

# Technical Memorandum Compendium

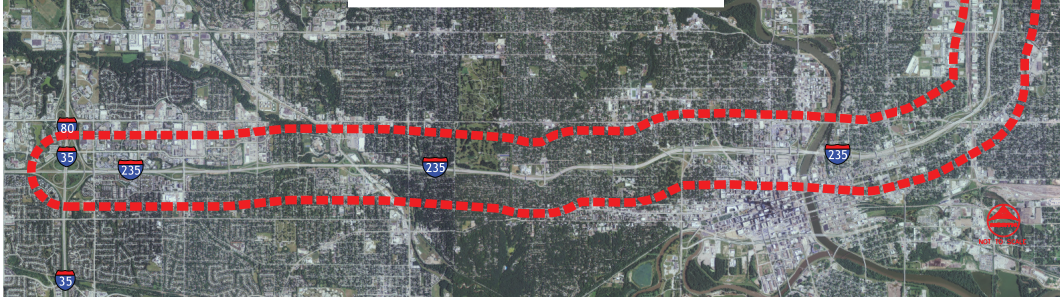
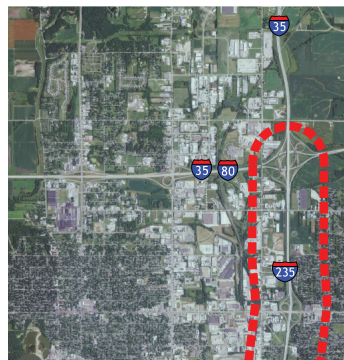
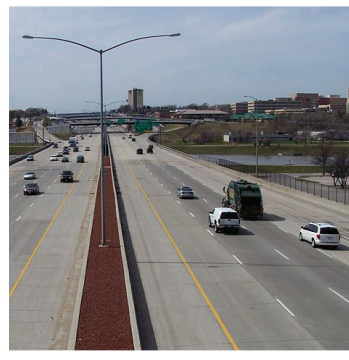
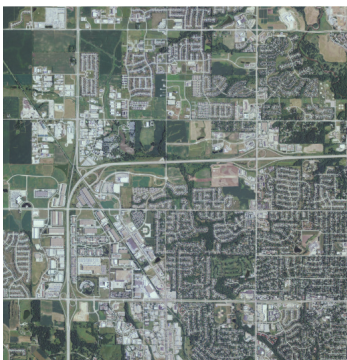
## Interstate 235

### Ramp Management Feasibility Study

April 2014

# DRAFT

Prepared For:



Prepared By:



HRG Project Number:  
40120022.06

# Technical Memorandum Compendium

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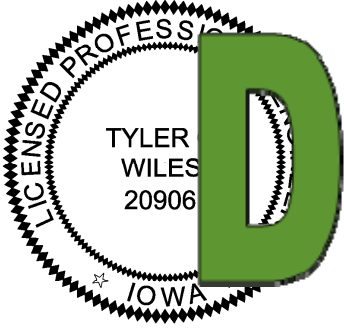
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### CERTIFICATIONS

	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.	
	<p>4.P. Wiles, P.E. Number: 20906 I hereby certify that this is a true and correct copy of the original as shown to me by the engineer's seal: Signature: _____</p>	<p>DATE: DECEMBER 11, 2013.</p>

## PREFACE

The Interstate 235 Ramp Management Feasibility Study has been completed in a system of technical memorandums documenting the project. These technical memorandums are compiled to form the final project deliverable.

### *Technical Memorandum #1: Existing Conditions Review*

The first of the three memorandums produced documents the existing conditions of the I-235 study corridor. The existing conditions review included a high-level review of crash history, entrance ramp geometrics, documentation of traffic volume data, documentation of travel time data, and completion of traffic operations analysis.

### *Technical Memorandum #2: Ramp Management Strategy Review*

The second memorandum reviews three components. The first component is the overall ramp management strategy which includes evaluation of isolated ramps versus a group strategy and assessment of metering timing parameters. The second component is the evaluation of I-235 corridor operations for existing and future conditions, with and without the use of ramp metering. The final component is the ramp meter design criteria including whether there is a single lane or dual lane and if dual, whether a dual/simultaneous vehicle release or alternating vehicle release strategy is utilized. In addition, stop bar placement, pavement marking/signing modifications and ITS infrastructure improvements are discussed. The strategy is developed based on the findings of the first memorandum titled *Existing Conditions Review Technical Memorandum*.

### *Technical Memorandum #3: Benefit/Cost Analysis*

Based on the ramp management strategies and locations identified within the second technical memorandum, a review of the anticipated user benefit and implementation/operating costs of the selected ramp metering concept is completed. The goal of the *Benefit/Cost Technical Memorandum* is to quantify the relative benefit of implementing the ramp management strategy along the I-235 corridor.

