



Ramp Metering: A Proven Effective Strategy



WHAT IS RAMP METERING?

Ramp metering is a strategy used to regulate the volume of vehicles entering a freeway at a given time thereby seeking optimal freeway operations. Access to the freeway is controlled using a traffic signal that is powered by an algorithm that uses real-time system traffic data to determine the rate at which vehicles should enter the freeway. This breaks up the platoons of vehicles attempting to merge onto the mainline. Vehicles already on the mainline will not need to reduce their speed as much due to the spacing of the entering vehicles.

Rather than acting in isolation, ramp metering is an integral part of an agency's overall corridor management and operations program. Agencies can align ramp metering programs with programs or efforts, such as arterial management, incident management, work zone management, integrated corridor management or with others, to optimize the combined effect of their tools and strategies. Coordinating these programs and deploying ramp metering will likely depend on the capabilities of the agencies involved.

BENEFITS OF RAMP METERING

Ramp metering is a widely proven, cost-effective strategy to increase the efficiency of a freeway system. Metro areas that deployed ramp meters touted benefits such as increases in freeway mainline throughput, decreases in overall travel delays, increases in travel time reliability, reductions in freeway crashes and their severity, and even benefits to the environment through reductions in fuel consumption and emissions.

RAMP METERING IN THE TOP U.S. METROPOLITAN AREAS^{1,2}



Ramp Meter Penetration

- No ramp metering
- 1–100 ramp meters
- 101–300 ramp meters
- More than 300 ramp meters

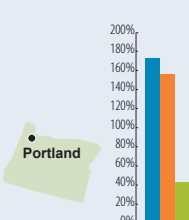
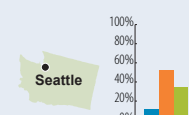
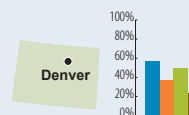
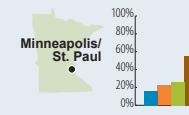
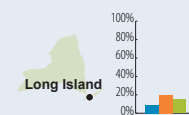
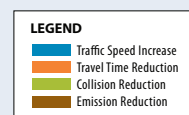
Ramp Meter Control

Local or Fixed-Time Control: Meters are either fixed/pre-timed to meet historical trends or are responsive/actuated to meet local, real-time conditions in the vicinity of the ramp.

System Control: Meters are responsive/actuated to system-wide conditions (i.e., optimizing flow along an entire facility, corridor, or system wide).

Note: 1. According to the 2010 United States Census, metro areas have a population greater than one million people.
2. Ramp metering information is current as of 2014.

BENEFITS IN SELECTED CITIES



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KEYS FOR SUCCESSFUL DEPLOYMENT, OPERATION, AND EXPANSION

Whether an agency is expanding their already robust system, or deploying ramp meters for the first time, there are key components at each of the planning, implementation, and operations stages that agencies should keep in mind.

IS RAMP METERING RIGHT FOR YOU?

Ramp metering should be deployed with the purpose of addressing existing operational issues. The primary issue mitigated by ramp metering is recurring mainline congestion, however agencies may also want to increase safety and control mainline access, especially during construction activities, special events, or traffic incidents. All of these issues have the potential to be aided through ramp metering, but if they are not present in the region or corridor, ramp metering is likely not an applicable strategy and should not be pursued.



FEASIBILITY STUDIES & BENEFIT/COST ANALYSIS

Agencies should conduct feasibility studies and benefit/cost analysis on proposed ramp metering locations. Benefit/cost analysis monetizes the estimated benefits of ramp metering associated with travel time, crash reduction, and emissions reduction savings and compare against estimated capital and operations and maintenance costs.

BENEFIT/COST ANALYSIS TOOLS

U.S. Department of Transportation Research & Innovative Technology Administration ITS Joint Programs Office Knowledge Resources: Users can browse benefits and costs of various projects.

FHWA Tool for Operations Benefit Cost Analysis (TOPS-BC): Users can select different project aspects and parameters to test the affect on total cost.

COMMON CHALLENGES

These challenges were gathered from a 2014 survey of agencies in the top metropolitan areas in the United States. The percentages refer to the share of survey respondents who faced a particular challenge during attempts to deploy ramp meters.

GETTING READY FOR RAMP METERING

After affirming the feasibility of ramp metering, agencies should plan for implementation based on regional policy and recommended outcomes from feasibility studies. This also includes assessing staffing needs, organizational capabilities, and agency readiness as well as planning for data collection, funding procurement, and equipment testing.

GAIN PUBLIC/AGENCY SUPPORT

Agencies should devote substantial effort to outreach and collaboration. First, the agency should partner with other relevant agencies to gain concurrence and support. For both agencies and the public, one of the best ways to encourage support is by proactively disseminating information and clearly communicating the benefits of ramp metering. This may include gathering public feedback, conducting open houses, and issuing statements to local media. In order to reach a broader local population, the agency should maintain important information on a web site and distribute it via brochure or flyer. Providing clear information and addressing questions adds transparency to the planning process, which the public will generally favor.

