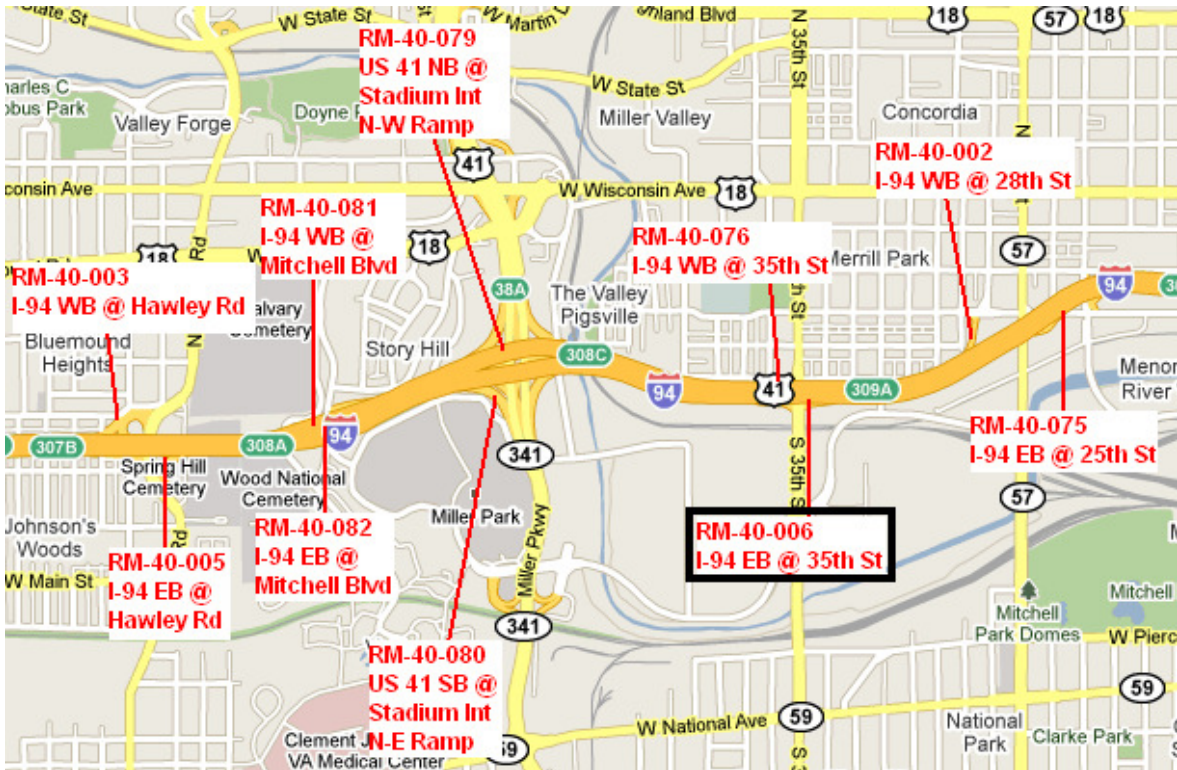


Figure 2. Locations of RM-67-123 and RM-67-069

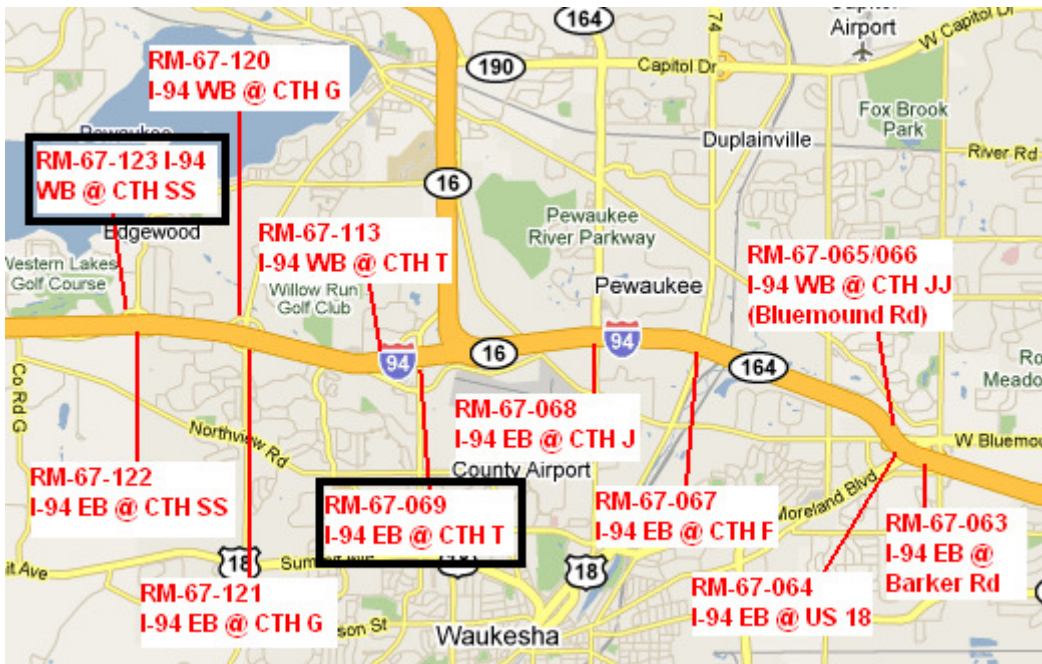


Figure 3. Locations of RM-40-108 and RM-40-109