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## PROJECT INTRODUCTION AND BACKGROUND

### A. Purpose

The purpose of the series of technical memorandums is to study the feasibility of implementing ramp metering along the Interstate 235 (I-235) corridor located in Des Moines, Iowa. Ramp meters smooth the flow of traffic entering freeway facilities allowing vehicles to merge onto the freeway facility with minimal effect on traffic flow. The smoothing of traffic is completed by splitting the large clusters, or platoons, of vehicles that enter the entrance ramp from the upstream terminal intersection. Typically, ramp metering is used to reduce congestion, reduce the number of crashes, and improve travel time reliabilities. As a result of implementing ramp metering, improvements to travel speed, travel time, delay, and crash rates are commonly observed.

Ultimately, this series of technical memorandums will serve as a foundation to the question of whether the I-235 corridor would benefit from the implementation of ramp metering strategies with regards to traffic operations as well as from a benefit/cost perspective.

### B. Study Area Background

The project study area includes the I-235 corridor from the southwest I-35/I-80 systems interchange (Southwest Mixmaster) located in West Des Moines, Iowa to the northeast I-35/I-80 systems interchange (Northeast Mixmaster) located in Ankeny, Iowa. I-235 is an urban interstate corridor approximately fourteen miles long with four different posted speed limit zones ranging from 55 to 65 mph along the facility.

I-235, also named the MacVicar Freeway, in honor of two former mayors of Des Moines, John MacVicar Sr. and John MacVicar Jr., was originally constructed between 1961 and 1968 and was reconstructed between 2002 and 2007. The reconstruction project included bridge widening and replacement, installation of noise walls, reconstructing several of the existing interchanges, and repaving the facility. The new facility also eliminated all left-lane exits and entrances and is six lanes wide throughout the route with an eight-lane stretch between 63rd Street (Highway 28) and 7th Street as well as between 5th Avenue and E. 14th Street.

As a part of the reconstruction project, an Environmental Impact Statement (EIS) was completed in the spring of 1999, with the Record of Decision being signed in April 1999. The following is an excerpt from the EIS regarding the use of ramp metering as a potential alternative to mitigate the needs of the corridor:

*Ramp Metering – This strategy examined the advantages of metering several high volume ramps along the I-235 corridor, especially in the highly congested Des Moines central business district. The main purpose of metering ramps along I-235 is to improve traffic flows, by diverting some short distance traffic to other facilities, and smoothing the flows of traffic entering the freeway. This is accomplished through the installation of traffic signals on major on-ramps. These signals would meter the flow of traffic entering the freeway at any given point,*

*and encourage some short distance traffic to find alternative routes by marginally increasing travel times for trips entering I-235.*

*While improved efficiency associated with ramp metering creates marked improvements on I-235, it does not completely solve the projected transportation deficiencies. Therefore, ramp metering was incorporated into the build alternatives to provide a more comprehensive solution to projected traffic demands.*

However, through the selection of the preferred alternative within the EIS, which incorporated input from the Des Moines Area Metropolitan Planning Organization (DMA MPO) and the Iowa DOT Commission (Commission) as well as input from the Metropolitan I-235 Citizens Design Committee, it was decided not to include ramp metering along the corridor as part of the I-235 corridor reconstruction efforts. The following is an excerpt from the EIS:

*Ramp Metering – Ramp metering was not recommended at this time. However, the Commission recommended that the locations for ramp metering be identified and those locations be designed to be compatible with possible future metering.*

The final preferred alternative included a compromise between the full build alternative and the limited build alternative, which included the use of TDM-10 and a Freeway Incident Management system. TDM-10 is a travel demand management strategy attempting to maximize the people-moving capacity of existing transportation systems by encouraging the use of alternative travel modes with the goal of reducing the total number of vehicles needed to transport the same number of people by ten percent during peak periods.

I-235 is a prominent auxiliary Interstate route providing a means of transportation access to daily commuters along with intra-urban and through motorists. The corridor runs just north of downtown Des Moines through the core of the Des Moines metropolitan area. I-235 currently carries approximately between 63,000 and 118,300 vehicles per day according to the Iowa DOT 2012 Annual Average Daily Traffic (AADT) Flow Maps.

As part of the 1999 EIS, traffic volume projections for the year 2020 were provided along the corridor. Currently, west of 63rd Street (Iowa Highway 28), those traffic projections have already been surpassed by 2012 traffic volumes. East of 63rd Street, current daily traffic is below however increasing towards the 2020 traffic volume projections.

## EXECUTIVE SUMMARY

This series of technical memorandums documented the feasibility of ramp metering along the I-235 corridor. The technical memorandums were divided into three sections with the first memorandum reviewing existing conditions, the second reviewing operations and developing the metering strategy and the third providing a benefit-cost analysis. Findings of the three memorandums are summarized below. For additional information, refer to the individual technical memorandums themselves.

### Technical Memorandum #1: Existing Conditions Review

The first of the three memorandums, titled Existing Conditions Review Technical Memorandum documented the existing conditions along the I-235 corridor including;

- Conducted a traffic operational analysis of the existing traffic volumes to identify areas of operational concern,
- Collected and reviewed travel time information during peak periods to supplement traffic operational analysis,
- Inventoried and reviewed existing entrance ramp geometrics to identify potential geometric constraints,
- Reviewed historical crash records to identify safety concerns along the current corridor,
- Reviewed available Intelligent Transportation System (ITS) communications infrastructure sources of information to identify potential communication infrastructure needs.

