ACTIVE TRANSPORTATION AND DEMAND MANAGEMENT WEBINAR SERIES

Webinar #3: Ramp Metering
Benefits, Opportunities, and Keys for Overcoming Common Challenges

December 10, 2014
Agenda

- Housekeeping
- Introduction
- Overview of Active Transportation and Demand Management (ATDM)
- Overview of Ramp metering
- Practitioner panel
- Open discussion
HOUSEKEEPING
INTRODUCTION
Purpose of Today’s Webinar

- Increase awareness
- Provide general information
- Provide resources and technical assistance to agencies new to ramp metering, agencies considering expanding or upgrading their ramp metering program
ATDM Webinar Series

- This is the third in a series of ATDM webinars
- Topics based on **what matters most to you!**
- Upcoming ATDM webinars:
  - Traffic Management Capability Maturity Framework (Jan 2015)
  - ADM Part II (Feb 2015)
- Completed Webinars
  - October 22, 2014: Active Demand Management
    [https://connectdot.connectsolutions.com/p6byoty6abj/](https://connectdot.connectsolutions.com/p6byoty6abj/)
  - November 18, 2014: Active Traffic Management (ATM) Feasibility Study
    [https://connectdot.connectsolutions.com/p34emklqwwh/](https://connectdot.connectsolutions.com/p34emklqwwh/)

Federal Highway Administration
Office of Operations
– Transportation Management

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Today’s Speakers

James Colyar
Transportation Specialist, FHWA Office of Operations

Les Jacobson
Senior ITS Manager, Parsons Brinckerhoff

Nick Thompson
Managed Lane and ITS Lead, Parsons Brinckerhoff
Practitioner Panel

Mark Leth
Assistant Regional Administrator - Traffic, Washington State DOT

Brian Kary
Freeway Operations Engineer, Minnesota DOT

Jason Sims
Traffic Center Manager
Kansas City SCOUT, Missouri DOT

Javier Rodriguez
ITS Operations Engineer, Florida DOT

Meredith McDiarmid
State Systems Operations Engineer, North Carolina DOT
OVERVIEW OF ATDM

James Colyar
What is Active Management?

The fundamental concept of taking a dynamic approach to a performance based process.
Moving Towards Active Management

Transportation Agency Operators: Moving from Static to Proactive Management

- High complexity, high reward
- Emerging

- Low risk
- Proven

Proactive Management
- Respond to predicted changes in supply & demand
- Ability to delay or eliminate breakdowns

Responsive Management
- Respond to current conditions
- Account for traffic impacts due to conditions
- Reduce time of degraded operation

Static Management
- Time of day
- Set-it and forget it
- Will work when there is limited variability

Actively Managing Operations
Goal of ATDM Concept

- Attain the capability to dynamically monitor, control, and influence travel, traffic, and facility demand of the entire transportation system and over a traveler's entire trip chain.
What does ATDM include?

Active Demand Management (ADM): A suite of strategies intended to reduce or redistribute travel demand to alternate modes or routes. Incentivizes drivers by providing rewards for travelling during off-peak hours with less traffic congestion.

Active Traffic Management (ATM): A suite of strategies that actively manage traffic on a facility.

Active Parking Management (APM): A suite of strategies designed to affect the demand on parking capacity.

Examples of ATDM Implementation Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADM</td>
<td>Comparative multi-modal travel times, dynamic ride-sharing, pricing, and incentive approaches.</td>
</tr>
<tr>
<td>ATM</td>
<td>Dynamic speed limits, dynamic shoulder use, queue warning, adaptive ramp metering.</td>
</tr>
<tr>
<td>APM</td>
<td>Parking pricing, real-time parking availability and reservation systems.</td>
</tr>
</tbody>
</table>
FHWA’s ATDM Program

