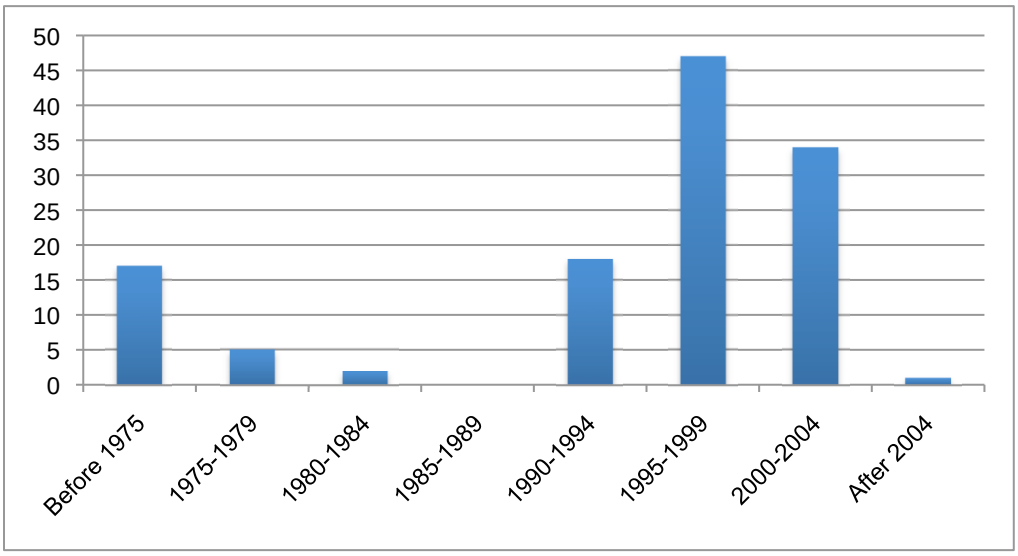
WISCONSIN TRAFFIC OPERATIONS & SAFETY LABORATORY
UNIVERSITY OF WISCONSIN-MADISON
Department of Civil and Environmental Engineering

Date: 8/18/2008

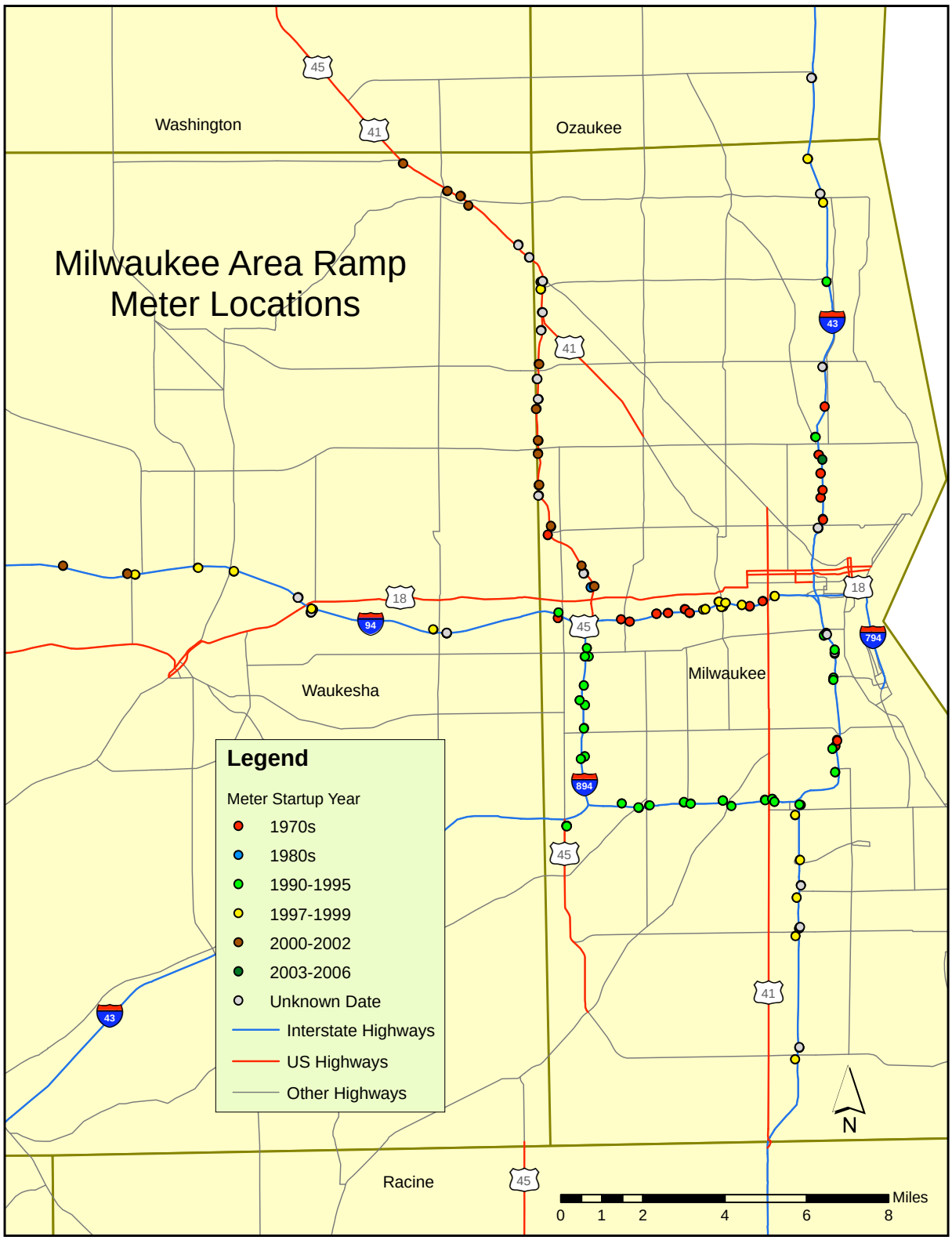
Subject: Ramp Metering Evaluation – Technical Memo #2
Background and Related Efforts

