

ITS Radar Helpdesk Query: Environmental Impacts of Ramp Metering

Query no:	5	Query initiator:	Chris Gould
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Query topic areas:	Environmental Impacts of Ramp Metering		
Categories and level of relevance :	Traffic Management Technology	Very relevant	
	Safety	Some relevance	
	Technology Solutions	Some relevance	
Transferability to Highways Agency :	Meets Policy Objectives	Yes	
	Cost/Benefits Information	Available, but not in this note.	
	Development status	Well developed	
	Innovative	Not particularly	
	UK legal issues	N/A	
Summary:	<p>We have identified very little research carried out into the environmental impacts of introducing ramp metering. The vast majority of research has been focused on the traffic effects of ramp metering, such as throughput, flow, speed and journey time and the costs/benefit ratio of schemes.</p> <p>Quoted results identified are all in the USA as follows:</p> <ul style="list-style-type: none"> • Twin Cities, Minnesota- emissions reduced by 1,160 tonnes/ year; • Twin Cities, Minnesota- fuel use rose by 5.5 million US gallons /yr. • Denver, Colorado - emissions reduced by 24%; • Portland, Oregon - fuel use fell by 540 2,040 litres per weekday. • Long Island - 6.7% increase in NOx emissions; • Long Island - 17.4% reduction in CO; and • Long Island - 13.1% reduction in HC. 		

Introduction

This document is provided in response to the above query regarding the results of research into the environmental impacts of ramp metering.

The following section summarises available published research on the effects of ramp metering:

Twin Cities Ramp Meter Evaluation – Minnesota Dept. of Transportation, February 2001

The Minnesota Department for Transportation (Mn/DOT) uses ramp meters to manage access on to approximately 210 miles of freeways in the Twin Cities Metropolitan area. There was (at Feb. 2001) approximately 430 ramp meters installed to facilitate the merging of traffic onto freeways and managing the flow through bottlenecks.

A study was commissioned in 2000 to determine the effectiveness of the ramp metering policy following queries from the public on its usefulness. For the study data needed to be collected so a 'before' and 'after' comparison of ramp metering could be made. As no 'before' data was available the decision was made to switch off the entire system for a number of weeks in order to collect the data and create a representation of the conditions before ramp metering was installed.

It was found by comparing the data sets that the operation of ramp metering in this area produced net annual savings of 1,160 tonnes of emissions or \$4 million.

However, the report also states that the operation of ramp metering caused an annual increase in fuel consumed of 5.5 million US gallons or circa \$8 million. The report states that, "The analysis as is shows a dis-benefit for metering, because the reduction in freeway speed in the meters off condition actually results in fuel savings."

The report makes reference to other research carried out in Dever, Detroit and Long Island which evaluated emissions as part of their ramp meter study. These schemes also showed some improvement in overall emissions due to ramp metering. The Twin Cities report states that, "Long Island showed a 6.7 percent increase in NOx, and improvements in CO and HC of 17.4 and 13.1 percent, respectively."

The Twin Cities report goes on to say, of secondary research, "Four areas which evaluated fuel consumption impacts of ramp metering showed savings due to ramp metering ranging from about six to thirteen percent." The report also notes that in the Twin Cities evaluation, impacts of ramp metering on fuel consumption may be conservative in so far as no account was taken of the beneficial effect on fuel consumption of smoother flow on the main line.

Assessing the Benefits and Costs of Intelligent Transportation Systems: Ramp Meters UCB-ITS-PRR-99-19 California PATH Research Report Seungmin Kang, David Gillen 1999

This document reviews several ramp metering system evaluations, most undertaken in the 1980's and 1990's, Once again, there is little conclusive evidence of the environmental benefits or dis-benefits of ramp metering. The environmental benefits quoted are as follows:

- Denver, Colorado – 1981/82 – Vehicle emissions dropped by 24%;
- Portland, Oregon – 1981 – 16 meters installed along I-5. It was estimated that fuel consumption, including that caused by ramp delay, was reduced by 540 US gallons per week day (2,040 litres).