- Increase awareness and understanding of ATDM.
- Train agencies to deploy effective ATDM systems.
- Research and investigate key ATDM challenges, gaps, and risks.
- Develop tools and guidance for practitioners.
- Evaluate and demonstrate the effectiveness of ATDM.
Summary

- ATDM represents next evolutionary step in Transportation Systems Management & Operations (TSM&O).
- Based on real time and predicted information and dynamic actions.
- Performance driven.
- Demand management much more prominent than historical ITS and Operations.
- Several National program activities underway.
OVERVIEW OF RAMP METERING
Ramp Metering 101

- Reduces overall freeway congestion by managing the amount of traffic entering the freeway and by breaking up platoons.
- Algorithm determines entrance rate based on mainline volume, speed, queue length.

**HOW RAMP METERING WORKS**

1. Vehicle pulls up to stop bar
2. Vehicle detected, signal turns green
3. Vehicle merges onto freeway
Ramp Metering 101

- First deployed in the 1960’s in Chicago, now in metro areas in the US, Europe, and Australia
- Varying degrees of scale, sophistication
- Many U.S. metro areas have not implemented ramp metering
- Many areas expanding ramp metering (68%)

Ramp Metering in the Top U.S. Metropolitan Areas

<table>
<thead>
<tr>
<th>Ramp Meter Penetration</th>
<th>Ramp Meter Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ramp metering</td>
<td><strong>Local or Fixed-Time Control:</strong> 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.</td>
</tr>
<tr>
<td>1–100 ramp meters</td>
<td><strong>System Control:</strong> Meters are responsive/actuated to system-wide conditions (i.e., optimizing flow along an entire facility, corridor, or system wide).</td>
</tr>
<tr>
<td>101–300 ramp meters</td>
<td></td>
</tr>
<tr>
<td>More than 300 ramp meters</td>
<td></td>
</tr>
</tbody>
</table>

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.
Ramp Metering 101

- Fits within other TSM&O programs
- Support/complement other programs
- Align goals/objectives (HOV, transit use, safety, etc.)
- 84% claimed as a “critical tool for managing system”
Ramp Metering Benefits

- Mobility, Reliability, and Efficiency
  - Reduced travel times
  - Increased travel time reliability
  - Increased mainline speeds

- Safety
  - Crash reduction

- Reduced Environmental Impacts
  - Reduces stop-and-go conditions
  - Less fuel consumed

- High Benefit/Cost Ratio
  - Cost effectiveness
  - Twin Cities metering had B/C ratio of 15 : 1

Examples of actual measured benefits
Ramp Metering Deployment Challenges

Primary Challenges Currently Experienced by Agencies Deploying Ramp Metering:

- Existing Ramp Geometry (58%)
- Heavy Ramp Volume (25%)
- Costs and Funding (42%)
- Public Opposition (33%)
- Local Agency Opposition (17%)
- Lack of Agency Support (17%)
Deployment Challenges: Existing Geometry and Heavy Ramp Volume

- **Geometric considerations for ramp metering suitability**
  - Acceleration length
  - Mainline weaving
  - Limited sight distances
  - Experienced by 58% of agencies surveyed

- **Heavy Ramp Volume**
  - Queue length
  - Arterial backup
  - Ramp storage
  - Experienced by 25% of agencies surveyed
Deployment Challenges (continued)

- **Costs & Funding**
  - Initial deployment, operations & maintenance
  - Priority of projects / competition for funding
  - Experienced by 42% of agencies surveyed

- **Public Opposition**
  - Misconceptions about ramp metering
  - Experienced by 33% of agencies surveyed

- **Local Agency Opposition**
  - Negative perceptions of ramp metering
  - Equity issues
  - Experienced by 17% of agencies surveyed

- **Lack of Agency Support**
  - Agency understanding
  - Sufficient staffing
  - Communication
  - Experienced by 17% of agencies surveyed
Keys to Successful Ramp Metering Deployment/Expansion