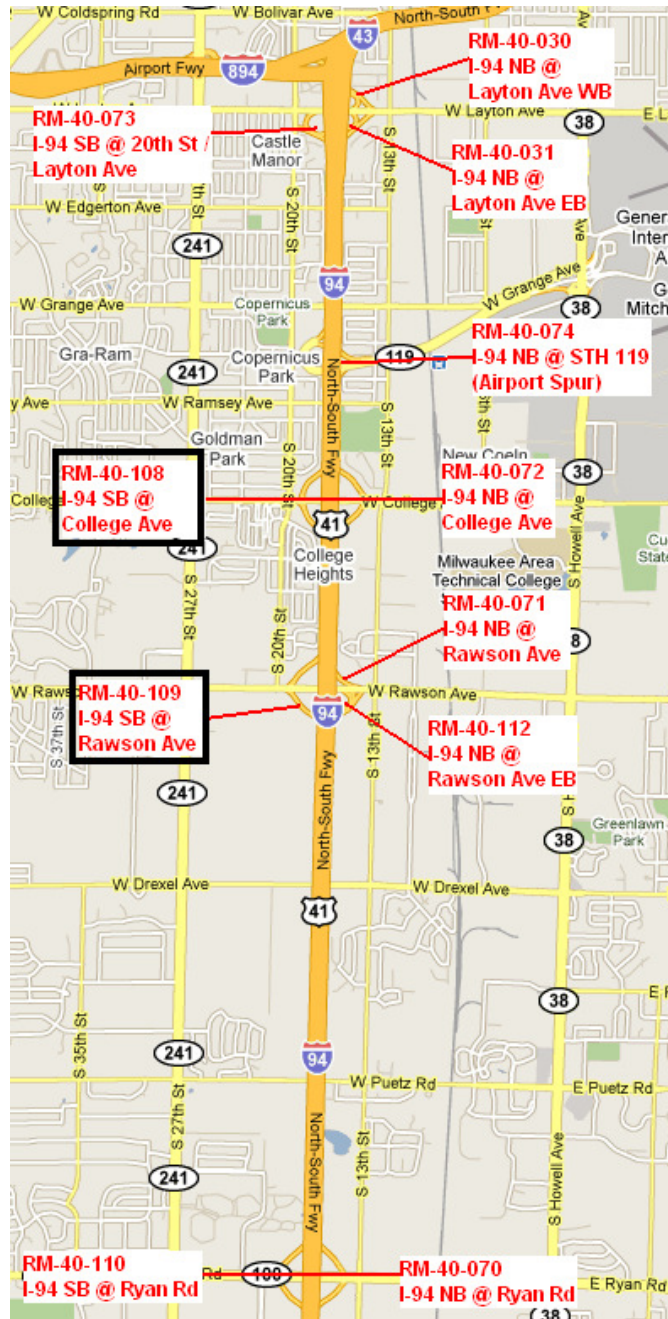


Figure 4. Locations of RM-40-015 and RM-40-124

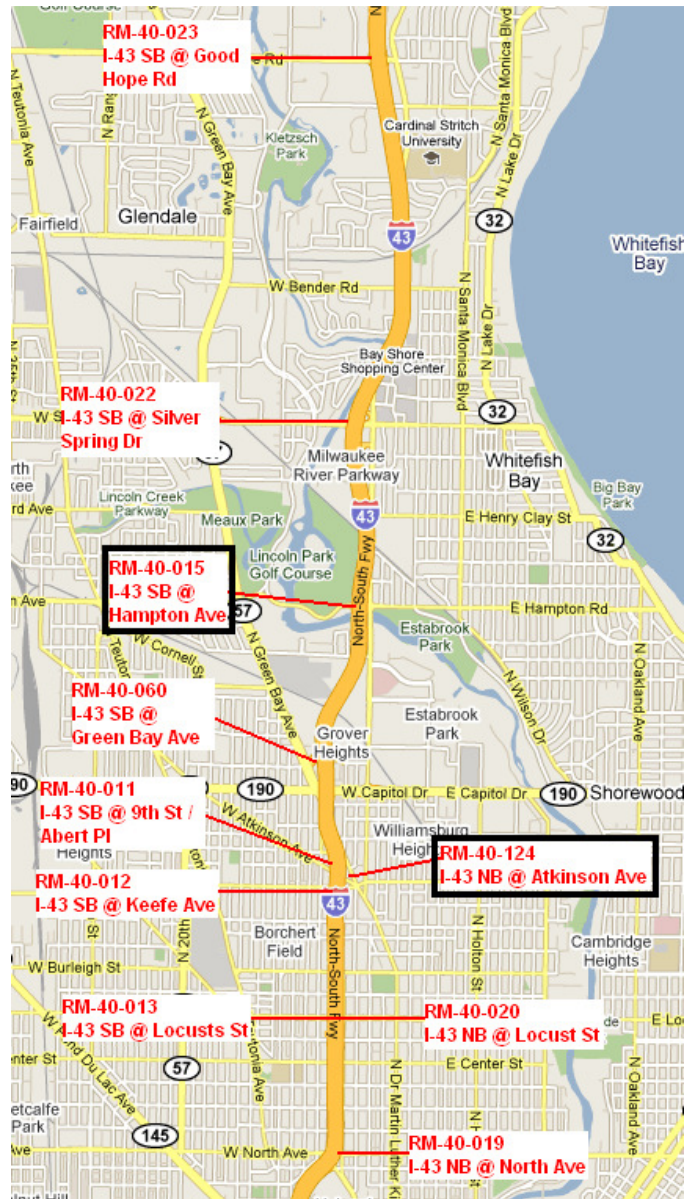
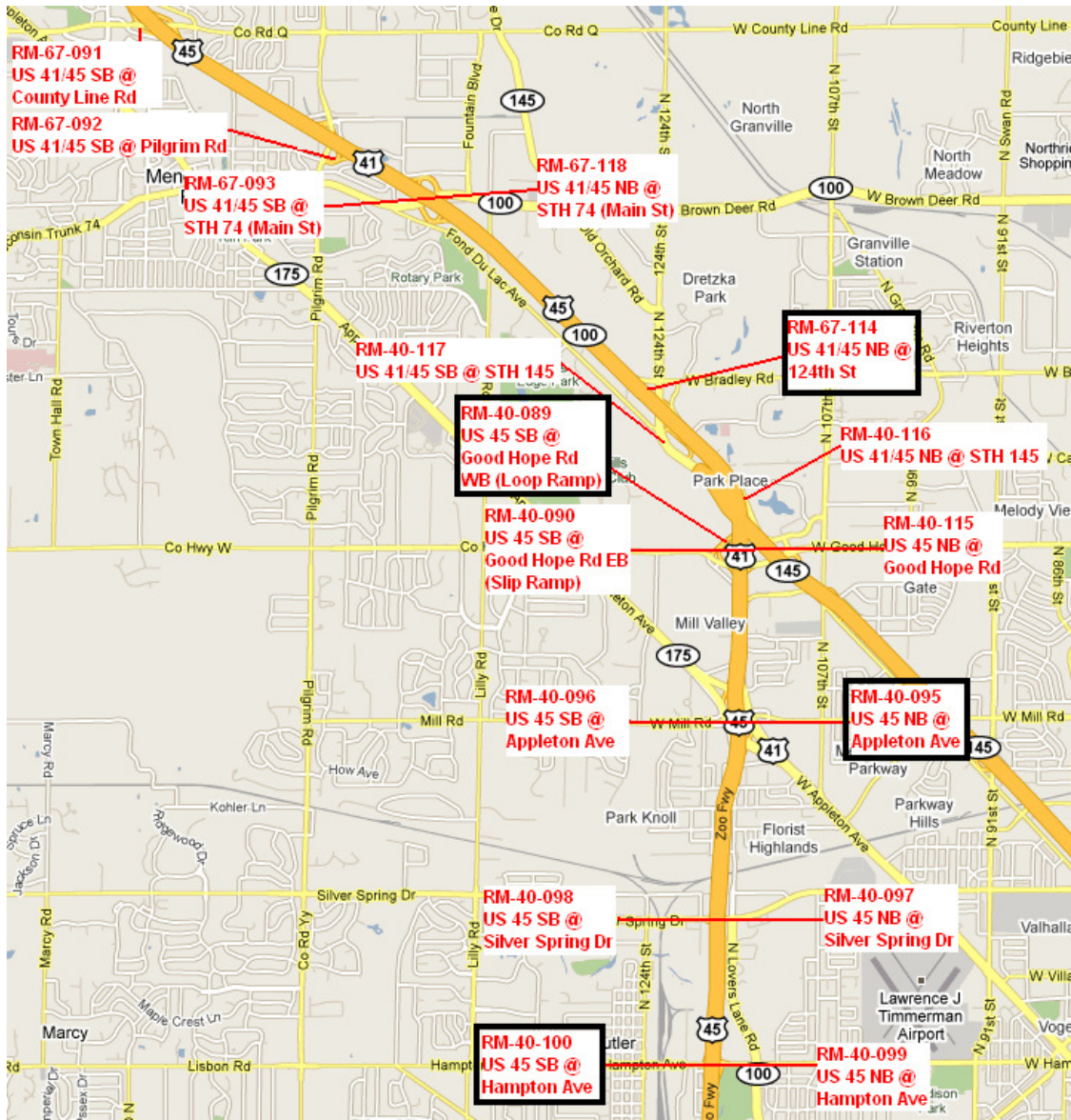