As discussed in the previous memo, ramp meters have been in operation in Wisconsin for forty years. The figure below illustrate when the meters were installed, and the figure on the next page depicts where these are located in the Milwaukee area. Six additional meters are currently operating on the Madison Beltline, but there are no others elsewhere as of this writing.



Wisconsin Ramp Meter Installation Dates (124 Total)

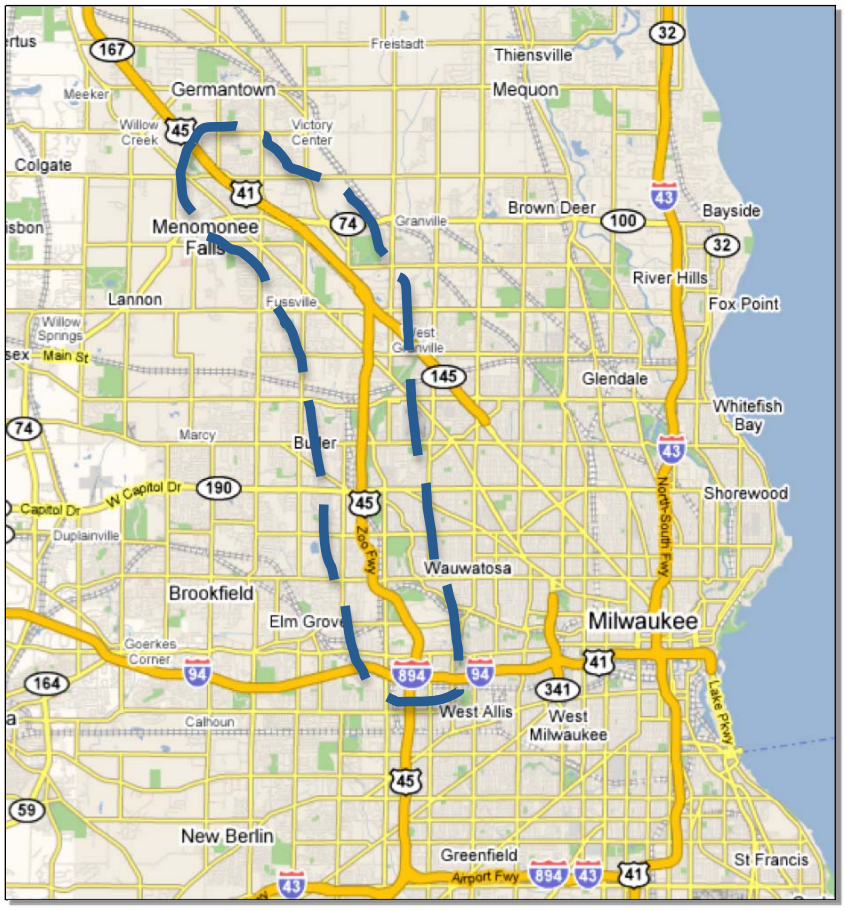
A chief barrier to performing a broad assessment of metering effectiveness is data availability. Operations data (volumes, speeds, densities) are not available prior to 1996, thus eliminating roughly half the meters from the assessment. In many cases, operations data since 1996 missing, incomplete, or the data in the period prior to meter turn-on is confounded by associated construction or workzone activity. Crash data are not available prior to 1998, thus eliminating roughly 30 additional meters from that component of the assessment. Furthermore, records on installation dates are sometimes inconsistent, incomplete, or missing, thus removing additional locations from the analysis. These limitations are discussed in greater detail in subsequent memos.