- Suitability & Feasibility: Is Ramp Metering Right for You?
- Getting Ready for Ramp Metering
  - Gain Public & Agency Support
  - Identify Costs & Funding Sources
  - Understand Traffic Conditions
  - Consider Queue Lengths & Delays
- Operating Ramp Metering Effectively
  - Monitor Performance
  - Analyze Benefits and Costs
  - Monitor and Manage Ramp Queues
Keys to Success: Feasibility & Suitability

- Agency must assess both the suitability and feasibility of ramp metering
- Consistency with regional/agency goals and priorities
- Operational challenges must be relevant to ramp metering

Knowledge of agency and regional policies and priorities

Are you experiencing these challenges?
- Mainline congestion
- Safety issues at merge points
- Safety issues on the mainline
- Construction impacts
- Special event impacts

Ramp metering deployment decision process flow

Ramp meter may not be a suitable option

Needs can be addressed by ramp metering
Ramp metering feasibility
- Feasibility studies
- Benefit/cost analysis
- Agency capability and maturity

58% of agencies said studies/evaluations helped overcome barriers to expansion
Keys to Success: Getting Ready for Ramp Metering

Gain public and agency support

– Familiarize the public
  • Provide easily accessible resources and materials (open houses, brochure, press releases, FAQ’s on website, etc.)
  • Address misconceptions
  • Articulate the benefits

– Inter-agency coordination and communication: early & often
Keys to Success: Public Outreach Examples
Keys to Success: Public Outreach Examples (cont.)

Ramp Meters

What are ramp meters?
Ramp meters are stop-and-go traffic signals that act as traffic signals and are synchronized with fixed traffic signals at the end of the ramp. Ramp meters automatically adjust the speed of traffic entering the highway to ensure a steady flow of traffic.

Why do WSDOT install ramp meters?
Ramp meters are installed to help reduce congestion and improve traffic flow. They work by allowing only a certain number of vehicles to enter the highway at a time.

How do I use a ramp meter?
When the light is green, you can enter the highway at the ramp meter. When the light is red, you must wait until the light turns green before entering the highway.

Where can I find ramp meters?
Ramp meters are located at many intersections along major highways in Washington State.

Why are ramp meters effective?
Ramp meters are effective because they help to reduce congestion and improve traffic flow on highways.

Ramp Signaling

What you should know about Ramp Signaling

Ramp Signaling is a traffic control device that helps to reduce congestion and improve traffic flow. Ramp Signaling works by allowing only a certain number of vehicles to enter the highway at a time.

Consideration when using Ramp Signaling

- Pay attention to the red light before entering the highway.
- Wait until the green light before entering the highway.
- Be patient and considerate of other drivers.

The Ramp Signaling Program is part of an overall congestion-relief plan, which along with the 95 Express, is helping I-95 become a safer, more efficient road to travel in Miami-Dade County.

For more information about Ramp Signaling, please visit www.95Express.com, or call 1-877-95X-FDOT (1-877-959-3368).
Identify Costs and Funding Sources

- Itemize the specific costs
- Prioritize in budget/planning efforts
- 42% of agencies without ramp meters said capital costs were a barrier to deployment
- 25% of agencies without ramp meters said operations and maintenance costs were a barrier to deployment
**Keys to Success: Getting Ready for Ramp Metering (cont.)**

- **Understand Traffic Conditions**
  - Volumes on ramps, mainline, and arterials
  - Impact of queue spillover onto arterials
  - 83% of agencies said general public found queue backup onto arterials to be an issue

- **Consider Queue Lengths and Delays**
  - Data collection, queue detection
  - Consider mainline and arterial traffic conditions
  - 78% of agencies said general public found queue wait to be an issue
Keys to Success: Operating Effectively

- Monitor & Report Performance
  - Establish benchmarks
  - Measure several dimensions of performance
  - Identify areas of improvement
  - Report results to public, media
  - 42% used this to overcome barriers to ramp metering expansion
Keys to Success: Operating Effectively (cont.)