Figure 5. Locations of RM-67-114, RM-40-089, RM-40-095, and RM-40-100



During Start-Up Analysis

There are 29 ramp meters whose start-up dates are known with certainty. For these ramp meters, one month of V-SPOC data before the start-up date is used for the analysis to determine if the ramp meters met the warrant requirement during start-up. As mentioned previously, the peak hour periods used are 6 – 8 AM and 4 – 8 PM and the percentage of the missing data is noted to show the result reliability. Table 2 below summarizes the results of the analysis.

Concluding Remarks

Fortunately, nearly all meters in Wisconsin currently meet the WisDOT warrant requirements for installation and to continue operating. No meters meet the TXDOT warrants, primarily because the traffic flow rate requirement for Texas warrants is higher than that for Wisconsin warrants.

There are relatively few ramp meters in Wisconsin that do not currently meet the Wisconsin warrant requirements. These metering locations are further evaluated to determine whether they are candidates for turning off. The analysis result confirms that RM-67-069 should remain off, and RM-67-123 should be considered for turn-off and evaluated in the same manner as the five previously turned off meters.

Table 1. Present Analysis for Ramp Meters

*Note: Column “% of Flow > 2300 for C2” is rounded up to have no decimal values

RM	Location	Missing	Wisconsin Warrant				Meets warrant requirement?	Texas Warrant									Meets warrant requirement?	
			Currently (June - Sept 2009)					Avg Flow for C2	Max Flow for C2	% of Flow > 2300 for C2	Currently (June - Sept 2009)							
			C1	C2	C3	C4					C1	C2	C3	C4	C5	C6		C7
RM-13-0001	USH 12/14 EB @ Whitney Way	24%	Y	Y	Y		Y	1331	2869	17%	Y	N	Y	Y				N
RM-13-0002	USH 12/14 WB @ Fish Hatchery Rd	27%	Y	Y	N		Y	1388	5188	33%	N	N	Y	Y				N
RM-13-0004	USH 12/14 WB @ Park St	49%	Y	Y	N		Y	641	2811	7%	N	N	Y	N				N
RM-13-0006	USH 12/14 WB @ Todd Dr (Landmark Ramp)	26%	Y	Y	N		Y	981	2256	0%	Y	N	Y	N				N
RM-40-0001	I-94 @ 20th St	No data for entrance ramp																
RM-40-0002	I-94 WB @ 28th St	5%	Y	Y	Y		Y	1822	2744	17%	Y	N	Y	Y				N
RM-40-0003	I-94 WB @ Hawley Rd	14%	Y	Y	Y		Y	1503	2561	2%	Y	N	Y	Y				N
RM-40-0004	I-94 EB @ 84th St	12%	Y	Y	Y		Y	1559	2520	1%	Y	N	Y	Y				N
RM-40-0005	I-94 EB @ Hawley Rd	12%	Y	Y	N		Y	1450	2311	0%	Y	N	Y	Y				N
RM-40-0006	I-94 EB @ 35th St	18%	Y	N	N		N	1517	2532	7%	Y	N	N	Y				N
RM-40-0007	I-94 EB @ 68th St	12%	Y	Y	Y		Y	1580	2491	2%	Y	N	Y	Y				N
RM-40-0008	I-94 @ 13th St	No data for entrance ramp																
RM-40-0009	I-94 WB @ 70th St	14%	Y	Y	Y		Y	1476	2446	2%	Y	N	N	Y				N
RM-40-0010	I-94 WB @ 84th St	19%	Y	Y	N		Y	1357	2521	4%	Y	N	Y	Y				N
RM-40-0011	I-43 SB @ 9th St / Abert Pl	12%	Y	Y	Y		Y	1225	7863	0%	Y	N	Y	Y				N
RM-40-0012	I-43 SB @ Keefe Ave	36%	Y	N	Y		Y	1129	1911	0%	Y	N	N	Y				N
RM-40-0013	I-43 SB @ Locust St	24%	Y	Y	N		Y	1472	2534	7%	Y	N	Y	N				N
RM-40-0015	I-43 SB @ Hampton Ave	30%	Y	N	N		N	908	1597	0%	Y	N	N	Y				N
RM-40-0016	I-794 @ 7th St/Clybourn St	4%	Y	Y	Y		Y	1379	3215	4%	N	N	Y	Y				N
RM-40-0017	I-43/94 NB @ Howard Ave	13%	Y	Y	Y		Y	757	2174	0%	Y	N	Y	Y				N
RM-40-0019	I-43 NB @ North Ave	12%	Y	Y	Y		Y	1712	2675	14%	Y	N	Y	Y				N
RM-40-0020	I-43 NB @ Locust St	13%	Y	Y	N		Y	1345	2150	0%	Y	N	Y	Y				N
RM-40-0021	I-94 EB @ Moorland Rd SB	19%	Y	Y	N		Y	1506	2518	2%	Y	N	Y	Y				N

