ADOT
Transportation Technology Group

Executive Summary for the:

ADOT System-Wide Ramp Metering Evaluation

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Adding lanes to increase capacity is a countermeasure often used to mitigate freeway congestion. However, as the physical footprint of freeways reach their right-of-way boundaries or other constraints are imposed, effective ramp metering becomes essential in achieving peak-performance from existing freeways.

Ramp metering is a traffic management strategy used to regulate the flow of traffic entering the freeway during peak traffic periods. This strategy is used to improve freeway throughput, travel time, travel time reliability, safety, fuel use, and emissions. This project entailed evaluations, implementations, and recommendations to improve the effectiveness of Arizona's ramp metering system.

Evaluations included:

- Perceptions of ramp metering
- Ramp Metering state-of-practice
- Current ADOT ramp metering system
- Define ramp metering objective and measures
- Ramp metering model simulation
- Testing proposed ramp metering operation

Implementations included:

- System-wide improvements to ramp metering and traffic detectors data collection
- System-wide improvements to ramp metering holiday operations

Recommendations included:

- Ramp metering model simulation alternatives
- Proposed ramp metering with strategies in place to meet the ramp metering objective
- Design guidelines for ramp metering
- Operation and maintenance guidelines for ramp metering

Objectives of Ramp Metering:

The following objectives for ramp metering guide ramp metering strategies to maximize the quality of service for drivers and to satisfy ADOT's requirements for this project. "Quality of service" describes how well a transportation system operates from a driver's perspective.

Objective A

Minimize trip travel time. The trip travel time affects travel delay and productivity of motorists.

Objective B

Minimize fuel use and vehicle emissions. Fuel used and vehicle emissions affects fuel cost and environmental impacts.

Objective C

Minimize crashes. Crashes affect personal safety and property damage.

Objective D

Avoid queue spillback. Ramp meter queue spillback into the cross-street intersection affects cross-traffic if vehicles do not clear the intersection.

Objective E

Easily implementable. The effort required to implement changes affects how soon improvements can be realized.

Technical Advisory Committee:

A technical advisory committee was formed for this project comprised of representatives from local cities and towns, Maricopa County, Maricopa Association of Governments, Federal Highway Administration, Arizona Department of Public Safety, and Arizona Department of Transportation. The Technical Advisory Committee was consulted with at various project stages and was provided an opportunity to review and comment on project documents and findings. United Civil Group thanks the committee members. Their participation helped make this project a success and is greatly appreciated.

Public Perception of Ramp Metering:

United Civil Group collected public comments related to ramp metering received by Arizona Department of Transportation and Technical Advisory Committee members from 2010 to 2012. These comments are summarized in Figure 1.

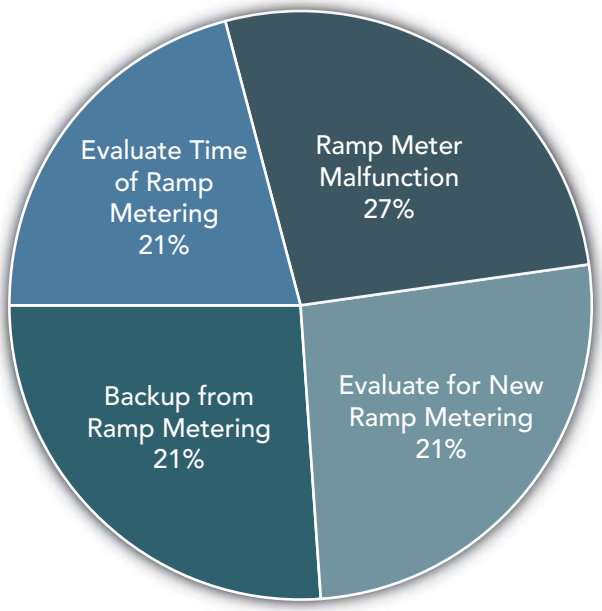

*Figure 1. Summary of 18 public comments from 2010 through 2012—**Public Comments***

Ramp Metering Enforcement by the Arizona Department of Public Safety:

United Civil Group worked with Captain Burley Copeland of Arizona Department of Public Safety who prepared and distributed a survey to 150 Sergeants, and line-level Officers. Completed surveys of enforcement actions routinely taken by Phoenix-Metro region officers related to ramp metering were summarized.