- Analyze Benefits and Costs
  - FHWA resources
    - Intelligent Transportation Systems (ITS) database
    - Tool for Operations Benefit/Cost (TOPS-BC)
    - Highway Capacity Manual, ATDM strategies section
  - Build case for ramp metering, use to reach out to stakeholders

- Monitor and Manage Ramp Queues
  - Can negatively affect public relations
  - Establish policies for queue wait times
  - Adjust algorithm parameters
Special Treatments: HOV & Transit Bypass lanes (79% had configurations in addition to the standard 1-car-per-green)

- Adaptive Ramp Metering
- Arterial Signal Integration
Nick Thompson

PRACTITIONER PANEL
Ramp Metering Practitioner Panel

Mark Leth - Washington State Department of Transportation

Brian Kary - Minnesota Department of Transportation

Jason Sims - Kansas City Scout

Javier Rodriguez - Florida Department of Transportation

Meredith McDiarmid - North Carolina Department of Transportation
Mark Leth

RAMP METERING IN THE SEATTLE AREA
Beginning to Current

TMC 1960’s

TMC (open 2015)
Initial Action

- First ramp meter activated in 1966
- Mitigation during initial Interstate 5 construction in north Seattle
- Removed after freeway constructed
The Beginnings of a System

- Initial operation in 1981 of 22 ramp meters along I-5 north of Seattle Central Business District
- AM & PM peak periods
- Centralized control
- Significant mobility and collision reduction benefit
Continued Expansion

- Currently operate 150 ramp meters on freeways within the Central Puget Sound area – close to 25 more coming soon
- Many added during past freeway HOV lane expansion
- In recent years, continued expansion & control system enhancement by the Traffic Operations program – metered shoulder lanes, etc.
- Fuzzy logic algorithm’s, updates every 20 seconds, continued automation of features, etc.
Ramp Metering - Getting to “Yes” (and sustaining)

- Initial Planning
- What’s the Message?
- Influential Champion(s)
- Dialogue w/Local Agencies & Politicians
- Targeted Audience for Additional Outreach when necessary
Challenges Along the Way & How to Overcome Them

Agency Internal Support

- ITS, ramp metering, etc. has not been the core business of a state DOT
- Limited resources are moving DOT’s more towards operational solutions – the opportunity is expanding
- Monitor, measure & report on outcomes; benefits vs. cost
- Professional, focused traffic operations organization
- Anticipate and mitigate operational problems quickly or in advance of potential impact (complaints!)
Challenges Along the Way & How to Overcome Them (cont.)

- Political opposition
  - Data driven support on need and benefits, including benefit to the local population
  - Disprove the myths & find common ground
    - Reduce cut through traffic through neighborhoods
    - Agreement on ongoing performance measurement, quick response to local concerns, etc.
  - Avoid agreements that limit flexibility (such as hours of operation). Active Traffic Management is most effective when system operations can immediately respond to emergent conditions.
Challenges Along the Way & How to Overcome Them (cont.)

- Retaining an Integrated O&M Workforce
  - ITS Design & Operations
  - TMC Operations
  - Software Development & Support
  - ITS Maintenance
  - Sustainable, flexible funding source
Mitigating Ongoing Challenges
Field Actions

Continued pursuit of practical, supported & fundable solutions

• Dynamic ramp metering lane designation
  – HOV 2+ bypass OR HOV 3+ bypass
  – HOV to HOV OR Freight bypass
  – HOV bypass OR General Purpose bypass

• Increased use of metered shoulder lanes on ramps
Mitigating Ongoing Challenges
Field Actions

- Restripe of existing ramps, with or without minor widening of the ramp and/or connecting arterial.

- Implementation of “form two lines when metered” operations that is in place elsewhere in the country.
Questions?