RM	Location	Missing	Wisconsin Warrant				Meets warrant requirement?	Avg Flow for C2	Max Flow for C2	% of Flow > 2300 for C2	Texas Warrant							Meets warrant requirement?	
			Currently (June - Sept 2009)								Currently (June - Sept 2009)								
			C1	C2	C3	C4					C1	C2	C3	C4	C5	C6	C7		
RM-40-0022	I-43 SB @ Silver Spring Dr.	11%	Y	Y	Y		Y	842	2045	0%	N	N	Y	Y					N
RM-40-0023	I-43 SB @ Good Hope Rd	21%	Y	Y	N		Y	1577	3283	29%	Y	N	Y	Y					N
RM-40-0024	US 45 SB @ 97th St/Wisconsin Ave	12%	Y	Y	Y		Y	648	1826	0%	Y	N	Y	Y					N
RM-40-0025	US 45 SB @ Watertown Plank Rd	4%	Y	Y	Y		Y	1843	2853	24%	Y	N	Y	Y					N
RM-40-0026	US 45 SB @ North Ave	12%	Y	Y	Y		Y	1307	2161	0%	Y	N	Y	Y					N
RM-40-0027	I-43/94 SB @ 9th/Mineral St	24%	Y	Y	Y		Y	1577	3283	29%	Y	N	Y	Y					N
RM-40-0028	I-43/94 SB @ Lapham Blvd	50%	Y	Y	N		Y	1029	2522	1%	N	N	Y	N					N
RM-40-0030	I-94 NB @ Layton Ave WB	14%	Y	Y	N		Y	899	1644	0%	Y	N	N	Y					N
RM-40-0031	I-94 NB @ Layton Ave EB	10%	Y	Y	Y		Y	965	1827	0%	N	N	Y	Y					N
RM-40-0032	I-43/894 WB @ 27th St SB	Data have 20000-something vphpl.																	
RM-40-0033	I-43/894 WB @ 27th St NB	Data have 30000-something vphpl.																	
RM-40-0034	I-43/894 EB @ 27th St	16%	Y	Y	Y		Y	1355	2546	2%	Y	N	Y	Y					N
RM-40-0035	I-894/US 45 NB @ Beloit Rd	10%	Y	Y	Y		Y	1076	1857	0%	N	N	Y	Y					N
RM-40-0036	I-894/US 45 NB @ Oklahoma Ave	12%	Y	Y	Y		Y	1377	2196	0%	N	N	Y	Y					N
RM-40-0037	I-894/US 45 NB @ National Ave	13%	Y	Y	Y		Y	1192	2141	0%	Y	N	Y	Y					N
RM-40-0038	I-894/US 45 NB @ Lincoln Ave	14%	Y	Y	Y		Y	1481	2459	4%	Y	N	Y	Y					N
RM-40-0039	I-894/US 45 NB @ Greenfield Ave WB (Slip Ramp)	10%	Y	N	N		N	1138	1856	0%	Y	N	N	Y					N
RM-40-0040	I-894/US 45 NB @ Greenfield Ave EB (Loop Ramp)	10%	Y	Y	N		Y	1285	2118	0%	Y	N	Y	Y					N
RM-40-0041	I-894/US 45 SB @ Greenfield Ave	14%	Y	Y	N		Y	1499	2619	9%	Y	N	Y	N					N
RM-40-0044	I-894/US 45 SB @ National Ave	12%	Y	Y	N		Y	1231	2256	0%	Y	N	Y	Y					N
RM-40-0045	I-894/US 45 SB @ Beloit Rd	12%	Y	Y	N		Y	1178	2203	0%	Y	N	Y	Y					N
RM-40-0046	I-43 NB @ S. 108th St	12%	Y	Y	Y		Y	1618	2719	15%	N	N	Y	Y					N
RM-40-0047	I-43/894 WB @ 84th St	10%	Y	Y	Y		Y	1230	2114	0%	Y	N	Y	Y					N
RM-40-0048	I-43/894 EB @ Forest Home Ave	34%	Y	Y	N		Y	1079	1848	0%	Y	N	Y	N					N
RM-40-0049	I-43/894 EB @ 76th St	34%	Y	N	Y		Y	1037	1757	0%	Y	N	N	Y					N
RM-40-0050	I-43/894 WB @ 60th St	10%	Y	Y	Y		Y	1215	2005	0%	Y	N	Y	Y					N

RM	Location	Missing	Wisconsin Warrant				Meets warrant requirement?	Avg Flow for C2	Max Flow for C2	% of Flow > 2300 for C2	Texas Warrant							Meets warrant requirement?
			Currently (June - Sept 2009)								Currently (June - Sept 2009)							
			C1	C2	C3	C4					C1	C2	C3	C4	C5	C6	C7	
RM-40-0051	I-43/894 EB @ 60th St	10%	Y	Y	N		Y	1352	2104	0%	Y	N	Y	Y				N
RM-40-0052	I-43/894 EB @ Loomis Rd	11%	Y	Y	Y		Y	1407	2909	0%	Y	N	Y	Y				N
RM-40-0053	I-43/894 WB @ Loomis Rd	11%	Y	Y	N		Y	1236	2160	0%	Y	N	Y	N				N
RM-40-0054	I-43/94 SB @ Howard Ave	13%	Y	Y	Y		Y	1157	2382	0%	Y	N	Y	Y				N
RM-40-0055	I-43/94 SB @ Holt Ave	13%	Y	Y	Y		Y	769	2327	0%	Y	N	Y	Y				N
RM-40-0056	I-43/94 @ Lapham C-D Rd	34%	Y	Y	N		Y	677	1242	0%	Y	N	Y	N				N
RM-40-0057	I-43/94 @ Lapham Blvd	34%	Y	Y	N		Y	380	789	0%	N	N	Y	N				N
RM-40-0060	I-43 SB @ Greenbay Ave	13%	Y	Y	Y		Y	1070	1864	0%	Y	N	Y	Y				N
RM-40-0061	I-94 WB @ STH 100	11%	Y	Y	Y		Y	1202	2197	0%	Y	N	Y	Y				N
RM-40-0070	I-94 NB @ Ryan Rd	12%	Y	Y	N		Y	763	1795	0%	N	N	Y	N				N
RM-40-0071	I-94 NB @ Rawson Ave	17%	Y	Y	N		Y	1230	2064	0%	N	N	Y	N				N
RM-40-0072	I-94 NB @ College Ave	No data beyond May 2009																
RM-40-0073	I-94 SB @ 20th St/Layton Ave	10%	Y	Y	N		Y	806	1703	0%	Y	N	Y	Y				N
RM-40-0074	I-94 NB @ STH 119 (Airport Spur)	Data have 20000-something vphpl.																
RM-40-0075	I-94 EB @ 25th St	5%	Y	Y	N		Y	1707	2571	9%	Y	N	Y	N				N
RM-40-0076	I-94 WB @ 35th St	11%	Y	Y	Y		Y	1585	2499	2%	Y	N	Y	Y				N
RM-40-0077	US 41 NB @ Stadium Int S-E Ramp	34%	Y	Y	N		Y	386	2318	0%	Y	N	Y	N				N
RM-40-0078	US 41 NB @ Stadium Int S-W Ramp	35%	Y	Y	Y		Y	1079	1804	0%	Y	N	Y	Y				N
RM-40-0079	US 41 NB @ Stadium Int N-W Ramp	19%	Y	Y	Y		Y	1230	2058	0%	Y	N	Y	Y				N
RM-40-0080	US 41 SB @ Stadium Int N-E Ramp	34%	Y	Y	N		Y	664	2589	1%	Y	N	Y	N				N
RM-40-0081	I-94 WB @ Mitchell Blvd	12%	Y	Y	Y		Y	973	2454	0%	Y	N	Y	Y				N
RM-40-0082	I-94 EB @ Mitchell Blvd	17%	Y	Y	N		Y	1359	2478	0%	Y	N	N	Y				N
RM-40-0083	I-794 WB @ Carferry Dr	27%	Y	Y	N		Y	269	931	0%	N	N	Y	N				N
RM-40-0084	I-43 SB @ Brown Deer Rd EB	15%	Y	Y	Y		Y	1140	2265	0%	Y	N	Y	Y				N
RM-40-0085	I-43 SB @ Brown Deer Rd WB	11%	Y	Y	Y		Y	1057	1984	0%	Y	N	Y	Y				N
RM-40-0089	US 45 SB @ Good Hope Rd WB (Loop Ramp)	41%	Y	N	N		N	1084	1772	0%	Y	N	N	Y				N