Milwaukee Area Ramp Meter Locations
Washington
Ozaukee
Waukesha
Milwaukee
Racine
Legend
Meter Startup Year
1970s
1980s
1990-1995
1997-1999
2000-2002
2003-2006
Unknown Date
Interstate Highways
US Highways
Other Highways
N
Miles
0 1 2 4 6 8

The sections below first summarize two primary meter operations evaluations. The US 45 report was completed October 2004; the Madison beltline report was completed January 2005. Following that is a summary of an evaluation of the meter retiming procedure completed December 2005, the statewide ramp control plan completed July 2006, and lastly a synopsis of the ITS sketch planning – or the traffic operations infrastructure plan (TOIP) – completed in 2008.

Ramp Metering on US 45 in Milwaukee

Roughly 15 miles of southbound US 45 entering the Milwaukee metropolitan area is metered. In early 2000, seven ramps were furnished with meters. This was in addition to the six currently metered southbound on-ramps. WisDOT funded a before and after evaluation of this installation. The report on this evaluation, "Evaluation of Ramp Meter Effectiveness for Wisconsin Freeways, A Milwaukee Case Study," was published in October 2004.



Map of US 45 Study Corridor

The study was completed by both UW-Milwaukee and Marquette University, and it covered several facets of operations and safety effects of ramp metering. The final report includes discussion of the following:

- Traffic diversion, primarily spatial diversion because of little evidence of modal or temporal diversion, utilizing cutlines crossing two parallel arterials. The data collected included 18 hours of operation during the before condition and 18 hours during the after condition.
- Origin-destination trip length changes, based on license plate video survey. However, the original data was not available to the project team. Without knowing the sample size, collection times, or capture rate, any conclusions drawn from that information may not be reliable.
- Modeling approaches to evaluating ramp meter effects, including microscopic, mesoscopic, and macroscopic approaches.
- Traffic operations effects, including speeds and delays
- Safety effects

The "with ramp metering" data collection for the diversion evaluation began three weeks after the additional meters were activated. Evidence from the Twin Cities ramp meter shutdown indicates that even eight weeks may not be sufficient to reach equilibrium after a system shock, although that was a larger change to the system (Mn/DOT 2001). Furthermore, only 18 hours of data were evaluated in each condition. With historical loop data readily available via the recently developed WisTransPortal transportation data hub, additional data will be incorporated and a validation of these results completed.

Among the key findings were increased mainline speeds and reduced crashes. Overall, vehicle hours of travel decreased by 2% following meter installation. It is noted in the report that much of the corridor was not congested during the evaluation times, so as traffic volumes continue to grow, this travel time savings is expected to grow. The existing meters were primarily deployed in the southern, more congested portion of the corridor.

A stated preference survey indicated that drivers would respond to delays at metered ramps. Where traffic volumes were heaviest or ramp queues longest, a significant number of drivers would divert their travel away from the freeway or from a specific ramp. If a metered ramp had waiting vehicles, 82% of surveyed drivers said they would take an alternate route.

Following meter deployment, an origin-destination survey indicated that drivers may be less likely to use the freeway for very short trips, which would cause less entering and exiting and less disruption to traffic flow. However, the original data from origin-destination license plate video survey was not available to the project team. Without knowing the sample size, collection times, or capture rate, any conclusions drawn from that information may not be reliable.

Travel speeds in the most congested south portion of the corridor increased by as much as 13% during the afternoon peak period. The average speed on the entire southbound US 45 section evaluated increased by 4% during the afternoon peak. New ramp meter operation, in conjunction with relatively minor geometric improvements in ramp merging areas and mainline resurfacing, resulted in a 21% crash rate reduction.

Recommended Follow-Up

The "with ramp metering" data collection for the diversion evaluation began three weeks after the additional meters were activated. Evidence from the Twin Cities ramp meter shutdown indicates that eight weeks may not be sufficient to reach equilibrium, although that was a larger change to the system. Furthermore, only 18 hours of data were evaluated in each condition. With historical loop data readily available via the WisTransPortal, additional data could be incorporated

The original data from origin-destination license plate video survey was not available to the project team. Without knowing the sample size, collection times, or capture rate, any conclusions drawn from that information may not be reliable.

Ramp Metering on Madison Beltline

Evaluation of five metering locations, including qualitative and quantitative impacts, including travel time, traffic flow, safety, public perception, and air quality.

In July 2001, the Wisconsin Department of Transportation implemented ramp metering along the US 12/18 Beltline freeway in Dane County. The evaluation analyzed the impact of ramp metering on the Madison Beltline from five metering locations, including qualitative and quantitative impacts such as travel time, traffic flow, safety, public perception, and air quality. The report was published in January 2005.

