WISCONSIN TRAFFIC OPERATIONS
& SAFETY LABORATORY
UNIVERSITY OF WISCONSIN-MADISON **Department of Civil and Environmental Engineering**

Date:	March 3, 2011
To:	Marie Treazise and Chris Quesnell, WisDOT Bureau of Traffic Operations
From:	William J. Melendez, Wisconsin TOPS Lab
Subject:	RM-67-062 (I-94 WB at Moorland Road) Turn-Off Analysis

On December 9, 2009, the Wisconsin Department of Transportation (WisDOT) turned off the ramp meter RM 67-062 located on I-94 westbound at Moorland Road in an effort to evaluate its performance and determine whether it should remain operational. The basic objective of the performance assessment was to determine whether the ramp meter has been an effective element addressing congestion in the on-ramp location providing smoother merging into the mainline freeway.

WisDOT proposed a set of warrants to provide an approach to ramp metering installation.[1] Two principal considerations were established: traffic criteria, which is related to the traffic conditions on the ramp and the mainline; and design criteria, which is related to the geometric design.

Previous Analysis

In January 2010, a previous operational analysis was performed for this ramp meter[2]. As mentioned, the ramp was turned off on December 9, 2009. The data used was between November 9, 2009 to January 9, 2010, which covers a 30-day period before and after the meter became inactive. The morning operating peak period was from 7:00AM to 8:30AM while the afternoon peak period was from 3:30PM to 5:30PM. This analysis revealed that there was an improvement on the ramp for both the ramp speed and occupancy for both AM and PM while the mainline speed decreased by approximately 6 mph with the meter turned off. At the end of the analysis it was recommended to keep the ramp meter inactive because it showed improvements on the ramp and although the mainline got worse, it was not too substantial compared to the ramp improvements. The very high ramp volumes and other considerations also were considered in the decision to leave the meter inactive.

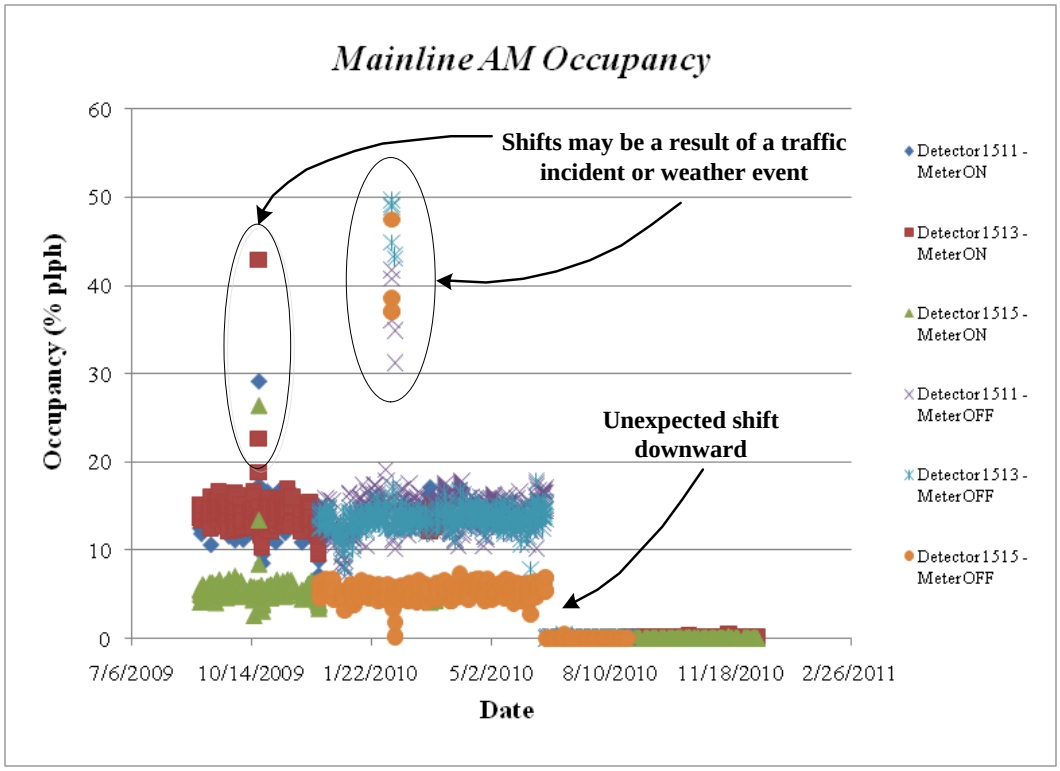
[1] *WisDOT Ramp Metering and Control Plan.* Wisconsin Department of Transportation and Wilbur Smith Associates. July 2006. Available at http://www.topslab.wisc.edu/its/rampmetering/WisDOT_ramp_control_plan.pdf