RM	Location	Missing	Wisconsin Warrant				Meets warrant requirement?	Avg Flow for C2	Max Flow for C2	% of Flow > 2300 for C2	Texas Warrant							Meets warrant requirement?
			Currently (June - Sept 2009)								Currently (June - Sept 2009)							
			C1	C2	C3	C4					C1	C2	C3	C4	C5	C6	C7	
RM-40-0090	US 45 SB @ Good Hope Rd EB (Slip Ramp)	10%	Y	Y	N		Y	782	1379	0%	Y	N	Y	Y				N
RM-40-0095	US 45 NB @ Appleton Ave	11%	Y	N	N		N	1278	2189	0%	Y	N	N	Y				N
RM-40-0096	US 45 SB @ Appleton Ave	5%	Y	Y	N		Y	1146	1984	0%	Y	N	Y	Y				N
RM-40-0097	US 45 NB @ Silver Spring Dr	5%	Y	Y	N		Y	1215	2101	0%	Y	N	Y	Y				N
RM-40-0098	US 45 SB @ Silver Spring Dr	12%	Y	Y	N		Y	921	2223	0%	Y	N	Y	Y				N
RM-40-0099	US 45 NB @ Hampton Ave	11%	Y	Y	N		Y	1420	2315	0%	Y	N	Y	Y				N
RM-40-0100	US 45 SB @ Hampton Ave	47%	Y	N	N		N	959	1834	0%	Y	N	N	Y				N
RM-40-0101	US 45 NB @ Capitol Dr	5%	Y	Y	N		Y	1527	2359	0%	Y	N	Y	Y				N
RM-40-0104	US 45 NB @ North Ave	8%	Y	Y	N		Y	1619	2511	11%	Y	N	Y	Y				N
RM-40-0106	US 45 NB @ Wisconsin Ave	13%	Y	Y	N		Y	1130	2719	39%	Y	N	Y	Y				N
RM-40-0107	US 45 NB @ Burleigh St	13%	Y	Y	N		Y	1499	2325	0%	Y	N	Y	Y				N
RM-40-0108	I-94 SB @ College Ave	50%	Y	N	N		N	728	2258	0%	N	N	N	N				N
RM-40-0109	I-94 SB @ Rawson Ave	34%	Y	N	N		N	567	1233	0%	N	N	N	N				N
RM-40-0110	I-94 SB @ Ryan Rd	14%	Y	Y	N		Y	489	1190	0%	N	N	Y	N				N
RM-40-0112	I-94 NB @ Rawson Ave EB	22%	Y	Y	N		Y	870	1723	0%	N	N	Y	N				N
RM-40-0115	US 45 NB @ Good Hope Rd	10%	Y	Y	N		Y	852	1587	0%	N	N	Y	Y				N
RM-40-0116	US 41/45 NB @ STH 145	11%	Y	Y	N		Y	1243	2454	1%	N	N	Y	Y				N
RM-40-0117	US 41/45 SB @ STH 145	10%	Y	Y	N		Y	1442	2431	3%	Y	N	Y	Y				N
RM-40-0124	I-43 NB @ Atkinson Ave	11%	Y	N	N		N	1262	2034	0%	Y	N	N	Y				N
RM-40-0125	I-43 NB @ Highland Ave/Kilbourn Ave	6%	Y	Y	Y		Y	905	1926	0%	N	N	Y	Y				N
RM-40-0126	I-43 SB @ Fond du Lac Ave	No data for mainline																
RM-40-0127	I-43 NB @ McKinley Ave	5%	Y	Y	Y		Y	497	1151	0%	N	N	Y	Y				N
RM-40-0128	I-43 SB @ Wisconsin Ave	11%	Y	Y	Y		Y	1337	2638	5%	N	N	Y	Y				N
RM-40-0129	I-94 WB @ 11th St/Tory Hill	12%	Y	Y	Y		Y	171	453	0%	N	N	N	Y				N
RM-40-0201	I-794 @ Lincoln Memorial Dr	No data for entrance ramp																
RM-45-0086	I-43 SB @ County Line Rd (Ozaukee)	14%	Y	Y	Y		Y	1078	1927	0%	Y	N	Y	Y				N

