Urban Partnership Agreement: Minnesota Evaluation Report

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16. Abstract

This document presents the final report on the national evaluation of the Minnesota Urban Partnership Agreement (UPA) under the United States Department of Transportation (U.S. DOT) UPA Program. The Minnesota UPA projects focus on reducing congestion by employing strategies consisting of combinations of tolling, transit, telecommuting/TDM, and technology, also known as the 4 Ts. The Minnesota UPA projects include high-occupancy toll (HOT) lanes, a priced dynamic shoulder lane (PDSL), active traffic management (ATM) strategies, new and expanded park-and-ride lots, new buses, a drive assist system (DAS) for shoulder-running buses, dual bus lanes in downtown Minneapolis, real-time traffic and transit information, and telework programs. The national evaluation of the Minnesota UPA projects is guided by the National Evaluation Framework, the Minnesota UPA National Evaluation Plan, and individual test plans for various components. This report provides information on the use of the new Minnesota UPA projects. Changes in travel speeds, travel times, trip-time reliability, park-and-ride lot use, and transit ridership are described. The results of interviews and workshops with local stakeholders, surveys of different user groups, and interviews and focus groups with Minnesota State Patrol officers, bus operators, and service patrol personnel are presented. The air quality, energy, and safety impacts of the Minnesota UPA projects are examined. Information on changes in unemployment rates, gasoline prices, and parking costs is also summarized.

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LIST OF ABBREVIATIONS

4Ts	Tolling, Transit, Telecommuting, and Technology
AA	Alternatives Analysis
APC	Automatic passenger counter
AVL	Automatic vehicle location
BRT	Bus rapid transit
CRD	Congestion Reduction Demonstration
CSC	Customer Service Center
CTS	Center for Transportation Studies
DEED	Department of Employment and Economic Development
DFL	Democratic-Farmer-Labor
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HOT	High-occupancy tolling
HOV	High-occupancy vehicle
IR	Independent Republicans
ITS	Intelligent transportation systems
ITS-OTMC	Intelligent Transportation Systems-Operational Testing to Mitigate Congestion
JPO	Joint Program Office
LED	Light-emitting diode
LRT	Light-rail transit
MARQ2	Marquette and Second Avenue (downtown Minneapolis)
Mn/DOT	Minnesota Department of Transportation
MSA	Metropolitan Statistical Area
MVTA	Minnesota Valley Transit Authority
NEF	National Evaluation Framework
NPR	National Public Radio
OTMC	Operational Testing to Mitigate Congestion
PDSL	Priced dynamic shoulder lane

RITA	Research and Innovative Technology Administration
ROWE	Results Only Work Environment
SOV	Single-occupant vehicle
TDM	Travel demand management
TMO	Traffic management operations
UPA	Urban Partnership Agreement
U.S. DOT	U.S. Department of Transportation

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EXECUTIVE SUMMARY

This report presents the final national evaluation of the Minnesota Urban Partnership Agreement (UPA) projects under the U.S. Department of Transportation (U.S. DOT) UPA program. It summarizes information from the pre-deployment period and one full year of operation of all the Minnesota UPA projects.

Background

In 2006, the U.S. DOT, in partnership with metropolitan areas, initiated a program to explore reducing congestion through the implementation of pricing activities combined with necessary supporting elements. This program was instituted through the UPAs and the Congestion Reduction Demonstrations (CRDs). Within each program, multiple sites around the U.S., including Minnesota, were selected through a competitive process. The selected sites were awarded funding for implementation of congestion reduction strategies. The applicants' proposals for congestion reduction were based on four complementary strategies known as the 4Ts: Tolling, Transit, Telecommuting, which includes additional travel demand management (TDM) strategies, and Technology.

The UPA and CRD national evaluation is sponsored by the U.S. DOT. The Research and Innovative Technology Administration's (RITA's) Intelligent Transportation Systems Joint Program Office (ITS JPO) is responsible for the overall conduct of the national evaluation. Representatives from the modal agencies are actively involved in the national evaluation. The Battelle team was selected by the U.S. DOT to conduct the national evaluation through a competitive procurement process.

The purpose of the national evaluation is to assess the impacts of the UPA/CRD projects in a comprehensive and systematic manner across all sites. The national evaluation will generate information and produce technology transfer materials to support deployment of the strategies in other metropolitan areas. The national evaluation will also generate findings for use in future federal policy and program development related to mobility, congestion, and facility pricing. The Battelle team developed a National Evaluation Framework (NEF) to provide a foundation for evaluation of the UPA/CRD sites. The NEF is based on the 4Ts congestion reduction strategies and the questions that the U.S. DOT seeks to answer through the evaluation. The NEF was used to develop the Minnesota UPA National Evaluation Strategy, the Minnesota UPA National Evaluation Plan, and 11 Test Plans. These plans guided the Minnesota UPA National Evaluation.

The Minnesota UPA

The Minnesota UPA partners include the Minnesota Department of Transportation (MnDOT), the Twin Cities Metropolitan Council, Metro Transit, the City of Minneapolis, Minnesota Valley Transit Authority (MVTA), and Anoka, Dakota, Ramsey, and Hennepin counties. The Center for Transportation Studies (CTS) and the Hubert H. Humphrey School of Public Affairs at the University of Minnesota are also partners in the UPA, as are the four transportation management organizations (TMOs) in the area.

The Minnesota projects focus on reducing traffic congestion in the I-35W corridor and in downtown Minneapolis. I-35W South is the section south of downtown Minneapolis and I-35W North is the section north of downtown Minneapolis. Intelligent transportation systems (ITS) technologies underlie many of the Minnesota UPA projects, including those dealing with tolling, real-time traffic and transit information, and a driver assist system (DAS) for shoulder-running buses. Minnesota UPA projects include high-occupancy toll (HOT) lanes and a priced dynamic shoulder lane (PDSL) on I-35W South, six new or expanded park-and-ride facilities, 27 new buses, double contraflow bus lanes on Marquette and 2nd Avenues (MARQ2) in downtown Minneapolis, and a "Transit Advantage" bus bypass lane/ramp at the Highway 77/Highway 62 intersection. Other projects include the DAS for shoulder-running buses, real-time transit and next bus arrival information, and eWorkPlace, a telework program.

The initial implementation of the Minnesota UPA projects occurred against a backdrop of the highest unemployment rates in the state and in the Minneapolis-St. Paul area in recent times. The annual seasonally-adjusted unemployment rate for the state was 3.1 percent in 2000. It was 8.1 percent in 2009, before declining to 7.3 percent in 2010 and 6.4 percent in 2011. The annual average non-seasonally-adjusted unemployment rate for the Minneapolis-St. Paul metropolitan area was 2.7 percent in 2000, 7.9 in 2009, 7.2 in 2010, and 6.4 percent in 2012. These trends could attenuate the UPA projects' effectiveness and be reflected in the observed travel patterns.

In addition, gasoline prices increased from the pre-deployment to post-deployment periods. The price of a gallon of regular conventional retail gasoline in Minnesota was $2.45 in September 2009. The price increased to $3.72 a gallon in June 2011, reached a high of $3.81 in September 2011, and was $3.41 in November 2011. These increases in gasoline prices may have influenced travel behavior and use of the Minnesota UPA projects.

The Minnesota UPA analysis was complicated by the nature of the projects and other non-UPA improvements occurring in the I-35W corridor at the same time. The addition of the MnPASS HOT lanes, the PDSL, the new and expanded park-and-ride lots, the new bus routes, the new auxiliary lanes on I-35W South, and the MARQ2 lanes in downtown Minneapolis provided additional capacity on I-35W South and travel options for users. The new general-purpose freeway lanes in the Crosstown Commons section, which were not part of the UPA, also added capacity and, along with other improvements in this section, eliminated a major bottleneck on the freeway. All of these improvements should result in increased travel speeds, reduced travel times, and increased throughput.

Another component of the UPA on I-35W South was the deployment of ATM strategies, including speed harmonization. The use of advisory speeds and speed harmonization result in lower speeds being posted, which may in turn result in slower speeds and longer travel times on I-35W South. Thus, the UPA projects and other improvements in the corridor have conflicting results – the new HOT lanes, PDSL, the transit improvements, and new general-purpose freeway lanes should increase speeds and reduce travel times, while the advisory speeds and speed harmonization may reduce travel speeds and increase travel times. Both may result in improved trip-time reliability and increased throughput, however. It was not possible to fully assess the impacts of these individual competing strategies.

The following points highlight the major elements of the national evaluation analysis of the Minnesota UPA projects.

- **I-35W HOT Lanes and PDSL.** The opening of the HOT lane segment in the Crosstown Commons section of I-35W South on November 18, 2010 provided a 16-mile HOT lane in the northbound direction from Highway 13 to downtown Minneapolis. The HOT lane in the southbound direction is approximately 14 miles. The opening of this segment resulted in a significant increase in use of the HOT lanes. As of December, 2011, there were a total of 7,397 active I-35W MnPASS accounts, with 8,425 transponders assigned to these accounts. Use of the HOT lanes and PDSL by MnPASS users increased from a total of 25,024 monthly trips in October 2009 to 60,937 trips in November 2011. Total monthly revenues increased from $19,609 in October 2009 to $94,619 in November 2011. The MnPASS users have resulted in increased vehicle volumes in the HOT lanes. At the same time, approximately 1,500 carpools, vanpools, and buses use the HOT lanes for free during the morning peak hours. The number of vehicles violating the occupancy requirements has declined. It appears that some carpoolers have become MnPASS customers.
- **Transit.** The new and expanded park-and-ride lots added a total of 2,347 new parking spaces. New routes and expanded services were initiated with some of the park-and-ride lots. Use of the park-and-ride lots along I-35W South and Cedar Avenue increased by 641 vehicles from September 2009 to October 2011. Use of the park-and-ride lots along I-35W North increase by 48 vehicles over the same period. Bus ridership on routes serving the I-35W South and Cedar Avenue park-and-ride lots increased by 13 percent. The MARQ2 lanes in downtown Minneapolis have resulted in increased bus operating speeds. The HOT lanes have also resulted in increased operating speeds and reduced travel times, although a slight decline in speeds was noted in one section.
- **Telecommuting.** Initiated in March 2009, the telework program, eWorkPlace, had 48 participating employers and 4,200 employees as of June 2011. It was estimated that 420 telework participants drove alone in the I-35W South study corridor when not telecommuting. Based on participant survey data, this reduction eliminated over 1,260 solo car trips per week, for an annual reduction of 0.52 million vehicle miles traveled (VMT) in the I-35W South corridor.
- **Technology.** The technology components of the Minnesota UPA included the ATM signs, the real-time transit and traffic dynamic message signs along I-35W South, the real-time next bus arrival signs on the MARQ2 lanes in downtown Minneapolis, and the DAS for shoulder running buses. These technologies were successfully deployed and have enhanced operation of I-35W South and provided improved information for bus riders and motorists. No negative impacts on safety from these projects were identified in the evaluation.

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CHAPTER 1.0 INTRODUCTION

This report presents the national evaluation of the Minnesota Urban Partnership Agreement (UPA) sponsored by the U.S. Department of Transportation (U.S. DOT) UPA program. Minnesota is one of six locations selected by the U.S. DOT to implement a suite of strategies aimed at reducing congestion under the UPA and the Congestion Reduction Demonstration (CRD) programs.

The Minnesota UPA included 24 projects focusing on tolling, transit, telecommuting/travel demand management (TDM), and technology (4Ts) in the I-35W corridor in the Minneapolis-St. Paul metropolitan area. The U.S. DOT also selected a team led by Battelle to conduct an independent evaluation of the UPA projects. This document presents the Minnesota UPA National Evaluation Final Report developed by the Battelle team in cooperation with the Minnesota UPA partners and the U.S. DOT. The report presents information from the pre- and post-deployment periods, including a full year of operation for all UPA projects.

This report is divided into five sections following this introduction. Chapter 2.0 summarizes the UPA and CRD programs. Chapter 3.0 highlights the Minnesota UPA local agency partners and projects. Chapter 4.0 presents the national evaluation methodology and the data used in the evaluation. Chapter 5.0 describes the various impacts from the projects and the major findings from the evaluation. Chapter 6.0 highlights the overall conclusions from the national evaluation of the Minnesota UPA projects. Appendix A through Appendix K present more detailed information on each of the 11 analysis areas. Appendix L contains the hypothesis and questions guiding the Minnesota UPA national evaluation.

The evaluation report is intended to serve the needs of a variety of readers. For a reader seeking an overall understanding of the strategies used in the Minnesota UPA and the key findings about their effectiveness and impact, Chapters 3.0 and 6.0 will be most useful. Readers interested in specific types of transportation projects, such as transit, should consult the pertinent project descriptions in Chapter 3.0, along with the associated analysis in Chapter 5.0. For analysis of cross-cutting effects, such as equity and benefit-cost analysis, readers will find those results in Chapter 5.0. Readers interested in an in-depth understanding of the evaluation should consult the appendices, each of which focuses on a different aspect of the evaluation, along with previously-published evaluation planning documents.

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CHAPTER 2.0 THE UPA/CRD PROGRAMS

Minnesota, focusing on the Minneapolis-St. Paul metropolitan area, was one of six sites awarded a grant by the U.S. DOT in 2007 and 2008 for implementation of congestion reduction strategies under the UPA and the CRD programs. The other areas are Atlanta, Los Angeles, Miami, San Francisco, and Seattle-Lake Washington. A set of coordinated strategies known as the 4Ts incorporate tolling, transit, telecommuting/TDM, and technology tailored to the needs of each site.

The national evaluation is assessing the impacts of the UPA and CRD projects in a comprehensive and systematic manner across all sites. The objective is to document the extent to which congestion reduction is realized from the 4T strategies and to identify the associated impacts and contributions of each strategy. The evaluation also seeks to determine the contributions of non-technical success factors – outreach, political and community support, and institutional arrangements – to the success of the projects and the overall net benefits relative to costs. Detailed documentation of the national evaluation framework and the evaluation planning documents specifically for the Minnesota UPA can be found at http://www.upa.dot.gov/publ.htm.

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CHAPTER 3.0   MINNESOTA URBAN PARTNERSHIP AGREEMENT

This chapter presents the Minnesota UPA, describing the Minnesota UPA partners, the transportation system and underlying congestion issues in the Minneapolis-St. Paul metropolitan area, and the Minnesota UPA projects and deployment schedule. It also describes two projects in the I-35W South corridor constructed at the same time that were not part of the UPA but affected its success.

3.1   The Minnesota UPA Partners

The Minnesota UPA partners included the Minnesota Department of Transportation (MnDOT), the Twin Cities Metropolitan Council, Metro Transit, the City of Minneapolis, Minnesota Valley Transit Authority (MVTA), and Anoka, Dakota, Ramsey, and Hennepin counties. The Center for Transportation Studies (CTS) and the Hubert H. Humphrey School of Public affairs at the University of Minnesota were also partners in the UPA, as were the four transportation management organizations (TMOs) in the area.

MnDOT and the Metropolitan Council were the lead agencies for the Minnesota UPA. MnDOT was responsible for the project schedule and financial management, system design and integration oversight, coordinating project activities, and reporting to federal agencies. The Metropolitan Council, the Metropolitan Planning Organization (MPO) for the seven-county metropolitan area, also operates Metro Transit, which provides bus, light-rail transit (LRT), specialized transportation, and ridesharing services in the metropolitan area. The Metropolitan Council and Metro Transit were responsible for the transit elements of the UPA. The City of Minneapolis and the MVTA were designated as the lead agencies for implementing some of the transit projects. Anoka, Dakota, Ramsey, and Hennepin counties assisted with project elements.

3.2   The Transportation System in the Minneapolis-St. Paul Area

The agencies and local communities in the Twin Cities have a history of working together on innovative approaches to addressing traffic congestion and providing mobility options for residents and visitors. In addition, MnDOT has been at the forefront of freeway traffic management strategies, including examples of these strategies, including the development and operation of a regional traffic management system, freeway ramp metering, and the freeway incident response safety team (FIRST) program. Working with Metro Transit, MnDOT initiated the first high-occupancy vehicle (HOV) lane on I-394 in the 1980s, which also included new park-and-ride lots, new express bus service, and three parking garages in downtown Minneapolis with discounted carpool parking and a bus station. The partners later expanded the HOV lanes into the state's first HOT lanes.

The UPA provided these agencies with an opportunity to expand on strategies to address congestion on I-35W, a major north-south travel corridor in the metropolitan area. I-35W South, from south of the Minnesota River into downtown Minneapolis, is heavily traveled during the morning and afternoon peak periods, as well as throughout the day. The section that I-35W South shares with Highway 62, called the Crosstown Commons section, has been a bottleneck since the 1980s. Thus, the UPA projects in Minnesota focused primarily on addressing traffic congestion and providing mobility options in the I-35W South corridor, but at the same time complementary strategies were taken for improving bus flow and reducing bus travel times through downtown Minneapolis, which was a second major focus of the Minnesota UPA. In addition, the UPA projects along I-35W North, the section north of downtown Minneapolis, included a new park-and-ride lot, expansion of an existing park-and-ride lot, and new and enhanced transit services. Further, the strategies leveraged the capabilities of Intelligent Transportation Systems (ITS) technologies in many of the projects, including those dealing with tolling, ATM, real-time traffic and transit information, and driver assist systems for shoulder-running buses.

3.3 Minnesota UPA Projects and Deployment Schedule

This section presents the UPA projects and the deployment schedule. Figure 3-1 highlights the general location of the various Minnesota UPA projects, which are described in the following pages by the tolling, transit, telecommuting, and technology categories.

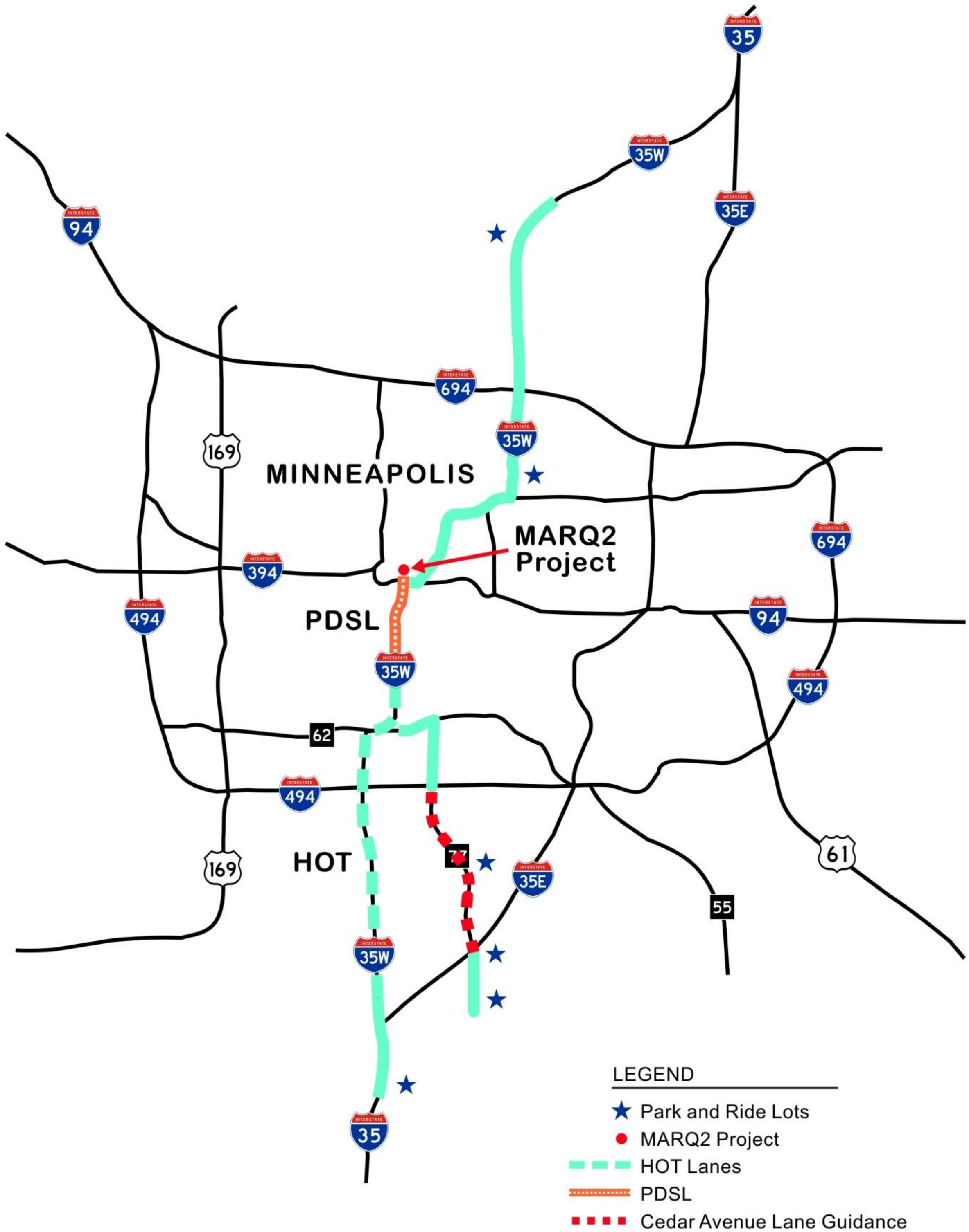

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Figure 3-1. General Location of Minnesota UPA Projects

3.3.1 Tolling Projects

Minnesota's tolling strategy was to open up the capacity of HOV lanes to other vehicles for drivers with a willingness to pay for a faster more reliable commute. Existing HOV lanes on I-35W South were expanded to HOT lanes, new HOT lanes were added in the Crosstown Commons section, and an existing shoulder lane was converted to a priced dynamic shoulder lane (PDSL). The result was approximately 16 miles of HOT lanes in the northbound direction and 14 miles in the southbound direction, with access points at strategic locations. Figure 3-2 shows a map of the I-35W South HOT lanes.

Minnesota Department of Transportation.

Figure 3-2. I-35W MnPASS Express Lane Map

Operation of the I-35W HOT lanes was able to take advantage of the same technology and operating system as the I-394 HOT lanes, including electronic toll collection (ETC), known as MnPASS. MnPASS users lease small electronic transponders, which attach to the windshield of their vehicles. The toll is automatically deducted from the drivers' pre-paid MnPASS account by toll recording equipment located along the HOT lanes. The toll level varies based on the amount of traffic congestion in the HOT lane.

Single-occupant vehicles with a valid MnPASS transponder are able to use the HOT lanes and the PDSL on I-35W South during the HOT operating hours. Buses, vanpools, and carpools with two or more people are able to use the HOT lanes and the PDSL for free during the MnPASS operating period.

The I-35W HOT lanes use dynamic pricing. Tolls are charged by the segment of the HOT lane a user travels. Electronic signs in advance of each entry point display the tolls by destination. The tolls for one section may range from $0.25 to $8.00. The average total during the peak period is $1.00 to $4.00. Figure 3-3 shows a section the I-35W South HOT lane.

The operating hours for the HOT lanes vary by direction and segment. The HOT lanes from Highway 13 to the Crosstown Commons section operate from 6:00 a.m. to 10:00 a.m. in the northbound direction of travel. The HOT lanes and the PDSL from the Crosstown Commons section into downtown Minneapolis operate from 6:00 a.m. to 10:00 a.m. and from 2:00 p.m. to 7:00 p.m. in the northbound direction of travel. The HOT lanes are in operation in the southbound direction from 42nd Street to I-494 from 6:00 a.m. to 10:00 a.m. and from 2:00 p.m. to 7:00 p.m. The southbound HOT lane from I-494 to Highway 13 is in operation from 2:00 p.m. to 7:00 p.m. The HOT lanes are open to general-purpose traffic at other times. The PDSL is closed to through traffic and operates as a shoulder at all other times. The afternoon opening hour was changed from 2:00 pm to 3:00 pm in 2012, after the period covered by the national evaluation.

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Figure 3-3. I-35W South HOT Lane (MnPASS)

Two auxiliary lanes were constructed on I-35W South as part of the Minnesota UPA. An auxiliary lane and collector ramp was constructed on I-35W South in the northbound direction from 90th Street and I-494. An auxiliary lane was also constructed on I-35W South in the southbound direction from 106th Street to Highway 13.

3.3.2 Transit Projects

The Minnesota UPA transit strategy focused on expanding and enhancing transit service as a mobility alternative to driving in the I-35W corridor. The major transit UPA projects included the dual bus lanes on Marquette and Second Avenues (MARQ2) in downtown Minneapolis, new and expanded park-and-ride lots in the I-35W corridor, the DAS for shoulder running buses, and the purchase of new buses.

New Buses. A total of 27 new buses were purchased as part of the Minnesota UPA. These vehicles included nine standard 40-foot buses, five hybrid 40-foot buses, and 13 coach buses. The 27 buses accounted for 1,278 additional seats. The buses are being used to operate new and expanded express bus service.

Downtown Minneapolis Dual Bus Lanes on Marquette and 2nd Avenues. Double contraflow bus lanes were constructed on Marquette and 2nd Avenues in downtown Minneapolis. Called the MARQ2 project, the lanes replaced existing single contraflow lanes on each avenue. The project stretched over 12 blocks and included reconstruction of 24 blocks and almost two miles of new roadways. The project involved construction of wider sidewalks and 28 passenger shelters, as well as improved lighting and landscaping. The shelters follow a unique design, include radiant heat and lights, and use backlit advertising panels. Real-time bus arrival signs were added at passenger shelters and other strategic locations, and seven LCD indoor real-time transit signs were located in key buildings. A total of 200 new trees were planted along the two avenues as part of the project. A new bus operating strategy was also implemented with the MARQ2 lanes. Bus stops were designated for different express routes every two blocks, further enhancing the flow of buses through the downtown area. Express routes in downtown Minneapolis were moved to the MARQ2 lanes from the Nicollet Mall and other streets to take advantage of the increased capacity of the MARQ2 lanes.

Park-and-Ride Facilities. A total of six new or expanded park-and-ride facilities have been constructed and opened as part of the Minnesota UPA. Two of the park-and-ride facilities are on I-35W north of downtown Minneapolis, one is on I-35 south of downtown Minneapolis, and three are on Cedar Avenue. In addition, electronic next trip information signs and electronic lot full/not full signs were added to the Burnsville Transit Station as part of the Minnesota UPA.

- **I-35W and 95th Avenue Park-and-Ride.** A new 553-space parking garage was constructed adjacent to the existing 1,002-space surface parking lot at 95th Avenue along I-35W in Blaine. Other elements of the project included a covered walkway from the garage to the bus staging area, and a landscaped entry boulevard. A replacement wetland and wetland buffer zone was developed as part of the project. Construction of the new garage resulted in the loss of 82 parking spaces in the surface lot for a new total capacity of 1,473 spaces at the facility. Electronic next trip information signs are located in the passenger waiting area. Electronic lot full/not full signs are located on the approach to the lot. A new express route to the University of Minnesota was implemented with the expansion of the park-and-ride lot.

- **I-35W and County Road C Park-and-Ride.** A new 460-space parking garage was constructed along I-35W at County Road C in Roseville. Recycled aluminum was used on the panel façade of the garage, providing a sheet screen effect. The project included construction of Iona Lane to access the facility and coordination with the city of Roseville's construction of two other adjacent streets. The city will maintain Iona Lane. Electronic next trip information signs are located in the passenger waiting area. Electronic lot full/not full signs are located on the approach to the lot. A new express route to downtown Minneapolis was implemented with the opening of the facility.
- **Cedar Grove Park-and-Ride.** A new 164-space surface parking lot and an enclosed passenger waiting facility was constructed along Cedar Avenue at Highway 13 in Eagan. Regionally-sourced Kasota stone was used with the glass-enclosed waiting area, which also uses energy efficient color changing light-emitting diode (LED) accent lights, low volatile organic compound paints to improve indoor air quality, and a ground source heat pump for heating and cooling. In the future, the facility will be connected by a skyway across Cedar Avenue to a bus rapid transit (BRT) station.
- **Kenrick Avenue Park-and-Ride.** A new 751-space parking garage was constructed at Kenrick Avenue and I-35 in Lakeville. A bus-only direct access ramp to I-35 was constructed as part of the project and upgrades were installed at two intersections to accommodate the increased traffic from the park-and-ride lot. LED lighting is used in the garage. Electronic next trip information signs are located in the passenger waiting area. Electronic lot full/not full signs are located on the approach to the lot. A new express route to downtown Minneapolis was implemented with the opening of the facility.
- **Lakeville Cedar Station.** A new 191-space surface park-and-ride lot was constructed along Cedar Avenue near 181st Street in Lakeville. The site was designed to accommodate an additional 200 parking spaces, which will be added when demand warrants. The passenger shelter uses the same design as other shelters along Cedar Avenue, providing a common look to the BRT system. A portion of 181st Street was constructed as part of the park-and-ride project to provide vehicle and bus access to the lot. The street will be maintained by the city of Lakeville.
- **Apple Valley Transit Station.** This facility included construction of a new 486-space parking garage, a 264-space surface parking lot, and separate northbound and southbound transit stations connected by a skyway across Cedar Avenue. A side platform BRT station, bus pull-outs, passing lanes, and side-running shoulders were also constructed as part of the project. The facility replaces an existing 468-space surface lot and use of 300 spaces at an adjoining business parking lot. The Apple Valley Transit Station is shown in Figure 3-4.

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Figure 3-4. Apple Valley Transit Center

Transit Advantage Bus Bypass Lane. The “Transit Advantage” bus bypass lane/ramp was constructed to facilitate the movement of northbound buses at the Highway 77/Highway 62 intersection. A new bus-only left-turn lane was constructed and new traffic signals were installed to allow buses to make a left turn from Highway 77 to Highway 62. Approximately 52 in-service buses and eight pull-out buses use the bypass lane in the morning peak period.

Cedar Avenue DAS Shoulder Running Buses. The DAS for shoulder-running buses was developed and implemented on Cedar Avenue by the MVTA. The DAS provides feedback to bus operators through a “heads up” windshield display, a vibrating seat, and an active steering wheel. The project included the development and use of a driver training simulator, equipping 10 MVTA buses with the DAS technology, and operating the buses in regular service.

3.3.3 Telecommuting

The telecommuting strategy of the Minnesota UPA focuses on increasing the use of Results Only Work Environment (ROWE), telecommuting, and flexible work arrangements throughout the region, including increasing the number of teleworkers and/or workers on flexible schedules in the I-35W South corridor. ROWE provides employees flexibility in the work location and hours by focusing on performance and results rather than a presence at the office during standard work hours. The telecommuting program was called eWorkPlace and the term telework was used with the program.

3.3.4 Technology Projects

In addition to ITS technologies incorporated into other projects, the technology strategy of the Minnesota UPA included the following specific technology projects.

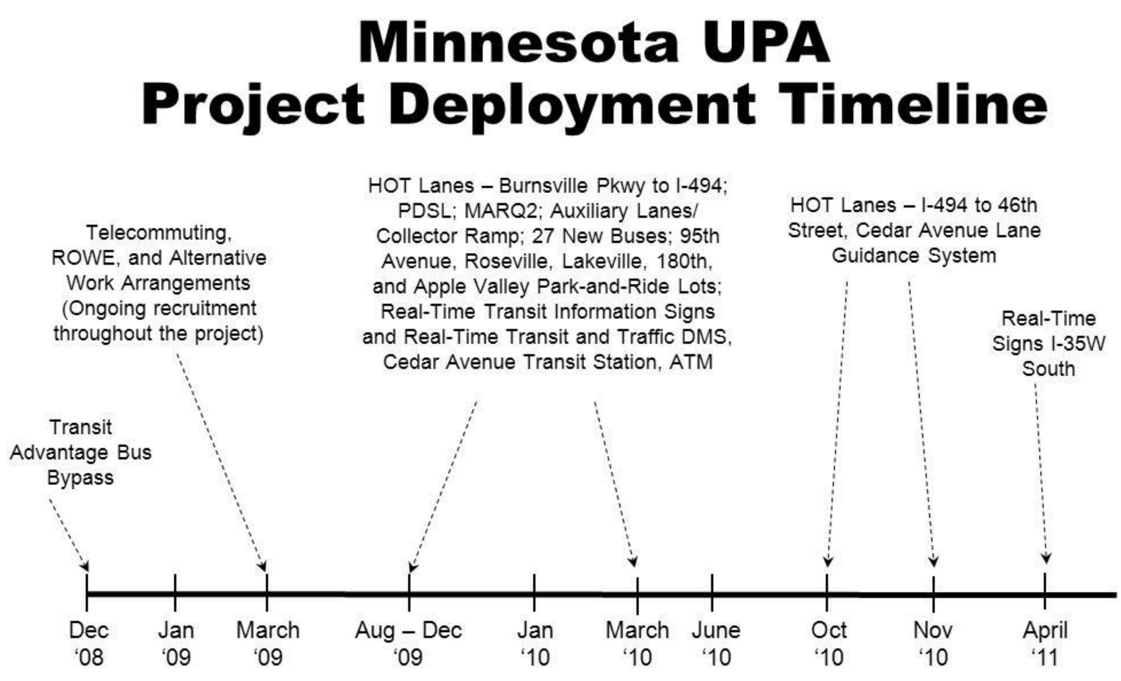
Real-Time Transit Information and Real-Time Traffic and Transit Information. Real-time transit information, including next bus arrival information, is being provided along the MARQ2 lanes in downtown Minneapolis and at park-and-ride facilities. Dynamic message signs (DMS) along I-35W display real-time traffic and transit travel times to downtown Minneapolis.

Problems unrelated to the UPA caused a delay in the operation of the signs along I-35W South, however, allowing only a limited review of their use in this evaluation.

Active Traffic Management (ATM) Strategies. The ATM components of the Minnesota UPA included intelligent lane control signals (ILCS), along with real-time transit and traffic DMS noted above. MnDOT uses the “Smart Lanes” term to refer to the ATM components on I-35W South. The system includes 174 ILCS at gantries spaced approximately every 0.5 miles on I-35W South from Burnsville to downtown Minneapolis. The use of the ILCS is primarily for incident management and speed harmonization. The ILCS also designate when the MnPASS HOT lanes, including the PDSL, are in operation. Loop detectors measure traffic speeds downstream of the ILCS signs. Speeds are posted up to one and one-half miles upstream and are advisory only.

3.3.5 Minnesota UPA Project Deployment Schedule

Figure 3-5 presents the deployment timeline for the various Minnesota UPA projects. The Transit Advantage project became operational in December 2008. The majority of projects came online between September and December 2009. The I-35W HOT lanes in the Crosstown Commons Section and the DAS for shoulder running buses were completed in the fall of 2010. The real-time signs on I-35W South were implemented in April 2011.



Texas Transportation Institute.

Figure 3-5. UPA Projects and Deployment Timeline

3.4 Non-UPA Projects on I-35W South

Other projects were under construction on I-35W South at the same time as the UPA projects. This situation made evaluation of the UPA projects more difficult as the pre-deployment period was impacted by construction and the post-deployment period was influenced by the operation of these projects, as well as the UPA projects. Further, the multiple projects made it more difficult separate and to brand the UPA projects, causing some confusion on the part of policy makers and the public.

The rebuilding of the I-35W South Crosstown Commons section represents the major project influencing the UPA pre- and post-deployment periods. The rebuilding of the Crosstown Commons section enabled the completion of one of the key UPA projects, the new HOT lanes from I-494 to 42nd Street. When Minnesota was selected as a UPA site, the new HOT lanes were incorporated into the Crosstown Commons section design. The major element of the Crosstown Commons section reconstruction was the addition of a general-purpose freeway lane in each direction of travel. The additional lanes and other design improvements removed a major bottleneck in the corridor. The new general-purpose freeway lanes and the new HOT lanes added capacity in the corridor, complicating the evaluation of the other UPA projects.

A second project, the on-line I-35W South and 46th Street Transit Station was also constructed and opened during the same time period as the deployment of the Minnesota UPA projects. The station, which is located in the median of I-35W South at 46th Street, is one element of the long-term BRT system planned for the corridor. The station allows buses to stop on I-35W South to pick-up and drop-off passengers without leaving the freeway. Transfer connections to local buses are provided on the 46th Street bridge. The I-35W South and 46th Street Station represents the first on-line bus station in the area. Separating this project from the UPA projects caused some confusion with policy makers and the public.

CHAPTER 4.0 NATIONAL EVALUATION METHODOLOGY AND DATA

This section highlights the national UPA/CRD evaluation methodology and the data used in conducting the Minnesota UPA national evaluation. An overview of the national UPA/CRD evaluation methodology is presented first in Section 4.1. The four objective questions posed by the U.S. DOT to guide the national evaluation are described, along with the associate analysis. The major data sources used in the Minnesota UPA national evaluation are presented in Section 4.2.

4.1 Four U.S. DOT Evaluation Questions

The national evaluation is assessing the impacts of the UPA/CRD projects in a comprehensive and systematic manner across all sites. The Battelle team developed a National Evaluation Framework (NEF) to provide a foundation for evaluation of the UPA/CRD sites. The NEF was based on the 4T congestion reduction strategies and the questions that the U.S. DOT sought to answer through the evaluation. The NEF defined the questions, analyses, measures of effectiveness, and associated data collection for the entire UPA/CRD evaluation. The framework was a key driver of the site-specific evaluation plans and test plans, and its served as a touchstone throughout the project to ensure that national evaluation objectives were supported through the site-specific activities.

Table 4-1 presents the four U.S. DOT objective questions[1] and the analysis areas used in the Minnesota UPA evaluation to address these questions. As noted in the table, the analysis focused on the overall reduction in congestion, the performance of the 4Ts, and associated impacts. Elements of the analysis are presented in Sections 5.0 and 6.0. Appendix A through J presents detailed information on the 10 analyses. Appendix K summarizes information on changes exogenous factors.

[1] "Urban Partnership Agreement Demonstration Evaluation – Statement of Work," United States Department of Transportation, Federal Highway Administration; November 29, 2007.

Table 4-1. U.S. DOT Objective Questions and Minnesota UPA Evaluation Analyses

U.S. DOT 4 Objective Questions	Evaluation Analyses
#1 – How much was congestion reduced?	#1 – Congestion
#2 – What are the associated impacts of the congestion reduction strategies?	**Strategy Performance**
	#2 – Strategy Performance: Tolling #3 – Strategy Performance: Transit #4 – Strategy Performance: Telecommuting/TDM #5 – Strategy Performance: Technology
	Associated Impacts
	#6 – Associated Impacts: Safety #7 – Associated Impacts: Equity #8 – Associated Impacts: Environmental
#3 – What are the non-technical success factors?	#9 – Non-Technical Success Factors
#4 – What is the overall cost and benefit of the strategies?	#10 – Benefit Cost Analysis

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4.2 Minnesota UPA Evaluation Process and Data

The Minnesota UPA evaluation involved several steps. Members of the national evaluation team worked closely with the local partners and U.S. DOT representatives on the following activities and products:

- Project kick-off conference call, site visit, and workshop;
- Minnesota UPA National Evaluation strategy;
- Minnesota UPA National Evaluation Plan;
- 11 Minnesota UPA test plans;
- Collection of one year of pre-deployment and one year of post-deployment data;
- Analysis of the collected data, surveys, and focus groups; and
- Two Interim Minnesota UPA National Evaluation Reports and a National Evaluation Findings Report.

A wide range of data was collected and analyzed as part of the Minnesota UPA. Table 4-2 presents the data, the data sources, and related analysis areas used in the Minnesota UPA national evaluation. Each appendix presents detailed descriptions of the data sources and the analysis techniques.

Members of the Battelle team worked with representatives from the Minnesota UPA partnership agencies and the U.S. DOT on all aspects of the national evaluation. This team approach included the participation of local representatives throughout the process and the use of site visits, workshops, conference calls, and e-mails to ensure ongoing communication and coordination. The local agencies were responsible for data collection and conducting surveys, focus groups, and interviews. The Battelle team was responsible for analyzing the local data and survey results.

Table 4-2. Minnesota UPA National Evaluation Data Sources

Data	Source	Major Analysis Areas(s)
Freeway Loop Detector Data	MnDOT	• Congestion Analysis • Environmental Analysis • Benefit Cost Analysis
Crash Data	Minnesota Department of Public Services (DPS)	• Safety Analysis • Benefit Cost Analysis
Transit Ridership Data	Metro Transit and MVTA	• Transit Analysis
Transit Travel Speeds	Metro Transit and MVTA	• Transit Analysis
Park-and-Ride Lot Counts	Metro Transit and MVTA	• Transit Analysis
MnPASS Registered Customers, Transponders issues, Monthly Use and Revenue	Cofiroute, USA	• Tolling Analysis
HOT Lane Violations	Minnesota State Patrol and MnDOT	• Tolling Analysis
MnPASS Customer On-line Survey	Cofiroute, USA and MnDOT	• Tolling Analysis • Equity Analysis
I-35W South Commuter Survey	MnDOT and DRG	• Tolling Analysis • Congestion Analysis • Equity Analysis • Technology Analysis • Safety Analysis • Non-Technical Success Factors Analysis
Transit On-Board Ridership Survey	Metro Transit and MVTA	• Transit Analysis • Non-Technical Success Factors Analysis
eWorkPlace Telecommuter Surveys	Hubert H. Humphrey School of Public Affairs	• Telecommuting Analysis
Minnesota State Patrol, FIRST Operators, and Metro Transit and MVTA Focus Groups	MnDOT	• Congestion Analysis • Safety Analysis • Transit Analysis • Non-Technical Success Factors Analysis
Stakeholder Interviews and Workshops	Hubert H. Humphrey School of Public Affairs	• Non-Technical Success Factors Analysis • Equity Analysis • Environmental Analysis
Downtown Minneapolis and University of Minnesota Parking Rates	City of Minneapolis University of Minneapolis	• Transit Analysis
Unemployment Rates – State and Metro Area	Minnesota Department of Economic Development	• Congestion Analysis
Gasoline Prices	U.S. Energy Administration	• Congestion Analysis
Socio-Economic Data	U.S. Census Bureau	• Equity Analysis

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CHAPTER 5.0 MAJOR FINDINGS

This section highlights the major findings from the national evaluation of the Minnesota UPA projects. The contextual changes occurring in the Minneapolis-St. Paul metropolitan area during the evaluation period – including the increase in the unemployment rate – are highlighted in Section 5.1. The Minnesota UPA's use of the 4Ts – tolling, transit, telecommuting, and technology – are described in Section 5.2. Information on changes from the pre- and post-deployment periods is also presented. A summary of the impacts of the Minnesota UPA projects by the four U.S. DOT objective questions and 10 evaluation analyses is provided in Section 5.3.

5.1 Contextual Changes During the Evaluation Period

The initial implementation of the Minnesota UPA projects occurred against a backdrop of the highest unemployment rates in the state and in the Minneapolis-St. Paul area in recent times. The annual seasonally-adjusted unemployment rate for the state was 3.1 percent in 2000. It was 8.1 percent in 2009, before declining to 7.3 percent in 2010 and 6.4 percent in 2011. The annual average non-seasonally-adjusted unemployment rate for the Minneapolis-St. Paul metropolitan area was 2.7 percent in 2000, 7.9 in 2009, 7.2 in 2010, and 6.4 percent in 2012. These trends could attenuate the UPA projects' effectiveness and be reflected in the observed travel patterns.

In addition, gasoline prices increased from the pre-deployment to post-deployment periods. The price of a gallon of regular conventional retail gasoline in Minnesota was $2.45 in September 2009. The price increased to $3.72 a gallon in June 2011, reached a high of $3.81 in September 2011, and was $3.41 in November 2011. These increases in gasoline prices may have influenced travel behavior and use of the Minnesota UPA projects.

5.2 Use of the Minnesota UPA Projects

The implementation and use of the Minnesota UPA projects, along with their possible influence on the transportation system in the Minneapolis-St. Paul metropolitan area are highlighted in this section. The Minnesota UPA analysis is complicated by the nature of the projects and other non-UPA improvements occurring in the I-35W corridor at the same time. The addition of the MnPASS HOT lanes, the PDSL, the new and expanded park-and-ride lots, the new bus routes, the new auxiliary lanes on I-35W South, and the MARQ2 lanes in downtown Minneapolis provided additional capacity on I-35W South and travel options for users. The new general-purpose freeway lanes in the Crosstown Commons section, which were not part of the UPA, also added capacity and, along with other improvements in this section, eliminated a major bottleneck on the freeway. All of these improvements should result in increased travel speeds, reduced travel times, and increased throughput.

Another component of the UPA on I-35W South was the deployment of ATM strategies, including speed harmonization. The use of advisory speeds and speed harmonization result in lower speeds being posted, which in turn may result in slower speeds and longer travel times on I-35W South. Thus, the UPA projects and other improvements in the corridor have conflicting results – the new HOT lanes, PDSL, the transit improvements, and new general-purpose freeway lanes should increase speeds and reduce travel times, while the advisory speeds and speed harmonization may reduce travel speeds and increase travel times. Both may result in improved trip-time reliability and increased throughput, however. While it was not possible to separate the impacts of these individual competing strategies, in the findings below reference is made to potential effects where appropriate.

5.2.1 Tolling

The tolling component of the Minnesota UPA focused on providing a HOT lane option for travelers on I-35W South. Three different approaches were used to develop the HOT lanes. First, the existing HOV lanes on I-35W South from Highway 13 to I-494 were expanded to HOT lanes in October 2009. Second, the innovative PDSL on I-35W South from 42nd Street to downtown Minneapolis was also opened in October 2009. Third, the new HOT lanes in the Crosstown Commons section of I-35W South, from I-494 to 42nd Street, were opened in November 2010. These segments combine to provide 16 miles of MnPASS HOT lanes and PDSL in the northbound direction into downtown Minneapolis and 14 miles of HOT lanes in the southbound direction. Figure 5-1 illustrates the I-35W South MnPASS HOT lane.

Minnesota Department of Transportation

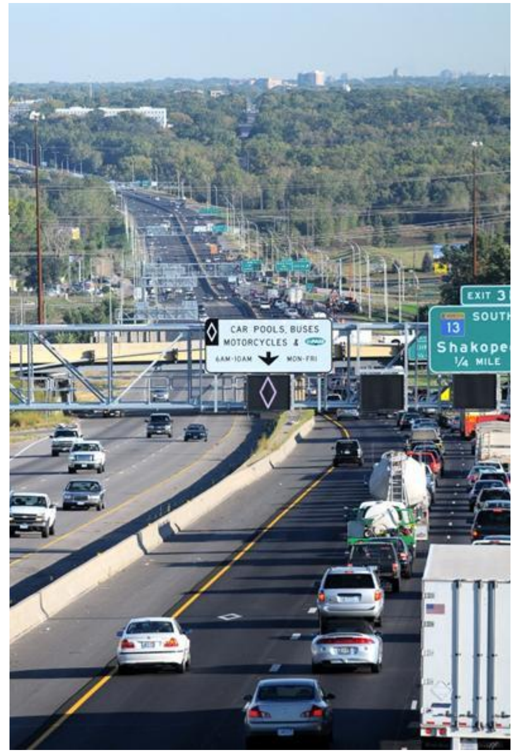


Figure 5-1. I-35W South MnPASS HOT Lane

Table 5-1 summarizes the growth in the number of MnPASS accounts opened and transponders purchased, use of the MnPASS HOT lanes, and growth in revenue from October 2009 to November 2011. As of November 2011, there were 7,397 active I-35W MnPASS accounts, with 8,425 transponders in use. Almost 61,000 trips were made by MnPASS customers in November 2011, accounting for $94,619 in revenue. The number of new I-35W MnPASS accounts and use of the HOT lanes continued to increase in 2012, after the period covered in the national evaluation.

Table 5-1. I-35W South MnPASS Accounts, Trips, and Revenue

	October 2009	November 2011
Number of I-35W MnPASS Active Accounts	3,287	7,397
Number of I-35W MnPASS Transponders	3,649	8,425
Monthly I-35W MnPASS Trips		
Northbound Trips	15,913	38,972
Southbound Trips	9,111	21,965
Total Monthly Trips	25,024	60,937
Total Monthly Revenue	$19,609	$94,619

Data from Confiroute

The MnPASS HOT lane has experienced steady growth in use since 2009. Figure 5-2 presents information on the monthly use of the different segments of the I-35W MnPASS HOT lanes during the morning peak hours in the northbound direction, based on the toll reader location. The figure highlights the growth in MnPASS use over time and the increase after the November opening of the HOT lanes in the Crosstown Commons section. The significant decline in use in July 2011 reflects the two-week shutdown of the Minnesota state government when the MnPASS system was not in operation.

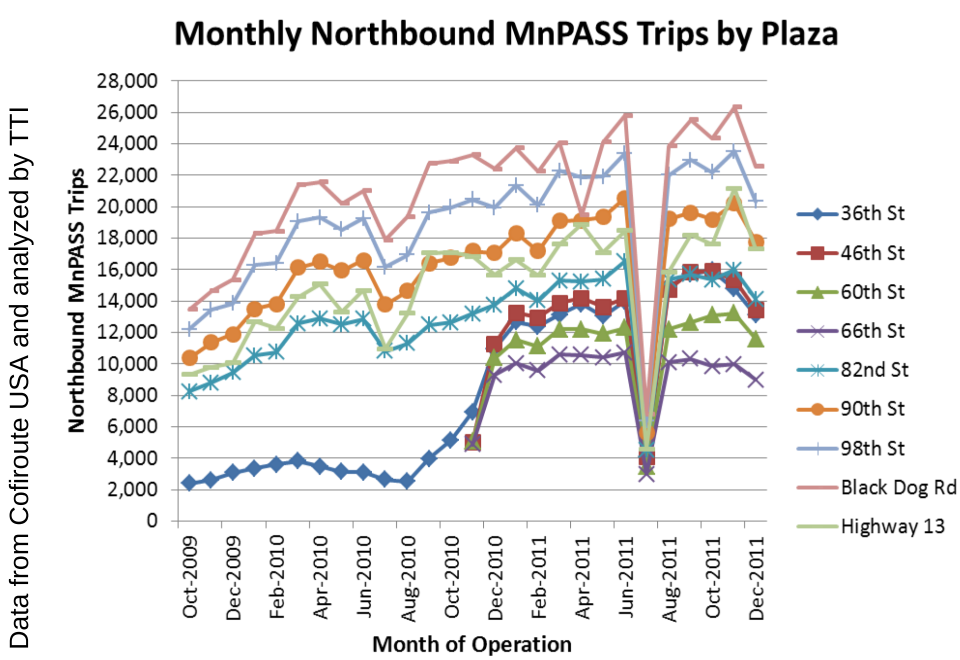


Figure 5-2. Monthly I-35W MnPASS Trips Northbound in the A.M. Peak Period, Highway 13 to Downtown Minneapolis

The number of times I-35W MnPASS customers used the HOT lanes was also examined. Figure 5-3 presents the use frequency of the I-35W South HOT lanes for two time periods. Phase I represents the period from October 2009 to November 18, 2010 when the HOT lanes from Highway 13 to I-494 (the section with the existing HOV lane expanded into a HOT lane) and the PDSL were in operation. Phase 2 represents the period from November 19, 2010 to December 31, 2011 when the HOT lanes in the Crosstown Commons section became operational, providing users with a full 16 miles of HOT lanes in the northbound direction in the morning peak period.

Data from Cofiroute USA and analyzed by TTI

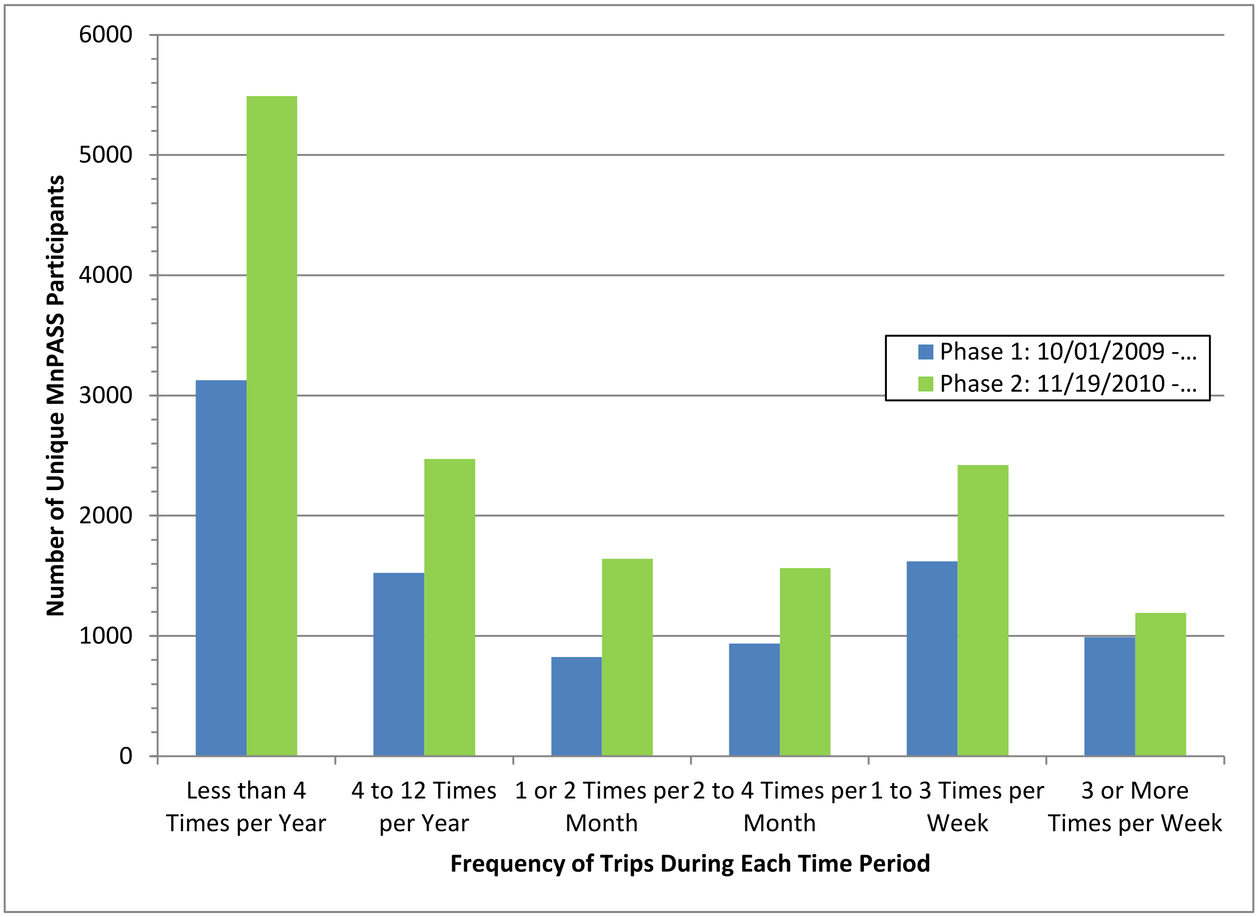


Figure 5-3. I-35W South MnPASS HOT Lanes Frequency of Use

Figure 5-3 shows frequent MnPASS HOT lanes users – those who use the HOT lanes 3 or more times a week and 1-to-3 times a week; infrequent users – those who use it 2-to-4 times a month, 1-or 2 times a month, and 4-to-12 times a year; and very infrequent users – those who use it less than 4 times per year. As illustrated in Figure 5-3, I-35W South MnPASS users in all categories increased after the HOT lanes in the Crosstown Commons section were open.

Approximately 1,200 MnPASS customers used the HOT lanes 3 or more times a week in the full deployment period and approximately 2,200 customers used it 1-to-3 times a week. The number of infrequent users also increased, as did the number of very infrequent users. Individuals in these two categories may only pay to use the HOT lanes when they have a critical need for the travel-time savings and the trip-time reliability provided by the HOT lanes. These use patterns are similar to those reported by I-35W MnPASS customers in an on-line survey conducted in January 2012.

The MnDOT I-35W HOV Quarterly Reports provide information on the use of the HOV/HOT lanes and the general-purpose lanes. Table 5-2 presents information from the July – September 2011 Quarterly Report on use of the I-35W HOT lanes northbound at Black Dog Road in the morning peak period.

Based on the quarterly report available through the national evaluation, vanpools and carpools comprised approximately 48 percent of the vehicles using the I-35W HOT lanes, compared to 38 percent MnPASS users, 2 percent buses, and 5 percent SOVs and toll violators. Table 5-2 also shows the higher volumes during the peak hour from 7:00 a.m. to 8:00 a.m. As described next, the introduction of the MnPASS HOT program resulted in an increase in vehicles in the I-35W HOT lane during the morning peak period, a change in the mix of user groups, and a reduction in the number of individuals violating the occupancy requirements.

Table 5-2. Use of I-35W HOT Lane at Black Dog Road – A.M. Peak Period July – September 2011

	6:00 a.m. – 7:00 a.m.		7:00 a.m. – 8:00 a.m.		8:00 a.m. – 9:00 a.m.		Total 6:00 a.m. – 9:00 a.m.	
	Vehicle	Percent	Vehicle	Percent	Vehicle	Percent	Vehicle	Percent
Total Vehicles[1]	704		1,234		877		2,815	
Carpools/Vanpools[2]	247	35%	604	49%	497	57%	1,348	48%
Tolled at Black Dog Road[3]	379	54%	563	46%	325	37%	1,267	45%
Transit Buses[4]	17	2%	27	2%	14	2%	58	2%
SOVs (Violators)[5]	61	9%	40	3%	41	4%	142	5%

I-35W HOV Report, Including MnPASS Data 2011 – 3rd Quarter July-September, Minnesota Department of Transportation, Regional Transportation Management Center.

[1] Average weekday volume northbound July – September 2011 from loop detector data.

[2] Total vehicles less tolled vehicles, SOVs, and buses.

[3] MnPASS data.

[4] Number of transit buses northbound during January-March 2010 (MVTA only).

[5] Average percent SOVs northbound in a three-day study in the spring of 2010 x total vehicles.

Table 5-3 presents information on use of the I-35W HOV lanes for October – December 2008 and July – September 2009 in the pre-HOT lane deployment period and three quarters when MnPASS HOT lanes were in operation: January – March 2010, and October – December 2010, and July – September of 2011. The vehicle volumes in the HOT lane continued to increase after the expansion from HOV to HOT operations and the opening of the new HOT lanes in the Crosstown Commons section. The total number of vehicles in the northbound direction in the morning peak period increased from 2,068 during October – December 2008 to 2,815 in July – September 2011.

Table 5-3. Historical Use of I-35W HOV and HOT Lanes at the Minnesota River and Black Dog Road – A.M. Peak Period (6:00 a.m. – 9:00 a.m.)

	October-December 2008		July-September 2009		January-March 2010		October-December 2010		July-September 2011	
	Vehicle	%	Vehicle	%	Vehicle	%	Vehicle	%	Vehicle	%
Total Vehicles[1]	2,068		1,896		2,428		2,556		2,815	
Carpools/Vanpools[2]	1,718	83%	1,576	83%	1,406	58%	1,401	55%	1,348	48%
Tolled at Black Dog Road[3]	0	—	0	—	848	35%	969	38%	1,267	45%
Transit Buses[4]	47	2%	42	2%	46	2%	53	2%	58	2%
SOVs (Violators)[5]	303	15%	278	15%	127	5%	133	5%	142	5%

I-35W HOV Report, Including MnPASS Data 2009 – 4th Quarter October – December, Minnesota Department of Transportation, Regional Transportation Management Center. I-35W HOV Report, Including MnPASS Data 2010 1st Quarter January-March, Minnesota Department of Transportation, Regional Transportation Management Center. 3rd Quarter July-September, Minnesota Department of Transportation, Regional Transportation Management Center

[1] Average weekday volume northbound during reporting period from loop detector data for all quarterly reports.

[2] Average percent carpools/vanpools northbound from an October 2005 study x total vehicles for 2008 and 2009 quarterly reports. Total vehicles less tolled vehicles, SOV (violators), and buses from a 2010 quarterly report.

[3] MnPASS data.

[4] Number of transit buses northbound during reporting period (MVTA only) prior to July-September 2010. MVTA and one Metro Transit route from October-December 2010 on.

[5] Average percent SOVs northbound in a 1997 three-day study and a two-day 2001 study x total vehicles for the 2008 and 2009 quarterly reports. Average percent SOVs northbound in a three-day study in the spring of 2010 x total vehicles for the 2010 quarterly reports.

The table highlights the changes in user groups with the opening of the HOT lanes and ongoing use. In July – September 2011, there were 1,267 tolled vehicles using the HOT lanes during the three-hour a.m. peak period, accounting for 45 percent of the total vehicles. Tolled vehicles accounted for 35 percent of the total users in the January – March 2010 and 38 percent in October – December 2010. The number of carpools and vanpools declined from previous reports to 1,348, representing 48 percent of the total vehicles. The number of buses remained relatively constant, accounting for 2 percent of the total vehicles. The number of single-occupant vehicles (SOVs) violating the operating requirements declined from 15 percent in 2008 to 5 percent in 2011.

In considering these changes, it is important to note that the methodology MnDOT used in calculating the use by different groups changed from the pre- to post-deployment periods. The methodology for estimating carpool use in 2008 and 2009 was based on a 2005 study, while the 2010 and later rates are back calculated. The SOV rate from 2008/2009 is based on data studies in 1997 and 2001, while the 2010 and later rate is based on a 2010 study. Comparisons of 2008/2009 to 2010 and later should consider these differences. Comparisons of changes from 2010 on may be more appropriate based on the same methodology used.

These figures appear to indicate that the change from HOV to HOT operations and the addition of the new HOT lanes and the PDSL have resulted in a decline in carpooling and an increase in MnPASS use. A small percentage of the I-35W MnPASS customers responding to the online survey, which had a 2.26 percent margin of error at the 95th percent confidence interval, reported previously carpooling in the I-35W HOV lanes (2 percent) or driving alone in the HOV lanes and violating the occupancy requirements (1 percent). Further, 6 percent of the I-35W MnPASS customers responded that they carpool extremely often or often in the HOT lanes and 11 percent reported carpooling somewhat frequently. The survey results and the changes in carpool use presented in Table 5-3 suggest that the MnPASS HOT lanes have attracted carpoolers to become MnPASS customers and that some commuters switch between carpooling and driving alone in the MnPASS HOT lanes on a regular basis.

Information from the Minnesota State Patrol provided by MnDOT on MnPASS HOT lane violations for the eight-month period from May through December 2011 was reviewed and analyzed. The majority of citations and warnings were issued to individuals driving alone in the MnPASS HOT lanes without a MnPASS account and active transponder. A total of 1,515 citations and 231 warnings were issued to drivers in this category over the eight-month period. Discounting for July, when the MnPASS lanes were not in operation for 21 days due to the Minnesota state government shutdown, there were an average of 249 citations and warnings a month to non-MnPASS drivers. MnPASS customers with an inactive, malfunctioning, or not engaged transponder represent the second largest number of citations and warnings. Finally, individuals illegally crossing the double white lines separating the MnPASS lanes from the adjacent general-purpose freeway lanes accounted for 32 citations and 134 warnings during the eight-month period.

While it appears the number of violators has decreased from the previous HOV operations, when violation rates were approximately 15 percent, the number of citations and warnings issued to drivers without an active MnPASS account remained relatively constant over the eight-month period. This trend suggests that some drivers may feel they can violate both the MnPASS toll and the carpool requirements and not get caught. These trends suggest that additional outreach and public education on use of the MnPASS HOT lanes is needed.

5.2.2 Transit

Transit represented a key element of the Minnesota UPA. The Minnesota UPA transit projects focused on making riding the bus in the I-35W and Cedar Avenue corridors and in downtown Minneapolis more attractive and convenient by reducing bus travel times, increasing trip-time reliability, adding transit services and park-and-ride lot capacity, and making other improvements. The major transit projects included the Transit Advantage Bus Bypass Lane at the Highway 77/Highway 62 Interchange, the MARQ2 dual bus lanes in downtown Minneapolis, six new or expanded park-and-ride lots, 27 new buses, and the driver assist system (DAS) for shoulder running buses. Other transit projects were the next bus arrival signs along the MARQ2 lanes and the bus and freeway travel times and park-and-ride lot space availability signs along I-35W.

Metro Transit and MVTA examined the impact of the Transit Advantage bus bypass lane/ramp at the Highway 77/Highway 62 intersection shortly after it opened in December 2008. The analysis indicated a travel-time savings of 60 to 90 seconds for buses using the facility during the morning peak period. A total of 52 in-service MVTA buses and eight Metro Transit pull-out buses use the facility in the morning peak period.

The MARQ2 lanes in downtown Minneapolis, illustrated in Figure 5-4, have been referred to as "the jewel in the crown" of the Minnesota UPA by one of the local stakeholders. The MARQ2 lanes provide significant improvements in bus operations in the downtown area, as well as enhanced passenger amenities. Further, the MARQ2 lanes benefit more than buses operating on I-35W. Other express routes and riders also benefit from use of the MARQ2 lanes.

Metro Transit

Figure 5-4. MARQ2 Lanes in Downtown Minneapolis

The target speed of buses on the MARQ2 lanes is 8 mph. The largest increase in bus operating speeds was realized on 2nd Avenue in the morning peak period; speeds were 4.3 mph in 2008 and 7.4 in 2011, representing a 72 percent increase. Buses operating on 2nd Avenue in the afternoon peak period experienced a 60 percent increase in speeds, from 4.0 mph to 6.4 mph. Buses operating speeds on Marquette Avenue increased by 31 percent in the morning peak period, and by 46 percent in the afternoon peak period.

To take advantage of the additional capacity and the higher operating speeds of the MARQ2 lanes, express routes in downtown Minneapolis were moved from the Nicollet Mall and other streets to the MARQ2 lanes. This consolidation of express routes on MARQ2 has resulted in an increase in bus throughput in the morning and afternoon peak periods and an increase in ridership. The number of buses operating on the MARQ2 lanes increased from 475 buses to 586 buses, a 23.4 percent increase in the morning peak period and by 51.7 percent in the afternoon peak period.

Five new park-and-ride lots were constructed and one park-and-ride lot was expanded as part of the Minnesota UPA. The park-and-ride lots were a key element in addressing constraints in the ability to attract new riders to transit in the I-35W and Cedar Avenue corridors. The park-and-ride lots were also intended to provide capacity for future ridership growth in the I-35W and Cedar Avenue corridors. Figure 5-5 shows the Apple Valley Transit Station associated with the park-and-ride lot.

AgentsRanking.com (http://agentsranking.com/minnesota/apple-valley-minnesota-real-estate.html)

Figure 5-5. Apple Valley Transit Station

Daily use of the new and expanded park-and-ride lots has continued to increase since the end of 2009. Total use of the lots along both I-35W North and I-35W South and Cedar Avenue increased from 2009 to 2011. Use of the park-and-ride lots along I-35W South and Cedar Avenue increased by 641 vehicles. Use of the expanded I-35W and 95th Avenue North park-and-ride lot increased by 57 vehicles and the new park-and-ride lot at I-35W North and County Road C increased from zero to 119 vehicles in September 2011. The larger increase in use of the I-35W South park-and-ride lots may reflect both new routes from these lots and the benefits provided to riders from buses using the MnPASS HOT lanes.

The total annual regional ridership on Metro Transit and MVTA express and local bus routes increased from 2006 to 2008, experienced a decline in 2009, and increased in 2010 and 2011. The 2011 ridership, including express ridership, did not return to 2008 levels, however. The decrease in ridership from 2008 to 2009 most likely reflects the record high unemployment experienced in the state and the metropolitan area in 2009.

New express bus routes were implemented with four of the new and expanded park-and-ride lots. New Metro Transit routes include 467 from the Kenrick park-and-ride lot to downtown Minneapolis (nine inbound and nine outbound trips), 252 from the 95th Avenue park-and-ride lot to the University of Minnesota (one inbound and one outbound trip), and 264 from the County Road C park-and-ride to downtown Minneapolis (10 inbound and 11 outbound trips). New MVTA routes include 475 from the Cedar Grove park-and-ride lot to the University of Minnesota (four inbound and four outbound trips) and 477V from the Lakeville Cedar park-and-ride lot to downtown Minneapolis (five inbound and five outbound trips).

Ridership levels on I-35W South routes experienced the largest increase of 13 percent, followed by 8 percent on Cedar Avenue routes, 8 percent on I-94, and 7 percent on I-35W North routes. These increases occurred against the backdrop of high unemployment rates, which appear to have dampened higher increases.

The express bus routes operating on the MARQ2 lanes experienced a larger percentage increase in ridership compared to the non-MARQ2 express bus routes. The average weekday ridership on the MARQ2 routes increased by 9 percent while on the non-MARQ2 routes it was only approximately 2 percent.

Prior to the UPA projects, buses operating on I-35W South were able to use the HOV lanes from Highway 13 to I-494. Buses were also able to operate in the freeway shoulders during congested periods at speeds up to 35 mph. With the expansion of the UPA projects, buses operate in the MnPASS HOT lanes and the PDSL.

The changes in bus speeds and travel times between April 2009 and April 2011 on the three sections of the I-35W MnPASS lanes – the section south of I-494 where the existing HOV lanes were expanded to HOT lanes, the new HOT lanes in the Crosstown Commons section, and the new PDSL north of 38th Street – varied by segment and by direction of travel. Buses traveling in the HOT lanes in the Crosstown Commons section recorded the largest increase in speeds in both directions of travel. Bus speeds increased by 29.0 mph in the northbound direction and 10.5 mph in the southbound direction. Prior to the new HOT lanes, buses operated in the congested general-purpose freeway lanes. With lane drops and merge points, this section was a major bottleneck.

There was a 3.2 mph decrease in speeds with buses using the PDSL segment in the northbound direction. In April 2009, buses operated using the right-shoulder when appropriate and the general-purpose freeway lanes. In April 2011, buses operated in the PDSL at slightly slower speeds. There was a 1.9 mph decrease in bus speeds on the HOT lanes south of I-494 in the northbound direction during the morning peak. With the addition of toll paying MnPASS vehicles, there are more vehicles in the HOT lanes than the previous HOV lanes, resulting in the slight decrease in speeds.

Bus travel times decreased by approximately 4 minutes overall in the northbound direction. There was a travel-time reduction of approximately 5 minutes in the Crosstown Commons section offsetting slight increases in bus travel times south of I-494 and in the PDSL section. In the southbound direction, bus travel times were reduced by a little over one minute in the Crosstown Commons section and HOT segment south of I-494.

The slower speeds and increased travel times in the PDSL section may be influenced by a number of factors. First, it appears that the re-construction of the Crosstown Commons section resulted in shifting congestion to other bottleneck locations including the section of I-35W where the PDSL is located. This section includes the exit to downtown Minneapolis, as well as the merges to I-94 eastbound and westbound. Second, buses now share the PDSL with other vehicles, where-as they previously operated on the bus-only right shoulders. Third, the buses may be delayed at the traffic light at 11th Street and 4th Avenue, which is the first signalized intersection after exiting the PDSL. This intersection was used as the end point in the travel-time calculations. The previous time point is at I-35W South and Lake Street, so it would not capture the full use of the PDSL. The city of Minneapolis has plans to conduct a systematic re-timing of the downtown traffic signals in 2012, which could resolve this issue.

As part of the Minnesota UPA National Evaluation, MnDOT sponsored focus groups and interviews with transit operators, Minnesota State Patrol officers, and FIRST operators. The Metro Transit and MVTA operators provided positive comments and feedback on the UPA projects. They also noted the improvement in traffic flow with the rebuilding of the Crosstown Commons section, even though only the MnPASS HOT lane in this section was part of the UPA. The new MnPASS lanes and PDSL were well received by the bus operators. Bus drivers reported they liked using the MnPASS lanes. Benefits from the MnPASS HOT lanes cited by bus operators included faster operating speeds and reduced trip times and a safer operating environment for buses. Some operators noted they save 10 minutes a trip due to the MnPASS lanes and MARQ2 lanes. Although not a UPA project, the bus operators also provided positive comments on the 46th Street bus stop in the median of I-35W South.

The bus operators also had positive comments on the MARQ2 lanes. They noted that the MARQ2 lanes have made driving through downtown Minneapolis easier, faster, and safer. The operators noted receiving positive feedback from passengers on the MARQ2 lanes and the enhanced waiting environment provided by the new shelters, next bus arrival signs, and wider sidewalks. One of the transit operators noted the MARQ2 lanes were "probably the best system they could have thought of."

The results of an on-board survey of riders on I-35W routes indicate positive feedback about the UPA projects. The survey of 2,724 passengers has a margin of error of +/- 1.2 percent at the 95 percent confidence level. Overall, riders provided positive rates from the MARQ2 lanes, the MnPASS HOT lanes, and the real-time transit information in downtown Minneapolis.

The MVTA developed and implemented the DAS for shoulder-running buses on Cedar Avenue. Ten MVTA buses were equipped with the DAS technology – which provides feedback to bus operators through a "heads up" windshield display, a vibrating seat, and an active steering wheel – and operated in regular service. The FTA sponsored a separate evaluation of the DAS technology, which was used in the national evaluation. The results from the FTA study indicated that the DAS resulted in a 10 percent increase in use of the shoulder and a slight increase in operating speeds of shoulder-running buses. There were no reported crashes involving shoulder-running buses during the evaluation period. Surveys of MVTA operators driving the DAS buses indicated generally positive feedback from use of the technology.

5.2.3 Telecommuting

The Minnesota UPA was the only UPA or CRD site with an extensive telecommuting program, which was funded entirely by the state of Minnesota. The initial UPA target of 500 telecommuters in the I-35W corridor was expanded to a metropolitan-wide focus with a larger target of 2,700 telecommuters as a result of the state funding for the program. Managed by the Humphrey School of Public Policy at the University of Minnesota, with support from MnDOT, the telecommuting program was initiated in March 2009 and concluded in June 2011 when the state funding expired. Approximately 93 percent of the participating employers surveyed indicated intent to continue their programs, with two-thirds planning to expand their programs.