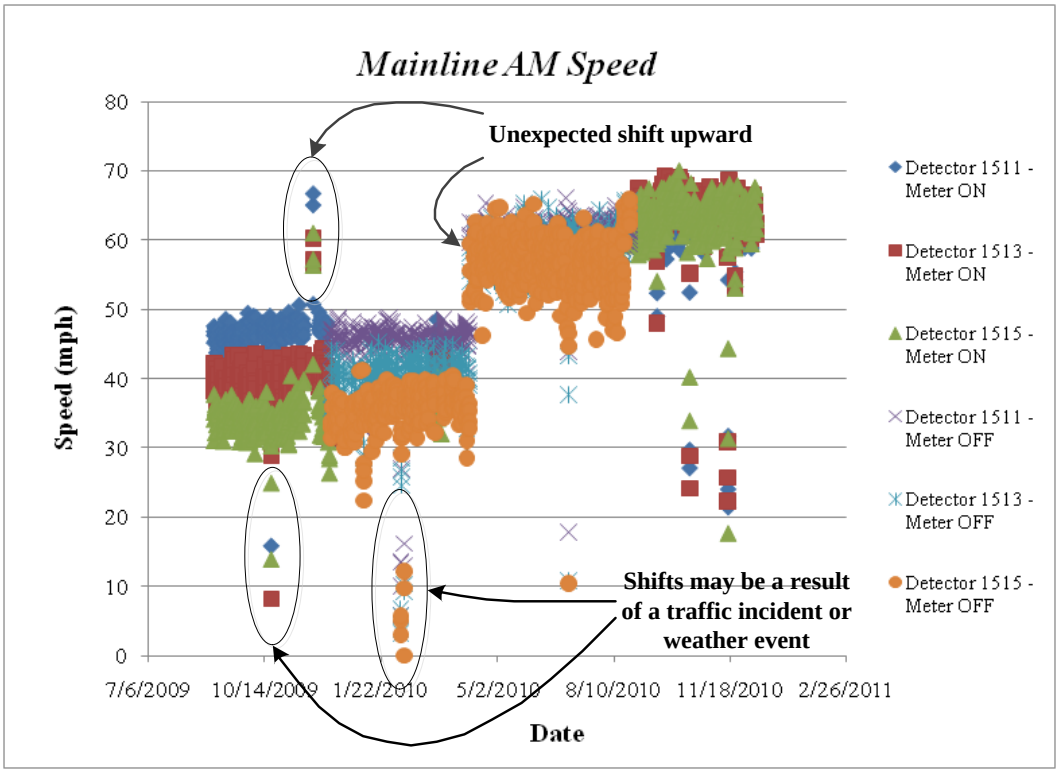
[2] Memo Available at http://www.topslab.wisc.edu/its/rampmetering/evaluation/RM5_Operations_20091229.pdf

Updated Analysis

WisDOT turned back on the ramp meter on March 10, 2010 at 4:19PM but shortly later on March 16, 2010 at 3:44PM it again was set inactive. On August 24, 2010 at 4:30PM it became and remains active. The previous analysis was performed with a 30-day period before and after the ramp meter became inactive on December 9, 2009, and the limited data - which combined with the holidays and winter season - might not provide good feedback on what is the pattern along the freeway. For this new analysis, the data was retrieved from September 1, 2009 up to December 10, 2010, which covers slightly more than a full year of data. The metering periods for this analysis are from 7:15AM to 8:15AM and from 4:15PM to 5:30PM.

During the analysis several situations were encountered as shown in the following two figures.





These figures show the occupancy and speed for the three mainline loops during the AM peak period. As mentioned, the data retrieved was from September 9, 2009 through December 10, 2010, weekdays only and excluding holidays and two other days with a large proportion of bad data.

As noticed in the first figure, there is a big shift downward in occupancy on June 17, 2010 when the meter was still off. This situation occurred for all the three mainline loops for both AM and PM period as well as for the ramp detector. A few other scattered shifts are seen around October 20, 2009 and February 9, 2010 which may be a result of a traffic incident or a weather condition.

Meanwhile, in the second figure there are two occasions when there is a big shift upward in speed; for a short period between November 18-24 and more noticeably from April 8 and on. Also, there are two shits downward during October 20, 2009 and February 9, 2010. These short period shifts may be a result of a traffic incident or weather event. Interestingly, the shift upward during November 18-24 was also encountered during the PM period, however, in this case the shift was downward which suggests that it was not related to any kind of event.