GENERAL TIMELINE FOR PUBLIC OUTREACH PRIOR TO INITIAL DEPLOYMENT

For the initial implementation of ramp metering in a region, the public involvement plan should start three to five years prior to ramp meter activation and continues through one year after turn-on, with multiple objectives like increasing driver education and acceptance, addressing enforcement issues, and allowing for design changes prior to construction per public feedback. In the six months prior to metering, the agency should keep communities and agencies informed by holding public meetings and distributing flyers.

CASE STUDIES

Miami faced public opposition during their efforts to deploy ramp metering. Through outreach and educational efforts, the agency was able to shift public opinion and raise the support required to start metering.

New York City ran a public relations campaign to re-brand ramp meters as "merge lights" as a means of circumventing pre-existing negative perceptions about ramp metering.

IDENTIFY COST & SECURE FUNDING SOURCES

Agencies can utilize FHWA resources and tools to identify capital and operating costs related to the installation of new systems. Agencies can strengthen their case for deploying ramp metering by itemizing specific costs, thus increasing transparency. Providing benefit/cost information can help strengthen the case for ramp meter expansion by showcasing the benefits and providing leverage for requesting funds. In order to secure funding, agencies must also communicate the high priority of ramp metering to authorities.

CASE STUDY

The Twin Cities evaluated the costs and benefits of their ramp metering system, which provided the agency with empirical basis for the expenses associated with ramp metering. The evaluation yielded a **benefit/cost ratio of 15 to 1**, thus the benefits of ramp metering dramatically outweighed its costs.



58%	Existing Ramp Geometry	25%	Heavy Ramp Volume
42%	Cost/Funding	17%	Local Agency Opposition
33%	Public Opposition	17%	Lack of Agency Resources

MANAGE QUEUES & DELAYS

Queue management is crucial for optimizing freeway operations, and long queues generally contribute to negative public perception. Queue management is closely related to the geometric limitations of the existing ramps, so both could be considered when exploring options.

Ramp metering technology has developed various methods of queue detection and corresponding solutions, such as being hard-wired into the controller or with the software as a function of the control algorithm. If adding storage capacity at a ramp is not feasible, an agency could consider adjusting the metering control scheme to increase ramp metering capacity.

Agencies should create policies on maximum queue wait time, and be able to communicate and justify these policies publicly.

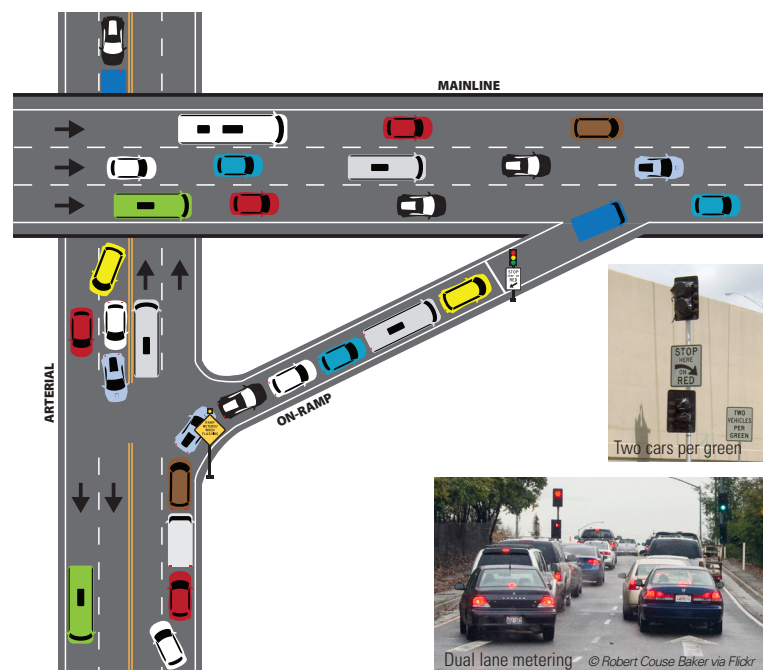
MNDOT POLICY

"...onto adjacent arterials by keeping local ramp wait times to under 4 minutes. Freeway-to-freeway ramp wait times are kept under 2 minutes."

SOURCE: MnDOT

CASE STUDY

San Diego had insufficient storage on many of its ramps, but the local agency collaborated with agencies responsible for arterial signals to reduce the impact of long queues on arterial traffic.



UNDERSTAND TRAFFIC CONDITIONS

The agency should study pre-metering traffic conditions of the corridor. The current and anticipated mainline volumes, ramp volumes, and surrounding arterial volumes should be evaluated in regards to how they will be impacted by ramp metering. The capacity of the ramps will likely influence the other aspects of the ramp meter operations.