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RAMP METERING IN MINNESOTA

Brian Kary
RAMP METERING IN MINNESOTA

BRIAN KARY
FREeways OPERATIONS ENGINEER
MnDOT Ramp Meters

- 1969 – First MN ramp meters tested on I-35E in St. Paul

- Today – The system includes over 420 ramp meters.

- Metering rates adjust every 30 seconds based on real-time traffic conditions
How do Ramp Meters Operate in Minnesota?
Minnesota Ramp Control Algorithms

- ZONE algorithm – 1990s
- Stratified Zone Metering (SZM) – 2000s
- Density Based Algorithm - 2014
Ramp Meter Zone

- System measures highest density up to 3 miles downstream
- Metering rates adjust every 30 seconds based on mainline conditions and ramp demand
- Queue detector measures demand and prevents backup onto cross street
Ramp Meter Challenges
Why are Ramp Meters Controversial?

- The results are counter-intuitive
  - The public is less tolerable of waiting when meters are working correctly
- The safety benefits are not perceived by the motorists
  - Saving 6 crashes a day does not sound like a lot
- People do not like to wait in line
Ramp Meter Shutdown Study

- Legislatively mandated study in 2000
- Turned off the meters for 5-weeks in Sept 2000
- Results of the study found:
  - Improved Throughput by 10%
  - Improved Freeway Travel Times by 20%
  - Improved Travel Time Reliability by 90%
  - Reduced Crashes by 25%
  - Reduced Congestion resulting in Reduced Emissions and Fuel Consumption
Benefit/Cost Analysis

- Annual savings of approximately $40 Million to the Twin Cities Traveling Public
- Annual cost of $2.6 Million to operate ramp meters
- 15.1:1 Benefit/Cost Ratio for Ramp Metering
Mn/DOT Policy

• Ramp meter waits
  – no more than four minutes per vehicle on local ramps
  – two minutes per vehicle on freeway-to-freeway ramps.

• Vehicles waiting at meters will not back up onto adjacent roadways

• Meter operation will respond to congestion and operate only when needed.

• Limited Hours of Operations
  – AM Peak – 5:30 AM to 9:00 AM
  – PM Peak – 2:00 PM to 6:30 PM
Jason Sims

KANSAS CITY SCOUT
Accelerating Ramp Metering Deployment

December 10th, 2014

E. Jason Sims P.E.
Traffic Center Manager Kansas City Scout
Partners

- Kansas Department of Transportation
- MoDOT
- MARC Mid-America Regional Council
- FHWA U.S. Department of Transportation
Project Map

Ramp Meter Location
KC Scout Ramp Metering
Corridor Adaptive Approach
Look and Feel of Kansas City Ramp Meters
One-Lane Ramp, One Vehicle Per Green
Two-Lane Ramp, One Vehicle Per Green
Public Relations Challenges
Campaign Objectives

- Maximize communication
- Build on existing partnerships
- Create new relationships
## Reach Targeted Audiences

<table>
<thead>
<tr>
<th>Audience</th>
<th>Thematic Outreach Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical staff and local officials</td>
<td>Technical content with emphasis on facts, benefits, and experiences of other communities</td>
</tr>
<tr>
<td>Local public officials</td>
<td>Less technical content with accent on ramp metering benefits and safety</td>
</tr>
<tr>
<td>Law enforcement (highway patrol)</td>
<td>Focuses on ramp metering operation and enforcement</td>
</tr>
<tr>
<td>General public</td>
<td>Highly graphic, non-technical, and focuses on the need for ramp metering</td>
</tr>
</tbody>
</table>
Measuring Performance
**The Impact of the KC Scout**

As Kansas City’s driving population grows, traffic issues such as congestion, crashes, and air pollution become even more prevalent. Inadequate funding and, in some cases, inadequate planning, have made new construction and improvements an increasingly difficult solution. Still, the need for a more efficient and effective system for freeway travelers continues.

In states, technology and traffic management have become the answer to these problems. For Kansas City, the answer is Scout.