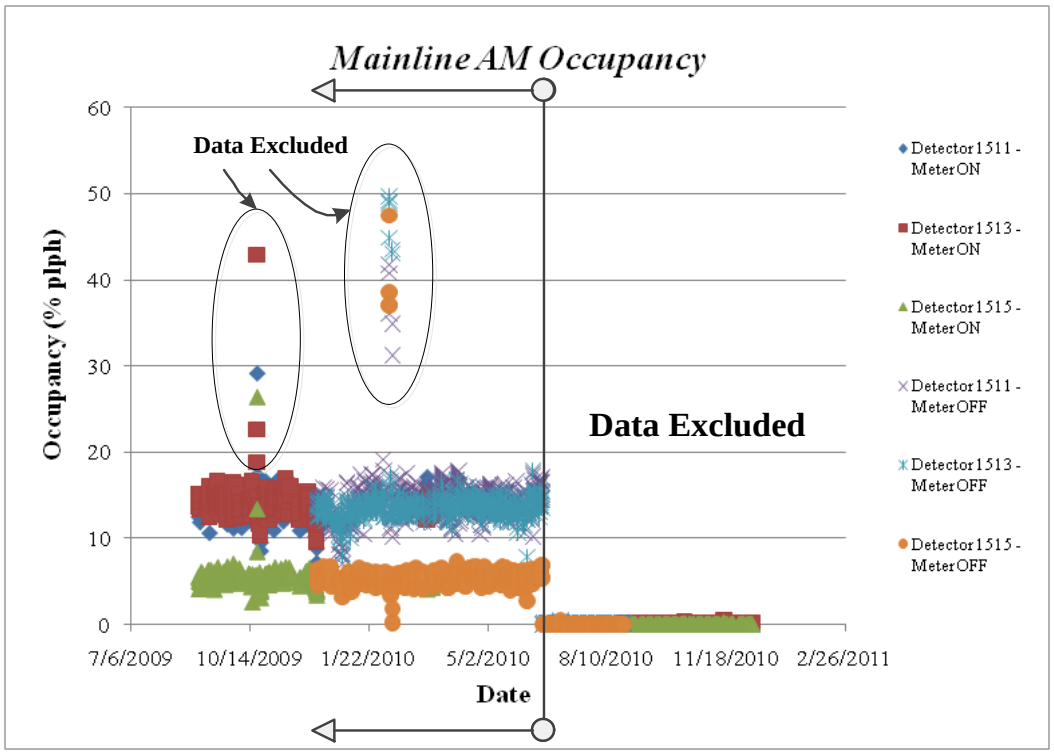
Another interesting aspect encountered during the analysis was an unexpected shift upward in speed around August 17, 2010, roughly a week before the meter was turned on. It is hardly seen in the figure above, and to the casual observer this shift might suggests an improvement in the mainline speed due to the meter. However, since it occurred a week before the meter was turned on, it is most likely not related to a meter improvement.

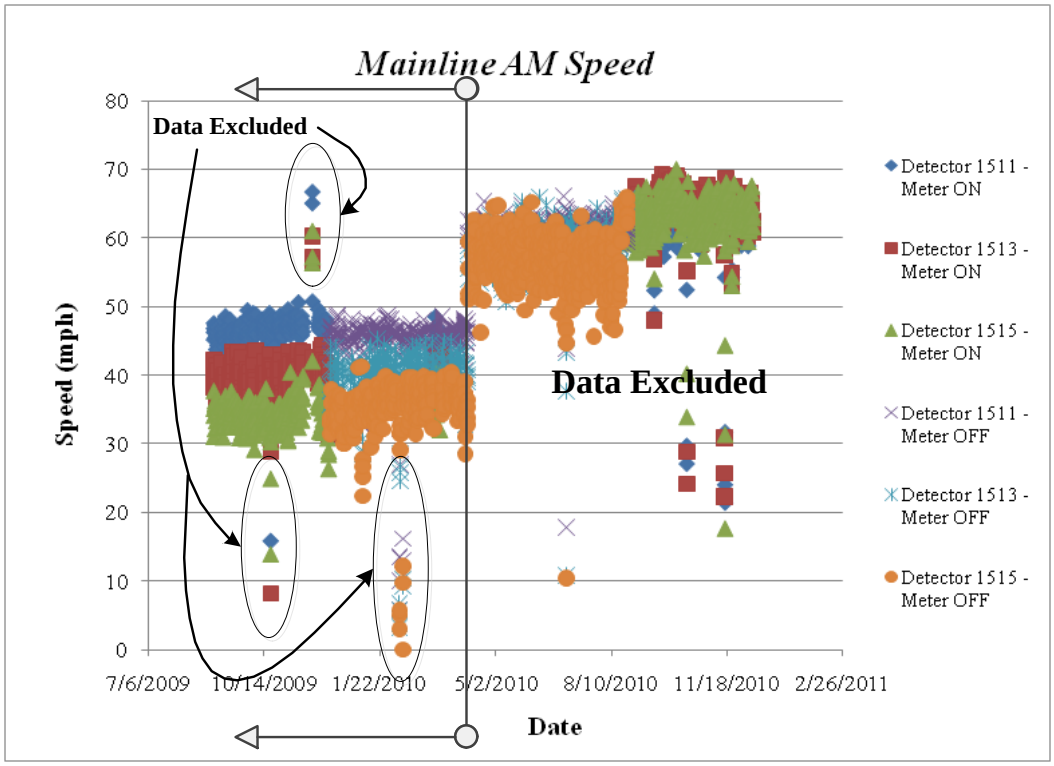
There were a few aspects that were considered to be a cause for these unexpected results. First, the I-94 - Calhoun Road construction were thought to be a cause, however, this project was completed around September 15, 2009 which preceded this analysis. Another cause for these results was thought to be calibration, and indeed it does. It was reported that there was mainline calibration problems for much of the I-94 Eastbound corridor in Waukesha County. Certainty, calibration problems affect the evaluations work performed on archived data from V-SPOC[3].