UK – M8 Motorway Ramp Metering (TABASCO project) – Tempo Secretariat, February 2004

Glasgow City Council decided to introduce ramp metering at M8 Junction 16 eastbound, Variable Message Signs (VMS) associated with the ramp metering system and dynamic signal control of the urban junctions from 16 to 15 eastbound were also introduced.

In this report a number of different indicators were developed to satisfy the requirements of the reporting objectives for the various stakeholders in the project, including the EU, Scottish Executive, the Police, Glasgow City Council and the systems manufacturer. Of these indicators, included was a measure of the reduction in emissions and the reductions in the noise levels.

The report breaks down the effect on emission and noise on discrete sections of the carriageway during different time periods following the schemes introduction. On the eastbound section of the motorway it was found, where data was available, that the overall noise level increased by 1 decibel and during the spring/summer periods, CO and HC's emissions decreased but NOx increased. In the autumn/winter time periods all emission types increased. On the urban diversion routes it was found that all emission types and noise levels increased at all times of year, but on the urban network it was found that all emission types decreased during all time periods.

Intelligent Transportation Infrastructure Benefits: Expected and Experienced – The MITRE Corporation, January 1996

The report summarises North American examples of and experiences of the introduction of ITS systems, including a look at a freeway management system in Seattle, Washington that uses ramp metering. A study carried out in Seattle over six years found that on differing sections of the carriageway traffic grew between 10% and 100%, with speeds remaining steady or increasing by up to 48%.

No clear statement on the impact of ramp metering on emissions or fuel consumption was noted.

Ten Years of Ramp-Metering in the Netherlands – H. Taale & F. Middelham, 2000

This paper focuses on the results of many studies conducted in the Netherlands following the introduction of ramp metering on a number of different roads and junctions. The paper predominantly addresses the different metering algorithms and their impacts.

No results are cited regarding the effect of ramp metering on the environment.

I-580 Ramp Metering, “Before” and “After” Evaluation, Final Report – Kimley-Horn and Associates, Inc – February 2005

This paper documents the evaluation of the “Before” and “After” situation post implementation of ramp metering on the I-580 between the Cities of Pleasanton and Livermore in California. This paper does not directly address the environmental impacts of ramp metering, but details the change in the number of vehicles using the ramps “before” and “after” its introduction.

Other Reports

There are several other reports that discuss the results of implementing ramp metering, particularly from the Netherlands where research and application of this technique is widespread. However, a theme that runs through most research is that the studies generally focus only on the direct traffic effects, i.e. capacity, flow, speed, journey time, etc, and not the resulting environmental impacts of the schemes introduction.

References

1. Twin Cities Ramp Meter Evaluation – Minnesota Dept. of Transportation, February 2001
http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/@cx01!.PDF
2. Assessing the Benefits and Costs of Intelligent Transportation Systems: Ramp Meters UCB-ITS-PRR-99-19 California PATH Research Report Seungmin Kang, David Gillen
<http://www.path.berkeley.edu/PATH/Publications/PDF/PRR/99/PRR-99-19.pdf>
3. UK M8 Motorway Ramp Metering (TABASCO project) – Tempo Secretariat, February 2004
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4. Intelligent Transport Infrastructure Benefits: Expected and Experienced – The MITRE Corporation, January 1996
http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/1mz01!.pdf
5. Ten Years of Ramp Metering in the Netherlands – H. Taale & F. Middelham, 2000
http://www.ltrc.lsu.edu/TRB_82/TRB2003-000237.pdf
6. I-580 Ramp Metering, “Before” and “After” Evaluation, Final Report – Kimley-Horn and Associates, Inc – February 2005
http://apps.mtc.ca.gov/meeting_packet_documents/agenda_526/TETAP-I580_Before-After-Evaluation_Executive-Summary.pdf

The Tempo documentation is held online, but is password protected. Please contact the ITS Radar helpdesk if you wish to be sent an e-copy of this documentation.