The term teleworking was used rather than telecommuting, and the program was implemented under the brand of eWorkPlace. The program goal was to reduce peak period commuting by eliminating trips and shifting travel to off-peak hours. The eWorkPlace program promoted telecommuting, flexible work scheduling, and ROWE ("Results Only Work Environment"). Pioneered by the electronic retailer Best Buy, which is headquartered in Minneapolis, ROWE strives for a workplace transformation through an aggressive results-oriented management philosophy providing employees with more flexibility in their day-to-day work schedule and work location.

The eWorkPlace program had three major objectives. The first objective was to establish new or expand existing telework programs to retain a minimum of 2,700 employees, for at least three months, with 500 of these employees using the I-35W corridor. The second objective was to reduce congestion by eliminating or shifting a minimum of 5,400 peak hour trips. The third objective was to provide examples of successful telework programs to share with interested employers.

Metro Transit and four Transportation Management Organizations (TMOs) in the Twin Cities region conducted the eWorkPlace recruiting activities in coordination with the Humphrey School and its consultants. The TMOs are Downtown Minneapolis TMO, Anoka County TMO, Saint Paul Smart Trips, and Commuter Services. CultureRx LLC, a consulting firm specializing in the adoption of ROWE, was responsible for working with employers interested in implementing ROWE.

A number of on-line tools were available through the eWorkPlace free web-portal. eWorkPlace also provided other services to interested employers and employees. The eWorkPlace program, through a free web-portal, provided a range of on-line tools and other services to assist employers in establishing and maintaining telework programs. Examples of these tools included the Manager's Guide to Telework, Telework and Quickstart Advice, Quickstart Telework Agreement, Telework Discussion Application, Telework Implementation Steps, and Telework Policy Agreement. Consultants were also available to provide support to participating employers.

A total of 48 employers and over 4,200 employees participated in eWorkPlace, surpassing the goal of 2,700 employees. Participating employees completed surveys and travel diaries one-week, three-months, and nine-months after registering. The survey and travel diary results were used to analyze the impacts of the program. The survey included a question on use of I-35W and I-394. A question on travel distance on normal commute days was also included.

The impact of the eWorkPlace program on travel behavior throughout the metropolitan area was estimated through the analysis of survey responses. The eWorkPlace Final Report analyzes the responses from multiple commute tool surveys completed by telework and ROWE participants. Survey participants provided home and office addresses to establish commuting distances, as well as the number of days they teleworked in an average week.

On office days, participants in the program reported driving alone or using public transit for 71.2 percent and 18.7 percent of commute trips, respectively, indicating the bulk of the new program participants were drawn from the pool of single-occupancy users rather than public transit users.

Data from the commute tool survey travel diaries indicated that teleworkers take 80 percent fewer trips during the workday and 93 percent fewer peak period trips, compared to non-teleworkers on the days that they telecommute. Thus, eWorkPlace participants avoided making 11,350 additional trips per week by teleworking. Importantly, there were no statistical differences between daily non-peak travel between office and telework days indicating that on telework days, the participants are driving less.

Participants teleworked an average of 1.5 days per week, reducing their peak-hour trips on those days by 92.6 percent overall and 96.7 percent on the I-35W and I-394 corridors. The average VMT saved on a telework day versus an office day was 27.96 miles per person per day, a 91.5 percent decline in the average of total daily VMT, half of which could have been travelled on I-394 and I-35W.

The commute tool surveys included a question that explicitly asked commuters if they used the I-35W or I-394 corridors and established their distance travelled. Unfortunately, the survey instrument only asked for the use of both the freeways and did not break down use by each facility. Additionally, the travel diary part of the commute tool survey documents all trips made by a participant's most recent day worked in the office and most recent day of teleworking, specifying whether I-35W or I-394 was used for each trip.

Commute tool survey data and average annual daily traffic (AADT) assumptions were used to separate the benefits specific to the I-35W study corridor from the I-35W/I-394 combination.[2] A total of 35.3 percent of the commute tool survey respondents' stated that they use I-35W or I-394 for commuting. AADT was used to estimate the proportion of those travelers on only I-35W immediately south of downtown Minneapolis (38.7 percent). Using these two percentages, a conservative assumption was made that approximately 14 percent of telework program participants travel on the I-35W study corridor.[3] This figure was used in the analysis of the telework impacts on peak hour trips on I-35W.

Using the above percentages, it is estimated that 570 of the 4,212 participants use the I-35W study corridor as part of their commute. Of that subset, 420 telework participants would drive alone on the I-35W corridor when not teleworking, with the others using public transit.[4] Based on the survey data indicating that telework occurs 1.5 times per week, or 3 commute trips, this reduction eliminates over 1,260 single-occupancy vehicle trips per work week on I-35W. The number of telework participants removed in the peak period represents about 1 percent of the morning overall peak period trips on I-35W per week.

The local partners estimated a 7.46 million annual reduction in VMT from the eWorkPlace program. Further, half of this amount was estimated from I-35W and I-394. Based on the same assumption of 14 percent of this reduction occurring on I-35W, an estimated 0.52 million annual reduction in VMT occurred on I-35W study corridor from eWorkPlace.

5.2.4 Technology

Technology was an important supporting element of the Minnesota UPA projects. ITS technologies were incorporated in many of the Minnesota UPA projects, including the MnPASS HOT lanes and the DAS for shoulder running buses, enabling a wide variety of improvements. The technology analysis focused on the ATM strategies and the transit and highway travel-time dynamic message signs (DMS), as the ITS technologies contributing to congestion reduction,

[2] In other words, the survey question grouped travel on I-35W with I-394, while the interest of the national evaluation is exclusively with I-35W South. Thus, assumptions are made to calculate benefits to the I-35W corridor.

[3] MnDOT 2008-2009 AADT on select gateways to Minneapolis; I-35W south of downtown: 162,000 vehicles/days; I-35W north of downtown: 109,000 vehicles/day; and I-394: 148,000 vehicles a day. The total AADT for these three downtown gateways is 419,000 vehicles/day (162,000/419,000 = 0.387 ≈ 39 percent). That is, 39 percent of 35 percent of teleworkers who use I-35W or I-394 = 0.14 = 14 percent, estimated percentage telework participants who travel on the I-35W study corridor south of downtown Minneapolis.

[4] The estimate of 420 participants is based on the conservative calculation of 4,212 telework participants, 71.2 percent who drive alone and 14 percent who likely drive on the I-35W study corridor.

rather than those technologies acting as enablers of other congestion reduction strategies, such as tolling.

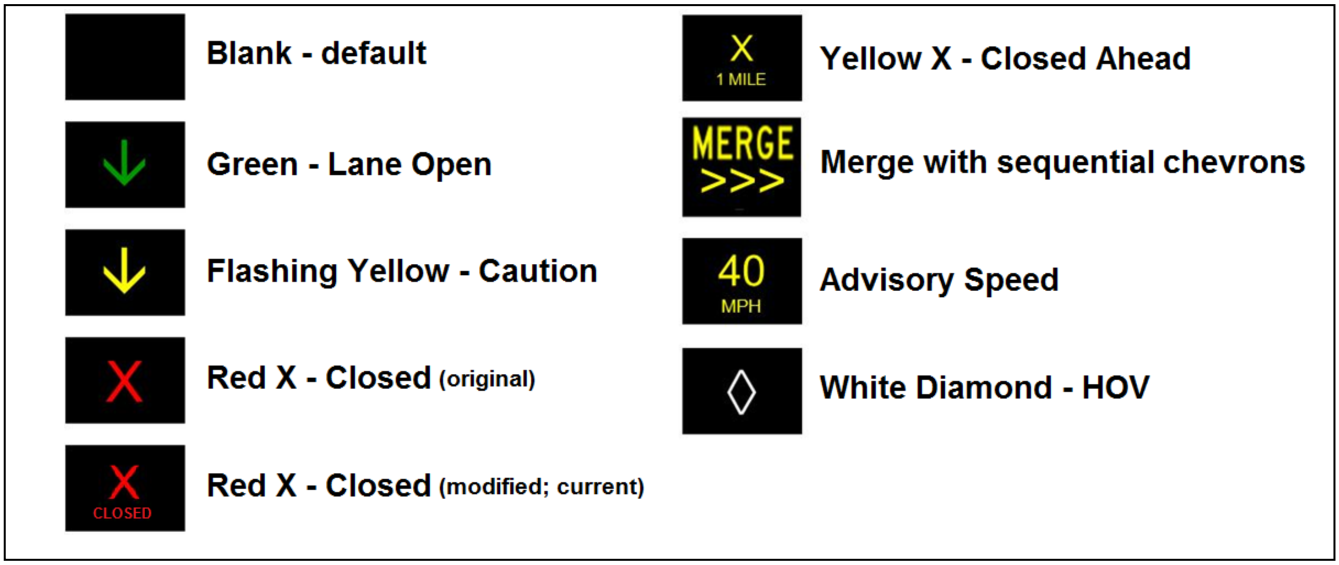
The ATM components of the Minnesota UPA included intelligent lane control signals (ILCS), along with real-time transit and traffic DMS. MnDOT uses the “Smart Lanes” term to refer to the ATM components on I-35W South. The ATM elements were deployed on I-35W South in two phases from 2009 to 2010. The Smart Lanes were fully operational in July 2010. The system includes 174 ILCS at gantries spaced approximately every 0.5 miles on I-35W South from Burnsville to downtown Minneapolis. Real-time transit and traffic signs are also located at strategic points. These signs display the travel times for buses using the MnPASS HOT lanes and for vehicles in the general-purpose freeway travel lanes.

Called Smart Lanes, the ATM includes ILCS, which utilize a MnDOT-developed freeway management system software, IRIS. The system automatically activates advisory speeds in advance of congested areas, with advisory speeds posted up to one and one-half miles upstream of congested areas. The ILCS are over each lane and are located on gantries spaced approximately every 0.5 miles on I-35W South from Burnsville to downtown Minneapolis.

The use of the ILCS is primarily for incident management and speed harmonization. The ILCS also designate when the MnPASS HOT lanes, including the priced dynamic shoulder lane (PDSL), are in operation. Loop detectors measure traffic speeds downstream of the ILCS signs. Speeds are posted up to one and one-half miles upstream. The speeds are advisory only.

Figure 5-6 presents the standard ICLS sign options, which are described in the following.

- The green arrow is used when the PDSL is open. It is also used for lanes not affected by an incident.
- The flashing yellow arrow is used for lanes adjacent to an incident either in the next lane or on the shoulder. The flashing yellow arrow is unique to Minnesota. It has been in the MN MUTCD for nearly two decades for use outside the Lowry Tunnel on I-94 adjacent to downtown Minneapolis.
- The red X is used either when lanes are closed due to an incident or when the PDSL is closed. As noted on Figure 5-6, this sign has been modified to include the word “Closed.”
- The yellow X with the 1 mile distance and the Merge with a left or right arrow is used to alert motorists of a lane closure and merge ahead. Prior to the Red X, motorists first encounter the yellow X, followed by a Merge with left or right arrow.
- Advisory Speed Signs. The speed is amber on black since the variable speed is advisory only. The sign could allow for regulatory black on white messages in the future.
- The white diamond is displayed to show when HOT lane restrictions are in place during peak periods.



Minnesota Department of Transportation.

Figure 5-6. ILCS Sign Options

The system automatically activates advisory speeds in advanced of congested areas, including those caused by incidents, by an algorithm that examines current speed and congestion levels in the corridor, especially downstream. Operators need not deploy the variable advisory speeds, although they can override the signs as needed. Advisory speeds are posted on up to three gantries in advance of the congested area based on 30-second binned loop detector data. The posted advisory speed remains constant for one-minute before changing again, even if a new speed is recommended based on the algorithm only 20 seconds after the previous recommendation was posted. The variable speeds will change every 30 seconds, but the algorithm is using the last two sets of 30-second data to smooth out any irregularities in the data.

The advisory speeds posted are always the same for all signs on a single gantry. A white diamond may remain displayed on the sign over the HOT lane, however. Since conditions in the HOT lane may be less congested than the general-purpose freeway lanes, the white diamond reinforces the special requirements for use of the lane and discourages drivers who are not MnPASS customers or carpoolers from entering the lane. Posted advisory speeds are in 5 mph increments between a minimum advised 30 mph and a maximum advised speed that is 5 mph under the posted speed limit in that section; the speed limit in the corridor ranges from 60 mph in the south to 50 mph in the north, i.e., the maximum posted advisory speed in the south is 55 mph and in the north is 45 mph. In keeping with state legislation, the posted speeds are advisory only.

As part of the UPA, DMS displaying real-time transit and traffic travel times were deployed at strategic locations along I-35W South, where motorists could access park-and-ride lots to take transit. The signs are intended to encourage motorists to switch to riding the bus by providing comparisons of the travel times.

The congestion and transit analyses indicate that travel speeds increased overall in the corridor. Variations in changes in travel speeds and travel times for the three segments of I-35W South – Highway 13 to I-494, I-494 to 46th Street, and 46th Street into downtown Minneapolis – did occur, however. Travel speeds decreased slightly, with corresponding increases in travel times in some sections from the pre-deployment period to the post-deployment period. These changes may be the result mostly of the improvements in the Crosstown Commons section, but speed harmonization and the posting of lower advisory speeds may have played a role. Further, ATM speed harmonization may have supported the increase in throughput on I-35W South.

The national evaluation's safety analysis examined the number of crashes on I-35W South during six months in both the pre- and post-deployment periods. The pre-deployment period was November 2008 to April 2009 and the post-deployment period was November 2010 to April 2011. The total number of crashes was similar for the two time periods – 428 in the pre-deployment six months and 427 in the post-deployment six months. When the growth in VMT in the post-deployment period is considered, however, crashes declined by 22 percent in the post-deployment period. This change is statistically significant at the 95 percent confidence level. As noted in the safety analysis, examining crash data over a longer post-deployment period is needed to fully assess the potential impacts of the ATM strategies and other UPA projects. In addition, it was not possible to separate the safety impacts of the reconstruction of the Crosstown Commons section from the UPA projects. Data were not available to assess the impact of the ATM strategies on possible changes in the duration of incidents.

The MnDOT sponsored interviews with Minnesota State Patrol officers and FIRST operators, and focus groups with Metro Transit and MVTA bus operators included questions related to the Smart Lanes, including the ILCS and real-time traffic and transit information, received positive comments from Minnesota State Patrol officers, FIRST operators, and Metro Transit and MVTA operators. Representatives from all three groups noted that the ILCS were effective in slowing down traffic and moving traffic to other lanes in the case of a crash or other situation. Examples of comments included "really great, we utilize them for crashes and debris on the road," from a State Patrol officer; "when the lane closure signs are on, they are the best of all for the FIRST drivers," from a FIRST operator; "they are wonderful, they work," and from another FIRST operator; "they have helped a lot," from a bus operator.

State Patrol officers and FIRST operators further indicated the ILCS enhanced their ability to respond to crashes and to help maintain traffic flow during incidents. They commented that for the most part the motoring public does move out of the lanes when flashing the yellow X and the red X are posted. It was noted that some motorists do not seem to fully understand what the different symbols and colors mean and how they should respond, however. It was also noted that while the advisory speed signs may slow traffic a little, many motorists do not obey them if traffic is flowing at faster speeds.

5.3 Assessment of U.S. DOT Four Objective Questions

The four U.S. DOT objective questions and the 10 analysis areas used in the Minnesota UPA evaluation were presented and discussed in Section 4 of this report. Appendix A though J presents detailed information on the 10 analyses. This section summarizes the impacts by the hypotheses/questions for each of the 10 analysis areas.

5.3.1 Summary of Congestion Impacts

As highlighted in Table 5-4, the UPA strategies appear to have helped reduced congestion levels on I-35W South. Peak-period, end-to-end median corridor travel times improved, peak-period travel time reliability and median travel speeds in each section in both peak directions of travel improved, and total and per lane vehicle throughput increased. It is not possible to separate the impacts of the UPA projects – including the HOV-to-HOT expansion, new HOT lanes, the new PDSL, and ATM and speed harmonization – and the impacts of the new general-purpose freeway lanes in the Crosstown Commons section, however.

The results of surveys, interviews, and focus groups with MnPASS customers, travelers on I-35W South, Minnesota State Patrol Officers, FIRST operators, bus operators, and local stakeholders also indicate a general perception that travel times have been reduced, trip-time reliability has been improved, the duration of congestion has declined, and congestion has been reduced with the deployment of the UPA projects and other improvements to I-35W South. The wording of some questions was not precise enough to accurately measure the perceived changes in some of these hypotheses, however.

It was not possible to assess the impact of the UPA projects on traffic congestion on surrounding facilities adjacent to I-35W South, as data was not available on these facilities. Details on the congestion analysis can be found in Appendix A.

Table 5-4. Summary of Congestion Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Deployment of the UPA improvements will reduce the travel time of users in the I-35W corridor.	Somewhat	Travel times on I-35W South from Highway 13 to downtown Minneapolis were reduced. The travel time savings varied by section.
• Deployment of the UPA improvements will improve the reliability of user trips in the I-35W corridor.	Supported	Travel time reliability, as measured by the 95th percentile travel times and the Buffer Index, improved on I-35W South in the post-deployment period.
• Traffic congestion on I-35W will be reduced to the extent that travelers in the corridor will experience a noticeable improvement in travel time.	Supported	Survey and interview results indicated that among a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported an improvement in travel conditions on I-35W South.
• Deployment of the UPA projects will not cause an increase in the extent of traffic congestion on surrounding facilities adjacent to I-35W.	Unknown	Data from adjacent facilities was not available to allow this hypothesis to be examined.
• Deploying the UPA improvements will result in more vehicles and persons served in the I-35W corridor during peak-periods.	Supported	Increases in vehicle throughput across all lanes were observed in each segment and for the full length of I-35W South. Significant increases in average median VMT were observed in the general-purpose lanes in each peak direction of travel in each evaluation.
• A majority of survey respondents will indicate a noticeable reduction in travel times after the deployment of the UPA improvements.	Apparent Support[1]	Survey and interview results indicate that a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported an improvement in travel conditions on I-35W South.
• A majority of survey respondents will indicate a noticeable improvement in trip-time reliability after the deployment of the UPA projects.	Apparent Support[1]	Survey and interview results indicate that a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported an improvement in travel conditions on I-35W South.
• The majority of survey respondents will indicate a noticeable reduction in the duration of congestion after deployment of the UPA projects.	Apparent Support[1]	Survey and interview results indicate that among a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders indicated that the duration of congestion on I-35W South had been reduced.
• A majority of survey respondents will indicate a noticeable reduction in the extent of congestion after the deployment of the UPA projects.	Apparent Support[1]	Survey and interview results indicate that among a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders indicated that the extent of congestion on I-35W South had been reduced.

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[1]The wording of many of the survey, interview, and focus group questions was more general than these specific hypotheses. The results offer apparent support for these hypotheses.

5.3.2 Summary of Tolling Impacts

As highlighted in Table 5-5, the hypotheses related to the MnPASS lanes and tolling aspects of the Minnesota UPA are supported by the operation of the lanes. The analysis indicates that vehicular throughput has increased on I-35W South – and is being sustained – as a result of the MnPASS HOT lanes, including the PDSL. The results of the surveys of MnPASS customers and travelers on I-35 indicated that some individuals driving alone in the general-purpose freeway lanes have become MnPASS customers and have shifted to using the MnPASS lanes on a regular or somewhat frequent basis. The MnDOT quarterly reports and the MnPASS and I-35W commuter survey results present different perspectives on changes in carpools. The MnDOT quarterly reports and the MnPASS survey indicate some carpoolers have become MnPASS customers and use the MnPASS HOT lanes as solo drivers. The I-35W South commuter telephone survey indicated some carpoolers have remained carpoolers after the expansion to HOT lanes. According to MnDOT data, violation of the HOV requirements have been reduced with the expansion of the HOV lanes to the MnPASS HOT lanes, although 2011 data from the Minnesota State Patrol indicate an ongoing low level of MnPASS toll payment violations. Finally, the use data on the I-35W MnPASS lanes and the PDSL indicates that vehicular throughput is being maintained. Appendix B contains details on the tolling analysis.

Table 5-5. Summary of Tolling Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Vehicle access on the HOT lanes and PDSL on I-35W will be regulated to increase vehicular throughput in the corridor.	Supported	The analysis presented in the congestion analysis indicates that vehicle throughput has increased on I-35W South as a result of the MnPASS lanes, including the PDSL.
• Some general-purpose lane travelers will shift to the I-35W HOT lanes and PDSL, while HOV lane travelers will remain in the HOT lane.	Supported	The results from the MnPASS customer survey, as well as the surveys of travelers in the I-35W South corridor discussed in Appendix A, indicate that some SOV travelers have become MnPASS customers and shifted to using the MnPASS lanes, while some carpoolers have continued their use of the MnPASS HOT lanes.
• HOV violations will be reduced.	Supported	According to the MnDOT Quarterly Reports, HOV violations were reduced from approximately 15% to 5% with the expansion of the existing I-35W HOV lanes to MnPASS HOT lanes in October 2010. Data from the Minnesota State Patrol indicate an ongoing low level of violations of MnPASS toll payments, however.
• After ramp-up, the HOT lanes and PDSL on I-35W maintains vehicular throughput gains on the priced facility.	Supported	The congestion analysis indicates that the vehicular throughput gains are being sustained after the opening of the MnPASS lanes and the ramp-up period.

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5.3.3 Summary Transit Impacts

Table 5-6 presents a summary of the transit impacts for each of the hypothesis in the transit analysis. The first hypothesis is supported, with the HOT lanes, PDSL, MARQ2 lanes, Transit Advantage bus bypass lane, and the shoulder running buses combining to increase bus travel speeds, reduce bus travel times, and improved bus trip-time reliability. The MARQ2 lanes appear to have had the largest positive impact, while the addition of tolled vehicles in the PDSL and the existing HOV lane resulted in no change or slight degradation in travel speeds and travel times. The new and expanded park-and-ride lots and the new and expanded transit service resulted in new riders being attracted to transit services. The number of vehicles parking at park-and-ride lots and ridership levels on routes serving these lots increased in both the I-35W North and the I-35W South corridors. The on-board survey results indicate that some former drivers have switched modes to riding the bus. Congestion levels on I-35W South have been reduced due to the reconstruction of the Crosstown Commons section and the UPA projects. While the small number of individuals changing from driving alone to riding the bus represents a small impact, they do contribute to reducing congestion. All of the UPA transit strategies contributed to enhancing transit operations in the I-35W North, I-35W South, and Cedar Avenue corridors, as well as in downtown Minneapolis. Further details on the transit analysis can be found in Appendix C.

Table 5-6. Summary of Transit Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• The HOT lanes, PDSL, MARQ2 bus lanes, and Transit Advantage project, and shoulder running lane guidance system will increase bus travel speeds, reduce bus travel times, and improve bus trip-time reliability in the I-35W and Cedar Avenue corridors, and downtown Minneapolis	Supported	The HOT lanes, PDSL, MARQ2 lanes, Transit Advantage Project, and shoulder running lane guidance system resulted in increased bus travel speeds, reduced bus travel times, and improved bus trip-time reliability on I-35W South and Cedar Avenue, and in downtown Minneapolis.
• The new park-and-ride lots and new and expanded transit services will result in ridership increases including a mode shift to transit.	Supported	Use of the new and expanded park-and-ride lots increased by approximately 690 vehicles between 2009 and 2011. Ridership has increased. The onboard survey results indicted some new riders formerly drive alone.
• The mode shift to transit from the UPA transit strategies will reduce congestion on I-35W, downtown Minneapolis, and other roadways.	Supported	The results from the on-board survey indicate that former automobile drivers have been attracted to transit due to the UPA projects. Congestion has been reduced on I-35W South with the UPA projects and the reconstruction of the Crosstown Commons section. Given the small number of new bus riders, the impact on congestion is probably small, however.
• What was the relative contribution of each of the Minnesota UPA transit strategies to mode shift to transit?	Supported	All of the strategies enhanced both the short-term and long-term operation of bus service in the corridor. It was not possible to identify the relative contribution of the individual transit projects.

5.3.4 Summary of Telecommuting Impacts

Table 5-7 summarizes the impacts of the eWorkPlace program across the three hypotheses in the national evaluation. As presented in the table, the eWorkPlace programs supported all three hypotheses. The eWorkPlace programs resulted in an estimated reduction of 1,260 single-occupancy vehicle trips to I-35W per week. The eWorkPlace program enhanced congestion mitigation in the I-35W corridor and region-wide. The eWorkPlace program also had secondary benefits of increased employee productivity. Appendix D presents further information on the evaluation of telecommuting.

Table 5-7. Summary of Telecommuting Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
Use of telecommuting, ROWE, and other flexible work schedules removed trips and VMT from the I-35W corridor.	Supported	An estimated 1,260 single-occupancy vehicle trips per week were removed during the peak hour due to the telework initiative on I-35W. A total of 570 of the 4212 new telework participants are estimated to be from the I-35W study corridor, with 420 participants estimated to be single-occupancy drivers using the I-35W study corridor. Each of these participants teleworked an average of 1.5 times a week. No results show diversion to travel shifting to off-peak hours but the program initiatives were geared towards eliminating trips rather than moving them temporally.
Integration of telecommuting into the UPA project enhanced congestion mitigation.	Supported	Telecommuting initiatives as part of the UPA have resulted in regional as well as corridor-specific impacts in terms of VMT reductions. The local partners estimated a 7.46 million annual reduction in VMT from the eWorkPlace program. In the study corridor, the annual VMT reduction due to the eWorkplace participants is 520,000 vehicle-miles.
What was the relative contribution of the telecommuting strategies to overall travel behavior changes, including secondary impacts of telecommuting?	Supported	The local partners reported that teleworkers take 80 percent fewer trips during the work day and 93 percent fewer peak-period trips compared to non-teleworkers. The eWorkPlace participants avoided making 11,350 additional vehicle trips per week in the region by teleworking based on these percentages. 75 percent of participating employers reported an increase in productivity and 93 percent planned to either continue or expand their telework program

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5.3.5 Summary of Technology Analysis

The results of the technology analysis related to the three hypotheses and questions are summarized in Table 5-8. The impact of the ATM strategies and the DMS on throughput increases experienced on I-35W South from the pre- to post-deployment periods was inclusive.

It was not possible to identify the specific impacts on throughput from the ATM strategies and the DMS. The reconstruction of the Crosstown Commons section, better utilization of the HOV/HOT lanes, and geometric improvements may be the major contributors to the improvements in throughput. The impact of the ATM strategies on safety and the number and duration of incidents was inconclusive. A longer period is needed to more fully assess the potential safety impacts and data on incidents is also needed. More conclusive results may be found as more years of crash data become available for comparison. While the ATM strategies and DMS appear to contribute to the increases in throughput, it was not possible to separate out the impacts of specific components. Further information on the technology analysis is contained in Appendix E.

Table 5-8. Summary of Technology Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Active traffic management strategies, including speed harmonization and DMS with transit and highway travel times, promoting better utilization and distribution of traffic to available capacity on I-35W South.	Inconclusive	It was not possible to separate the potential impacts from the ATM strategies and the DMS, the HOT lanes, the new general purpose freeway lanes in the Crosstown Commons section, and other improvements on the throughput increase experienced on I-35W South.
• Active traffic management strategies will reduce the number and duration of incidents that result in congestion on I-35W South.	Inconclusive	Data were not available to fully assess this hypothesis. The number of crashes on I-35W South for the six month pre- and post-deployment periods remained the same, but crashes decreased by 22 percent when increases in VMT were considered. Data over a longer pre-deployment period are needed to more fully assess the potential impacts, however. No data were available to compare possible changes in the duration of incidents.
• What was the relative contribution of each technology enhancement on congestion reduction congestion on I-35W South.	Supported	The ATM and DMS components appear to support increased throughput, but it was not possible to separate out the impacts associated with specific components.

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5.3.6 Summary of Safety Impacts

Table 5-9 summarizes the safety impacts across the hypotheses and questions. Crash reductions in the six-month post-deployment period were realized on the order of 9 percent for fatal plus injury crashes and greater than 20 percent for property damage only (PDO) and total crashes when the change in VMT was accounted for on I-35W South. Further analysis of data over a longer time period than available for this evaluation is needed to fully assess the safety impacts of the UPA projects and the influence of the improvements in the Crosstown Commons section. The ATM strategies may contribute to the reduced crash rates and the improved safety reported by MnPASS customers, freeway travelers, Minnesota State Patrol officers, FIRST operators, and bus operators. The analysis further indicates that the HOT lanes and the PDSL did not degrade the safe operation of I-35W South. The majority of MnPASS customers, Minnesota State Patrol officers, FIRST operators, and Metro Transit and MVTA operators indicated the HOT lanes and the PDSL provide safe operating environments. Information from MVTA and Metro Transit indicated no accidents involving the MARQ2 lanes or the DAS for shoulder running buses, and positive feedback from bus operators on the safety-related elements of these projects was received in the focus groups and surveys. Appendix F presents details on the safety analysis.

Table 5-9. Summary of Safety Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Active traffic management will reduce the number of primary and/or secondary crashes.	Supported, but more analysis needed	Crash rates were statistically significantly lower (by more than 25 percent for PDO crashes and more than 20 percent for total crashes) in the post-deployment period, but more extensive analysis over a longer period is needed. The influence of the reconstruction of the Crosstown Commons section on safety improvements also needs further study. Positive reactions on improved safety were received from the majority of MnPASS customers, general-purpose freeway lanes travelers, bus operators, Minnesota State Patrol officers, and FIRST operators.
• The HOT lanes and the PDSL on I-35W South will not adversely affect highway safety.	Supported	Overall crash rates on I-35W South were statistically lower in the post-deployment period. The majority of MnPASS customers and bus operators reported the MnPASS HOT lanes provided safe operating environments.
• The MARQ2 dual bus lanes in Downtown Minneapolis will not adversely affect safety.	Supported	No accidents reported by MVTA or Metro Transit and positive feedback were received from bus operators.
• The lane guidance system for shoulder running buses will not adversely affect safety.	Supported	No accidents reported by MVTA and 62 percent of the MVTA operators using the DAS reported it provided improved safety.

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5.3.7 Summary of Equity Analysis

Table 5-10 presents a summary of the equity analysis across the four questions. The Minnesota UPA projects benefited all I-35W South user groups – motorists in the general-purpose freeway lanes, carpoolers using the HOV and HOT lanes, bus riders, and MnPASS customers. MnPASS customers experienced an increase in operating expenses due to the HOT lane tolls, but they received the benefit of reduced mean travel times. All geographic areas in the I-35W South corridor benefited from the UPA projects. Residents in the communities south of the Minnesota River have access to the HOT lanes and PDSL, the MARQ2 lanes, and the new park-and-ride lots and the new and expanded bus services. Residents in communities north of the river have access to the MnPASS HOT lanes and the PDSL, the MARQ2 lanes, and additional transit services. In addition, bus riders from throughout the metropolitan area benefit from express and limited stop routes using the MARQ2 lanes. The geographic areas reflect relatively similar socio-economic and demographic characteristics with South Minneapolis, Richfield, and Bloomington being more ethnically and socio-economically diverse. The environmental analysis indicated that the UPA projects resulted in reduced emissions in the section of I-35W from Highway 13 to I-494. The analysis for the other sections of I-35W South were inconclusive due to data limitations and numerous confounding factors, but appears to be a possible increase in vehicle emissions and air pollutants in the communities north of the Minnesota River, which also receive fewer benefits from the UPA projects. Finally, the proposed reinvestment of any MnPASS revenues between capital improvements and transit improvements on I-35W South represents an equitable approach benefiting all users groups.

Table 5-10. Summary of Equity Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
How do the impacts from the I-35W South UPA projects affect the different user groups?	Supports all user groups	All user groups – motorists in the general-purpose freeway lanes, carpoolers, bus riders, and MnPASS users benefited. MnPASS users' operating expenses increased due to the HOT lane tolls, but they received the benefit of reduced mean travel times.
How do the impacts from the I-35W South UPA projects differ across geographic areas?	Positive impacts on all areas, but benefits vary slightly by geographic area	All the geographic areas received benefits. Residents in communities south of the Minnesota River have access to the new park-and-ride lots and the new and expanded bus services, as well as the HOT lanes, the PDSL, and the MARQ2 lanes. Residents in communities north of the river have access to the MnPASS HOT lanes and the PDSL, the MARQ2 lanes, and additional bus services. Bus riders on express and limited stop routes from throughout the metropolitan area benefit from the MARQ2 lanes.
Are the air quality impacts from the I-35W South UPA projects different across geographic and socio-economic groups?	Positive or neutral impacts on most areas and socio-economic groups, but possible negative impacts on some communities and populations	There were differences in air quality impacts across geographic areas and socio-economic groups. Residents of South Minneapolis, Richfield, and Bloomington – which reflect more diverse ethnic groups and lower income groups – may be exposed to increases in air pollution.
How does reinvestment of potential revenues from the I-35W HOT lanes and PDSL impact various transportation system users?	Supports all user groups	The required reinvestment of potential revenues between capital improvements and transit improvements on I-35W South benefits all user groups.

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5.3.8 Summary of Environmental Analysis

Table 5-11 presents a summary of the questions examined in the environmental analysis of the Minnesota UPA projects, and details of the analysis are presented in Appendix H. The Minnesota UPA projects were found to have positive impacts on air quality, perceptions of overall environmental quality, and energy consumption. The analysis of the section of I-35W South from Highway 13 to I-494 indicated positive impacts on air quality (11-12 percent reduction in emissions) from the expansion of the existing HOV lanes to HOT lanes. However, the adjacent general purpose lanes in this section experienced an increase in emissions and energy use (28 – 32 percent) due to a large increase in volume, as described earlier.

The impacts on air quality from the new HOT lane in the Crosstown Commons section and the PDSL were inconclusive due to the addition of the general-purpose freeway lanes in the Crosstown Commons section, lack of needed data, and other factors influencing the increase in vehicle volumes on I-35W South.

The review of the stakeholder interviews and the print news media indicated positive perceptions on air quality, energy consumption, and the environment from the transit and telecommuting projects.

Table 5-11. Summary of Environmental Impacts Across Questions

Questions	Result	Evidence
What are the impacts of the Minnesota UPA strategies on air quality?	Positive impacts in some sections but, inconclusive in other sections of I-35W South.	Positive impacts on air quality from the expansion of the HOV lanes to HOT lanes on I-35W South between Highway 13 and I-494 but negative impact in general purpose lanes due to increase in volumes. Not able to fully assess the impacts of other I-35W South segments due to confounding effect of other projects, lack of data, and other factors.
What are the impacts on perceptions of overall environmental quality?	Positive impacts	Responses from some individuals during the stakeholder interviews and coverage in a few newspaper articles noted the positive impact on air quality, energy consumption, and the environment from the Minnesota UPA transit and telecommuting projects.
What are the impacts on energy consumption?	Positive impacts in some sections, but, inconclusive in other sections of I-35W South.	Reduction in fuel use from the expansion of the existing HOV lanes to HOT lanes in the section of I-35W South from Highway 13 to I-494 but increase in fuel use in the general purpose lanes due to increase in volumes. Not able to fully assess the impacts on other sections of I-35W South due to other projects, lack of data, and other factors.

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Similar to the air quality analysis, the analysis of the section of I-35W South from Highway 13 to I-494 with the expansion of the HOV lanes to HOT lanes resulted in a fuel use reduction on the HOV/HOT lanes. The impacts on fuel use from the HOT lanes in the Crosstown Commons section and the PDSL were inconclusive due to the addition of the new general-purpose freeway lanes, the lack of data, and other factors influencing the increase in vehicle volumes on I-35W South.

5.3.9 Summary of Non-Technical Success Factors

As highlighted in Table 5-12, people, process, structures, the media, and competencies all played supporting roles in the successful implementation, deployment, and operation of the Minnesota UPA projects. The multi-agency organization structure supported the initial implementation of the UPA projects. Support from agency leaders, clear authority for staff to make decisions, and the roll of neutral conveners played by the Citizens League, 35W Solutions Alliance, the Humphrey School, and CTS were also important. The local agencies used a wide variety of outreach approaches – workshops, forums, one-on-one meetings, presentations to groups, and newsletters and e-mails – to provide information to the public, commuters, and policy makers. These techniques were viewed as effective and beneficial by the policy makers, local officials, and interest groups included in the stakeholder interviews and workshops. The agencies built on a foundation of strong working relationships to successfully implement and operate the UPA projects. The media presented information on the UPA projects in a positive and descriptive manner. As such, the media played the role of informing the public, rather than attempting to influence public opinion. The results of the stakeholder interviews indicated that senior agency personnel possessed the technical expertise and project management skills needed to successfully deploy the various projects. The results from surveys and interviews indicate general support from different user groups to the UPA projects as appropriate methods to address traffic congestion, although some strategies were viewed more favorably than others. Appendix I contains details on the analysis of non-technical success factors.

Table 5-12. Summary of Non-Technical Success Factors

Questions	Results	Evidence
What role did the following areas play in the success of the Minnesota UPA project deployment?		
1. People	Effective	Key elements included the multi-agency organization structure, support throughout the agencies, and neutral conveners.
2. Processes	Effective	Forums, workshops, meetings, presentations, and newsletters were used to communicate with different groups.
3. Structures	Effective	The strong agency working relationships supported the implementation of the UPA projects.
4. Media	Effective	Played role of informing the public, rather than attempting influencing public opinion.
5. Competencies	Effective	Agency personnel had the technical expertise and project management skills needed to successfully deploy the UPA projects.
Does the public support the UPA strategies as effective and appropriate ways to reduce congestion?	Supported	The reports from the various surveys of bus riders, commuters in the I-35W South corridor, and I-35W MnPASS customers indicate general support for the UPA strategies as effective and appropriate methods to reduce congestion.

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5.3.10 Summary of Benefit Cost Analysis

This analysis examined the net societal costs and benefits of the Minnesota UPA projects and the reconstruction of the Crosstown Commons section over a 10-year post-deployment period. The cost of the Crosstown Commons section reconstruction was included in the benefit cost analysis as the benefits of the reconstruction could not be separated out, and thus, were included in the overall benefits in the I-35W South corridor. As presented in Table 5-13, the result was a benefit-to-cost ratio of 6.0 and a net benefit of $422,701,558. The analysis had several limitations and required numerous assumptions. None of these would change the overall conclusion of a benefit to cost ratio above 1.0, however, although the exact value of that ratio could change.

For example, the reduction in crashes by VMT on I-35W South represent a major benefit in the analysis. The estimated benefit would be lower if the crash reduction by VMT had not occurred. Crash data over a longer period of time is needed to fully assess possible changes in crashes by VMT, which would influence the benefit cost analysis. In addition, vehicle operating costs included only reduced fuel consumption for automobile travel. Data on possible reduction in fuel used by buses was not available. The future year costs and benefits represent the best estimates available, but they are only estimates, and the actual costs and benefits may vary. Possible costs and benefits associated with Cedar Avenue were also not included in the analysis due to lack of data. Appendix J contains further details on the benefit cost analysis.

Table 5-13. Question for the Benefit Cost Analysis

Hypotheses/Questions	Result	Evidence
What are the overall benefits, costs, and net benefits from the Minnesota UPA projects?	Positive	Benefits: $505,601,501 Costs: $83,953,942 Net Benefits: $421,701,558 Benefit-to-cost ratio of 6.0 The costs and benefits of the Crosstown Commons section reconstruction are included in these figures.

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CHAPTER 6.0 SUMMARY AND CONCLUSIONS

This report has presented the results from the national evaluation of the Minnesota UPA projects. The report included a summary of the UPA and CRD programs, the Minnesota UPA partners and projects, and the evaluation process and data. The major findings from the evaluation were presented. Appendix A through K contain more detailed descriptions of the 11 analysis areas. This section summarizes the major findings from the evaluation and presents overall conclusions on the Minnesota UPA project.

6.1 Summary of Major Findings

Table 6-1 highlights the key findings from the national evaluation of the Minnesota UPA projects based on the U.S. DOT's four objective questions. Overall, the projects resulted in positive benefits during the one-year post-deployment analysis period. The Minnesota UPA projects have added significant capacity in the I-35W South corridor. The MnPASS HOT lanes, park-and-ride lots, and MARQ2 lane accommodate future growth in the corridor, while providing travel options to residents and visitors. As use of the different projects continues to grow in the future, ongoing benefits to travelers in the I-35W South corridor and downtown Minneapolis will be realized.

Table 6-1. U.S. DOT Objective Questions and Minnesota UPA Impacts

U.S. DOT 4 Objective Questions Evaluation Analyses
How much was congestion reduced?
Congestion. The MnPASS HOT lanes and the addition of the non-UPA general-purpose freeway lanes resulted in increased peak period travel speeds, reduced trip times, and improved trip-time reliability. The projects also resulted in increased throughput in the corridor. Tolling. The I-35W South MnPASS HOT lanes, including the innovative PDSL, averaged 50,000-to-60,000 total monthly trips and $74,000-to-$102,000 in monthly revenues during the full year of post-deployment in 2011. Transit. The new and expanded park-and-ride lots resulted in an additional 641 parked vehicles and 13 percent increase in ridership on routes from the I-35W South park-and-ride lots. The MARQ2 lanes increased the speed of buses though downtown Minneapolis, resulting in increased ridership on buses using the MARQ2. Telecommuting/TDM. The eWorkPlace telework program included 48 participating employers, with approximately 4,200 participating employees in the metropolitan area. An estimated 408 telework participants drove alone in the I-35W South corridor when not telecommuting, resulting in an estimated daily reduction of 3,000 VMT in the I-35W South corridor. Technology. The technology components, including ATM signs, the DAS for shoulder running buses, the real-time traffic and transit information DMS, and the real-time next bus arrival signs were all deployed successfully and contributed to the overall operation of the I-35W South corridor and downtown Minneapolis. The PDSL in-pavement lighting survived a winter, but was terminated due to corrosion.
What are the associated impacts of the congestion reduction strategies?
Safety. The total number of crashes on I-35W South for the six-month pre- and post-deployment periods remained approximately the same, but were statistically lower in the post-deployment period when growth in VMT is accounted for. Thus, the addition of the MnPASS HOT lanes, and the PDSL did not appear to negatively impact safety, while the ATM strategies may have played a supporting role in a positive impact on safety. The addition of the general purpose freeways lanes in the Crosstown Commons section may have made played the largest role in improving safety. Equity. All user groups, geographic areas, and socio-economic groups benefits from the UPA projects. Environmental. The environmental analysis indicated reductions in vehicle emissions in the section south of I-494, with inconclusive results in other sections.
What are the non-technical success factors?
Non-Technical Success Factors. The local partners built on existing strong working relationships, but established new collaborative approaches in the UPA projects. There was clear authority for project deployment. The local print media was objective and generally supportive of the UPA projects.
What is the overall cost and benefit of the strategies?
Benefit Cost Analysis (BCA). The Minnesota UPA projects in the I-35W South corridor, the MARQ2 lanes in downtown Minneapolis, the portion of the telecommuting program focusing on the I-35W South corridor, and the reconstruction of the Crosstown Common section had a benefit-to-cost ratio of 6.1.

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6.2 Conclusions

As presented in this report, the Minnesota UPA projects were deployed on schedule and have resulted in positive benefits to travelers in the corridor. The following conclusions can be drawn from the experience in deploying the UPA projects and in the use of the different projects.

- The deployment of the UPA projects built on the strong existing working relationships among the local partners. New working relationships were established, however. There were clear lines of authority and responsibility in deploying the various projects. A team atmosphere existed among the partners – no one wanted to let the other team members down. The timeline was challenging, but also resulted in innovative approaches and less debate over small issues.
- While a common log and "tag line" was used in deploying and introducing the UPA projects, each project was primarily marketed individually. The local print media was generally positive toward the UPA. An opportunity may have been missed, however, to provide the public and policy makers with a better understanding of the "package of solutions/approaches" used to address congestion on I-35W South.
- The MARQ2 and MnPASS HOT lanes represent "jewels in the crown" of the UPA projects. Both are the most visible from a community-wide perspective. Smaller projects, such as the Transit Advantage bus bypass ramp, delivered important benefits, however indicated that small projects can impact benefits, just like larger projects.
- Use of MnPASS HOT lanes, new park-and-ride lots, new and expanded transit service, the MARQ2 lanes, and the eWorkPlace was good during the post-deployment phase. The higher unemployment rates during the post-deployment period may have dampened the use of some elements. The UPA projects provide the capacity for further growth in the corridor and provide ongoing travel options for residents and visitors.

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Appendix A. Congestion Analysis

A major focus of the Minnesota UPA projects was to reduce traffic congestion on I-35W South. The congestion analysis provides an assessment of the cumulative effects of the UPA projects on overall congestion on I-35W South. The congestion analysis follows the evaluation principles presented in the National Cooperative Highway Research Program (NCHRP) *Guide to Effective Freeway Performance Measurement: Final Report and Guidebook.* Based on these principles, the congestion analysis focuses on reductions in travel times and improved travel-time reliability for users of I-35W South, reductions in the spatial and temporal extent of congestion on I-35W South, improvement in the vehicle and passenger carrying ability of I-35W South, and changes in travelers' perceptions of congestion on I-35W South.

Table A-1 lists the nine congestion hypotheses. The first hypothesis relates to the UPA projects reducing travel times for users on I-35W South, while the second hypothesis addresses improving trip-time reliability for users. The third hypothesis is that the UPA projects will reduce traffic congestion on I-35W South to the extent that users will experience a noticeable improvement in travel time. The fourth hypothesis relates to the UPA project not causing an increase in traffic congestion on surrounding facilities adjacent to I-35W South. The fifth hypothesis is that UPA projects will result in more vehicles and more persons served in the I-35W South corridor during the peak periods. The final four hypothesis addresses survey respondents indicating a noticeable reduction in travel times, improvement in trip-time reliability, reduction in the duration of congestion, and reduction in the extent of congestion after the deployment of the UPA projects.

The congestion analysis is complicated by the nature of the Minnesota UPA projects and other non-UPA improvements. The addition of new UPA high-occupancy toll (HOT) lanes and the priced dynamic shoulder lane (PDSL) provide additional capacity on I-35W South and travel options for users. The new general-purpose freeway lanes in the Crosstown Commons section, which were not part of the UPA, also add capacity and, along with other improvements in this section, eliminate a major bottleneck on the freeway. All of these improvements should result in increased travel speeds, reduced travel times, and increased throughput. As discussed in this Appendix, it was not possible to separate the potential impacts of the UPA-funded new HOT lanes and PDSL from the non-UPA general-purpose freeway lanes and other improvements.

Another component of the UPA on I-35W South was the deployment of Active Traffic Management (ATM), including speed harmonization. Called Smart Lanes, the ATM includes intelligent lane control signals (ILCS), which utilize a Minnesota Department of Transportation (MnDOT)-developed freeway management system software, Intelligent Roadway Information System (IRIS). The system automatically activates advisory speeds in advance of congested areas, with advisory speeds posted up to one and one-half miles upstream of congested areas. The ILCS are over each lane and are located on gantries spaced approximately every 0.5 miles on I-35W South from Burnsville to downtown Minneapolis.

Table A-1. UPA Congestion Analysis Hypotheses

Hypotheses/Questions
• Deployment of the UPA improvements will reduce the travel time of users in the I-35W South corridor.
• Deployment of the UPA improvements will improve the reliability of user trips in the I-35W South corridor.
• Traffic congestion on I-35W South will be reduced to the extent that travelers in the corridor will experience a noticeable improvement in travel time.
• Deployment of the UPA projects will not cause an increase in the extent of traffic congestion on surrounding facilities adjacent to I-35W South.
• Deploying the UPA improvements will result in more vehicles and persons served in the I-35W South corridor during peak-periods.
• A majority of survey respondents will indicate a noticeable reduction in travel times after the deployment of the UPA improvements.
• A majority of survey respondents will indicate a noticeable improvement in trip-time reliability after the deployment of the UPA projects.
• The majority of survey respondents will indicate a noticeable reduction in the duration of congestion after deployment of the UPA projects.
• A majority of survey respondents will indicate a noticeable reduction in the extent of congestion after the deployment of the UPA projects.

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The use of advisory speeds and speed harmonization typically result in lower speeds being posted on the ILCS, which in turn results in slower speeds and longer travel times on I-35W South. Thus, the UPA projects and other improvements in the corridor have conflicting results – the new HOT lanes, PDSL, and new general-purpose freeway lanes should increase speeds and reduce travel times, while the advisory speeds and speed harmonization should reduce travel speeds and increase travel times. Both may result in improved trip-time reliability and increased throughput, however. It was not possible to assess the impacts of these individual competing strategies.

The remainder of this appendix is divided into nine sections. The data sources used in the analysis are described next in Section A.1, followed by the traffic data analysis methods in Section A.2. Section A.3 presents the analysis of travel times on I-35W South. Travel-time variability is discussed in Section A.4. Travel speeds are presented in Section A.5, and vehicle throughput is discussed in Section A.6. A discussion of the perception of changes in congestion from survey results of MnPASS customers and commuters using I-35W South, and focus groups and interviews with Metro Transit and Minnesota Valley Transit Authority (MVTA) operators, Minnesota State Patrol Officers, and Freeway Incident Response Safety Team (FIRST) operators is presented in Section A.7. The potential impacts of exogenous factors, including changes in gasoline prices and unemployment rates on travel on I-35W South are discussed in Section A.8. The appendix concludes with summary of the congestion analysis in Section A.9.

A.1 Data Sources

The primary data source for the congestion analysis was the MnDOT's Regional Transportation Management Center (RTMC) sensor detection system. As part of the RTMC, MnDOT maintains a system of sensors to monitor traffic flow on the freeway system in the Minneapolis-St. Paul Metropolitan area. These sensors are located in each freeway lane at approximately 0.5-mile intervals in both directions of travel. The sensors measure volume and loop occupancy at 30-second intervals. MnDOT stores and archives these data on a daily basis. These records contain the following data for each active traffic detector:

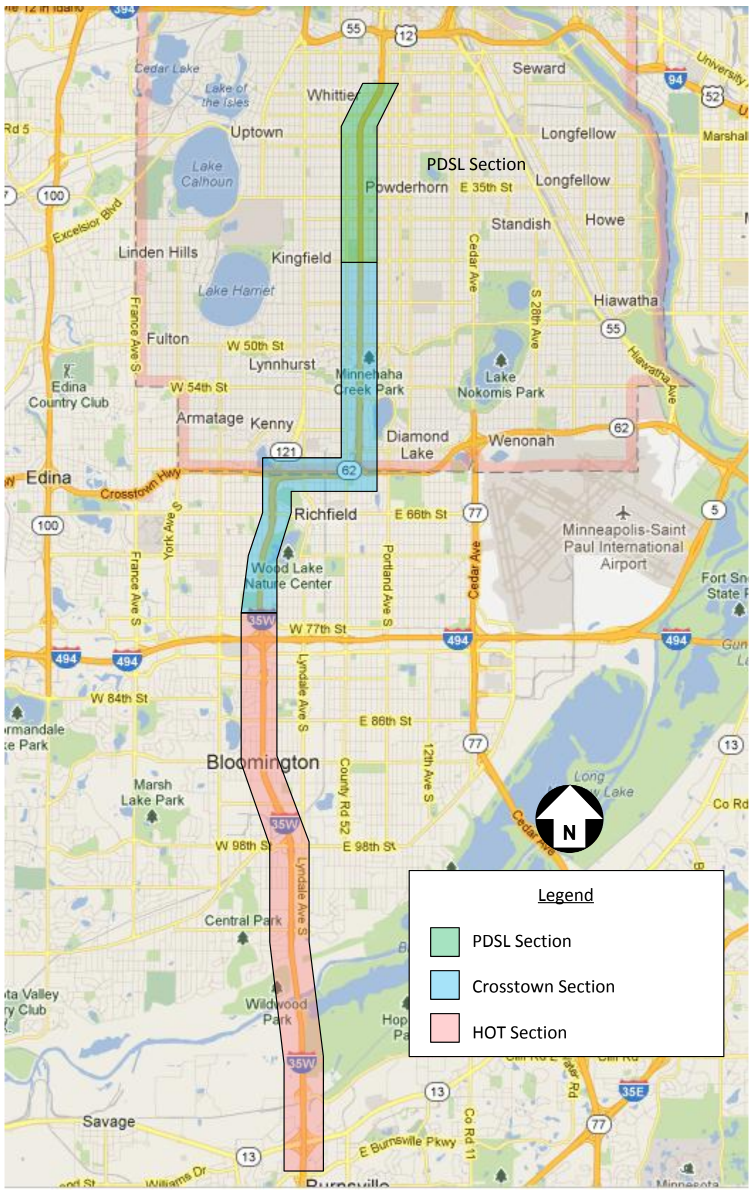
- Volume – the number of vehicles passing the detector during a 30-second sampling period;
- Occupancy – the percentage of time during a 30-second sampling period that the detector was occupied by a vehicle;
- Flow rate – the total number of vehicles that would pass over the detector if the 30-second volume was sustained for a full hour (i.e., volume x 120); and
- Speed – the average speed of all vehicles passing the detector during a 30-second sampling period. The speed is not a measured parameter but computed based upon the measured volume and occupancy.

These sensor data were used to derive travel time and throughput-based performance measures. The sensor data were examined for the pre-deployment period of October 2008 to April 2009 and the post-deployment period of December 2010 to November 2011. Data for non-holiday weekdays from 6:00 a.m. to 10:00 a.m. in the northbound direction of travel and 3:00 p.m. to 7:00 p.m. in the southbound of travel direction were analyzed. These time periods correspond to the MnDOT defined peak-period, peak direction of travel. The four seasonal periods examined were winter (December to February), spring (March to May), summer (June to August), and fall (September to November).

Due to construction activities, some sensors were not operational for the pre-deployment summer months. As a result, no data are shown for this time period. In addition, as noted in Appendix K – Exogenous Factors, the Minneapolis-St. Paul area experienced almost record snowfall in the winter of 2010-2011. Snowfall of approximately 10 inches in November and 34 inches in December, 2010, and 17 inches in January, 16 inches in February, and 8 inches in March 2011 may have impacted travel conditions during those months, which would be reflected in the post-deployment sensor data for those periods.

Due to the timing of the completion of the I-35W South re-construction of the Crosstown Commons section, the section I-35W South shares with Highway 62, the analysis of the UPA projects focused on both the full 16 miles from Highway 13 to downtown Minneapolis and three different sections of I-35W South. The three sections of I-35W South examined were: northbound and southbound lanes from Highway 13 to I-494 where the existing HOV lanes were expanded to HOT lanes; northbound and southbound from I-494 to 42nd Street, which includes the Crosstown Commons section with the new HOT lanes and the new general-purpose freeway lanes, which were not part of the Minnesota UPA program; and northbound and southbound from 38th Street to 26th Street, with the new PDSL in the northbound direction. Figure A-1 shows the limits of each segment examined in the evaluation.

Due to the location of some sensors, the data from the loop detectors covers approximately 14 miles in both the northbound and the southbound directions. This distance is shorter than the distance used in the transit analysis contained in Appendix C – Transit Analysis. The transit analysis includes travel times for buses into downtown Minneapolis. While the travel times are not directly comparable between the congestion analysis and the transit analysis due to the difference in the miles monitored, the results are similar. Further, the analysis of travel speeds and trip-time reliability are comparable.



Google maps, modified by Battelle

Figure A-1. Three Study Sections for I-35W South

Information on the perceptions of changes in congestion levels on I-35W South was obtained through focus groups, an online survey, and a telephone interview. An online survey of I-35W South MnPASS customers was conducted in January 2012. The methodology and key results for this survey are described in Appendix B – Tolling Analysis. A telephone survey of morning peak-period commuters on I-35W South was conducted as part of the national evaluation. The methodology for this telephone survey is also described in Appendix B – Tolling Analysis. The process for conducting the focus groups conducted with Metro Transit and MVTA bus operators, Minnesota State Patrol Officers, and FIRST operators is discussed in Appendix C – Transit Analysis.

A.2 Traffic Data Analysis Methods

To examine the congestion reduction effects and impacts of the UPA improvements in the corridor, the national evaluation team used a number of traditional congestion-related performance metrics including travel time (both mean and 95th percentile), buffer index, travel speeds, vehicle throughput, flow rates, and vehicle miles travelled (VMT). For many of the metrics (such as travel time, travel speeds, and flow rates), the national evaluation team used trimmed means, whereby the top and bottom 5 percent of the observations were not used in the analysis. For other measures (such as throughput, and VMT), median values were used. This was done to offset the effects of uncontrolled variables, such as weather and traffic incidents in the analysis.

The first level of analysis focused on comparing pre- and post-deployment effects in the peak direction of travel, aggregated for the across the entire peak period. The analysis was performed only on the peak direction of travel; therefore, the AM peak analysis focuses on northbound (or inbound) direction, and the PM peak analysis focuses on southbound (or outbound) direction. Initial comparisons were performed on each section of roadway by season because of concerns regarding seasonal effects on travel behavior and because of the different types of improvements being performed in the corridor.

While the season-based comparison revealed that seasonal traffic variations by section and lane types existed in the corridor, no particular useful trends could be deduced from these analyses. Therefore, in the next step of the analysis, the national evaluation team expanded the analysis to investigate the effect of UPA strategies within the peak periods. To accomplish this, the linear mixed effect modeling approach was utilized to capture the fixed effects of UPA strategies by time-of-day within the peak periods while a seasonal factor was simultaneously captured as a random-effect factor. This was done to allow the national evaluation team to examine the magnitude and statistical significance of the effect of UPA strategies by time-of-day while still recognizing the seasonal variation in traffic condition and thus producing defensible and robust estimates of the before-and-after changes in the performance measures of interest.

Linear mixed effects models were used to quantify and evaluate the statistical significance of the effects of UPA strategies on travel conditions on I-35W South. The models were calibrated for travel time, travel speeds, and flow rate in each section of I-35W South by direction and lane type. The 30-minute time block indicator variables were treated as fixed effects in the models to capture the effects of time on traffic performance, and to segregate the effects of UPA strategies on each section. The seasonal factor and interactions with time blocks were treated as random effects. In the end, eight models were developed for the following conditions:

- The general-purpose lanes in the HOT section in the northbound direction during the AM peak;
- The general-purpose lanes in the HOT section in the southbound direction during the PM peak;
- The MnPASS lane in the HOT section in the northbound direction during the AM peak;
- The MnPASS lane in the HOT section in the southbound direction during the PM peak;
- The general-purpose lanes in the Crosstown Commons section, in the northbound direction during the AM peak;
- The general-purpose lanes in the Crosstown Commons section in the southbound direction during the PM peak;
- The general-purpose lanes in the PDSL section, in the northbound direction during the AM peak; and
- The general-purpose lanes in the PDSL section in the southbound direction during the PM peak.

No models were developed for the MnPASS lane in the Crosstown Commons and PDSL sections, because this lane did not exist in the pre-deployment period.

Flow rate (veh/hr/ln) was used as a response variable to investigate the effects of UPA strategies on traffic flow. Flow rate was used because it is a normalized measure of how many vehicles can move through a cross section on a per-lane basis and can be related directly to the level of congestion experienced at the cross sections. Since the number of lanes in each cross section directly influence flow rates, the flow rate data were split into two groups:

- The data from the stations that have the same general-purpose lane configuration in the pre- and post-deployment periods (i.e., the same number of pre- and post-deployment number of general-purpose lanes); and
- The data from the stations with an increase in number of general-purpose lanes in the post-deployment period. Note that there was no change in the number of general-purpose lanes in the PDSL section.

In this case, the effects being captured in these cross sections in the flow rate models can be attributed directly to UPA strategies depending on the characteristics of the cross sections being examined.

The season and station groups were considered as random factors since their effects on the flow rates are not of primary interest by itself. In addition, not all stations were included in the model calibration. The time block and UPA strategies were treated as fixed effects as their effects on observed flow rates are the primary objective of this analysis. The best fitted model was determined based on overall goodness-of-fit statistics (Akaike Information Criterion), t-value of model coefficients, and logical interpretation of the sign of model coefficients. The log-likelihood ratio test was used to determine the most parsimonious model among competing candidate model structures. The fixed-effect variables are considered statistically significant at the 95 percent confidence level if the t-value is less than -1.96 or greater than 1.96.

A.3 Travel Times

Travel time is a core measure for assessing facility performance. Travel time is the time required for vehicles to traverse the distance between two reference points. Travel time is deemed an important quality of service measures because it is highly impacted by congestion (i.e., higher levels of congestion result in higher travel times).

A.3.1 Corridor Travel Times

Table A-2 and Figure A-2 show the changes in mean peak-period travel times in the general-purpose lanes through the entire corridor, pre- and post-deployment of the UPA improvements. The table and figure show that, over the entire peak period, there was an approximate three-minute reduction in the mean travel time during the post-deployment evaluation period. This table shows that this reduction in peak-period travel time remained relatively constant across all seasons, except northbound in the AM peak during the spring. During all other seasons, mean peak-period corridor travel times in the general-purpose lanes were generally less in the post-deployment period.

Table A-2. Changes in Mean Corridor Peak-Period Travel Times of the General-Purpose Lanes of I-35W South in the UPA Improvement Corridor by Season

Direction of Travel/Peak Period	Season	Mean Travel Time (Minutes)			
		Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change
Northbound (AM Peak)	Fall	20.8	17.0	-3.8	-18%
	Winter	21.0	17.7	-3.3	-16%
	Spring	14.9	16.8	1.9	13%
	Summer	-	15.9	-	-
	All Seasons	**18.9**	**16.8**	**-2.1**	**-11%**
Southbound (PM Peak)	Fall	18.8	14.6	-4.2	-22%
	Winter	20.4	15.2	-5.2	-26%
	Spring	16.1	13.5	-2.5	-16%
	Summer	-	16.5	-	-
	All Seasons	**18.4**	**15.0**	**-3.5**	**-19%**

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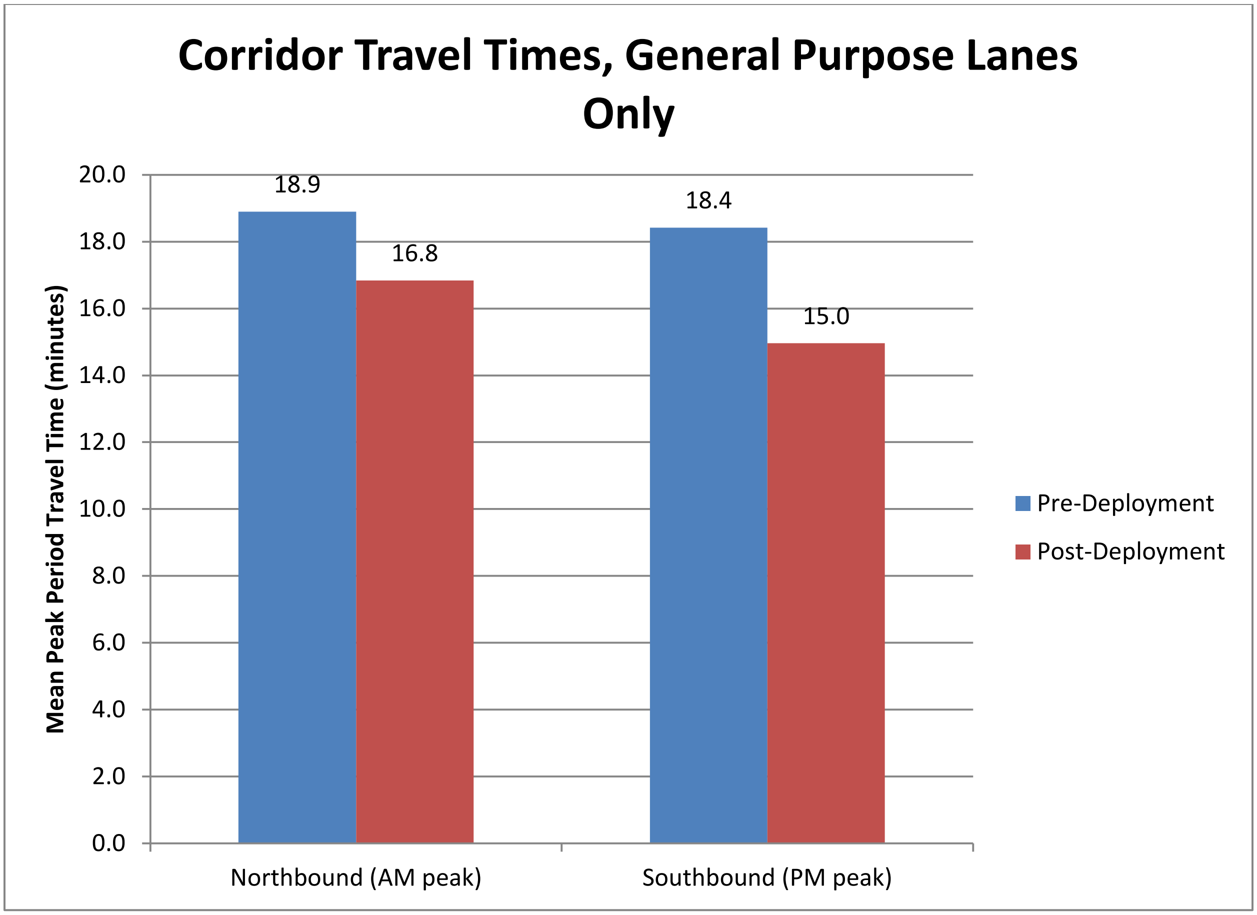

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Figure A-2. Comparison of Corridor Mean Peak-Period Travel Time in the General-Purpose Lanes for I-35W South – Pre-and Post- Deployment of the UPA Minneapolis Improvements Aggregated across Seasons

Table A-3 and Figure A-3 show the changes in mean corridor travel times in the general-purpose lanes in northbound direction during the AM peak, divided into 30-minute intervals in each peak period. Table A-3 shows that there was a consistent reduction in travel times in the northbound (or inbound) direction during the AM peak. During this time period, northbound users of the general-purpose lanes experienced between a 2-to-4 minute reduction in travel times. The greatest reduction in travel time occurred between 8:30 a.m. and 9:30 a.m. Northbound travelers in the general-purpose lanes experienced a 4-minute reduction in travel time.

Table A-4 and Figure A-4 show a similar trend for southbound travelers in the general-purpose lanes in the PM peak. The table shows a 3-to-7 minute reduction in southbound travel times in the general-purpose lanes for all portions of the PM peak. The greatest reduction in travel times occurred during the heart of the peak (i.e., between 4:30 p.m. and 6:00 p.m.). General-purpose lane travelers during these intervals experienced a 6-to-7 minute reduction in travel time through the corridor. Travelers traveling on the shoulders of the PM peak period (before 4:00 p.m. and after 6:00 p.m.) also experienced between a 3-to-4 minute reduction in end-to-end travel time in the UPA corridor.

Table A-3. Changes in the Mean Corridor Travel Times in the General-Purpose Lanes for I-35W South by Time Intervals within the Peak Period – Northbound, AM Peak

Time Period		Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	14.7	12.5	-2.2	-17%	0.485	*
6:30	7:00	16.3	14.0	-2.3	-17%	0.271	*
7:00	7:30	19.3	17.0	-2.3	-13%	0.258	*
7:30	8:00	24.2	21.7	-2.5	-11%	0.253	*
8:00	8:30	23.0	19.9	-3.1	-16%	0.233	*
8:30	9:00	21.0	17.0	-4.0	-24%	0.254	*
9:00	9:30	17.9	14.2	-3.7	-26%	0.228	*
9:30	10:00	16.2	13.4	-2.7	-20%	0.219	*

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"*" denotes a statistically significant change at a 95 percent confidence level. "-"denotes a changes that was not statistically significant.

Table A-4. Changes in the Mean Corridor Travel Times in the General-Purpose Lanes for I-35W South by Time Intervals within the Peak Period – Southbound, PM Peak

Time Period		Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	15.4	12.5	-2.9	-22.8%	0.216	*
15:30	16:00	17.0	13.4	-3.7	-27.3%	0.216	*
16:00	16:30	19.2	14.4	-4.8	-33.1%	0.202	*
16:30	17:00	22.1	16.3	-5.7	-35.0%	0.200	*
17:00	17:30	23.8	17.1	-6.7	-39.1%	0.196	*
17:30	18:00	21.2	15.4	-5.8	-37.8%	0.198	*
18:00	18:30	16.5	12.8	-3.7	-28.8%	0.260	*
18:30	19:00	15.0	11.9	-3.1	-26.0%	0.306	*

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"*" denotes a statistically significant change at a 95 percent confidence level. "-" denotes a changes that was not statistically significant.

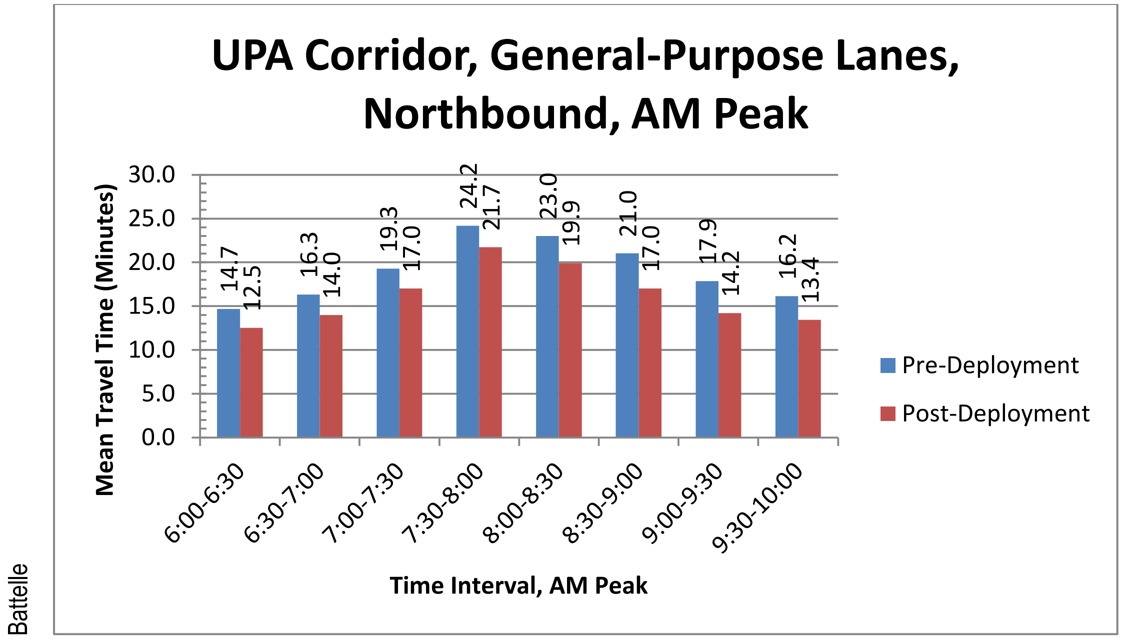

Figure A-3. Pre- and Post-Deployment Mean Corridor Travel Times in the General-Purpose Lanes in the Northbound Direction during the AM Peak

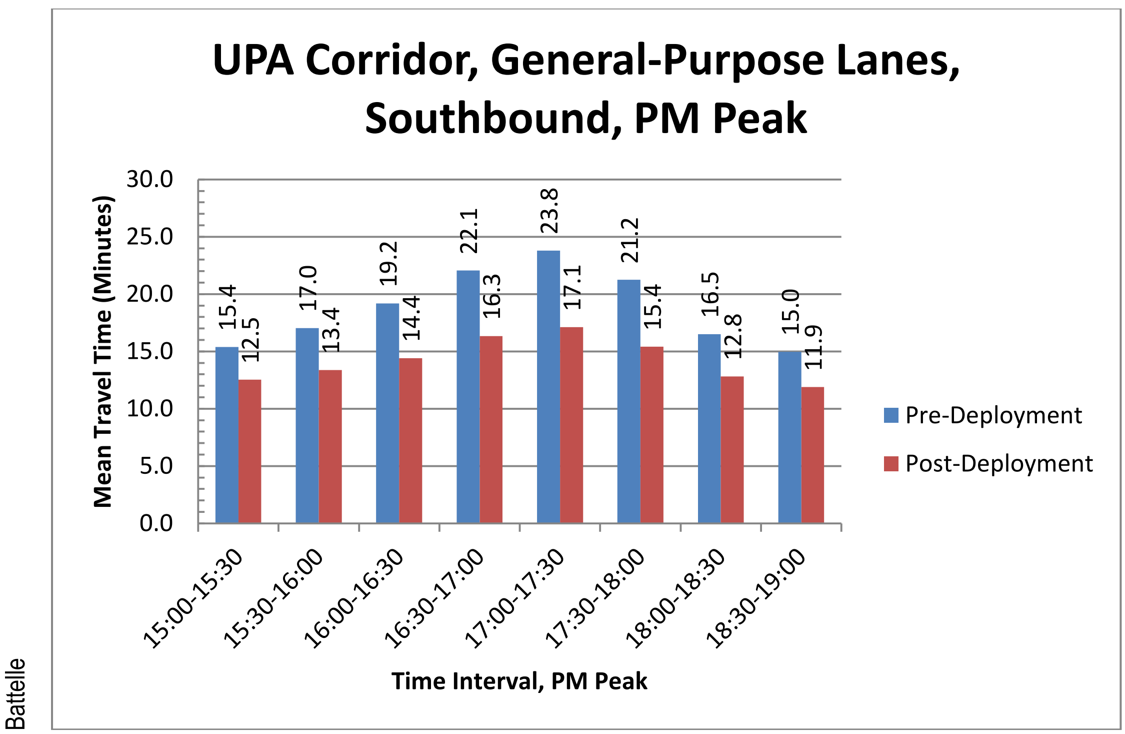

Figure A-4. Pre- and Post-Deployment Mean Corridor Travel Times in the General-Purpose Lanes in the Southbound Direction during the PM Peak

Table A-5 and Figure A-5 compare the mean peak-period travel time of the MnPASS Lane to the general-purpose lanes in the peak direction of travel. All three segments are included in the morning peak period. In the PM peak, the MnPASS travel time includes general-purpose travel time in the PDSL section as MnPASS users traveling southbound in the PM peak would have to use the facility to travel through the UPA corridor. The table and figure illustrate that in the morning peak-period, MnPASS users save over two minutes compared to motorists in the general-purpose freeway lanes. In the afternoon peak-period, MnPASS travelers save approximately 1½ minutes over the general-purpose freeway lane users.