Given the fact that calibration was the principal cause of these shifts it was necessary to evaluate the ramp meter while trying to control the factors causing these shifts. Due to the unexpected shift downward in occupancy as seen in the first figure, the data after June 17, 2010 was excluded because it does not provide reliable results. The unexpected shift upward in the mainline speed after April 8, 2010 as seen in the second figure above, also suggests unreliable results. Moreover, the fact that there was an improvement in the mainline speed while the meter was still off clearly suggests that the data would not provide useful results. All of these unexpected shifts were excluded from the analysis as well as some scattered shifts to get a better and accurate set of data. At this end, the ramp meter was evaluated using the data as follows:

RAMP METER ON	RAMP METER OFF
Data from September 1, 2009 to November 17, 2009	Data from December 9, 2009 to March 10, 2010
Data from November 25, 2009 to December 9, 2009	Data from March 16, 2010 to April 7, 2010
Data from March 10, 2010 to March 16, 2010	

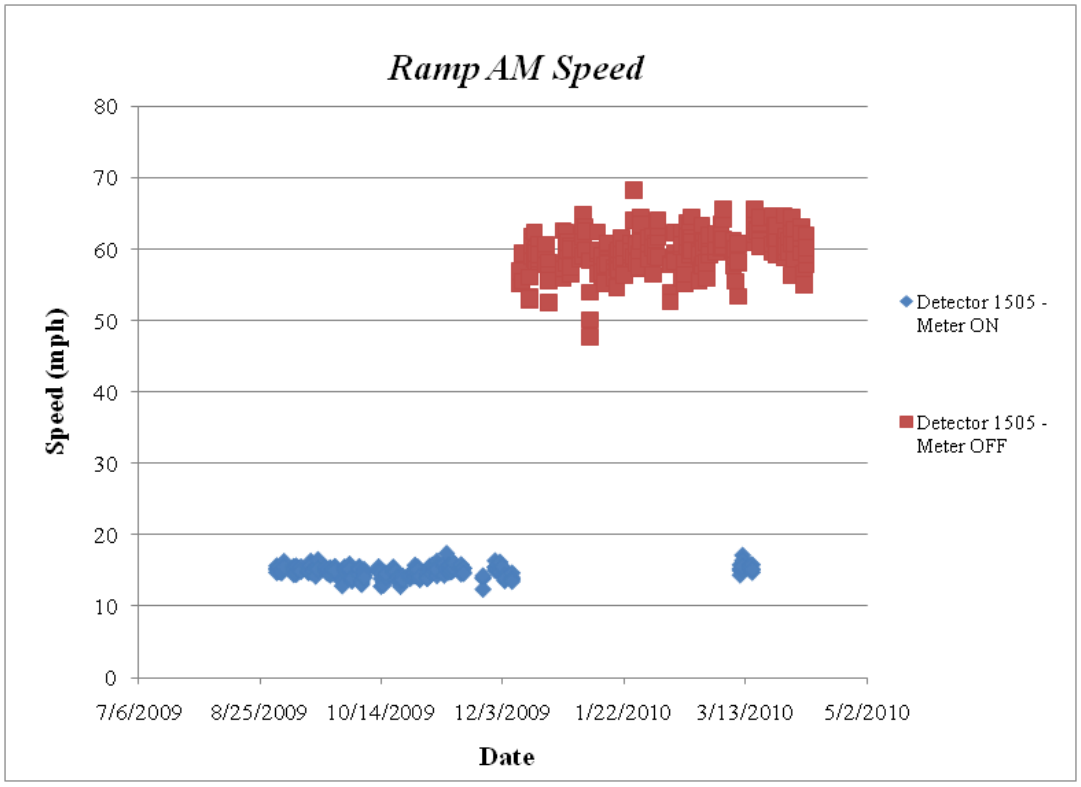
[3] WisTransPortal Volume, Speed, and Occupancy (V-SPOC) Application Suite, http://transportal.cee.wisc.edu/applications/vspoc.html