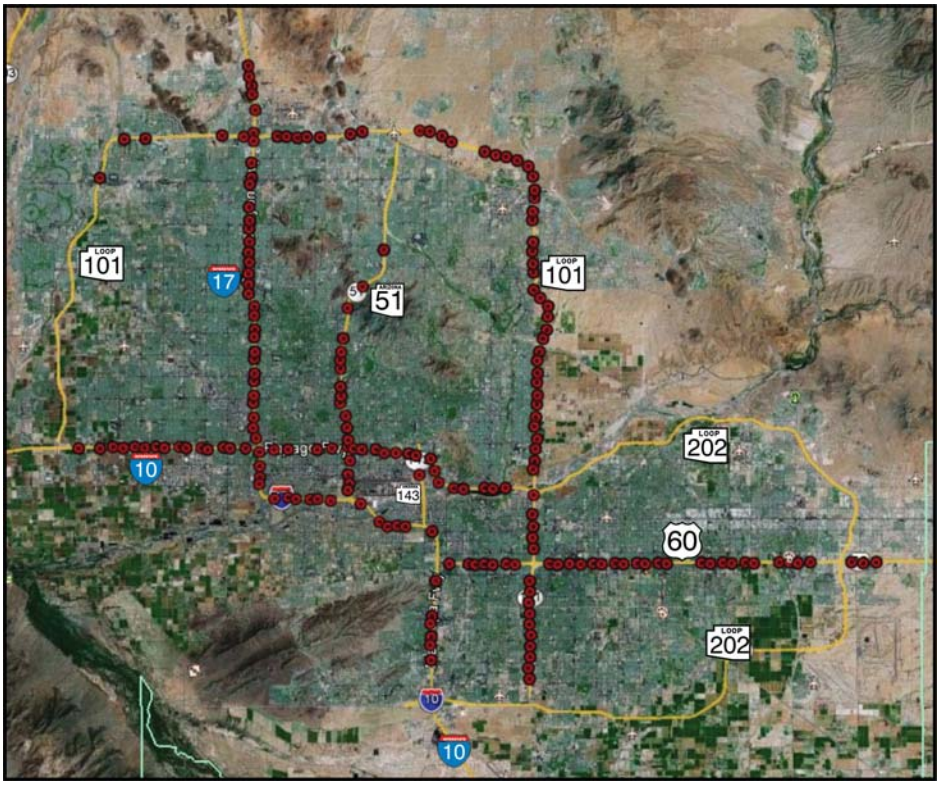

*Figure 2. Ramp Meter Locations—**Source: ADOT, United Civil Group (map: Google Earth)***

Ramp Metering Locations:

As of summer 2012, Arizona Department of Transportation operates 201 ramp meters in the Phoenix-Metro region as depicted in Figure 2.

Management of Non-Recurring Congestion and Incidents:

Ramp metering operation during non-recurring congestion and incidents is currently determined on a case-by-case basis by ADOT ramp metering staff. Ramp metering operation may be changed in real-time to respond during non-recurring congestion and incidents to manage traffic flow using ramp meters. Instances where ramp meters may be turned on, turned off, or have their metering rate adjusted include traffic detours, crashes, weather, freeway closure, and special events. In the future, integrated corridor management plans for non-recurring congestion and incidents can be developed that include ramp metering operation.

Ramp Metering Model Simulation:

Ramp metering simulation of five different areas was modeled using VISSIM modeling software to develop ramp meter operation strategies. The simulation model was calibrated to actual loop detector speed data. Alternative ramp metering strategies were developed. Figure 3 illustrates example results of a modeled location.