Table A-5. Comparison of Post-Deployment General-Purpose Lanes and MnPASS Lane Mean Travel Times for each Peak Period by Season

Direction of Travel/Peak Period	Season	Mean Travel Time (Minutes)			
		General-Purpose Lanes	MnPASS Lane	Change in Travel Time	Percent Change
Northbound (AM Peak)	Fall	17.0	13.4	-3.6	-21%
	Winter	17.7	14.1	-3.6	-20%
	Spring	16.8	13.7	-3.1	-18%
	Summer	15.9	13.8	-2.0	-13%
	All Seasons	**16.8**	**13.8**	**-2.4**	**-15%**
Southbound (PM Peak)	Fall	14.6	13.1*	-1.5	-10%
	Winter	15.2	14.5*	-0.7	-4%
	Spring	13.5	12.9*	-0.6	-5%
	Summer	16.5	13.8*	-2.7	-16%
	All Seasons	**15.0**	**13.6***	**-1.4**	**-9%**

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* Includes the travel time in the general-purpose lanes in the PDSL section as part of the MnPASS travel time.

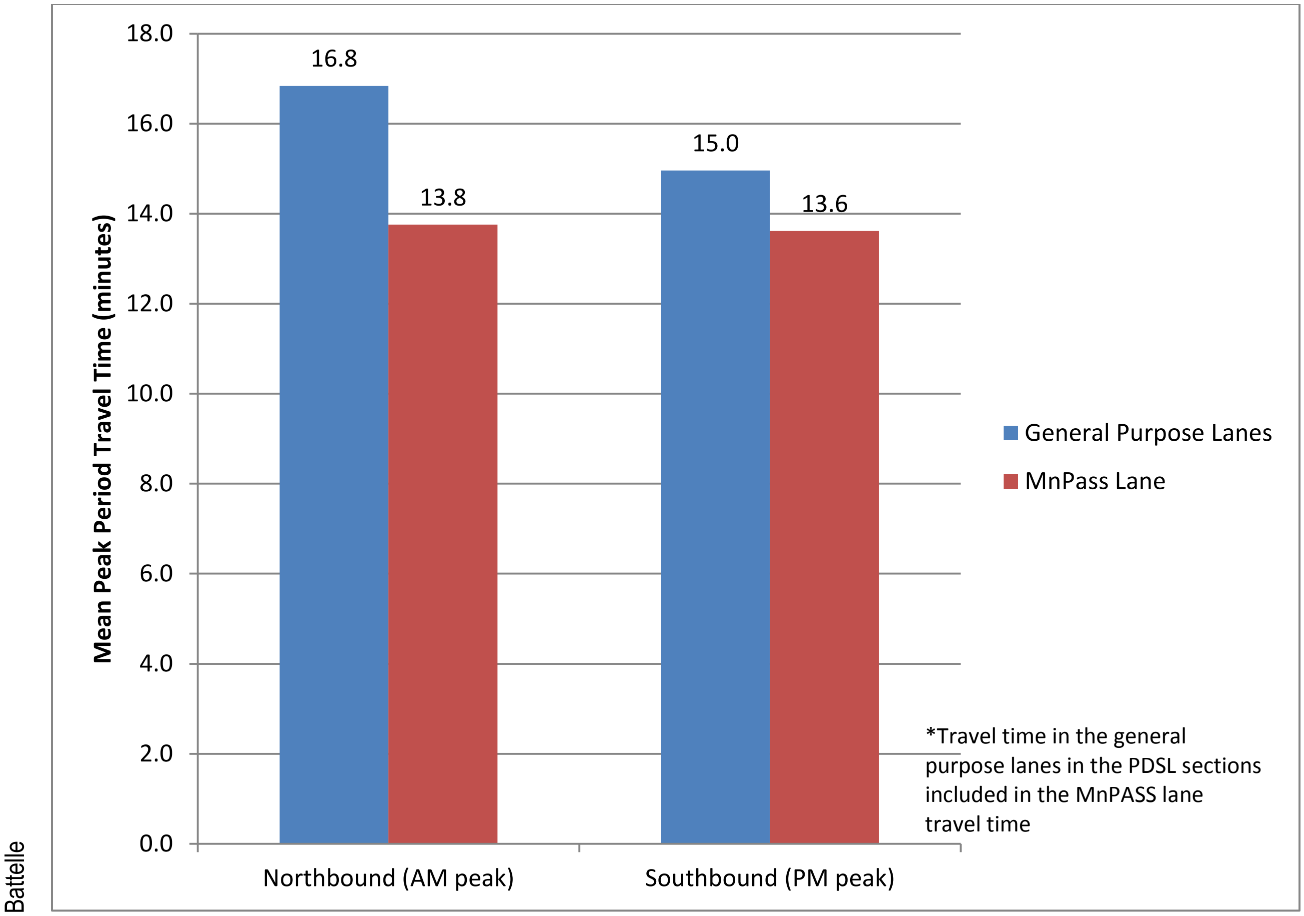

Figure A-5. Comparison of Mean Peak-Period Travel Time through the UPA Corridor Using the General-Purpose and MnPASS Lanes Aggregated across Seasons

A.3.2 Segment Travel Times

Table A-6 and Table A-7 presents the mean peak-period travel times for the general-purpose freeway lanes, and the MnPASS lane for each of the three corridor segments in the peak period, peak direction of travel for the four evaluation seasons. The mean travel times aggregated over all the seasons for each section are also presented. The pre-deployment travel time, the post-deployment travel time, the change, and the percent change are highlighted. Figure A-6 illustrates the pre- and post-deployment mean travel times in the three sections.

Table A-6. Comparison of Pre- and Post-Deployment Mean Peak-Period Travel Time, by Section and Season – Northbound, AM Peak

Section	Season	General-Purpose Lanes				MnPASS Lane			
		Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change
HOT	Fall	9.1	8.2	-0.9	-9%	6.7	5.7	-1.0	-15%
	Winter	9.7	8.9	-0.8	-8%	5.8	6.1	0.3	6%
	Spring	6.9	8.4	1.5	22%	6.6	6.0	0.6	-10%
	Summer	-	7.7	-	-	-	6.1	-	-
	All Seasons	**8.6**	**8.3**	**-0.3**	**-3%**	**6.4**	**6.0**	**-0.4**	**-6%**
Crosstown Commons	Fall	10.0	6.2	-3.9	-38%	-	5.5	-	-
	Winter	9.4	6.2	-3.2	-34%	-	5.7	-	-
	Spring	6.2	5.9	-0.32	-5%	-	5.5	-	-
	Summer	-	5.8	-	-	-	5.7	-	-
	All Seasons	**8.5**	**6.0**	**-2.5**	**-30%**	**-**	**5.6**	**-**	**-**
PDSL	Fall	1.8	2.7	0.9	52%	-	2.2	-	-
	Winter	1.9	2.6	0.7	40%	-	2.3	-	-
	Spring	1.9	2.5	0.7	36%	-	2.2	-	-
	Summer	-	2.4	-	-	-	2.1	-	-
	All Seasons	**1.8**	**2.5**	**0.7**	**39%**	**-**	**2.2**	**-**	**-**
All Sections	Fall	20.8	17.0	-3.8	-18%	-	13.4	-	-
	Winter	21.0	17.7	-3.3	-16%	-	14.0	-	-
	Spring	14.9	16.8	1.9	13%	-	13.7	-	-
	Summer	-	15.9	-	-	-	13.8	-	-
	All Seasons	**18.9**	**16.8**	**-2.1**	**-11%**	**-**	**13.8**	**-**	**-**

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Table A-7. Comparison of Pre- and Post-Deployment Mean Peak-Period Travel Time, by Section and Season – Southbound, PM Peak

Section	Season	General-Purpose Lanes				MnPASS Lane			
		Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change
HOT	Fall	7.5	7.6	0.1	0%	6.6	6.0	-0.6	-10%
	Winter	8.7	7.5	-1.2	-14%	7.2	6.4	-0.8	-12%
	Spring	6.7	6.6	-0.1	-1%	6.6	5.7	-0.9	-14%
	Summer	-	9.3	-	-	-	6.9	-	-
	All Seasons	**7.6**	**7.7**	**0.10**	**1%**	**6.8**	**6.2**	**-0.6**	**-9%**
Crosstown Commons	Fall	7.3	5.1	-2.2	-31%	-	5.2	-	-
	Winter	7.3	5.6	-1.7	-23%	-	6.0	-	-
	Spring	6.4	5.0	-1.4	-22%	-	5.2	-	-
	Summer	-	5.2	-	-	-	5.0	-	-
	All Seasons	**7.0**	**5.2**	**-1.8**	**-25%**	**-**	**5.4**	**-**	**-**
PDSL	Fall	3.9	2.0	-1.9	-47%	-	-	-	-
	Winter	4.5	2.2	-2.3	-31%	-	-	-	-
	Spring	3.0	2.0	-1.0	-22%	-	-	-	-
	Summer	-	2.0	-	-	-	-	-	-
	All Seasons	**3.8**	**2.0**	**-1.8**	**-25%**	**-**	**-**	**-**	**-**
All Sections	Fall	18.8	14.6	-2.5	-14%	-	11.2	-	-
	Winter	20.4	15.2	-3.4	-17%	-	12.4	-	-
	Spring	16.1	13.6			-	11.0	-	-
	Summer	-	16.5			-	11.9	-	-
	All Seasons	**18.4**	**15.0**	**-3.5**	**-19%**	**-**	**11.6**	**-**	**-**

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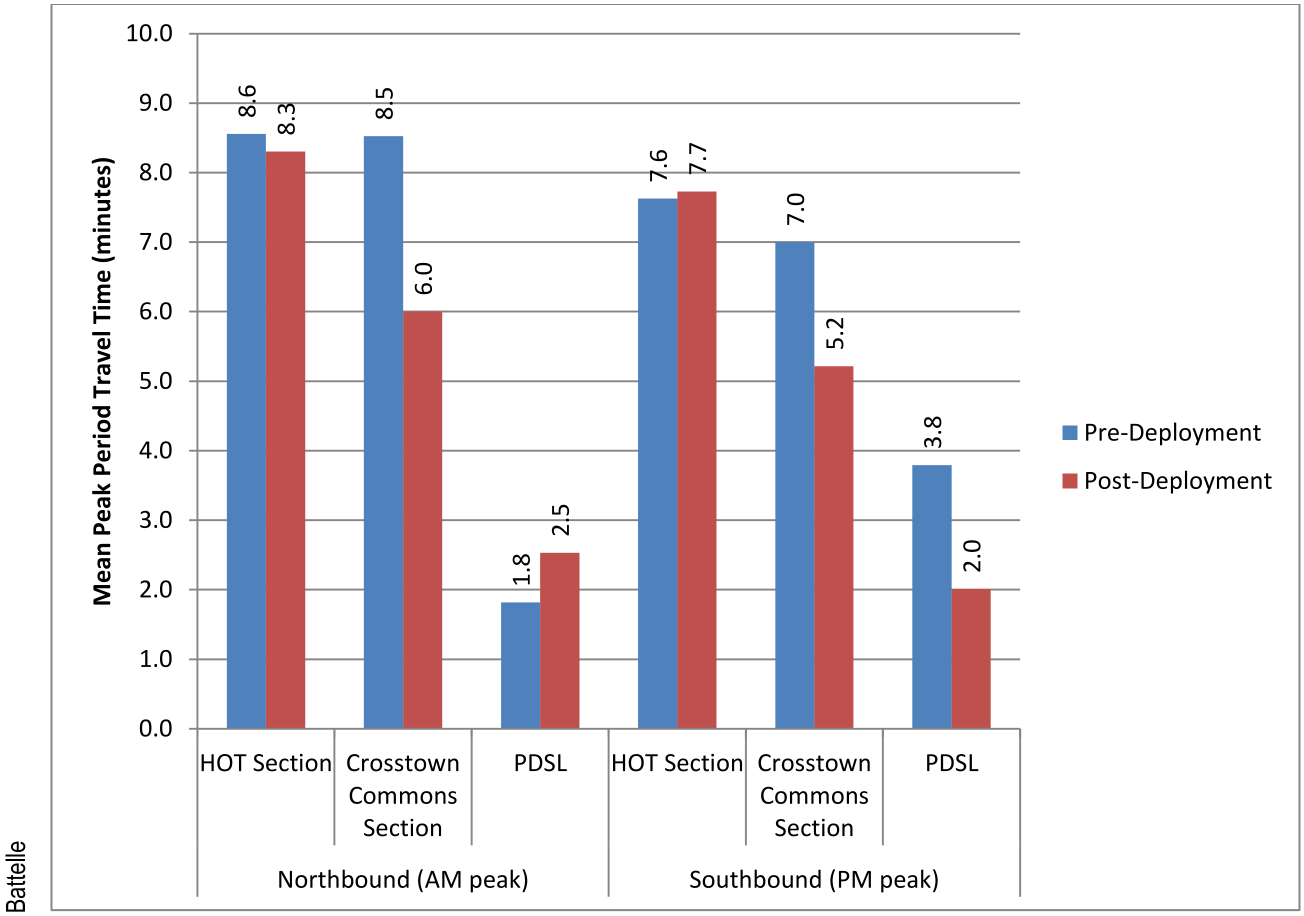

Figure A-6. Pre- and Post-Deployment Mean Peak-Period Travel Times in the General-Purpose Lanes by Section Aggregated across Seasons

A.3.2.1 HOT Section

Table A-8 provides a comparison of the mean travel times in the peak direction of travel in general-purpose lanes in the HOT section, while Table A-9 compares mean travel times in the peak direction of travel in the MnPASS lane in the HOT section. Figure A-7 through Figure A-10 shows the mean travel time in the general-purpose lanes and MnPASS lane pre- and post-deployment of the conversion of the HOV lane to HOT operations in the peak direction of travel for each peak period.

Table A-8. Comparison of Mean Travel Times in the General-Purpose Lanes in HOT Section Pre- and Post-Deployment of the UPA Improvements

HOT Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	6.1	5.7	-0.4	-7.4%	0.111	*
6:30	7:00	7.2	7.2	0.0	0.2%	0.109	-
7:00	7:30	9.5	9.9	0.4	3.7%	0.109	*
7:30	8:00	11.7	11.8	0.2	1.4%	0.109	-
8:00	8:30	9.3	9.5	0.3	2.7%	0.109	*
8:30	9:00	7.7	7.8	0.1	0.7%	0.109	-
9:00	9:30	6.7	6.5	-0.2	-3.4%	0.109	*
9:30	10:00	6.5	6.2	-0.4	-6.2%	0.109	*

HOT Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	5.7	5.9	0.2	3.1%	0.113	-
15:30	16:00	6.2	6.6	0.3	4.9%	0.113	*
16:00	16:30	7.6	7.3	-0.3	-3.6%	0.113	*
16:30	17:00	10.2	8.8	-1.3	-15.0%	0.113	*
17:00	17:30	11.3	9.5	-1.9	-19.6%	0.113	*
17:30	18:00	9.4	8.0	-1.4	-17.8%	0.113	*
18:00	18:30	6.4	6.1	-0.2	-3.9%	0.114	*
18:30	19:00	5.8	5.5	-0.3	-5.0%	0.115	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

Table A-9. Comparison of Mean Travel Times in the HOV/HOT Lanes in HOT Section Before and After the UPA Improvements

HOT Section, MnPASS Lane, Northbound, AM Peak

Time Period		Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	5.6	5.8	0.1	2.0%	0.236	-
6:30	7:00	6.0	6.1	0.1	1.0%	0.224	-
7:00	7:30	6.3	6.5	0.2	3.0%	0.223	-
7:30	8:00	6.5	6.6	0.1	2.2%	0.223	-
8:00	8:30	6.2	6.3	0.1	1.6%	0.224	-
8:30	9:00	6.0	6.0	0.0	-0.2%	0.229	-
9:00	9:30	5.9	5.8	-0.2	-2.6%	0.233	-
9:30	10:00	5.8	5.6	-0.2	-3.5%	0.240	-

HOT Section, MnPASS, Southbound, PM Peak

Time Period		Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	5.9	5.6	-0.4	-6.6%	0.043	*
15:30	16:00	6.1	5.8	-0.3	-4.4%	0.040	*
16:00	16:30	6.4	6.1	-0.3	-5.0%	0.038	*
16:30	17:00	6.8	6.4	-0.4	-6.4%	0.038	*
17:00	17:30	7.0	6.5	-0.5	-8.2%	0.038	*
17:30	18:00	6.9	6.2	-0.7	-11.0%	0.038	*
18:00	18:30	6.9	5.8	-1.1	-18.5%	0.041	*
18:30	19:00	6.4	5.5	-0.9	-16.1%	0.043	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

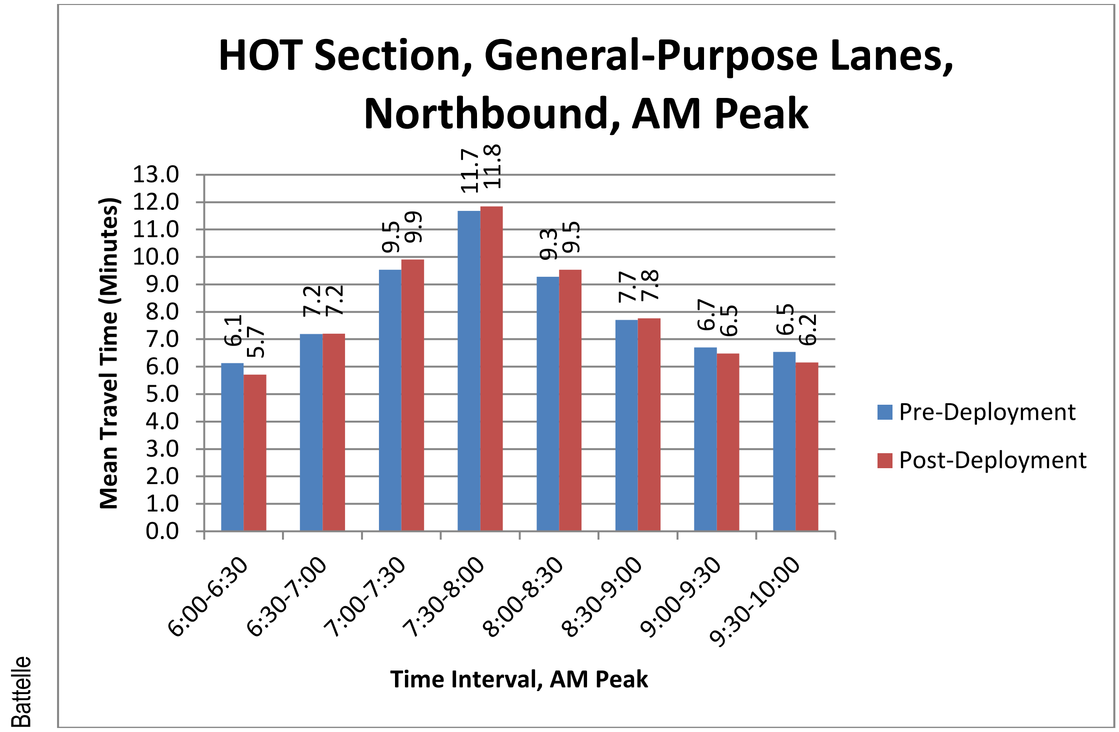

Figure A-7. Pre- and Post-Deployment Mean Travel Times in the General-Purpose Lanes of the HOT Section in the Northbound Direction during the AM Peak

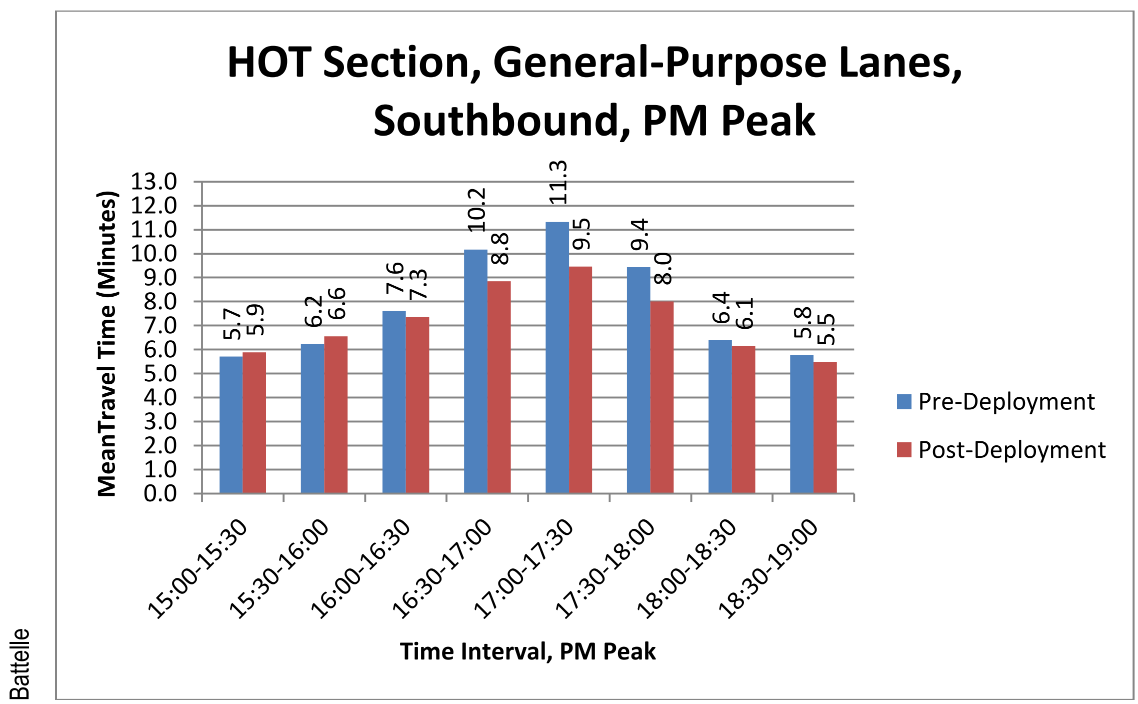

Figure A-8. Pre- and Post-Deployment Mean Travel Times in the General-Purpose Lanes of the HOT Section in the Southbound Direction during the PM Peak

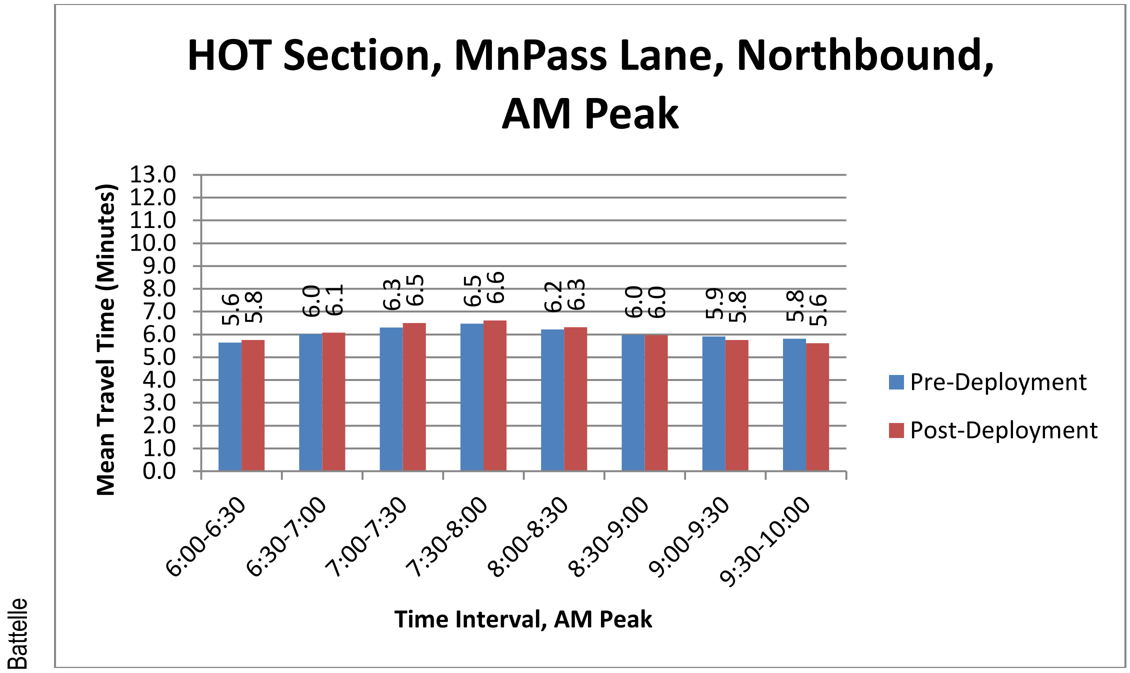

Figure A-9. Pre- and Post-Deployment Travel Times in the MnPASS Lanes of the HOT Section in the Northbound Direction during the AM Peak

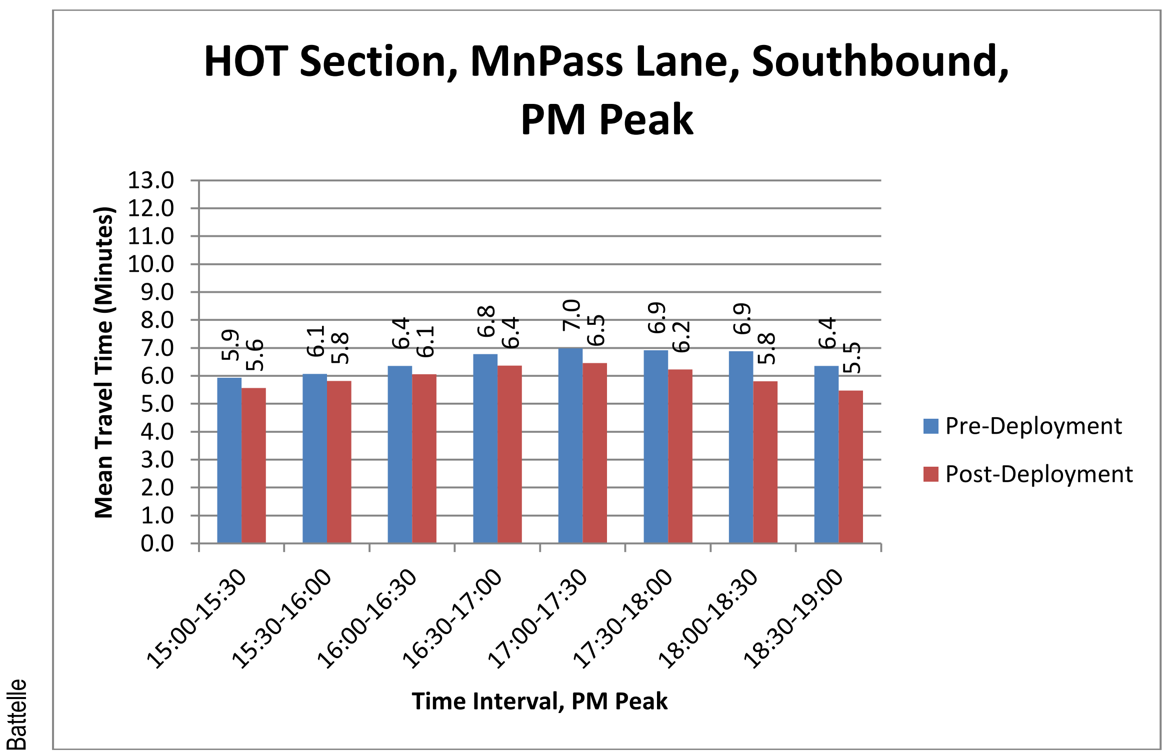

Figure A-10. Pre- and Post-Deployment Mean Travel Times in the MnPASS Lane of the HOT Section in the Southbound Direction during the PM Peak

The analysis shows that the mean travel time in the general-purpose lanes increased slightly in this section of the I-35W South UPA corridor during the heart of the AM peak (from 6:30 a.m. to 9:00 a.m.) after HOT operations began in this section. While some of these increases were statistically significant, the actual differences in mean travel time were relatively small (less than 0.5 minutes); and therefore, most likely to be unperceivable to motorists using the general-purpose lanes in this section of I-35W South in the AM peak.

In the PM peak, however, the analysis showed that the mean travel time in the general-purpose lanes in this sections of I-35W South declined significantly during the PM peak after the UPA improvements were complete, particularly during the heart of the PM peak period (between 4:30 p.m. and 6:00 p.m.). During these time intervals, expected travel times in the southbound direction in this section of I-35W South decreased by 1-to-2 minutes. This represents a 15-to-20 percent reduction in southbound travel times during the PM peak.

The analysis also showed that converting the HOV lanes to HOT operations in this section had little impact on the expected travel time in the MnPASS lane. For the most part, northbound travel times in the MnPASS lanes during the AM peak remained the same (at approximately six minutes) after the conversion to HOT operations as before. Southbound MnPASS travel times in the PM peak improved slightly during the after period, with the biggest improvement occurring between 6:00 p.m. and 7:00 p.m.

A.3.2.2 Crosstown Commons Section

Table A-10 shows the expected travel time in the general-purpose lanes in the Crosstown Commons section for the peak directions of travel (i.e., northbound in the AM peak and southbound in the PM peak, respectively). Figure A-11 and Figure A-12 show the pre- and post-deployment travel times in the Crosstown Commons section for both peak direction of travel.

The table and figures show significant reductions in general-purpose travel times occurred during the post-deployment evaluation period in both peak periods. In the morning peak, expected travel times in the general-purpose lanes improved by almost five minutes during the peak of the AM peak period (from 7:30 a.m. to 9:00 a.m.). Similarly, travel times in the general-purpose lanes during the PM peak improved by more than two minutes in the southbound direction. These changes are most likely due to completion of the Crosstown Commons construction project, which included the new UPA MnPASS lane and the new general-purpose freeway lanes in each direction of travel.

Table A-10. Comparison of Mean Travel Times in the General-Purpose Lanes in Crosstown Commons Section Pre- and Post-Deployment of the UPA Improvements

Crosstown Commons Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Mean Travel Time (minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	6.3	5.0	-1.3	-26%	0.416	*
6:30	7:00	7.0	5.0	-2.0	-40%	0.391	*
7:00	7:30	7.9	5.1	-2.8	-54%	0.388	*
7:30	8:00	11.4	6.7	-4.7	-71%	0.392	*
8:00	8:30	11.8	7.2	-4.6	-64%	0.390	*
8:30	9:00	11.4	6.5	-4.9	-76%	0.387	*
9:00	9:30	8.9	5.5	-3.4	-63%	0.372	*
9:30	10:00	7.7	5.3	-2.4	-46%	0.370	*

Crosstown Commons Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	6.5	4.9	-1.6	-32%	0.038	*
15:30	16:00	6.9	5.1	-1.8	-36%	0.038	*
16:00	16:30	7.1	5.2	-1.9	-37%	0.038	*
16:30	17:00	7.3	5.5	-1.8	-32%	0.038	*
17:00	17:30	7.3	5.5	-1.8	-32%	0.038	*
17:30	18:00	7.3	5.2	-2.1	-40%	0.038	*
18:00	18:30	6.7	4.8	-1.9	-40%	0.038	*
18:30	19:00	6.0	4.7	-1.3	-28%	0.038	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

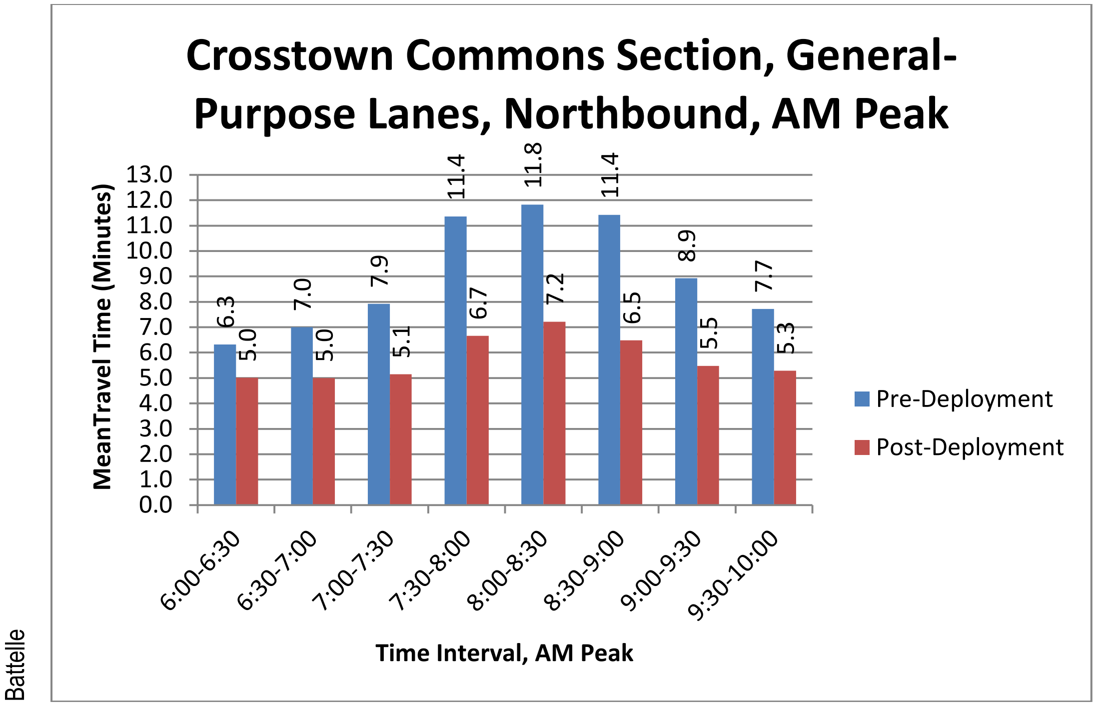

Figure A-11. Pre- and Post-Deployment Mean Travel Times in the General-Purpose Lanes of the Crosstown Commons Section in the Northbound Direction during the AM Peak

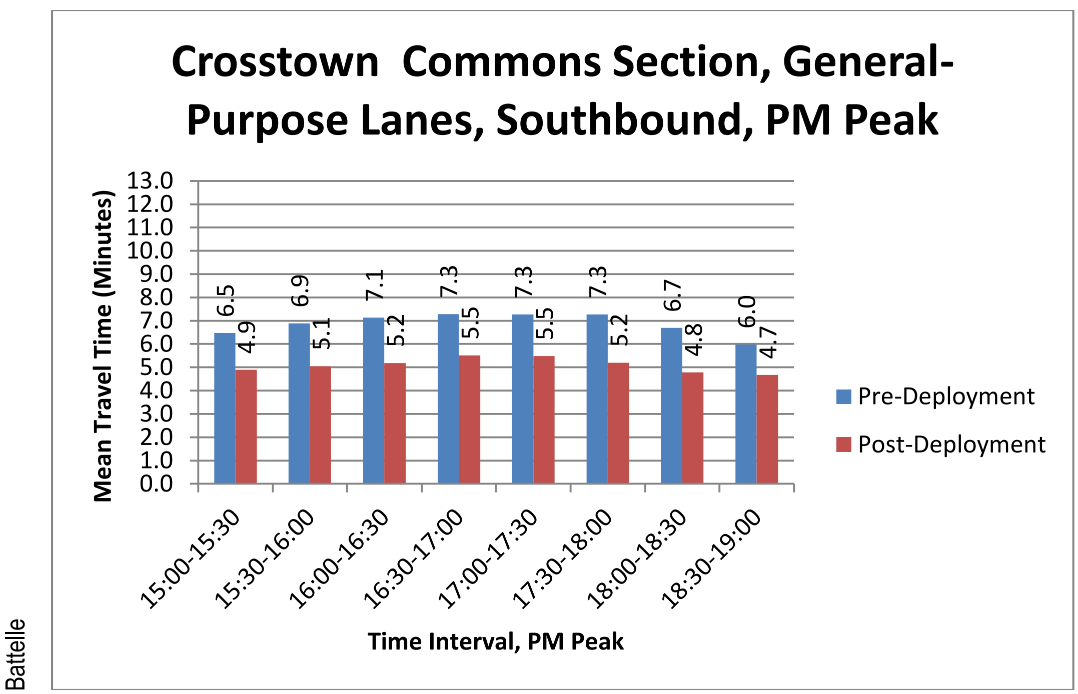

Figure A-12. Pre- and Post-Deployment Mean Travel Times in the General-Purpose Lanes of the Crosstown Commons Section in the Southbound Direction during the PM Peak

A.3.2.3 Price Dynamic Shoulder Lane (PDSL) Section

Table A-11 shows the expected travel time in the general-purpose lanes in the PDSL section for the peak directions of travel (i.e., northbound in the AM peak and southbound in the PM peak, respectively). Figure A-13 and Figure A-14 show the pre- and post-deployment expected travel times in the PDSL section for both peak directions of travel.

Table A-11. Comparison of Mean Travel Times in the General-Purpose Lanes in the PDSL Section Pre- and Post-Deployment of the UPA Improvements

PDSL Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Expected Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	1.7	1.9	0.2	8.3%	0.388	-
6:30	7:00	1.7	1.9	0.2	10.3%	0.388	-
7:00	7:30	1.7	2.1	0.3	15.6%	0.388	-
7:30	8:00	1.6	3.2	1.6	49.6%	0.388	*
8:00	8:30	1.7	3.1	1.4	45.4%	0.388	*
8:30	9:00	1.8	2.9	1.1	38.5%	0.388	*
9:00	9:30	1.8	2.4	0.6	24.5%	0.388	-
9:30	10:00	1.8	2.1	0.3	14.7%	0.388	-

PDSL Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Expected Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Time	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	3.2	1.8	-1.4	-79.6%	0.042	*
15:30	16:00	3.9	1.8	-2.0	-110.8%	0.041	*
16:00	16:30	4.2	1.9	-2.3	-119.1%	0.041	*
16:30	17:00	4.5	2.1	-2.4	-115.8%	0.041	*
17:00	17:30	4.4	2.3	-2.1	-92.5%	0.041	*
17:30	18:00	4.1	2.2	-1.9	-83.9%	0.041	*
18:00	18:30	3.0	2.0	-1.0	-53.1%	0.041	*
18:30	19:00	2.3	1.8	-0.5	-29.9%	0.044	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

Figure A-13 shows that northbound travel time in the PDSL section actually became worse during the heart of the AM peak (from 7:30 a.m. to 9:00 a.m.) in the post-deployment evaluation, increasing from less than two minutes to approximately three minutes in the post-deployment period. This suggests that, in the pre-deployment period, construction in the Crosstown Commons section may have been metering demand to this downstream segment of I-35W South. With the construction project complete, traffic demands are no longer constrained in the Crosstown Commons section, so it can flow more smoothly into the PDSL section, where this traffic hits a new bottleneck downstream of the PDSL traffic. Congestion from this new bottleneck then backs up into the PDSL section causing travel times to increase during the heaviest portion of the morning peak.

As shown in Figure A-14, southbound expected travel times improved significantly in the PDSL section in the PM peak in the post-deployment of the UPA improvements. Mean travel times decreased by approximately two minutes throughout the PM peak. The improvement in mean travel times in the PM peak in the southbound direction can be directly attributed to the completion of the Crosstown Commons widening project.

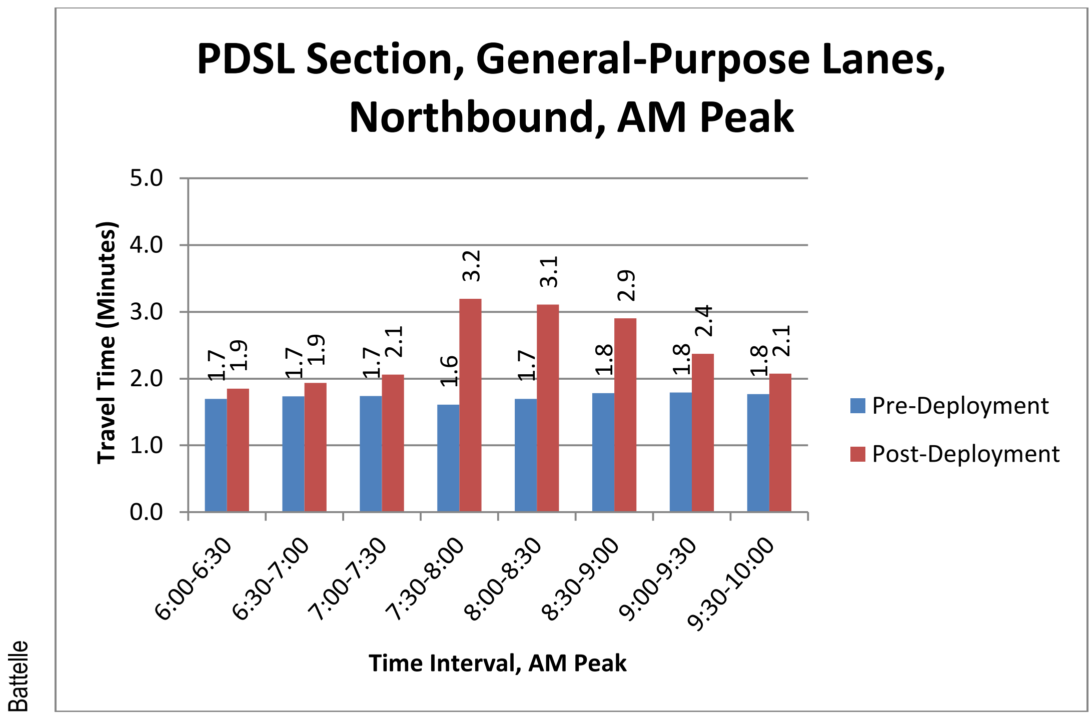

Figure A-13. Pre- and Post-Deployment Travel Times in the General-Purpose Lanes in the PDSL Section in the Northbound Direction during the AM Peak

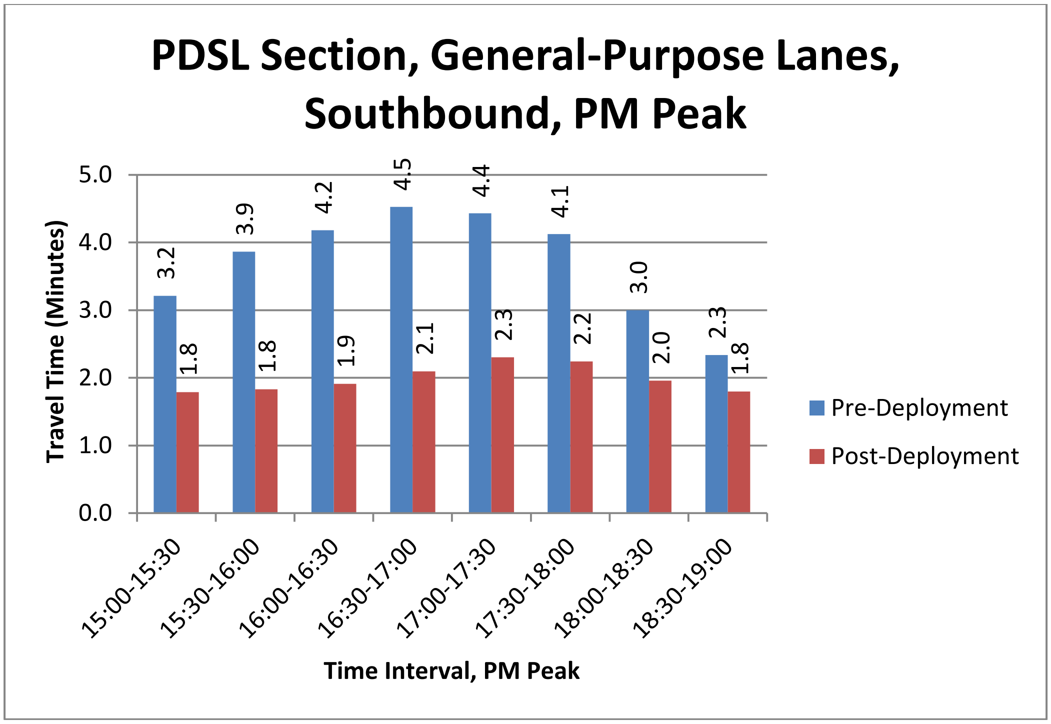

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Figure A-14. Pre- and Post-Deployment Travel Times in the General-Purpose Lanes in the PDSL Section in the Southbound Direction during the PM Peak

A.4 Travel Time Variability

The 95th percentile travel time and the Buffer Index are often used as measures of travel reliability. The 95th percentile travel time represents the worst travel time that a traveler would expect to experience during the "heaviest" traffic day. The Buffer Index represents the extra time, or time cushion, travelers need to add to their average trip time to ensure an on time arrival. An increase in the 95th percentile travel time or the Buffer Index indicates that travel time in a corridor has become less reliable, while a decrease in these values signify an improvement in travel time reliability.

A.4.1 95th Percentile Travel Times

Table A-12 and Figure A-15 show how the 95th percentile corridor travel times changed pre- and post-deployment by season. The table shows a reduction of approximately 17 percent and 27 percent in the 95th percentile travel times for trips using the entire corridor during the AM and PM peaks respectively. This suggests that travel time reliability improved substantially during the post- deployment evaluation period.

Table A-12. Changes in 95th Percentile Corridor Travel Time for the General-Purpose Lanes on I-35W South in the UPA Improvement Corridor by Season

Direction	Season	95th Percentile Travel Time (minutes) General-Purpose Lanes			
		Pre-Deployment	Post-Deployment	Change in 95th Percentile Travel Time	Percent Change
Northbound (AM Peak)	Fall	28.4	23.8	-4.6	-16%
	Winter	35.8	30.3	-5.6	-16%
	Spring	27.0	24.5	-2.5	-9%
	Summer	-	22.5	-	-
	All Seasons	**30.4**	**25.2**	**-5.2**	**-17%**
Southbound (PM Peak)	Fall	28.0	22.1	-5.9	-21%
	Winter	40.9	25.3	-15.5	-38%
	Spring	20.9	18.0	-2.9	-14%
	Summer	-	21.8	-	-
	All Seasons	**29.9**	**21.8**	**-8.1**	**-27%**

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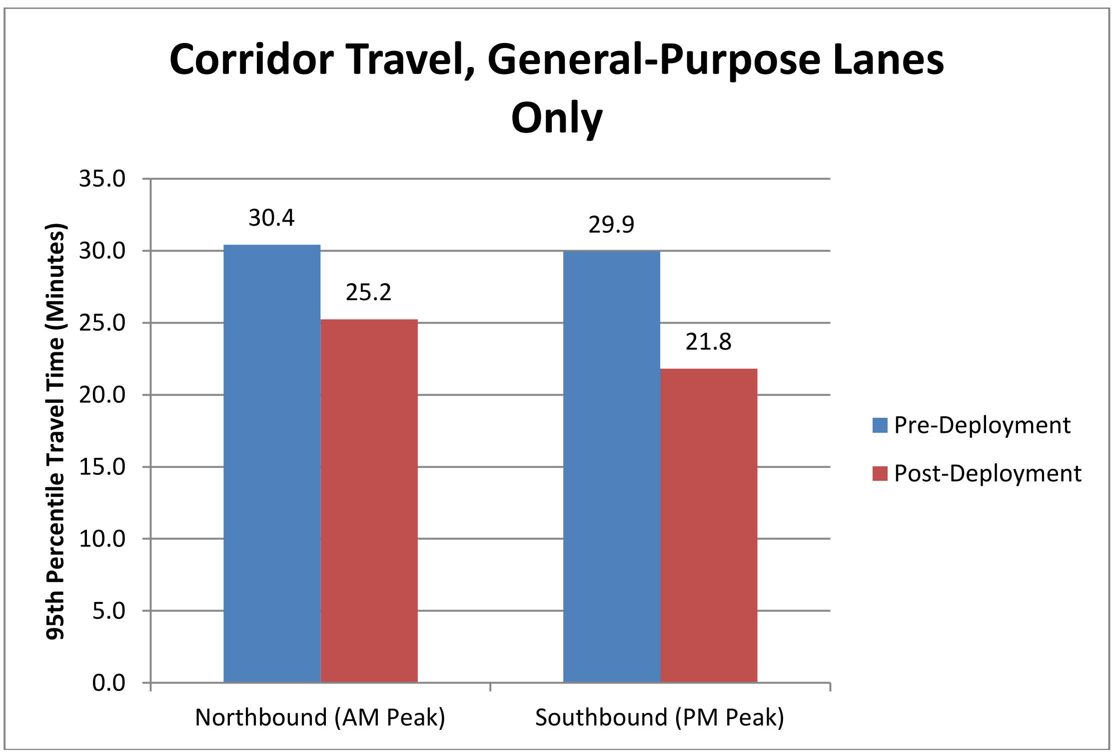

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Figure A-15. Comparison of Corridor 95th Percentile Travel Time in the General-Purpose Lanes on I-35W South – Pre- and Post-Deployment of the UPA Minneapolis Improvements Aggregated across Seasons

Table A-13 and Table A-14 presents the 95th percentile peak-period travel time for each section of I-35W South by season in the AM and PM peak, respectively. Figure A-16 provides a graphical comparison of the pre-and post-deployment 95th percentile travel times for each section, aggregated across all seasons.

The tables and figure show similar trends in the 95th percentile travel times to those described previously for the mean travel times. In the general-purpose lanes in the HOT section, the 95th percentile travel time dropped approximately 20 percent in the fall and winter months in the northbound direction in the morning peak period. An increase in the 95th percentile travel time occurred during the spring post-deployment period, however.

In the southbound direction, the 95th percentile travel time decreased by almost four minutes in the PDSL section and by almost three minutes in the Crosstown Commons section in the afternoon peak period. A reduction of over five minutes in the 95th percentile travel times was also observed for the Crosstown Commons section in the morning peak period northbound direction. In the northbound direction in the morning peak, the 95th percentile travel time in the general-purpose lanes increased by approximately two minutes in the PDSL section.

Table A-13. Comparison of Pre- and Post-Deployment 95th Percentile Travel Time by Section and Season – Northbound, AM Peak

Section	Season	95th Percentile Travel Time (Minutes)							
		General-Purpose Lanes				MnPASS Lane			
		Pre- Deployment	Post- Deployment	Change in 95th Percentile	Percent Change	Pre- Deployment	Post- Deployment	Change in 95th Percentile	Percent Change
HOT	Fall	14.0	11.5	-2.5	-18%	7.5	6.6	-0.9	-12%
	Winter	19.7	16.0	-3.7	-19%	10.4	8.4	-1.9	-19%
	Spring	9.9	13.0	3.2	32%	6.5	7.0	0.5	8%
	Summer	-	10.1	-	-	-	6.5	-	-
	All Seasons	**14.5**	**12.7**	**-1.8**	**-13%**	**8.1**	**7.1**	**-1.0**	**-12%**
Crosstown Commons	Fall	12.5	8.4	-4.2	-33%	-	6.1	-	-
	Winter	13.9	9.4	-4.5	-32%	-	6.8	-	-
	Spring	14.7	7.8	-6.9	-47%	-	6.1	-	-
	Summer	-	7.7	-	-	-	5.9	-	-
	All Seasons	**13.7**	**8.3**	**-5.4**	**-39%**		**6.2**		
PDSL	Fall	1.9	3.9	2.0	106%	-	2.7	-	-
	Winter	2.2	4.8	2.6	115%	-	3.1	-	-
	Spring	2.5	3.7	1.2	50%	-	2.8	-	-
	Summer	-	3.7	-	-	-	2.6	-	-
	All Seasons	**2.2**	**4.0**	**1.8**	**83%**	**-**	**2.8**	**-**	**-**

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Table A-14. Comparison of Pre- and Post-Deployment 95th Percentile Travel Time by Section and Season – Southbound, PM Peak

Section	Season	95th Percentile Travel Time (Minutes)							
		General-Purpose Lanes				MnPASS Lane			
		Pre-Deployment	Post-Deployment	Change in 95th Percentile	Percent Change	Pre-Deployment	Post-Deployment	Change in 95th Percentile	Percent Change
HOT	Fall	11.3	13.6	2.4	21%	7.5	7.0	-0.4	-6%
	Winter	21.3	14.0	-7.3	-34%	12.8	9.0	-3.8	-30%
	Spring	9.0	9.3	0.3	4%	7.4	6.3	-1.1	-15%
	Summer	-	12.5	-	-	-	7.1		
	All Seasons	**13.8**	**12.4**	**-1.5**	**-11%**	**9.2**	**7.3**	**-1.8**	**-20%**
Crosstown Commons	Fall	10.0	5.9	-4.1	-41%	-	5.5	-	-
	Winter	11.6	8.2	-3.4	-29%	-	7.6	-	-
	Spring	7.1	6.2	-0.9	-13%	-	5.6	-	-
	Summer	-	6.4	-	-	-	5.5	-	-
	All Seasons	**9.6**	**6.8**	**-2.8**	**-29%**	**-**	**6.2**	**-**	**-**
PDSL	Fall	6.8	2.5	-4.2	-63%	-	-	-	-
	Winter	8.1	3.2	-4.9	-61%	-	-	-	-
	Spring	4.8	2.5	-2.3	-48%	-	-	-	-
	Summer	-	2.6	-	-	-	-	-	-
	All Seasons	**6.5**	**2.7**	**-3.8**	**-58%**	**-**	**-**	**-**	**-**

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In the PM peak, the 95th percentile travel time for traffic traveling in the general-purpose lane in the southbound direction also improved substantially. In the PDSL section, the 95th percentile travel times improved by approximately four minutes, a 58 percent reduction. The 95th percentile travel times in the Crosstown Commons section and the HOT lane sections also reduced substantially. This suggests that travel time reliability has improved substantially in the post-deployment period.

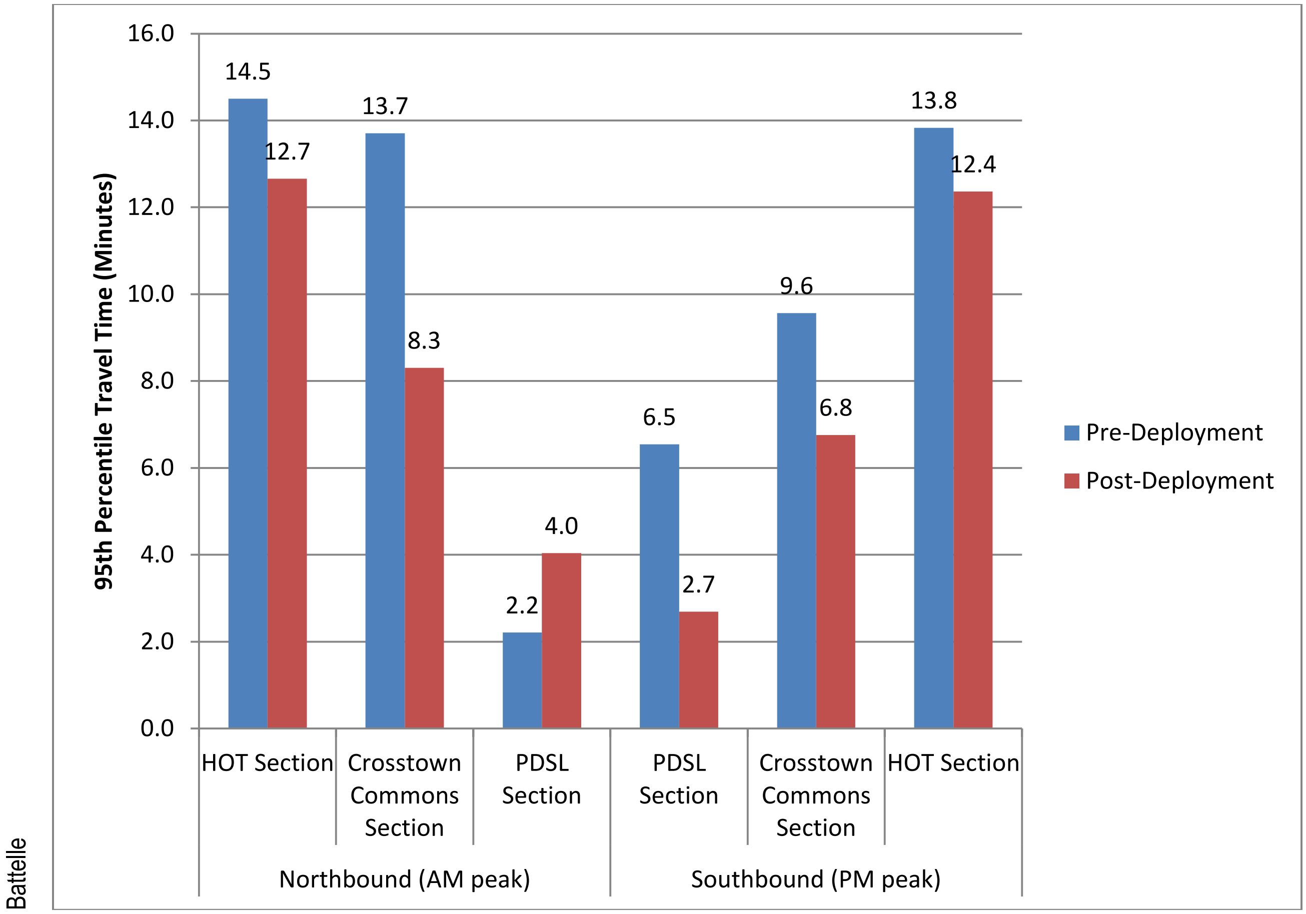

Figure A-16. Pre- and Post-Deployment Peak-Period 95th Percentile Travel Times in the General-Purpose Lanes by Section Aggregated across Seasons

A.4.2 Buffer Index

Table A-15 and Table A-16 present the pre- and post-deployment changes in the Buffer Index. Overall, the buffer index for the HOV lanes, MnPASS HOT lanes, and PDSL is more stable than the buffer index for the general-purpose freeway lanes. This trend supports the argument that HOV, HOT, and PDSL lanes provide a more consistent trip.

Table A-15. Comparison of Pre- and Post-Deployment Buffer Index in Each UPA Section by Season – Northbound, AM Peak

Section	Season	Buffer Index							
		General-Purpose Lanes				MnPASS Lane			
		Pre-Deployment	Post-Deployment	Change in Buffer Index	Percent Change	Pre-Deployment	Post-Deployment	Change in Buffer Index	Percent Change
HOT	Fall	0.7	0.5	-0.2	-27%	0.3	0.1	-0.2	-63%
	Winter	1.6	1.2	-0.5	-28%	0.8	0.4	-0.4	-50%
	Spring	0.6	0.8	0.2	35%	0.2	0.2	0.0	25%
	Summer	-	0.4	-	-	-	0.1	-	-
	All Seasons	**1.0**	**0.7**	**-0.3**	**-27%**	**0.4**	**0.2**	**-0.21**	**-53%**
Crosstown Commons	Fall	0.5	0.5	0.0	2%	-	0.1	-	-
	Winter	0.5	0.7	0.2	38%	-	0.2	-	-
	Spring	0.7	0.4	-0.3	-42%	-	0.1	-	-
	Summer		0.4	-	-	-	0.1	-	-
	All Seasons	**0.6**	**0.5**	**-0.1**	**-11%**	**-**	**0.2**	**-**	**-**
PDSL	Fall	0.1	0.6	0.5	493%	-	0.2	-	-
	Winter	0.3	1.2	0.9	343%	-	0.4	-	-
	Spring	0.5	0.7	0.2	37%	-	0.2	-	-
	Summer		0.8	-	-	-	0.2	-	-
	All Seasons	**0.3**	**0.8**	**0.5**	**184%**	**-**	**0.3**	**-**	**-**

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Table A-16. Comparison of Pre- and Post-Deployment Buffer Index in Each UPA Section by Season – Southbound, PM Peak

Section	Season	Buffer Index							
		General-Purpose Lanes				MnPASS Lane			
		Pre-Deployment	Post-Deployment	Change in Buffer Index	Percent Change	Pre-Deployment	Post-Deployment	Change in Buffer Index	Percent Change
HOT	Fall	0.7	1.3	0.6	85%	0.3	0.3	-0.1	-22%
	Winter	2.9	1.5	-1.3	-47%	1.4	0.7	-0.8	-54%
	Spring	0.6	0.6	0.1	13%	0.2	0.1	-0.1	-33%
	Summer	-	0.9	-	-	-	0.3	-	-
	All Seasons	**1.4**	**1.1**	**-0.3**	**-22%**	**0.7**	**0.3**	**-0.3**	**-50%**
Crosstown Commons	Fall	0.5	0.3	-0.2	-41%	-	0.1	-	-
	Winter	0.7	0.8	0.1	8%	-	0.5	-	-
	Spring	0.2	0.4	0.2	91%	-	0.1	-	-
	Summer	-	0.3	-	-	-	0.1	-	-
	All Seasons	**0.5**	**0.4**	**-0.1**	**-4%**	**-**	**0.2**	**-**	**-**
PDSL	Fall	0.9	0.4	-0.4	-50%	-	-	-	-
	Winter	1.2	0.7	-0.5	-42%	-	-	-	-
	Spring	0.6	0.4	-0.2	-29%	-	-	-	-
	Summer		0.45	-	-	-	-	-	-
	All Seasons	**0.9**	**0.5**	**-0.4**	**-44%**	**-**	**-**	**-**	**-**

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A.5 Travel Speeds

Table A-17 and Table A-18 present information on mean peak travel speeds for the general-purpose freeway lanes, the HOT lanes, and the PDSL by season and section for the combined morning and afternoon peak periods. Figure A-17 shows the mean peak-period travel speed aggregated across all seasons for each section of the UPA deployment corridor.

In the HOT section, mean peak-period travel speeds in the general-purpose lanes and in the HOV and HOT lanes do not appear to be significantly impacted as a result of expanding HOT operations. Mean-peak-period travel speeds in general-purpose lanes changed between the pre- and post-deployment periods in the Crosstown Commons section. This change may be due to the completion of the construction and the opening of the new HOT and general-purpose freeway lanes. Speeds in the PDSL section improved in the southbound direction during the afternoon peak, while speeds in the northbound direction declined in the PDSL section in the morning peak in the post-deployment period.

Table A-17. Comparison of Pre- and Post-Deployment Mean Peak-Period Travel Speeds in Each UPA Section by Season – Northbound, AM Peak

Section	Season	Mean Travel Speeds (mph)							
		General-Purpose Lanes				MnPASS Lane			
		Pre-Deployment	Post-Deployment	Change in Speed	Percent Change	Pre-Deployment	Post-Deployment	Change in Speed	Percent Change
HOT	Fall	50.9	52.4	1.5	3%	66.4	65.7	-0.7	-1%
	Winter	52.4	53.7	1.3	2%	65.5	64.5	-1.0	-2%
	Spring	62.4	54.9	-7.5	-12%	69.7	66.4	-3.3	-5%
	Summer	-	55.3	-	-	-	66.3	-	-
	All Seasons	**55.2**	**54.1**	**-1.2**	**-2%**	**67.2**	**65.7**	**-1.5**	**-2%**
Crosstown Commons	Fall	37.7	55.6	17.9	47%	-	58.4	-	-
	Winter	35.2	54.8	19.6	56%	-	56.9	-	-
	Spring	38.0	57.0	19.0	50%	-	58.4	-	-
	Summer	-	57.5	-	-	-	59.3	-	-
	All Seasons	**37.0**	**56.2**	**19.3**	**52%**	**-**	**58.3**	**-**	**-**
PDSL	Fall	70.3	52.6	-17.7	-25%	-	56.1	-	-
	Winter	68.2	55.3	-12.9	-19%	-	55.7	-	-
	Spring	71.1	56.2	-14.9	-21%	-	56.9	-	-
	Summer	-	58.5	-	-	-	59.4	-	-
	All Seasons	**69.9**	**55.7**	**-14.2**	**-20%**	**-**	**57.0**	**-**	**-**

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Table A-18. Comparison of Pre- and Post-Deployment Mean Peak-Period Travel Speeds in Each UPA Section by Season – Southbound, PM Peak

Section	Season	Mean Travel Speeds (mph)							
		General-Purpose Lanes				MnPASS Lane			
		Pre-Deployment	Post-Deployment	Change in Speed	Percent Change	Pre-Deployment	Post-Deployment	Change in Speed	Percent Change
HOT	Fall	58.6	61.2	2.6	0.0	66.2	67.8	1.6	2%
	Winter	61.4	62.1	0.7	0.0	65.2	66.0	0.8	1%
	Spring	64.1	64.3	0.2	0.0	60.6	68.5	7.9	13%
	Summer	-	57.1	-	-	-	66.2		
	All Seasons	**61.4**	**61.2**	**-0.2**	**0.0**	**64.0**	**67.1**	**3.1**	**5%**
Crosstown Commons	Fall	43.9	62.4	18.5	0.4	-	60.6	-	-
	Winter	45.6	60.5	14.9	0.3	-	58.0	-	-
	Spring	50.6	63.3	12.7	0.3	-	61.0	-	-
	Summer	-	60.5	-	-	-	60.9	-	-
	All Seasons	**46.7**	**61.7**	**15.0**	**0.3**	**-**	**60.1**	**-**	**-**
PDSL	Fall	35.9	64.5	28.6	0.8	-	-	-	-
	Winter	39.3	62.0	22.7	0.6	-	-	-	-
	Spring	47.5	64.8	17.3	0.4	-	-	-	-
	Summer	-	64.6	-	-	-	-	-	-
	All Seasons	**40.9**	**64.0**	**23.1**	**0.6**	**-**	**-**	**-**	**-**

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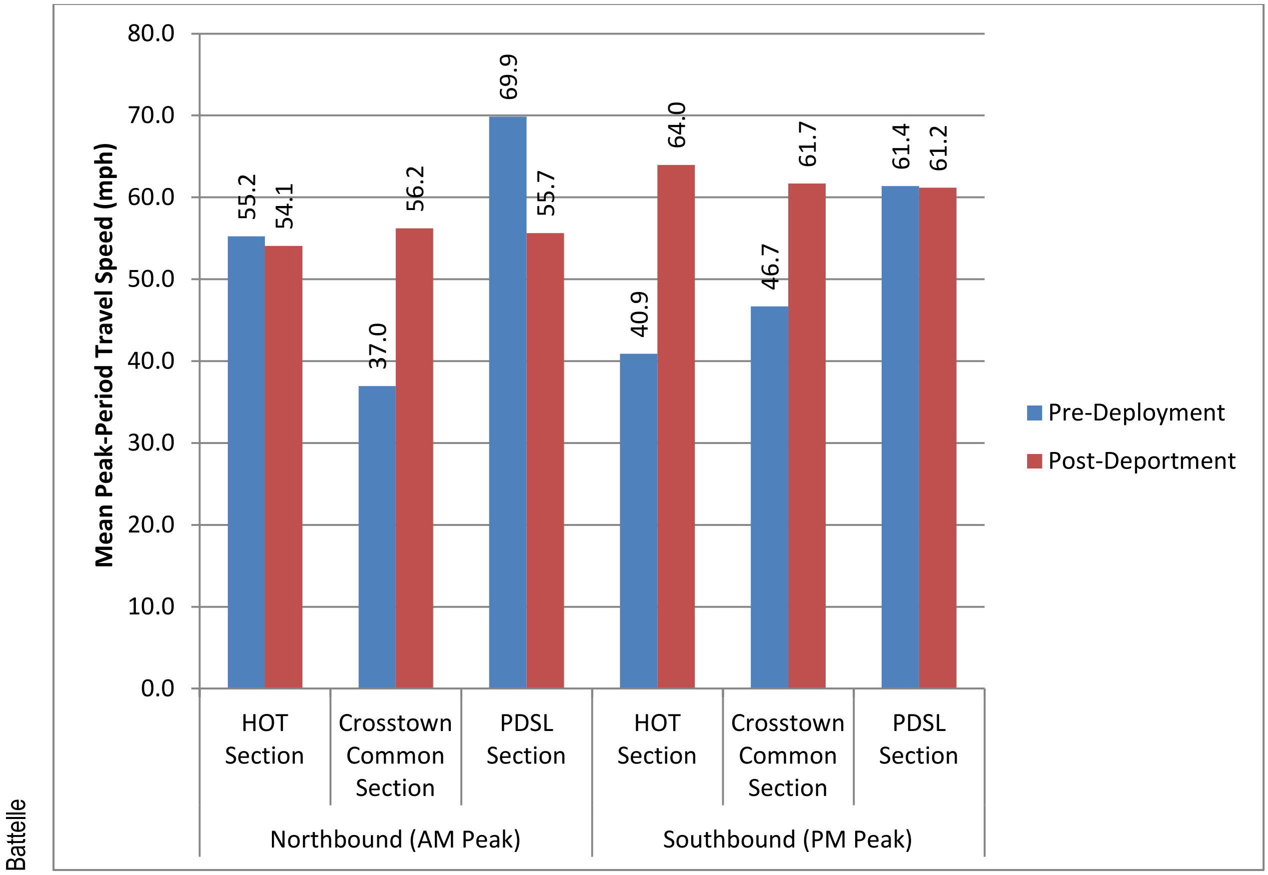

Figure A-17. Pre- and Post-Deployment Peak-Period Mean Travel Speed in the General-Purpose Lanes by Section Aggregated across Seasons

A.5.1 HOT Section

Table A-19 shows a comparison of the peak-period travel speeds for the general-purpose lanes in the peak direction of travel. Table A-20 shows the mean travel speed of traffic using the MnPASS lane in the HOT section of I-35W South. Figure A-18 through Figure A-21 provides a graphical representation of travel speed in both the general-purpose lanes and MnPASS lane in the HOT section for each peak direction of travel. A statistical analysis performed on these travels speeds revealed the following for the HOT section:

- The travel speed on general-purpose lanes in the northbound direction in the AM peak period decreased between 6:30 a.m. and 9:00 a.m. in the post-deployment period. The magnitude of the change was less than 5 mph.
- Between 3:00 p.m. and 5:00 p.m., travel speeds in the general-purpose lanes were slightly less (less than 3 mph) in the post-deployment period than in the pre-deployment period in the HOT section. After 5:30 p.m., travel speeds actually increased between 3 mph and 6 mph in the post-deployment period.

Table A-19. Comparison of Mean Peak-Period Travel Speeds in the General-Purpose Lanes in HOT Section Pre- and Post-Deployment of the UPA Improvements

HOT Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speed	% Change	Standard Error	Statistically Significant Change
6:00	6:30	64.7	69.2	4.5	6.5%	0.470	*
6:30	7:00	57.4	56.6	-0.8	-1.4%	0.464	-
7:00	7:30	46.7	42.0	-4.7	-11.1%	0.463	*
7:30	8:00	37.9	34.9	-3.1	-8.8%	0.464	*
8:00	8:30	48.7	44.6	-4.1	-9.2%	0.464	*
8:30	9:00	55.3	54.2	-1.1	-2.1%	0.464	*
9:00	9:30	60.4	62.2	1.8	2.9%	0.464	*
9:30	10:00	61.2	64.6	3.4	5.3%	0.464	*

HOT Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speed	% Change	Standard Error	Statistically Significant Change
15:00	15:30	68.2	67.4	-0.9	-1.3%	0.474	-
15:30	16:00	63.9	62.7	-1.2	-1.9%	0.475	*
16:00	16:30	55.7	53.8	-1.8	-3.4%	0.475	*
16:30	17:00	44.4	41.4	-3.0	-7.2%	0.475	*
17:00	17:30	39.8	40.0	0.2	0.6%	0.475	-
17:30	18:00	47.8	51.1	3.3	6.5%	0.475	*
18:00	18:30	64.1	70.1	6.0	8.5%	0.477	*
18:30	19:00	68.7	73.8	5.1	6.9%	0.478	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

Table A-20. Comparison of Mean Travel Speeds in the MnPASS Lane in HOT Section Pre- and Post-Deployment of the UPA Improvements

HOT Section, MnPASS Lane, Northbound, AM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speed	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	70.1	68.7	-1.5	-2.1%	0.236	*
6:30	7:00	66.1	65.1	-1.0	-1.5%	0.224	*
7:00	7:30	63.2	60.9	-2.3	-3.8%	0.223	*
7:30	8:00	61.5	59.8	-1.7	-2.8%	0.223	*
8:00	8:30	64.2	62.7	-1.5	-2.4%	0.224	*
8:30	9:00	66.7	66.5	-0.3	-0.4%	0.229	-
9:00	9:30	68.1	68.6	0.5	0.8%	0.233	*
9:30	10:00	68.9	70.4	1.6	2.2%	0.240	*

HOT Section, MnPASS Lane, Southbound, PM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speed	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	66.6	71.1	4.5	6.3%	0.270	*
15:30	16:00	66.5	70.6	4.1	5.8%	0.278	*
16:00	16:30	65.8	69.8	4.0	5.8%	0.279	*
16:30	17:00	64.4	66.9	2.5	3.8%	0.262	*
17:00	17:30	61.7	64.5	2.8	4.3%	0.251	*
17:30	18:00	58.0	61.4	3.4	5.5%	0.248	*
18:00	18:30	56.3	60.6	4.3	7.1%	0.247	*
18:30	19:00	57.4	63.0	5.6	8.9%	0.252	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

While a statistically significant change was detected in mean travel speed on the MnPASS lane in the northbound direction of the AM peak, the change in speeds in the MnPASS lane in this section are not substantial (less than 3 mph). Overall speeds remain relatively high (around 60 mph) both pre- and post-deployment of the UPA projects. A slight speed improvement was detected (at the 95 percent confidence level) after 9:00 a.m. This change could potentially be due to stricter enforcement of single occupant vehicle (SOV) violations in the post-deployment period.