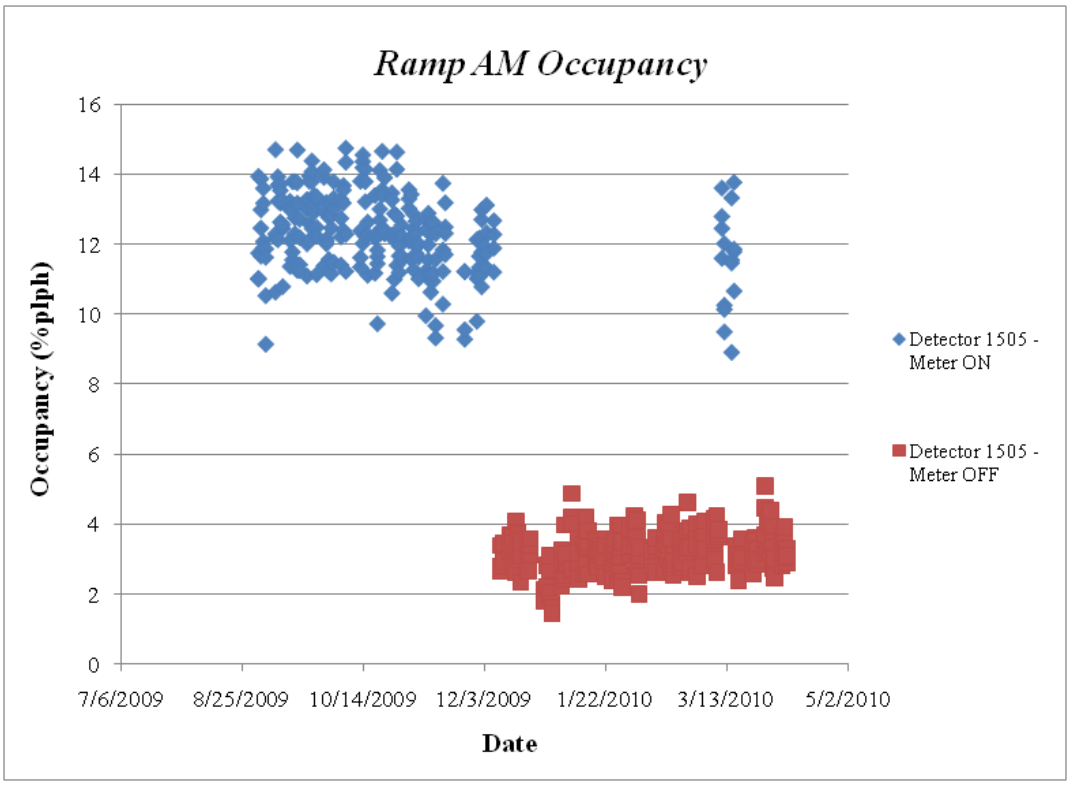

Mainline AM Occupancy
Occupancy (% plph)
60
50
40
30
20
10
0
Data Excluded
Data Excluded
7/6/2009
10/14/2009
1/22/2010
5/2/2010
8/10/2010
11/18/2010
2/26/2011
Date
Detector1511 - MeterON
Detector1513 - MeterON
Detector1515 - MeterON
Detector1511 - MeterOFF
Detector1513 - MeterOFF
Detector1515 - MeterOFF

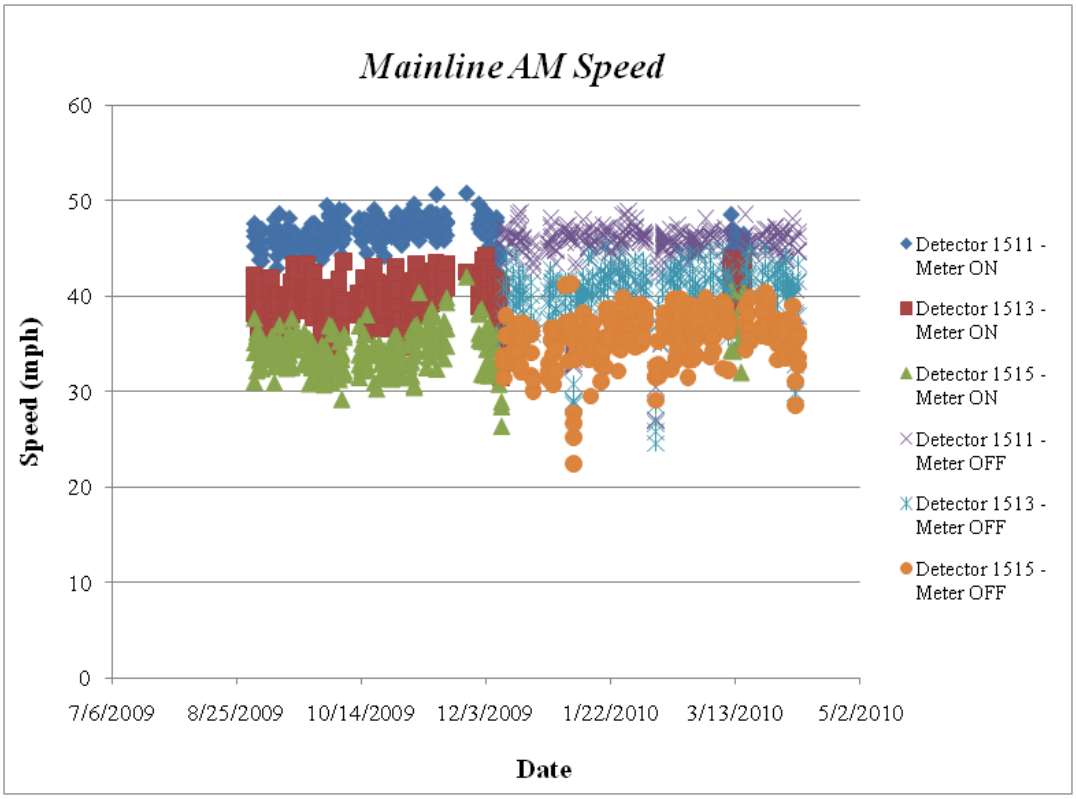

Mainline AM Speed
Speed (mph)
80
70
60
50
40
30
20
10
0
Data Excluded
Data Excluded
7/6/2009
10/14/2009
1/22/2010
5/2/2010
8/10/2010
11/18/2010
2/26/2011
Date
Detector 1511 - Meter ON
Detector 1513 - Meter ON
Detector 1515 - Meter ON
Detector 1511 - Meter OFF
Detector 1513 - Meter OFF
Detector 1515 - Meter OFF