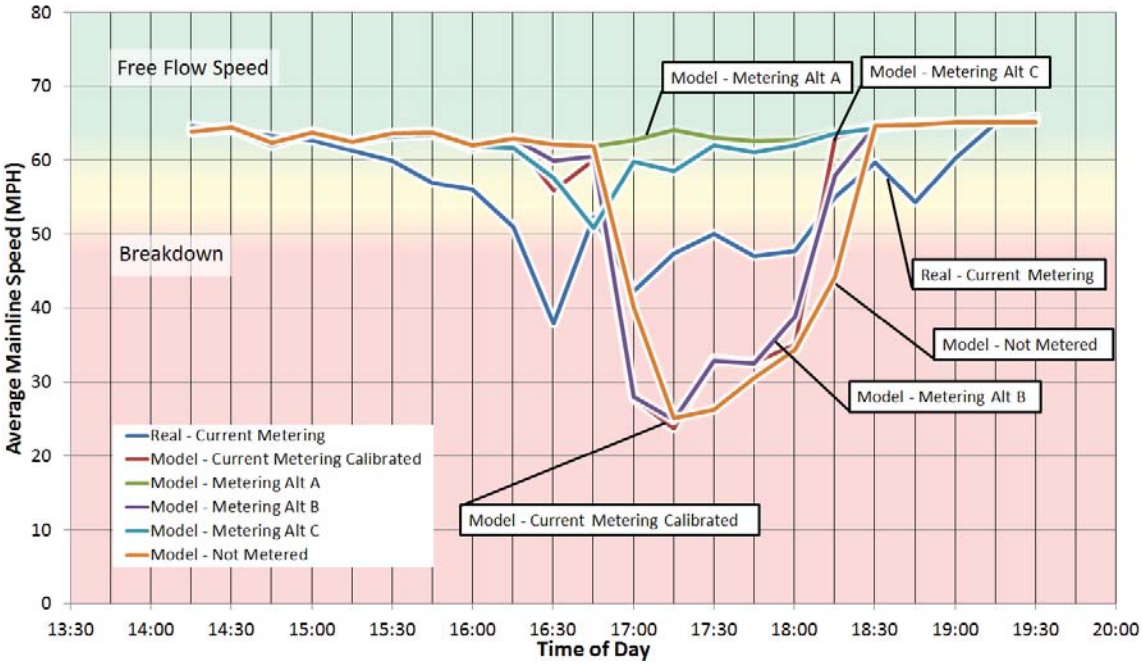

Figure 3. Modeling Results of Example Location (I-10 Eastbound at Elliot Road)—Source: United Civil Group

Ramp Metering Time-of-Day:

The ramp metering start time is set to begin prior to the time of day when freeway congestion historically begins. The stop time is set to end after the time of day when freeway congestion historically ends. Archived traffic data collected by the freeway mainline detectors was used to determine the time of day of historical freeway congestion. Ramp meters have similar start and stop times to regulate the traffic flow rate arriving at the point of recurring congestion. Figure 4 graphically depicts these strategies and the times of day of ramp metering on two sample freeway corridors.