The findings showed a crash reduction. While the entire Beltline from Stoughton Road to Old Sauk experienced a 57% reduction in crashes, the area identified as the eastbound ramp meter influence zone near Whitney Way experienced an even greater reduction in crashes during metered and non-metered periods - 86% for both periods. The westbound ramp meter influence zone near Park Street and Fish Hatchery Road showed a 50% reduction in crashes during metered time periods, and an overall reduction of 27%.

Ramp metering improved WisDOT's ability to mitigate effects of traffic incidents. About 96% of public safety agency representatives surveyed for the study found the time to clear crashes has improved because of the introduction of ramp meters along the Beltline, while approximately 64% of the agency respondents found that the time to respond to accidents has improved with ramp metering.

Despite significant growth in traffic volumes, travel times increased only slightly during three of the four metering periods, with a slight reduction in the westbound AM metering period. Three out of the four travel periods experienced a lower variability in travel speeds, which translates to improved travel time reliability, an increasingly prominent economic consideration. During the westbound morning peak period, the variation of travel times was reduced from +/- 10.9 seconds down to +/- 3.8 seconds after ramp metering.

Although the Madison Beltline has relatively few alternative routes, results from the ramp counts indicate that motorists at some locations are seeking alternative routes to avoid congested ramps

Evaluation of Ramp Meter Retiming Procedure

Review of retiming process developed in southeast Wisconsin and evaluation of whether the process is effective in minimizing delay and crashes in the southeast Wisconsin freeway system.

The three documents for these evaluations are available on the Sketch Planning workgroup page: http://www.topslab.wisc.edu/workgroups/sketchplanning.htm#ramp. The Sketch Planning project is further discussed in a later section of this report.

Many ramp meters were added to the Milwaukee freeway system in the 1990s. After initial adjustments, many of these meters were not retimed for several years. By early 2000s, a standard retiming approach was developed, and in 2003 and 2004, all meters were retimed and based on this approach as well as feedback from operators. The need to balance quality freeway operations with the negative effects of ramp queue spillback was paramount.

A December 2005 report documented a review of retiming process developed in southeast Wisconsin and evaluation of whether the process is effective in minimizing delay and crashes in the southeast Wisconsin freeway system. After the 2003-2004 retiming, no significant change in traffic flow was observed. Surveyed operators generally agreed with the approach of the retiming procedure, but field observations and adjustments based on experience are necessary. This is consistent with traffic signal retiming practice.

The evaluation recommended four key improvements. First, there needs to be a better understanding and accommodation of temporal variations in traffic flow and its effect on ramp meter timing. Second, although resource-intensive, simulation may provide valuable insight into alternative timing plans. Third, WisDOT operates their meters as local-responsive only (not systemwide), but relative to other states, meter operation is “quite sophisticated.” And fourth, there remains a longer-term need to move forward with system-wide or corridor based algorithms.

Wisconsin Statewide Ramp Control Plan

Report on the development of an institutional and procedural plan for integrating the implementation criteria for ramp control strategies into statewide planning and programming processes.

This effort laid the groundwork for an institutional and procedural plan for integrating the implementation criteria for ramp control strategies into statewide planning and programming processes. This project encompassed not only ramp meters but also ramp control gates. The focus was on implementation guidelines or warrants, and this part concluded with the issuance of a report Statewide Ramp Metering and Control Plan in July 2006 (WisDOT 2006).

The study cautioned that it is not appropriate to make final implementation decisions based on a high level scan and that metering success is highly dependent on local conditions. The report presents a methodology for deployment considerations that could be applied statewide with minimal data input. This was key because of the limited resources available for additional data collection. The methodology was incorporated into a spreadsheet tool, the Wisconsin Ramp Analysis Tool (WRAT), and piloted on select corridors.

Wisconsin Statewide Freeway Surveillance and Ramp Control Sketch Planning

Currently underway is the Statewide Freeway Surveillance and Ramp Control sketch planning activity, which is one component of the broader sketch planning project for statewide traffic operations. The other two components are traveler warning / information systems and traffic signal systems.

Each component will apply the overarching corridor planning methodology across the state to identify potential areas or corridors that may benefit from various ITS deployments. The second application will aid in prioritizing deployments subject to the considerable financial constraints facing the state. The criteria are based on readily accessible data such as traffic volumes, heavy vehicle volumes, forecast growth, and crash history.

Preliminary results of a prototype implementation planning tool should be available later in 2007. More information is available on the Sketch Planning workgroup page: http://www.topslab.wisc.edu/workgroups/toip.html and these and other related documents are available on the ramp metering resources page http://www.topslab.wisc.edu/workgroups/toip/rampcntrl.html.