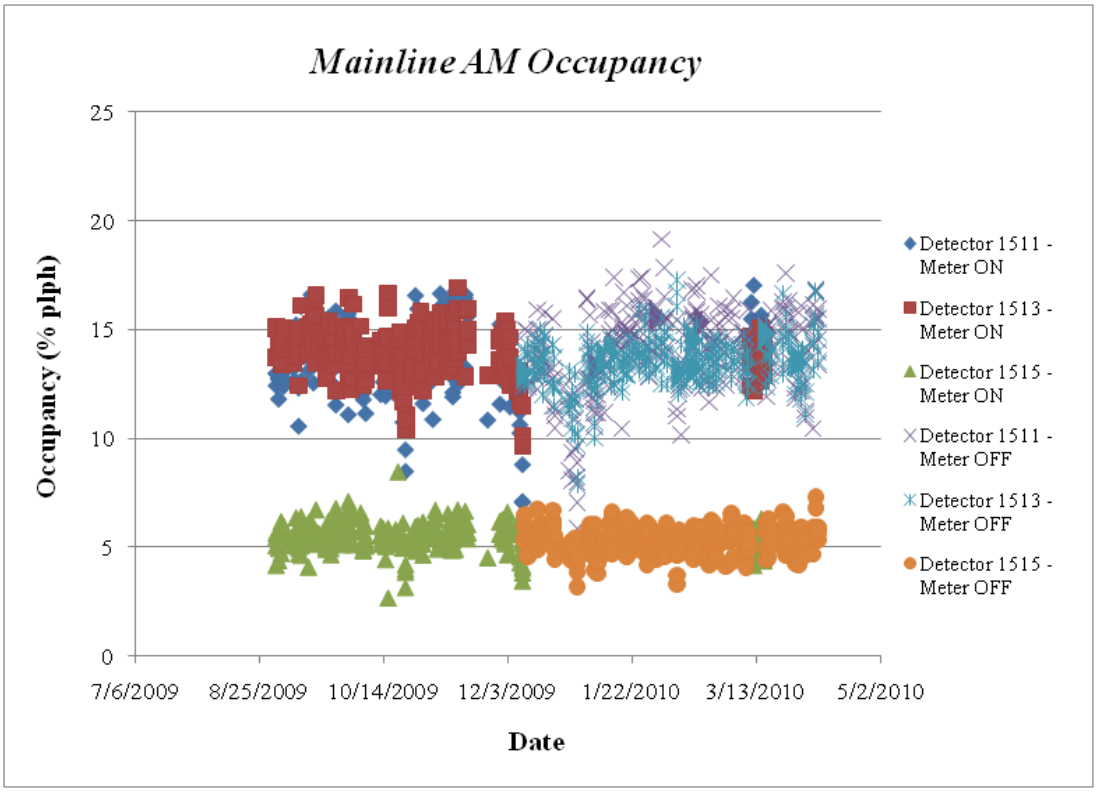
The previous table shows the timeframes that were used for the data analysis. While the figures give a visual representation of how the data was analyzed. As seen, the data was analyzed from September 1, 2009 thru April 7, 2010 but excluding the shifts occurring in October 20, between November 18-24, and in February 9, 2010.

The following figures show how is the data after excluding the data that was not used for the analysis.




Ramp AM Occupancy
Occupancy (%plph)
16
14
12
10
8
6
4
2
0
7/6/2009
8/25/2009
10/14/2009
12/3/2009
1/22/2010
3/13/2010
5/2/2010
Date
Detector 1505 - Meter ON
Detector 1505 - Meter OFF


Mainline AM Speed
Speed (mph)
60
50
40
30
20
10
0
7/6/2009
8/25/2009
10/14/2009
12/3/2009
1/22/2010
3/13/2010
5/2/2010
Date
Detector 1511 - Meter ON
Detector 1513 - Meter ON
Detector 1515 - Meter ON
Detector 1511 - Meter OFF
Detector 1513 - Meter OFF
Detector 1515 - Meter OFF



Results

As mentioned, the ramp meter analysis was based on the data before April 8, 2010, which did not have major calibration problems. Both the mainline and ramp were evaluated based on the flow, speed and occupancy in order to determine if it is feasible whether to maintain the meter on or not. Statistical significance is indicated if the difference exceeds the 0.05 level of significance.