From the existing conditions review, the following points can be concluded

- With regards to traffic operations, the majority of existing operational concerns occur along the east/west segment of the corridor.
  - Eastbound in the AM peak period and westbound in the PM peak period
- Impacts to travel times caused by congestion were noted mostly along the east/west segment of the corridor.
- The east/west segment of the corridor contained multiple segments with crash rates above the statewide average

### Technical Memorandum #2: Ramp Management Strategy Review

The Ramp Management Strategy Review Technical Memorandum was the second installment and was divided into three components. Together, the first and second components provided an overview of the overall ramp management strategy including evaluation of isolated entrance ramps versus a group strategy assessment of metering timing parameters and an operational analysis of the effects of ramp metering. The existing conditions analysis for I-235, documented in the Existing Conditions Review Technical Memorandum, demonstrated that sections along the I-235 study corridor operate at or near capacity through several interchanges along the corridor, in particular along the east-west segment. These sections do not generally experience the type of dramatic speed reductions that would justify an isolated ramp metering strategy, however aggregated together, corridor speed reductions exist.

The east-west segment, from University Avenue west, has a number of deficient and potentially deficient segments, with most occurring in the westbound direction. Due to

the anticipated corridor operational benefits and to minimize trip diversion to the surface street network, the group strategy along the east/west segment is recommended over the isolated strategy. The geographical extents of the east/west segment are between the western terminus, the southwest I-35/I-80 systems interchange (Southwest Mixmaster) and University Avenue (east of downtown). If resources are limited, priority should be given to the segment from 2nd Avenue west, in the westbound direction.

The north-south segment of I-235, from University Avenue north to the end of the study area at the I-35/I-80 systems interchange, has limited congestion and relatively low projected growth. The north/south segment should be monitored in the future, however near term benefits of ramp metering strategies are not currently present and even long-term benefits are projected to be negligible.

Also, due to the variability of traffic volumes temporally along the corridor both by peak period as well as seasonality, the use of a traffic responsive metering system is recommended.

The final component provided an overview of the proposed ramp meter design criteria including single lane or dual lane operation and if dual, whether a dual/simultaneous vehicle release or alternating vehicle release strategy is utilized. From use of a developed sketch planning spreadsheet tool, it was determined that in general, current and short-term traffic volume demand do not require dual lane operation along the corridor, however the Iowa DOT may wish to consider the implementation of dual lane operation as a long term strategy and minimize future reconstruction efforts by adding the additional infrastructure required for dual lane operations. The decision to deploy single lane operation or dual lane operations should be made on a ramp by ramp basis as part of the final design process. As discussed within the Single vs. Dual Lane Operation section of this technical memorandum, the existing entrance ramp geometrics generally align with the cross section widths necessary to deploy dual lane operations and provide for emergency vehicle by-pass operations. Under the dual lane operation strategy, an alternating vehicle release strategy is recommended over a dual/simultaneous release strategy.

In addition, the final component provided an overview of the proposed ramp meter design criteria including stop bar placement, pavement marking/signing modifications and necessary ITS infrastructure improvements. Pavement marking/signing modifications along with ITS infrastructure improvements associated with ramp metering implementation were identified.

### Technical Memorandum #3: Benefit/Cost Analysis

The Benefit/Cost review component was the third and final installment in a series of three technical memorandums to study the feasibility of ramp metering along the I-235 corridor.

The analysis summarized in the benefit/cost analysis memorandum utilized the TOPS-BC spreadsheet tool which estimates changes in travel time, crash rates and fuel consumption; and then monetizes these changes to estimate project benefits and allow benefits to be compared to cost. Both annualized net benefits and benefit/cost ratios were calculated. In addition to existing conditions, forecasts were developed for 5-year and 20-year time horizons.

As discussed prior, the north-south section of I-235, from University Avenue north to the end of the study area at I-80/I-35, has limited congestion and relatively low projected growth. In addition, the east-segment, from University Avenue west, has a number of deficient and potentially deficient segments, with most occurring in the westbound direction.

The TOPS-BC analysis showed that ramp metering would have significant benefits for the east-west segment over the 20-year analysis period while benefits for the north-south segment would be minimal. An investment in ramp metering for the westbound segment would slightly exceed annualized cost in the first year with significant increases over time until a 13:1 benefit/cost ratio is achieved 20 years out on the east-west segment. The north-south segment on the other hand does not achieve a 1:1 ratio until 10 years out and benefits are limited throughout the full study period.

### Next Steps

From review of the data analyzed as part of the Interstate 235 Ramp Management Feasibility Study, the recommended next steps include:

- Further engineering analysis of ramps in the east-west segment of the corridor that have physical limitations or limited storage capabilities;
- Microsimulation analysis of the east-west corridor to identify potential queue spillbacks or impacts on surface street intersections.
- Resolve any institutional issues including operating policies and requirements for memoranda of understanding with municipalities.
- Develop initial timing plans.
- Develop specifications for design.