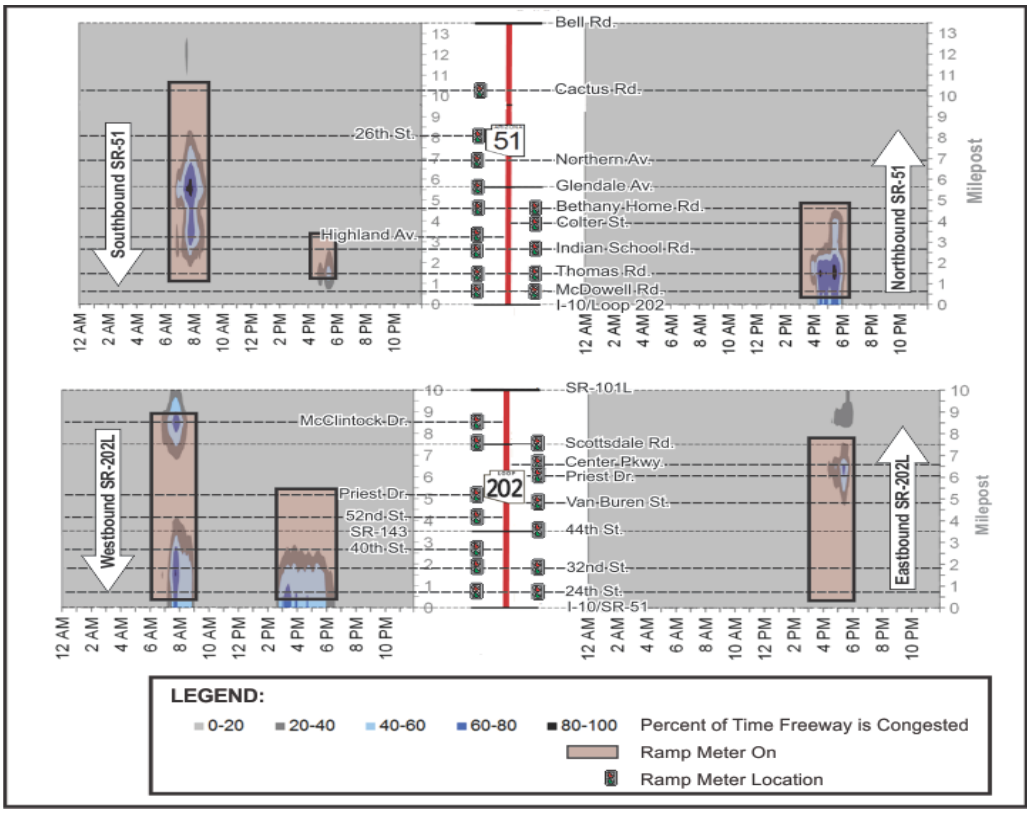

Figure 4. Ramp Metering Time of Day—Source: MAG, United Civil Group

Holiday Schedule:

Ramp meters are inactive on holidays chosen based on their traffic patterns and ADOT policy. United Civil Group provided new programming that has been implemented system-wide to automatically inactivate ramp meters during holidays.

Metering Rate:

ADOT's ramp metering system supports local traffic responsive ramp metering. "Local traffic responsive ramp metering" means each ramp meter can utilize real-time traffic data to adjust traffic control operation based on the local vehicle detectors connected to it. The proposed improved metering rates are automatically controlled by the ramp metering software as depicted in Figure 5.

Freeway Ramp Metering and Traffic Detection Reporting:

Ramp meters and traffic report real-time freeway traffic data in the Phoenix-Metro region every 20 seconds, 24 hours a day. Ramp meters that are not centrally-connected do not report freeway traffic data. Traffic