In the PM peak, mean travel speeds in the MnPASS lane remained high (greater than 60 mph) in the post-deployment period. This suggests MnPASS lane in this section of I-35W South has substantial capacity to absorb additional travel demand, even after HOT operations were implemented.

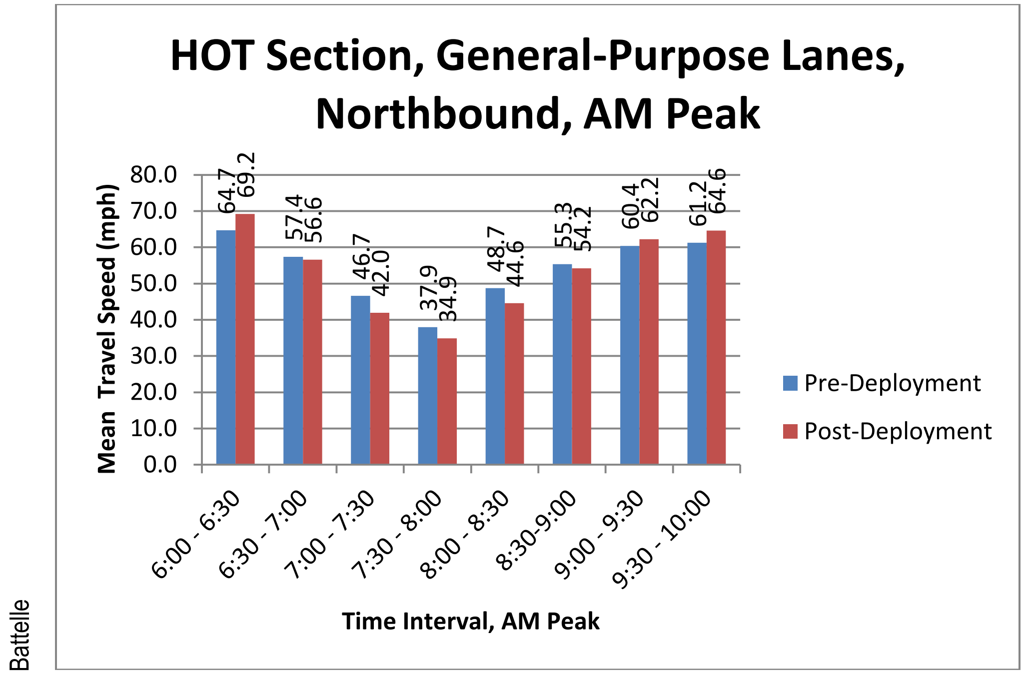

Figure A-18. Pre- and Post-Deployment Mean Travel Speeds in the General-Purpose Lanes of the HOT Section in the Northbound Direction during the AM Peak

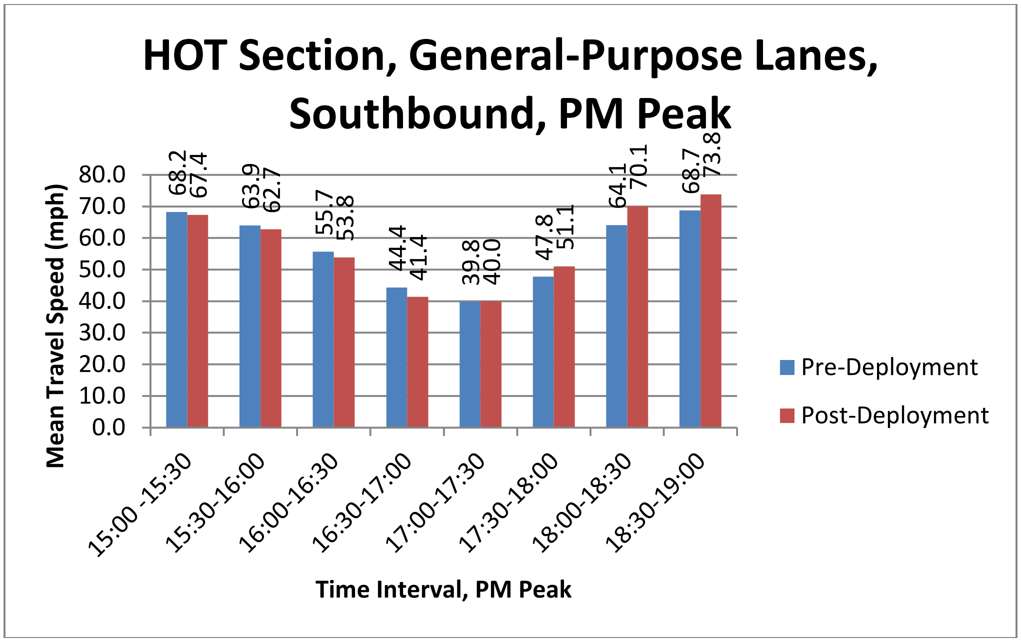

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Figure A-19. Pre- and Post-Deployment Mean Travel Speeds in the General-Purpose Lanes of the HOT Section in the Southbound Direction during the PM Peak

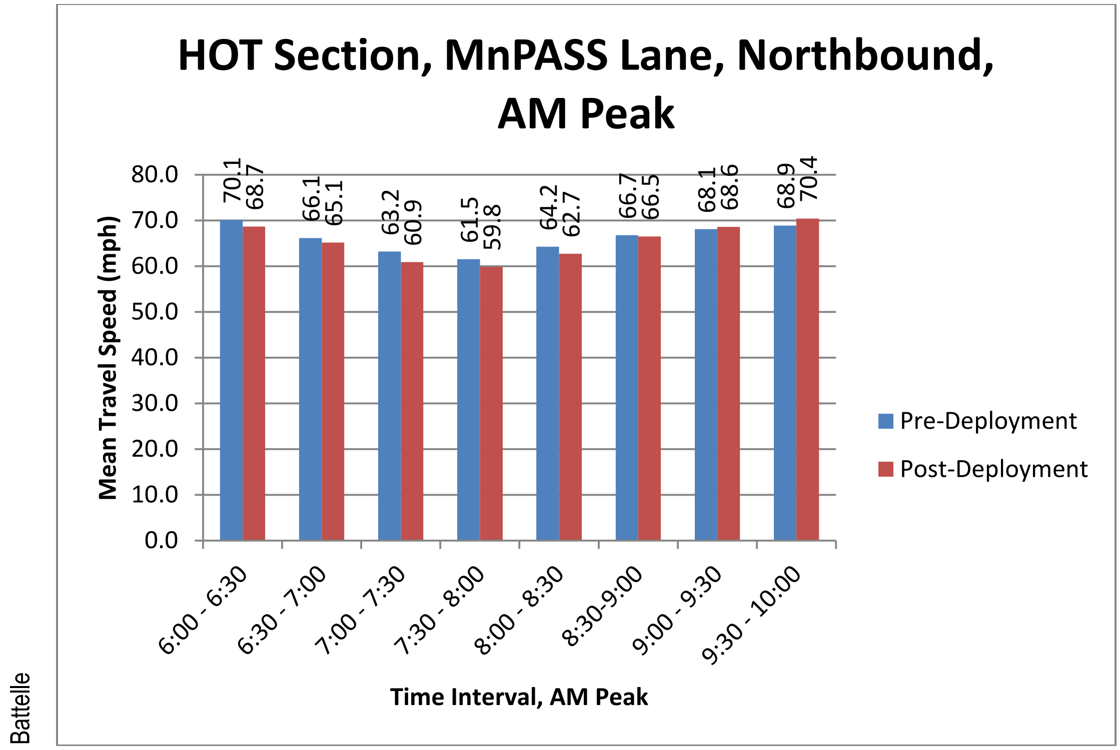

Figure A-20. Pre- and Post-Deployment Mean Travel Speeds in the MnPASS Lane of the HOT Section in the Northbound Direction during the AM Peak

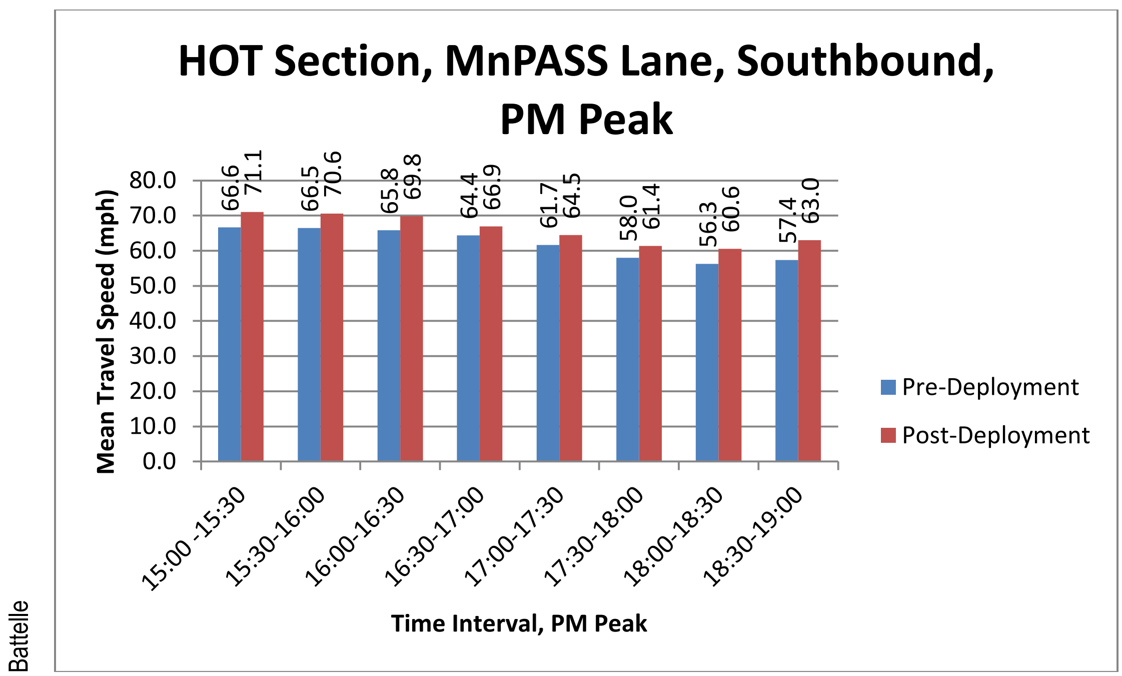

Figure A-21. Pre- and Post-Deployment Mean Travel Speeds in the MnPASS Lane of the HOT Section in the Southbound Direction during the PM Peak

A.5.2 Crosstown Commons Section

Table A-21 shows how mean travel speeds in the Crosstown Commons section varied throughout the peak period in the peak direction of the flow, while Figure A-22 and Figure A-23 show the pre- and post-deployment travel speed for each 30-minute interval in the peak direction of flow.

Table A-21. Comparison of Peak-Period Travel Speeds in the General-Purpose Lanes in Crosstown Commons Section Pre- and Post-Deployment of the UPA Improvements

Crosstown Commons Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speed	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	49.4	61.9	12.5	20.2%	0.416	*
6:30	7:00	44.8	62.0	17.2	27.8%	0.391	*
7:00	7:30	40.6	60.4	19.9	32.9%	0.388	*
7:30	8:00	29.1	48.2	19.1	39.6%	0.392	*
8:00	8:30	27.9	45.4	17.6	38.6%	0.390	*
8:30	9:00	28.7	50.1	21.5	42.8%	0.387	*
9:00	9:30	36.8	57.2	20.4	35.7%	0.372	*
9:30	10:00	41.8	58.7	17.0	28.9%	0.370	*

Crosstown Commons Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speed	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	50.4	61.2	10.8	17.7%	0.275	*
15:30	16:00	48.9	61.9	13.0	21.0%	0.276	*
16:00	16:30	47.7	62.0	14.3	23.0%	0.276	*
16:30	17:00	44.7	60.5	15.7	26.0%	0.277	*
17:00	17:30	43.5	59.1	15.6	26.4%	0.278	*
17:30	18:00	42.4	56.0	13.7	24.4%	0.278	*
18:00	18:30	42.2	56.5	14.3	25.3%	0.278	*
18:30	19:00	42.6	59.1	16.6	28.0%	0.279	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

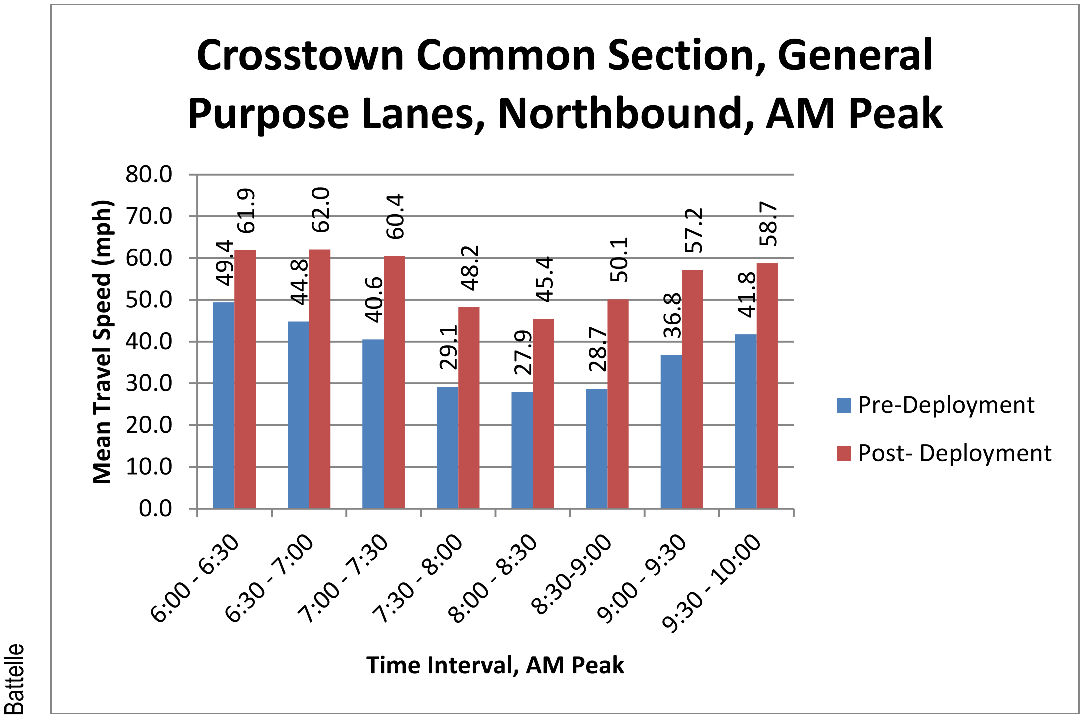

Figure A-22. Pre- and Post-Deployment Average Travel Speeds in the General-Purpose Lanes of the Crosstown Commons Section in the Northbound Direction during the AM Peak

The analysis shows that in the post-deployment period, travels speeds improved significantly in the Crosstown Commons section during the post-deployment period. On average, speeds in the general-purpose lanes in Crosstown Commons section during the AM peak period increased between 13 mph and 22 mph throughout the entire duration of the peak period. Similarly, travel speeds in the southbound direction during the PM peak increased between 10 mph to 15 mph and the difference is statistically significant at the 95 percent confidence level in both directions.

It is important to note, however, that mean travel speeds in the PM peak never dropped below 55 mph in this section during the PM peak during the post-deployment compared to the pre-deployment mean speeds. Prior to the UPA improvements, mean travel speeds in this section of I-35W South were below 45 mph from 4:30 p.m. to 7:00 p.m. During the post-deployment periods, mean travel speeds remained well above 45 mph for the entire duration of the peak period.

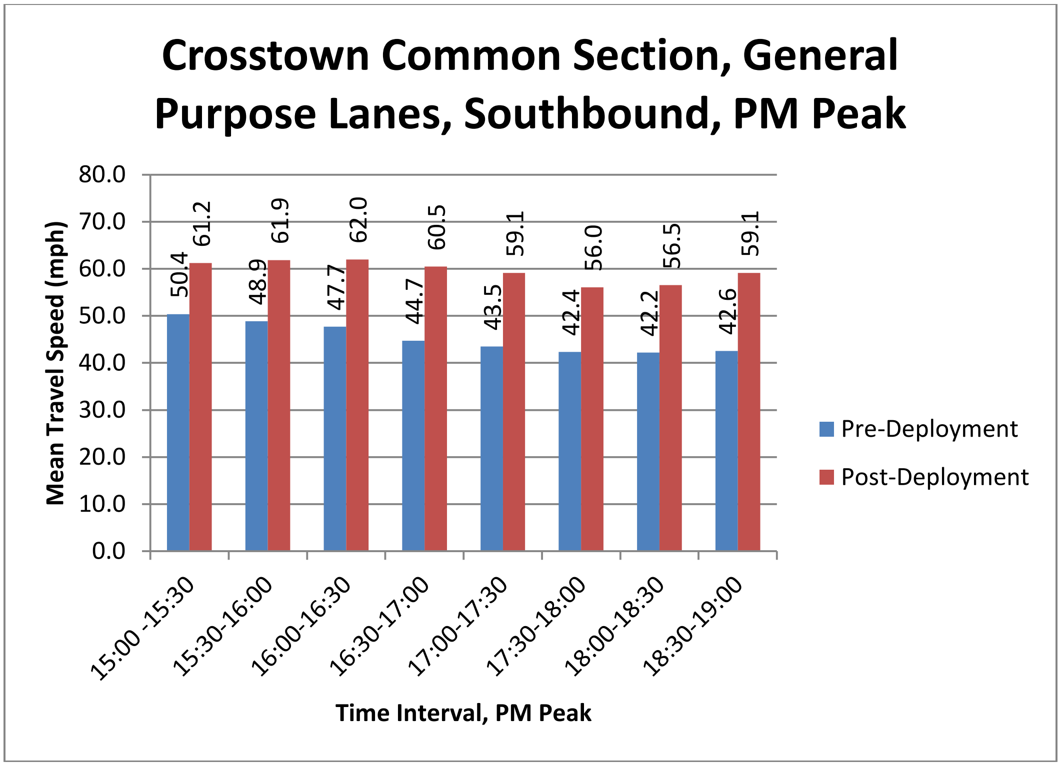

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Figure A-23. Pre- and Post-Deployment Average Travel Speeds in the General-Purpose Lanes of the Crosstown Commons Section in the Southbound Direction during the PM Peak

A.5.3 PDSL Section

Table A-22 shows how travel speeds in the PDSL section varied throughout the peak period in the peak direction of the flow, while Figure A-24 and Figure A-25 show the pre- and post-deployment travel speeds for each 30-minute interval in the peak direction of flow.

This table and these figures show that the northbound travel speeds declined in the post-deployment period compared to the pre-deployment period. Travel speeds were degraded particularly from 7:30 a.m. to 9:00 a.m. This could be attributed to the construction in the Crosstown Commons, which restricted the traffic flow going into the PDSL section in the pre-deployment period, thus causing traffic volume to be lighter than expected. After the construction ended in the post-deployment period, the traffic flow resumed normal conditions, and thereby increased traffic congestion on the PDSL section.

The trend was reversed during the PM peak. Travel speeds in the general-purpose lanes in the southbound direction improved significantly in the PDSL during the post-deployment period. This was possibly due to the fact that there was no longer the construction impact in the Crosstown Commons section in the post-deployment period.

Table A-22. Comparison of Peak-Period Travel Speeds in the General-Purpose Lanes in PDSL Section Pre- and Post-Deployment of the UPA Improvements

PDSL Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speeds	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	71.5	65.7	-5.8	-8.9%	0.388	*
6:30	7:00	69.9	63.0	-6.9	-10.9%	0.388	*
7:00	7:30	69.5	59.7	-9.8	-16.5%	0.388	*
7:30	8:00	70.7	41.1	-29.6	-72.0%	0.388	*
8:00	8:30	69.4	42.8	-26.6	-62.1%	0.388	*
8:30	9:00	68.6	46.1	-22.5	-48.9%	0.388	*
9:00	9:30	68.4	54.8	-13.6	-24.8%	0.388	*
9:30	10:00	68.7	59.7	-9.0	-15.0%	0.388	*

PDSL Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Mean Travel Speed (mph)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Travel Speeds	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	53.5	67.7	14.2	26.5%	0.538	*
15:30	16:00	48.5	67.9	19.4	40.0%	0.536	*
16:00	16:30	45.8	67.4	21.5	46.9%	0.528	*
16:30	17:00	37.0	66.0	28.9	78.1%	0.511	*
17:00	17:30	34.0	63.6	29.6	87.1%	0.511	*
17:30	18:00	30.3	58.4	28.1	92.7%	0.508	*
18:00	18:30	30.2	53.3	23.2	76.8%	0.508	*
18:30	19:00	33.3	54.9	21.6	64.9%	0.509	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

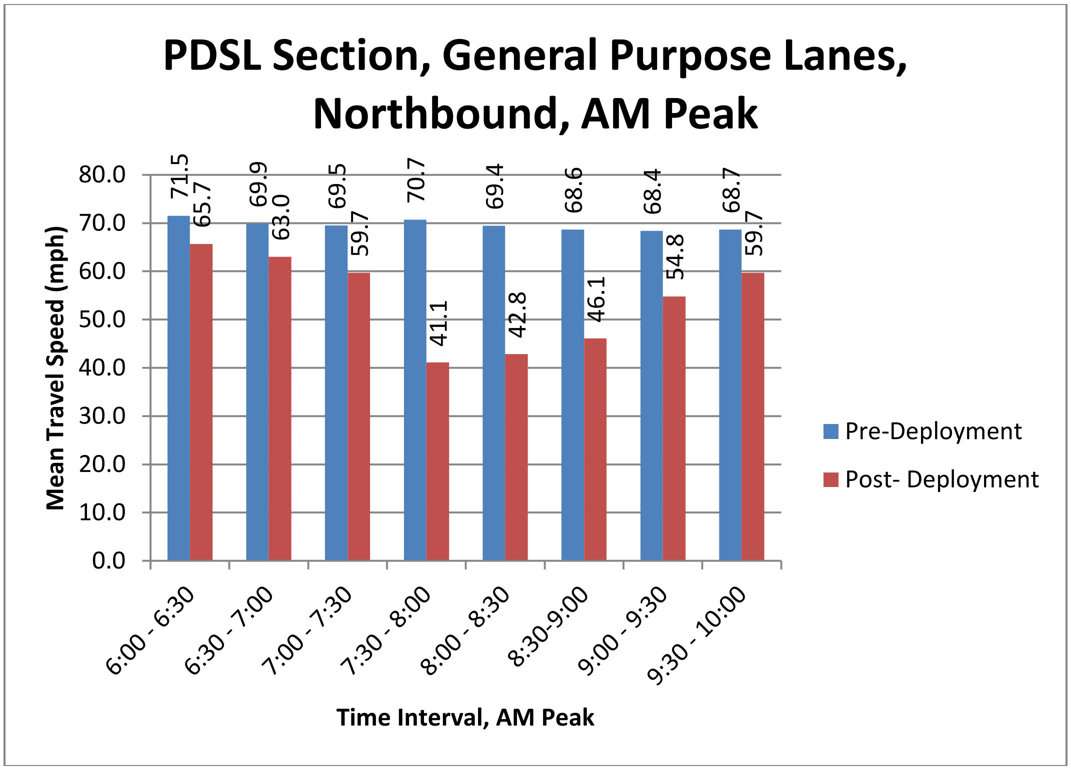

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Figure A-24. Pre- and Post-Deployment Average Travel Speeds in the General-Purpose Lanes of the PDSL Section in the Northbound Direction during the AM Peak

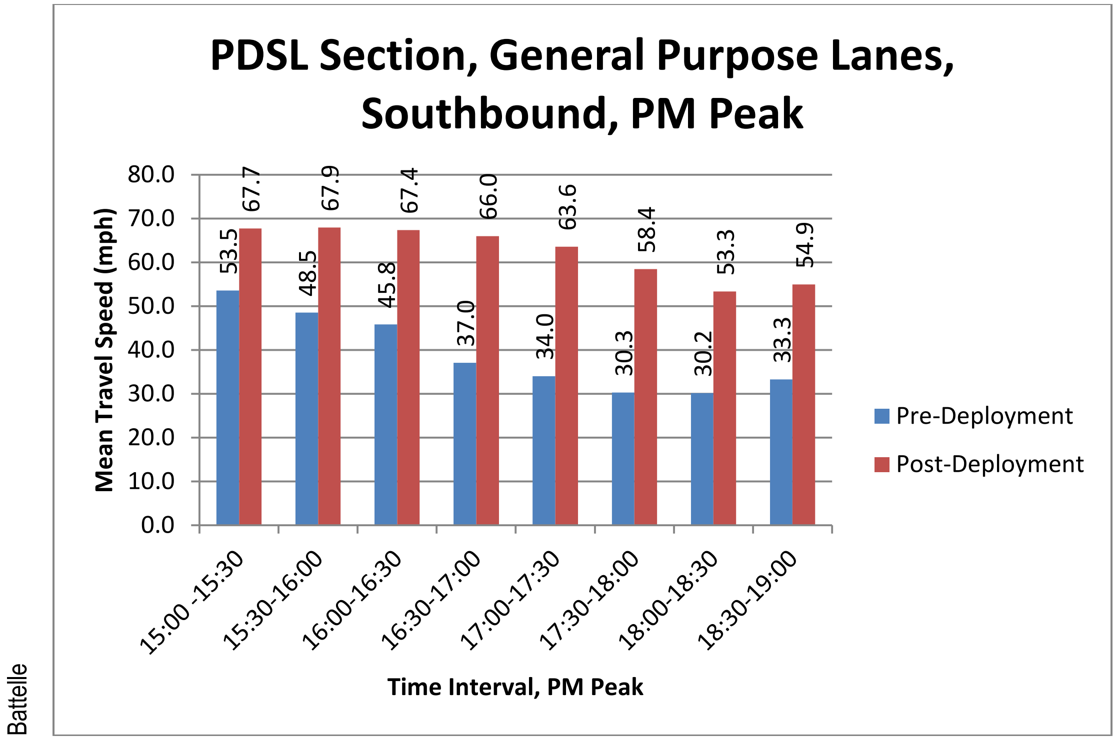

Figure A-25. Pre- and Post-Deployment Average Travel Speeds in the General-Purpose Lanes of the PDSL Section in the Southbound Direction during the PM Peak

A.6 Throughput

Throughput is a measure of the total number of vehicles and persons serviced on a facility or corridor. It is hypothesized that because of the UPA improvements, more vehicles and individuals will be able to be served by facilities after the improvements are made as compared to before implementing the improvements.

A.6.1 Vehicle Throughput

Table A-23 through Table A-26 presents pre- and post-deployment information on median peak-period vehicle throughput on peak-period directions on I-35W South. Table A-23 and Table A-24 show the change in median peak-period vehicle throughput for the peak direction of travel in the corridor. Table A-25 and Table A-26 show how the median per-lane vehicle throughput in each peak direction of flow changes post-deployment of the UPA improvements.

The values shown with an asterisk (*) in the tables indicate a concern associated with the data. These values appear to be significantly lower than expected based on trends in the data, and could be influenced by the construction, including lane closures, occurring during the time period.

Table A-23 indicates an increase in vehicle throughput in both peak-period directions in the HOT section. In the morning peak, the total throughput in the northbound direction in the HOT section increased by approximately 17 percent, while the total throughput in HOT section the southbound direction increased by 25 percent in the afternoon peak period.

Total vehicle throughput in the Crosstown Commons section increased by approximately 43 percent and 49 percent, respectively in the morning and afternoon peak direction of travel. Approximately 28 percent and 15 percent of the increase in the morning peak and afternoon median peak throughput could be attributed to the new MnPASS lane in this section, with the remaining increases attributed to the new general-purpose freeway lanes.

Vehicle throughput in the PDSL section increased by approximately 18 percent in the northbound direction during the morning peak period. The majority of this increase (52 percent) occurred in the PDSL lane. In the southbound direction, vehicle throughput in the PDSL section increased by 25 percent during the PM peak. The evaluation team attributes this reduction to the elimination of the queue spillback from of the Crosstown Commons section into the PDSL section.

Table A-25 and Table A-26 provide the pre- and post-deployment of the per-lane vehicle throughput for the three segments. The per-lane comparison was used to normalize the vehicle throughput to account for lane additions occurring in the Crosstown Commons section. Figure A- 26 illustrates that vehicle throughput, when examined on a per-lane basis, increased in the post-deployment period, particularly in the general-purpose lanes in the HOT and PDSL sections. Per-lane vehicle throughput in the general-purpose lanes dropped slightly in the Crosstown Commons section; however, this is attributable to the increase in the total number of lanes through this section.

Table A-23. Pre- and Post-Deployment Median Peak-Period General-Purpose and MnPASS Lane Throughput by Season – Northbound (AM Peak)

Direction	Section	Location	Season	Peak-Period Throughput (Vehicles)											
				General-Purpose Lanes				MnPASS Lane				Total			
				Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change	Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change	Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change
Northbound (AM Peak)	HOT	98th St	Fall	12174	14575	2401	20%	2899	2957	58	2%	15073	17532	2459	16%
			Winter	11113	13524	2411	22%	2705	2584	-122	-4%	13818	16108	2290	17%
			Spring	12034	14238	2205	18%	2433	2680	247	10%	14466	16918	2452	17%
			Summer	-	14451	-	-	-	2739	-	-	-	17190	-	-
			All Seasons	**11774**	**14197**	**2423**	**21%**	**2679**	**2740**	**61**	**2%**	**14452**	**16937**	**2484**	**17%**
	Crosstown Commons	Diamond Lake Rd	Fall	17396	21750	4354	25%	-	2217	-	-	17396	23967	6571	38%
			Winter	14973	19891	4918	33%	-	1786	-	-	14973	21676	6703	45%
			Spring	8031*	21088	-	-	-	1884	-	-	8031*	22972	-	-
			Summer		21750	-	-	-	1904	-	-	-	23654	-	-
			All Seasons	**16185**	**21120**	**4935**	**30%**	**-**	**1947**	**-**	**-**	**16185**	**23067**	**6882**	**43%**
	PDSL	28th St	Fall	23123	24416	1293	6%	-	2422	-	-	23123	26838	3715	16%
			Winter	21617	23395	1778	8%	-	1902	-	-	21617	25297	3680	17%
			Spring	22542	24555	2013	9%	-	2070	-	-	22542	26624	4082	18%
			Summer		24918	-	-	-	1929	-	-	-	26847	-	-
			All Seasons	**22427**	**24321**	**1893**	**8%**	**-**	**2081**	**-**	**-**	**22427**	**26402**	**3974**	**18%**

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* Throughput for this season suspected of being influenced by a construction lane closure.

Table A-24. Pre- and Post-Deployment Median Peak-Period General-Purpose and MnPASS Lane Throughput by Season – Southbound (PM Peak)

Direction	Section	Location	Season	Median Peak-Period Throughput (Vehicles)											
				General-Purpose Lanes				MnPASS Lane				Total			
				Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change	Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change	Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change
Southbound (PM Peak)	HOT	98th St	Fall	12093	16686	4593	38%	4671	3736	-935	-20%	16764	20422	3658	22%
			Winter	11076	15798	4723	43%	4371	3422	-949	-22%	15446	19220	3774	24%
			Spring	12445	16962	4518	36%	4169	3640	-529	-13%	16613	20602	3989	24%
			Summer		16525	-	-	-	4117	-	-	-	20642	-	-
			All Seasons	**11871**	**16493**	**4622**	**39%**	**4403**	**3729**	**-675**	**-15%**	**16274**	**20221**	**3947**	**24%**
	Crosstown Commons	Diamond Lake Rd	Fall	23417	30908	7491	32%	-	1706	-	-	23417	32613	9197	39%
			Winter	18337	27155	8818	48%	-	1424	-	-	18337	28579	10242	56%
			Spring	9070*	29716	-	-	-	1525	-	-	9070*	31240	-	-
			Summer		30058	-	-	-	1827	-	-	-	31885	-	-
			All Seasons	**20877**	**29459**	**8582**	**41%**	**-**	**1620**	**-**	**-**	**20877**	**31079**	**10203**	**49%**
	PDSL	28th St	Fall	27283	35013	7730	28%	-	-	-	-	27283	35013	7730	28%
			Winter	24989	31550	6560	26%	-	-	-	-	24989	31550	6560	26%
			Spring	28770	34274	5504	19%	-	-	-	-	28770	34274	5504	19%
			Summer		34256	-	-	-	-	-	-	-	34256	-	-
			All Seasons	**27014**	**33773**	**6759**	**25%**	**-**	**-**	**-**	**-**	**27014**	**33773**	**6759**	**25%**

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* Throughput for this season suspected of being influenced by a construction lane closure.

Table A-25. Pre- and Post-Deployment Median Peak-Period Per-Lane Throughput General-Purpose and MnPASS Lane by Season – Northbound, AM Peak

Direction	Section	Location	Season	Median Peak-Period Throughput (veh/h/l)							
				General-Purpose Lanes				MnPASS Lane			
				Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change	Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change
Northbound (AM Peak)	HOT	98th St	Fall	1522	1822	300	20%	725	739	14	2%
			Winter	1389	1691	301	22%	676	646	-30	-4%
			Spring	1504	1780	276	18%	608	670	62	10%
			Summer	-	1806	-	-	-	685	-	-
			All Seasons	**1472**	**1775**	**303**	**21%**	**670**	**685**	**15**	**2%**
	Crosstown Commons	Diamond Lake Rd	Fall	1450	1359	-90	-6%	-	554	-	-
			Winter	1248	1243	-5	0%	-	446	-	-
			Spring	669*	1318	-	-	-	471	-	-
			Summer	-	1359	-	-	-	476	-	-
			All Seasons	**1349**	**1320**	**-29**	**-2%**	**-**	**487**	**-**	**-**
	PDSL	28th St	Fall	1445	1526	81	6%	-	606	-	-
			Winter	1351	1462	111	8%	-	476	-	-
			Spring	1409	1535	126	9%	-	517	-	-
			Summer	-	1557	-	-	-	482	-	-
			All Seasons	**1402**	**1520**	**118**	**8%**	**-**	**520**	**-**	**-**

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* Throughput for this season suspected of being influenced by a construction lane closure.

Table A-26. Pre- and Post-Deployment Median Peak-Period Per-Lane Throughput General-Purpose and MnPASS Lane by Season – Southbound, PM Peak

Direction	Section	Location	Season	Median Peak-Period Throughput (veh/h/l)							
				General-Purpose Lanes				MnPASS Lane			
				Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change	Pre-Deployment	Post-Deployment	Change in Throughput	Percent Change
Southbound (PM Peak)	HOT	98th St	Fall	1344	1854	510	38%	1038	830	-208	-20%
			Winter	1231	1755	525	43%	971	760	-211	-22%
			Spring	1383	1885	502	36%	926	809	-117	-13%
			Summer	-	1836	-	-	-	915	-	-
			All Seasons	**1319**	**1833**	**514**	**39%**	**979**	**829**	**-150**	**-15%**
	Crosstown Commons	Diamond Lake Rd	Fall	1735	1717	-17	-1%	-	379	-	-
			Winter	1358	1509	150	11%	-	316	-	-
			Spring	672*	1651	-	-	-	339	-	-
			Summer	-	1670	-	-	-	406	-	-
			All Seasons	**1546**	**1637**	**90**	**6%**	**-**	**360**	**-**	**-**
	PDSL	28th St	Fall	1516	1945	429	28%	-	-	-	-
			Winter	1388	1753	364	26%	-	-	-	-
			Spring	1598	1904	306	19%	-	-	-	-
			Summer	-	1903	-	-	-	-	-	-
			All Seasons	**1501**	**1876**	**375**	**25%**	**-**	**-**	**-**	**-**

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* Throughput for this season suspected of being influenced by a construction lane closure.

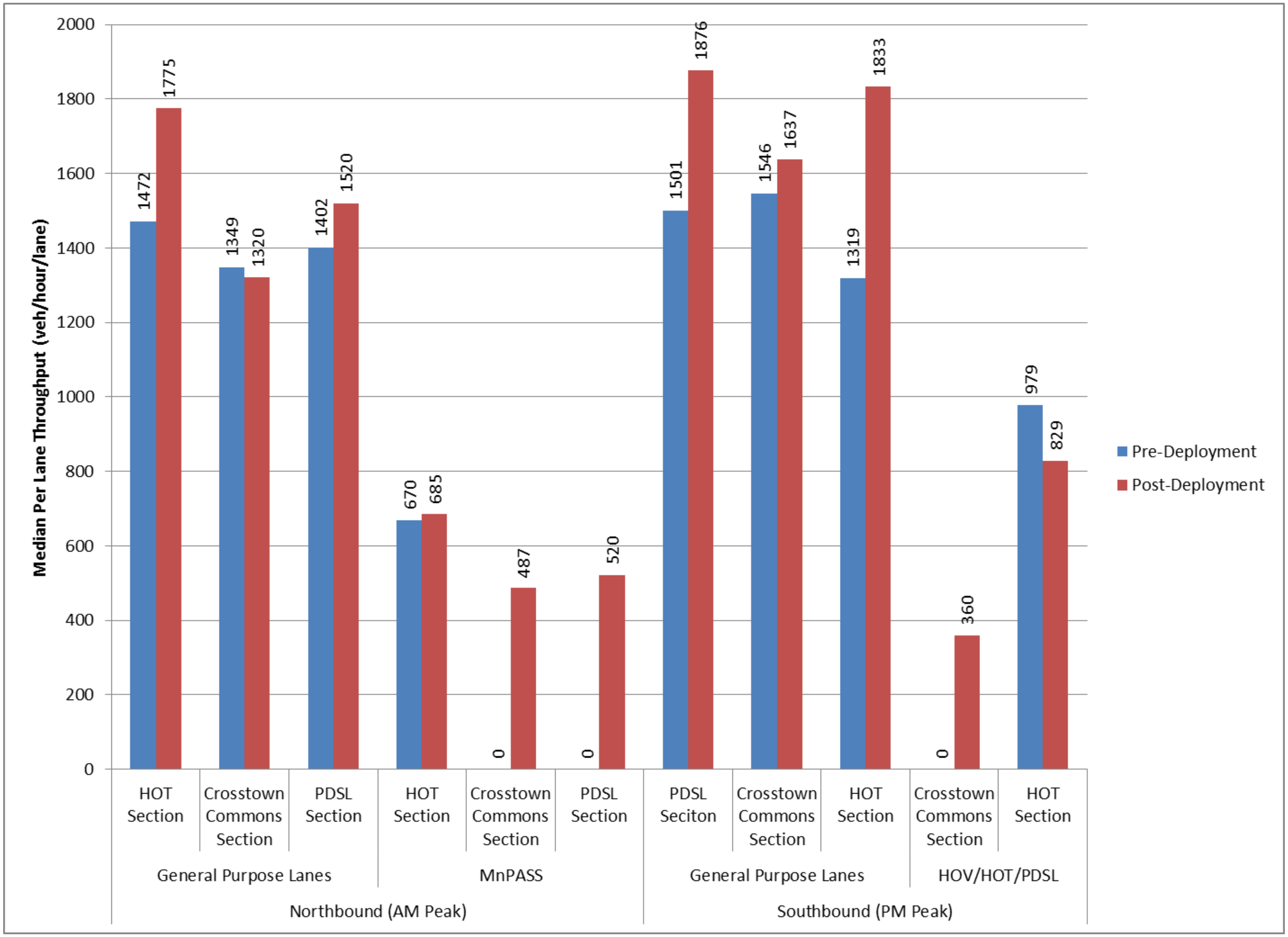

Figure A- 26. Pre- and Post-Deployment Median Peak-Period per Lane Vehicle Throughput by Direction and Section

A.6.2 Travel Volumes

To further investigate the effects of UPA strategies on traffic flow, the national evaluation team also examined flow rates (veh/hr/ln) in each of the sections of I-35W South. Flow rate was used because it is a normalized measure of how many vehicles can move through a cross section on a per-lane basis and can be related directly to the level of congestion experienced at the cross sections. As discussed previously, since the number of lanes in each cross-section directly influence flow rates, the data were split into two groups:

- The data from the stations that have the same general-purpose lane configuration in the before and after periods; and
- The data from the stations with an increase in number of general-purpose lanes in the after period.

Note that there was no change in the number of general-purpose lanes in the PDSL section.

A.6.2.1 HOT Section

Table A-27 through Table A-30 provides a comparison of the flow rates in both the general-purpose lanes and the MnPASS lanes in the HOT Section. Table A-27 and Table A-28 show the flow rates for the general-purpose lanes for that portion of the HOT section where no change in the number of lanes occurred.

Table A-29 and Table A-30 show the changes in flow rates in the general-purpose lanes and MnPASS lane in that portion of the HOT section where capacity was added.

For the HOT section, the analysis of flow rates indicates the following.

- During the AM peak period, there is statistical evidence of traffic shifting from the general-purpose lanes to the MnPASS lane, particularly between 7:00 a.m. to 8:00 a.m. During this period, the general flow rate dropped by approximately 34-39 vphpl, while the flow rate in the MnPASS lane increased by 100-150 vphpl. Given that the general-purpose cross section has two to three lanes on average, a 35 vphpl decrease translates to a 70-105 vph reduction in flow rate in this section. This reduction is only slightly below the range of observed increase in flow rate on the MnPASS lane during the same period.
- Toward the end of the AM peak period (from 9:00 a.m. to 10:00 a.m.), a reverse shifting trend of traffic from the MnPASS lane to the general-purpose lanes was observed in the northbound direction. An increase in flow rate of about 170 vphpl on the general-purpose lanes with two to three lanes in most cross sections during this period was approximately equivalent to 340-510 vph, which is consistent with the observed decrease in flow rate on MnPASS lane, which showed a reduction in flow rate of about 500 vphpl.
- A similar trend was observed in the southbound direction during PM peak period at the beginning and the end of the peak period. The flow rate trend suggests that a traffic shift from the MnPASS lane to the general-purpose lanes occurred during the shoulders of the PM peak period (i.e., before 3:30 p.m. and after 6:00 p.m.

- An overall increase in flow rate was observed from 4:00 p.m. to 6:00 p.m. in the southbound direction during the PM peak period on both general-purpose lanes and MnPASS lane.
- On the general-purpose lanes, the flow rate increased in both peak direction of flow during AM and PM peak periods, with the larger increase observed in the PM peak.

Table A-27. Comparison of Peak-Period Flow Rate in General-Purpose Lanes in the Portion of the HOT Section where No Increase in Capacity Occurred between Pre- and Post-Deployment

HOT Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	1391	1494	103	7%	3.79	*
6:30	7:00	1580	1709	128	8%	3.23	*
7:00	7:30	1533	1606	74	5%	3.19	*
7:30	8:00	1431	1533	102	7%	3.18	*
8:00	8:30	1357	1509	152	10%	3.28	*
8:30	9:00	1309	1482	174	12%	3.37	*
9:00	9:30	1046	1385	339	24%	3.47	*
9:30	10:00	998	1306	308	24%	3.41	*

HOT Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	1428	1615	187	12%	3.26	*
15:30	16:00	1470	1659	189	11%	3.30	*
16:00	16:30	1358	1619	261	16%	3.20	*
16:30	17:00	1184	1541	357	23%	3.11	*
17:00	17:30	1106	1486	381	26%	3.09	*
17:30	18:00	1118	1469	351	24%	3.21	*
18:00	18:30	1090	1442	352	24%	3.66	*
18:30	19:00	1000	1271	272	21%	3.85	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

Table A-28. Comparison of Peak-Period Flow Rate in General-Purpose Lanes in the Portion of the HOT Section where an Increase in Capacity Occurred between Pre- and Post-Deployment

HOT Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	1444	1110	-334	-30%	3.75	*
6:30	7:00	1648	1378	-270	-20%	3.62	*
7:00	7:30	1647	1362	-285	-21%	3.61	*
7:30	8:00	1560	1256	-304	-24%	3.58	*
8:00	8:30	1448	1195	-253	-21%	3.56	*
8:30	9:00	1417	1182	-235	-20%	3.60	*
9:00	9:30	1232	1156	-76	-7%	3.63	*
9:30	10:00	1216	1141	-75	-7%	3.65	*

HOT Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	1645	1321	-323	-24%	4.1	*
15:30	16:00	1775	1442	-332	-23%	3.9	*
16:00	16:30	1748	1485	-264	-18%	3.8	*
16:30	17:00	1711	1535	-176	-11%	3.7	*
17:00	17:30	1684	1544	-141	-9%	3.7	*
17:30	18:00	1610	1444	-166	-11%	3.8	*
18:00	18:30	1288	1247	-41	-3%	4.2	*
18:30	19:00	1084	1011	-73	-7%	4.4	*

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"*" denotes a statistically significant difference at a 95th percent confidence level. "-" denotes a difference that is NOT statistically significant.

Table A-29. Comparison of Mean Peak-Period Flow Rate in the MnPASS Lane in the Portion of the HOT Section where No Increase in Capacity Occurred between Pre- and Post-Deployment

HOT Section, MnPASS Lane, Northbound, AM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	480	383	-97	-25%	3.65	*
6:30	7:00	647	766	119	15%	3.39	*
7:00	7:30	784	1047	264	25%	3.32	*
7:30	8:00	704	1020	315	31%	3.30	*
8:00	8:30	620	821	201	24%	3.40	*
8:30	9:00	649	615	-34	-6%	3.59	*
9:00	9:30	958	424	-534	-126%	3.76	*
9:30	10:00	854	383	-471	-123%	3.81	*

HOT Section, MnPASS, Southbound, PM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	565	498	-67	-13%	2.75	*
15:30	16:00	582	639	57	9%	2.61	*
16:00	16:30	620	778	158	20%	2.50	*
16:30	17:00	682	923	241	26%	2.47	*
17:00	17:30	710	899	189	21%	2.46	*
17:30	18:00	696	772	76	10%	2.52	*
18:00	18:30	997	521	-475	-91%	2.76	*
18:30	19:00	798	364	-434	-119%	2.85	*

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Table A-30. Comparison of Mean Peak-Period Flow Rate in the MnPASS Lane in the Portion of the HOT Section where an Increase in Capacity Occurred between Pre- and Post-Deployment

HOT Section, MnPASS Lane, Northbound, AM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	570	295	-275	-93%	4.30	*
6:30	7:00	811	571	-240	-42%	4.26	*
7:00	7:30	994	835	-158	-19%	4.24	*
7:30	8:00	919	785	-134	-17%	4.24	*
8:00	8:30	802	646	-156	-24%	4.25	*
8:30	9:00	783	499	-284	-57%	4.24	*
9:00	9:30	1006	361	-645	-179%	4.24	*
9:30	10:00	896	334	-563	-169%	4.24	*

HOT Section, MnPASS Lane, Southbound, PM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	797	605	-191	-32%	4.85	*
15:30	16:00	880	761	-119	-16%	4.74	*
16:00	16:30	951	914	-37	-4%	4.61	*
16:30	17:00	1066	1063	-3	0%	4.47	-
17:00	17:30	1125	1076	-49	-5%	4.37	*
17:30	18:00	1131	963	-168	-17%	4.39	*
18:00	18:30	1380	678	-703	-104%	4.65	*
18:30	19:00	1028	471	-557	-118%	4.83	*

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A.6.2.2 Crosstown Commons Section

Table A-31 and Table A-32 provide a comparison of the pre- and post-deployment peak-period flow rates for the Crosstown Commons section. Table A-31 compares the flow rates for those portions where capacity was added in the section during the post-deployment period. Table A-32 shows the flow rates for those portions of the Crosstown Commons section where capacity remained the same between the pre- and post-deployment periods. The modeling results indicated an increase in flow rate in the general-purpose lanes during both peak periods of both directions. The increase was found to be greater in the northbound AM peak

(300-600 vphpl) than in the southbound, PM peak (100-200 vphpl) direction, particularly in the middle of peak period.

Table A-31. Comparison of Mean Peak-Period Flow Rate in the General-Purpose Lanes in the Portion of the Crosstown Commons Section where No Increase in Capacity Occurred between Pre- and Post-Deployment

Crosstown Commons Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	633	1008	376	37%	3.42	*
6:30	7:00	829	1413	584	41%	3.39	*
7:00	7:30	877	1517	640	42%	3.37	*
7:30	8:00	805	1424	620	44%	3.41	*
8:00	8:30	740	1324	584	44%	3.40	*
8:30	9:00	752	1279	527	41%	3.40	*
9:00	9:30	761	1224	463	38%	3.39	*
9:30	10:00	783	1220	437	36%	3.40	*

Crosstown Commons Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	1374	1457	83	6%	3.49	*
15:30	16:00	1424	1545	121	8%	3.51	*
16:00	16:30	1397	1533	136	9%	3.52	*
16:30	17:00	1375	1548	173	11%	3.53	*
17:00	17:30	1316	1499	183	12%	3.55	*
17:30	18:00	1253	1413	160	11%	3.57	*
18:00	18:30	1176	1269	92	7%	3.62	*
18:30	19:00	1080	1087	7	1%	3.75	-

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Table A-32. Comparison of Mean Peak-Period Flow Rate in the General-Purpose Lanes in the Portion of the Crosstown Commons Section where an Increase in Capacity Occurred between Pre- and Post-Deployment

Crosstown Common Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	796	921	125	14%	8.30	*
6:30	7:00	1117	1366	249	18%	8.27	*
7:00	7:30	1082	1471	389	26%	8.25	*
7:30	8:00	1025	1408	383	27%	8.33	*
8:00	8:30	1007	1275	268	21%	8.27	*
8:30	9:00	970	1245	275	22%	8.32	*
9:00	9:30	970	1145	175	15%	8.17	*
9:30	10:00	969	1138	169	15%	8.06	*

Crosstown Commons Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Mean Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	1162	1555	393	25%	9.48	*
15:30	16:00	1203	1651	447	27%	9.46	*
16:00	16:30	1204	1652	448	27%	9.43	*
16:30	17:00	1222	1665	443	27%	9.30	*
17:00	17:30	1200	1633	433	27%	9.29	*
17:30	18:00	1154	1530	376	25%	9.44	*
18:00	18:30	1095	1382	287	21%	9.76	*
18:30	19:00	1028	1187	160	13%	10.39	*

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A.6.2.3 PDSL Section

Table A-33 provides a comparison of the pre- and post-deployment peak-period flow rates for the PDSL Section. For the PDSL section, the modeling results indicated the following.

- An increase in flow rate was observed on the general-purpose lanes during peak period in both directions. The increase was found to be larger in the southbound PM peak (200-600 vphpl) than the northbound AM peak (100-300 vphpl) direction, particularly in the middle of the peak period.

- The increase in flow rate on the general-purpose lanes is logical due to the lane addition in the Crosstown Commons section, thus alleviating the bottleneck condition that previously existed in the before period.
- The increase in flow rate on the general-purpose lanes in the northbound direction in the AM peak is less than the southbound direction in the PM peak because the PDSL introduced in the after period also carries some of the traffic demand, thus reducing the per-lane vehicle flow in the northbound direction in the AM peak.

Table A-33. Comparison of Peak-Period Flow Rate in the General-Purpose Lanes in the PDSL Common Section where an Increase in Capacity Occurred between Pre- and Post-Deployment

PDSL Section, General-Purpose Lanes, Northbound, AM Peak

Time Period		Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
6:00	6:30	947	1002	54	5%	4.27	*
6:30	7:00	1371	1584	213	13%	3.98	*
7:00	7:30	1469	1742	273	16%	3.96	*
7:30	8:00	1568	1698	131	8%	4.11	*
8:00	8:30	1480	1633	153	9%	4.07	*
8:30	9:00	1430	1595	166	10%	4.02	*
9:00	9:30	1287	1401	115	8%	3.95	*
9:30	10:00	1237	1365	128	9%	3.89	*

PDSL Section, General-Purpose Lanes, Southbound, PM Peak

Time Period		Flow Rate (vphpl)					
Beginning	End	Pre-Deployment	Post-Deployment	Change in Flow Rate	Percent Change	Standard Error	Statistically Significant Change
15:00	15:30	1278	1651	373	23%	3.73	*
15:30	16:00	1292	1751	459	26%	3.43	*
16:00	16:30	1297	1823	526	29%	3.37	*
16:30	17:00	1317	1870	553	30%	3.27	*
17:00	17:30	1325	1861	536	29%	3.24	*
17:30	18:00	1292	1753	461	26%	3.26	*
18:00	18:30	1216	1555	338	22%	3.49	*
18:30	19:00	1105	1324	219	17%	4.00	*

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A.6.3 Vehicle Miles Traveled

Table A-34 and Figure A-27 show the pre- and post-deployment median peak-period VMT. Significant increases in median VMT were observed in the general-purpose lanes in both peak directions of travel in each section of I-35W South in the post-deployment period. The largest change in VMT occurred in the Crosstown Commons section. The data indicate that VMT decreased in the MnPASS lane in the HOT section. Part of this decrease could be attributed to the completion of the Crosstown Commons construction project eliminating the bottleneck in the general-purpose lanes in this section and improving overall flow in this section.

Table A-34. Comparison of Pre- and Post-Deployment Median Peak-Period VMT by Section in the UPA Corridor

Direction	Section	Lane Type	Median Peak-Period VMT			
			Pre-Deployment	Post-Deployment	Change in VMT	Percent Change
Northbound (AM Peak)	HOT Section	General Purpose	75246	87639	12393	16%
		MnPASS	19345	17483	-1862	-10%
		Total	**94591**	**105121**	**36714**	**11%**
	Crosstown Commons Section	General Purpose	46556	83270	36714	79%
		MnPASS	6524	9215	2691	41%
		Total	**53080**	**92485**	**39405**	**74%**
	PDSL Section	General Purpose	41730	49298	7569	18%
		MnPASS	-	4459	-	-
		Total	**41730**	**53757**	**12027**	**29%**
Southbound (PM Peak)	HOT Section	General Purpose	88832	113810	24977	28%
		MnPASS	28369	21546	-6823	-24%
		Total	**117201**	**135356**	**18154**	**15%**
	Crosstown Commons Section	General Purpose	86741	100993	14252	16%
		MnPASS	1443	8767	7323	507%
		Total	**88184**	**109760**	**21576**	**24%**
	PDSL Section	General Purpose	39725	67231	27506	69%
		Total	**39725**	**67231**	**27506**	**69%**

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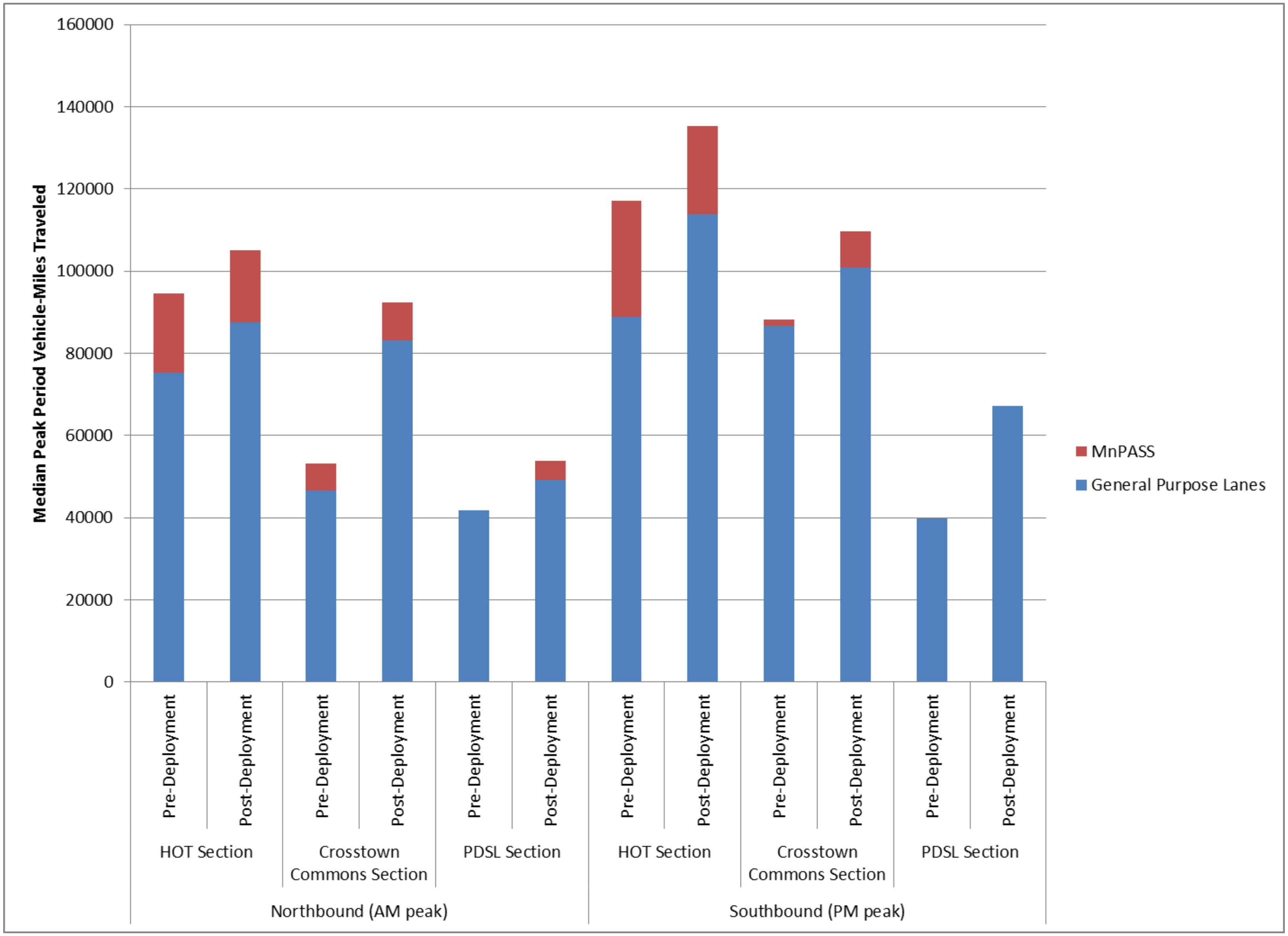

Figure A-27. Pre- and Post-Deployment Average Median Peak-Period VMT by Section Aggregated across Seasons

A.7 Perception of Congestion on I-35W South

This section examines perceived changes in congestion resulting from the UPA projects. As part of the UPA national evaluation, a variety of surveys, interviews, and focus groups were conducted to obtain information from different user groups. An online survey of I-35W South MnPASS customers, and telephone interviews of commuters on I-35W South were conducted. In addition, focus groups were conducted with Metro Transit and MVTA bus operators, and Minnesota State Patrol Officers and FIRST operators were interviewed. Interviews and workshops were also conducted with local stakeholders. Many of the surveys, interviews, and focus groups included questions or discussions related to perceptions on changes in congestion levels on I-35W South due to the UPA projects. The responses to those questions are summarized in this section.

- The online survey of I-35W South MnPASS customers included a question on changes in congestion on I-35W South. The survey results have a 2.26 percent margin of error at the 95 percent confidence level. A total of 56 percent of the survey respondents indicated that, in general, travel on I-35W South was easier and less congested than a year ago, while 31 percent indicated congestion was about the same as a year ago, and 13 percent indicted it was more congested than a year ago.
- In the focus groups and interviews, Minnesota State Patrol officer, FIRST operators, and bus operators noted that congestion levels have been reduced on I-35W South. The re-building of the Crosstown Commons section, with the addition of a new general-purpose travel lane and a new HOT lane, was identified as the major factor in reducing congestion. The officers and operators indicated that traffic flows freer at all times on I-35W South, including the morning and afternoon peak periods. They did note that the re-building of the Crosstown Commons section has resulted in some shifting of congestion and bottlenecks to other locations, including the section of I-35W just south of downtown Minneapolis where travel splits to go east and west on I-84 into downtown Minneapolis. Congestion on the exit and merge ramps from southbound I-35W South to eastbound on the Crosstown Commons section was also noted as problem area.
- The results of the telephone survey of travelers using I-35W South indicated a general perception that traffic congestion had been reduced and traffic flow had improved, as compared to two years ago. The survey results have a sampling error of +/- 4 percent at the 95 percent confidence level. A total of 52 percent of the respondents indicated travel on I-35W South was easier and less congested than two years ago, with 26 percent indicating it was the same as two years ago, and 22 percent indicating travel was worse. A second question asked about changes in traffic flow on I-35W South as related to “cars braking and stop-and-go conditions.” A total 41 percent of the respondents indicated that the traffic flow was better than two years ago, 35 percent responded it was the same, and 24 percent indicated it was worse.
- Agency personnel, local officials, and local policy makers responded during the stakeholder interviews that they felt congestion levels had improved on I-35W South since the UPA projects were implemented and the new lanes in the Crosstown Commons

section were open. Some individuals noted they drive on I-35W South on a regular basis and have noticed the improvements.

A.8 Potential Impacts of Exogenous Factors on I-35W South Congestion

Figure A-28 presents pre- and post-deployment information on the average monthly gasoline prices and total peak-period VMT on I-35W South. Figure A-29 illustrates the unemployment rates in the Minneapolis/St. Paul metropolitan area and VMT on I-35W South. As these figures illustrate, peak-period travel on I-35W South remained relatively constant regardless of unemployment rates and the price of gasoline. The significant drop in gasoline prices in December 2008 in the pre-deployment period and the significant spike in gasoline prices in May 2011 had little impact on peak-period VMT. Similarly, the fluctuations in the unemployment rate in the region do not appear to have impacted VMT.

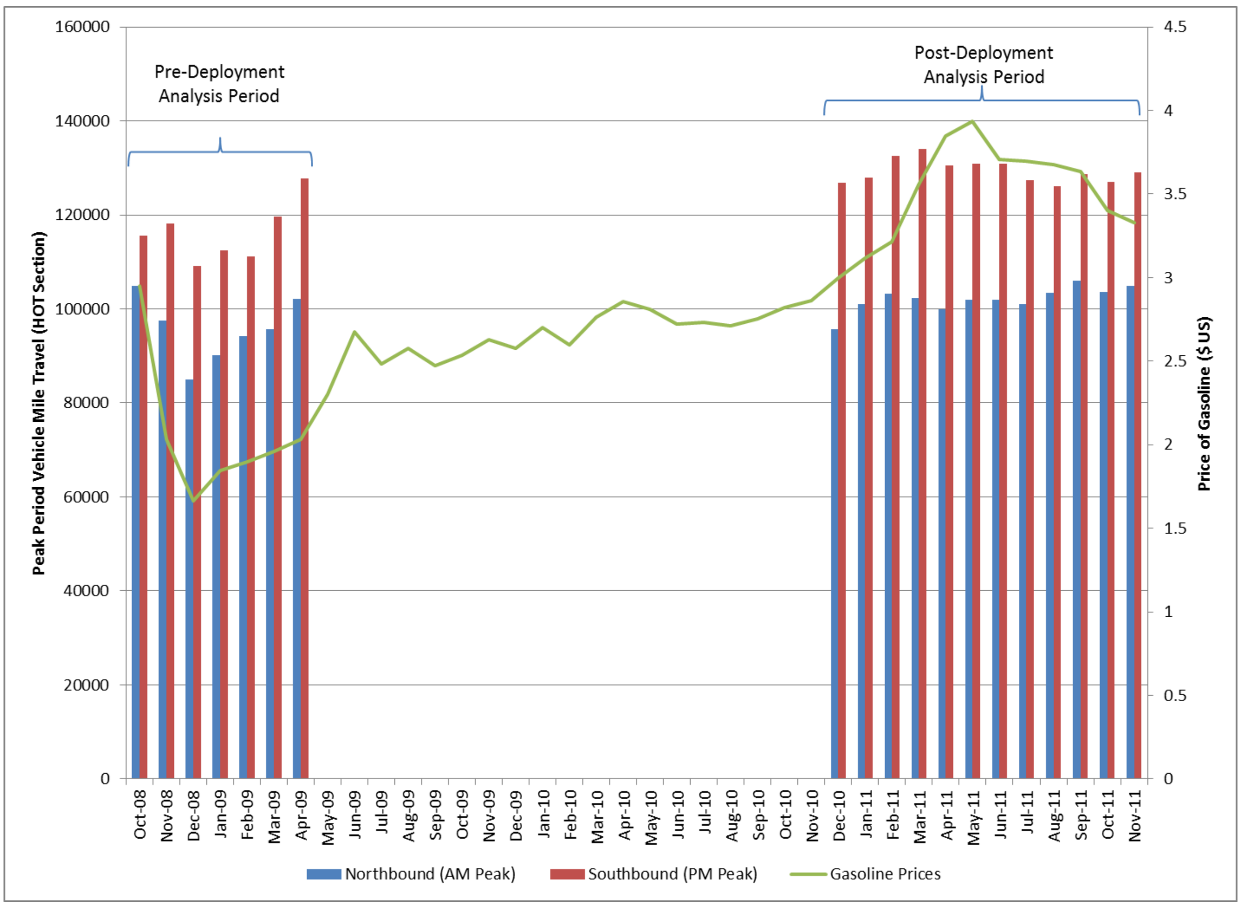

Figure A-28. Impact of Gasoline Prices versus Peak-Period VMT in the UPA I-35W Evaluation Corridor

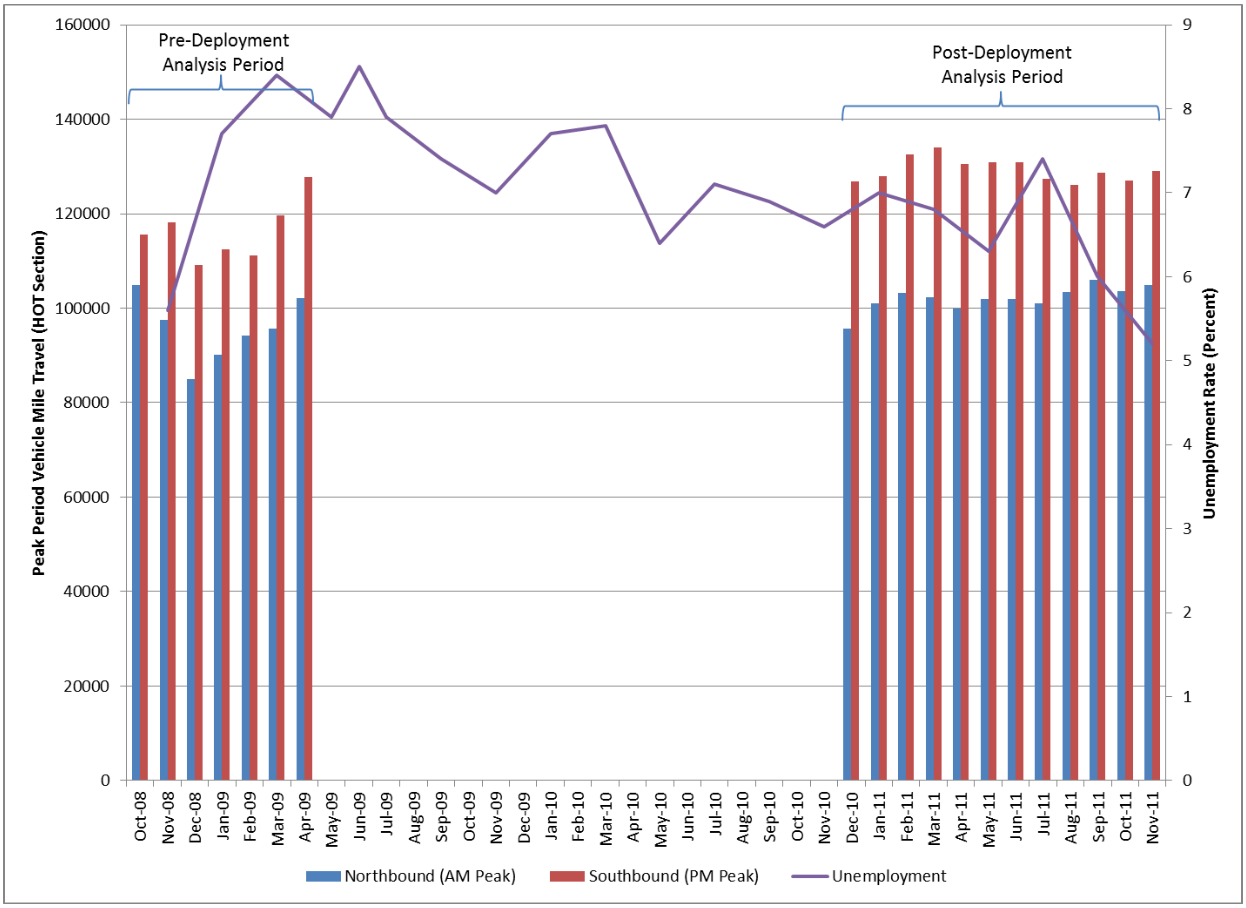

Figure A-29. Comparison of the Unemployment Rate and I-35W South Peak-Period VMT

A.9 Summary of Congestion Impacts

As highlighted in Table A-35, implementation of the UPA strategies appeared to help reduce congestion levels on I-35W South. Peak-period, end-to-end mean corridor travel times improved, peak-period travel-time reliability and mean travel speeds for each section in both peak directions of travel improved, and total and per-lane vehicle throughput increased. As noted throughout the analysis, however, it is not possible to separate the impacts of the UPA projects – including the HOV-to-HOT expansion, new HOT lanes, the new PDSL, and ATM and speed harmonization – and the impacts of the new general-purpose freeway lanes in the Crosstown Commons section.

The results of surveys, interviews, and focus groups with MnPASS customers, travelers on I-35W South, Minnesota State Patrol Officers, FIRST operators, bus operators, and local stakeholders also indicate a perception that travel times have been reduced, trip-time reliability has been improved, the duration of congestion has declined, and congestion has been reduced with the deployment of the UPA projects and other improvements to I-35W South.

Table A-35. Summary of Congestion Impacts across Hypotheses

Hypotheses/Questions	Result	Evidence
• Deployment of the UPA improvements will reduce the travel time of users in the I-35W South corridor.	Somewhat	Travel times on I-35W South from Highway 13 to downtown Minneapolis were reduced. The travel-time savings varied by section.
• Deployment of the UPA improvements will improve the reliability of user trips in the I-35W South corridor.	Supported	Travel-time reliability, as measured by the 95^{th} percentile travel times and the Buffer Index, improved on I-35W South in the post-deployment period.
• Traffic congestion on I-35W South will be reduced to the extent that travelers in the corridor will experience a noticeable improvement in travel time.	Supported	Survey and interview results indicate that a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported an improvement in travel conditions on I-35W South.
• Deployment of the UPA projects will not cause an increase in the extent of traffic congestion on surrounding facilities adjacent to I-35W South.	Unknown	Data from adjacent facilities was not available to allow this hypothesis to be examined.
• Deploying the UPA improvements will result in more vehicles served in the I-35W South corridor during peak-periods.	Supported	Increases in vehicle throughput across all lanes were observed in each segment and for the full length of I-35W South. Significant increases in median VMT were observed in the general-purpose lanes in each peak direction of travel in each evaluation.
• A majority of survey respondents will indicate a noticeable reduction in travel times after the deployment of the UPA improvements.	Supported	Survey and interview results indicate that a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported an improvement in travel conditions on I-35W South.
• A majority of survey respondents will indicate a noticeable improvement in trip-time reliability after the deployment of the UPA projects.	Supported	Survey and interview results indicate that a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported an improvement in travel conditions on I-35W South.
• The majority of survey respondents will indicate a noticeable reduction in the duration of congestion after deployment of the UPA projects.	Supported	Survey and interview results indicate that a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported that the duration of congestion on I-35W South had been reduced.
• A majority of survey respondents will indicate a noticeable reduction in the extent of congestion after the deployment of the UPA projects.	Supported	Survey and interview results indicate that a majority of travelers, as well as Minnesota State Patrol Officers, FIRST operators, bus drivers, and local stakeholders reported that the extent of congestion on I-35W South had been reduced.

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Appendix B. Tolling Analysis

The tolling analysis focuses on the effect of the MnPASS high-occupancy toll (HOT) lanes and the priced dynamic shoulder lane (PDSL) on travel behavior, vehicular throughput, and traffic congestion on I-35W South. Table B-1 presents the hypotheses/questions for the tolling analysis. The tolling analysis is closely related to the congestion analysis in Appendix A and the transit analysis in Appendix C, which both examine changes in travel mode.

The first hypothesis is that the HOT lanes and the PDSL will increase vehicular throughput in the corridor during the peak periods. The second related hypothesis is that some travelers currently using general-purpose freeway lanes will shift to the HOT lanes and the PDSL, while current HOV lane users will continue to use the HOT lanes and will also use the PDSL. A third hypothesis is that HOV lane violations will be reduced with the expansion of the existing I-35W HOV lanes to HOT lanes. The fourth hypothesis relates to maintaining the vehicular throughput gains over time.

Table B-1. Tolling Hypotheses/Questions

Hypotheses/Questions
• Vehicle access on the HOT lanes and PDSL on I-35W will be regulated to increase vehicular throughput in the corridor.
• Some general-purpose lane travelers will shift to the I-35W HOT lanes and PDSL, while HOV lane travelers will remain in the HOT lane.
• HOV violations will be reduced.
• After ramp-up, the HOT lanes and PDSL on I-35W maintains vehicular throughput gains on the priced facility.