RM	Location	Missing	Wisconsin Warrant				Meets warrant requirement?	Texas Warrant										
			Currently (June - Sept 2009)					Avg Flow for C2	Max Flow for C2	% of Flow > 2300 for C2	Currently (June - Sept 2009)							Meets warrant requirement?
			C1	C2	C3	C4					C1	C2	C3	C4	C5	C6	C7	
RM-45-0087	I-43 SB @ Mequon Rd (STH 167)	12%	Y	Y	Y		Y	798	1454	0%	N	N	Y	Y				N
RM-45-0088	I-43 SB @ Pioneer Rd	10%	Y	Y	N		Y	713	1300	0%	N	N	Y	Y				N
RM-66-0111	US 41/45 SB @ Lannon Rd	No data for entrance ramp																
RM-67-0042	I-94 EB @ Moorland Rd SB	10%	Y	Y	Y		Y	1063	2894	0%	Y	N	Y	Y				N
RM-67-0043	I-94 EB @ Moorland Rd NB	28%	Y	N	Y		Y	756	1339	0%	Y	N	N	Y				N
RM-67-0062	I-94 WB @ Moorland Rd	30%	Y	Y	N		Y	811	1788	0%	Y	N	Y	Y				N
RM-67-0063	I-94 EB @ Barker Rd	20%	Y	Y	N		Y	1222	2382	0%	Y	N	Y	N				N
RM-67-0064	I-94 EB @ US 18	19%	Y	Y	N		Y	1334	2260	0%	Y	N	Y	Y				N
RM-67-0065/0066	I-94 WB @ CTH JJ (Bluemound Rd)	28%	Y	Y	N		Y	1045	1820	0%	Y	N	Y	N				N
RM-67-0067	I-94 EB @ CTH F	15%	Y	Y	N		Y	1192	2236	0%	Y	N	Y	Y				N
RM-67-0068	I-94 EB @ CTH J	10%	Y	Y	N		Y	1450	2517	6%	Y	N	Y	Y				N
RM-67-0069	I-94 EB @ CTH T	38%	Y	N	N		N	485	1093	0%	N	N	N	Y				N
RM-67-0091	US 41/45 SB @ County Line Rd	13%	Y	Y	N		Y	734	1424	0%	N	N	Y	Y				N
RM-67-0092	US 41/45 SB @ Pilgrim Rd	10%	Y	Y	N		Y	888	2210	0%	Y	N	Y	Y				N
RM-67-0093	US 41/45 SB @ STH 74 (Main St)	10%	Y	Y	N		Y	748	1723	0%	Y	N	Y	Y				N
RM-67-0113	I-94 WB @ CTH T	25%	Y	Y	N		Y	505	1456	0%	N	N	Y	Y				N
RM-67-0114	US 41/45 NB @ 124th St	14%	Y	N	N		N	700	1744	0%	Y	N	N	Y				N
RM-67-0118	US 41/45 NB @ STH 74 (Main St)	13%	Y	Y	N		Y	916	2619	0%	Y	N	Y	Y				N
RM-67-0119	US 41/45 NB @ Pilgrim Rd	28%	Y	Y	N		Y	886	2242	0%	Y	N	Y	Y				N
RM-67-0120	I-94 WB @ CTH G	No sufficient data																
RM-67-0121	I-94 EB @ CTH G	12%	Y	Y	N		Y	691	1629	0%	N	N	Y	Y				N
RM-67-0122	I-94 EB @ CTH SS	12%	Y	Y	N		Y	1060	1911	0%	Y	N	N	Y				N
RM-67-0123	I-94 WB @ CTH SS	12%	Y	N	N		N	1014	1947	0%	Y	N	N	Y				N