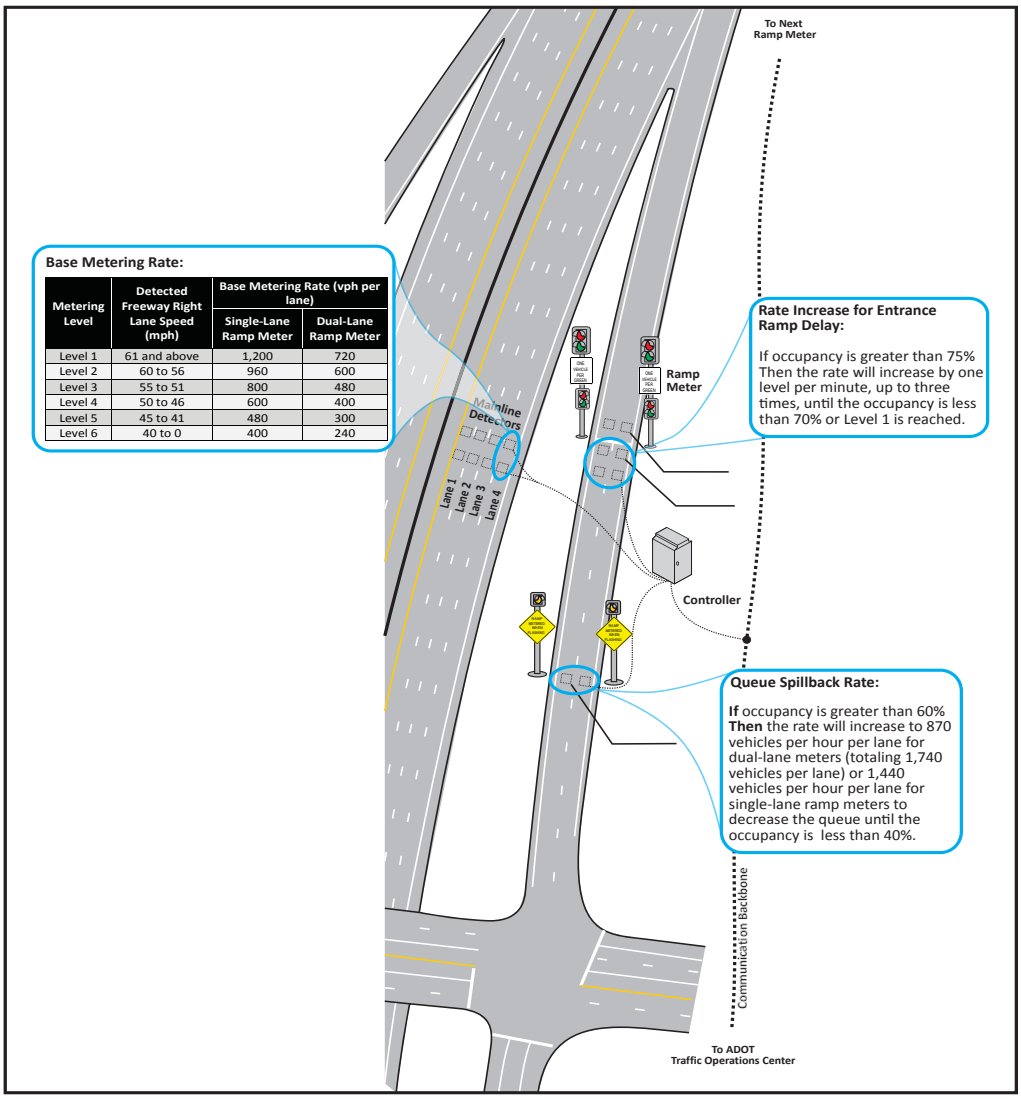

Figure 5. Proposed Metering Rate—Source: United Civil Group

Webpage Address	Real-Time	Historical	Speed	Volume	Occupancy	Classification
http://www.aztechrads.org/monitor/dataDump.jsp?logId=detstn_mc2070	●		●	●	●	●
http://www.aztechrads.org/fms/	●		●	●	●	●
ftp://ftp.az511.gov/pub/webdata/ips.out	●		●	●	●	
http://www.az511.gov/adot/files/traffic/	●		●			
ftp://ftp.az511.gov/pub/traffic/		●	●	●	●	

Table 2. Freeway Traffic Data Websites

data collection stations are located where long gaps between ramp meters occur. Freeway traffic data is reported through the websites shown in Table 2.

Freeway detectors classify vehicles by length to distinguish between motorcycles, passenger vehicles, and heavy vehicles. United Civil Group coordinated with the ADOT Transportation Technology Group and the ADOT Multimodal Planning Division to make this data more useful for both groups. The new classification method was implemented system-wide on February 15, 2013.

Future Ramp Metering Recommendations:

In the future, completion of the following ramp metering tasks is recommended to further improve ADOT's ramp metering system.

- Fully implement the ramp metering operation proposed in the *ADOT System-Wide Ramp Metering Evaluation Report*
  - Observe and fine-tune ramp metering operation
  - Conduct a before-and-after evaluation and present results of changes implemented
- Participate in development of corridor management plans to improve ramp metering operation during non-recurring congestion and incidents.
- Implement system-wide traffic adaptive ramp metering control so that ramp meters may work together to automatically optimize operation, considering the real-time traffic conditions at other locations.
  - Define desired capabilities, functions, and operation of the ramp metering system
  - Identify a new or existing system-wide traffic adaptive ramp metering algorithm to use
  - Implement a system that logs the ramp metering operation each day, allowing the use of dynamic ramp metering start and stop times based on real-time traffic conditions
  - Modify the ramp metering system to allow the controller to accept metering rates transmitted from a remote site that processes the traffic data of multiple ramp meters
  - Test the traffic adaptive ramp metering control
  - Implement the ramp metering control system-wide