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This appendix is divided into eight sections. The data sources used in the analysis are described next in Section B.1, followed by a summary of the number of MnPASS accounts and transponders in Section B.2. Information on the use of the MnPASS lanes is presented in Section B.3 and enforcement and violations are discussed in Section B.4. Operation of the MnPASS HOT lanes is described in Section B.5 and the results from the on-line survey of I-35W MnPASS customers related to the tolling analysis hypotheses is presented in Section B.6. The results from the telephone survey of I-35W South commuters related to the tolling analysis hypotheses is presented in Section B.7. The appendix concludes with a summary of the tolling impacts on I-35W South in Section B.8.

B.1 Data Sources

The tolling analysis relied primarily on seven data sources. First, the MnPASS Express Lanes Monthly Status Reports prepared by Cofiroute USA, the operator of the MnPASS system, were reviewed. These monthly reports provide information on the number of new MnPASS accounts, the method used to open accounts, and the status of accounts. The monthly summaries also document the number of trips, total revenue, average revenue, and the maximum toll on a daily basis for the I-35W HOT lanes. A comparison of monthly use with the previous year is presented. The monthly status report contains similar information on the I-394 HOT lanes.

Second, Cofiroute USA provided the national evaluation team with the data files for all I-35W MnPASS transactions on a monthly basis. The files were provided in a Microsoft Access Database. For analysis purposes, the files were converted into a SAS data set. The data were examined to identify monthly transaction trends.

Third, the MnDOT I-35W HOV Quarterly Reports for October-December 2009 through July-September 2011 were examined. These reports track use of the I-35W HOV and HOT lanes. The reports are based on loop detector data for a three-month period, MnPASS data, the estimated carpool/vanpool use based on an October 2005 survey, and the estimate of non-MnPASS single-occupant vehicles (SOVs) from a three-day study in October 2009.

Fourth, data from the Minnesota State Patrol on citations and warnings issued for violations of the I-35W South MnPASS HOT lanes operating requirements were examined. Data on MnPASS customers without active or engaged transponders, non-MnPASS customers, and individuals crossing the double-white line lane markings from May 2011 through December 2011 were reviewed and summarized.

Fifth, the results from the interviews and focus groups with Minnesota State Patrol officers, Freeway Incident Response and Safety Team (FIRST) operators, and Metro Transit and Minnesota Valley Transit Authority (MVTA) bus operators were reviewed to identify benefits from the MnPASS HOT lanes and any concerns. Results from the Metro Transit ridership survey discussed in Appendix C – Transit Analysis, are also highlighted.

Sixth, Cofiroute USA administered an on-line survey of individuals with active I-35W South MnPASS accounts. The surveys included the questions identified by the national evaluation team in the *Minnesota UPA Surveys, Interviews, and Focus Group Test Plan*. The survey was administered in January 2012 using SurveyMonkey. Individuals with active I-35W MnPASS accounts received an e-mail with a survey identification number and directions on accessing SurveyMonkey. Individuals completing the survey were eligible for the chance to win $15 in MnPASS toll credits. A total of 1,502 individuals completed the on-line survey, representing a 20 percent response rate.

Seventh, MnDOT sponsored a telephone survey of peak period commuters on I-35W South. The purpose of the survey was to obtain information on their current travel mode, any recent changes in their mode of travel, and their perspective on different UPA projects. The telephone survey included motorists using the I-35W South general-purpose freeway lanes, carpoolers using the MnPASS HOT lanes, and bus passengers riding buses that use the MnPASS HOT lanes. A total of 499 telephone surveys completed were between April 26 and May 24, 2011.

B.2 I-35W MnPASS Accounts and Transponders

Table B-2 presents information on the number of new I-35W MnPASS accounts opened by month for the period from August 2009 through December 2011 from the monthly reports. A total of 7,840 new I-35W MnPASS accounts were opened during the 29-month period. A total of 443 accounts were closed or are in collection/ suspended status, resulting in 7,397 active accounts as of December 31, 2011. New accounts continued to be opened in 2012, after the end of the national evaluation period.

Approximately 52 percent of the I-35W MnPASS accounts were opened from August to December, 2009, prior to and during the initial months of operation of the HOT lanes south of I-494 and the PDSL. The purchase of transponders ranged from 65-to-141 a month from January to August 2010. The number of transponders purchased increased to approximately 250 a month in September and October and to almost 400 a month in November and December 2011, corresponding to the opening of the new MnPASS HOT lanes in the Crosstown Commons section in November 2011.

Registering on-line through the MnPASS website represented the most popular method to open a MnPASS account. Approximately 90 percent of I-35W MnPASS accounts were opened on-line. Registering by phone/fax was slightly more popular at 5 percent, than using the mobile Customer Service Center (CSC) at 3 percent or registering in person at 2 percent.

Individuals with MnPASS accounts may purchase multiple transponders. As of December 31, 2011, 8,425 transponders were assigned to active I-35W MnPASS account holders. Approximately 88 percent of the I-35W MnPASS accounts have one transponder, 11 percent have two transponders, and 1 percent have three or more transponders.

Table B-2. I-35W MnPASS Accounts by Month

Year	Month	Total
2009	August*	487
	September	1,469
	October	1,331
	November	320
	December	310
2010	January	141
	February	128
	March	71
	April	110
	May	77
	June	112
	July	65
	August	109
	September	243
	October	249
	November	397
	December	391
2011	January	207
	February	142
	March	117
	April	123
	May	134
	June	183
	July**	62
	August	144
	September	217
	October	197
	November	216
	December	88
Total New Accounts		**7,840**
Closed/Suspended Accounts		**443**
Total Active Accounts		**7,397**

MnPASS Express Lanes Monthly Reports, Cofiroute USA

*Includes some accounts opened in July 2009.
**The Minnesota state government shut down from July 1 through July 21, 2011. New MnPASS accounts could not be opened during the government shutdown.

The growth in I-35W MnPASS accounts and transponders has been good in comparison to the HOV lanes on I-394, which were expanded to HOT lanes in 2005. As of December 31, 2011, there were 12,015 active MnPASS accounts on I-394, with 15,428 assigned transponders. After a little over two years of operation, the number of I-35W MnPASS accounts were at approximately 60 percent and the number of transponders were at approximately 54 percent of those on the six-year old I-394 HOT lanes.

B.3 Use of the I-35W MnPASS HOT Lanes

Data on daily and monthly trips, total revenue, the average toll, and the maximum toll in the monthly MnPASS reports were reviewed. Additionally, all MnPASS transactions on the I-35W MnPASS HOT lanes were examined for October 2009 through December 2011. Table B-3 presents the total MnPASS trips recorded by month and the total revenues. The trips are provided by the three sections – northbound, southbound, and the PDSL. From October 2009 to October 2010, the northbound section extended from Highway 13 to I-494 and the southbound section was from I-494 to Highway 13. With the opening of the HOT lanes in the Crosstown Commons section in November 2010, the northbound section extended from Highway 13 to downtown Minneapolis and the southbound section was from 42nd street to Highway 13. Use of the PDSL northbound from 42nd Street into downtown Minneapolis was included in the total northbound trips beginning in October 2010.

The table illustrates the steady growth in use of the HOT lanes since 2009, and the significant increase from December 2010 through November 2011. This growth reflects the opening of the new HOT lanes in the Crosstown Commons section and the resulting completion of the 16-mile HOT lane from TH 13 into downtown Minneapolis in the northbound direction. As the table highlights, total use by MnPASS account holders increased from 24,754 monthly trips in October 2009 to a high of 60,937 total trips in November 2011. Total monthly revenues increased from $19,609 in October 2009 to a high of $102,578 in September 2011. Use of the HOT lane and revenues continued to increase in 2012, after the end of the national evaluation period.

Figure B-1 presents information on the monthly use of the different segments of the I-35W MnPASS HOT lanes during the morning peak hours in the northbound direction, based on the toll reader location. The figure highlights the growth in MnPASS use over time and the increase after the November opening of the HOT lanes in the Crosstown Commons section. The significant decline in use in July 2011 reflects the two-week shutdown of the Minnesota state government when the MnPASS system was not in operation.

Table B-3. I-35W Total MnPASS Trips and Revenue by Month

Month	Total Trips				Total Revenue
	Northbound	Southbound	PDSL	Total	
December 2011	34,149	21,028	*	55,177	$76,270
November 2011	38,972	21,965	*	60,937	$94,619
October 2011	37,533	21,382	*	58,915	$90,504
September 2011	38,163	21,532	*	59,695	$102,578
August 2011	36,258	21,938	*	58,196	$92,933
July 2011**	10,341	6,353	*	16,694	$23,108
June 2011	37,210	23,347	*	60,557	$90,818
May 2011	34,926	22,575	*	57,501	$81,906
April 2011	35,844	21,415	*	57,259	$84,066
March 2011	35,538	21,596	*	57,134	$75,034
February 2011	32,272	19,233	*	51,505	$71,119
January 2011	33,979	21,198	*	55,177	$82,523
December 2010	31,014	19,458	*	50,472	$74,388
November 2010	28,835	18,312	*	47,147	$54,141
October 2010	27,180	16,459	*	43,639	$43,766
September 2010	22,309	15,599	3,939	41,847	$41,414
August 2010	19,537	13,691	2,486	35,714	$26,055
July 2010	18,039	12,915	2,607	33,561	$26,107
June 2010	21,151	14,947	3,081	39,179	$36,824
May 2010	20,036	13,906	3,101	37,043	$34,554
April 2010	21,123	14,743	3,452	39,318	$36,959
March 2010	20,798	14,192	3,778	38,768	$32,820
February 2010	17,811	12,069	3,576	33,456	$28,736
January 2010	17,863	12,439	3,331	33,633	$31,647
December 2009	14,801	11,460	2,986	29,247	$26,486
November 2009	14,558	10,065	2,573	27,196	$20,871
October 2009	13,521	9,111	2,392	25,024	$19,609

MnPASS Express Lane Monthly Report, Cofiroute USA.

*PDSL was combined with Northbound Totals.

**Due to the Minnesota state government shut down from July 1 to July 21, 2011, the MnPASS lanes were not in operation for 15 weekdays from July 1, to July 15, 2011.

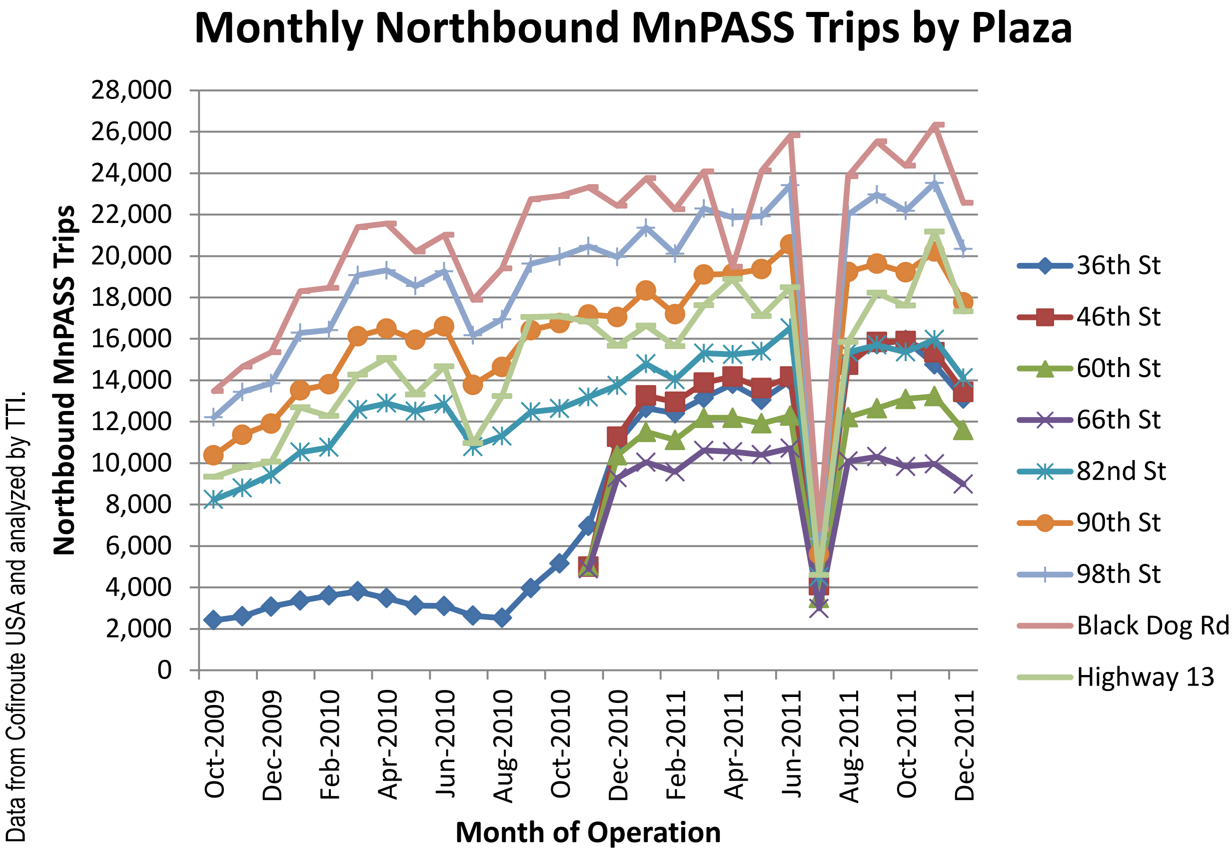

Figure B-1. Monthly I-35W MnPASS Trips Northbound in the A.M. Peak Period, Highway 13 to Downtown Minneapolis

Figures B-2 and B-3 present information on the most frequently used sections of the MnPASS HOT lanes in the northbound and the southbound direction for the period from November 2010 through December 2011. Data on the first and the last toll reader for vehicles in the MnPASS lanes were examined. As illustrated in Figure B-2, the first and third most heavily used sections in the northbound direction begin at Highway 13 and end south of I-494. These MnPASS patterns reflect commute trips from southern suburbs to employment locations along I-494. The second most frequently used origin-destination pattern was from Highway 13 all the way into downtown Minneapolis, reflecting commute trips from southern suburbs into the downtown area. Other well used segments are the PDSL and the sections from Highway 13 to either Blackdog Road or 98th Street, which allow users to bypass congestion associated with the bridge crossing the Minnesota River.

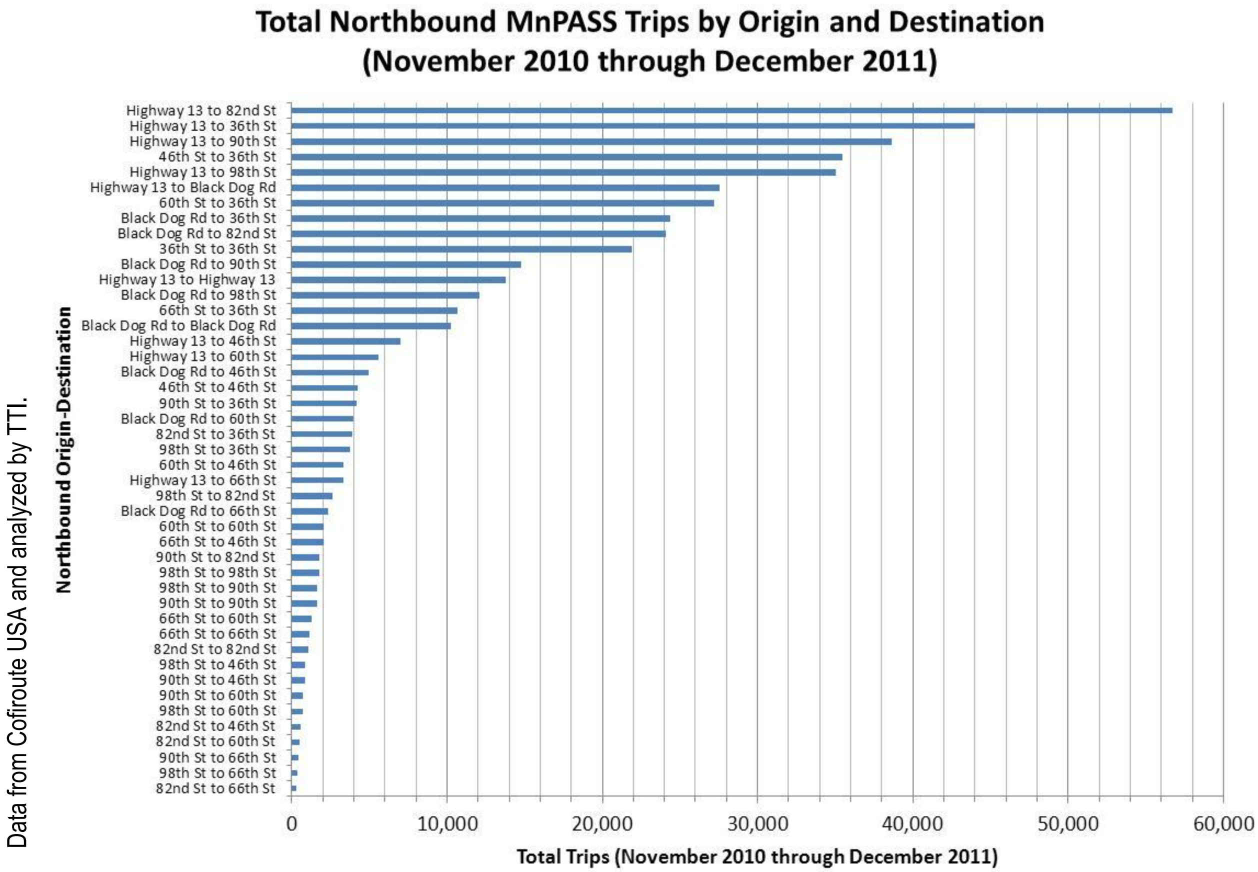

Figure B-2. Total Northbound MnPASS Trips by Origin and Destination (November 2010 through December 2011)

As illustrated in Figure B-3, the heaviest use of the MnPASS lanes in the southbound direction was also south of I-494, with the third highest use from 60th Street, just north of the Crosstown Commons section to Blackdog Road, south of the Minnesota River Bridge. These travel patterns reflect the reserve of the morning trips, with commuters traveling from employment locations along I-494 and in downtown Minneapolis to southern suburbs.

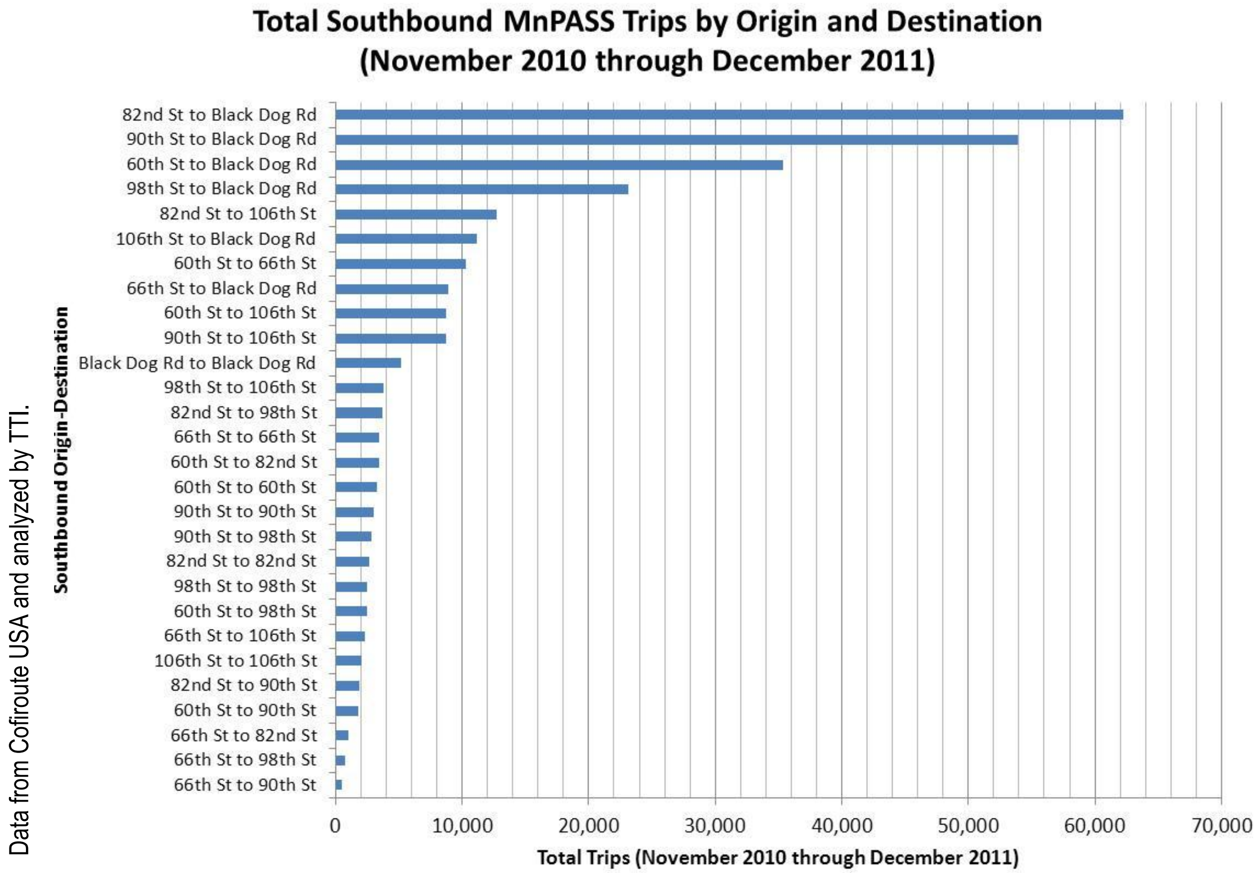

Figure B-3. Total Southbound MnPASS Trips by Origin and Destination (November 2010 through December 2011)

Figure B-4 presents a comparison of the total number of weekday trips in November 2010 and in November 2011. On average, daily use has increased by approximately 500-to-750 trips. Excluding the Thursday and Friday of Thanksgiving, total daily trips in November 2011 ranged from a low of 1,903 to a high of 3,639. Daily revenue corresponds with these trends, reflecting higher use equaling higher revenues.

The average tolls on the HOT lanes in November 2010 were $1.19 in the northbound direction and $1.19 in the southbound direction. In comparison, the average tolls on the HOT lanes in November 2011 were $1.68 in the northbound direction and $1.33 in the southbound direction. The maximum toll in November 2010 in the northbound direction was $5.50 on one day. The maximum toll in November 2011 was $8.00 on four days and $7.00 on eight days. The higher tolls in 2011 reflect the use of the additional HOT lane segments in the Crosstown Commons section. Since the toll level is based on vehicle volumes and maintaining a free flowing condition; the higher tolls may also reflect higher vehicle volumes in the lanes.

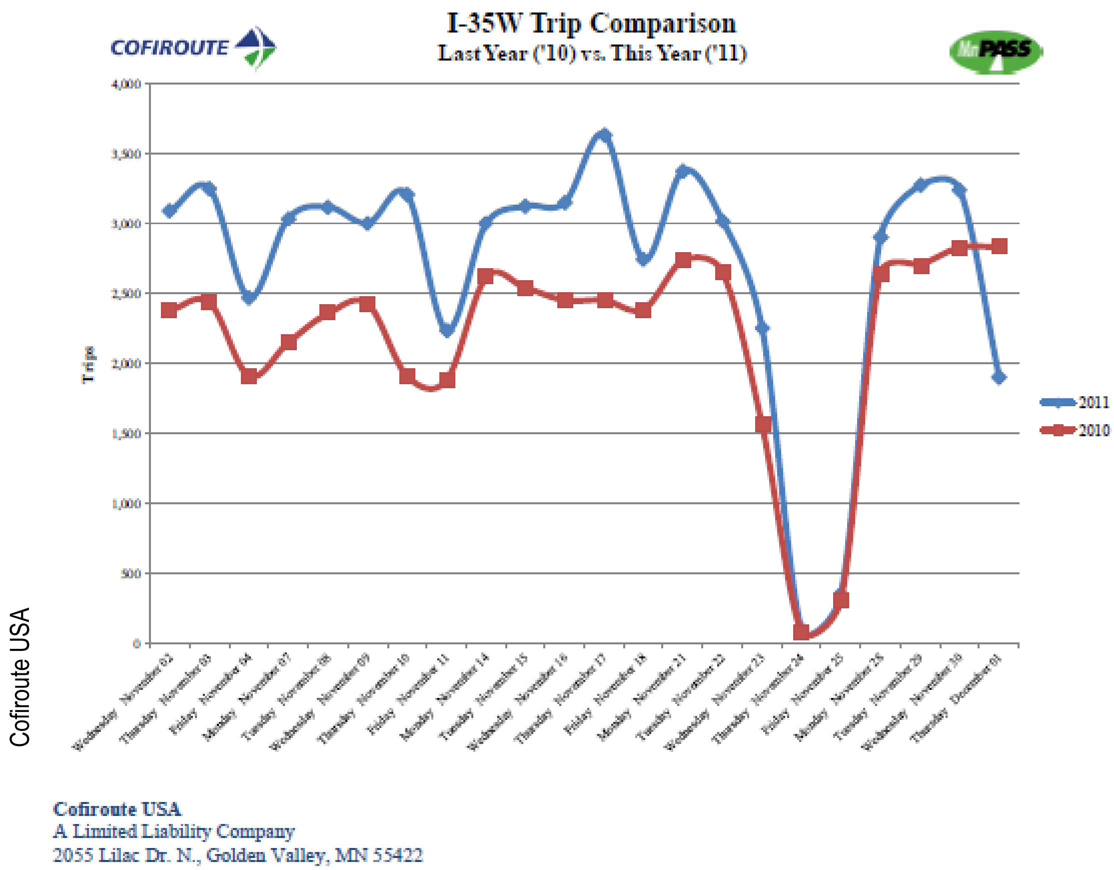

Figure B-4. I-35W Daily Comparison MnPASS Trips November 2010 and November 2011

The number of times I-35W MnPASS customers used the HOT lanes was also examined. Figure B-5 presents the use frequency of the I-35W South HOT lanes for two time periods. Phase I represents the period from October 2009 to November 18, 2010 when the HOT lanes from Highway 13 to I-494 (the section with the existing HOV lane expanded into a HOT lane) and the PDSL were in operation. Phase 2 represents the period from November 19, 2010 to December 31, 2011 when the HOT lanes in the Crosstown Commons section became operational, providing users with a full 16 miles of HOT lanes in the northbound direction in the morning peak period.

The figure highlights frequent MnPASS HOT lanes users – those who use the HOT lanes 3 or more times a week and 1-to-3 times a week; infrequent users – those who use it 2-to-4 times a month, 1-or 2 times a month, and 4-to-12 times a year; and very infrequent users – those who use it less than 4 times per year. As illustrated in Figure B-5, I-35W South MnPASS users in all categories increased after the HOT lanes in the Crosstown Commons section were open.

The figure highlights that approximately 1,200 MnPASS customers used the HOT lanes 3 or more times a week in the full deployment period and approximately 2,200 customers used it 1-to-3 times a week. The number of infrequent users also increased, as did the number of very infrequent users. Individuals in these two categories may only pay to use the HOT lanes when they have a critical need for the travel time savings and the trip-time reliability provided by the HOT lanes. These use patterns are similar to those reported by I-35W MnPASS customers in an on-line survey, which is described in Section B.6.

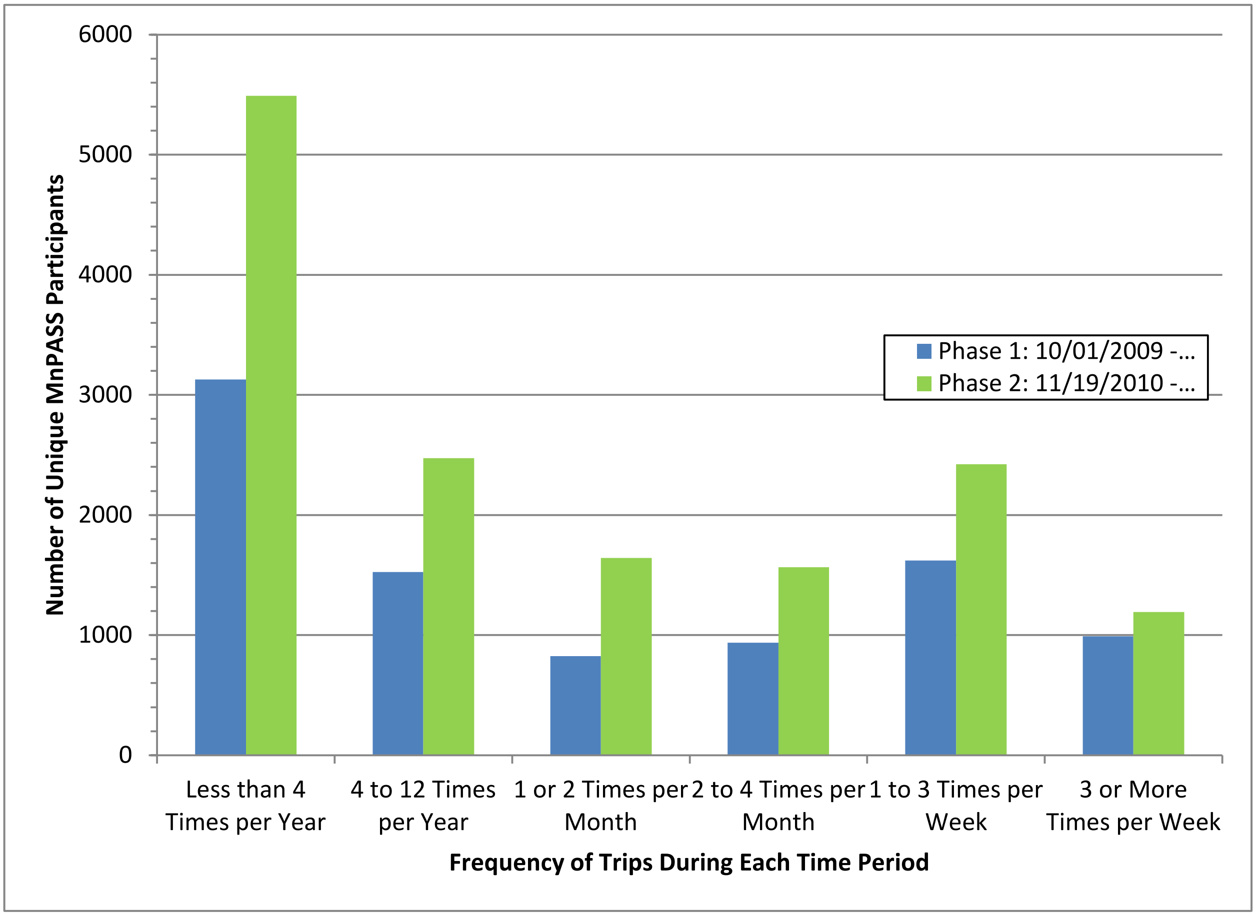

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Figure B-5. I-35W South MnPASS HOT Lanes Frequency of Use

The MnDOT I-35 HOV Quarterly Reports provide information on the use of the HOV/HOT lanes and the general-purpose lanes. Data from the October – December 2009 Quarterly Report for through the July – September 2011 Quarterly for were reviewed. Table B-4 presents information from the July – September 2011 Quarterly Report on use of the I-35W HOT lanes northbound at Black Dog Road in the morning peak period. As noted in the footnotes, the average weekday vehicle volume is obtained from loop detector data. The number of carpools/vanpools is calculated by taking the total vehicles less tolled vehicles, violating SOVs, and buses. MnPASS data was used to identify MnPASS users. Data from MVTA and one Metro Transit route was used to identify the number of transit buses. The violators/violation rate was estimated based on a three-day study conducted in the spring of 2010.

As Table B-4 presents, the MnDOT data indicates that as of the July – September 2011 Quarterly Report, vanpools and carpools comprised approximately 48 percent of the vehicles using the I-35W HOT lanes, compared to 38 percent MnPASS users, 2 percent buses, and 5 percent SOVs and toll violators. It also shows the higher volumes during the peak hour from 7:00 a.m. to 8:00 a.m. As described next, the introduction of the MnPASS HOT program resulted in an increase in vehicles in the I-35W HOT lane during the morning peak period, a change in the mix of user groups, and a reduction in the number of individuals violating the occupancy requirements.

Table B-4. Use of I-35W HOT Lane at Black Dog Road – A.M. Peak Period July – September 2011

	6:00 a.m. – 7:00 a.m.		7:00 a.m. – 8:00 a.m.		8:00 a.m. – 9:00 a.m.		Total 6:00 a.m. – 9:00 a.m.	
	Vehicle	Percent	Vehicle	Percent	Vehicle	Percent	Vehicle	Percent
Total Vehicles[1]	704		1,234		877		2,815	
Carpools/Vanpools[2]	247	35%	604	49%	497	57%	1,348	48%
Tolled at Black Dog Road[3]	379	54%	563	46%	325	37%	1,267	45%
Transit Buses[4]	17	2%	27	2%	14	2%	58	2%
SOVs (Violators)[5]	61	9%	40	3%	41	4%	142	5%

I-35W HOV Report, Including MnPASS Data 2011 – 3rd Quarter July-September, Minnesota Department of Transportation, Regional Transportation Management Center.

[1] Average weekday volume northbound July-September 2011 from loop detector data.

[2] Total vehicles less tolled vehicles, SOVs, and buses.

[3] MnPASS data.

[4] Number of transit buses northbound during January-March 2010 (MVTA only).

[5] Average percent SOVs northbound in three-day study in spring 2010 x total vehicles.

Table B-5 presents information on use of the I-35W HOV lanes for October – December 2008 and July – September 2009 in the pre-HOT lane deployment period with January – March 2010, and October – December 2010, and July – September of 2011 with the MnPASS HOT lanes in operation. The vehicle volumes in the HOT lane continued to increase after the expansion from HOV to HOT operations and the opening of the new HOT lanes in the Crosstown Commons section. The total number of vehicles in the northbound direction in the morning peak period increased from 2,068 during October – December 2008 to 2,815 in July – September 2011.

The table highlights the changes in user groups with the opening of the HOT lanes and ongoing use. In July – September 2011, there were 1,267 tolled vehicles using the HOT lanes during the three-hour a.m. peak period, accounting for 45 percent of the total vehicles. Tolled vehicles accounted for 35 percent of the total users in the January – March 2010 and 38 percent in October – December 2010. The number of carpools and vanpools declined from previous reports to 1,348, representing 48 percent of the total vehicles. The number of buses remained relatively constant, accounting for 2 percent of the total vehicles. The number of SOVs violating the operating requirements declined from 15 percent in 2008 to 5 percent in 2011.

In considering these changes, it is important to note that the methodology MnDOT used in calculating the use by different groups changed from the pre- to post-deployment periods. The methodology in 2008 and 2009 was based on a 2005 study, while the 2010 and later rates are back calculated. The single-occupant vehicle rate from 2008/2009 is based on data studies in 1997 and 2001, while the 2010 and later rate is based on a 2010 study. Comparisons of 2008/2009 to 2010 and later should consider these differences. Comparisons of changes from 2010 on may be more appropriate based on the same methodology used.

These figures indicate that the change from HOV to HOT operations and the addition of the new HOT lanes and the PDSL has resulted in a decline in carpooling and an increase in MnPASS use. A small percentage of the I-35W MnPASS customers responding to the online survey described in Section B.6 reported previously carpooling in the I-35W HOV lanes (2 percent) or driving alone in the HOV lanes and violating the occupancy requirements (1 percent). Further, 6 percent of the I-35W MnPASS customers responded that they carpool extremely often or often in the HOT lanes and 11 percent reported carpooling somewhat frequently. The survey results and the changes in carpool use presented in Table B-4 suggest that the MnPASS HOT lanes have attracted carpoolers to become MnPASS customers and that some commuters switch between carpooling and driving alone in the MnPASS HOT lanes on a regular basis.

Table B-5. Historical Use of I-35W HOV and HOT Lanes at the Minnesota River and Black Dog Road – A.M. Peak Period (6:00 a.m. – 9:00 a.m.)

	October-December 2008		July-September 2009		January-March 2010		October-December 2010		July-September 2011	
	Vehicle	%	Vehicle	%	Vehicle	%	Vehicle	%	Vehicle	%
Total Vehicles[1]	2,068		1,896		2,428		2,556		2,815	
Carpools/Vanpools[2]	1,718	83%	1,576	83%	1,406	58%	1,401	55%	1,348	48%
Tolled at Black Dog Road[3]	0	—	0	—	848	35%	969	38%	1,267	45%
Transit Buses[4]	47	2%	42	2%	46	2%	53	2%	58	2%
SOVs (Violators)[5]	303	15%	278	15%	127	5%	133	5%	142	5%

I-35W HOV Report, Including MnPASS Data 2009 – 4th Quarter October – December, Minnesota Department of Transportation, Regional Transportation Management Center. I-35W HOV Report, Including MnPASS Data 2010 1st Quarter January-March, Minnesota Department of Transportation, Regional Transportation Management Center. 3rd Quarter July-September, Minnesota Department of Transportation, Regional Transportation Management Center.

[1] Average weekday volume northbound during reporting period from loop detector data for all quarterly reports.

[2] Average percent carpools/vanpools northbound from October 2005 study x total vehicles for 2008 and 2009 quarterly reports. Total vehicles less tolled vehicles, SOV (violators), and buses for 2010 quarterly report.

[3] MnPASS data.

[4] Number of transit buses northbound during reporting period (MVTA only) prior to July-September 2010. MVTA and one Metro Transit route from October-December 2010 on.

[5] Average percent SOVs northbound in 1997 three-day study and two-day 2001 study x total vehicles for 2008 and 2009 quarterly reports. Average percent SOVs northbound in three-day study in spring 2010 x total vehicles for 2010 quarterly reports.

B.4 MnPASS Enforcement and Violations

The Minnesota State Patrol is responsible for traffic enforcement on Interstate freeways and state roadways. The State Patrol provides regular patrols on I-35W, as well as other freeways in the Minneapolis-St. Paul metropolitan area. In addition, MnDOT funds extra State Patrol coverage on the I-35W MnPASS HOT lanes during the morning and afternoon operating periods.

Information from the Minnesota State Patrol provided by MnDOT on MnPASS HOT lane violations for the eight-month period from May through December 2011 was reviewed and analyzed. As presented in Table B-6, the State Patrol issues citations and warnings for a number of violations, including MnPASS customers without active or engaged transponders, individuals without MnPASS accounts, and individuals crossing the double white lines separating the MnPASS lanes from the adjacent general-purpose freeway lanes.

The State Patrol also issues citations and warnings to individuals speeding, individuals not wearing seat belts, and individuals committing other traffic violations. These types of citations and warnings were not included in Table B-6, as they do not relate specifically to the MnPASS lane operations.

As presented in Table B-6, the majority of citations and warnings were issued to individuals driving alone in the MnPASS HOT lanes without a MnPASS account and active transponder. A total of 1,515 citations and 231 warnings were issued to drivers in this category over the eight-month period. Discounting for July, when the MnPASS lanes were not in operation for 21 days due to the Minnesota state government shutdown, there were an average of 249 citations and warnings a month to non-MnPASS drivers. MnPASS customers with an inactive, malfunctioning, or not engaged transponder represent the second largest number of citations and warnings. Finally, individuals illegally crossing the double white lines separating the MnPASS lanes from the adjacent general-purpose freeway lanes accounted for 32 citations and 134 warnings during the eight-month period.

The number of citations and warnings issued to drivers without an active MnPASS account remained relatively constant over the eight-month period. This trend suggests that some drivers may feel they can violate both the MnPASS toll and the carpool requirements and not get caught. These trends suggest that additional outreach and public education on use of the MnPASS HOT lanes is needed.

The interviews and focus groups with Minnesota State Patrol officers, FIRST operators, and bus operators identified some enforcement concerns related to the MnPASS lanes. State Patrol officers noted the difficulty of enforcing the PDSL due to the lack of space to pull vehicles over. The PDSL is the left shoulder, which is where officers would typically pull a vehicle over. With the PDSL, officers must follow suspected violators off the freeway and onto the downtown streets. Officers must then traverse the downtown streets to return to the freeway in the southbound direction. Bus operators in the focus groups voiced concerns with SOVs violating the MnPASS lanes and with SOVs swerving in and out of the MnPASS lanes, illegally crossing the double white lines.

Table B-6. MnPASS Violations – May through December 2011

Month	MnPASS Account Holders		Non-MnPASS Account Holders		Crossing Double-White Lines	
	Citations	Warnings	Citations	Warnings	Citations	Warnings
May	6	15	190	39	4	29
June	5	25	179	25	6	14
July	2	3	81	11	–	6
August	9	9	204	36	1	15
September	6	10	254	41	3	22
October	8	9	204	34	5	16
November	6	8	207	25	1	20
December	10	7	196	20	12	12
Total	52	86	1,515	231	32	134

Minnesota State Patrol

B.5 MnPASS Lanes Operations

Information on changes in the average median travel time, the end-to-end travel times, the average peak period and peak hour travel speeds, and the buffer index for the I-35W MnPASS lanes and the general-purpose freeway lanes was presented in Appendix A – Congestion Analysis. The information was examined by the three major segments, the total facility, by direction of travel, and by fall, winter, spring, and summer.

The changes in travel times and travel speeds presented in Appendix A were examined as part of the tolling analysis. As presented in Appendix A, travel times in the general-purpose freeway lanes were reduced in all sections in the northbound and southbound directions during the peak periods, except the section with the PDSL in the northbound direction, where travel times increased slightly. Travel times in the MnPASS lanes south of I-494 remained similar before and after expansion from HOV to HOT operation. Travel speeds increased in all sections at all times, except in the HOT lanes south of I-494, which remained relatively similar before and after expansion to MnPASS HOT operation. The buffer index improved in all sections for both the general-purpose freeway lanes and the MnPASS lanes. The buffer index and trip-time reliability was more stable or consistent in the MnPASS lanes, however.

Additionally, as noted in Appendix A, the interviews and focus groups with Minnesota State Patrol officers, FIRST operators, and bus operators indicated mostly positive responses to the MnPASS lanes. Bus operators noted trip-time savings from use of the lanes and easier driving once they entered the MnPASS lanes. They did note some concerns with having to cross three lanes of general traffic at some locations to enter the MnPASS lanes, however. As noted above, State Patrol officers did voice concern with the lack of enforcement space in the PDSL segment.

B.6 On-line MnPASS User Survey

An online survey of I-35W MnPASS account holders was conducted in January 2012. The survey included questions from the *Minnesota UPA Surveys, Interviews, and Focus Groups Test Plan*. The survey was administered by Cofiroute using Survey Monkey. Individuals with active I-35W MnPASS accounts were sent an e-mail requesting that they complete the on-line survey. The e-mail included a survey identification number, which had to be entered to access the survey and to register the individual for the chance to be one of the five winners of $15 in toll credit vouchers. MnDOT and Cofiroute have used this same on-line survey methodology with other surveys of both I-35W and I-394 MnPASS customers.

A total of 1,502 individuals completed the survey, representing a 20 percent response rate. The survey results have a 2.26 percent margin of error at the 95th percent confidence interval. Given the on-line survey methodology, there is a potential for self-selection bias. The socio-demographic characteristics of the respondents to this survey are similar to those of other I-35W MnPASS surveys, and are comparable to those of the Metro Transit On-Board Ridership Survey and the I-35W South Commuter Survey. A comparison of the number of months the respondents reported they had been a MnPASS customer with the number of accounts opened by month presented in Table B-2 indicates that the respondents may be more heavily weighted toward individuals who have been MnPASS customers for one-to-two years, however. The survey results were not weighted.

The socio-demographic characteristics of the respondents are presented first in this section, followed by a summary of use of the MnPASS HOT lanes and prior mode of travel. Cross-tabulation analyses of some variables, related to the prior mode of travel and use of the MnPASS HOT lanes are presented. Responses to other questions and related cross tabulations are presented in the appropriate appendices, including Appendix A – Congestion Analyses, Appendix E – Technology Analysis, Appendix F – Safety Analysis, Appendix G – Equity Analysis, and Appendix I – Non-Technical Success Factors Analysis.

B.6.1 Socio-Demographic Characteristics

Based on the survey, the vast majority of respondents were Caucasian/white. Males represented a slightly higher percentage of MnPASS customers. Respondents have family incomes over $70,000 and are in the working age groups. Slightly over half have two working automobiles available for their use, and over half reside south of the Mississippi River.

- Slightly more males responded to the survey than females, with 52 percent males and 48 percent females. A majority of respondents, 56 percent, reported their total family income last year was $100,000 or more, compared to approximately 2 percent below $29,000, 7 percent in the $30,000-to-$49,000 range, 12 percent in the $50,000-to-$69,000 range, and 24 percent in the $70,000-to-$99,000 range.
- In terms of age, 34 percent of the respondents indicated they were between 45 and 54 years of age, 27 percent were in the 35-to-45 age group, 17 percent were 55-to-64 years of age, and 13 percent were 24-to-34 years of age. Combined, the 18-to-24 age

group and the under 18 age group accounted for less than 1 percent of the respondents, and 6 percent of the respondents were 65 years of age and older.

- The vast majority of respondents, 95 percent, identified themselves as Caucasian/White, compared to a little over 1 percent for African American/Black, Asian, and Hispanic/Latino each. Only .3 percent of the respondents were American Indian.
- The majority of respondents, 56 percent, indicated they had two working automobiles available for their use, 21 percent reported one working automobile, 17 percent reported 3 automobiles available, and less than one percent indicated they did not have access to an automobile.
- Respondents were asked open-ended questions on the zip code they traveled from on a typical day and zip code they traveled to on a typical day. The majority of respondents, 66 percent, were traveling from zip codes south of the Minnesota River. Approximately 28 percent of the respondents were commuting from zip code zones in Lakeville, 17 percent were from Burnsville, 6 percent from Savage, 5 percent from Prior Lake, 5 percent from Apple Valley, 3 percent from Northfield, and 2 percent from Farmington. Two zip codes from Iowa and one from Wisconsin were listed. North of the Minnesota River, approximately 6 percent of the respondents were from zip codes in Bloomington and approximately 6 percent were traveling from zip codes zones in Minneapolis. Approximately 20 percent of the respondents reported destination zip codes in the downtown area of Minneapolis. Other reported zip codes destinations included Bloomington, 19 percent; Eden Prairie, 5 percent; and Edina, 7 percent. Additional destinations with approximately 2 percent each were Burnsville, Golden Valley, St. Paul, Falcon Heights, Arden Hills, Crystal, Eagan, Fridley, and Brooklyn Center. Five percent of the respondents did not provide a zip code destination. The remaining 26 percent was spread through the metropolitan area.

B.6.2 MnPASS HOT Lane Mode of Travel and Use

The key questions on the survey for analyzing the tolling hypotheses relate to the prior mode of travel. As noted in this section, 93 percent of the respondents previously drove alone – 83 percent in the I-35W general-purpose freeway lanes and 8 percent on another roadway.

- Before becoming an I-35W MnPASS customer, 85 percent of the respondents reported driving alone in the general-purpose freeway lanes, 8 percent drove alone on another roadway, 2 percent did not make the trip, 2 percent carpooled in the HOV lanes, 1 percent rode the bus on the HOV lanes, and 1 percent drove alone in the HOV lane.
- A total of 6 percent of the respondents indicated they carpool for free on the I-35W MnPASS lanes extremely often or very often, while 11 percent reported carpooling somewhat often, and 83 percent reported carpooling not very often or not at all.
- Of those individuals carpooling, 82 percent reported sharing a ride with family members, 24 percent rode with co-workers or co-students, and 5 percent carpooled with neighbors.
- The majority of respondents, 60 percent, reported being a MnPASS customer for one-to-two years. Of the remainder, 21 percent reported having a MnPASS account for two-to-

three years, 16 percent for six months-to-one year, and 3 percent for over three years. As noted previously, the respondents reflect more individuals who reported being MnPASS customers for one-to-two years than the registration information in Table B-2 reflects. That information indicates that approximately 20 percent of I-35W South MnPASS customers have registered in the previous six month-to-one year, 30 percent registered in the previous one-to-two years, and 50 percent registered in the previous two-to-three years.

- Slightly over half, 51 percent, reported making more than six one-way trips a week on I-35W, including trips taken in the I-35W MnPASS lanes. Only 17 percent reported using the I-35W MnPASS lanes for more than six one-way trips a week, however, with 12 percent reporting making five one-way trips a week, 22 percent making one or two one-way trips, and 2 percent making less than 1 one-way trip a week on the I-35W MnPASS lanes.
- Work commute trips represent 88 percent of reported trips, followed by work appointments, 12 percent; personal business, 11 percent; recreational, 4 percent; medical, 2 percent; and school, 2 percent.
- In response to a question on the MnPASS lane segments most frequently used (multiple responses possible), 73 percent identified using the MnPASS section northbound from Burnsville Parkway to Highway 62, 53 percent reported the corresponding southbound section from I-494 to Burnsville Parkway, 40 per cent reported using the northbound section from Highway 62 to downtown Minneapolis, and 25 percent used the southbound segment from 42nd Street to I-494.
- Survey respondents were asked which of six factors influence their use of the MnPASS lanes, with multiple responses allowed. Congestion levels on the freeway lanes was selected by 94 percent of the respondents, followed by important work meeting – cannot afford to be late with 62 percent, family responsibilities – cannot afford to be late with 31 percent, and personal business meetings – cannot afford to be late with 19 percent.
- Survey respondents were asked to select the best things about traveling in the MnPASS toll lanes from a list of seven factors, with multiple selections possible. Time savings were selected by 93 percent of the respondents followed by 69 percent for less/no traffic, 69 percent for ability to travel faster, 60 percent for less stress/relaxing, and 50 percent for ease and convenience. Less wear and tear on an automobile was selected by 23 percent of the respondents and more safe/safety was identified by 20 percent.
- Separate, open-ended questions asked respondents how much time they saved per one-way trip during the morning and the afternoon rush hour when they used the I-35W MnPASS toll lanes. In the morning rush hour, approximately 8 percent of the respondents indicated they saved 30 minutes by using the MnPASS lanes, 18 percent reported saving 20 minutes, 22 percent reported saving 15 minutes, 22 percent said they saved 10 minutes, 8 percent reported saving 5 minutes, and 6 percent reported no time savings. The reported time savings in the afternoon rush hour were 8 percent 30 minutes, 15 percent 20 minutes, 19 percent 15 minutes, 20 percent 10 minutes, 12 percent 5 minutes, and 10 percent no time savings.

B.6.3 Cross Tabulations

Cross tabulations were examined for some variables to obtain a better understanding of prior mode and the use of the I-35W South MnPASS HOT lanes. Table B-7, presents the number of trips per week using the I-35W South MnPASS HOT lanes by prior mode of travel. The results indicate that 32 percent of regular users of HOT lanes (5 or more trips) and another 20 percent of frequent users (3 to 4 trips) formerly drove alone in the general-purpose freeway lanes. These results are similar to those who reported driving alone on another freeway or roadway (57 percent), and those who did not previously make the trip (or left the prior mode blank), at 55 percent. The former carpoolers show a lot higher percentage in the two heavy use categories (68 percent), suggesting that these carpoolers are diverting to using the HOT lanes regularly now instead of carpooling. This suggests that people need to save the time, but the carpool is a logistics hassle, and the cost of the HOT lanes is not a limiting factor. The former bus riders have the opposite result, with only 31 percent being heavy HOT lane users. This may reflect that bus riders continue to primarily use the bus, but may supplement occasionally with HOT lane use. These results are not statistically significant, but offer an interesting observation on possible implications of the MnPASS HOT lanes.

Table B-7. I-35W South MnPASS Trips per Week by Prior Mode

Number of Trips per Week on I-35W South MnPASS HOT Lanes	Prior Mode													
	Drove Alone in general purpose lanes	Percent	Drove alone in HOV lanes	Percent	Drove alone on another freeway or roadway	Percent	Carpooled in the HOV lanes	Percent	Rode bus	Percent	Did not make trip/blank	Percent	Total	Percent
5+ trips a week	405	32%	3	37%	47	38%	18	52%	5	26%	21	40%	499	33%
3-4 trips a week	248	20%	0	0%	24	19%	5	15%	1	5%	8	16%	286	19%
1 or 2 trips a week	282	22%	4	50%	28	22%	7	21%	4	21%	11	21%	336	22%
Less than 1 trip a week or no trips	329	26%	1	13%	26	21%	4	12%	9	48%	12	23%	381	26%

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Table B-8 presents the prior mode of travel by the number of years the respondent has been a MnPASS customer. There is no statistical significance between prior mode of travel and the number of years an individual has been a MnPASS customer.

It is likely that the inconclusiveness of the general test for both cross tabulations is affected by the dominance of "drove alone" as a prior mode. To test this, a second chi-square was run, testing "drove alone" against all other prior modes and years of use. The calculated X2 is less than the critical X2 at 10 percent, suggesting there is not a relationship between trips per week and prior mode or prior mode and years of usage.

Table B-8. Prior Mode by Years MnPASS Customer

Previous Mode	Number of Years I-35W South MnPASS Customer									
	Over 3 Years		2-3 Years		1-2 Years		6 Months to 1 Year		Total	
Carpooled in HOV Lanes	2	6.1%	10	30.3%	14	42.4%	7	21.2%	33	100%
Drove Alone on I-35W South General-Purpose Freeway Lanes	40	3.2%	263	20.9%	762	60.6%	193	15.3%	1,258	100%
Drive Alone on Another Freeway or Roadway	2	1.6%	26	20.8%	73	58.4%	24	19.2%	125	100%
Road Bus on I-35W South or Other Freeway	2	10.5%	3	15.8%	13	68.4%	1	5.3%	19	100%
Drove Alone in the I-35W HOV Lanes	1	12.5%	1	12.5%	2	25%	4	50%	8	100%
Did Not Make Trip	0	0	4	12.9%	19	61.3%	8	25.8%	31	100%
Other	1	5.6%	2	11.1%	13	72.2%	2	11.1%	18	100%

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B.7 I-35W South Commuter Telephone Survey

As part of the UPA national evaluation, MnDOT sponsored a telephone survey of commuters in the I-35W South corridor. The Dieringer Research Group (DRG), Inc. conducted the interviews, following the questionnaire contained in the *Minnesota UPA National Evaluation Surveys, Interviews, and Focus Groups Test* Plan. The purpose of the survey was to gather information from morning commuters traveling northbound on I-35W corridor between Burnsville Parkway and downtown Minneapolis to gain insights on attitudes and perception about the UPA projects. The interviews focused on travelers in the I-35W general-purpose freeway lanes and carpoolers using the MnPASS HOT lanes to understand if the UPA improvements changed their general perception of traffic flow, travel behavior, and their travel mode.

A total of 499 interviews were completed between April 26 and May 24, 2011. The average interview length was 12 minutes. A carpool sample was provided by MnDOT and a sample based on zip codes along the I-35W corridor was purchased. The sampling error was +/- 4 percent at the 95 percent confidence level. Respondents had to meet the following qualifications to participate in the telephone interview.

- Be at least 18 years of age;
- Travel northbound on I-35W between Burnsville Parkway and downtown Minneapolis;
- Personally travel at least 3-4 times a week, Monday–Friday;
- Drive regularly on I-35W for two or more years;
- Not have participated previously in MnDOT sponsored research; and
- No conflicting professional bias.

The interviews were included both general freeway users and carpoolers, with each group responding to a series of questions most relevant to them. Table B-9 presents the travel modes used by respondents.

Table B-9. Commute Modes Used by Respondents[1]

When Traveling on I-35W , do you currently:	Number	Percentage
Travel in I-35W South general lanes	400	80%
Carpool in I-35W MnPASS lanes	118	24%
Ride the bus in I-35W corridor	47	9%
Use I-35W MnPASS lanes as a toll paying MnPASS customer	43	9%

DRG, Inc.

[1] Respondents were able to select more than one mode.

Since it was possible for one commuter to utilize multiple modes of travel, mutually exclusive model groups were created to remove possible overlap for statistical testing purposes. Table B-10 presents this breakdown.

Table B-10. Respondents Mode of Travel

	Number	Percentage
General Users Only	316	63%
Carpool/Bus Riders Only	73	15%
Multiple Commuting Methods	110	22%
Total Sample	499	100%

DRG, Inc.

The following highlights the profile of the interview respondents.

- Primary purpose for using I-35W is for commuting to work.
- Over two-thirds have a four-year college degree or higher, earning an income between $50,000 to $200,000.
- Average number of working automobiles is 2.
- Majority are white or Caucasian.
- Slightly over half are male.
- Twelve percent ride the bus in the I-35W corridor.

The key questions from the survey for addressing the second hypothesis related to I-35W South HOV lane travelers remaining in the MnPASS HOT lane focused on how long the respondents had been carpooling on I-35W South. As presented in Table B-11, 66 percent of the 118 individuals responding to this question indicated they had been carpooling for over three years. Based on the 118 sample size, this response has a 9.00 margin of error at the 95 percent level. The 66 percent is statistically significant, but the other categories are too small to report any significance. These results support the hypotheses that some carpoolers using the I-35W South HOV lanes continue to use the MnPASS HOT lanes.

Table B-11. How Long Respondents Have Been Carpooling on I-35W South

How long have you been carpooling on I-35W?	Number	Percent
Less than 1 year	10	8.5%
1 to 2 years	12	10.2%
2 to 3 years	13	11.0%
Over 3 years	78	66.1%
Don't know	5	4.2%
Total	**118**	**100%**

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B.8 Summary of Tolling Impacts

As highlighted in Table B-12, the hypotheses related to the MnPASS lanes and tolling aspects of the Minnesota UPA are supported by the operation of the lanes. The analysis presented in Appendix A indicates that vehicular throughput has increased on I-35W South – and is being sustained – as a result of the MnPASS HOT lanes, including the PDSL. The results of the surveys of MnPASS customers and travelers on I-35 indicated that some individuals driving alone in the general-purpose freeway lanes have become MnPASS customers and have shifted to using the MnPASS lanes on a regular or somewhat frequent basis. The MnDOT quarterly reports and the MnPASS and I-35W commuter survey results present different perspectives on changes in carpools. The MnDOT quarterly reports and the MnPASS survey indicate some carpoolers have become MnPASS customers and use the MnPASS HOT lanes as solo drivers. The I-35W South commuter telephone survey indicated some carpoolers have remained carpoolers after the expansion to HOT lanes. According to MnDOT data, violation of the HOV requirements have been reduced with the expansion of the HOV lanes to the MnPASS HOT lanes, although 2011 data from the Minnesota State Patrol indicate an ongoing low level of MnPASS toll payment violations. Finally, the use data on the I-35W MnPASS lanes and the PDSL indicates that vehicular throughput is being maintained.

Table B-12. Summary of Tolling Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Vehicle access on the HOT lanes and PDSL on I-35W will be regulated to increase vehicular throughput in the corridor.	Supported	The analysis presented in Appendix A indicates that vehicle throughput has increased on I-35W South as a result of the MnPASS lanes, including the PDSL.
• Some general-purpose lane travelers will shift to the I-35W HOT lanes and PDSL, while HOV lane travelers will remain in the HOT lane.	Supported	The results from the MnPASS customer survey, as well as the surveys of travelers in the I-35W South corridor discussed in Appendix A, indicate that some SOV travelers have become MnPASS customers and shifted to using the MnPASS lanes, while some carpoolers have continued their use of the MnPASS HOT lanes.
• HOV violations will be reduced.	Supported	According to the MnDOT Quarterly Reports, HOV violations were reduced from approximately 15% to 5% with the expansion of the existing I-35W HOV lanes to MnPASS HOT lanes in October 2010. Data from the Minnesota State Patrol indicate an ongoing low level of violations of MnPASS toll payments, however.
• After ramp-up, the HOT lanes and PDSL on I-35W maintains vehicular throughput gains on the priced facility.	Supported	The analysis presented in Appendix A indicates that the vehicular throughput gains are being sustained after the opening of the MnPASS lanes and the ramp-up period.

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Appendix C. Transit Analysis

Transit represented a key element of the Minnesota UPA. The Minnesota UPA transit projects focused on making riding the bus in the I-35W and Cedar Avenue corridors and in downtown Minneapolis more attractive and convenient by reducing bus travel times, increasing trip-time reliability, adding transit services and park-and-ride lot capacity, and making other improvements. The major transit projects included the Transit Advantage Bus Bypass Lane at the Highway 77/Highway 62 Interchange, the Marquette Avenue and Second Avenue (MARQ2) dual bus lanes in downtown Minneapolis, six new or expanded park-and-ride lots, 27 new buses, and the driver assist system (DAS) for shoulder running buses. Other transit projects were the next bus arrival signs along the MARQ2 lanes and the bus and freeway travel times and park-and-ride lot space availability signs along I-35W.

Table C-1 presents the hypotheses for the Minnesota UPA transit analysis. The first hypothesis relates to the increased travel speeds of buses, the travel-time savings, and the improved trip-time reliability provided by the MnPASS high-occupancy toll (HOT) lanes, the priced dynamic shoulder lane (PDSL), the Transit Advantage project, the MARQ2 project, and the DAS for shoulder running buses. The second and third hypotheses relate to increasing transit ridership, influencing a mode shift to transit, and reducing congestion on I-35W resulting from adding capacity at new and existing park-and-ride lots and adding service to new and existing bus routes. The last hypothesis relates to the relative contribution of each of the transit strategies to mode shift and congestion reduction.

Table C-1. Transit Analysis Approach

Hypotheses/Questions
• The HOT lanes, PDSL, MARQ2 bus lanes, Transit Advantage project, and the DAS for shoulder running buses will increase bus travel speeds, reduce bus travel times, and improve bus on-time performance in the I-35W and Cedar Avenue corridors, and downtown Minneapolis
• The new park-and-ride lots and new and expanded transit services will result in ridership increases including a mode shift to transit.
• The mode shift to transit from the UPA transit strategies will reduce congestion on I-35W, downtown Minneapolis, and other roadways.
• What was the relative contribution of each of the Minnesota UPA transit strategies to mode shift to transit?

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The remainder of this appendix is divided into six sections. The data sources used in the analysis are presented in Section C.1. Information on bus travel times, bus speeds, bus throughput, and bus on-time performance is presented in Section C.2. Data on park-and-ride lot use are provided in Section C.3. Changes in transit ridership are discussed in Section C.4. The results from a 2011 Metro Transit on-board ridership survey, which included questions related to some of the UPA projects, and a 2011 on-onboard survey conducted by the MVTA on the Cedar Avenue shoulder running bus system and driver assist system (DAS), are presented in Section C.5. The results from focus groups conducted with Metro Transit and MVTA bus operators and a survey and focus groups of MVTA operators trained in using the DAS are summarized in Section C.6. The appendix concludes with a summary of the impacts from the transit UPA projects in Section C.7.

C.1 Data Sources

A variety of data sources from Metro Transit and MVTA, along with special studies and surveys, were used to analyze the Minnesota UPA transit projects. A first data source was bus travel-time data and on-time performance data collected through the Metro Transit automatic vehicle location (AVL) system and the MVTA AVL system and on-board surveyors. A second data source was park-and-ride lot counts and license plate surveys conducted by Metro Transit and MVTA. A third data source was ridership data for bus routes in the I-35W South, I-35W North, and Cedar Avenue corridors. The I-394 corridor, which also has a MnPASS HOT lane, and the I-94 North corridor were used as control corridors for the transit analysis.

Data from these three sources were collected from February 2009 through October 2011. The pre-deployment data collection period was from February 2009 to October 2009. Most of the transit projects were implemented between October and December, 2009. The reconstruction of the Crosstown Commons section, including the new MnPASS HOT lane, was not completed until November 2010. The post-deployment data collection period was November 2010 to October 2011.

The data were analyzed by examining the percent changes and the overall trends. The percent changes in ridership were analyzed using a three-month average for March, April, and May. These months were selected as they are generally unaffected by winter weather and are before summer holidays. Additionally, these months were not influenced by the opening of the various HOT lane segments. The month of April was also used to examine some elements, including bus travel speeds and bus travel times. Park-and-ride lot counts were taken in selected months in 2009, 2010, and 2011.

Special data collection activities were conducted by Metro Transit and MVTA to obtain bus travel speeds and travel times on the Transit Advantage project, which was completed in December 2008, and the MARQ2 lanes, which opened in December 2009. The travel time savings on the Transit Advantage project were analyzed by comparing bus travel times before and after the project opened. A comparison was also made of the travel times of vehicles using Transit Advantage with those of buses traveling the prior route.

For the MARQ2 lanes, Metro Transit staff collected and analyzed bus travel speed data in March 2008, prior to construction, and in March 2010 and February 2011 after the opening of the lanes in December 2009. Two data collectors were used to collect bus numbers and time-of-day information on the MARQ2 lanes. The data collectors were located in skyways at 10th Street and at either 3rd Street or 4th Street, which represent the beginning and end points of the lanes. The individuals recorded the number of each bus and the time it passed under their location. This information was entered into an Excel spreadsheet and the time stamp of each vehicle at the start and end locations were compared to calculate the total time taken to traverse the facility. This number was then compared to the distance between the two points to calculate an average speed.

Other data sources used in this analysis included the on-board surveys of passengers conducted by Metro Transit and the focus groups of Metro Transit and MVTA bus operators sponsored by MnDOT. The onboard ridership survey was conducted in November 2011 and the focus groups were conducted in May 2011.

The FTA sponsored a separate evaluation of the DAS for shoulder running buses. This evaluation, which was conducted by the National Bus Rapid Transit Institute (NBRT) at the Center for Urban Transportation Research (CUTR) focused on assessing the six broad areas of bus driver satisfaction, customer satisfaction, efficiency/productivity, technical performance, maintenance, and safety. The evaluation used a "with and without" approach. Performance data were collected from the same bus operators with the DAS set to passive mode for a 20-day period and then to an active mode for a 35-day period. The evaluation also included an examination of MVTA bus accident data, DAS maintenance records, an on-board survey of riders, and surveys and focus groups with MVTA operators trained to use the DAS. The evaluation is documented in *Cedar Avenue Driver Assist Evaluation Report*, FTA Report No. 0010, December 2011.

C.2 Bus Travel Time and On-Time Performance Data

The HOT lanes, PDSL, MARQ2 lanes, and the Transit Advantage project focus on increasing travel speeds for buses, reducing bus travel times, and improving bus on-time performance. Data to assess these changes were obtained through the Metro Transit AVL system, which provides continuous travel time data, and, for the MVTA from the new AVL system and manually for buses using on-board and/or point-checks with time resolution of seconds rather than minutes. Information on travel times, travel speeds, and on-time performance for buses using the MnPASS HOT lanes on I-35W South is presented next, followed by information on changes in bus travel speeds on the MARQ2 lanes and influence of the DAS on shoulder running bus travel speeds.

Metro Transit and MVTA examined the impact of the Transit Advantage bus bypass lane/ramp at the Highway 77/Highway 62 intersection shortly after it opened in December 2008. The analysis indicated a travel-time savings of 60-to-90 seconds for buses using the facility during the morning peak period. A total of 52 in-service MVTA buses and eight Metro Transit pull-out buses use the facility in the morning peak period.

Tables C-2, C-3, C-4, and C-5 present information on the changes in bus speeds and travel times between April 2009 and April 2011 on the three sections of the I-35W MnPASS lanes – the section south of I-494 where the existing HOV lanes were expanded to HOT lanes, the new HOT lanes in the Crosstown Commons section, and the new PDSL north of 38th Street. As presented in the tables, the changes in speeds and travel times varied by segment and by direction of travel. These changes and the differences by segments and direction of travel are similar to those described in Appendix A – Congestion Analysis. Thus, it appears the data from the MnDOT loop detectors and the data from the Metro Transit and MVTA AVL systems reflect similar changes.

Buses traveling in the HOT lanes in the Crosstown Commons section recorded the largest increase in speeds in both directions of travel. Bus speeds increased by 29.0 mph in the northbound direction and 10.5 mph in the southbound direction. Prior to the new HOT lanes, buses operated in the congested general-purpose freeway lanes. With lane drops and merge points, this section was a major bottleneck. There was a 3.2 mph decrease in speeds with buses using the PDSL segment in the northbound direction. In April 2009, buses operated using the right-shoulder when appropriate and the general-purpose freeway lanes. In April 2011, buses operated in the PDSL at slightly slower speeds. There was a 1.9 mph decrease in bus speeds on the HOT lanes south of I-494 in the northbound direction during the morning peak. With the addition of toll paying MnPASS vehicles, there are more vehicles in the HOT lanes than the previous HOV lanes, resulting in the slight decrease in speeds.

Bus travel times decreased by approximately 4 minutes overall in the northbound direction. There was a travel time reduction of approximately 5 minutes in the Crosstown Commons section offsetting slight increases in bus travel times south of I-494 and in the PDSL section. In the southbound direction, bus travel times were reduced by a little over 1 minute in the Crosstown Commons section and HOT segment south of I-494.

The slower speeds and increased travel times in the PDSL section may be influenced by a number of factors. First, as discussed in Appendix A – Congestion Analysis, it appears that the re-construction of the Crosstown Commons section resulted in shifting congestion to other bottleneck locations including the section of I-35W where the PDSL is located. This section includes the exit to downtown Minneapolis, as well as the merges to I-94 eastbound and westbound. Second, buses now share the PDSL with other vehicles, where as they previously operated on the bus-only right shoulders. Third, the buses may be delayed at the traffic light at 11th Street and 4th Avenue, which is the first signalized intersection after exiting the PDSL. This intersection was used as the end point in the travel time calculations. The previous time point is at I-35W South and Lake Street, so it would not capture the full use of the PDSL. The city of Minneapolis has plans to conduct a systematic re-timing of the downtown traffic signals in 2012.

Table C-2. Bus Speeds in the MnPASS Lanes Northbound in the Morning Peak

HOT Segment	Apr 2009	Apr 2011	Change
PDSL Section	29.6 mph	26.4 mph	-3.2 mph
Crosstown Commons Section HOT Section	28.0 mph	57.0 mph	+29.0 mph
South of I-494 HOT Section	53.8 mph	51.9 mph	-1.9 mph

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Table C-3. Bus Speeds in the MnPASS Lanes Southbound in the Afternoon Peak

HOT Segment	Apr 2009	Apr 2011	Change
PDSL Section	n/a	n/a	n/a
Crosstown Commons Section HOT Section	47.9 mph	58.3 mph	+10.5 mph
South of I-494 HOT Section	47.4 mph	48.8 mph	+1.4 mph

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Note: The PDSL operates only in the northbound direction.

Table C-4. Bus Travel Times in the MnPASS Lanes Northbound in the Morning Peak

HOT Segment	Apr 2009	Apr 2011	Change
PDSL Section	03:19	03:43	+00:24
Crosstown Commons Section HOT Section	09:56	04:51	-05:05
South of I-494 HOT Section	06:48	07:03	+00:15
TOTAL	**20:03**	**15:37**	**-04:26**

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Note: Data is in minutes and seconds.

Table C-5. Bus Travel Times in the MnPASS Lanes Southbound in the Afternoon Peak

HOT Segment	Apr 2009	Apr 2011	Change
PDSL Section	n/a	n/a	n/a
Crosstown Commons Section HOT Section	05:46	04:44	-01:02
South of I-494 HOT Section	07:43	07:30	-00:13
TOTAL	**13:29**	**12:14**	**-01:15**

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Note: Data is in minutes and seconds. The PDSL operates only in the northbound direction.

As illustrated in Figure C-1, the on-time performance for buses operating on I-35W South varied considerably over the course of the evaluation period. Bus on-time performance suffered during the re-construction of the Crosstown Commons section, which included lane and ramp closures. Table C-6 presents the three-month averages for 2009, 2010, and 2011. The best on-time performance rating – 87.2 percent – was recorded in March from May 2011 during the post-deployment period. These results highlight the benefits of the UPA projects on bus on-time performance.

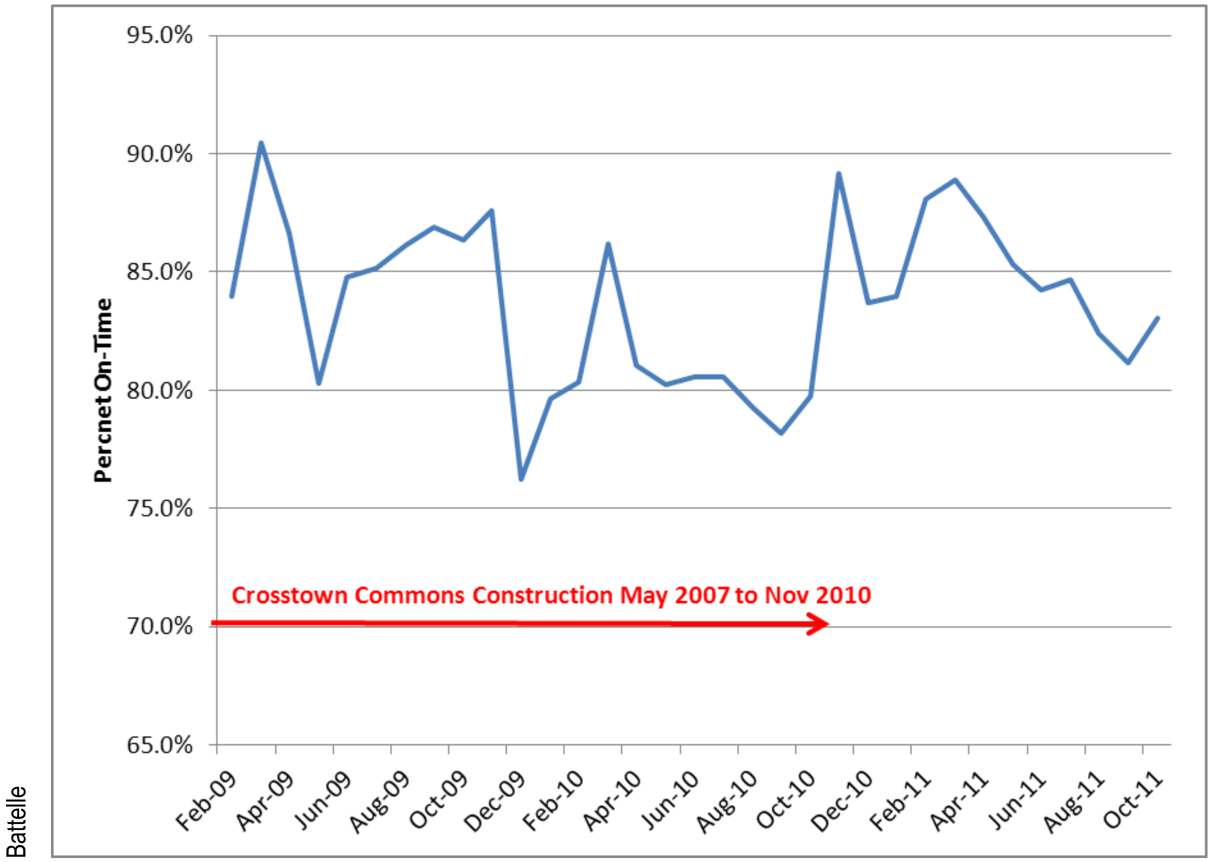

Figure C-1. Percent On-Time Performance of Buses on I-35W South (All Day)

Table C-6. I-35W Bus On-Time Performance I-35W South (All Day)

March-May 2009	March-May 2010	March-May 2011
85.8%	82.5%	87.2%

Battelle

*Percentage of buses meeting on-time performance measure.