Figure 6. Average Combined Flow Rate vs. Minimum Threshold for Category C2

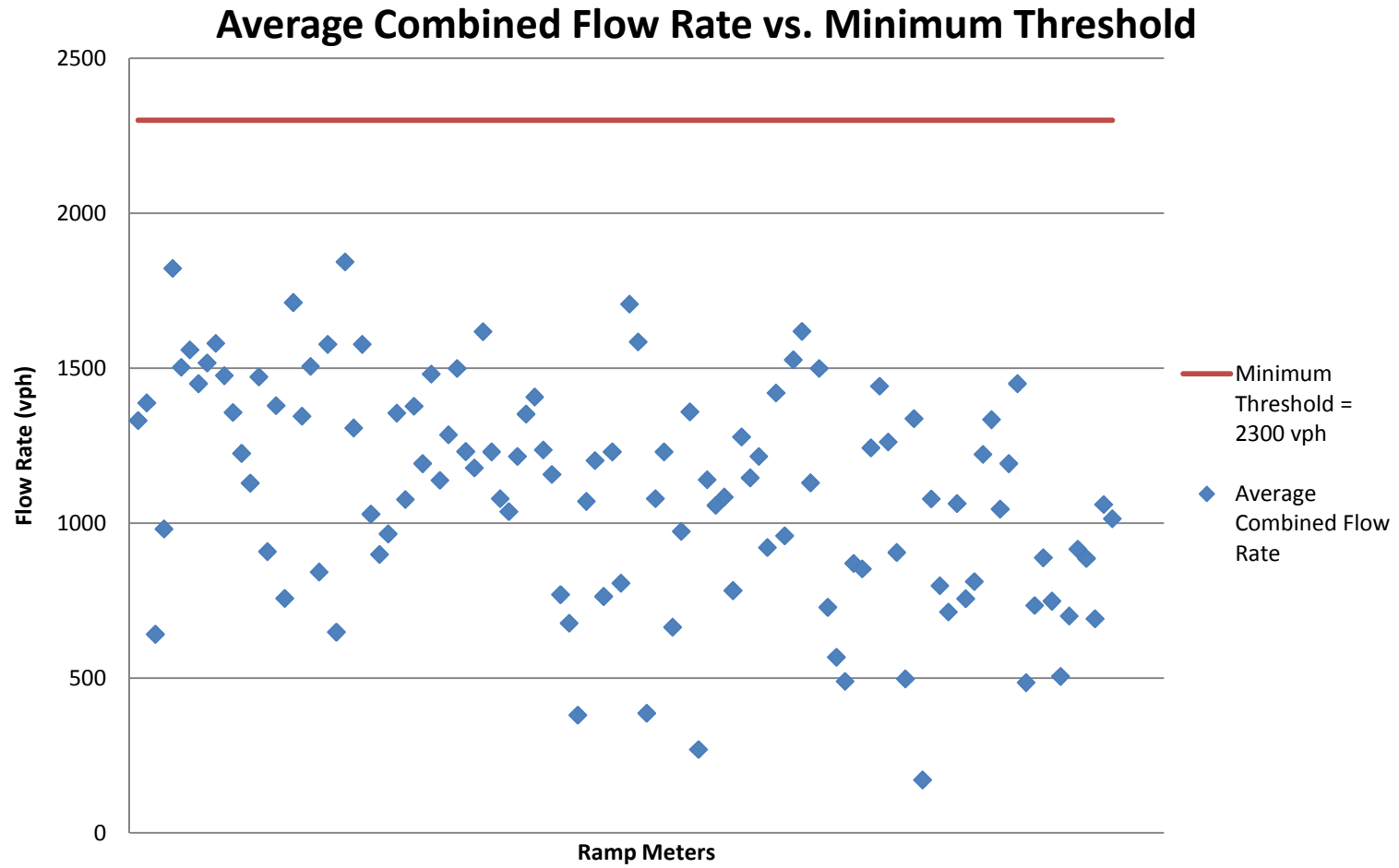


Figure 7. Maximum Combined Flow Rate vs. Minimum Threshold for Category C2

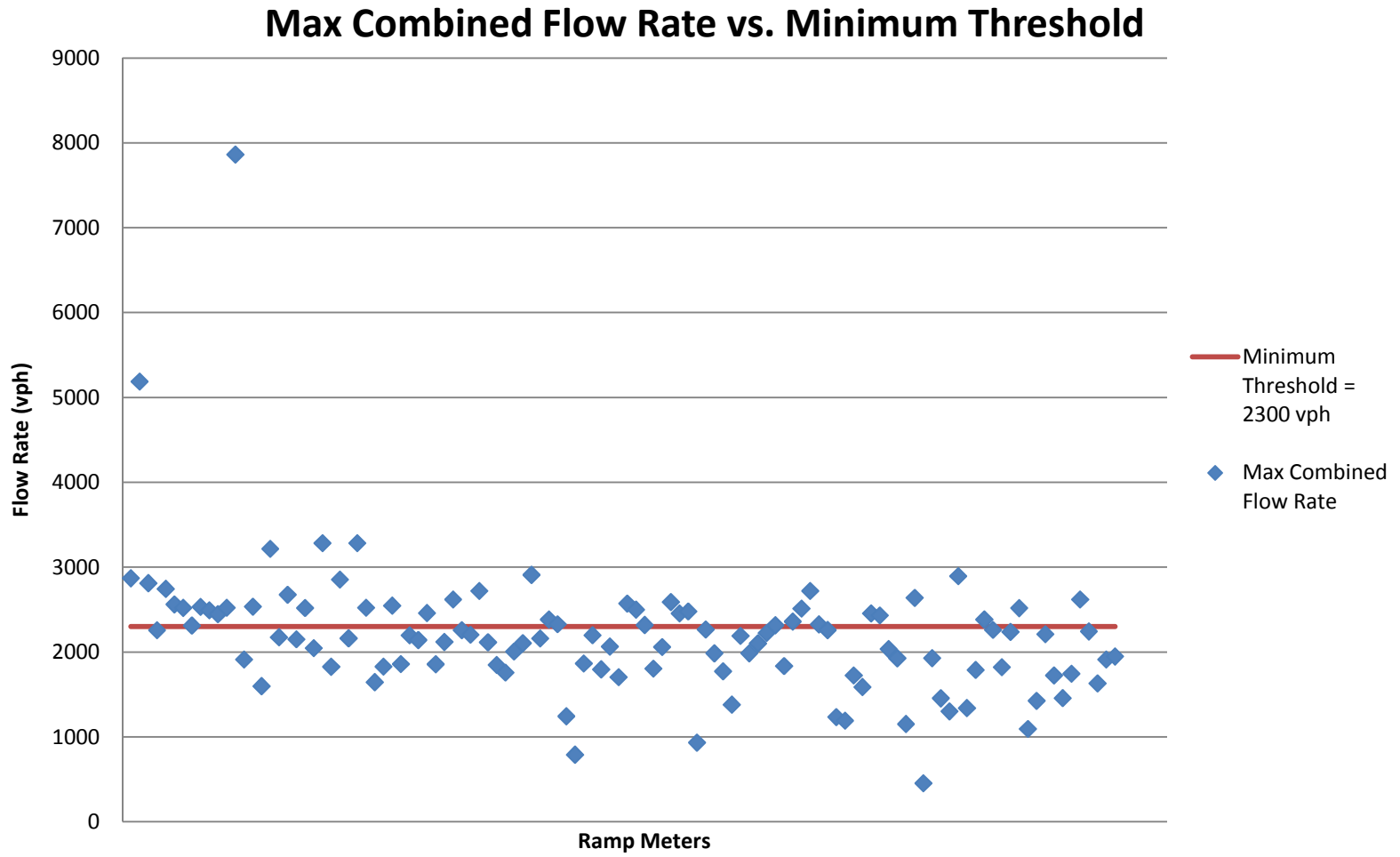


Table 2. During Start-Up Analysis

*Note: Column “% of Flow > 2300 for C2” is rounded up to have no decimal values

RM	Location	Missing (During Start-Up)	During Start-Up																
			WisDOT Warrant				Meet warrant requirement?	Avg Flow for C2	Max Flow for C2	% of Flow > 2300 for C2	TXDOT Warrant							Meet warrant requirement?	
			C1	C2	C3	C4					C1	C2	C3	C4	C5	C6	C7		
RM-13-006	USH 12/14 WB @ Todd Dr (Landmark Ramp)	49%	Y	N	Y		Y	689	1499	0%	N	N	No Data	Y					N
RM-67-043	I-94 EB @ Moorland Rd NB	3%	Y	Y	Y		Y	1632	3531	22%	Y	N	Y	Y					N
RM-67-062	I-94 WB @ Moorland Rd	2%	N	Y	Y		Y	1885	2476	9%	N	N	Y	Y					N
RM-67-063	I-94 EB @ Barker Rd	4%	Y	Y	N		Y	2440	3937	60%	Y	Y	Y	Y					Y
RM-67-064	I-94 EB @ US 18	8%	N	Y	Y		Y	1368	2220	0%	Y	N	N	Y					N
RM-67-065/066	I-94 WB @ CTH JJ (Bluemound Rd)	7%	Y	Y	N		Y	3100	4176	84%	Y	Y	Y	Y					Y
RM-67-067	I-94 EB @ CTH F	5%	N	Y	Y		Y	577	1176	0%	N	N	Y	Y					N
RM-67-068	I-94 EB @ CTH J	3%	N	Y	Y		Y	2580	3911	71%	N	Y	Y	Y					N
RM-67-069	I-94 EB @ CTH T	5%	N	Y	Y		Y	2951	3725	84%	N	Y	Y	Y					N
RM-40-070	I-94 NB @ Ryan Rd	100%	No Data																
RM-40-075	I-94 EB @ 25th St	79%	Insufficient Data																
RM-40-077	US 41 NB @ Stadium Int S-E Ramp	67%	Insufficient Data																
RM-40-078	US 41 NB @ Stadium Int N-E Ramp	80%	Insufficient Data																
RM-40-080	US 41 SB @ Stadium Int N-E Ramp	84%	Insufficient Data																
RM-40-082	I-94 EB @ Mitchell Blvd	13%	Y	Y	N		Y	1748	2837	23%	N	N	Y	Y					N
RM-40-089	US 45 SB @ Good Hope Rd WB (Loop Ramp)	44%	Y	N	N		N	1078	2376	1%	Y	N	N	Y					N
RM-40-090	US 45 SB @ Good Hope Rd EB (Slip Ramp)	13%	N	Y	Y		Y	1061	1845	0%	N	N	Y	Y					N
RM-67-091	US 41/45 SB @ County Line Rd	100%	No Data																
RM-67-092	US 41/45 SB @ Pilgrim Rd	100%	No Data																
RM-67-093	US 41/45 SB @ STH 74 (Main St)	100%	No Data																
RM-40-108	I-94 SB @ College Ave	42%	N	Y	Y		Y	955	2728	1%	N	N	Y	Y					N

