# Evaluating the Benefits of a System-Wide Adaptive Ramp-Metering Strategy in Portland, Oregon

## Overview
The project seeks to evaluate the benefits of the System-Wide Adaptive Ramp Metering (SWARM) system implemented in the Portland Metropolitan area as compared to a pre-timed system.

The results presented here are drawn from a two-week pilot study of the southbound Oregon highway 217 corridor in June, 2006. The pilot study was part of an effort to develop a strategic design for a future regional-level study.

## Objectives
The objective of this study was to quantify system-wide benefits in terms of reduced delay, emissions and fuel consumption, and safety improvements on and off the freeway due to implementation of the SWARM system.

## Background
Starting in 1981, the Oregon Department of Transportation (ODOT) implemented pre-timed ramp metering to manage traffic congestion during the morning and afternoon peak periods.

The SWARM system was first implemented in Southern California and was adapted for use in Portland. It has been implemented in stages since May 2005 and is operating on six of the seven metered freeway corridors.

## SWARM Algorithm
SWARM computes metering rates in real-time under both a local mode with respect to conditions near each ramp and a global mode operating on an entire freeway system. The more restrictive rate is applied.

## Results
VMT exhibited only a marginal increase during the study period of SWARM operation as compared to the pre-timed study period. However, VHT and average travel time increased under SWARM, corresponding to an increase in total delay on the freeway. Empirical evidence suggests that this increase resulted from higher metering rates at most of the on-ramps. These higher metering rates under SWARM resulted in lower travel times on several major on-ramps, indicating a tradeoff between an increase in freeway delay and lower on-ramp delays.

<table>
<thead>
<tr>
<th>Performance Comparison</th>
<th>VMT</th>
<th>VHT</th>
<th>Travel-Time</th>
<th>Delay (vehicle-hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Timed</td>
<td>65,871</td>
<td>1,337</td>
<td>8.8</td>
<td>210</td>
</tr>
<tr>
<td>SWARM</td>
<td>66,426</td>
<td>1,416</td>
<td>9.2</td>
<td>283</td>
</tr>
<tr>
<td>% Change</td>
<td>0.8%</td>
<td>6.0%</td>
<td>5.1%</td>
<td>34.7%</td>
</tr>
</tbody>
</table>

Most on-ramp flows were slightly larger when SWARM was in operation. The increases in flow (except at Hall Blvd.) were between three and nine percent.

Whether the increase in the total freeway delay was solely caused by the higher merging rates remains an open question since the bottleneck discharge rate could not be measured from the data. Moreover, delays could not be quantified at all on-ramps due to the limitations on data collection efforts, and hence, it was not feasible to analyze the system-wide trade-offs between the freeway and on-ramp delays.

## Next Steps
The lessons learned from the pilot are being used in the design of a subsequent study that will include northbound I-205 and either northbound I-5 or northbound OR-217.

Archival data does not include vehicle inflows to the ramp or metering rates and times and counting on-ramp inflows during the pilot study was labor intensive.

Electronic data collection devices – programmable logic controllers (PLCs) – will be installed on the key on-ramps in each corridor to measure vehicle flows entering and leaving the on-ramp. During the SWARM period of the study, the PLCs will also collect data about meter activation times and metering rates.

## Acknowledgements
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