As noted previously, bus travel speeds on the MARQ2 lanes were measured through special monitoring. The target speed of buses on the MARQ2 lanes is 8 mph. Table C-7 presents the results of the monitoring for March 2008 (before the MARQ2 lanes), May 2010 (five months after the opening of the MARQ2 lanes), and April 2011 (15 months after opening of the MARQ2 lanes). The travel speeds of buses using the MARQ2 lanes increased significantly from the before period. The largest increase in bus operating speeds was realized on 2nd Avenue in the morning peak period; speeds were 4.3 mph in 2008 and 7.4 in 2011, representing a 72 percent increase. Buses operating on 2nd Avenue in the afternoon peak period experienced a 60 percent increase in speeds, from 4.0 mph to 6.4 mph. Buses operating speeds on Marquette Avenue increased by 31 percent in the morning peak period, and by 46 percent in the afternoon peak period.

Metro Transit personnel continue to examine the operation of the lanes, and other factors influencing the movement of buses in the downtown area, to maximize the benefits from the MARQ2 project. These increases in operating speeds are realized by buses on all routes using the MARQ2 lanes, not just those operating on I-35W.

Table C-7. Changes in MARQ2 Lanes Average Speeds (mph)

	March 2008	May 2010	April 2011	Percent Change 2008-2011
Marquette Ave. AM	5.1 mph	6.8 mph	6.7 mph	31%
Marquette Ave. PM	3.9 mph	5.8 mph	5.7 mph	46%
2nd Ave. AM	4.3 mph	6.6 mph	7.4 mph	72%
2nd Ave. PM	4.0 mph	5.9 mph	6.4 mph	60%

Metro Transit

The addition of the second bus-only lane to Marquette and 2nd Avenues provided increased capacity for buses. To take advantage of this capacity and the higher operating speeds, express routes in downtown Minneapolis were moved from the Nicollet Mall and other streets to the MARQ2 lanes. As discussed in Section C.5, this consolidation of express routes on MARQ2 has resulted in increased ridership. Table C-8 and C-9 show the increase in bus throughput in the morning and afternoon peak period for selected months from February 2009 to February 2012. The number of buses operating on the MARQ2 lanes increased by 23.4 percent in the a.m. peak period (111 more buses) and by 51.7 percent in the p.m. peak period (200 more buses).

Table C-8. Morning Peak Period Bus Throughput on MARQ2 Lanes for Selected Months

Segment	Feb 2009	Apr 2010[1]	Feb 2011	Feb 2012	% Change 2009 – 2012
Marquette Ave.	201	253	249	251	24.9%
2nd Avenue	274	338	328	335	22.3%
Total	475	591	577	586	23.4%

Battelle

[1] April 2010 represents the first month after the express buses on the Nicollet Mall were re-routed to the MARQ2 lanes.

Table C-9. Afternoon Peak Period Bus Throughput on MARQ2 Lanes for Selected Months

Segment	Feb 2009	Apr 2010[1]	Feb 2011	Feb 2012	% Change 2009 – 2012
Marquette Ave.	180	343	338	334	85.6%
2nd Avenue	207	253	256	253	22.2%
Total	387	596	594	587	51.7%

Battelle

[1] April 2010 represents the first month after the express buses on the Nicollet Mall were re-routed to the MARQ2 lanes.

The FTA-sponsored evaluation of the Cedar Avenue shoulder running buses and the DAS was not able to assess any direct impact on travel times and on-time performance of DAS-equipped buses. The "with and without" analysis conducted in March 2011 used the on-board computers on the DAS-equipped buses to collect lane-position and speed data. The results during the period the DAS was in use were compared to the results during the period the DAS was not in use.

The results of the analysis were mixed, with a 10 percent overall increase in use of the shoulder. Two of the six bus operators increased their use of the shoulders with the DAS, four operators used the shoulder slightly less, and one operator used the shoulder significantly less. The average speed operating in the shoulder lane did increase with the use of the DAS. The maximum operating speed in the shoulders for buses is 35 mph. The average speed without the DAS was close to 31 mph. The average speed with the DAS increased to 34 mph, with all six operators recording faster travel speeds with the DAS. The analysis was not able to document overall changes in travel times and on-time performance even with the slight increase in speeds with the DAS in use.

C.3 Park-and-Ride Lot Use

Five new park-and-ride lots were constructed and one park-and-ride lot was expanded as part of the Minnesota UPA. The park-and-ride lots were a key element in addressing constraints in the ability to attract new riders to transit in the I-35W corridor. The park-and-ride lots were also intended to provide capacity for future ridership growth in the I-35W corridor.

Two of the park-and-ride lots are located along I-35W North and four facilities are located along I-35W South and Cedar Avenue. One lot opened in September 2009, two followed in November, and two more opened in December. The final facility opened in March 2010. The lots added a total of 2,347 new parking spaces – 960 along I-35W North and 1,387 along I-35W South and Cedar Avenue. New routes were implemented with three lots, while existing and restructured routes serve other lots.

Metro Transit and MVTA conduct counts of vehicles parked at park-and-ride lots on an annual basis. Additional counts were taken at the new and expanded lots as part of the UPA monitoring and evaluation activities. Daily counts were taken in September 2009, January 2010, April 2010, October 2010, January 2011, April 2011, and September 2011.

Table C-10 presents the 2009, 2010, and 2011 daily counts for the park-and-ride lots in the I-35W corridor. Table C-11 presents similar information for park-and-ride lots in the I-394 and I-94 corridors.

Daily use of the new and expanded park-and-ride lots has continued to increase since the end of 2009. Total use of the lots along both I-35W North and I-35W South and Cedar Avenue increased from 2009 to 2011. Use of the expanded I-35W and 95th Avenue North park-and-ride lots increased by 57 vehicles and the new park-and-ride lot at I-35W North and County Road C increased from zero to 119 vehicles in September 2011. Park-and-ride lots at the Rosedale Transit Center and I-35W North and County Road H experienced declines in the number of parked vehicles. The decline in the use of the Rosedale Transit Center partially reflects the Rosedale Shopping Center Management's decision to reduce the number of parking spaces available to Metro Transit for the park-and-ride lot. Some users of the Rosedale lot may have shifted to the new I-35W North and County Road C facility.

Use of the park-and-ride lots along I-35W South increased by 641 vehicles. The larger increase in use of the I-35W South park-and-ride lots may reflect both new routes from these lots and the benefits provided by use of the MnPASS/HOT lanes. As discussed next, there has been some redistribution of use among the various lots. Use of the park-and-ride lot on I-94 increased by 24 vehicles from September 2009 to September 2011, while the lots along I-394 increased by 60 vehicles in April 2011, but declined below September 2009 levels in September 2011.

Metro Transit and MVTA conduct license plate surveys of vehicles parked at park-and-ride lots every other year on the even year. The locations corresponding to the address on record for the license plates of vehicles at the lots are mapped to illustrate the park-and-ride lot travel shed. Metro Transit and MVTA compare the results to previous years to identify possible changes in the use of park-and-ride lots by bus riders. This information is especially important with the opening of new lots, as existing park-and-ride lot users may change to locations that are more convenient. Metro Transit and MVTA completed license plate surveys of park-and-ride lots in September and October of 2008 and in September and October 2010.

Comparing the results of the 2008 and 2010 license plate surveys indicates some shifting to new lots by existing riders. The opening of the new park-and-ride lot at I-35W South and Kenrick Avenue attracted some existing riders to change from other park-and-ride lots, primarily the Burnsville Transit Station and the Apple Valley Transit Center. The expanded Apple Valley Transit Center lost some riders to the new Kenrick facility, but it also gained some existing riders from other facilities, including the Burnsville Transit Station. New license plates were recorded in the 2010 surveys, indicating that new riders have been attracted to the system.

Table C-10. Daily Park-and-Ride Lot Use in the I-35W Corridor

Lot	2009		2010			2011		
I-35W North (Date Opened/Expanded)	**Capacity**	**Sept Use**	**Jan Use**	**April Use**	**Oct Use**	**Jan Use[1]**	**April Use**	**Sept Use**
95th Ave N. & I-35W (11/09)	1,500	835	795	752	855	855	851	892
Rosedale Transit Center	375	327	294	294	240	n/a	211	204
County Road H & I-35W	211	129	137	122	87	n/a	116	124
County Road C & I-35W (12/09)	460	—	38	40	68	115	128	119
TOTAL	**2,546**	**1,291**	**1,264**	**1,208**	**1,250**	**970**	**1,306**	**1,339**
I-35W South	**Capacity**	**Sept Use**	**Jan Use**	**April Use**	**Oct Use**	**Jan Use[1]**	**April Use**	**Sept Use**
I-35W and Kenrick Avenue (9/09)	751	—	213	267	271	317	373	395
Cedar Grove Transit Center (3/10)	164	—	—	3	30	35	47	44
South Bloomington Transit Center	195	111	115	134	161	n/a	156	180
Burnsville Transit Station	1,376	1,225	1,125	1,153	1,178	1,240	1,148	1,217
Knox Avenue/Best Buy	525	120	110	117	123		147	138
Heart of the City	370	114	71	64	53	43	54	51
Cedar Avenue/180th – Lakeville Cedar Park (11/09)	190	—	18	22	19	15	20	18
Cedar Avenue/155th – Apple Valley Transit Center (12/09)	750	594	584	677	697	741	738	762
TOTAL	**4,321**	**2,164**	**2,236**	**2,437**	**2,532**	**2,391**	**2,683**	**2,805**

Metro Transit

[1]January 2011 data from automatic counters. Data not available for all lots.

Table C-11. Daily Park-and-Ride Lot Use in the Control Corridors

Lot	2009		2010			2011		
I-394	**Capacity**	**Sept Use**	**Jan Use**	**April Use**	**Oct Use**	**Jan Use**	**April Use**	**Sept Use**
Plymouth Road Transit Center	111	105	81	99	83	n/a	87	79
General Mills Boulevard	123	128	111	109	120	n/a	110	111
County Road 73 – South	732	429	448	427	480	n/a	499	429
County Road 73 – North	288	*	*	*	*	n/a	*	*
Louisiana Transit Center	330	300	283	281	317	n/a	326	300
TOTAL	**1,584**	**962**	**923**	**916**	**1,000**	n/a	**1,022**	**919**
I-94N	**Capacity**	**Sept Use**	**Jan Use**	**April Use**	**Oct Use**	**Jan Use**	**April Use**	**Sept Use**
65th Avenue & Brooklyn Blvd.	239	129	131	128	140	n/a	130	153

Metro Transit

***The north County Road 73 park-and-ride lot was temporarily closed in January 2009 to save operating costs because there was capacity at the south lot.

C.4 Transit Ridership Data

Both Metro Transit and MVTA collect ridership data on a regular basis. Metro Transit uses both automatic passenger counters (APCs) and fare collection data to determine ridership. Approximately one-third of Metro Transit's bus fleet is equipped with APCs. Depending on the analytic purpose, Metro Transit uses a combination of data from fareboxes, smart card readers, and APCs. These data sources can be compared and/or combined for a complete ridership data set. They can also be integrated with schedule and AVL system data for additional performance analyses. MVTA uses farebox revenues and manual driver counts to calculate ridership.

As Table C-12 shows, total annual regional ridership on Metro Transit and MVTA express and local bus routes increased from 2006 to 2008, experienced a decline in 2009, and increased in 2010 and 2011. The 2011 ridership, including express ridership, did not return to 2008 levels, however. The decrease in ridership from 2008 to 2009 most likely reflects the record high unemployment experienced in the state and the metropolitan area in 2009. As discussed in Appendix K – Exogenous Factors, the non-seasonally adjusted annual unemployment rate for Metropolitan Statistical Area (MAS) was 5.1 in 2008 and 7.9 in 2009. While the unemployment rate declined to 7.2 in 2010 and 6.4 in 2011, it was still above the 2008 rate of 5.1.

Table C-12. Metro Transit and MVTA Annual Bus Ridership

Year	Metro Transit			MVTA		
	Express	Local	Total	Express	Local	Total
2006	8,228,759	56,169,965	64,398,724	1,709,100	596,792	2,305,902
2007	8,621,591	59,244,097	67,865,688	1,781,133	646,595	2,427,928
2008	9,658,916	61,955,141	71,614,057	1,865,487	730,558	2,596,045
2009	9,022,934	57,378,284	66,401,218	1,719,524	669,400	2,388,924
2010	9,243,906	57,638,455	66,882,361	1,708,533	685,471	2,394,004
2011	9,512,433	60,270,168	69,782,601	1,757,131	778,178	2,535,309

Metro Transit and MVTA.

New express bus routes were implemented with four of the new and expanded park-and-ride lots. New Metro Transit routes include 467 from the Kenrick park-and-ride lot to downtown Minneapolis (nine inbound and nine outbound trips), 252 from the 95th Avenue park-and-ride lot to the University of Minnesota (one inbound and one outbound trip), and 264 from the County Road C park-and-ride to downtown Minneapolis (10 inbound and 11 outbound trips). New MVTA routes include 475 from the Cedar Grove park-and-ride lot to the University of Minnesota (four inbound and four outbound trips) and 477V from the Lakeville Cedar park-and-ride lot to downtown Minneapolis (five inbound and five outbound trips).

Table C-13 presents the average weekday boardings for March to May in 2009, 2010, and 2011 for routes in the I-35W North, I-35W South, Cedar Avenue, I-394, and I-94 corridors. Ridership levels on I-35W South routes experienced the largest increase of 13 percent, followed by 8 percent on Cedar Avenue routes, 8 percent on I-94, and 7 percent on I-35W North routes. These increases occurred against the backdrop of high unemployment rates, which appear to have dampened higher increases. Ridership declined slightly on I-394 over the same time period.

Table C-13. Average Weekday Boardings – March – May 2009, 2010, and 2011

Corridor	March – May 2009	March – May 2010	March – May 2011	% Change 2009-2011
A.M. Peak Period (6:00 a.m. – 9:00 a.m.)				
I-35W North	3,412	3,421	3,656	7%
I-35W South	10,297	10,679	11,643	13%
Cedar Avenue	1,815	1,755	1,958	8%
I-394	552	551	536	(-3%)
I-94	2,001	2,047	2,166	8%

Metro Transit and MVTA.

The express bus routes operating on the MARQ2 lanes experienced a larger percentage increase in ridership compared to the non-MARQ2 express bus routes. Table C-14 shows that average weekday ridership on the MARQ2 routes increased by 9 percent while on the non-MARQ2 routes it was only approximately 2 percent. Figure C-2 shows the overall trend line from February 2009 to October 2011.

Table C-14. Average Weekday Ridership MARQ2 vs. Non-MARQ2 Buses

Service	Mar-May 2009	Mar-May 2010	Mar-May 2011	% Change 09–11
MARQ2 Express Buses	30,100	30,653	32,846	9%
Non-MARQ2 Express Buses	11,011	10,917	11,221	2%

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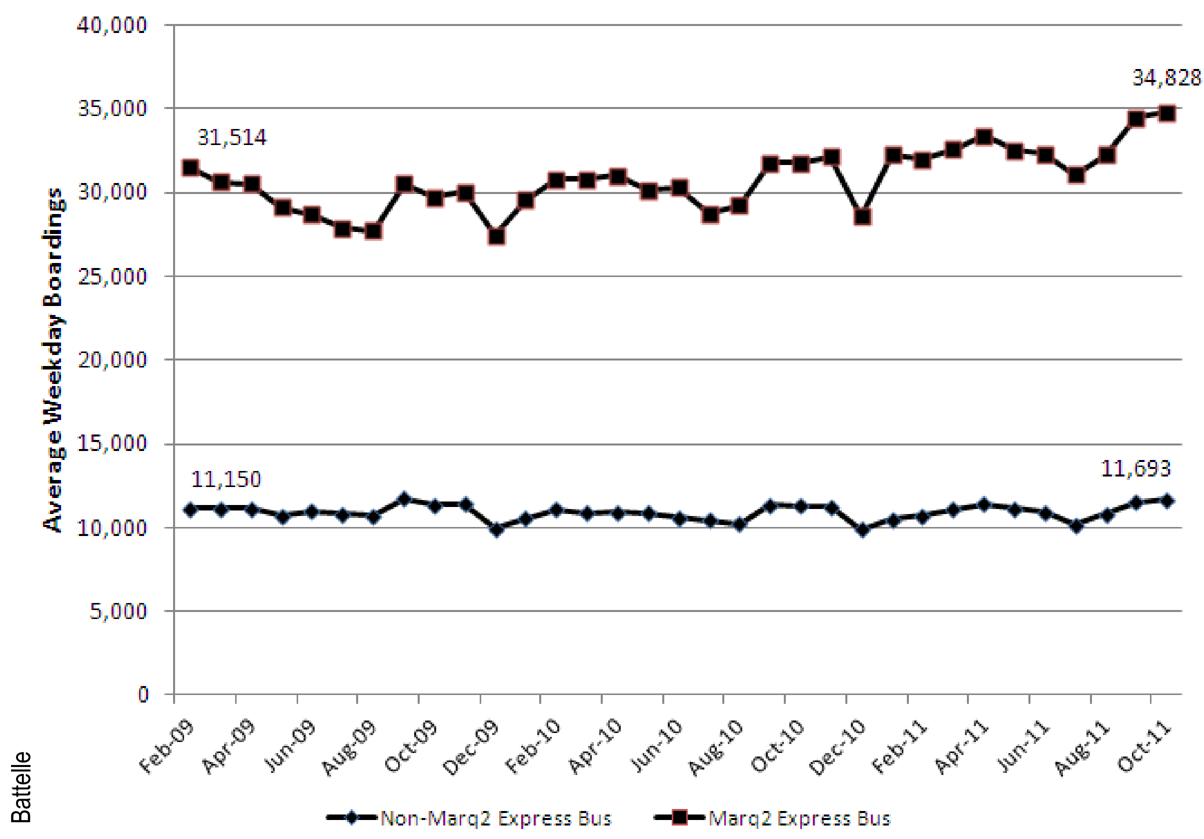


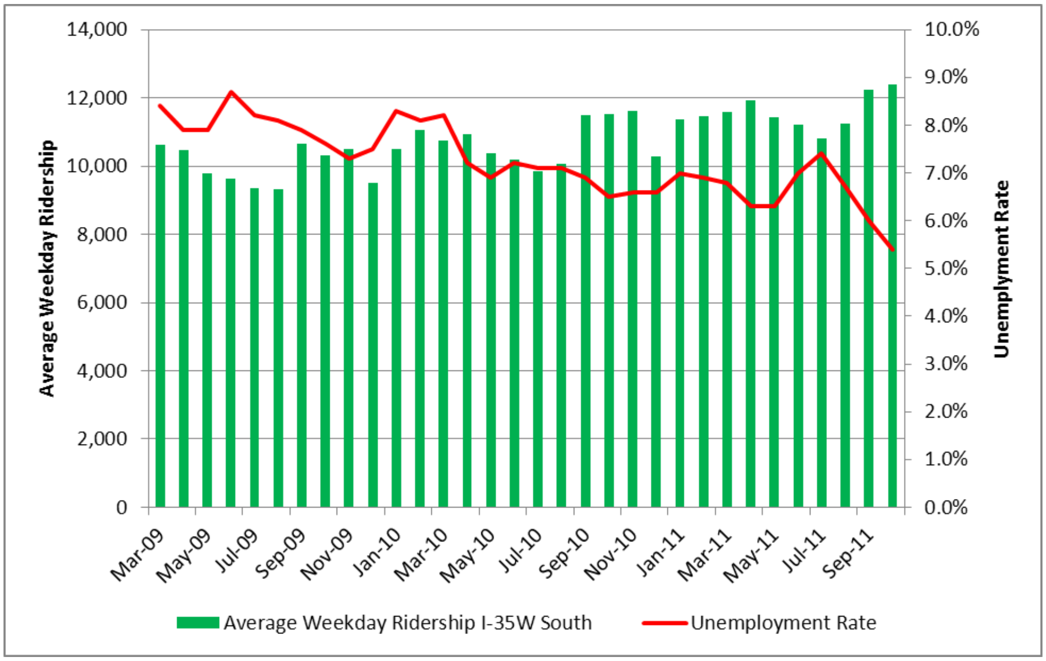
Figure C-2. Average Weekday Ridership MARQ2 vs. Non-MARQ2 Buses

The potential impact of the recession and the increases in the price of gasoline on bus ridership during the time pre- and post-deployment time period was examined. Appendix K – Exogenous Factors discusses the changes in the unemployment rate in the Minneapolis-St. Paul metropolitan area, including the increase in unemployment, and the increase in gasoline prices.

Figure C-3 presents the average weekday transit ridership in the I-35W South corridor and the Minneapolis-St. Paul-Bloomington MSA non-seasonally adjusted unemployment rate. Figure C-4 presents the average weekday ridership in the I-35W corridor and the average price for a gallon of gasoline. The overall average weekday ridership by month for the I-35W South corridor reflects the typical seasonality of transit use in Minnesota. Ridership levels tend to be higher in the winter – when people avoid driving (transit's foul weather friends) with the exception of December, which is lower due to the holidays. Ridership declines slightly over the summer when school is out, people are taking vacation, and commuters are shifting their travel behavior to take advantage of outdoor and other activities.

As illustrated in Figure C-3, ridership levels on buses in the I-35W South corridor remained strong even when unemployment rates were high. The ridership increases in 2010 and 2011 may be attributed to both the UPA projects and the improving economy. The high unemployment rate may have dampened or delayed the potential ridership increase from the UPA projects. The increase in cost of a gallon of gasoline may have influenced some of the ridership gains, but from Figure C-4, it does not appear to have had a major impact.

Minnesota Department of Employment and Economic Development.



Unemployment rate for Minneapolis-St. Paul-Bloomington MSA (not seasonally adjusted).

Figure C-3. Average Weekday Ridership by Month in I-35W South Corridor versus Unemployment Rate

U.S. Energy Information Administration.

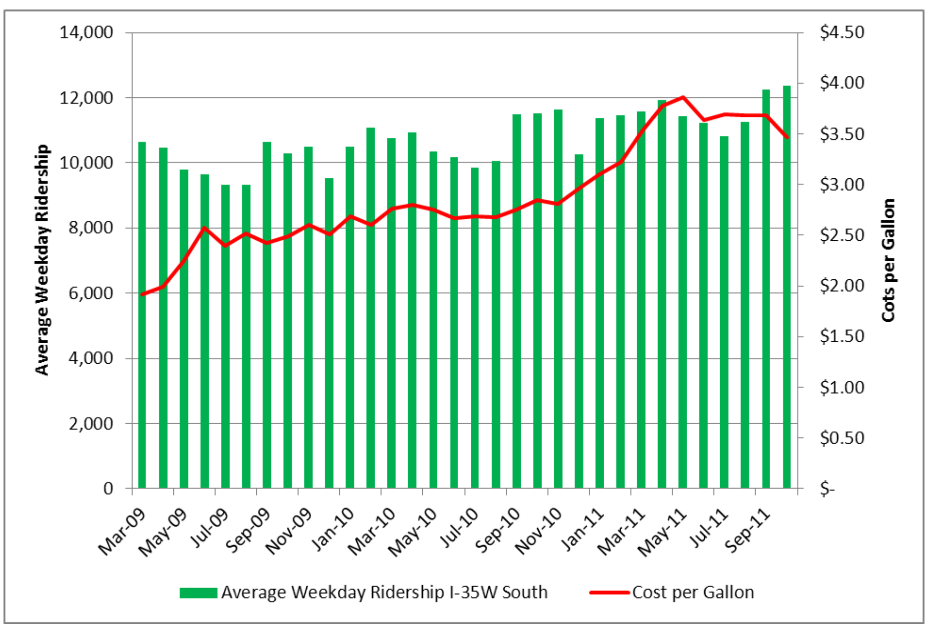


Figure C-4. Average Weekday Ridership by Month in I-35W South Corridor versus Average Cost per Gallon of Regular Gasoline

Other research has documented that a positive relationship exists between transit ridership and the cost of gasoline, and a negative relationship exists between transit ridership and the unemployment rate. To better understand the strength of these relationships on the I-35W South corridor, correlation coefficient values (i.e. r values) were calculated using data for these three variables from the time period of the evaluation (March 2009 to October 2011).

There are general rules for interpreting coefficient values. Values between 0.0 and +0.3 (0 and -0.3) indicate a weak positive (negative) linear relationship. Values between +0.3 and +0.7 (-0.3 and -0.7) indicate a moderate positive (negative) linear relationship. Values between +0.7 and +1.0 (-0.7 and -1.0) indicate a strong positive (negative) linear relationship.

As presented in Table C-15, the analysis of the Minnesota UPA data indicates that the unemployment rate had a stronger influence on transit ridership in the I-35W South corridor than gasoline prices. The coefficient value for the relationship between average weekday transit ridership on I-35W South and the cost per gallon of regular gas was +.672. This indicates a moderate positive linear relationship. The coefficient value for the relationship between average weekday ridership and the average monthly unemployment rate was -0.718. This indicates a strong negative linear relationship. In both instances, the coefficient values were statistically significant at the 0.01 level, meaning the results are highly reliable.

A linear regression was calculated using average weekday ridership as the dependent variable and gas prices and unemployment as the independent variables. The results showed that 75.3 percent of the change in transit ridership on I-35W South could be attributed to changes in gas prices and unemployment.

Table C-15. Correlation Coefficients Between Ridership, Gasoline Prices, and Unemployment Rates

Service		I-35W South Avg Weekday Ridership	Cost per Gallon of Regular Gas	Monthly Unemployment Rate
I-35W South Avg Weekday Ridership	Pearson Correlation	1	.672*	-.718*
	Sig. (2-tailed)		.000	.000
	N	32	32	32
Cost per Gallon of Regular Gas	Pearson Correlation	.672*	1	-.717*
	Sig. (2-tailed)	.000		.000
	N	32	32	32
Monthly Unemployment Rate	Pearson Correlation	-.718*	-.717*	1
	Sig. (2-tailed)	.000	.000	
	N	32	32	32

Battelle

*Correlation is significant at the 0.01 level (2-tailed).

C.5 I-35W Metro Transit and MVTA On-Board Transit Ridership Survey

In November 2011, Metro Transit conducted an on-board survey of all I-35W express bus routes. Only express routes utilize I-35W. 4,460 passengers were surveyed and 2,724 completed surveys were returned, accounting for a 61 percent response rate. The margin of error is +/- 1.2 percent at the 95 percent confidence level. The responses to the key survey questions are summarized in this section. Information on the socio-economic profile of riders on the I-35W express routes is presented first. Responses related to the number of years individuals have been riding the bus and prior mode of travel are discussed. The respondents rating of certain transit services attributes are described. Riders perceptions related to the real-time transit and next bus arrival signs, service on the MARQ2 lanes, bus usage of the MnPASS HOT lanes, and the new and expanded park-and-ride lots are examined.

The responses for some questions are broken out for I-35W North and South routes. Two of the UPA-funded park-and-ride lots are on I-35W North and four are in the I-35W South corridor. Buses from all six park-and-ride lots use the MARQ2 lanes in downtown Minneapolis. Buses on I-35W South use the MnPASS HOT lanes. Thus, riders on I-35W South buses receive additional benefits over riders on buses using I-35W North. Riders on I-35W South buses had to endure reconstruction of the Crosstown Commons section, however. These differences may results in different perspectives on some of the transit service attribute questions.

Table C-16 present the socio-economic profile of riders on the I-35W North and South express routes from this survey, and the profile for all Metro Transit bus routes from 2008 system-wide on-board survey. I-35W express bus riders can be characterized as working age – approximately 90 percent are between 25 years and 64 years of age – White, with middle-to-high incomes and at least one automobile available. These characteristics are similar to those of other express bus routes, but are different from those on all Metro Transit bus routes, which include more diverse age groups, ethnicity, income levels, and automobile availability levels.

In general, the socio-economic profiles of I-35W North and South riders are similar with a few minor differences. Riders in both the north and south corridors are predominately White – 88.8 percent and 82.0 percent respectively. However, there was a slightly larger number of Hispanics/Latino and African American riders in the I-35W South corridor than on I-35W North routes. Riders are more evenly split between males and females on the I-35W South, whereas there is a greater percentage of female riders on I-35W North. The breakdown of annual household incomes is very similar in both corridors. The vast majority of riders in both corridors have access to at least one personal vehicle – 99.2 percent of I-35W North riders and 99.3 percent of I-35W South riders.

As presented in Table C-17, the vast majority of riders use the bus to get to and from work, with 95.3 percent of riders on I-35W North and 94.5 percent on I-35W South reporting work trips. School was identified as the trip purpose by 4.5 percent of I-35W North riders and 4.8 percent of I-35W South riders.

Table C-16. Socio-Economic Comparison of I-35W and All Metro Transit Bus Riders

		2008 Metro Survey	2011 UPA Survey		2011 UPA Survey	
		(all routes)	(I-35W North)		(I-35W South)	
		%	N	%	N	%
Age	Under 18	4%	5	0.5%	15	1.0%
	18-24	22%	75	7.5%	94	6.5%
	25-34	23%	242	24.2%	419	29.1%
	35-44	17%	219	21.9%	322	22.4%
	45-54	19%	280	28.0%	322	22.4%
	55-64	12%	168	16.8%	239	16.6%
	65 or over	3%	11	1.1%	28	1.9%
Ethnicity	African American/Black	23%	20	2.1%	71	5.0%
	American Indian	3%	2	0.2%	15	1.1%
	Asian	5%	64	6.6%	106	7.5%
	Caucasian/White	62%	864	88.8%	1160	82.0%
	Hispanic/Latino	4%	8	0.8%	31	2.2%
	Other	4%	15	1.5%	32	2.3%
Gender	Male	41%	326	32.9%	648	45.3%
	Female	59%	665	67.1%	781	54.7%
Annual Household Income	Less than $10,000	19%	11	1.3%	25	1.9%
	$10,000 to $19,999	13%	10	1.2%	19	1.4%
	$20,000 to $29,999	13%	27	3.1%	49	3.7%
	$30,000 to $39,999	12%	40	4.6%	103	7.9%
	$40,000 to $49,999	9%	72	8.3%	103	7.9%
	$50,000 to $59,999	7%	81	9.4%	119	9.1%
	$60,000 to $69,999	6%	68	7.9%	118	9.0%
	$70,000 to $79,999	4%	74	8.5%	100	7.6%
	$80,000 to $89,999	4%	170	19.6%	191	14.6%
	$90,000 to $99,999	3%	313	36.1%	485	37.0%
	$100,000 or more	10%	0	0.0%	0	0.0%
Number of automobiles available for use	0	44%	8	0.8%	94	6.7%
	1	30%	271	27.4%	510	36.1%
	2	19%	513	51.8%	655	46.4%
	3	5%	147	14.8%	123	8.7%
	4 or more	2%	51	5.2%	31	2.2%

Metro Transit

Table C-17. Trip Purposes of I-35W Bus Riders

Trip Purpose	I-35W North		I-35W South	
	N	%	N	%
Work	984	95.3%	1,398	94.5%
Personal business	1	0.1%	6	0.4%
Medical	1	0.1%	3	0.2%
School	46	4.5%	71	4.8%
Other	0	0.0%	2	0.1%

Battelle

As presented in Table C-18, approximately half of the passengers in both corridors have been riding the bus for one to five years. A larger percentage of riders in the I-35W South corridor reported using the bus for one year or less. A total of 33.6 percent of riders in the south corridor reported using the bus for one year or less, compared to 23.9 percent in the north corridor.

Table C-18. Length of Time Riding the I-35W Express Buses

Length of Use	I-35W North		I-35W South	
	N	%	N	%
Less than 6 months	161	15.5%	274	18.3%
6 months to 1 year	87	8.4%	229	15.3%
1 to 5 years	501	48.1%	650	43.5%
More than 5 years	282	27.1%	318	21.3%
I don't normally ride this route	10	1.0%	23	1.5%

Battelle

Riders were asked their mode of travel prior to riding the bus to help identify possible change of modes fostered by the UPA projects. As presented in Table C-19, 34.2 percent of I-35W North riders reported driving alone on I-35W, compared to 19.8 percent for riders on I-35W South. A total of 26.3 percent of the I-35W North riders and 31.5 percent of the I-35W South riders did not make the trip before, while 21 percent and 28.2 percent reported riding on another bus on I-35W or another roadway, and 11.2 percent and 8 percent reported driving alone on another freeway or roadway. A total of the 2.6 percent of the I-35W South riders and 1.6 percent of the I-35W North rides reported previously carpooling in the I-35W HOV lanes. Since there is not an HOV lane on I-35W North, it is not clear if the 1.6 percent reporting previously carpooling, did so on the HOV lanes on I-35W South or I-394, or misunderstood the question.

Table C-19. Previous Mode of Travel

Mode	I-35W North		I-35W South	
	N	%	N	%
Drove alone in I-35W general purpose freeway lanes	344	34.2%	286	19.8%
Carpooled in the I-35W HOV lanes	16	1.6%	37	2.6%
Did not make the trip	265	26.3%	455	31.5%
Drove alone on another freeway or roadway	113	11.2%	115	8.0%
Rode another bus on I-35W or other roadway	211	21.0%	407	28.2%
Other	58	5.8%	145	10.0%

Battelle

Riders on the I-35W express routes were asked to rate 10 specific aspects of the bus service on a scale of very good (5), good (4), fair (3), poor (2), or very poor (1) as well as their overall level of satisfaction with Metro Transit. Independent sample t-tests were conducted to assess statistical significance of the difference in responses between I-35W North and South riders. The results are provided in Table C-20.

Riders in the I-35W North corridor gave higher ratings than riders in the I-35W South corridor in the categories of service reliability, hours of service, frequency of service, wait time at the park-and-ride lots, parking availability at the park and ride lots, and value for the money. Given the construction activities along I-35W during 2009 and 2010, the lower rating for some of these attributes is not surprising. The difference in results was statistically significant at the 95 percent confidence level for all categories except for service reliability and frequency of service, which means that the higher ratings in these two categories could have been due to random error.

Riders in the I-35W South corridor gave higher ratings than riders in the I-35W North corridor in the categories of travel time, availability of seats, speed of commute, and safety. In every category, the difference was statistically significant at the 95 percent confidence level. The higher ratings for travel times and speed of commute by I-35W South riders are probably due, at least in part, to the MnPASS HOT lanes and other improvements.

Table C-20. Service Element Ratings I-35W North vs. I-35W South

Service Element	I-35W North	I-35W South	North v South Sig
Service Reliability	4.45	4.41	0.164
Travel Time	4.25	4.35	**0.000**
Hours of Bus Service	3.83	3.70	**0.000**
Frequency of Service	3.66	3.59	0.070
Wait Time at Park-and-Rides	4.06	3.95	**0.001**
Availability of Seats	3.70	3.97	**0.000**
Parking Availability at Park-and-Rides	4.47	4.37	**0.004**
Value for the Money	4.31	4.20	**0.000**
Speed of Commute	4.10	4.19	**0.002**
Safety	4.32	4.43	**0.000**
Overall Satisfaction with Metro Transit	4.22	4.22	n/a

Battelle

Note: Sig values in bold are significant at the 95 percent confidence level.
Scale:
5 – Very Good
4 – Good
3 – Fair
2 – Poor
1 – Very Poor

The real-time travel signs along I-35W North became operational in April 2010, and the real-time travel signs along I-35W South became operational in April 2011. The next-bus arrival signs on Marquette and 2nd Avenues in downtown Minneapolis became operational in December 2009 when the expanded MARQ2 lanes opened. Survey respondents were asked if they had seen these signs and if the signs influenced them to take the bus. As presented in Tables C-21 and C-22, 69 percent of all riders reported noticing the signs on I-35W, and 80 percent reported noticing the next-bus arrival signs on Marquette and 2nd Avenues.

In terms of the signs' influence on travel behavior, a slightly larger percentage of riders taking the bus for one year or less reported they were influenced to take the bus because of the signs compared to the more established riders. These results makes sense given that the more established riders had likely made their decision to take transit before the signs were installed. Overall, 8 percent of I-35W riders said they were influenced to take the bus because of the real-time travel signs on I-35W. For new riders, 9 percent indicated they were influenced to ride the bus due to the signs. Overall, 11 percent of I-35W riders said they were influenced to take the bus because of the next-bus arrival signs in the MARQ2 lanes. For new riders, 14 percent indicated the MARQ2 next-bus arrival sign influenced their decision to ride the bus.

Table C-21. Real-Time Travel Time Signs

Question	Yes		No		Don't Know	
	N	%	N	%	N	%
I noticed the real-time transit signs along the I-35W corridor.	1811	69%	509	19%	310	12%
Real-time transit signs along the I-35W influenced me to ride the bus. (All riders)	199	8%	2089	80%	335	13%
Real-time transit signs along the I-35W influenced me to ride the bus. (New riders only – riding one year or less)	74	9%	587	73%	147	18%

Battelle

Table C-22. Real-Time Bus Arrival Signs

Question	Yes		No		Don't Know	
	N	%	N	%	N	%
I noticed the real-time bus arrival and transit information signs in downtown Minneapolis.	2084	80%	282	11%	250	10%
Real-time bus arrival and transit signs in downtown Minneapolis influenced me to ride the bus. (All riders)	274	11%	2066	79%	275	11%
Real-time bus arrival and transit signs in downtown Minneapolis influenced me to ride the bus. (New riders only – riding the bus one year or less)	112	14%	568	71%	125	16%

Battelle

In a follow up question, passengers were asked to rate their level of satisfaction with bus service in downtown Minneapolis since the MARQ2 lanes opened. As presented in Table C-23, roughly half of the respondents stated that their level of satisfaction with speed, on-time performance, and overall level of satisfaction was better since the opening of the MARQ2 lanes. Approximately one quarter of the respondents said their level of satisfaction was the same. Approximately 20 percent did not know or did not have an opinion. Less than 4 percent said their level of satisfaction was worse.

Table C-23. Quality of Service on Marquette and 2nd Avenues

Service Aspect	Better		Same		Worse		Don't Know	
	N	%	N	%	N	%	N	%
Speed of Service	1517	56%	543	20%	55	2%	601	22%
On-time Performance	1278	47%	736	27%	97	4%	591	22%
Overall Satisfaction	1411	53%	679	25%	68	3%	527	20%

Battelle

Passengers were asked whether they thought the I-35W MnPASS HOT lanes had improved bus travel speeds and reliability. The riders were also asked whether the MnPASS HOT lanes and the new/expanded park-and-ride lots influenced them to ride the bus. The results are shown in Table C-24. A majority of the riders on I-35W South believe that the MnPASS lanes have improved bus travel speeds and reliability, 61 percent and 55 percent, respectively. Approximately a third said they did not know. In regard to the influence of the MnPASS lanes and new/expanded park-and-ride lots on travel behavior, a slightly greater percentage of new riders said they were influenced compared to I-35W riders as a whole. A total of 17 percent of all I-35W riders said they were influenced to take transit because of the I-35W MnPASS lanes. For new riders, 23 percent indicated the MnPASS HOT lanes influenced their decision to use transit. Similarly, 21 percent of all I-35W riders said they were influenced to take transit because of the new/expanded park-and-ride lots. For new riders, 25 percent indicated the new expanded park-and-ride lots influenced their decision to ride the bus.

Table C-24. Perceptions of the MnPASS Lanes

Question	Yes		No		Don't Know	
	N	%	N	%	N	%
The MnPass lanes have improved bus travel speeds on I-35W South.	842	61%	88	6%	453	33%
The MnPASS lanes have improved bus trip-time reliability on I-35W South.	757	55%	129	9%	489	36%
The MnPASS lanes influenced me to ride the bus.	236	17%	798	59%	325	24%
The MnPASS lanes influenced me to ride the bus. (New riders only)	107	23%	184	39%	176	38%
The new and expanded park-and-ride lots influenced me to ride the bus.	278	21%	653	50%	388	30%
The new and expanded park-and-ride lots influenced me to ride the bus. (New riders only)	112	25%	150	33%	191	42%

Battelle

An onboard survey was conducted on the DAS-equipped buses as part of the FTA-sponsored evaluation. The survey was administered on June 22, 2010. Surveys were distributed to 457 passengers on routes with the DAS-equipped buses, with 135 completed surveys for a response rate of 30 percent. The survey focused on obtaining information on the influence of the DAS-equipped buses on attracting new bus riders and any changes noticed in ride quality when the DAS was used. Key results from the on-board survey are summarized below. The results indicate low awareness of the DAS among riders, but high satisfaction with the trip-time reliability, on-time performance, and ride quality of shoulder running buses.

- Approximately 12 percent of the riders responded that the presence of the DAS influenced their decision to ride the route and trip.
- Approximately 67 percent of the passengers had been riding the route for one year or more, with 33 percent riding for less than one year.

- Approximately 82 percent of the respondents reported they ride the bus four-to-five days a week.
- Approximately 17 percent of the respondents indicated awareness of when the DAS was in operation on a trip, while 83 percent indicated they were not aware of the DAS in operation.
- Approximately 80 percent of the respondents rated the ride quality of buses operating in the shoulder as very good or good, 95 percent reported being very satisfied or satisfied, with both travel time reliability and on-time performance of the service.

C.6 Focus Groups with Metro Transit and MVTA Bus Operators

As part of the Minnesota UPA National Evaluation, MnDOT sponsored focus groups and interviews with transit operators, Minnesota State Patrol officers, and FIRST operators. One focus group was held with five Metro Transit operators and one focus group was held with three MVTA operators. The focus groups were conducted by William & Kaye, Inc. in May 2011. Personnel from MnDOT's Market Research Group assisted with arranging the focus groups and attended both sessions.

To participate in the focus groups, Metro Transit and MVTA bus operators had to regularly drive routes using I-35W South. The routes had to originate in Burnsville or Apple Valley, enter I-35W northbound prior to 46th Street, and use the MnPASS HOT lanes and/or the PDSL. The operators further had to have driven these routes for the past two years, allowing them to observe possible changes due to the UPA projects or other projects in the corridor.

The purpose of the focus groups was to obtain insights about the UPA projects and their impact on transit operations and traffic congestion on I-35W South and downtown Minneapolis from bus drivers. Questions covered bus use of HOT lanes and the PDSL, the MARQ2 lanes, the Transit Advantage project, the ATM signs, and other elements.

The focus groups represent a qualitative market research technique. Focus groups are considered an exploratory approach used to gain insights on topics, obtain feedback on products or services, and gather information on issues or concerns. As noted, the focus groups were conducted with Metro Transit and MVTA bus operators to obtain their perspective on the UPA projects and to gain insight into benefits from the projects or possible concerns.

The Metro Transit and MVTA operators provided positive comments and feedback on the UPA projects. They also noted the improvement in traffic flow with the rebuilding of the Crosstown Commons section, even though only the MnPASS HOT lane in this section was part of the UPA. The new MnPASS lanes and PDSL were well received by the bus operators. Bus drivers reported they liked using the MnPASS lanes. Benefits from the MnPASS HOT lanes cited by bus operators included faster operating speeds and reduced trip times and a safer operating environment for buses. Some operators noted they save 10 minutes a trip due to the MnPASS lanes and MARQ2 lanes. Although not a UPA project, the bus operators also provided positive comments on the 46th Street bus stop in the median of I-35W South.

The bus operators also had positive comments on the MARQ2 lanes. They noted that the MARQ2 lanes have made driving through downtown Minneapolis easier, faster, and safer. The operators noted receiving positive feedback from passengers on the MARQ2 lanes and the enhanced waiting environment provided by the new shelters, next bus arrival signs, and wider sidewalks. One of the transit operators noted the MARQ2 lanes were "probably the best system they could have thought of."

The bus operators who use the Transit Advantage bus bypass lanes also gave it high marks. They noted that it had reduced travel times and improved safety by resolving a major bottleneck for buses operating in the corridor.

The bus operators did identity a few issues and concerns with the MnPASS HOT lanes. Most of these concerns focused on perceptions that SOVs are violating the operating requirements by not being registered MnPASS customers with valid toll tags. Concerns with SOVs weaving in and out of the MnPASS lanes – crossing the double white line – were voiced by some of the focus group participants. A few operators also noted concerns with entering the freeway and crossing the general-purpose freeway lanes to access the MnPASS lanes under congested conditions. An issue with the Lake Street bus stop – which required operators to exit the PDSL, travel across three general-purpose freeway lanes to the bus stop and then cross back to the PDSL – was also described. It was noted that this issue has been resolved by eliminating the Lake Street bus stop for express buses.

The bus operators did not have extensive comments on the ATM strategies or the in-pavement lighting. One bus operator noted that the ATM signs "have helped a lot" in slowing traffic when incidents occur.

The FTA-sponsored evaluation of the DAS included obtaining feedback from MVTA bus operators on use of the system, which was intended to provide them with aids when driving on the shoulder, including reducing their stress levels. The 25 drivers who had completed DAS training and were operating DAS-equipped buses completed a survey. Two focus groups, consisting of eight drivers each, were also conducted. Key results from the operator survey and focus groups are summarized in the following.

- In the survey, 88 percent of the bus operators strongly agreed or agreed that the DAS was easy to use and 64 percent strongly agreed or agreed that the DAS made driving on the shoulder less stressful. Thus, it appears the DAS was successful in reducing operators' stress levels when driving on the shoulder. A total of 84 percent of the operators strongly agreed or agreed that the driver simulator helped them better understand the DAS and 100 percent strongly agreed or agreed that the amount of training on the simulator and on-the-road was sufficient.
- The survey responses and the focus group discussions indicted that the operators found the vibrating seat component the most beneficial. The steering wheel feedback and the heads-up display were rated lower, with 48 percent of the operators strongly disagreeing or disagreeing that the steering wheel feedback was helpful and 40 percent strongly disagreed or disagreed that the heads-up display was helpful. In the focus groups some

operators noted they did not like even the mild torque on the steering wheel and some operators commented that the heads-up display was distracting.

C.7 Summary Transit Impacts

Table C-25 presents a summary of the transit impacts for each of the hypothesis in the transit analysis. The first hypothesis is supported, with the HOT lanes, PDSL, MARQ2 lanes, Transit Advantage bus bypass lane, and the shoulder running buses combining to increase bus travel speeds, reduce bus travel times, and improved bus trip-time reliability. The MARQ2 lanes appear to have had the largest positive impact, while the addition of tolled vehicles in the PDSL and the existing HOV lane resulted in no change or slight degradation in travel speeds and travel times. The new and expanded park-and-ride lots and the new and expanded transit service resulted in new riders being attracted to transit services. The number of vehicles parking at park-and-ride lots and ridership levels on routes serving these lots increased in both the I-35W North and the I-35W South corridors. The on-board survey results indicate that some former drivers have switched modes to riding the bus. As discussed in Appendix A, congestion levels on I-35W South have been reduced due to the reconstruction of the Crosstown Commons section and the UPA projects. While the small number of individuals changing from driving alone to riding the bus represents a small impact, they do contribute to reducing congestion. As discussed in this appendix, all of the UPA transit strategies contributed to enhancing transit operations in the I-35W North, I-35W South, and Cedar Avenue corridors, as well as in downtown Minneapolis.

Table C-25. Summary of Transit Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• The HOT lanes, PDSL, MARQ2 bus lanes, and Transit Advantage project, and shoulder running lane guidance system will increase bus travel speeds, reduce bus travel times, and improve bus trip-time reliability in the I-35W and Cedar Avenue corridors, and downtown Minneapolis	Supported	The HOT lanes, PDSL, MARQ2 lanes, Transit Advantage Project, and shoulder running lane guidance system resulted in increased bus travel speeds, reduced bus travel times, and improved bus trip-time reliability on I-35W South and Cedar Avenue, and in downtown Minneapolis.
• The new park-and-ride lots and new and expanded transit services will result in ridership increases including a mode shift to transit.	Supported	Use of the new and expanded park-and-ride lots increased by approximately 690 vehicles between 2009 and 2011. Ridership has increased. The onboard survey results indicted some new riders formerly drive alone.
• The mode shift to transit from the UPA transit strategies will reduce congestion on I-35W, downtown Minneapolis, and other roadways.	Supported	The results from the on-board survey indicate that former automobile drivers have been attracted to transit due to the UPA projects. As noted in Appendix A, congestion has been reduced on I-35W South with the UPA projects and the reconstruction of the Crosstown Commons section. Given the small number of new bus riders, the impact on congestion is probably small, however.
• What was the relative contribution of each of the Minnesota UPA transit strategies to mode shift to transit?	Supported	All of the strategies enhanced both the short-term and long-term operation of bus service in the corridor. It was not possible to identify the relative contribution of the individual transit projects.

Battelle

Appendix D. Telecommuting Analysis

The telecommuting element of the Minnesota UPA focused on introducing or expanding telecommuting and flexible work arrangements to employers in the metropolitan area, with a focus on the I-35W corridor. The program's goal related to the UPA was 500 new telecommuters who would otherwise be driving in the I-35W corridor. As presented in Table D-1, the hypotheses focus on reducing trips or changing trip times to outside the peak periods as a result of telecommuting or flexible work arrangements. To the extent possible, secondary impacts such as use of the vehicle not driven to the worksite and the influence of flexible arrangements on pre-existing commuting behavior were also examined.

Table D-1. Telecommuting Hypotheses/Questions

Hypotheses/Questions
• Use of telecommuting, ROWE, and other flexible work schedules removed trips and VMT from the I-35W corridor.
• Integration of telecommuting into the UPA project enhanced congestion mitigation.
• What was the relative contribution of the telecommuting strategies to overall travel behavior changes, including secondary impacts of telecommuting?

Battelle

D.1 Telecommuting Program

The telecommuting element of the Minnesota UPA was funded by the state, with no federal resources. The Hubert H. Humphrey School of Public Affairs managed the telecommuting component, with support from Mn/DOT. Due to the state funding, the scope of the program was expanded from the original UPA-driven target of 500 telecommuters in the I-35W corridor to a Twin Cities metropolitan-wide focus with a larger target of 2,700 new telecommuters. The formal telecommuting program was initiated in March 2009 and concluded in June 2011 when the state funding expired.

The telecommuting program was implemented under the brand of "eWorkPlace" and the term teleworking was used, rather than telecommuting. The two terms are used interchangeably in this analysis.

The goal of the eWorkPlace program was to reduce peak period commuting by eliminating commute vehicle trips and shifting travel to off-peak hours. This goal was accomplished through the promotion of increased use of:

1. telecommuting,
2. work scheduling, and a
3. Results-Only Work Environment (ROWE) program.

ROWE is a telecommuting concept pioneered at the electronic retailer Best Buy, headquartered in Minneapolis. ROWE strives for a workplace transformation focusing on an aggressive results-oriented management philosophy, which may result in employees having more flexibility in day-to-day work performance and travel.

The eWorkPlace program objectives included:

- Establishing or expanding telework programs to retain a minimum of 2,700 employees participating in the program for a minimum of three months (with 500 of these employees using the I-35W corridor);
- Reducing congestion by eliminating or shifting a minimum of 5,400 peak hour trips; and[1]
- Providing examples of successful telework programs to share with other employers.

The eWorkPlace program, through a free web-portal, provided a range of on-line tools and other services to assist employers in establishing and maintaining telework programs. Examples of these tools included the Manager's Guide to Telework, Telework and Quickstart Advice, Quickstart Telework Agreement, Telework Discussion Application, Telework Implementation Steps, and Telework Policy Agreement. During the UPA, consultants were also available to provide support to participating employers.

Metro Transit and four Transportation Management Organizations (TMOs) in the Twin Cities region conducted the eWorkPlace recruiting activities in coordination with the Humphrey School and its consultants. The TMOs are Downtown Minneapolis TMO, Anoka County TMO, Saint Paul Smart Trips, and Commuter Services. CultureRx LLC, a consulting firm specializing in the adoption of ROWE, was responsible for working with employers interested in implementing ROWE.

D.2 Data Sources

Data for the Minnesota UPA teleworking analysis was obtained from the Humphrey School and its consultants. The Humphrey School monitored and evaluated all elements of the eWorkPlace program, including employee productivity, employer costs, and other factors for participating employers. The national UPA evaluation has a narrower focus, with an interest in the impacts of the eWorkPlace program on traffic congestion (and by extension air quality) in the I-35W corridor. As a result, the national evaluation focused on the number of employees that used I-35W during peak period travel times who switched to telework, ROWE, or alternative work arrangements, thereby eliminating trips from I-35W or changing travel times to less congested time periods.

Information on the participating employers, the number of participating employees, and reductions in commute miles is available in the June 2011 reports, *eWorkPlace. Exceeding Expectations! A New Way to Stimulate the Economy* and *eWorkPlace Final Report*, prepared for

[1] Note that most of the program initiatives were focused on teleworking and eliminating the peak-hour trip rather than shifting travelers to off peak. No results were found indicating a shift in travel as a result of telecommuting.

Mn/DOT and the Humphrey School by SRF Consulting Group, Inc.[2] Additional information can be found in the August 2011 report, *Is Teleworking Really Working? Findings from the eWorkPlace Telecommuting Project in Minnesota* by the Humphrey School at the University of Minnesota[3].

Table D-2 summarizes the data gathered in the eWorkPlace program. All telework, alternative work hour, and ROWE participants were invited to respond to a commute tool survey including a participant survey and travel diary one week, three months, and nine months after registering for the program. As a result, participant surveys do not align to a single time period, but are based on when individuals began the telework program. Overall, approximately 24 percent of all participants responded to at least one commute tool survey. Longitudinal panel comparisons using mixed models described in the survey test plan were not possible due to the incomplete and erroneous survey responses at an individual-record level. Rather each wave of surveys was aggregated and compared to subsequent waves to calculate the measures of effectiveness identified in the test plan.

It should be noted that compared with the general population, there was an over-representation females (over 75 percent) for commute tool survey respondents, as well as participants with college degrees (over half) and who were married or partnered (over 67 percent). Each of these groups could potentially have had higher motivation, need and opportunity, for telecommuting than the general public. During the analysis, it was noted that ROWE and telework programs resulted in similar travel behavior changes. As a result, no distinction in the type of telework arrangement was made in the analysis.

Table D-2. eWorkPlace Data Sources

Source	Information
eWorkPlace Registration – Humphrey School	Participant Data – employer and employee numbers, demographics
The Commute Tool Survey (1 week, 3 months, 9 months after registration) – Humphrey School	Participant survey – commuting behavior and perception of telework
	Travel Diary – time, location and purpose of trips taken on the most recent telework and office days

Battelle

D.3 Participating Employers and Employees

The eWorkPlace telework program was initiated in March 2009 with Fairview Health Services adopting ROWE. Valspar became the second participating employer in May 2009. The official

[2] http://www.eworkplace-mn.com/LinkClick.aspx?fileticket=3OCE8iCOmxM%3d&tabid=244, and http://www.hhh.umn.edu/centers/slp/telecommunications/telecomm_technology/pdf/eWorkPlaceFinalReportWithAppendices.pdf.

[3] Lari, A., Douma, Frank, Yang, K.L., *Is Teleworking Really Working? Findings from the eWorkplace Telecommuting Project in Minnesota*, August 2011.

public launch of the eWorkPlace website and media campaign occurred in June 2009. Hennepin County and Carver County joined the program in the summer of 2009.

The formal state-funded eWorkPlace program concluded in June 2011 with 48 employers participating. Approximately 93 percent of the participating employers surveyed indicated intent to continue their programs, with two-thirds planning to expand their programs. Over 4,200 new employees participated in the telework program, exceeding the goal of 2,700 employees. The distribution of participating employers and employees in the region are presented in Figure D-1 in relation to the UPA I-35W study corridor. A 3-mile buffer zone from I-35W and I-394 is shown in the figure, in which 62 percent of employer offices are located. Table D-3 lists the participating employers in alphabetical order. Employers include national companies, such as Ecolab and Medtronic, smaller local businesses, state agencies, cities and counties, and private non-profit organizations.

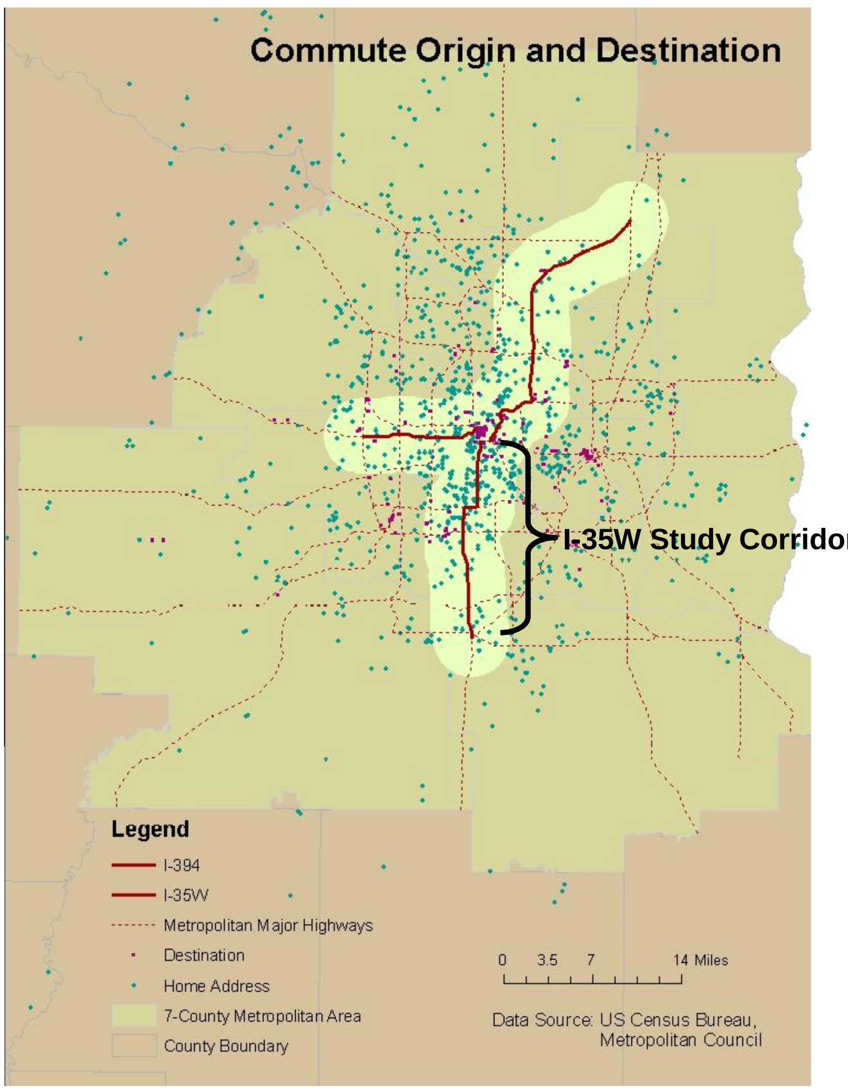


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Figure D-1. Telework Participant Home Locations and Commute Destinations

Table D-3. eWorkPlace Employers Participants as of June, 2011

Allina Hospitals and Clinics	Lifetrack Resources
Anoka County	Lutheran Social Services
Augsburg Fortress	Macalester College
Aveda Corporation	McGladrey
Behavioral Medical Interventions	Medtronic
BioScrip	Metro Transit
Campbell Mithun	Metropolitan Council
Carmichael Lynch	Minneapolis 311
Carver County	Minnesota Department of Administration
Catholic Charities	Minnesota Department of Transportation
City of Minneapolis (BIS)	Minnesota Pollution Control Agency
Commuter Services	MMIC Group
CSM Corporation	RESOURCE, Inc.
Design 1	Service 800
Ecolab	ShopNBC
EMA, Inc.	SUPERVALU
Eureka Recycling	TempForce, Inc.
Fairview Health Services	TURCK, Inc.
Global Citizens Network – International Student Exchange	US Bank
Global Tax Network	Valspar
Greater Twin Cities United Way	Vesta Valuation
Hennepin County Human Services and Public Health Department	Welsh Companies
Interactive Retirement Systems	Western National Insurance Group
Intermediate School District 287	Wilder Foundation

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D.4 Impacts of Telecommuting on Metropolitan Travel

The impact of the eWorkPlace program on travel behavior throughout the metropolitan area was estimated through the analysis of survey responses. The eWorkPlace Final Report analyzes the responses from multiple commute tool surveys completed by telework and ROWE participants. Survey participants provided home and office addresses to establish commuting distances, as well as the number of days they teleworked in an average week.

On office days, participants in the program reported driving alone or using public transit for 71.2 percent and 18.7 percent of commute trips, respectively indicating the bulk of the new program participants were drawn from the pool of single-occupancy users rather than public transit users.

Data from the commute tool survey travel diaries indicated that teleworkers take 80 percent fewer trips during the workday and 93 percent fewer peak period trips, compared to non-teleworkers on the days that they telecommute. Thus, eWorkPlace participants avoided making 11,350 additional trips per week by teleworking. Importantly, there were no statistical differences between daily non-peak travel between office and telework days indicating that on telework days, the participants are driving less. Table D-4 summarizes other findings from the survey data.

Table D-4. Survey Data

Description	Telework Survey Results
Average number of telework days per week reported by eWorkPlace participants	1.5 times per week
Peak-hour trip reduction by eWorkplace participants	• Daily average number trips in the peak hours* ○ Office day: 2.13 ○ Telework day: 0.15 • Total daily average reduction in the peak hour trips – 92.6 percent
	• 97 percent decline in peak hour travel on I-35W and I-394 on telework days • 0.72 peak-hour highway trips saved per day per person if teleworking**
Use of mode during non-telework days reported by eWorkPlace participants	Drove alone – 71.2 percent Public transit – 18.7 percent
Average change in daily non-peak hour trips	No statistically significant difference between office and telework days (0.25 and 0.26, respectively)
Average daily VMT per person saved on telework day vs. office day	27.96 miles/person[4] (91.5 percent reduction in the average total day VMT)
Annual telework mileage savings across all participants	7.46 million VMT regionally
	3.73 million VMT from I-35W and I-394
Annual telework trip savings across all participants	580,000 peak-hour trips across all modes regionally
	240,000 trips across all modes on I-35W and I-394
Reported average number of telework days per week among respondents to all three surveys (N = 191)	Survey 1 (after 1 week of telework program): 1.02*** Survey 2 (after 3 months of telework program): 1.24*** Survey 3 (after 9 months of telework program): 1.31

Is Teleworking Really Working? Findings from the eWorkPlace Telecommuting Project in Minnesota.

*Statistically significant difference at the $p<0.01$ level

**Statistically significant difference at the $p<0.05$ level

***Statistically significant difference between survey 1 and survey 2 at the $p <0.05$ level indicating an reported increase in days/week telecommuted by same set of participants from survey 1 to survey 2. The increase between survey 2 and survey 3 was not statistically significant.

[4]This value is derived from the commute tool survey travel diaries, which was used by UMN to calculate annual telework mileage savings.

Participants teleworked an average of 1.5 days per week, reducing their peak-hour trips on those days by 92.6 percent overall and 96.7 percent on the I-35W and I-394 corridors. The average VMT saved on a telework day versus an office day was 27.96 miles per person per day, a 91.5 percent decline in the average of total daily VMT, half of which could have been travelled on I-394 and I-35W.

D.5 Impact of Telecommuting on Travel in the I-35W Study Corridor

While the telecommuting initiative had a regional focus and showed significant benefits, the national evaluation was also interested the impact specific to the I-35W study corridor. The commute tool surveys included a question that explicitly asked commuters if they used the I-35W or I-394 corridors and established their distance travelled. Unfortunately, the survey instrument only asked for the use of both the freeways and did not break down use by each facility. Additionally, the travel diary part of the commute tool surveys document all trips made by a participant's most recent day worked in the office and most recent day of teleworking, specifying whether I-35W or I-394 was used for each trip.

Commute tool survey data and AADT assumptions were used to separate the benefits specific to the I-35W study corridor from the I-35W/I-394 combination.[5] A total of 35.3 percent of the commute tool survey respondents' stated that they use I-35W or I-394 for commuting. Average annual daily traffic (AADT) was used to estimate the proportion of those travelers on only I-35W immediately south of downtown Minneapolis (38.7 percent). Using these two percentages, a conservative assumption was made that approximately 14 percent of telework program participants travel on the I-35W study corridor.[6] This figure was used in the analysis of the telework impacts on peak hour trips on I-35W.

Using the above percentages, it is estimated that 570 of the 4,212 participants use the I-35W study corridor as part of their commute. Of that subset, 420 telework participants would drive alone on the I-35W corridor when not teleworking, with the others using public transit.[7] Based on the survey data indicating that telework occurs 1.5 times per week, or 3 commute trips, this reduction eliminates over 1,260 single-occupancy vehicle trips per work week on I-35W. The number of telework participants removed in the peak period represents about 1 percent of AM overall peak period trips on I-35W per week.

[5] In other words, the survey question grouped travel on I-35W with I-394, while the interest of this study is exclusively with I-35W south of downtown. Thus, assumptions are made to calculate benefits to the I-35W corridor.

[6] MnDOT 2008-2009 AADT on select gateways to Minneapolis; I-35W south of downtown: 162,000 vehicles/days; I-35W north of downtown: 109,000 vehicles/day; and I-394: 148,000 vehicles a day. The total AADT for these three downtown gateways is 419,000 vehicles/day (162,000/419,000 = 0.387 ≈ 39%). That is, 39% of 35% of teleworkers who use I-35W or I-394 = 0.14 = 14%, estimated percentage telework participants who travel on the I-35W study corridor south of downtown Minneapolis.

[7] The estimate of 420 participants is based on the conservative calculation of 4,212 telework participants, 71.2% who drive alone and 14% who likely drive on the I-35W study corridor.

The local partners estimated a 7.46 million annual reduction in VMT from the eWorkPlace program. Further, half of this amount was estimated from I-35W and I-394. Based on the same assumption of 14 percent of this reduction occurring on I-35W, an estimated 0.52 million annual reduction in VMT occurred on I-35W study corridor from eWorkPlace.

D.6 Telecommuting Impacts on Employers and Employees

Both employers and employees reported positive experiences with the telework program. Among employers, 75 percent reported an increase in productivity and 93 percent planned to either continue or expand their telework program. Other noted employer benefits included lower facility costs, less sick-time usage, improved work morale, fewer overtime expenditures, improved accommodation for persons with disabilities and domestic obligations, and better recruiting and retention.[8]

Employees also gained a number of benefits from teleworking. The average teleworker reduced their total daily VMT compared to non-telework days by 92 percent. This results in individual cost savings for fuel and maintenance costs, as well as parking costs and other travel expenditures. Additionally, telework participants save time, which contributed to an improved work-life balance cited by two-thirds of the study participants. Professionally, 67.1 percent of teleworkers and ROWE participants cited increased productivity due to fewer distractions, with only 1.9 percent reporting decreased productivity. Other benefits reported in the survey included comfort and convenience, decreased environmental impacts, the ability to avoid bad weather, and lower stress levels. While participants cited their average optimal number of telework days as 2.29, the average of actual telework days was 1.5, pointing to potential for more telework programs targeting such things as organizational rigidity and employer willingness.

[8] For more information, see *eWorkPlace. Exceeding Expectations! A New Way to Stimulate the Economy*, prepared for Mn/DOT and the Humphrey School by SRF Consulting Group, Inc. The report is available at http://www.eworkplace-mn.com/LinkClick.aspx?fileticket=3OCE8iCOmxM%3d&tabid=244.

D.7 Summary of Telecommuting Impacts

Table D-5 summarizes the impacts of the eWorkPlace program across the three hypotheses in the national evaluation. As presented in the table, the eWorkPlace programs supported all three hypotheses.

Table D-5. Summary of Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
Use of telecommuting, ROWE, and other flexible work schedules removed trips and VMT from the I-35W corridor.	Supported	An estimated 1,260 single-occupancy vehicle trips per week were removed during the peak hour due to the telework initiative on I-35W. A total of 570 of the 4212 new telework participants are estimated to be from the I-35W study corridor, with 420 participants estimated to be single-occupancy drivers using the I-35W study corridor. Each of these participants teleworked an average of 1.5 times a week. No results show diversion to travel shifting to off-peak hours but the program initiatives were geared towards eliminating trips rather than moving them temporally.
Integration of telecommuting into the UPA project enhanced congestion mitigation.	Supported	Telecommuting initiatives as part of the UPA have resulted in regional as well as corridor-specific impacts in terms of VMT reductions. The local partners estimated a 7.46 million annual reduction in VMT from the eWorkPlace program. In the study corridor, the annual VMT reduction due to the eWorkplace participants is 520,000 vehicle-miles.
What was the relative contribution of the telecommuting strategies to overall travel behavior changes, including secondary impacts of telecommuting?	Supported	The local partners reported that teleworkers take 80 percent fewer trips during the work day and 93 percent fewer peak-period trips compared to non-teleworkers. The eWorkPlace participants avoided making 11,350 additional vehicle trips per week in the region by teleworking based on these percentages. 75 percent of participating employers reported an increase in productivity and 93 percent planned to either continue or expand their telework program

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Appendix E. Technology Analysis

Technology was an important supporting element of the Minnesota UPA projects. Intelligent transportation systems (ITS) technologies were incorporated in many of the Minnesota UPA projects, enabling a wide variety of improvements. The technology analysis focused on the ITS technologies contributing to congestion reduction, rather than those technologies acting as enablers of other congestion reduction strategies, such as tolling. Further, the analysis focused on the role of technology in supporting congestion-reduction objectives, not determining how well the technology performed. The technology components of the Minnesota UPA included in this analysis are the active traffic management (ATM) strategies and the transit and highway travel-time dynamic message signs (DMS).

Table E-1 presents the three hypotheses and questions for assessing these technology elements. The first hypotheses focuses on the ATM strategies, including speed harmonization and DMS with transit and highway travel times, in promoting better utilization and distribution of traffic to available capacity on I-35W South. The second hypothesis is that ATM strategies will reduce the number and duration of incidents causing congestion on I-35W South. The final hypothesis relates to the relative contribution of the different technologies on congestion reduction on I-35W South.

Table E-1. Technology Analysis Approach

Hypotheses/Questions
• Active traffic management strategies, including speed harmonization and DMS with transit and highway travel times, promote better utilization and distribution of traffic to available capacity on I-35W South.
• Active traffic management strategies will reduce the number and duration of incidents that result in congestion on I-35W South.
• What was the relative contribution of each technology enhancement on congestion reduction on I-35W South?

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The evaluation attempted to isolate the extent to which the technology deployments contributed to the overall amount of congestion reduction and the variability of congestion in the I-35W South corridor. As discussed in this appendix, data were not available to fully assess the impacts of the ATM on traffic congestion on I-35W South. As a result, the analysis focused on discussing the application of the ATM strategies, examining available data on changes in throughput and crashes, and summarizing the perceptions of Minnesota State Patrol officers, Freeway Incident Response Safety Team (FIRST) operators, bus operators, and users of I-35W South.

The remainder of this appendix is divided into three sections. The use of ATM, including managed lane control, variable speed limits (VSL), and transit and highway DMS is described in Section E.2, along with the limited available data on congestion levels, throughput, and crashes to assess potential impacts. Section E.3 summarizes the perceptions of Minnesota State Patrol officers, FIRST operators, and Metro Transit and Minnesota Valley Transit Authority (MVTA) bus operators toward the ATM strategies from interviews and focus groups. It also highlights survey results from users of I-35W South related to the ATM features and feedback on the ATM strategies from MnDOT Talk, the Department's on-line community of 600 residents who regularly participate in on-line discussions, surveys, brainstorming sessions, and chats on transportation topics. The appendix concludes with a summary of the technology analysis in Section E.4.

E.1 Use and Impacts of the I-35W South ATM Strategies

The ATM components of the Minnesota UPA included intelligent lane control signals (ILCS), along with real-time transit and traffic DMS. MnDOT uses the "Smart Lanes" term to refer to the ATM components on I-35W South. The ATM elements were deployed on I-35W South in two phases from 2009 to 2010. The Smart Lanes were fully operational in July 2010. The system includes 174 ILCS at gantries spaced approximately every 0.5 miles on I-35W South from Burnsville to downtown Minneapolis. Real-time transit and traffic signs are also located at strategic points. These signs display the travel times for buses using the MnPASS HOT lanes and for vehicles in the general-purpose freeway travel lanes.