Peak Period AM

Flow (avg. vphpl)

	Meter Effect				
	Active	Inactive	Change	Impact	Significance
Mainline	1326.2	1294.68	-31.52	Improves	Non significant
Ramp	377.74	395.14	17.39	Worsens	**Statistically significant**

Speed (avg. mph)

	Meter Effect				
	Active	Inactive	Change	Impact	Significance
Mainline	40.23	40.4	0.17	Worsens	Non significant
Ramp	14.89	59.6	44.71	Worsens	**Statistically significant**

Occupancy (avg. % plph)

	Meter Effect				
	Active	Inactive	Change	Impact	Significance
Mainline	11.04	10.92	-0.12	Worsens	Non significant
Ramp	12.29	3.22	-9.08	Worsens	**Statistically significant**

Peak Period PM

Flow (avg. vphpl)

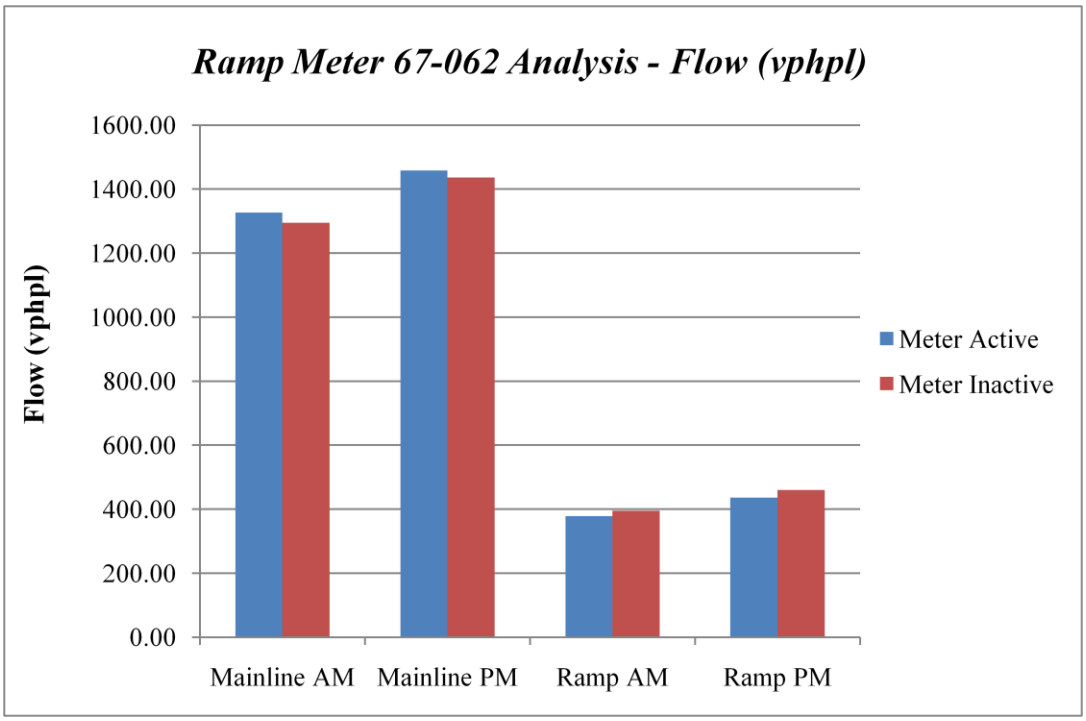
	Meter Effect				
	Active	Inactive	Change	Impact	Significance
Mainline	1458.11	1436.18	-21.93	Improves	Non significant
Ramp	436.12	459.43	23.31	Worsens	**Statistically significant**

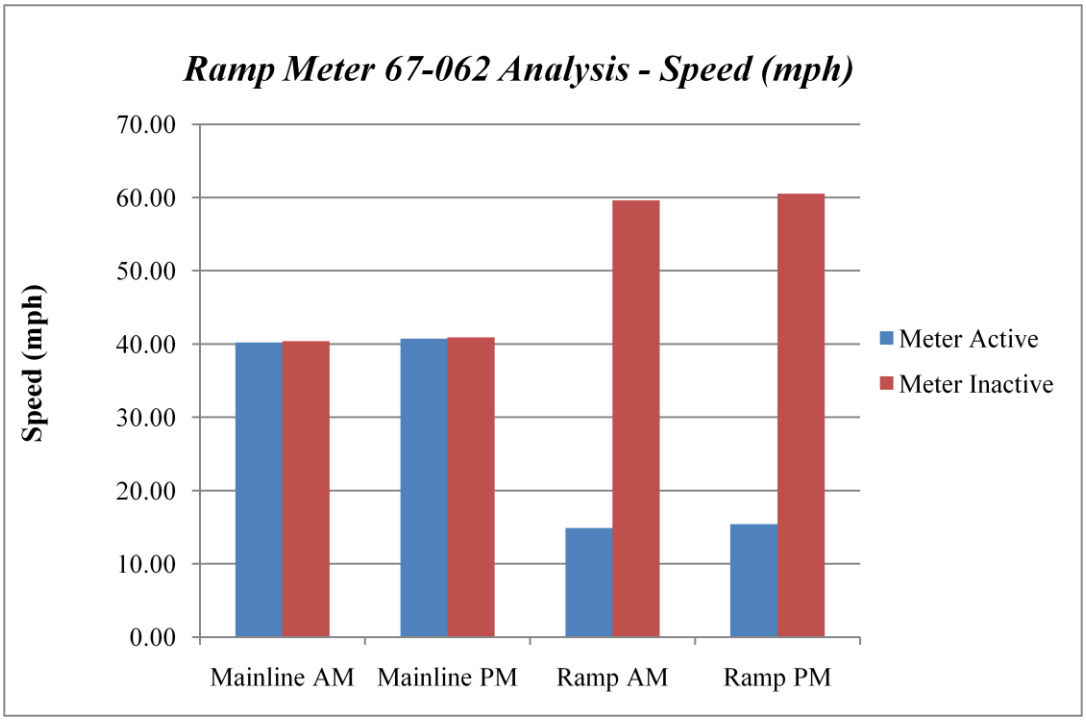
Speed (avg. mph)