Launched in 2004, Scout manages traffic on more than 100 miles of continuous freeways in the greater Kansas City metropolitan area. Scout uses cameras to monitor the highways from its state-of-the-art command center in Lees Summit. The system relies on traffic patterns to gather real-time accurate traffic information, and uses large electronic message boards to send crucial traffic notices to drivers along the freeways. Scout also uses a Regional Advisory Radio system on 1650 AM that most Missourians can tune into in the event of a freeway incident.

The system’s incident management program uses Motorist Assist, a roadside emergency response program with a comprehensive database of local emergency information to help clear roadways, reduce congestion, and aid injured or stranded travelers.

Congestion management tools include a pilot program for dynamic congestion pricing and an interstate-to-arterial program partnership with MADC’s Operation Greenlight (mob.org). There also is a partnership with MoDOT to keep travelers up to date with real-time travel information through redesigned travel web sites like kcotraffic.net. **My KCSCOUT** is a personalized mobile web app that provides real-time travel information for Kansas City, Mo. **My KCSCOUT** is available at kcotraffic.net.
Ramp Metering Website and Performance Measure Reports

www.kcscout.net

Scout App featuring “Real Time Performance Measures”
RAMP METERING ON INTERSTATE 95 – THE MIAMI EXPERIENCE

Javier Rodriguez
Ramp Metering on Interstate 95 – The Miami Experience

Federal Highway Administration – Ramp Metering Webinar
December 10, 2014
Javier Rodriguez, P.E., District Six ITS Operations Engineer
Ramp Meters in Miami

First Ramp Metering System in Florida
- Managed by D6 SunGuide Transportation Management Center

Phase 1A
- Launch Date: February 4, 2009
- 8 Signals; NB from NW 62 St to the Golden Glades Interchange (GGI) on I-95

Phase 1B
- Launch Date: April 14, 2010
- 12 Signals; SB from Ives Dairy Rd to NW 62 St on I-95
- 2 Signals; NB from the GGI to Ives Dairy Rd on I-95
Challenges

1. First in Florida
   - New Traffic Concept to South Florida, FDOT & Drivers

2. Initial Launch Vs. Official Launch
   - 2005 Vs. 2009 – Four Year Gap!

3. System Readiness
   - Integration with New Ramp Metering Software
     1. Software and Hardware Testing, Software Configuration

   Solutions
   1. Industry Experts Added to Team
   2. Dedicated Team Focused on Deployment
   3. Developed Procedures to Test & Configure Equipment & Software
Challenges

4. Staffing and Operational Needs
   1. Lack of Local Experience
   2. Transitioning Roles of TMC & Existing Staff
   3. Lack of Monitoring Ability

Solutions

1. Added Industry Experts to the Team
2. Modified Contract to Support TMC Transition
3. Added CCTVs to Monitor Operations
5. Agency Education & Coordination

- **Internal/External**
  1. Multiple On-Going Highway Projects

- **Training**

- **Enforcement**

- **Solution**
  1. Developed Specialized Trainings & Project Workshops w/ Stakeholders
  2. Modified FHP Hire-Back Contract to Support Enforcement
Challenges

6. Public Acceptance
   - Public Skepticism
   - Driver Adherence
     1. Driver Behavior = Project Success

Solution
1. Added Ramp Metering to 95 Express PI Effort to Maximize Benefit
2. Tri-Lingual Public Awareness Efforts & Material
3. Feedback from Field Observers & PIO Used to Ease Driver Adjustment
“Buckle Up America. Every Trip. Every Time.”

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Meredith McDiarmid

RALEIGH AREA RAMP METERING FEASIBILITY STUDY
Ramp Metering Feasibility Study

Meredith McDiarmid, PE

December 10, 2014
Feasibility Study Elements

- Data Collection
- National Research
- Legal and Legislative Review
- Screening and Detailed Analysis
- Plan for Marketing and Outreach
Feasibility Study Areas

- Triangle Area
- Wake and Durham Counties
- 208 sites
- Freeway Sections:
  - I-40
  - I-85
  - I-440
  - I-540
  - NC 147
  - US 1/64 WB
  - US 15/501
Ramp meters can work in NC too!