Figures E-1 and E-2 illustrate examples of the ILCS on I-35W South. The use of the ILCS is primarily for incident management and speed harmonization. The ILCS also designate when the MnPASS HOT lanes, including the priced dynamic shoulder lane (PDSL), are in operation. Loop detectors measure traffic speeds downstream of the ILCS signs. Speeds are posted up to one and one-half miles upstream. The speeds are advisory only.

Minnesota Department of Transportation.

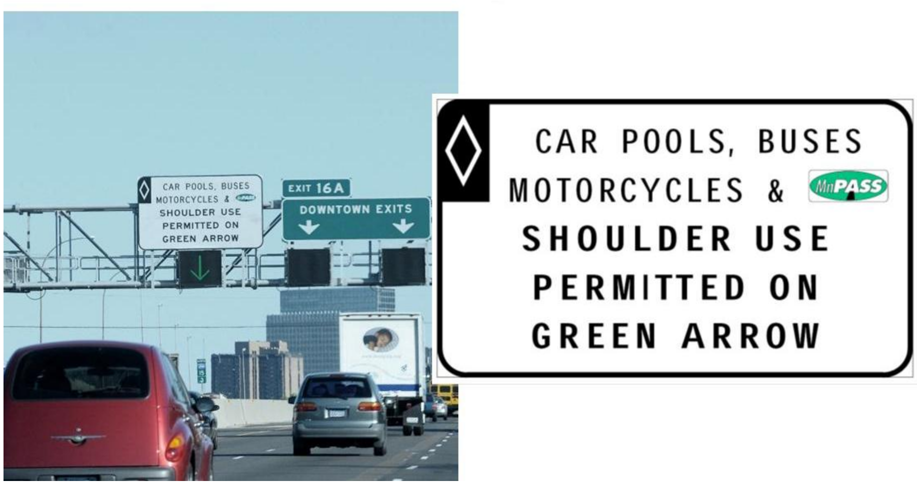

Figure E-1. ILCS on I-35W South

Minnesota Department of Transportation.

Figure E-2. I-35W South ILCS

Figure E-3 presents the standard ICLS sign options, which are described in the following.

- The green arrow is used when the PDSL is open. It is also used for lanes not affected by an incident.
- The flashing yellow arrow is used for lanes adjacent to an incident either in the next lane or on the shoulder. The flashing yellow arrow is unique to Minnesota. It has been in the MN MUTCD for nearly two decades for use outside the Lowry Tunnel on I-94 adjacent to downtown Minneapolis.
- The red X is used either when lanes are closed due to an incident or when the PDSL is closed. As noted on Figure E-3, this sign has been modified to include the word "Closed."
- The yellow X with the 1 mile distance and the Merge with a left or right arrow is used to alert motorists of a lane closure and merge ahead. Prior to the Red X, motorists first encounter the yellow X, followed by a Merge with left or right arrow.
- Advisory Speed Signs. The speed is amber on black since the variable speed is advisory only. The sign could allow for regulatory black on white messages in the future.
- The white diamond is displayed to show when HOT lane restrictions are in place during peak periods.

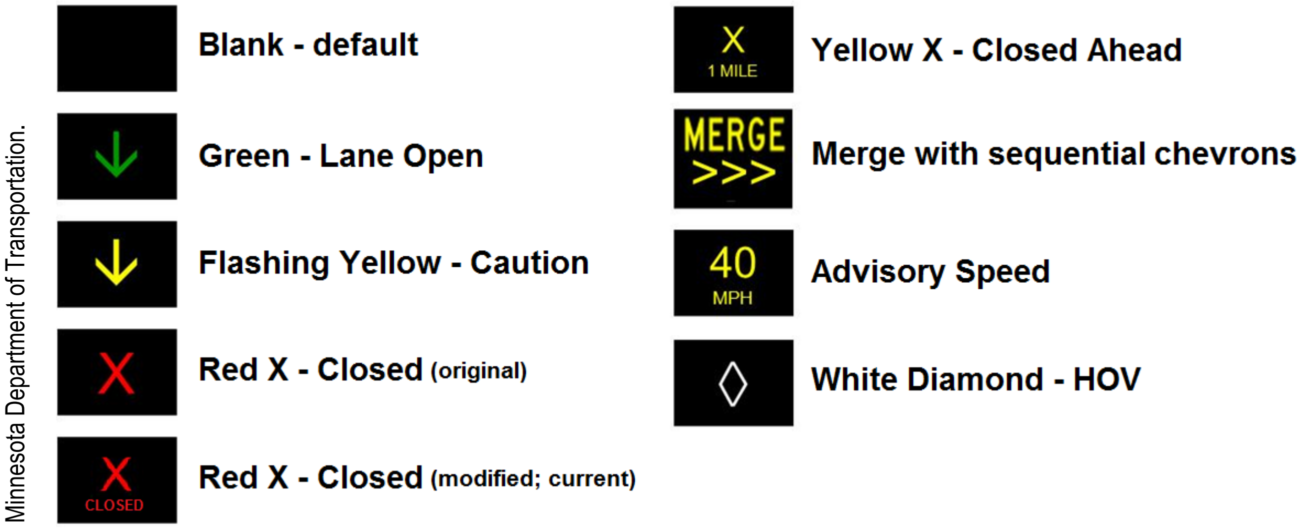

Figure E-3. ILCS Sign Options

The ATM components are managed from MnDOT's Regional Transportation Management Center (RTMC). The RTMC is a co-located operations center, which houses MnDOT's freeway management staff, FIRST dispatch, MnDOT's maintenance dispatch, and the Minnesota State Patrol Metropolitan Area dispatch. MnDOT uses an in-house developed freeway traffic management system software, Intelligent Roadway Information System (IRIS), to communicate with and control loop detectors, DMS, the freeway ramp metering system, and the ATM system.

The system automatically activates advisory speeds in advanced of congested areas, including those caused by incidents, by an algorithm that examines current speed and congestion levels in the corridor, especially downstream. Operators need not deploy the variable advisory speeds, although they can override the signs as needed. Advisory speeds are posted on up to three gantries in advance of the congested area based on 30-second binned loop detector data. The posted advisory speed remains constant for one-minute before changing again, even if a new speed is recommended based on the algorithm only 20 seconds after the previous recommendation was posted. The variable speeds will change every 30 seconds, but the algorithm is using the last two set s of 30-second data to smooth out any irregularities in the data.

The advisory speeds posted are always the same for all signs on a single gantry. A white diamond may remain displayed on the sign over the HOT lane, however. Since conditions in the HOT lane may be less congested than the general-purpose freeway lanes, the white diamond reinforces the special requirements for use of the lane and discourages drivers who are not MnPASS customers or carpoolers from entering the lane. Posted advisory speeds are in 5 mph increments between a minimum advised 30 mph and a maximum advised speed that is 5 mph under the posted speed limit in that section; the speed limit in the corridor ranges from 60 mph in the south to 50 mph in the north, i.e., the maximum posted advisory speed in the south is 55 mph and in the north is 45 mph. In keeping with state legislation, the posted speeds are advisory only.

As part of the UPA, DMS displaying real-time transit and traffic travel times were deployed at strategic locations along I-35W South, where motorists could access park-and-ride lots to take transit. The signs are intended to encourage motorists to switch to riding the bus by providing comparisons of the travel times.

In addition to the ILCS, in-pavement lighting was initially deployed to denote when the PDSL was open and closed. When the lane was closed, the in-pavement lighting was in the closed position, a yellow tapered line across the left lane was illuminated to encourage motorists to merge right. The in-pavement lighting did survive one Minnesota winter, with snow plowing, chemicals, and freeze/thaw conditions, but problems were encountered with corrosion. As a result, the in-pavement lighting was discontinued in 2011.

Appendix A – Congestion Analysis and Appendix C – Transit Analysis provide information to help assess the impact of the ATM components on promoting better utilization and distribution of traffic to available capacity. These analyses indicate that travel speeds increased overall in the corridor. Variations in changes in travel speeds and travel times for the three segments of I-35W South – Highway 13 to I-494, I-494 to 46th Street, and 46th Street into downtown Minneapolis – did occur, however. Travel speeds decreased slightly, with corresponding increases in travel times in some sections from the pre-deployment period to the post-deployment period. These changes may be the result of speed harmonization and the posting of lower advisory speeds.

Appendix A – Congestion Analysis indicates that overall congestion levels on I-35W South have declined, while vehicle throughput has increased. The ATM speed harmonization may have supported this increase in throughput, but it is not possible to identify the specific impact. The reconstruction of the Crosstown Commons section, the HOT lanes, and geometric improvements may have played a larger role in the throughput increases.

The survey of transit riders on buses using I-35W South is described in Appendix C – Transit Analysis. In response to questions related to the real-time traffic and transit DMS, 69 percent of the respondents indicated they had seen the signs and 8 percent indicated the signs had influenced their decision to ride the bus. These results indicate that the real-time transit and traffic DMS do influence travelers to use the bus. This influence may be both in terms of changing from driving alone to taking the bus and continuing to reinforce the decision to ride the bus.

Appendix F – Safety Analysis examined the number of crashes on I-35W South during six months in both the pre- and post-deployment periods. The pre-deployment period was November 2008 to April 2009 and the post-deployment period was November 2010 to April 2011. The total number of crashes was similar for the two time periods – 428 in the pre-deployment six months and 427 in the post-deployment six months. When the growth in VMT in the post-deployment period is considered, however, crashes declined by 22 percent in the post-deployment period. This change is statistically significant at the 95 percent confidence level. As noted in the safety analysis, examining crash data over a longer post-deployment period is needed to fully assess the potential impacts of the ATM strategies and other UPA projects. Data were not available to assess the impact of the ATM strategies on possible changes in the duration of incidents.

E.2 Perceptions of Minnesota State Patrol Officers, FIRST Operators, and Bus Operators

As part of the national evaluation, MnDOT sponsored interviews with Minnesota State Patrol officers and FIRST operators, and focus groups with Metro Transit and MVTA bus operators. The interviews and focus groups were conducted by William & Kay, Inc. in May, 2011. Representatives from MnDOT's Market Research group assisted with organizing the interviews and focus groups. MnDOT personnel also attended all the interviews and focus groups. Appendix I – Non-Technical Success Factors contains additional background information on the interviews and focus groups and highlights the general comments from the three groups. Comments related to specific UPA projects are also summarized in Appendix A – Congestion Analysis, Appendix B – Tolling Analysis, Appendix C – Transit Analysis, and Appendix F – Safety Analysis. Comments from the interviews and focus groups addressing the Minnesota UPA ATM strategies are summarized in this section.

The Smart Lanes, including the ILCS and real-time traffic and transit information, received positive comments from Minnesota State Patrol officers, FIRST operators, and Metro Transit and MVTA operators. Representatives from all three groups noted that the ILCS were effective in slowing down traffic and moving traffic to other lanes in the case of a crash or other situation. Examples of comments included "really great, we utilize them for crashes and debris on the road," from a State Patrol officer; "when the lane closure signs are on, they are the best of all for the FIRST drivers," from a FIRST operator; "they are wonderful, they work," from another FIRST operator; and "they have helped a lot," from a bus operator.

State Patrol officers and FIRST operators further indicated the ILCS enhanced their ability to respond to crashes and to help maintain traffic flow during incidents. They commented that for the most part the motoring public does move out of the lanes when flashing the yellow X and the red X are posted. It was noted that some motorists do not seem to fully understand what the different symbols and colors mean and how they should respond, however. It was also noted that while the advisory speed signs may slow traffic a little, many motorists do not obey them if traffic is flowing at faster speeds.

Additionally, as part of the UPA national evaluation, MnDOT sponsored a telephone survey of travelers in the I-35W South corridor. The Dieringer Research Group (DRG), Inc. conducted the interviews and followed the questionnaire contained in the Minnesota UPA National Evaluation Surveys, Interviews, and Focus Groups Test Plan. A total of 499 interviews were completed between April 26 and May 24, 2011. The interviews include questions related to ATM components. Approximately 90 percent of the respondents indicated they had seen messages on the electronic signs along I-35W South. Respondents were also asked to rate the Smart Lanes, which was the local term used for the ATM components, as traffic management tools, with 10 being the highest and 1 being the lowest. The mean response for the Smart Lanes was 6.58.

MnDOT's Market Research group utilizes an on-line community of 600 residents who regularly participate in on-line surveys, discussions sessions, brainstorming sessions, and chats on a range of transportation topics. MnDOT used the on-line community to obtain feedback on the proposed I-35W South ATM signs. A total of 259 members of the on-line community participated in a survey in April and May, 2010.

The on-line survey results are summarized in the May 26, 2010 *MnDOT Talk: Active Traffic Management Signing* flyer. The on-line survey participants were first shown photographs of 10 signs and were asked what each sign was communicating to motorists. In general, respondents understood the merge signs, the red X, and the green and yellow arrow signs. Respondents indicated a better understanding that the lane was closed in one mile when "1 mile" was added to the red X sign. Most survey respondents also interpreted the sign with a speed (i.e., 45 mph) as a cautionary speed, but some respondents indicated uncertainty on when they should slow down.

Participants were shown a brief video which explained how ATM works. After the video, participants were asked a series of questions related to the ATM system and possible benefits. Overall, 95 percent strongly or somewhat agreed that the ATM strategies and signing would keep them informed of upcoming traffic conditions and 84 percent strongly or somewhat agreed that it would increase safety on the highway. Additionally, 76 percent strongly or somewhat agreed ATM would ease traffic congestion and 69 percent strongly or somewhat agreed it would be easy for motorists to understand.

E.3 Summary of Technology Analysis

The results of the technology analysis related to the three hypotheses and questions are summarized in Table E-2. The impact of the ATM strategies and the DMS on the throughput increases experienced on I-35W South from the pre- to post-deployment periods is inconclusive. It was not possible to identify the specific impacts on throughput from the ATM strategies and the DMS. The reconstruction of the Crosstown Common section, better utilization of the HOV/HOT lanes, and geometric improvements may be the main contributors to the improvements in throughput. The impact of the ATM strategies on safety and the number and duration of incidents was inconclusive. A longer period is needed to more fully assess the potential safety impacts and data on incidents is also needed. More conclusive results may be found as more years of crash data become available for comparison. While the ATM strategies appear to contribute to the increases in throughput, it was not possible to separate out the impacts of specific components.

Table E-2. Summary of Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Active traffic management strategies, including speed harmonization and DMS with transit and highway travel times, promoting better utilization and distribution of traffic to available capacity on I-35W South.	Inconclusive	It was not possible to separate the potential impacts from the ATM strategies, the HOT lanes, the new general purpose freeways lanes in the Crosstown Commons section, and other improvements on the throughput increase on I-35W South.
• Active traffic management strategies will reduce the number and duration of incidents that result in congestion on I-35W South.	Inconclusive	Data were not available to fully assess this hypothesis. The number of crashes on I-35W South for the six month pre- and post-deployment periods remained the same, but crashes decreased by 22 percent when increases in VMT were considered. Data over a longer pre-deployment period are needed to more fully assess the potential impacts, however. No data were available to compare possible changes in the duration of incidents.
• What was the relative contribution of each technology enhancement on congestion reduction congestion on I-35W South.	Supported	The ATM and DMS components appear to support increased throughput, but it was not possible to separate out the impacts associated with specific components.

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Appendix F. Safety Analysis

This appendix contains the safety-related analysis of the Minnesota UPA projects. As presented in Table F-1, two general types of safety implications were considered associated with the Minnesota UPA projects. First, some of the UPA projects, such as active traffic management (ATM), may enhance safety. Second, the high-occupancy toll (HOT) lanes, the priced dynamic shoulder lane (PDSL), the driver assist system (DAS) for shoulder running buses, and the Marquette and Second Avenues (MARQ2) dual bus lanes hold the potential to reduce safety. This analysis examines both types of safety impacts, the first testing for possible safety improvements, and the second testing for the absence of an undesirable degradation in safety. The first hypothesis is that ATM strategies on I-35W South will reduce the number of primary and secondary crashes. The second, third, and fourth hypothesis address the HOT lanes, the PDSL, the MARQ2 lanes, and the DAS for shoulder running buses not adversely affecting safety. The safety analysis also considers the potential influence of the reconstruction of the Crosstown Commons section, which included new general-purpose lanes in addition to the UPA-funded HOT lanes, on safety.

Table F-1. Safety Analysis Approach

Hypotheses/Questions
• Active traffic management will reduce the number of primary and/or secondary crashes.
• The HOT lanes and the PDSL on I-35W South will not adversely affect highway safety.
• The MARQ2 dual bus lanes in Downtown Minneapolis will not adversely affect safety.
• The driver assist system for shoulder running buses will not adversely affect safety.

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The remainder of this appendix is divided into four sections. The data sources used in the safety analysis are presented next in Section F.1. The possible influences from the UPA projects on safety on I-35W South are examined in Section F.2. Crash data for I-35W South are examined and the perceptions of Minnesota State Patrol Officers, FIRST operators, Metro Transit and MVTA bus operators, MnPASS HOT lane customers, and motorists in the general-purpose freeway lanes related to the safety implications of some UPA projects are discussed. Potential safety implications of the DAS for shoulder running buses on Cedar Avenue and the MARQ2 lanes in downtown Minneapolis are examined in Section F3. Accident data from the MVTA are examined along with the perceptions of MVTA and Metro Transit operators. The appendix concludes with a summary of the safety analysis in Section F.4.

F.1 Data Sources

The Minnesota Department of Public Safety (DPS) Crash Database was used to examine the safety implications of the UPA projects on traffic on I-35W South. The DPS Crash Database includes the official crash reports from the Minnesota State Patrol and local law enforcement departments. The major elements in the DPS Crash Database include the severity of the crash, the crash type, the location, and lighting, road surface, and weather conditions.

The national evaluation team also reviewed crash data from the MnDOT Incident Log and the Computer-Aided Dispatch (CAD) System. The MnDOT Incident Log was used to record freeway incidents until August 2008, when MnDOT transitioned to the State Patrol CAD system to collect this data. Due to the slightly different classifications associated with Incident Log and the CAD systems, using these sources proved problematic for the Minnesota UPA pre-deployment and post-deployment time periods. As a result, the DPS Crash Database described above was used in the Minnesota UPA safety analysis.

The national evaluation team also examined using the Traffic.com/NAVTEQ Incident and Event Database data, which had been tested in the area under a Strategic Highway Research Program 2 (SHRP2) project. Given the similarity of the Traffic.com/NAVTEQ data to the DPS Crash Database, the evaluation team determined that the marginal benefit to be gained from analyzing the data from this source was minimal, and, therefore the data was not used in the safety analysis.

The Federal Transit Administration (FTA) sponsored a separate evaluation of the DAS for shoulder running buses on Cedar Avenue. This evaluation included an examination of MVTA accident data and a survey of the 25 MVTA operators trained to use the DAS-equipped buses. The survey included safety-related questions associated with the use of the DAS. Information from the FTA-sponsored evaluation was used in this safety analysis.[1]

Information from the on-line and telephone surveys, interviews, and focus groups sponsored by MnDOT and MVTA was also used in the safety analysis. As part of the national evaluation, MnDOT sponsored interviews with State Patrol Officers and FIRST operators, and focus groups with Metro Transit and MVTA bus operators. The interviews and focus groups were conducted in May 2011 by William & Kay, Inc. Representatives from MnDOT's Market Research group assisted with recruiting the participants and organizing the interviews and focus groups. The Market Research staff also attended the interviews and focus groups. Questions in the focus groups and interviews examined perceptions in changes in safety on I-35W South due to the HOT lanes, the PDSL, and the ATM strategies, as well as the DAS for shoulder running buses and the MARQ2 lanes. More information on the interviews and focus groups are provided in Appendix A – Congestion Analysis and Appendix C – Transit Analysis.

The surveys of MnPASS users and travelers on I-35W South also included questions related to perceptions of the impact of different UPA projects on safety. The online MnPASS user survey was conducted for MnDOT in January 2012 by Cofiroute USA using SurveyMonkey®. Individuals with active I-35W MnPASS accounts were sent an e-mail requesting they complete the on-line survey and offering the potential to win $15 in MnPASS toll credit vouchers. A total of 1,502 MnPASS customers completed the survey, representing a 20 percent response rate. More information on the MnPASS customer survey is provided in Appendix B – Tolling Analysis.

[1] FTA Cedar Avenue Driver Assist System Evaluation Report, December 2011. FTA Report No. 0010, UDSOT.

A telephone survey of travelers using I-35W South was sponsored by MnDOT and conducted by the Dieringer Research Group, Inc. (DRG). It included questions on perceptions of changes in safety on I-35W South. The interviews were completed by a total of 499 individuals who regularly traveled northbound on I-35W South in the morning peak period. The survey focused primarily on motorists using the general-purpose freeway lanes and carpoolers using the MnPASS lanes. More information on the telephone surveys is provided in Appendix A – Congestion Analysis and Appendix I – Non Technical Success Factors.

F.2 Potential Safety Implications of the UPA Projects on I-35W South

This section presents the analysis of crash data and the perception of safety by users of I-35W South. The analysis using the DPS Crash Database is described in F.2.1. Safety-related information from the focus groups and interviews with Metro Transit and MVTA bus operators, Minnesota State Patrol officers, and FIRST operators, the on-line MnPASS customer survey, and the telephone interviews of motorists on I-35W South is presented in F.2.2.

F.2.1 I-35W South Crash Data

The examination of crash data and the overall safety analysis was complicated by a number of factors. As noted in the introduction, the Minnesota UPA projects may potentially have both positive and detrimental impacts on the safe operation of I-35W South. Further, as discussed in Appendix A – Congestion Analysis, the new HOT lanes in the Crosstown Commons section, the PDSL, the two auxiliary lanes added as part of the UPA, and the new non-UPA funded general-purpose freeway lanes in the Crosstown Commons section, added capacity to I-35W South. This added capacity resulted in increases in vehicle miles of travel (VMT), which also increases the potential for crashes. In addition, construction was occurring on I-35W South during much of the pre-deployment period. This situation made it difficult to obtain crash data for a period uninterrupted by construction.

As another complicating factor, MnDOT noted in the crash data file provided to the national evaluation team that “due to the directional change in the Highway 62 junction (Crosstown Commons area) this included crashes coded as heading north, northeast, or east. The directional data was selected based on direction traveling listed in the individual driver sections rather than the information listed under the column “RD_DIR” [road direction] in the spreadsheet. This was done to the significant number of crashes coded as “Z-other.”

As a result of construction on I-35W South, especially in the Crosstown Commons section, the national evaluation team used the six months from November 2008 to April 2009 for the pre-deployment period (when construction activities were lower) and the same six months from November 2010 to April 2011 for the post-deployment period. A concern with this approach was the small sample size, however. This concern was addressed by combining some of the injury categories as described next. The results provide a preliminary analysis of crash data on I-35W South for the pre- and post-deployment periods. A more robust analysis including longer post-deployment time periods is needed to fully assess the potential safety impacts of the UPA projects and other improvements on I-35W South.

The national evaluation team used the before-after evaluation approach in the crash analysis. This approach has been used to evaluate various safety countermeasures on other projects. As presented in Table F-2, the number of crashes by accident severity for the two time periods was examined first. The accident severity categories include fatal plus injury and property damage only (PDO). Originally, the team considered fatal, incapacitating injury, non-capacitating injury, and possible injury categories, and property damage only (PDO). However, the sample sizes were too small for individual crash type estimation. As a result, the fatal, incapacitating injury, non-capacitating injury, and possible injury categories were merged into one category – named fatal plus injury – to provide a sufficient sample size. The merging of subcategories of injury crashes into one is typically done in crash analysis. The percent changes in crashes were calculated in two ways: without accounting for changes in VMT and accounting for changes in VMT from the pre-deployment to the post-deployment periods.

The percent changes in crashes from before to after periods were computed following the procedure described in Hauer (1997).[2] The steps are summarized below.

Let K be the observed crash count of a road segment during the before period and L be the observed crash count during the after period. Let π be the expected number of crashes of a road segment in the after period had it not been treated and λ be the expected number of crashes of a road segment in the after period. Define the ratio of durations, r_d, by

r_d = (# of after crash data months) / (# of before crash data months).

The effect of the treatment on safety can be assessed by estimating the index of effectiveness, $\theta\,(=\lambda/\pi)$.

The naïve before-after evaluation method without accounting for changes in traffic volumes described in Hauer (1997) estimates the index of effectiveness θ by

$$\hat{\theta} = \frac{\hat{\lambda}/\hat{\pi}}{1 + V\hat{a}r\left(\hat{\pi}\right)/\hat{\pi}^2}$$

where $\hat{\pi}$ and $\hat{\lambda}$ are the estimates of π and λ, respectively, given by $\hat{\lambda} = L$ and $\hat{\pi} = r_d K$, and $V\hat{a}r\left(\hat{\pi}\right) = r_d^{\,2} K$. The standard error of $\hat{\theta}$ is given by

$$SE\left(\hat{\theta}\right) = \sqrt{\hat{\theta}^2 \left[\left(1/\hat{\lambda}\right) + \left(V\hat{a}r\left(\hat{\pi}\right)/\hat{\pi}^2\right)\right] \Big/ \left[1 + V\hat{a}r\left(\hat{\pi}\right)/\hat{\pi}^2\right]^2}$$

[2] Hauer, E. 1997. Observational Before-After Studies in Road Safety: Estimating the Effect of Highway and Traffic Engineering Measures on Road Safety. Pergamon Press, Elsevier Science, Ltd., Oxford, United Kingdom.

and the approximate 95% confidence interval for θ is given by

$$\hat{\theta} \pm 1.96 \cdot SE\left(\hat{\theta}\right).$$

The estimate for the percent change in crashes and the associated standard errors (SE) can then be obtained as follows:

$$\text{Percent change} = \left(\hat{\theta} - 1\right) \times 100,$$

$$SE = SE\left(\hat{\theta}\right) \times 100.$$

As a matter of fact, the assumption that there have been no changes from before to after periods other than the treatment is often violated. There will almost always be changes over time in traffic volumes, vehicle mix, weather, and so on. Because the naïve before-after evaluation does not control for those changes, the effect of treatment cannot be separated from those changes. Among several potential changes between before and after periods the changes in traffic volumes are often non-ignorable, and almost always need to be incorporated into the analysis. To incorporate traffic volume changes in the before-after analysis, the before crash count, *K*, can be replaced by $K \times \frac{VMT^{AT}}{VMT^{BT}}$ where VMT^{BT} and VMT^{AT} are the *VMT* during the before period and the *VMT* during the after period, respectively. The percent change in crashes with incorporating changes in VMT can be estimated by substituting $K \times \frac{VMT^{AT}}{VMT^{BT}}$ for K in the above steps.

As presented in Table F-2, the results show a statistically significant reduction of greater than 20 percent in crashes when VMT is taken into account in the PDO category and in total crashes. In the combined fatal-plus-injury category, a reduction of 9.4 percent was observed, although it is not statistically significant. This analysis indicates that the UPA projects and other improvements on I-35W South have not adversely affected safety based on the limited time period and the limited data examined. As noted previously, however, a longer period of time is needed to fully assess the potential safety impacts.

Table F-2. I-35W South DPS Crash Data Pre- and Post-Deployment by Consolidated Accident Severity

Accident Severity	Time Period		Percent change in crashes (from before to after time periods) with accounting for VMT change[2]	Percent change in crashes (from before to after time periods) without accounting for VMT change[2]
	Pre-Deployment Period Nov 2008 – April 2009	Post-Deployment Period Nov 2010 – Apr 2011		
Fatal Plus Injury[1]	90	105	-9.4 (12.1)	15.4 (16.4)
Property Damage Only	338	322	**-25.6*** (5.5)	-5.0 (7.4)
Total Crash	428	427	**-22.0*** (5.0)	-0.5 (6.8)
Monthly Average VMT	418,768	534,722		
6-month Average VMT (exposure in VMT for 6 months)	2,512,608	3,208,332		

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[1] Combines fatal, incapacitating injury, non-incapacitating injury, and possible injury.

[2] Standard errors are given in parentheses.

* Statistically significant results at 95 percent are presented in bold.

The location of the crashes by the three segments of I-35W South was also examined for the pre- and post-deployment period. The three segments are Highway 13 to 82nd Street, where the existing HOV lanes were expanded to HOT lanes, I-494 to 47th Street, where the new HOT lanes and the new general-purpose freeway lanes were added in the Crosstown Commons section, and 46th Street to Franklin Avenue, which includes the new PDSL. The ATM strategies, including the advisory speeds, were deployed along the full section of I-35W South.

Table F-3 presents the results for total crashes, not accounting for changes in VMT. The estimates for changes in VMT at individual locations were not available at the time of the analysis. The results show a statistically significant decline in total crashes for the section of I-35W South from 46th Street to Franklin Avenue, and slight increases in total crashes that are not statistically insignificant, for the other two sections. Given the small sample size and short time periods, however, more detailed analysis along with accounting for changes in VMT is needed to better assess possible changes in crash locations.

Table F-3. I-35W South DPS Crash Data by Freeway Segment Pre- and Post-Deployment

Section	Accident Severity	Number of Crashes: Pre-Deployment Period Nov 2008 – April 2009	Number of Crashes: Post-Deployment Period Nov 2010 – Apr 2011	Percent Change in Crashes (from before to after time periods) without Accounting for VMT Change[2]
46th St to Franklin Ave.	Fatal Plus Injury[1]	32	24	-27.3 (19.0)
	Property Damage Only	107	78	**-27.8*** (10.7)
	All Accidents Section Total	139	102	**-27.1*** (9.4)
I-494 to 47th St.	Fatal Plus Injury[1]	27	41	46.4 (35.0)
	Property Damage Only	141	143	0.7 (11.9)
	All Accidents Section Total	168	184	8.9 (11.6)
Highway13 to 82nd St.	Fatal Plus Injury[1]	31	40	25.0 (29.0)
	Property Damage Only	90	101	11.0 (15.9)
	All Accidents Section Total	121	141	15.6 (14.2)
	Grand Total	428	427	-0.5 (6.8)

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[1]Combines fatal, incapacitating injury, non-incapacitating injury, and possible injury.

[2]Standard errors are given in parentheses.

* Statistically significant results at 95percent are presented in bold.

F.2.2 Safety Perceptions of I-35W South Users

As noted previously, the focus groups and interviews with Metro Transit and MVTA bus operators, Minnesota State Patrol officers, and FIRST operators included safety-related questions. The on-line survey of I-35W MnPASS customers and the telephone interview of motorists on I-35W South also included questions on safety. As summarized below, most user groups indicated travel on I-35W South was safer after the UPA projects and other improvements. Bus operators, State Patrol officers, and FIRST operators also rated the safety of the different UPA projects as high.

- A total of 73 percent of the respondents to the I-35W MnPASS on-line survey rated the MnPASS toll lanes as safe to very safe. A total of 25 percent of the respondents rated them somewhat safe and 3 percent rated the MnPASS lanes as very unsafe to extremely unsafe. The on-line survey had a margin of error of 2.26 percent at the 95 percent confidence interval.
- Approximately 25 percent of the respondents to the I-35W South traveler telephone survey indicated that they feel safer traveling on I-35W South during the morning peak period than two years ago, while 63 percent reported feeling as safe as two years ago, and 12 percent reported feeling less safe. This telephone survey had a sampling error of

+/- 4 percent at the 95 percent confidence level. Most of the reasons given for feeling less safe related to driver behavior, not the UPA projects or other changes in the freeway. For example, 36 percent of the individuals who reported feeling less safe identified dangerous driving/drivers cutting in as a key reason for feeling less safe, while 13 percent cited drivers texting and talking on the phone. Factors noted by the 25 percent who reported feeling more safe included less traffic congestion/better flow, 27 percent; more lanes, 19 percent; wider lanes/more space, 18 percent; completed construction, 13 percent; and better design/safer than before, 9 percent.

- Minnesota State Patrol officers and FIRST operators participating in the interviews noted the safety benefits of the new general-purpose freeway lanes in the Crosstown Commons section, the HOT lanes, the PDSL, and the ATM strategies. The rebuilding of the Crosstown Commons section was identified as the most important element improving traffic flow on I-35W South and improving safety. One State Patrol officer noted he had responded to fewer crashes since completion of the Crosstown Commons section and another officer noted that "northbound I-35W is a lot safer roadway now." State Patrol officers and FIRST operators also provided positive comments on the ATM strategies, including the advisory speeds and the lane status signs. It was suggested the drivers do pay attention to these signs, making it easier to respond to and clear crashes and incidents. State Patrol officers raised concerns with the lack of a shoulder with the PDSL, which results in no space to pull violators over, and drivers crossing the double white lines to enter and exit the HOT lanes.
- Metro Transit and MVTA bus operators participating in the focus group reported feeling safer – both for themselves and for their passengers – when using the I-35W South MnPASS HOT lanes. They also noted the safety benefits of the ATM strategies in slowing traffic when incidents do occur.

F.3 Potential Safety Implications of the DAS for Shoulder Running Buses and the MARQ2 Lanes

This section presents the safety analysis of the DAS for shoulder running buses and the MARQ2 Lanes.

F.3.1 DAS for Shoulder Running Buses

As discussed in Appendix C – Transit Analysis, the FTA-sponsored evaluation of the DAS for shoulder running buses on Cedar Avenue included an assessment of possible safety impacts. The MVTA was responsible for implementing the DAS. The evaluation examined two safety-related hypotheses – the DAS will facilitate safer operations in the shoulder and bus drivers will perceive driving in the shoulder to be as safe or safer with the DAS.

Accident data from the MVTA for the first six months of operation with the DAS – November 2010 through April 2011 – were compared with accident data for November 2009 through April 2010 without the DAS. None of the reported accidents – eight between November 2009 and April 2010 and four between November 2010 and April 2011 – involved a bus operating on the shoulder.

The survey administered to the 25 trained MVTA operators of DAS-equipped buses included a question on their perceptions of the safety benefits of the system. Half of the operators agreed and 12 percent strongly agreed with the statement that “the DAS makes driving in the shoulder safer,” while 21 percent disagreed and 17 percent strongly disagreed with the statement. Thus, while the majority perceived safety benefits, a sizeable minority did not.

F.3.2 MARQ2 Lanes

A number of methods are used to ensure the safe operation of the MARQ2 lanes in downtown Minneapolis. First, bus operators for all transit systems using the lanes must take special training. Initial training was conducted prior to the opening of the MARQ2 lanes in December 2009. Bus operators from Metro Transit, MVTA, Southwest Transit, and Maple Grove Transit spent a weekend in intensive training on use of the lanes. The training included instruction on use of the second or passing lanes, use of the curb lane and designated bus stops to pick up and drop off passengers, transfer points for the Hiawatha LRT line, and safe driving tips. Ongoing training is provided for bus operators prior to their assignment to a route using the MARQ2 lanes. Safety features are also incorporated into the design and operation of the MARQ2 lanes, including overhead signs at intersections to alert motorists they should not enter the lanes.

The MVTA accident data examined in the DAS analysis described previously was also examined for any accidents associated with the MARQ2 lanes. None of the reported MVTA accidents were associated with the MARQ2 lanes. Metro Transit safety personnel reported there had been no significant incidents with the MARQ2 lanes.

The Metro Transit and MVTA bus operators participating in the MnDOT-sponsored focus groups gave high marks to the MARQ2 lanes, with one noting, “It was probably the best system they could have thought of.” Another operator stated the lanes “run smoothly.” A few concerns were raised with bicyclists and automobiles not observing the lane restrictions.

F.4 Summary of Safety Impacts

Table F-4 summarizes the safety impacts across the hypotheses and questions. The analysis presented in this appendix indicates that the UPA projects did not adversely affect safety on I-35W South and may have improved safety. As discussed, however, more extensive analysis over a longer time period is needed to fully assess the potential impacts of the various UPA projects, the Crosstown Commons section reconstruction, and other improvements on crashes and safety on I-35W South.

The analysis presented in this appendix indicates that there were crash reductions of 9 percent for fatal plus injury crashes and greater than 20 percent for PDO and total crashes when the change in VMT was accounted for on I-35W South in the post-deployment period. Further analysis of data over a longer time period than available for this evaluation is needed to fully assess the safety impacts of the UPA projects and the reconstruction of the Crosstown Commons section, but the ATM strategies appear to contribute to the reduced crash rates and the improved safety reported by MnPASS customers, freeway travelers, Minnesota State Patrol officers, FIRST operators, and bus operators. The analysis further indicates that the HOT lanes and the PDSL did not degrade the safe operation of I-35W South. The majority of MnPASS customers, Minnesota State Patrol officers, FIRST operators, and Metro Transit and MVTA operators indicated the HOT lanes and the PDSL provide safe operating environments. Information from MVTA and Metro Transit indicated no accidents involving the MARQ2 lanes or the DAS for shoulder running buses, and positive feedback from bus operators on the safety-related elements of these projects was received in the focus groups and surveys.

Table F-4. Summary of Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• Active traffic management will reduce the number of primary and/or secondary crashes.	Supports, but more analysis needed	Crash rates were significantly lower statistically (by more than 25 percent for PDO crashes and more than 20 percent for total crashes) in the post-deployment period, but more extensive analysis over a longer period is needed. It was not possible to separate the impacts of the ATM strategies from other UPA elements and the reconstruction of the Crosstown Commons section.Positive reactions on improved safety were received from the majority of MnPASS customers, general-purpose freeway lanes travelers, bus operators, Minnesota State Patrol officers, and FIRST operators.
• The HOT lanes and the PDSL on I-35W South will not adversely affect highway safety.	Supports	Overall crash rates on I-35W South were statistically lower in the post-deployment period. The majority of MnPASS customers and bus operators reported the MnPASS HOT lanes provided safe operating environments.
• The MARQ2 dual bus lanes in Downtown Minneapolis will not adversely affect safety.	Supports	No accidents reported by MVTA or Metro Transit and positive feedback were received from bus operators.
• The lane guidance system for shoulder running buses will not adversely affect safety.	Supports	No accidents reported by MVTA and 62 percent of the MVTA operators using the DAS reported it provided improved safety.

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Appendix G. Equity Analysis

This analysis examines potential equity concerns associated with the Minnesota UPA projects. It assesses whether the positive or negative effects of the MnPASS HOT lanes and other UPA projects fall disproportionately on different user groups, as well as different geographic areas.

Table G-1 presents the four questions in the equity analysis. The first question focuses on the potential impacts of the I-35W South UPA projects on different user groups. The second question addresses the possible impacts by geographic areas. The third question examines the air quality impacts across geographic and socio-economic groups. The final question focuses on the reinvestment of potential revenues from the HOT lanes and the Priced Dynamic Shoulder Lane (PDSL) and how this reinvestment impacts different user groups.

Table G-1. Equity Analysis Questions

Hypotheses/Questions
• How do the impacts from the I-35W South UPA projects affect the different user groups?
• How do the impacts from the I-35W South UPA projects differ across geographic areas?
• Are the air quality impacts from the I-35W South UPA projects different across geographic and socio-economic groups?
• How does reinvestment of potential revenues from the I-35W HOT lanes and PDSL impact various transportation system users?

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The remainder of this appendix is divided into six sections. The data sources used in the analysis are described next in Section G.1. Section G.2 presents the analysis of potential equity impacts to the different I-35W South user groups. Section G.3 discusses the possible equity impacts by geographic area. Section G.4 examines the air quality impacts from the I-35W South UPA projects across geographic and socio-economic groups. Section G.5 examines how the planned reinvestment of potential revenues from the I-35W MnPASS HOT lanes and the PDSL may impact various user groups. The appendix concludes with a summary of the potential equity impacts in Section G.6.

G.1 Data Sources

Data for the equity analysis were obtained from a number of different sources. Information from the congestion, tolling, transit, and environmental analyses were used in the equity assessment. Data on the changes in freeway travel times and travel speeds from Appendix A – Congestion Analysis were used, along with changes in transit services, bus travel speeds, zip code zones of park-and-ride lot users, and express bus fares from Appendix C – Transit Analysis. Information on the bus routes using the MARQ2 lanes in downtown Minneapolis was obtained from Metro Transit. Data on the average tolls in the MnPASS HOT lanes from Appendix B – Tolling Analysis and changes in vehicle emissions from Appendix H – Environmental Analysis were also used. The results of surveys of bus riders, MnPASS customers, and carpoolers and motorists in the general-purpose freeway lanes were also used in the equity analysis. The home zip code zones for survey respondents, MnPASS users, and park-and-ride lot users were correlated to Census tracks and community boundaries for use in the geographic analysis. Socio-economic and demographic data from the 2000 Census and the American Community Survey (ACS) 5-Year Estimates (2006 through 2010) were obtained for these areas and analyzed. The results from the environmental analysis presented in Appendix H were used in the equity analysis. Information on the reinvestment of possible toll revenues included in the Minnesota UPA application was also used in the analysis, along with the results of the stakeholder interviews on perceptions related to possible reinvestment options. The 2011 cost per mile of operating a vehicle was obtained from the AAA *Your Driving Costs* study.

G.2 Potential Equity Impacts on I-35W South User Groups

Table G-2 presents the potential benefits and costs associated with the UPA projects on the four major I-35W South user groups – travelers in the general-purpose freeway lanes, carpoolers, transit riders, and MnPASS customers using the HOT lanes. The table presents pre- and post-deployment information on the mean travel time, the vehicle operation costs, and other benefits for the different user groups. Information on travel time in the morning peak-period in the northbound direction for the pre- and post-deployment periods was obtained from Appendix A – Congestion Analysis. As noted in Appendix A, due to the sensor locations, this information covers approximately 14 miles of I-35W South. Information on transit fares and the transit elements was obtained from Appendix C – Transit Analysis. Information on the average MnPASS HOT lane toll for November 2011 was obtained from Appendix B – Tolling Analysis. As highlighted in Table G-2 and summarized below, all user groups benefited from the UPA projects.

- Travelers in the General-Purpose Freeway Lane. Prior to the deployment of the UPA projects, and the additional general-purpose freeway lanes and other improvements on the Crosstown Commons section, the morning peak-period mean travel time in the northbound direction for the 14 mile section for travelers in the general-purpose freeway lanes was 18.9 minutes. After deployment of the UPA projects and the new general-purpose freeway lanes in the Crosstown Commons section, the travel time was reduced to 16.8 minutes. There was no change in the cost of operating a vehicle in the general-purpose freeway lanes from the pre-to-post-deployment periods.
- Carpoolers. Prior to the deployment of the UPA projects, carpoolers on I-35W South were able to use the HOV lanes from Highway 13 to I-494. After deployment of the UPA projects, carpoolers were able to use the MnPASS HOT lanes and the PDSL from Highway 13 to downtown Minneapolis in the northbound direction. With the additional sections of HOT lanes and the PDSL, the mean travel time for carpoolers in the morning peak-period northbound direction was reduced from 16.7 minutes in the pre-deployment periods to 13.8 minutes in the post-deployment period. There was no change in the cost of operating carpool from the pre-to-post-deployment periods.

- Transit Riders. Prior to deployment of the UPA projects, bus riders from the communities south of the Minnesota River I-35W South received travel time savings from buses using the HOV lanes from Highway 13 to I-494. After deployment, bus riders also received travel time savings from buses using the new section of the MnPASS HOT lanes in the Crosstown Commons section and the PDSL. After deployment, bus riders experienced a reduction in mean travel times from 16.7 minutes to 13.8 minutes for the section of I-35W South examined in the congestion analysis. Bus riders also experienced trip-time savings from the Transit Advantage project at the Highway 62/Highway 77 interchange and the MARQ2 lanes in downtown Minneapolis. The MARQ2 lanes benefit not only riders on the I-35W bus routes, but also riders on all the express routes using the lanes. As of February 2012, riders on 586 express and limited-stop buses on 76 routes benefited from the trip-time savings, trip-time reliability, next bus arrival signs, passenger shelters, and other amenities associated with the MARQ2 lanes. Bus riders in the I-35W South corridor have also benefited from the new and expanded park-and-ride lots, new transit stations, new buses, the Cedar Avenue shoulder running bus system, and new routes, such as the new express route to the University of Minnesota from the Cedar Avenue park-and-ride lot. With no fare increases, the cost associated with riding the bus remained constant from the pre- to post-deployment periods. The freeway express bus peak hour fare has remained at $3.00, while the non-peak hour freeway express bus fare has remained at $2.25.
- MnPASS Customers. Prior to the deployment of the Minnesota UPA projects, there were no HOT lanes on I-35W for use by MnPASS customers. The HOV lanes from Highway 13 to I-494 were restricted to carpools, vanpools, and buses. As a result of the Minnesota UPA projects, MnPASS customers have access to the 16 miles of HOT lanes and the PDSL from Highway 13 to downtown Minneapolis in the northbound direction. MnPASS users experienced a reduction in the mean travel time from 18.9 minutes in the pre-deployment period, when they used the general-purpose freeway lanes to 13.8 minutes in the post-deployment period, when they used the MnPASS HOT lanes, for the portion of I-35W South examined in the congestion analysis. MnPASS users paid to use the MnPASS HOT lanes in the post-deployment period. As a result, the cost of using I-35W South increased for MnPASS users. The extra cost reflects the average toll for November 2011 of $1.68 in the northbound direction.

Table G-2. Potential Benefits and Cost on I-35W South User Groups

User Group	Mean Travel Time[1]		Other Qualitative Benefits	Costs[2]	
	Before	After		Before	After
General Purpose Lane Travelers	18.9	16.8		$8.19	$8.19
HOV/HOT Lane Carpoolers	16.7	13.8		$8.19	$8.19
Transit Riders	16.7	13.8	• New park-and-ride lots • Expanded park-and-ride lots • New transit stations • New routes • New buses	Freeway Express Bus Rush Hour Fare – $3.00. Non-Rush Hour Fare – $2.25	Freeway Express Bus Rush Hour Fare – $3.00. Non-Rush Hour Fare – $2.25
HOT Lane MnPASS Users	18.9	13.8		$8.19	$9.87[3]

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[1] Mean travel time from Appendix A – Congestion Analysis in minutes
[2] Vehicle operating cost per mile of 58.5 cents for sedan average from 2011 AAA "Your Driving Costs" multiplied by 14 miles.
[3] Vehicle operating costs of $8.19 plus average toll in November 2011 of $1.68 in the northbound direction.

G.3 Potential Equity Impacts by Geographic Areas

The potential equity impacts by geographic area were also examined. The analysis examined the access to the UPA projects in the I-35W South corridor and the MARQ2 lanes in downtown Minneapolis by geographic area. Table G-3 presents the potential equity impacts by geographic areas in the I-35W South corridor. Information on the access to the MnPASS HOT lanes and the mean pre- and post-deployment travel time savings for travelers using the general-purpose freeway lanes and the MnPASS HOT lanes is presented. Access to the UPA transit park-and-ride lots and the MARQ2 lanes is also highlighted.

As presented in Table G-3, the potential impacts of the UPA projects vary slightly by geographic areas in the I-35W South corridor. Residents of Apple Valley, Burnsville, and Lakeville are able to use the MnPASS HOT lanes and the PDSL for trips to downtown Minneapolis. Residents of the three communities – which are part of the metropolitan transit taxing district – have access to the new park-and-ride lots, transit stations, new and existing express bus service, and the MARQ2 lanes in downtown Minneapolis. Residents of the other six ex-urban communities have access to the MnPASS HOT lanes and the transit facilities, and services even though their cities are not contributing to the transit taxing district. Residents of Bloomington, and South Minneapolis have access to the MnPASS HOT lanes and PDSL. Residents in these areas also benefit from buses using the MARQ2 lanes. Residents in South Minneapolis are also able to access to additional services through the new I-35W South and 42nd Street Transit Station, which was not a UPA project, but is a key element of the ultimate BRT system on I-35W South.

Table G-3. Potential Equity Impacts by Geographic Areas in the I-35W South Corridor

Community	HOT Segments of I-35W South			Mean Travel Time[1]		Access to UPA Transit Projects
	Hwy 13 – I-494	I-494 – 42nd Street	42nd Street – Downtown Minneapolis	Before/After General Purpose Lanes	Before/After HOV/HOT Lanes	
South Minneapolis			X	1.8/2.5	1.8/2.2	Additional services from the I-35W and 42nd Street Transit Station /MARQ2
Bloomington		X	X	10.3/8.5	10.3/7.8	Some of the new transit services/ MARQ2
Apple Valley	X	X	X	18.9/16.8	16.7/13.8	New park-and-ride lots and express service/MARQ2
Burnsville	X	X	X	18.9/16.8	16.7/13.8	New park-and-ride lots and express service/MARQ2
Lakeville	X	X	X	18.9/16.8	16.7/13.8	New park-and-ride lots and express service/MARQ2
Elko	X	X	X	18.9/16.8	16.7/13.8	Access to new park-and-ride lots, express service, and MARQ2
Fairbault	X	X	X	18.9/16.8	16.7/13.8	Access to new park-and-ride lots, express service, and MARQ2
Farmington	X	X	X	18.9/16.8	16.7/13.8	Access to new park-and-ride lots, express service, and MARQ2
Prior Lake	X	X	X	18.9/16.8	16.7/13.8	Access to new park-and-ride lots, express service, and MARQ2
Savage	X	X	X	18.9/16.8	16.7/13.8	Access to new park-and-ride lots, express service, and MARQ2
Northfield	X	X	X	18.9/16.8	16.7/13.8	Access to new park-and-ride lots, express service, and MARQ2

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[1] Mean Travel time in minutes from loop detector data presented in Appendix A – Congestion Analysis for I-35W South. Before mean travel time is for general-purpose freeway lanes. After mean travel time is for MnPASS HOT lanes, based on travelers becoming MnPASS HOT lane users by paying the toll, carpooling, or riding the bus.

In addition, residents from throughout the Minneapolis-St. Paul Metropolitan area benefit from the MARQ2 lanes in downtown Minneapolis. The 76 express and limited stop routes using the MARQ2 lanes cover more than the I-35W South corridor. Riders on express and limited stop routes from other parts of Minneapolis, St. Paul, and suburban communities throughout the metropolitan area benefit from the increased travel speeds and improved trip time reliability offered by the MARQ2 lanes.

G.4 Potential Air Quality Impacts by Geographic Area and Socio-Economic Groups

The air quality impacts associated with the Minnesota UPA projects are presented in Appendix H – Environment Analysis. The analysis, which focused primarily on the section of I-35W South from Highway 13 to I-494, indicated that the UPA projects resulted in reductions in vehicle emissions. Due to data limitations and numerous confounding factors, the air quality analysis for other sections of I-35W South north of I-494 was inconclusive. The air quality impacts were examined by both geographic area and socio-economic groups.

The socio-economic characteristics of residents of the communities included in the geographic analysis were examined. The zip codes for survey respondents, MnPASS users, and park-and-ride lot users were matched to Census tracks and community boundaries. Data from the 2000 Census and the ACS 5-Year Estimates for 2006 through 2010 were obtained and analyzed for these areas.

Tables G-4 and G-5 summarized the results of this analysis. Table G-4 presents the age and ethnicity breakdowns for the different areas and Table G-5 present the income, gender, and vehicles per household breakdowns. In terms of age breakdown, Apple Valley, Burnsville, Elko, Fairbault, Farmington, and Lakeville reflect more typical suburban and smaller communities, with larger youth and working age populations. South Minneapolis reflects similar trends, but with slightly lower youth populations and a larger percent of the population in the working age categories. Bloomington reflects a higher percent of individuals 70 years of age and over.

In terms of ethnicity, the population of all of the communities are predominately white or Caucasian. Bloomington and South Minneapolis are the most ethnically diverse, with 10 percent and 15 percent Black populations, respectively. Most of the communities are characterized by annual household incomes in the $40,000 to $199,999 ranges. Communities with higher percentages of households with incomes below $20,000 include South Minneapolis (21 percent), Fairbault (18 percent), Northfield (16 percent), Bloomington (11 percent), and Burnsville (11 percent). Most of the communities are relatively close to a 50-50 split between males and females. Also as presented in Table G-5, the vast majority of households in all communities have at least one vehicle.

This information indicates that the communities served by the Minnesota UPA projects reflect relatively similar demographic and socio-economic characteristics. There are some differences, primarily in age and income, and ethnicity in the case of South Minneapolis and Bloomington. As noted previously, residents in these communities receive fewer benefits from the UPA projects than residents in other communities. As a result, the potential air quality impacts are distributed disproportionately among geographic areas and socio-economic groups.

Table G-4. Age and Ethnicity for Communities Influenced by the Minnesota UPA Projects

	Apple Valley		Bloomington		Burnsville		Elko		Fairbault		Farmington		Lakeville		South Minneapolis		Northfield		Prior Lake		Savage	
Age	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent	Population	Percent
<5	3,183	6.48%	4,861	5.16%	4,471	7.42%	323	8.69%	1,957	6.58%	3,114	9.61%	5,355	7.17%	12,775	6.98%	1,270	5.16%	5,868	8.36%	2,107	7.82%
5 - 9	3,408	6.94%	5,106	5.42%	3,870	6.42%	365	9.82%	1,990	6.69%	3,191	9.85%	6,546	8.76%	10,192	5.57%	1,431	5.82%	6,104	8.69%	2,551	9.46%
10 - 14	3,552	7.24%	5,158	5.47%	3,735	6.19%	345	9.28%	2,008	6.75%	2,830	8.73%	7,086	9.48%	8,131	4.44%	1,435	5.83%	5,484	7.81%	2,471	9.17%
15 - 19	3,396	6.92%	5,159	5.47%	3,790	6.29%	275	7.40%	2,174	7.31%	2,131	6.58%	6,012	8.05%	8,484	4.64%	3,125	12.70%	4,480	6.38%	1,942	7.20%
20 - 24	2,562	5.22%	4,923	5.22%	4,091	6.79%	128	3.44%	1,795	6.04%	1,392	4.30%	3,269	4.38%	16,436	8.98%	3,914	15.91%	3,194	4.55%	1,090	4.04%
25 - 29	3,248	6.62%	6,558	6.96%	5,214	8.65%	157	4.22%	2,069	6.96%	2,298	7.09%	3,866	5.17%	24,138	13.19%	1,001	4.07%	4,709	6.71%	1,696	6.29%
30 - 34	3,331	6.79%	5,415	5.74%	4,235	7.02%	288	7.75%	1,954	6.57%	2,867	8.85%	4,636	6.21%	18,667	10.20%	1,111	4.52%	5,600	7.97%	1,829	6.78%
35 - 39	3,266	6.65%	4,977	5.28%	3,979	6.60%	302	8.12%	1,891	6.36%	3,067	9.46%	5,533	7.41%	14,358	7.85%	1,254	5.10%	5,985	8.52%	2,239	8.31%
40 - 44	3,645	7.43%	5,603	5.94%	3,850	6.39%	352	9.47%	2,097	7.05%	3,057	9.43%	6,720	9.00%	12,807	7.00%	1,355	5.51%	6,175	8.79%	2,642	9.80%
45 - 49	4,200	8.56%	6,899	7.32%	4,373	7.25%	371	9.98%	2,284	7.68%	2,615	8.07%	7,519	10.06%	12,005	6.56%	1,565	6.36%	5,881	8.37%	2,624	9.73%
50 - 54	4,131	8.42%	7,353	7.80%	4,624	7.67%	284	7.64%	2,178	7.33%	1,838	5.67%	5,946	7.96%	11,489	6.28%	1,604	6.52%	4,665	6.64%	2,072	7.69%
55 - 59	3,567	7.27%	6,874	7.29%	3,839	6.37%	177	4.76%	1,922	6.46%	1,264	3.90%	4,162	5.57%	10,336	5.65%	1,406	5.71%	3,682	5.24%	1,326	4.92%
60 - 64	2,876	5.86%	6,135	6.51%	3,184	5.28%	144	3.87%	1,449	4.87%	994	3.07%	3,041	4.07%	8,021	4.38%	1,139	4.63%	2,859	4.07%	918	3.41%
65 - 69	1,858	3.79%	4,846	5.14%	2,390	3.96%	82	2.21%	1,181	3.97%	645	1.99%	2,118	2.84%	4,858	2.65%	760	3.09%	2,057	2.93%	633	2.35%
70 - 74	1,105	2.25%	4,087	4.34%	1,631	2.71%	61	1.64%	944	3.18%	440	1.36%	1,224	1.64%	3,195	1.75%	660	2.68%	1,323	1.88%	352	1.31%
75 - 79	757	1.54%	3,655	3.88%	1,217	2.02%	32	0.86%	677	2.28%	302	0.93%	776	1.04%	2,424	1.32%	571	2.32%	924	1.32%	247	0.92%
80 - 84	527	1.07%	3,279	3.48%	854	1.42%	16	0.43%	575	1.93%	182	0.56%	514	0.69%	2,091	1.14%	476	1.93%	585	0.83%	134	0.50%
85+	472	0.96%	3,389	3.59%	944	1.57%	15	0.40%	587	1.97%	179	0.55%	385	0.52%	2,611	1.43%	525	2.13%	652	0.93%	85	0.32%
Total	**49,084**	**100.00%**	**94,277**	**100.00%**	**60,291**	**100.00%**	**3,717**	**100.00%**	**29,732**	**100.00%**	**32,406**	**100.00%**	**74,708**	**100.00%**	**183,018**	**100.00%**	**24,602**	**100.00%**	**70,227**	**100.00%**	**26,958**	**100.00%**
Race																						
White	41,121	83.78%	77,156	81.84%	46,717	77.49%	3,524	94.81%	25,546	85.92%	29,263	90.30%	66,657	89.22%	123,917	67.71%	22,244	90.42%	58,863	83.82%	22,228	82.45%
Black or African American	2,689	5.48%	5,583	5.92%	6,046	10.03%	40	1.08%	1,775	5.97%	634	1.96%	1,938	2.59%	27,198	14.86%	269	1.09%	1,985	2.83%	1,165	4.32%
American Indian and Alaska Native	191	0.39%	324	0.34%	215	0.36%	4	0.11%	225	0.76%	128	0.39%	277	0.37%	4,340	2.37%	56	0.23%	836	1.19%	109	0.40%
Asian	2,611	5.32%	6,286	6.67%	3,043	5.05%	74	1.99%	511	1.72%	1,161	3.58%	3,181	4.26%	6,189	3.38%	722	2.93%	4,577	6.52%	2,340	8.68%
Native Hawaiian and Other Pacific Islander	34	0.07%	41	0.04%	52	0.09%	5	0.13%	14	0.05%	17	0.05%	26	0.03%	98	0.05%	8	0.03%	20	0.03%	68	0.25%
Some Other Race	984	2.00%	2,324	2.47%	2,085	3.46%	8	0.22%	1,076	3.62%	354	1.09%	810	1.08%	13,583	7.42%	835	3.39%	2,224	3.17%	360	1.34%
Two or More Races	1,454	2.96%	2,563	2.72%	2,133	3.54%	62	1.67%	585	1.97%	849	2.62%	1,819	2.43%	7,693	4.20%	468	1.90%	1,722	2.45%	688	2.55%
Total	**49,084**	**100.00%**	**94,277**	**100.00%**	**60,291**	**100.00%**	**3,717**	**100.00%**	**29,732**	**100.00%**	**32,406**	**100.00%**	**74,708**	**100.00%**	**183,018**	**100.00%**	**24,602**	**100.00%**	**70,227**	**100.00%**	**26,958**	**100.00%**

2000 Census and the American Community Survey (ACS) 5-Year Estimates.

Table G-5. Income, Gender and Vehicles Per Household for Communities Influenced by the Minnesota UPA Projects

	Apple Valley		Bloomington		Burnsville		Elko		Fairbault		Farmington		Lakeville		South Minneapolis		Northfield		Prior Lake		Savage	
Annual HH Income																						
Less than $10,000	390	2.12%	1,337	3.78%	1,236	5.05%	13	1.11%	454	5.92%	176	2.61%	298	1.70%	8,701	10.29%	341	5.52%	283	4.07%	107	1.25%
$10,000 to $14,999	297	1.61%	1,295	3.66%	715	2.92%	4	0.34%	581	7.57%	152	2.26%	303	1.73%	4,995	5.91%	268	4.34%	205	2.95%	87	1.02%
$15,000 to $19,999	448	2.43%	1,389	3.93%	865	3.53%	13	1.11%	377	4.91%	70	1.04%	191	1.09%	4,183	4.95%	382	6.18%	47	0.68%	148	1.73%
$20,000 to $24,999	335	1.82%	1,278	3.62%	1,139	4.65%	4	0.34%	436	5.68%	156	2.32%	267	1.53%	4,691	5.55%	214	3.46%	92	1.32%	108	1.26%
$25,000 to $29,999	633	3.44%	2,252	6.37%	1,197	4.89%	5	0.43%	349	4.55%	118	1.75%	427	2.44%	4,474	5.29%	213	3.45%	161	2.31%	171	2.00%
$30,000 to $34,999	497	2.70%	2,223	6.29%	1,171	4.78%	46	3.92%	578	7.53%	198	2.94%	403	2.30%	4,433	5.24%	148	2.39%	144	2.07%	82	0.96%
$35,000 to $39,999	686	3.72%	1,481	4.19%	986	4.03%	40	3.41%	483	6.30%	236	3.50%	323	1.84%	4,435	5.24%	310	5.01%	233	3.35%	80	0.93%
$40,000 to $44,999	748	4.06%	1,766	5.00%	1,341	5.48%	48	4.10%	377	4.91%	281	4.17%	592	3.38%	3,973	4.70%	216	3.49%	289	4.16%	262	3.06%
$45,000 to $49,999	984	5.34%	1,690	4.78%	1,046	4.27%	12	1.02%	484	6.31%	153	2.27%	620	3.54%	3,351	3.96%	224	3.62%	141	2.03%	292	3.41%
$50,000 to $59,999	1,579	8.57%	3,178	8.99%	2,253	9.21%	88	7.51%	995	12.97%	592	8.79%	1,321	7.55%	6,484	7.67%	569	9.20%	513	7.38%	862	10.07%
$60,000 to $74,999	2,367	12.85%	4,320	12.22%	2,659	10.86%	158	13.48%	796	10.38%	961	14.26%	1,749	9.99%	7,800	9.22%	767	12.41%	711	10.22%	684	7.99%
$75,000 to $99,999	3,254	17.67%	4,746	13.43%	3,405	13.91%	288	24.57%	993	12.94%	1,582	23.48%	3,538	20.21%	9,284	10.98%	968	15.66%	1,218	17.51%	1,973	23.05%
$100,000 to $124,999	2,411	13.09%	3,385	9.58%	2,801	11.44%	201	17.15%	467	6.09%	1,139	16.90%	2,885	16.48%	6,514	7.70%	688	11.13%	1,086	15.61%	1,318	15.40%
$125,000 to $149,999	1,279	6.94%	1,830	5.18%	1,476	6.03%	109	9.30%	159	2.07%	509	7.55%	1,592	9.09%	3,887	4.60%	366	5.92%	865	12.44%	1,027	12.00%
$150,000 to $199,999	1,449	7.87%	1,890	5.35%	1,321	5.40%	92	7.85%	41	0.53%	360	5.34%	1,831	10.46%	3,819	4.52%	276	4.46%	530	7.62%	895	10.45%
$200,000 or more	1,062	5.77%	1,287	3.64%	864	3.53%	51	4.35%	102	1.33%	55	0.82%	1,168	6.67%	3,534	4.18%	232	3.75%	437	6.28%	465	5.43%
Total	***18,419***	***100.00%***	***34,010***	***100.00%***	***24,475***	***100.00%***	***1,172***	***100.00%***	***7,672***	***100.00%***	***6,738***	***100.00%***	***17,508***	***100.00%***	***84,558***	***100.00%***	***6,182***	***100.00%***	***6,955***	***100.00%***	***8,561***	***100.00%***
Gender																						
Male	23,796	48.48%	44,745	47.46%	29,362	48.70%	1,889	50.82%	15,918	53.54%	16,288	50.26%	37,348	49.99%	92,839	50.65%	11,841	48.13%	34,760	49.50%	13,506	50.10%
Female	25,288	51.52%	49,532	52.54%	30,929	51.30%	1,828	49.18%	13,814	46.46%	16,118	49.74%	37,360	50.01%	90,449	49.35%	12,761	51.87%	35,467	50.50%	13,452	49.90%
Total	***49,084***	***100.00%***	***94,277***	***100.00%***	***60,291***	***100.00%***	***3,717***	***100.00%***	***13,814***	***100.00%***	***16,118***	***100.00%***	***74,708***	***100.00%***	***90,449***	***100.00%***	***24,602***	***100.00%***	***70,227***	***100.00%***	***26,958***	***100.00%***
HH Vehicles	656	3.56%	2,064	5.84%	1,347	5.50%	21	1.79%	664	8.65%	175	2.60%	254	1.45%	9,214	8.76%	471	7.62%	167	2.40%	69	0.81%
0	5,280	28.67%	12,438	35.19%	8,084	33.03%	139	11.86%	2,383	31.06%	1,419	21.06%	3,153	18.01%	35,126	33.41%	1,921	31.07%	1,419	20.40%	1,136	13.27%
1	8,140	44.19%	15,126	42.79%	10,949	44.74%	647	55.20%	3,471	45.24%	3,749	55.64%	9,355	53.43%	42,332	40.26%	2,834	45.84%	3,677	52.87%	4,923	57.50%
2	3,109	16.88%	4,152	11.75%	2,997	12.25%	300	25.60%	786	10.25%	1,073	15.92%	3,616	20.65%	14,659	13.94%	717	11.60%	1,210	17.40%	1,887	22.04%
3	1,234	6.70%	1,567	4.43%	1,098	4.49%	65	5.55%	368	4.80%	322	4.78%	1,130	6.45%	3,815	3.63%	239	3.87%	482	6.93%	546	6.38%
Total	***18,419***	***100.00%***	***35,347***	***100.00%***	***24,475***	***100.00%***	***1,172***	***100.00%***	***7,672***	***100.00%***	***6,738***	***100.00%***	***17,508***	***100.00%***	***105,146***	***100.00%***	***6,182***	***100.00%***	***6,955***	***100.00%***	***8,561***	***100.00%***

2000 Census and the American Community Survey (ACS) 5-Year Estimates.

G.5 Impact of Planned Reinvestment of Potential I-35W MnPASS Revenues

The state law authorizing the I-35W South HOT project addresses reinvestment of any revenues from the I-35W MnPASS HOT lanes. It requires that operation and enforcement expenses be paid first with revenue generated from the I-35W South MnPASS lanes. After operation and enforcement costs have been paid, revenues from the I-35W South MnPASS HOT lanes are to be divided equally between public transit services and other roadway improvements on I-35W South. This approach is slightly different than the law governing reinvestment of any revenues from the I-394 MnPASS lanes, which first require payment of the capital cost of the project. After that, any excess revenues from I-394 must be divided 50 percent for transportation capital improvements within the corridor and 50 percent for expansion and improvement of bus transit services in the corridor.

The stakeholder interviews conducted in 2009 and 2011 included questions related to the anticipated reinvestment of any MnPASS revenues. The results indicated an awareness of the division included in the state law noted above and support for this approach, which provides benefits to all I-35W South user groups.

The required reinvestment of potential I-35W MnPASS revenues is equitable across I-35W user groups. The division of possible revenues to both capital improvements on I-35W South and improvements in transit services in the corridor would benefit all user groups. Thus, the reinvestment represents an equitable approach for all I-35W South user groups – travelers in the general-purpose freeway lanes, bus riders, carpoolers using the MnPASS lanes, and MnPASS customers.

G.6 Summary of Equity Analysis

Table G-6 presents a summary of the equity analysis across the four questions. The Minnesota UPA projects benefited all I-35W South user groups – motorists in the general-purpose freeway lanes, carpoolers using the HOV and HOT lanes, bus riders, and MnPASS customers. MnPASS customers experienced an increase in operating expenses due to the HOT lane tolls, but they received the benefit of reduced mean travel times. The impacts of the UPA projects vary slightly across geographic areas, but all geographic areas in the I-35W South corridor benefit from the UPA projects to some extent. Residents in the communities south of the Minnesota River have access to the HOT lanes and PDSL, the MARQ2 lanes, and the new park-and-ride lots and the new and expanded bus services. Residents in communities north of the river have access to the HOT lanes and PDSL, the MARQ2 lanes, and some of the new services. In addition, bus riders throughout the metropolitan area benefit from express and limited-stop routes using the MARQ2 lanes. The geographic areas reflect relatively similar socio-economic and demographic characteristics with South Minneapolis and Bloomington being more ethnically and socio-economically diverse. The environmental analysis indicated that the UPA projects resulted in reduced emissions in the section of I-35W from Highway 13 to I-494. The analysis for the other sections of I-35W South were inconclusive due to data limitations and numerous confounding factors. Finally, the proposed reinvestment of any MnPASS revenues between capital improvements and transit improvements on I-35W South represents an equitable approach benefiting all users groups.

Table G-6. Summary of Equity Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
How do the impacts from the I-35W South UPA projects affect the different user groups?	Supports all user groups	All user groups – motorists in the general-purpose freeway lanes, carpoolers, bus riders, and MnPASS users benefited. MnPASS users' operating expenses increased due to the HOT lane tolls, but they received the benefit of reduced mean travel times.
How do the impacts from the I-35W South UPA projects differ across geographic areas?	Positive impacts on all areas, but benefits vary slightly by geographic area.	All the geographic areas received benefits. Residents in communities south of the Minnesota River have access to the new park-and-ride lots and new and expanded express bus services, as well as the HOT lanes and PDSL and MARQ2 lanes. Residents of Bloomington and South Minneapolis have access to the MnPASS HOT lanes, MARQ2 lanes, and some of the new services. Bus riders on express and limited- stop routes from throughout the metropolitan area benefit from the MARQ2 lanes.
Are the air quality impacts from the I-35W South UPA projects different across geographic and socio-economic groups?	Positive or neutral impacts on most areas and socio-economic groups, but possible negative impacts on some communities and populations	There were differences in air quality impacts across geographic areas and socio-economic groups. Communities north of the Minnesota River – which reflect more diverse ethnic groups and lower income groups – may have possible negative air quality impacts.
How does reinvestment of potential revenues from the I-35W HOT lanes and PDSL impact various transportation system users?	Supports all user groups	The required reinvestment of potential revenues between capital improvements and transit improvements on I-35W South benefits all user groups.

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Appendix H. Environmental and Energy Analysis

The environmental and energy analysis of the Minnesota UPA focuses on the potential impacts of the projects on air quality and energy consumption in the I-35W South corridor and downtown Minneapolis. Table H-1 lists the questions included in the environmental analysis. The first question addresses the air quality impacts of the Minnesota UPA projects. The second question focuses on the perceptions of the public and stakeholders related to the overall environmental impacts of the projects. The third question explores the potential impacts of the UPA projects on energy consumption.

Table H-1. Environmental and Energy Analysis Questions

Questions
• What are the impacts of the Minnesota UPA strategies on air quality?
• What are the impacts on perceptions of overall environmental quality?
• What are the impacts on energy consumption?

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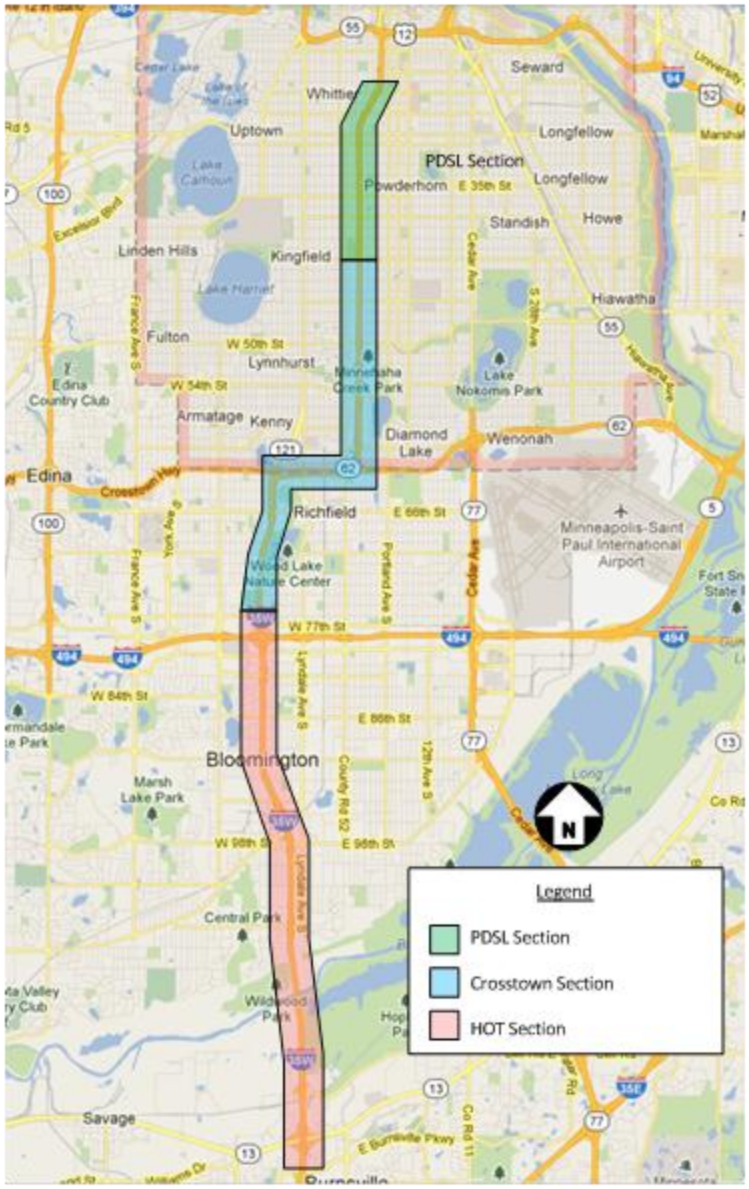
Questions one and three are addressed by quantifying the change in ozone precursors – Volatile Organic Compounds (VOC) and Nitrogen Oxides (NOx), Carbon Monoxide (CO), and Carbon Dioxide (CO_2), as an indicator of greenhouse gas potential, and energy use, expressed in gallons of fuel use. Question two is addressed by examining information from interviews with local stakeholders and the content analysis of print media.