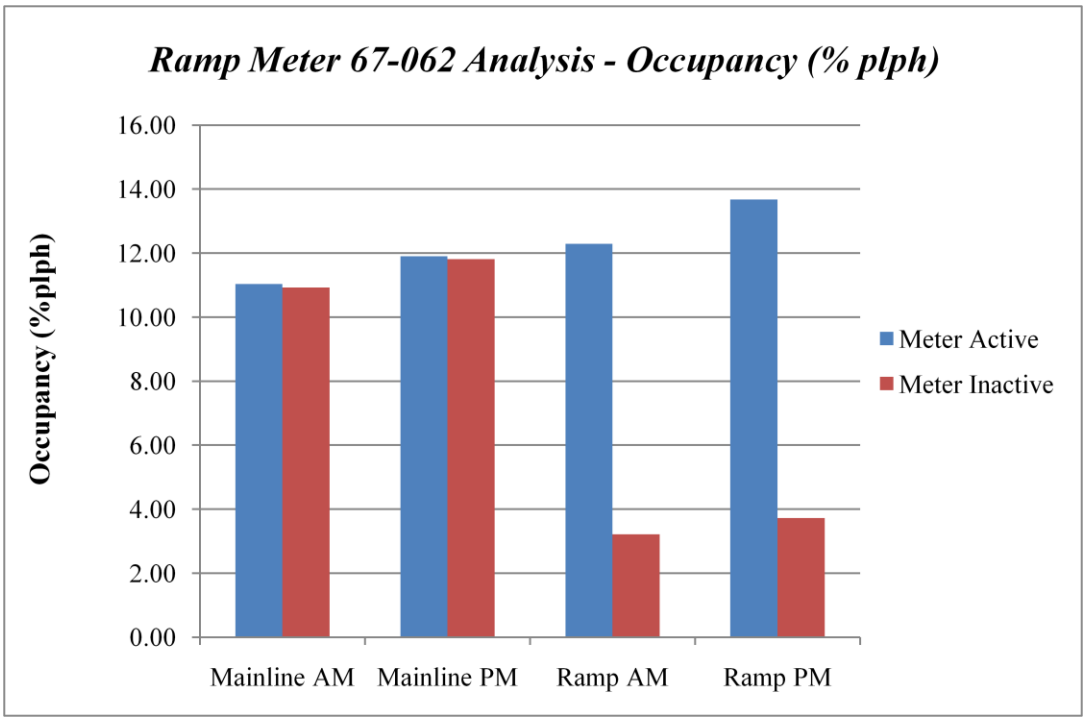
	Meter Effect				
	Active	Inactive	Change	Impact	Significance
Mainline	40.73	40.89	0.17	Worsens	Non significant
Ramp	15.41	60.53	45.11	Worsens	**Statistically significant**

Occupancy (avg. % plph)

	Meter Effect				
	Active	Inactive	Change	Impact	Significance
Mainline	11.9	11.81	-0.09	Worsens	Non significant
Ramp	13.67	3.72	-9.95	Worsens	**Statistically significant**


Ramp Meter 67-062 Analysis - Flow (vphpl)
Flow (vphpl)
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Mainline AM
Mainline PM
Ramp AM
Ramp PM
Meter Active
Meter Inactive


Ramp Meter 67-062 Analysis - Speed (mph)
Speed (mph)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Mainline AM
Mainline PM
Ramp AM
Ramp PM
Meter Active
Meter Inactive



Recommendation

The results of this analysis show that while there are significant improvements for the ramp when the meter is off, the major concern in implementing a ramp meter is to address the mainline. In this case, the mainline does not show any improvements. In fact, conditions slightly worsen when the meter is on but they were relatively small and are not statistically significant.

The ramp meter does not provide any improvements to the mainline having basically the speed and occupancy roughly equal, whether it is active or inactive. Also, the ramp has improvements when the meter is off. The nearest adjacent on-ramps are three miles in either direction, so there is no anticipated effect on operations or safety at these upstream or downstream locations.

Therefore, absent other operational, safety, or system considerations, it is recommended that WisDOT consider the ramp meter RM 67-062 be left inactive.