RM	Location	Missing (During Start-Up)	During Start-Up															
			WisDOT Warrant				Meet warrant requirement?	Avg Flow for C2	Max Flow for C2	% of Flow > 2300 for C2	TXDOT Warrant							Meet warrant requirement?
			C1	C2	C3	C4					C1	C2	C3	C4	C5	C6	C7	
RM-67-113	I-94 WB @ CTH T	75%	Insufficient Data															
RM-40-115	US 45 NB @ Good Hope Rd	0%	Y	Y	N		Y	888	1318	0%	N	N	Y	Y				N
RM-40-117	US 41/45 SB @ STH 145	33%	Y	Y	N		Y	1079	2406	5%	Y	N	Y	Y				N
RM-67-118	US 41/45 NB @ STH 74 (Main St)	21%	Y	Y	N		Y	828	1879	0%	N	N	Y	Y				N
RM-67-119	US 41/45 NB @ Pilgrim Rd	29%	Data have 80000-something vphpl															
RM-67-120	I-94 WB @ CTH G	9%	Y	Y	N		Y	1409	2344	1%	Y	N	N	Y				N
RM-67-121	I-94 EB @ CTH G	2%	Y	Y	N		Y	710	1336	0%	N	N	Y	Y				N
RM-40-124	I-43 NB @ Atkinson Ave	10%	Y	N	Y		Y	1248	1949	0%	Y	N	N	Y				N

Figure 8. (Start-Up) Average Combined Flow Rate vs. Minimum Threshold for Category C2

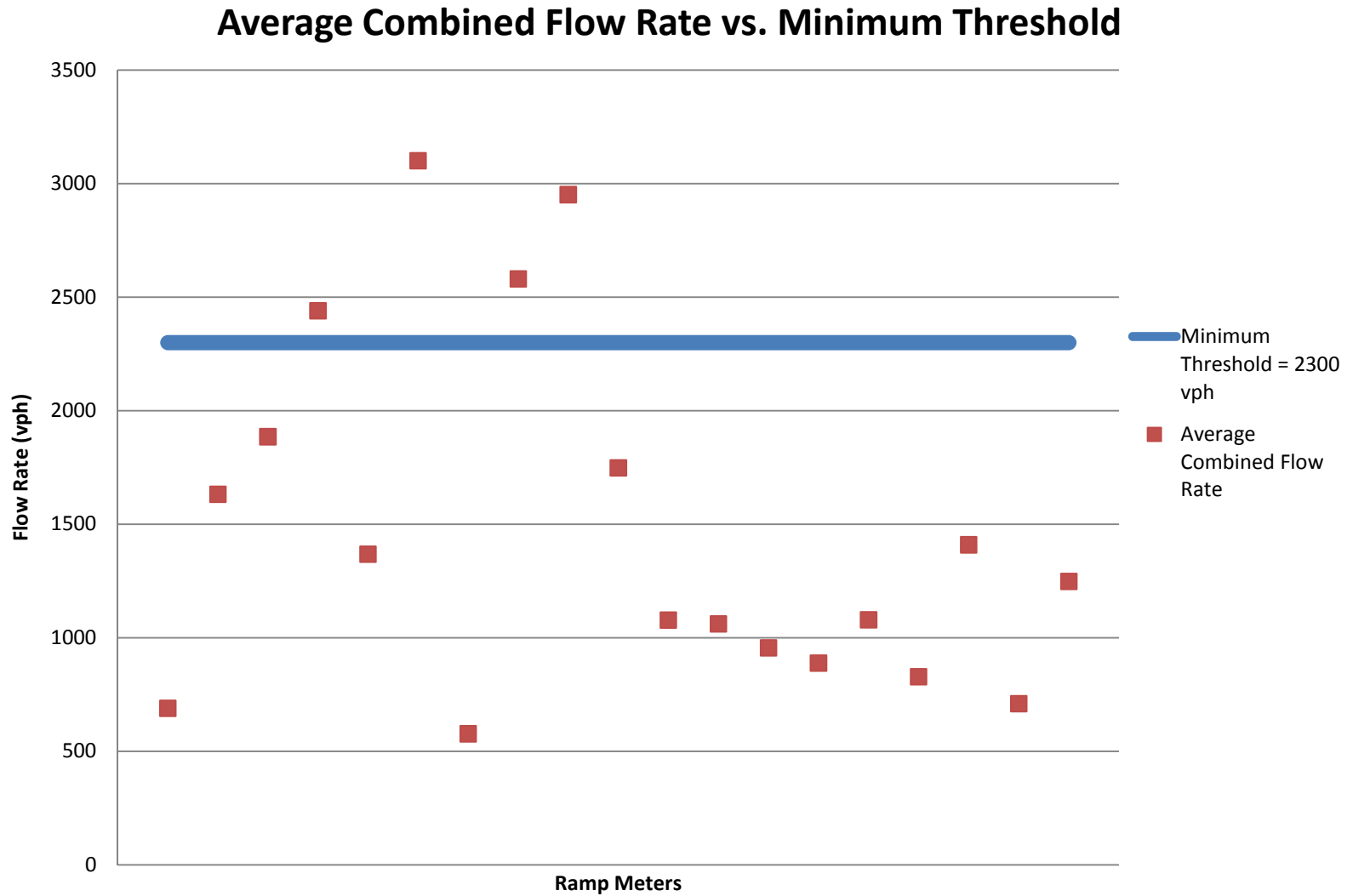


Figure 9. (Start-Up) Maximum Combined Flow Rate vs. Minimum Threshold for Category C2

Maximum Combined Flow Rate vs. Minimum Threshold