OPERATING RAMP METERS EFFECTIVELY

After turning on the ramp meters, agencies should determine their impact on operations, identify areas of improvement, and continue building inter-agency and public support. By building a robust performance assessment process, agencies can learn about their current system and whether it should be expanded.

PERFORMANCE MEASUREMENT & REPORTING

Agencies should establish which performance metrics to measure, appropriate benchmarks for those measures, monitoring procedures, and reporting procedures. Dimensions of performance metrics to measure can include safety, mobility, public acceptance, travel time reliability, facility throughput, and environmental impacts.

Measuring the costs and benefits of a proposed ramp metering system is a practiced strategy for accelerating ramp metering deployment. Agencies could face scrutiny regarding the proposed benefits of ramp metering in their regions. As discussed, a cost/benefit analysis can make the case for ramp metering more convincing.

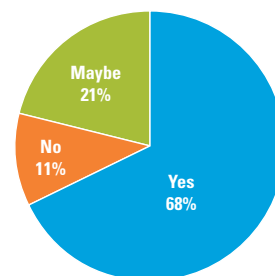
Agencies should give particular attention to the length and behavior of the ramp queues and establish policies and methods for regularly monitoring the ramp queues, as traffic conditions can change overtime and throughout the day.

THINKING ABOUT EXPANSION?

Agencies considering expansion or further development of their ramp metering program should first assess the current state of the program. In particular, the agencies should evaluate current performance metrics in order to target areas of opportunity and set expectations for improvement. The impact of the proposed expansion should be reported and shared with relevant stakeholders.

In a 2014 FHWA survey of the top metro areas, there was a high level of interest in expansion amongst areas that had already deployed ramp meters.

Question: Are there plans to expand your ramp meter system in the next 1 to 5 years?



"Our region first installed ramp metering in our state's largest urban area in the 1980's and we have steadily expanded the system since then. Other, smaller cities in our state have seen the benefits and are planning ramp meter systems."

– Pete Briglia, former WSDOT and TRB Freeway Operations Committee Chair

GOING ABOVE AND BEYOND

One of the key attitudes that agencies with successful ramp metering programs embrace is the desire for continued improvement in ramp metering operations. Through ongoing performance monitoring and internal agency assessment, enhanced ramp metering strategies can be identified and planned for in future regional planning efforts. Even agencies that already have ramp meters should assess both suitability and feasibility prior to expanding and improving their program. These approaches tend to require high organizational capability and are not necessarily suitable for all ramp metering locations.

Operational enhancements can include:

- **Extended Hours of Operation**
Policies that extend ramp meter operations outside the peak hours and for special events and construction activities offer further flexibility and control.
- **Special Ramp Treatments**
This encompasses strategies that can improve traffic conditions, improve safety at the merge point, and provide driver incentives for specific modes of travel. For instance, an agency could designate a bypass lane accessible only to HOVs or transit vehicles.
- **Adaptive Ramp Metering**
Adaptive ramp metering utilizes algorithms that can optimize either local or system-wide conditions. Adaptive ramp metering can also utilize advanced metering technologies such as dynamic bottleneck identification, automated incident detection, and integration with adjacent arterial traffic signal operations. This technique is effective for recurring and non-recurring congestion.
- **Integrated Freeway and Arterial Corridor**
When operating independently of the ramp meter signals, the arterial signals may release too many cars onto the ramp, causing backup onto the arterial. If the two systems are integrated, backup could be reduced leading to safer and more efficient conditions.

"Ramp meters are the most effective traffic management strategy available. They have consistently shown high levels of benefits across numerous deployments throughout the U.S."

– Brian Kary
Freeway Operations Engineer,
Minnesota DOT

RESOURCES FOR MORE INFORMATION

FHWA Ramp Management web site

http://www.ops.fhwa.dot.gov/freewaymgmt/ramp_mgmnt.htm

FHWA Office of Operations web site

<http://www.ops.fhwa.dot.gov/>

FHWA Operations Benefit/Cost Analysis Desk Reference web site

<http://ops.fhwa.dot.gov/publications/fhwahop13004/>

U.S. Department of Transportation Research & Innovative Technology Administration ITS Joint Programs Office Knowledge Resources web site (including benefit and cost databases)

<http://www.itsknowledgeresources.its.dot.gov/>

FHWA Ramp Management and Control Handbook

http://ops.fhwa.dot.gov/publications/ramp_mgmt_handbook/manual/manual/pdf/rm_handbook.pdf

Ramp Metering Public Outreach videos

Maximizing the Flow (Source: Kansas City Scout)

<http://www.kcscout.net/RMWatchTheVideo.aspx>

Ramp Metering: Signal for Success (Source: FHWA)

<https://www.youtube.com/watch?v=rsvaGXW6moA>

Ramp Meters: How-to (Source: RTC of Southern Nevada)

<https://www.youtube.com/watch?v=Lv3CHhsPN-Y>

To obtain more information on ramp metering, please contact:

FHWA Office of Operations

operationsfeedback@dot.gov



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