Minor legislative change to explicitly allow motorists to proceed past a “dark” ramp metering signal without stopping first

Minor revision to penalty for proceeding through a red ramp metering signal

Marketing and Public Outreach will be key to the success of the first ramp meter in NC

### 4.1. Ramp Meter Performance Data

The following tables summarize some of the available ramp meter performance data from existing ramp meter deployments.

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Location and Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>Atlanta – 10% decrease in peak period</td>
</tr>
<tr>
<td></td>
<td>Houston – 22% decrease in peak period</td>
</tr>
<tr>
<td></td>
<td>Arlington – 10% decrease in peak period</td>
</tr>
<tr>
<td>Travel speed</td>
<td>Milwaukee – 35% increase in peak period</td>
</tr>
<tr>
<td></td>
<td>Portland – 155% increase in peak period</td>
</tr>
<tr>
<td></td>
<td>Detroit – 8% increase</td>
</tr>
<tr>
<td></td>
<td>Los Angeles – 15 mph increase</td>
</tr>
<tr>
<td>Crash rate</td>
<td>Phoenix – 16% decrease during metered hours</td>
</tr>
<tr>
<td></td>
<td>Milwaukee – 15% decrease in peak period</td>
</tr>
<tr>
<td>Crash frequency</td>
<td>Portland – 43% decrease</td>
</tr>
<tr>
<td></td>
<td>Sacramento – 50% decrease</td>
</tr>
<tr>
<td></td>
<td>Los Angeles – 20% decrease</td>
</tr>
<tr>
<td>Driver hours saved</td>
<td>Sacramento – 50% decrease</td>
</tr>
<tr>
<td></td>
<td>Los Angeles – 8,470 hours per day</td>
</tr>
<tr>
<td>Vehicle volume</td>
<td>Milwaukee – 22% increase in peak period</td>
</tr>
<tr>
<td></td>
<td>Sacramento – 5% increase in peak period</td>
</tr>
<tr>
<td></td>
<td>Detroit – 14% increase in volume</td>
</tr>
<tr>
<td></td>
<td>Los Angeles – increase of 900 vehicles per day</td>
</tr>
<tr>
<td>Gallons of fuel saved</td>
<td>Portland – 700 gallons per weekday</td>
</tr>
<tr>
<td>Emissions reduction</td>
<td>Minneapolis – reduction of 1,160 tons annually</td>
</tr>
<tr>
<td>Benefit-Cost ratio</td>
<td>Atlanta – about 4:1 in year 1, about 20:1 after 5 years</td>
</tr>
</tbody>
</table>
Low Level Feasibility Study Findings

- Benefit Cost Ratios are the best way to prioritize potential ramp metering sites.
- In some cases, multiple ramp meters work together to address congestion.
- Implementation approaches can make or break a ramp metering program.
- Marketing and Public Outreach will take longer than implementation.
Ramp Meter Implementation

- Performed a deeper dive into an area local engineers believed had potential for successful first implementation
- Intentionally did not pick the highest B/C site to implement first
- First ramp meter implementation anticipated to begin late 2017 and operational 2018
Implementation Area

Wake County
I-540
4 Ramp Meters westbound
2018
$900K
Ramp Metering Feasibility Study

http://www.campo-nc.us/ramp-metering.html

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Knowledge and Technology Transfer

- Lessons Learned
- Engagement with professional associations
- Website [http://ops.fhwa.dot.gov/atdm/about/program.htm](http://ops.fhwa.dot.gov/atdm/about/program.htm)
Thanks for joining us!

We hope to see you at our next ATDM Webinar in January!