The environmental and energy analysis is complicated by the nature of the Minnesota UPA projects and other non-UPA improvements along the I-35W South corridor during the pre- and post-deployment periods. The addition of new UPA high-occupancy toll (HOT) lanes and the Priced Dynamic Shoulder Lane (PDSL) provides additional capacity on I-35W South and travel options for users. The new general-purpose freeway lanes in the Crosstown Commons section, which were not part of the UPA, also add capacity and, along with other improvements in this section of I-35W South, eliminate a major bottleneck on the freeway. All of these improvements should result in increased travel speeds and possibly traffic volumes. As discussed later, it is not possible to separate the potential impacts of the UPA-funded new HOT lanes and PDSL from the potential impacts of the non-UPA general-purpose freeway lanes and other improvements.

Another component of the UPA on I-35W South includes the deployment of Active Traffic Management (ATM), including speed harmonization. Also called Smart Lanes, the ATM includes intelligent lane control signals (ILCS). The system automatically activates advisory speeds in advance of congested areas, with advisory speeds posted up to one and one-half miles upstream of congested areas.

Figure H-1 presents a map of the UPA and non-UPA projects implemented during the analysis period.



Google Maps, modified by Battelle

Figure H-1. Three Sections of the I-35W South Corridor

The remainder of this appendix is divided into five sections. The data sources used in the analysis are presented in Section H.1. The analysis methods used in the air quality and energy assessment are discussed in Section H.2. The results of the analysis of the air quality and energy impacts on the I-35W South are summarized in Section H.3. Section H.4 highlights information from the stakeholder interviews and the content analysis of print media related to environmental perceptions. The appendix concludes with a summary of the environmental, energy, and stakeholder analyses in Section H.5.

H.1 Data Sources

The air quality emissions and energy analysis is based on the emissions rates of vehicles utilizing the freeway facilities in the Minneapolis-St. Paul Metropolitan area, and the volumes and speed of those vehicles. Emission rates were provided by the Metropolitan Council, the metropolitan planning organization (MPO) for the region. The amount (volumes) and speed of the vehicles using the affected portions of the I-35W South corridor in the pre- and post-deployment periods was measured by MnDOT freeway loop detector data processed and analyzed by the national evaluation team.

Emissions rates are modeled with Environmental Protection Agency (EPA) mobile source emissions factor models and are expressed in terms of grams of pollutant per mile of travel and gallons of fuel per mile of travel. In the Minneapolis-St. Paul Metropolitan area, based on applicable regulatory requirements the Metropolitan Council used the MOBILE6 model for emissions modeling.

The computed emissions rates utilize a database of measured emissions from vehicles of different types and ages along with estimates of the mix of vehicle types (e.g., motorcycles, passenger cars, small trucks, and long-haul trucks), and their distribution by vehicle age in the applicable region. This set of vehicles and ages is referred to as the fleet mix, and is specific to the type of roadway facility. For example, a fleet mix for freeways will contain more long-haul trucks than a fleet mix for arterials. Other factors considered in the development of the emissions factors include air temperatures, fuels used and their vapor content, and the presence or absence of a vehicle inspection and maintenance program.

The volume and speed data for the I-35W South corridor were obtained from the MnDOT loop detectors. MnDOT maintains a system of sensors as part of the Regional Transportation Management Center (RTMC) to monitor traffic flow on the freeway system in the Minneapolis-St. Paul Metropolitan area. These sensors are located in each freeway lane at approximately one-half mile intervals in both directions of travel. For this study, a representative set of sensors was selected along the several miles of I-35W South corridor where UPA projects were being implemented. The sensors measure volume and loop occupancy at 30-second intervals. These data were processed and analyzed by the national evaluation team.

The sensor data includes volume, expressed as the number of vehicles passing the detector during a 30-second sampling period, and speed, which is calculated based on the volume and, occupancy of each detector. The environmental analysis evaluated the MnDOT loop detector sensor data in terms of volumes and speeds, revealing how the projects affected the amount of traffic, the amount of stop-and-go, and the amount of free-flow travel. Changes in the amount and speed of travel are what changes air quality and energy use. Summaries of the traffic data prepared for and used in the environmental and energy analysis are presented in Sections H.2 and H.3. Additional information on the analysis of the loop detector data is presented in Appendix A – Congestion Analysis.

The pre-deployment sensor data covered the period from October 2008 through April 2009. The post-deployment data covered the period from December 2010 through November 2011. The analysis presented in Appendix A – Congestion Analysis, examined the data for the four seasons – winter (December to February), spring, (March to May), summer (June to August), and fall (September to November). The pre-deployment period does not include any summer months. Because the environmental analysis presented in Section H.3 compares pre- to post-deployment seasonal results it does not include the summer season for this reason.

The freeway data utilized in this analysis represents averages over all non-holiday weekdays within those seasons. Data for non-holiday weekdays from 6:00 a.m. to 10:00 a.m. in the northbound direction of travel and 3:00 p.m. to 7:00 p.m. in the southbound of travel direction were analyzed. These time periods correspond to the MnDOT defined peak-period, peak direction of travel.

Information on the perceptions of the Minnesota UPA projects' impacts on overall environmental quality was obtained from the results of the stakeholder interviews and the content analysis of print media presented in Appendix I – Non-Technical Success Factors Analysis. Two sets of stakeholder interviews were conducted by the national evaluation team. The first interviews were conducted in the summer of 2009 and the second interviews were conducted in May and June of 2011. Although a specific question on the environmental impacts of the projects was not included in the interview script, some individuals mentioned environmental-related benefits of the UPA projects. The content analysis of the print media examined the coverage of the UPA projects in newspapers in the Minneapolis-St. Paul metropolitan area. The articles were re-reviewed for this environmental analysis to identify any environmentally-related coverage or comments.

H.2 Air Quality and Energy Analysis Methodology

The Minnesota UPA projects change congestion levels, travel speeds, and the amount of traffic (volume) on I-35W South. These impacts cause changes in air quality and energy use. The speed, volume and congestion impacts on air quality and energy use were evaluated using the MOBILE6 emissions model factors for the speeds available from MnDOT sensor data. As illustrated in Figures H-1 and H-2, emissions factors in the region change significantly at different speeds. NOx and VOC are the principal components of ozone, a lung irritant for which there are federal standards. CO is a colorless, odorless pollutant that can cause dizziness or even death in high concentrations and is also regulated by federal standards. Until recently, the Twin Cities region was designated as nonattainment for CO health standards by the EPA.

As illustrated in Figures H-2 and H-3, extremely low or high speeds cause emissions per mile of travel to rise markedly; particularly at the higher extremes. This means measures that improve traffic flow do not necessarily improve air quality. For example, if traffic flow increases from 60 to 70 mph, emissions will increase. Projects and measures that increase speeds that were previously extremely low will substantially decrease some pollutant emissions such as NOx or CO, but will still slightly increase VOC emissions.

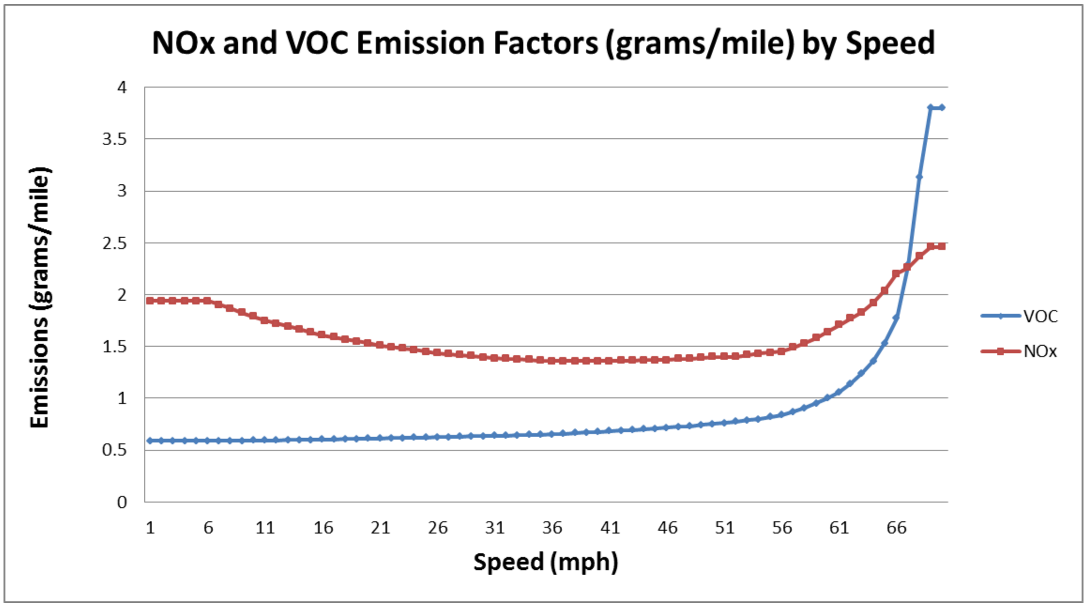


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Figure H-2. NOx and VOC Emission Factors (grams per mile of travel) for Twin Cities Area by Speed (miles/hour)

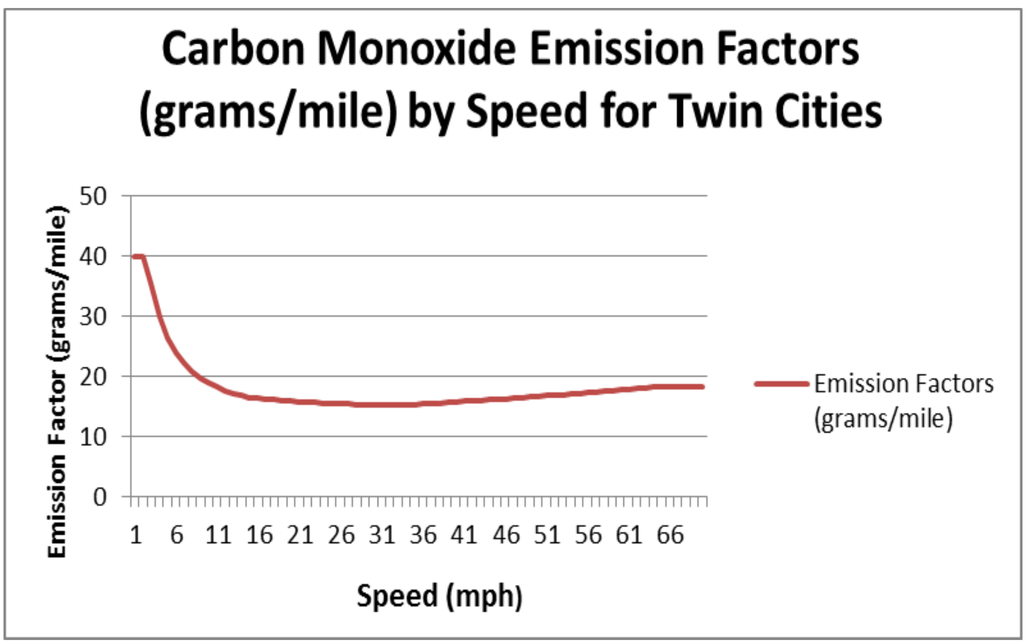

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Figure H-3. CO Emission Factors (grams per mile) for Twin Cities Area by Speed (miles/hour)

As noted in Section H.1, traffic volumes and for the Minnesota UPA pre- and post-deployment periods were obtained from the MnDOT loop detectors and processed by the national evaluation team. Speed data was derived from the loop detector data by MnDOT based on throughput, occupancy, and segment distance.

Data for the fall, winter, and spring morning and afternoon peak periods were used in the environmental analysis. For the environmental analysis, traffic volumes were provided in 5-minute intervals for the general-purpose freeway lanes, the HOV and HOT MnPASS lanes, and the PDSL. The data were also provided by the three segments used in the congestion analysis – the section from Highway 13 to I-494, where the existing HOV lanes were expanded to HOT lanes; the section from I-494 to 42nd Street, where general-purpose freeway lanes and HOT lanes were added in the Crosstown Commons section (not UPA funded); and 38th Street to 26th Street, which included the PDSL. The travel speed data was also provided at 5-minute intervals for speeds ranging from 1-to-80 mph.

The addition of the new general-purpose freeway lanes in the Crosstown Commons section, which was not part of the UPA, the new UPA-funded MnPASS HOT lanes in this section, and the active traffic management (ATM) Smart Lane components (including speed harmonization) make interpretation of the environmental analysis more challenging. The new general-purpose freeway lanes and the new HOT MnPASS lanes were naturally not covered by sensor data in the pre-deployment period. The speed harmonization may result in slower speeds in some sections of the freeway that would have experienced higher speeds in the absence of harmonization. This situation made it difficult to separate the large increases in traffic volumes from the pre-deployment period to the post-deployment period in a manner useful for reaching conclusions about possible environmental effects. The UPA HOV to HOT lane conversions are the least affected by these factors while the UPA PDSL lanes are strongly influenced.

Traffic data were analyzed only for the I-35W South corridor. No data were available on other freeway facilities or arterials adjacent to the I-35W South corridor. The large changes in traffic volumes, which play a dominant role in emissions and energy use, are thus difficult to evaluate or attribute. The changes in traffic volumes are likely the result of a combination of traffic moving to the freeway from arterials and other roadways because of reduced I-35W South congestion, traffic returning to freeways from arterials and other roadways after construction was completed, latent demand, traffic moving from off-peak to peak periods, and the influence of exogenous factors such as weather, gas prices and economic factors such as unemployment rates. Tables describing before and after traffic volumes and average speeds were developed as part of the environmental analysis and are presented in Section H.3.

Another key to emission changes is the change in the amount of time drivers spent at various speeds on the I-35W South corridor, especially at high or low speeds. As discussed later in Section H.3, the effect of changes in travel speed sometimes overshadowed the changes in traffic volumes. For example in some cases, traffic volume increased but emissions decreased.

Because of the primary role played by travel speeds in the environmental analysis, along with the need to adequately represent the changes in stop and go traffic observed in the I-35W South corridor after deployment of the UPA and non-UPA projects, an analysis was made of the percent of time drivers spent at each speed between 1 mph and 80 mph in the pre-and post-deployment periods for the MnPASS HOT lanes. The resulting frequency distribution was used in the environmental analysis by evaluating the emissions resulting from the peak period volumes at each speed from 1 mph to 80 mph and then weighting the emissions by the percentage of time at each speed.

Figures H-4 through H-7 illustrate the morning and afternoon peak period travel speeds for the UPA HOT lanes and for the adjacent general purpose lanes in the pre-deployment and post-deployment period. The figures illustrate that speeds as low as 35 mph were sometimes observed in the pre-deployment period, and that speeds over 65 mph were observed only about 9 percent of the time. In the post-deployment period, travel speeds were not observed below 50 mph and were above 65 mph more than 12.5 percent of the time. This finding is slightly counterintuitive; one would expect that the conversion from HOV lanes to HOT lanes would increase the amount of traffic in the lanes, thereby decreasing speeds. The increase in the observed travel speeds may be partially explained by the elimination of the upstream bottleneck of the Crosstown Commons section in the post-deployment period; however the reduction in volumes on the HOV/HOT lanes, along with the increased number of general purpose lanes also contribute to the increased speeds.

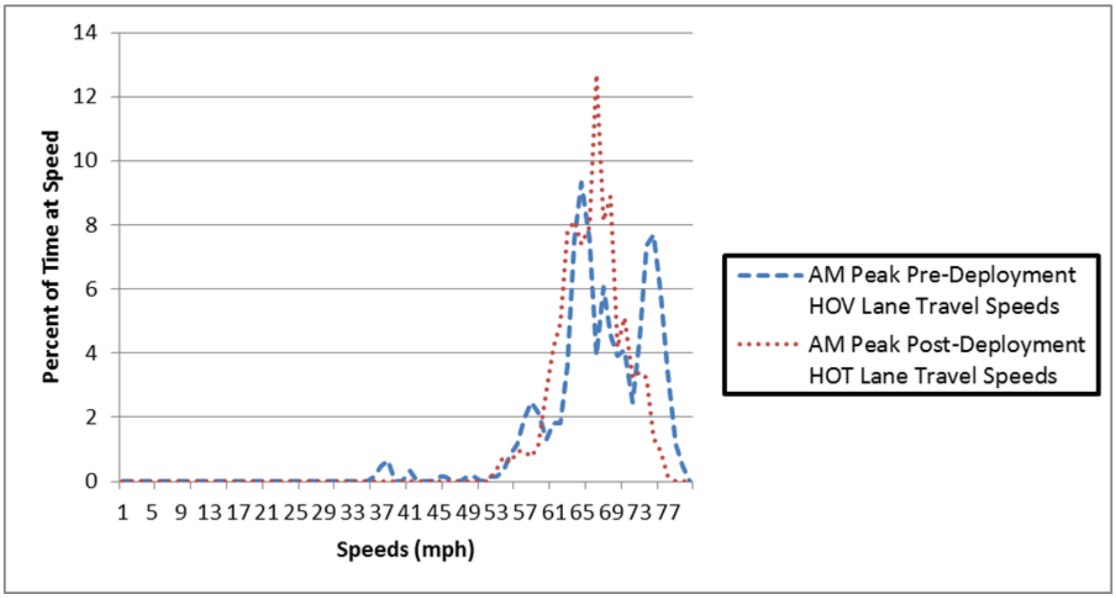

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Figure H-4. Pre- and Post-Deployment Speeds in the I-35W South HOV and HOT Lanes in the Morning Peak Period

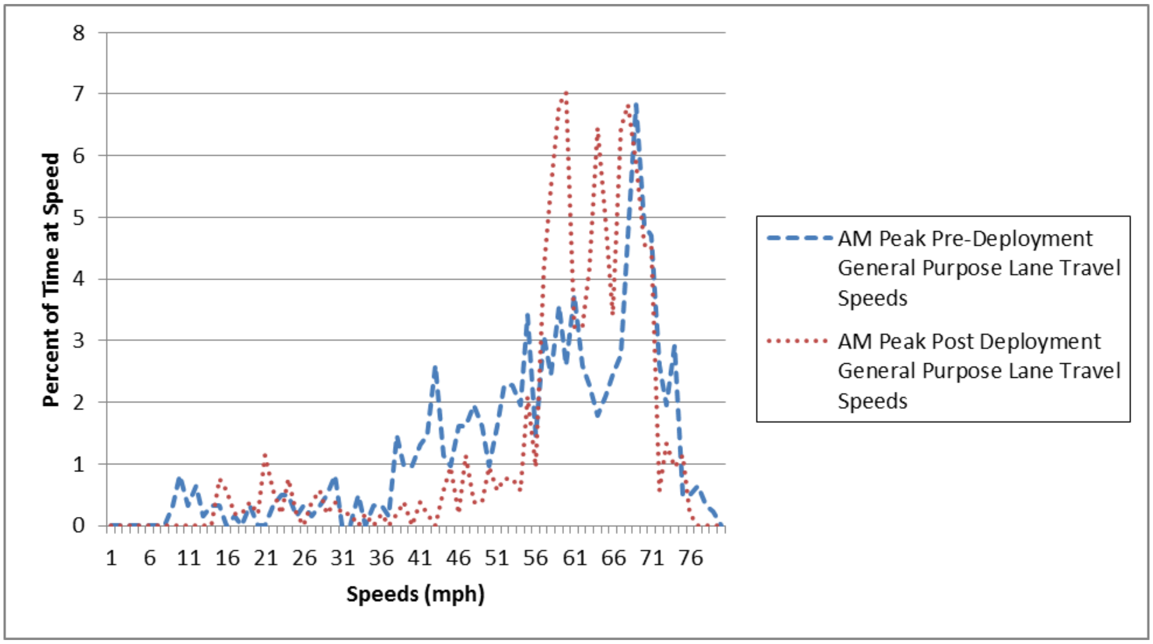

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Figure H-5. Pre- and Post-Deployment Speeds for the I-35W South General Purpose Lanes in the Morning Peak Period

In contrast to the HOT lanes, the general-purpose lanes experienced speeds as low as 9 mph some of the time during the pre-deployment period, while the lowest observed speeds in the post-deployment period were 15 mph, a significant decrease in the lower speeds. In addition, the post-deployment period exhibited a significantly higher proportion of frequency of speeds above 55 mph in comparison with the pre-deployment period. It is uncertain how much of this increase in speeds is due to the additional general-purpose lanes and resultant increase in capacity.

As illustrated in Figures H-6 and H-7, the results of the pre- and post-deployment comparison of travel speeds for the HOV and HOT lanes and the general-purpose freeway lanes in the afternoon peak period was similar to the morning peak, but was more pronounced. In addition, there was a decrease in the amount of time spent at speeds over 75 mph, although overall the amount of time spent at speeds above 60 mph is similar, at approximately 30 percent, but the distribution is different in the pre-and post-deployment periods.

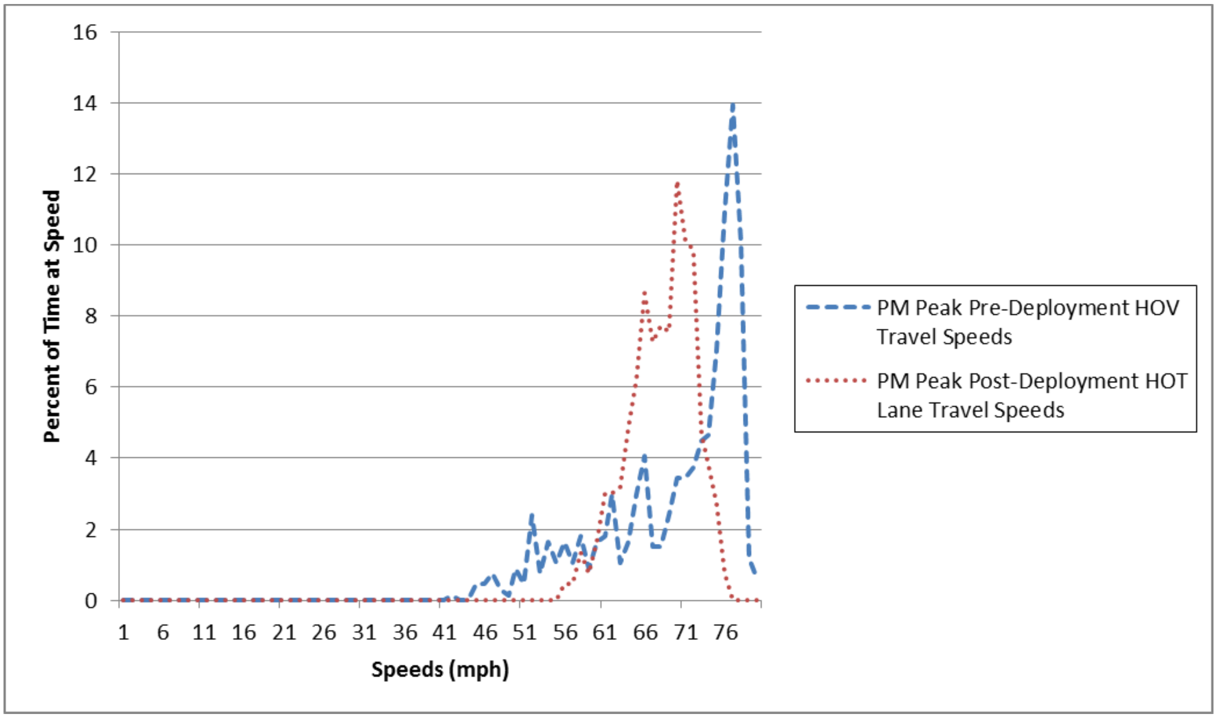

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Figure H-6. Pre- and Post-Deployment Speeds for I-35W South HOV and HOT Lanes in the Afternoon Peak Period

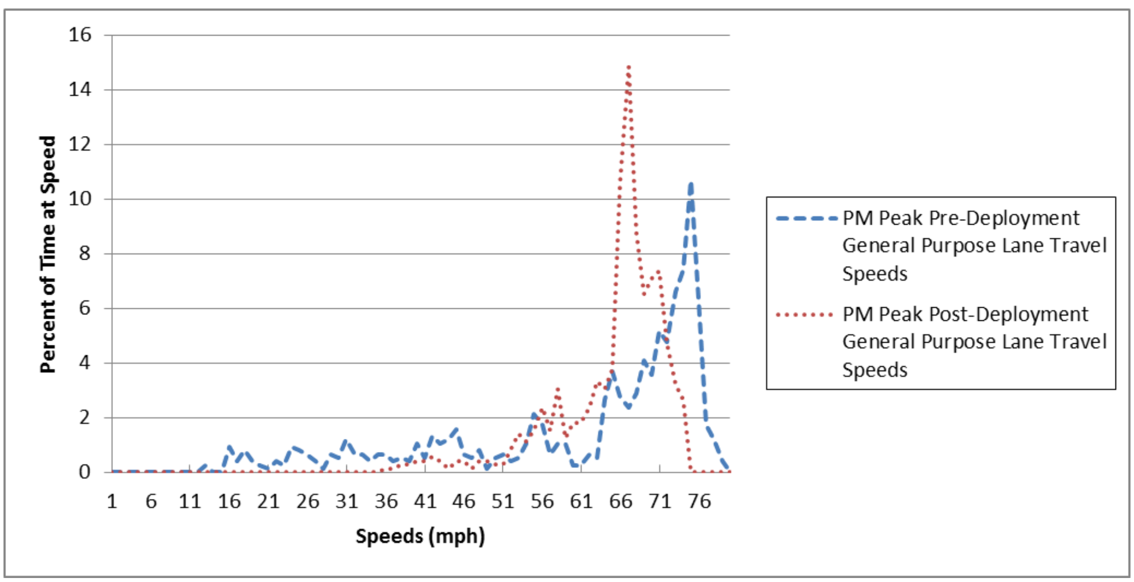

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Figure H-7. Pre- and Post-Deployment Speeds for I-35W South General Purpose Lanes in the Afternoon Peak Period

As noted previously, emissions and fuel economy factors were provided by the Metropolitan Council for 2010. These emissions and fuel economy rates were multiplied by the observed traffic statistics gathered using the freeway sensors, which recorded the number of vehicles and the travel speed. The travel distance was also considered, utilizing the lengths of the affected segments covered by each sensor.

The volume data were evaluated at the 5-minute level, and summed over the a.m. and p.m. peak periods consistent with the traffic analysis presented in Appendix A. For the environmental analysis, it was vital to evaluate the travel speed in as detailed a fashion as possible for the reasons described previously related to the dramatic changes in speeds in the highest and lowest ranges. One of the major changes resulting from the UPA projects and the new general-purpose freeway lanes in the Crosstown Commons section was a decrease in stop-and-go traffic, and an overall decrease in congestion. Evaluating the emissions change from these benefits was a vital objective of the environmental analysis.

The 5-minute speed data provides the most precise picture of the change in pre- and post-deployment stop-and-go traffic, while the volume data can be evaluated over the morning or afternoon peak periods. Therefore, to conduct the environmental analysis, frequency distributions were prepared for the 5- minute speed data for the morning and afternoon peak periods for the three segments of the I-35W South corridor, weighted by the segment lengths. For example, the 6.57 mile HOV/HOT section of I-35W South northbound was represented by 13 different sensor stations covering segments ranging in length from between 0.2-to-1.5 miles. The speed distribution evaluated all speeds between 1 mph and 80 mph. Examples of these frequency distributions for the HOT section were presented in Figures H-4 through H-7.

The frequency distribution of speeds was expressed in terms of the percentage of time spent at each speed over the morning or afternoon peak period. Each speed was multiplied by the appropriate emissions factors and fuel use rates and by the period volume, and then weighted by the speed's frequency of occurrence, for each of the three segments.

Emissions factors were calculated using MOBILE6 and were expressed in terms of grams per mile of travel for speeds ranging from 0 mph to 65 mph, which is the maximum speed for MOBILE6. Because the Minneapolis-St. Paul Metropolitan area is now officially classified as in attainment, no further emissions factor modeling will be performed, as there are no longer any air quality or transportation conformity requirements that pertain to the area that would necessitate upgrading from MOBILE6 to the newer MOVES model.[1] Note that MOBILE6, in contrast to MOVES, does not contain speed-dependent emission rates for CO2 or fuel use.

As noted previously, the assessment of the environmental changes resulting from the UPA projects was challenged by the mix of variables changing simultaneously during the pre- and post-deployment periods, including the following factors:

[1] Personal communication, Barbara Joy, Earth Matters Inc and Mark Filipi, Manager, Technical Planning Support, Metropolitan Transportation Services, Metropolitan Council May 7, 2012.

- Many traffic sensors were not operational during periods of construction, causing some uncertainty in comparing pre- and post-deployment data;
- The new general-purpose freeway lanes and the HOT lanes in the Crosstown Commons section along with lowered congestion levels, resulted in large increases in traffic volumes along sections of I-35W South, in the general purpose lanes. This made it difficult to distinguish between actual changes resulting from the UPA projects, the Crosstown Commons section, traffic that had formerly used arterials, or traveled during different time periods, or which represented latent demand for use of the I-35W South corridor.
- The implementation of Active Traffic Management (ATM), including speed harmonization, typically result in lower speeds being posted on the highway signs, which in turn results in slower speeds and longer travel times. Thus, the UPA projects and other improvements in the corridor have conflicting results: the new HOT lanes, PDSL, and new general-purpose freeway lanes increase speeds, while the advisory speeds and speed harmonization reduce travel speeds.

The pre- and post-deployment energy and air quality estimates on the section of I-35W South between Highway 13 and I-494, where the existing HOV lanes were converted to HOT lanes, seems to be most accessible for interpretation of the effects of the UPA projects as it is less influenced by change in other sections of the freeway. The pre- and post-deployment data for the PDSL section is impacted by the above factors such that the results cannot be interpreted without qualifications.

H.3 Air Quality and Energy Analysis

This section presents the results of the air quality and energy analysis for the UPA projects and for the Crosstown Commons improvements, which are located in the mid-section of the part of I-35W South affected by the set of UPA and non-UPA projects.

Presented first are tables for the two UPA projects showing pre- and post-deployment traffic, emissions, and energy use for:

- The converted HOV lanes between Highway 13 and I-494 (Table H-2), representing the UPA HOT section";
- The general purpose lanes adjacent to the converted HOT lanes between Highway 13 and I-494 (Table H-3), also representing the UPA HOT section (note these general purpose lanes include two new auxiliary lanes: one northbound from 90th to I-494 and one southbound from 106th Street to Highway 13); and
- The combined shoulder and general purpose lanes between 26^{th} and 38^{th} (Table H-4), representing the UPA Priced Dynamic Shoulder Lane section.

The shoulder and general purpose lanes for the Priced Dynamic Shoulder Lane section were combined because (a) there was no before data for the new lanes and (b) there is no shoulder lane in the southbound direction.

The values in the following three tables are for the fall season. Fall was selected for these tables because that season has (a) a complete set of months in both the pre- and post-deployment periods; (b) is not influenced by the record winter storms in the post-deployment period; and (c) was least affected by sensor outages and construction in the pre-deployment period.

All tables in this section distinguish between the a.m. and p.m. peak periods, as different patterns are observed. For example, the amount of traffic on a given section of the affected I-35W South corridor tends to be much higher in the afternoon peak period than it was during the morning peak period. Additionally, as shown in Tables H-7 through H-10, sometimes the direction of the results is different in the morning and afternoon. For example along the "HOT section," the converted HOT lanes show a slight increase in usage post-deployment in the morning in fall but a large decrease post-deployment in the afternoon.

Tables H-5 through H-10 present more detailed results for the interested reader. Tables H-5 and H-6 present summary traffic and speeds for the HOT, Crosstown Commons, and PDSL sections for fall, winter and spring, both pre- and post-deployment.

Tables H-7 and H-8 contain air quality estimates for the same seasons and sections while Tables H-9 and H-10 contain the corresponding energy use estimates.

Summer is not included, as there are no summer months in the pre-deployment period. It should be noted that the spring season was strongly influenced by sensor data gaps that make it difficult to compare before and after results for the spring season. However, pre-deployment fall or winter can be compared with post-deployment spring values to obtain additional perspective on the results.

Table H-2. Pre- and Post-Deployment Traffic Volumes, Emissions, and Energy Use on I-35W South HOT (High Occupancy) Lanes from Highway 13 to I-494

	Morning Peak		Afternoon Peak		Combined A.M. and P.M. Peak Values		Net Change	
	Pre-Deployment	Post-Deployment	Pre-Deployment	Post-Deployment	Pre-Deployment	Post-Deployment	Amount	Percent
Volumes	2,910	2,940	4,734	3,790	7,644	6,730	-914	-11.96
VOC (lbs)	24.86	25.09	40.51	32.3	65.37	57.39	-7.98	-12.21
NOx (lbs)	79.6	80.79	128.65	105.17	208.25	185.96	-22.29	-10.7
CO (lbs)	762	772	1,237.25	998.54	1,999.25	1,770.54	-228.71	-11.44
CO2 (tons)	11.65	11.78	18.97	15.19	30.62	26.97	-3.65	-11.92
Fuel Use (gal)	1,159	1,171	1,886	1,509	3,045	2,680	-365	-11.99

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Table H-3. Pre- and Post-Deployment Traffic Volumes, Emissions, and Energy Use on I-35W South General Purpose Lanes from Highway 13 to I-494

	Morning Peak		Afternoon Peak		Combined A.M. and P.M. Peak Values		Net Change	
	Pre-Deployment	Post-Deployment	Pre-Deployment	Post-Deployment	Pre-Deployment	Post-Deployment	Amount	Percent
Volumes	12,045.6	14,380.7	11,992.2	16,471.5	24,037.8	30,852.2	6,814.4	28.3
VOC (lbs)	107.0	126.8	102.0	139.9	209.1	266.7	57.6	27.5
NOx (lbs)	262.9	322.6	289.5	404.0	552.4	726.6	174.2	31.5
CO (lbs)	2,902.5	3,508.8	2,988.0	4,128.8	5,890.5	7,637.6	1,747.1	29.7
CO2 (tons)	48.4	57.6	47.3	65.0	95.7	122.6	27.0	28.2
Fuel Use (gal)	4,797.1	5,727.0	4,702.4	6,458.8	9,499.5	12,185.8	2,686.4	28.3

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Table H-4. Pre- and Post-Deployment Traffic Volumes, Emissions, and Energy Use on I-35W South Priced Dynamic Shoulder Lane Section from 26th to 38th St

	Morning Peak		Afternoon Peak		Combined A.M. and P.M. Peak		Net Change	
	Pre-Deployment	Post-Deployment	Pre-Deployment	Post-Deployment	Pre-Deployment	Post-Deployment	Amount	Percent
Volumes	22,860.5	26,606.5	26,854.6	34,684.8	49,715.2	61,291.3	11,576.1	23.3
VOC (lbs)	60.0	72.2	76.7	90.1	136.6	162.4	25.7	18.8
NOx (lbs)	197.9	185.0	162.3	285.1	360.2	470.1	109.9	30.5
CO (lbs)	1,864.0	2,006.0	1,830.1	2,758.1	3,694.2	4,764.1	1,069.9	29.0
CO2 (tons)	28.2	32.9	32.7	42.3	60.9	75.2	14.3	23.5
Fuel Use (gal)	2,807.0	3,267.0	3,255.1	4,204	6,062	7,471	1,409	23.2

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As shown in Table H-2, the net effect of the converted HOV/HOT lanes on I-35W South between highway 13 and I-494 is a substantial decrease (10-12 percent) in emissions and energy use in the high occupancy lanes. The effects during the morning peak period are a slight increase (in the 1 percent range), which are overshadowed by the much larger decrease in the afternoon.

The decrease in emissions and energy use is due to the significant decrease in volume during the afternoon. In the case of the HOT section emissions follow volume relatively closely. This is because average speeds did not change significantly pre- and post-deployment along this section.

Table H-3 lists traffic volumes, emissions and energy use for the general purpose lanes along the same "HOT section." In contrast to the HOT lanes themselves, the adjacent general purpose lanes exhibit a large increase in volumes both in the morning and in the afternoon peak period. Much of this increase is likely due to the addition of auxiliary lanes northbound from 90th to I-494 and southbound from 106th Street to Highway 13. These lanes helped get rid of back up of traffic exiting east and west on I-494 as well as on the bridge between 106th and Highway 13.

Emissions and energy use rise in an approximate linear fashion, similar to the HOT lanes themselves, because pre- and post-deployment speeds did not change as dramatically as they did for other sections such as in the PDSL section described next.

By examining Tables H-2 and H-3 one can see that the combined result for the HOT lanes and the adjacent general purpose lanes is an increase in emissions and energy use. Traffic volumes increased by a net 18.6 percent while emissions and energy use rose by similar amounts. The reasons for this are difficult to attribute due to the many confounding factors discussed in Section H.2.

The Priced Dynamic Shoulder Lane segment results are difficult to interpret as several things change at once, including large variations in traffic speeds, changes to southbound facilities such as Crosstown Commons and the HOT lane conversions and auxiliary lanes, as well as exogenous factors. Traffic volume increases significantly in both the southbound (23 percent) and the northbound (16 percent) directions. The southbound increase is larger than the northbound increase even through the shoulder lane was only added in the northbound direction. It is likely that much of this increase is due to the elimination of the Crosstown Commons bottleneck remedied by the non-UPA Crosstown Commons projects.

Also notable is that NOx emissions in the afternoon pre-deployment period are substantially lower than in the morning pre-deployment period even though volumes are quite a bit higher. This issue was closely examined and is due to the changes in speed. In the morning peak period pre-deployment phase, for example, average speeds were 70 miles per hour while in the afternoon peak period pre-deployment speeds were only 41 miles per hour. As noted in Section H.2, congestion levels can worsen and this can actually improve emissions, as it does in this case.

Because the pre- and post-deployment traffic speeds are so different, the emissions do not change in the nearly lockstep relationship to volume they did for the "HOT section." Volumes increased by 23 percent while NOx increased by 30.5 percent and VOC by only 18 percent.

The MOBILE6 model does not include speed data for CO_2 or fuel use; therefore, these two variables change at the same rate as volume, with some differences due to rounding.

Additional, and more detailed, results of the environmental and energy analysis are presented next, reporting the HOT, Crosstown Commons, and PDSL sections together for comparison of each project segment by season, lane type, and time of day. In the tables, "GP" refers to the general purpose lanes and "HL" refers to high occupancy lanes. Distinctions are made between General Purpose ("GP") and High Occupancy ("HL") lanes in Tables H-5 through H-10 because the changes in the high occupancy lanes are different, both directionally and in scale, from those in the general purpose lanes.

These tables are included to provide additional detail on the findings already discussed for the individual UPA projects presented in Tables H-2, H-3 and H-4. The individual seasons are presented to show the consistent changes across seasons. In addition, readers may wish to compare different seasons to extend the length of time between the pre- and post-deployment periods.

Seasonally, in the pre-deployment phase fall is represented by October and November of 2008; winter by December, 2008 and January – February of 2009; and spring by March and April of 2009. In the post-deployment phase fall is represented by September – November of 2011; winter by December, 2010 through February, 2011, and spring by March, 2011 through May, 2011. Therefore the longest length comparison period would be fall for pre-deployment and spring for post-deployment.

Tables H-5 and H-6 summarize the average volumes and speeds in the pre- and post-deployment periods by freeway segment/project type and season for the morning and afternoon peak periods, respectively. Morning and afternoon peak periods are presented separately as there are cases where the changes are opposite in nature. For example there is a small increase in high occupancy lane volumes (HL) between Highway 13 and I-494 in the morning peak and a dramatic decrease along the same segments during the afternoon peak. In addition, the lengths of the UPA projects are slightly different in the northbound direction (corresponding to the a.m. peak) and the southbound direction (corresponding to the p.m. peak period).

When the fall pre-deployment and the spring post-deployment traffic volumes results are compared (in order to maximize the temporal spread between pre- and post-deployment periods), the results are the same but somewhat more pronounced. The decrease in traffic volumes in the HOT lanes occurs in *both* the morning and afternoon peak periods and is larger than the decrease seen when the pre-deployment fall season is compared with the post-deployment fall season.

Tables H-7 through H-10 summarize the environmental and energy effects by each of these segments, also by season and time of day.

Lane types for which no data in the pre-deployment period exist (for example the new lanes constructed in the PDSL and Crosstown Commons sections) are indicated by "N/A".

The spring value for the Crosstown Commons section is starred, based on a concern associated with the pre-deployment data. These values are substantially lower than the fall and winter pre-deployment data for that section, and could be influenced by the construction, including lane closures or sensor outages occurring during the spring pre-deployment time period.

Tables H-7 and H-8 show emissions for the morning and afternoon peak periods, respectively. When comparing one season with another, VOC levels rise for all segments of the I-35W South corridor, except for the HOT lanes, where they fall, other than a small increase in the morning fall period. This small increase was not present in other seasons, or in any season for the afternoon peak period. In addition, the afternoon peak period decrease (roughly 20 percent), due to the drop in post-deployment traffic volumes in the HOT lanes, substantially overshadowed the small increase in the morning fall period (roughly 1 percent).

The primary changes in emissions and fuel use for the pre- and pre-deployment periods for all sections were from changes in volumes. Once again, the change in volume is likely due to a combination of factors. These include additional capacity in the corridor offered by the new shoulder, general purpose, and auxiliary lanes together with an apparent change caused by missing sensor data in the pre-deployment period combined with a possible change caused by traffic returning to I-35W South after reconstruction was completed, traffic moving from arterials to I-35W South in response to lowered congestion, traffic shifting from off-peak to peak periods, and induced travel due to latent demand for use of I-35W South. Exogenous factors such as gas prices, weather, and unemployment levels are also likely to have contributed to the changes in traffic volumes.

These factors cannot be quantified or their contribution attributed to the emission and energy use changes with the data that is currently available. It should be noted that the combined HOV/HOT lane and general purpose lane volumes on each section are greater in the post-deployment period than they are in the pre-deployment period. This indicates that the increases in the general purpose lane are not due to traffic moving from the HOV/HOT lanes to the general purpose lanes.

Comparisons across seasons are fairly consistent, with the exception of the spring season for the PDSL section. This section is possibly influenced by sensor outages, which cause the pre-deployment values to be much lower than for the other seasons. It should also be noted that there were record snowstorms during the winter post-deployment period, which may have decreased volumes and speeds overall during this particular time period.

Table H-5. Traffic Volumes and Speeds by Section of I-35W South and Season for Morning Peak Period

	Segment	NB Segment Length	Pre-Deployment Volumes	Pre-Deployment Speeds (mph)	Post-Deployment Volumes	Post-Deployment Speeds	Change in Volumes	Percent Change in Volumes	Change in Speeds	Percent Change in Speeds
FALL	HOT GP	6.571	12,046	50	14,381	52	+2,335	+19	2	4
	HOT HL	6.571	2,910	65	2,940	65	+30	+1	0	0
	XTown GP	5.16	17,040.06	38	21,408.64	54	+4,368.6	+25.6	16	42
	Xtown HL	5.16	N/A	N/A	2,264.14	58	N/A	N/A	N/A	N/A
	PDSL GP	2.026	22,861	70	24,185	52	+1,324.5	+5.8	-18	-25
	PDSL HL	2.026	N/A	N/A	2,421	56	2,421	N/A	N/A	N/A
WNTR	HOT GP	6.571	10,755	49	13,184	52	+2,429	+22.6	3	6
	HOT HL	6.571	2,714	62	2,521	63	-193	-7.1	1	1.6
	XTown GP	5.16	13,702.60	35	19,236.10	53	5,533.5	40.4	18	51
	Xtown HL	5.16	N/A	N/A	1,817.24	56	N/A	N/A	N/A	N/A
	PDSL GP	2.026	20,677.50	67	22,527.58	53	+1,850	+8.8	-14	-21
	PDSL HL	2.026	0.00	0	1,883.08	55	N/A	N/A	N/A	N/A
SPRING	HOT GP	6.571	12,002.18	60	14,090.36	54	+2,088.2	+17.4	-6	-10
	HOT HL	6.571	2,444.61	69	2,698.85	65	+254.2	+10.4	-4	-6
	XTown GP	5.16	7,815.87*	37	20,841.50	56	*	*	19	51
	Xtown HL	5.16	0.00	0	1,951.92	58	N/A	N/A	N/A	N/A
	PDSL GP	2.026	22,693.87	68	24,250.88	54	+1,557	+6.9	-14	-21
	PDSL HL	2.026	0.00	N/A	2,076.62	56	N/A	N/A	N/A	N/A

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***Volume and speeds potentially affected by construction during the spring.** **N/A = Data not available**

Table H-6. Traffic Volumes and Speeds by Section of I-35W South and Season (P.M. Peak)

	Segment	SB Segment Length	Pre-Deployment Volumes	Pre-Deployment Speeds (mph)	P.M. Post-Deployment Volumes	P.M. Post-Deployment Speeds (mph)	Change in Volume	Percent Change in Volume	Change in Speed	Percent Change in Speed
FALL	HOT GP	6.47	11,992	57	16,471	59	4,479	37	2	3.5
	HOT HL	6.47	4,734	61	3,790	67	-944	-20	6	10
	XTown GP	5.05	22,937	45	30,773	61	7,836	34	16	36
	Xtown HL	5.05	N/A	N/A	1,787	60	1,787	N/A	N/A	N/A
	PDSL GP	2	26,855	41	34,685	63	7,830	29	22	54
	PDSL HL	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WINTER	HOT GP	6.47	10,769	58	15,437	59	4,668	43	1	1.7
	HOT HL	6.47	4,420	65	3,489	64	-931	-21	-1	1.5
	XTown GP	5.05	17,676	43	26,378	57	8,702	49	14	33
	Xtown HL	5.05	N/A	N/A	1,481	56	1,481	N/A	N/A	N/A
	PDSL GP	2	23,981	37	30,553	59	6,572	N/A	22	59
	PDSL HL	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SPRING	HOT GP	6.47	12,220	62	16,886	63	4,666	38	1	1.6
	HOT HL	6.47	4,257	60	3,703	68	-554	-13	8	13
	XTown GP	5.05	9,047	50	29,620	62	20,573	227	12	24
	Xtown HL	5.05	N/A	N/A	1,613	60	1,613	N/A	N/A	N/A
	PDSL GP	2	29,020	48	34,099	63	5,079	18	15	31
	PDSL HL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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Table H-7. Pre- and Post-Deployment Emissions by Section and Season for the Morning Peak Period

	Segment	VOC Pre (lbs)	VOC Post (lbs)	NOx Pre (lbs)	NOx Post- (lbs)	CO Pre- (lbs)	CO Post- (lbs)	CO2 Pre (tons)	CO2 Post (tons)
FALL	HOT GP	107	127	262.9	322.6	2,902.5	3,508.8	48.3	57.6
	HOT HL	24.9	25.1	79.6	80.8	762	772	11.6	11.8
	XTown GP	124.72	146.97	266.69	346.88	3,012.75	4,149.14	53.6	67.4
	Xtown HL	0.00	15.36	0.00	43.59	0.00	449.92	0.00	7.1
	PDSL GP	59.99	65.73	197.91	167.29	1,864.04	1,819.44	28.2	29.9
	PDSL HL	0.00	6.48	0.00	17.70	0.00	186.52	0.00	3.0
WNTR	HOT GP	95.9	116.2	211.8	343.2	2,380	3,707	43.1	52.8
	HOT HL	23.2	21.5	71.8	68.1	704.5	658.6	10.9	10.1
	XTown GP	101.85	132.49	211.80	343.25	2,380.00	3,707.10	43.1	60.5
	Xtown HL	0.00	12.39	0.00	33.83	0.00	356.51	0.00	5.7
	PDSL GP	54.26	60.92	179.01	157.83	1,686.04	1,704.60	25.5	27.8
	PDSL HL	0.00	5.06	0.00	13.51	0.00	144.06	0.00	2.3
SPRING	HOT GP	103.2	123.2	303.5	324.6	3,073.3	3,477.6	48.1	56.4
	HOT HL	20.8	23.0	68.6	75.8	646.5	713.7	9.8	10.8
	XTown GP	57.56	142.13	121.88	388.00	1,374.24	4,088.73	24.6	65.6
	Xtown HL	0.00	13.24	0.00	37.58	0.00	387.88	0.00	6.1
	PDSL GP	59.55	65.37	196.47	172.07	1,850.45	1,845.38	28.0	30.0
	PDSL HL	0.00	5.56	0.00	15.18	0.00	159.96	0.00	2.6

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Table H-8. Pre- and Post-Deployment Emissions by I-35W South by Section and Season for the Afternoon Peak Period

	Segment	VOC Pre (lbs)	VOC Post (lbs)	NOx Pre (lbs)	NOx Post (lbs)	CO Pre (lbs)	CO Post (lbs)	CO2 Pre (tons)	CO2 Post (tons)
FALL	HOT GP	102.0	139.9	289.5	404.0	2,988	4,129.8	65.0	95.7
	HOT HL	40.5	32.3	128.6	105.2	1,237	998.5	19	15.2
	XTown GP	160.7	202.98	361.8	612.0	4,082.9	6,098.1	70.6	94.7
	Xtown HL	0.00	11.80	0.00	34.72	0.00	351.59	0.00	5.5
	PDSL GP	76.66	90.15	162.31	285.12	1,830.14	2,758.13	32.7	42.3
	PDSL HL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WINTER	HOT GP	91.9	131.1	255.8	378.6	2,666	3,870	42.5	60.9
	HOT HL	37.4	29.3	112.6	94.7	1,122	903	17.4	13.8
	XTown GP	123.08	175.75	282.54	489.11	3,179.93	5,097.70	54.4	81.2
	Xtown HL	0.00	9.88	0.00	26.98	0.00	284.33	0.00	4.6
	PDSL GP	67.19	80.22	147.69	231.64	1,670.95	2,367.39	29.2	37.3
	PDSL HL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SPRING	HOT GP	103.1	142.0	318.4	449.0	3,123	4,344	48.2	66.6
	HOT HL	36.0	31.0	106.0	102.4	1,073	964.0	16.8	14.6
	XTown GP	61.79	195.05	151.75	602.27	1,675.33	5,909.06	27.9	91.2
	Xtown HL	0.00	10.66	0.00	31.34	0.00	317.41	0.00	5.0
	PDSL GP	79.00	88.63	189.33	280.31	2,105.52	2,711.57	35.4	41.6
	PDSL HL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table H-9. Pre- and Post-Deployment Fuel Use for I-35W South by Section and Season

	Segment	Fuel Use Pre (Gal) (A.M. Peak)	Fuel Use Post (Gal) (A.M. Peak)	Fuel Use Pre (Gal) (P.M. Peak)	Fuel Use Post (Gal) (P.M. Peak)	Net Change in Fuel Use (A.M. + P.M.)	Percentage Change in Peak Period Fuel use
FALL	HOT GP	4,797.1	5,727.0	4,702.39	6,458.82	2,686.4	-28.3
	HOT HL	1,158.9	1,170.8	1,856.47	1,509.1	-358.4	11.9
	XTown GP	5,328.9	6,695.1	7,020.1	9,418.4	3,764.5	-30.5
	Xtown HL	0.00	708.06	0.00	546.81	1,254.9	N/A
	PDSL GP	2,807.0	2,969.6	3,255.1	4,204.2	1,111.8	-18.3
	PDSL HL	0.00	297.32	0.00	0.00	297.3	N/A
WINTER	HOT GP	4,283.3	5,250.3	4,222.9	6,053.3	1,409.1	-23.2
	HOT HL	1,080.8	1,004.0	1,733.3	1,368.1	2,797.4	-32.9
	XTown GP	4,285.2	6,015.6	5,410.0	8,073.2	4,394	45.3
	Xtown HL	0.00	568.3	0.00	453.2	1,021.5	N/A
	PDSL GP	2,538.9	2,766.1	2,906.8	3,703.4	1,023.8	18.8
	PDSL HL	0.00	231.22	0.00	0.00	231.22	N/A
	HOT GP	4,779.78	5,611.38	4,791.85	6,621.30	2,661.1	27.8
SPRING	HOT HL	973.55	1,074.80	1,669.07	1,452.20	115.6	4.4
	XTown GP	2,444.24	6,517.71	2,768.92	9,065.44	10,370.0	198.9
	Xtown HL	0.00	610.42	0.00	493.64	1,104.1	N/A
	PDSL GP	2,786.53	2,977.71	3,517.52	4,133.25	806.9	12.8
	PDSL HL	0.00	254.98	0.00	0.00	255.0	N/A

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As noted earlier, it is probably inappropriate to attribute all the emissions increases to the Minnesota UPA projects, since some or all increase in volume along I-35W South were originally volume elsewhere in the Twin Cities area, most likely on arterials. Since no pre- and post-deployment data are available on arterials, the extent of these impacts cannot be assessed. Other reasons for the increase in volume include latent demand, traffic moving from off-peak to peak periods, and exogenous factors such as changes in gasoline prices and unemployment levels.

As a rough indicator of the potential effect of adjusting the I-35W South UPA projects for volume, an example calculation for the emission changes in the Crosstown Commons section was made. The purpose of this example is to provide an approximate calculation of what the net environmental effect might be, if it is assumed that all of the observed traffic increases are due to traffic existing in the pre-deployment period that was travelling on arterials, local roads, or other routes.

For this illustrative example the increases in volume in the Crosstown Commons sections for the morning peak period in the fall were multiplied by emission factors representative of congested arterial speeds of 25 mph using MOBILE6 factors for arterials[2] and by the section length (5.16 miles for the Crosstown Commons section)

The results are an increase of 36 pounds of VOC, 67.5 pounds of NOx, and 1,136 pounds of CO. If all new volumes on the freeways in the post-deployment period were originally volumes on arterials or alternate routes in the pre-deployment period, then these additional emissions were originally part of the pre-deployment period and should be added to the pre-deployment emissions. Doing this provides for adjusted pre-deployment emissions totals of 161 pounds of VOC, 334 pounds of NOx, and 4,149 pounds of CO, resulting in an net estimated emissions decrease of 13.75 pounds of VOC; an increase of 12.7 pounds of NOx (because the manner in which speeds changed offset the change in volumes). CO was unchanged in the net, as CO emission factors do not change with respect to speed, so "normalizing "the volumes resulted in the same emissions.

H.4 Perceptions from Stakeholders and Print Media

The major results from the stakeholder interviews are discussed in Appendix I – Non-Technical Success Factors. Although specific questions on the environmental impacts of the Minnesota UPA projects were not included in the stakeholder interview scripts, some of the individuals mentioned environmental benefits associated with the UPA projects. Representatives from special interest groups and transit agencies, as well as local policy makers, discussed the environmental benefits associated with the Minnesota UPA transit components. They noted that the transit projects, and the potential related environmental benefits, were important factors in reaching agreement on the Minnesota UPA proposal. They also highlighted the environmental benefits realized from the MARQ2 lanes, other transit projects, and the eWorkPlace telecommuting program.

Representatives from the Citizens League, I-35 Solutions, Metro Transit, MVTA, and the Metropolitan Council, as well as elected officials, noted during the first interviews in 2009 that the inclusion of the transit projects in the Minnesota UPA application was important for gaining consensus among all groups. The transit and the telecommuting elements provided non-freeway projects, which were important to many groups. Providing more environmentally friendly travel options through the transit projects or removing trips from the freeway through telecommuting were suggested as key parts of the application.

Many of the same individuals mentioned that environmental benefits were being realized by the transit and telecommuting projects in the second interviews conducted in 2011. For example, as noted next in the review of print media, the air quality benefits of the MARQ2 lanes – including removing express bus trips from the Nicolette Mall and using clean fuel buses on the Mall –

[2] Emission factors for arterials are more representative than those for freeways used elsewhere in this analysis because the fleet mix (assortment of passenger cars, trucks, long haul trucks, etc is different on arterials than it is on freeways). Emission factors provided by the MN Council included a set for freeways and a set for arterials, for the Twin Cities area.

were noted by representatives from Metro Transit, MVTA, and the Metropolitan Council. The air quality benefits from the eWorkPlace telecommuting program, by removing commute trips from I-35W South, were also mentioned during the interviews.

The content analysis of print media coverage the Minnesota UPA projects is also presented in Appendix I – Non-Technical Success Factors. The print media articles were re-reviewed for this analysis to identify any environmental comments or perspectives. Two of the articles on the MARQ2 lanes, including the editorial in the Minneapolis Star Tribune, noted the air quality and noise improvements associated with removing bus trips from the Nicolette Mall and using cleaner buses on the Mall, as well as increasing bus travel speeds through the downtown area. The editorial noted the benefits to restaurants with sidewalk seating areas and diners, as well the benefits associated with enhancing the pedestrian environment of the Mall. The LED lighting and other energy saving features of some of the new park-and-ride lots were noted in one article. One article on the eWorkPlace program mentioned the potential air quality benefits from telecommuting.

As previously mentioned, the environmental benefits of the transit and telecommuting projects were mentioned by some stakeholders during both sets of interviews. The inclusion of the transit and telecommuting elements in providing non-roadway projects in the Minnesota UPA application were noted as important in reaching consensus on the application. The air quality, environmental, and energy saving benefits of the MARQ2 lanes, the park-and-ride lots, and the eWorkPlace telecommuting project were mentioned in some of the stakeholder interviews and in a few newspaper articles.

H.5 Summary of Environmental Analysis

Table H-10 presents a summary of the questions examined in the environmental analysis of the Minnesota UPA projects. As discussed in this appendix, the Minnesota UPA projects had positive impacts on air quality, perceptions of overall environmental quality, and energy consumption. The analysis of the section of I-35W South from Highway 13 to I-494 indicated positive impacts on air quality (11-12 percent reduction in emissions) from the expansion of the existing HOV lanes to HOT lanes. However, the adjacent general purpose lanes in this section experienced an increase in emissions and energy use (28-32 percent) due to a large increase in volume, as described earlier.

The impacts on air quality from the new HOT lane in the Crosstown Commons section and the PDSL were inconclusive due to the addition of the general-purpose freeway lanes in the Crosstown Commons section, lack of needed data, and other factors influencing the increase in vehicle volumes on I-35W South.

The review of the stakeholder interviews and the print news media indicated positive perceptions on air quality, energy consumption, and the environment from the transit and telecommuting projects.

Similar to the air quality analysis, the analysis of the section of I-35W South from Highway 13 to I-494 with the expansion of the HOV lanes to HOT lanes resulted in a fuel use reduction on the HOV/HOT lanes. The impacts on fuel use from the HOT lanes in the Crosstown Commons section and the PDSL were inconclusive due to the addition of the new general-purpose freeway lanes, the lack of data, and other factors influencing the increase in vehicle volumes on I-35W South.

Table H-10. Summary of Impacts Across Questions

Questions	Result	Evidence
What are the impacts of the Minnesota UPA strategies on air quality?	Positive impacts in some sections but, inconclusive in other sections of I-35W South.	Positive impacts on air quality from the expansion of the HOV lanes to HOT lanes on I-35W South between Highway 13 and I-494 but negative impact in general purpose lanes due to increase in volumes. Not able to fully assess the impacts of other I-35W South segments due to confounding effect of other projects, lack of data, and other factors.
What are the impacts on perceptions of overall environmental quality?	Positive impacts	Responses from some individuals during the stakeholder interviews and coverage in a few newspaper articles noted the positive impact on air quality, energy consumption, and the environment from the Minnesota UPA transit and telecommuting projects.
What are the impacts on energy consumption?	Positive impacts in some sections, but, inconclusive in other sections of I-35W South.	Reduction in fuel use from the expansion of the existing HOV lanes to HOT lanes in the section of I-35W South from Highway 13 to I-494 but increase in fuel use in the general purpose lanes due to increase in volumes. Not able to fully assess the impacts on other sections of I-35W South due to other projects, lack of data, and other factors.

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Appendix I. Non-Technical Success Factors Analysis

This analysis examines the non-technical success factors associated with the Minnesota UPA. These non-technical success factors include the institutional arrangements used to manage and guide the development of the initial proposal and the implementation of the Minnesota UPA projects, outreach activities, media coverage, and political and community support. Information on the non-technical success factors is of benefit to the U.S. DOT, state departments of transportation, MPOs, and local communities interested in planning and deploying similar projects.

Table I-1 presents the questions associated with the analysis of the non-technical success factors. The first question focuses on understanding how a wide range of variables influenced the successful deployment of the Minnesota UPA projects. The variables are grouped into the five major categories of people, process, structures, media, and competencies. The second question guiding this analysis focuses on examining public support for the Minnesota UPA projects as effective and appropriate ways to reduce congestion.

Table I-1. Non-Technical Success Factors Analysis Questions

Questions
• What role did factors related to these five areas play in the success of the Minnesota UPA deployment? 1. People (sponsors, champions, policy entrepreneurs, neutral conveners) 2. Process (forums, stakeholder outreach, meetings, alignment of policy ideas with favorable politics, and agreement on the nature of the problem) 3. Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules, and procedures) 4. Media (media coverage, public education) 5. Competencies (cutting across the preceding areas: persuasion, obtaining grants, conducting research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)
• Does the public support the UPA strategies as effective and appropriate ways to reduce congestion?

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This appendix is divided into seven sections addressing these questions. The data sources used in the analysis are described in Section I.1. Information on the multi-agency organizational structure used to assist in initiating and deploying the Minnesota UPA projects is presented in Section I.2, followed by a discussion of the information sharing and outreach activities in Section I.3 and a content analysis of print media coverage of the Minnesota UPA in Section I.4. The major themes from the stakeholder interviews and workshops are presented in Section I.5. The results from questions measuring the public perceptions of the UPA projects as congestion-reduction strategies included in surveys, focus groups, and interviews discussed in other appendices are summarized in Section I.6. A summary of the Minnesota UPA non-technical success factors is presented in Section I.7.

I.1 Data Sources

A variety of data sources was used in the non-technical success factors analysis. First, members of the national evaluation team reviewed the proposal submitted by the local partners to the U.S. DOT, attended one of the early outreach workshops in the corridor, and conducted two sets of interviews and workshops with local stakeholders and agency personnel. Second, print news media were monitored by the national evaluation team and articles on the Minnesota UPA projects were reviewed and analyzed. Finally, the local agencies conducted surveys of bus riders on routes using I-35W, MnPASS customers, and commuters in the I-35W corridor. Focus groups and interviews with Minnesota State Patrol Officers, Metro Transit and MVTA bus operators, and FIRST operators were also conducted. Members of the national evaluation team reviewed the results from these surveys, focus groups, and interviews for indications of support of the UPA projects as congestion reduction strategies.

I.2 Minnesota UPA Multi-Agency Organizational Structure

As noted earlier in this report, the Minnesota UPA partners included MnDOT, the Twin Cities Metropolitan Council, Metro Transit, the City of Minneapolis, MVTA, and Anoka, Dakota, Ramsey, and Hennepin counties. The Center for Transportation Studies (CTS) and the Hubert H. Humphrey School of Public affairs at the University of Minnesota were also partners in the UPA, as were four transportation management organizations (TMOs) in the area.

MnDOT and the Metropolitan Council were the lead agencies for the Minnesota UPA. MnDOT was responsible for the project schedule and financial management, system design and integration oversight, coordinating project activities, and reporting to federal agencies. MnDOT was also responsible for constructing and operating the I-35W HOT lanes, the PDSL, the auxiliary lanes, and the ATM. MnDOT also managed the telecommuting program with assistance from the Humphrey School.

The Metropolitan Council, the MPO for the seven-county metropolitan area, also operates Metro Transit, which provides bus, light-rail transit (LRT), specialized transportation, and ridesharing services in the metropolitan area. The Metropolitan Council and Metro Transit were responsible for the transit elements of the UPA, including the park-and-ride lots, the new buses, and the Transit Advantage project. The Metropolitan Council and Metro Transit were also responsible for processing the Federal Transit Administration (FTA) funding, including contract administration.

The City of Minneapolis was the lead agency on the MARQ2 bus lanes in downtown Minneapolis. The MVTA was responsible for the Cedar Avenue Lane Guidance System, including the bus operator driving simulator and deploying 10 buses equipped with the driver assist and lane guidance system. Anoka, Dakota, Ramsey, and Hennepin counties assisted with park-and-ride facilities and other project elements. The TMOs assisted with the telecommuting project.

Figure I-1 illustrates the initial agency organizational structure for the Minnesota UPA. The Leadership Team included the MnDOT Commissioner and the Chair of the Metropolitan Council. The Steering Committee included top staff members from the partnership agencies, counties, communities, and TMOs. MnDOT had overall project coordination responsibility. The Communications and Outreach Subcommittee included representatives from the various agencies, counties, and cities. The major project elements were the responsibility of MnDOT, Metro Transit, and the Humphrey School. The organizational structure also provided for ongoing coordination with FHWA and FTA personnel.

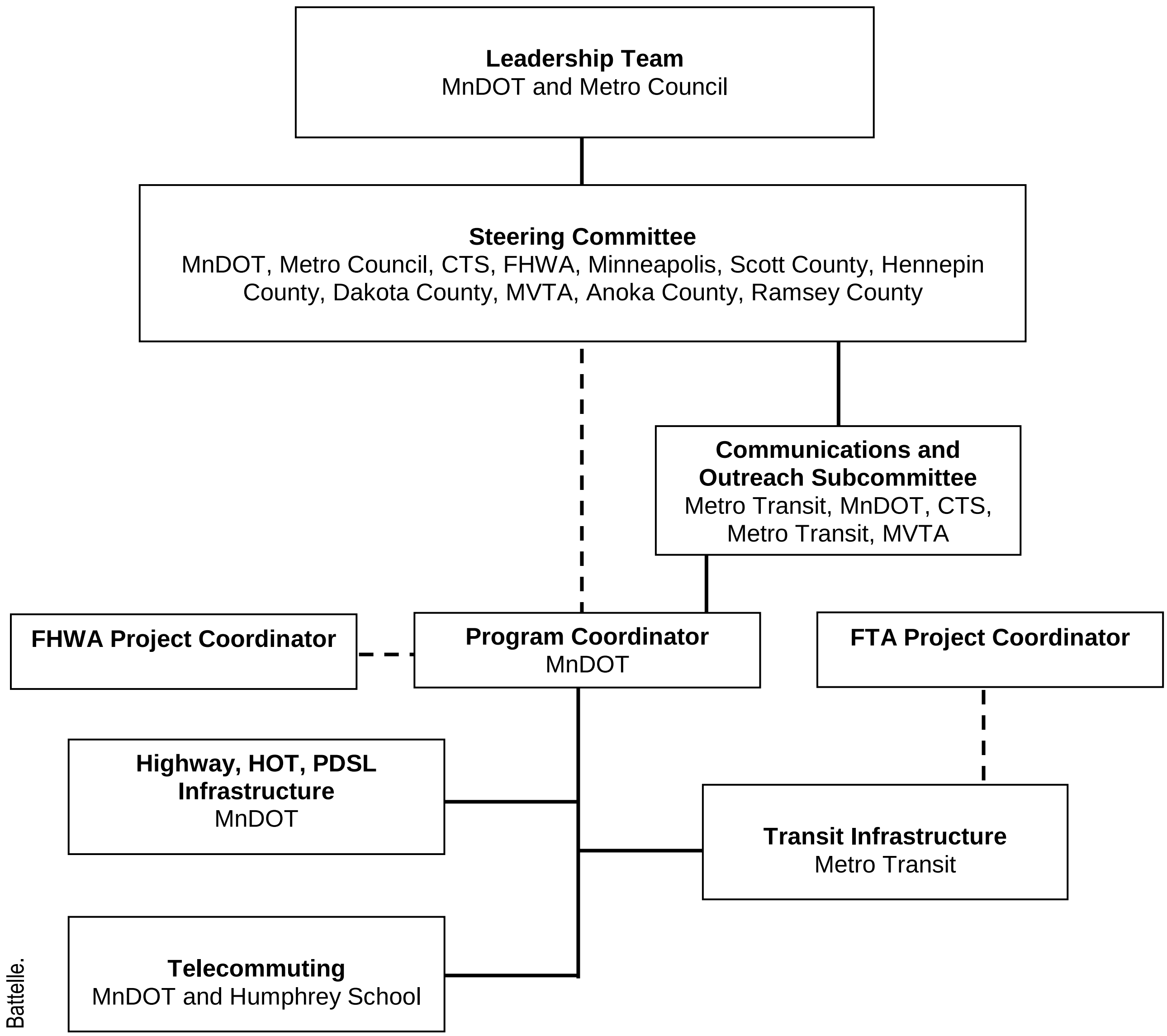


Figure I-1. Minnesota UPA Organizational Chart

Senior level staff at all the local agencies filled key positions in the Minnesota UPA organizational structure. Most of these individuals had worked together before on projects and already had strong working relationships. These senior staff brought leadership to the UPA, as well as the technical skills and project management competencies needed to successfully deploy the UPA projects. The organizational structure also provided clear lines of authority and responsibility for the different projects, facilitating the timely delivery of the UPA projects.

As discussed more extensively in the stakeholder interviews and workshops summary in Section I.5, as deployment of the Minnesota UPA projects progressed, the need for regular meetings of the Leadership Team and the Steering Committee diminished. The Leadership Team and the Steering Committee met less often as the UPA projects moved into implementation, construction, deployment, and operation. In addition, the Communication and Outreach Subcommittee made the decision to use a common logo for the UPA projects, but to market and promote them as individual projects. As a result, the Communications and Outreach Subcommittee also discontinued meeting on a regular basis. This "less meeting, more doing" is described in more detail in Section I.5.

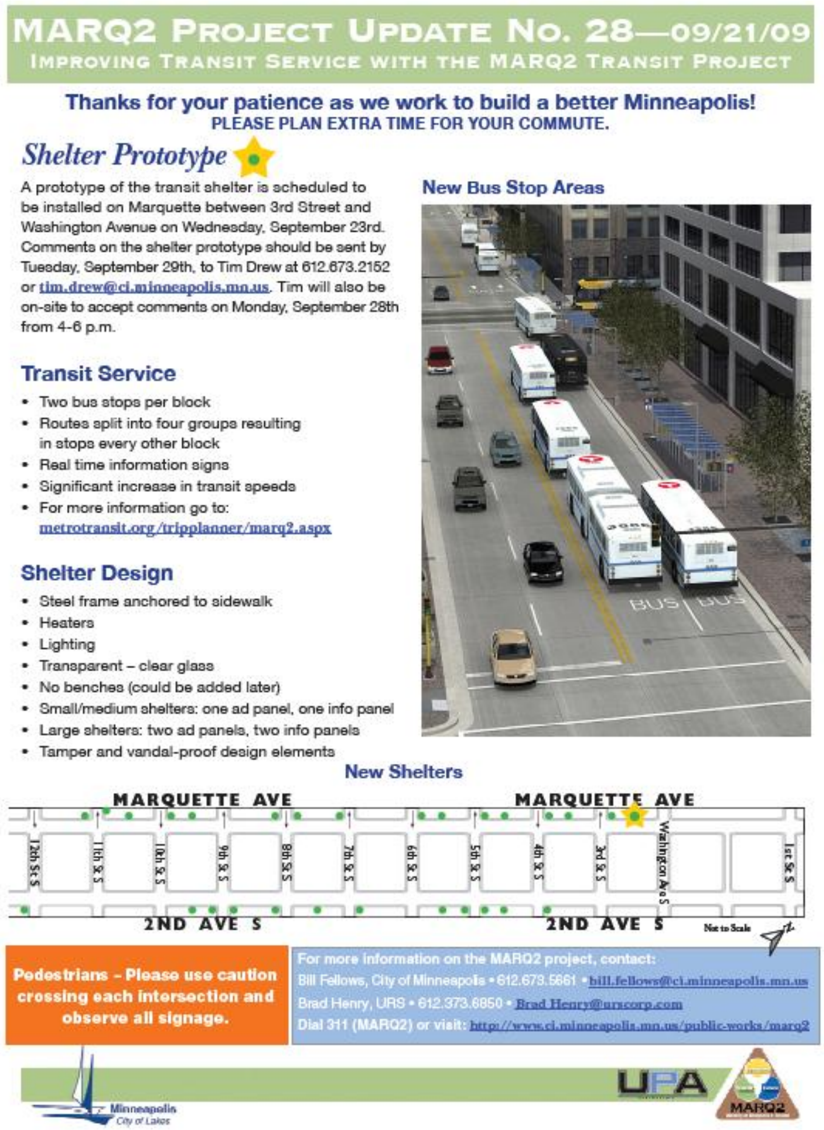
I.3 Public Information and Outreach Activities

The Minnesota UPA agencies used a number of methods to reach out to policy makers, business groups, commuters, and the general public. The overall approach was developed by the Communications and Outreach Subcommittee and the activities were conducted by the different agencies. Outreach and public information methods and techniques included workshops and meetings, presentations, Internet sites, electronic newsletters, e-mail updates, and corridor tours. A common logo was used for the Minnesota UPA projects and paired with agency or individual project logos. Examples of these techniques are highlighted in this section. Comments from the stakeholder interviews about the effectiveness of the different techniques are also summarized.

- **Workshops.** The local agencies sponsored workshops to explain the UPA projects at different points in the planning and implementation process. For example, a June 2008 *UPA: Innovative Choices for Congestion Relief Stakeholders Workshop* was held at the Best Buy Headquarters in Richfield. The workshop was facilitated by staff from the Humphrey School and featured presentations by MnDOT, Metro Transit, and Humphrey School staff. Displays were used in the open house portion of the workshop, providing participants with the opportunity to interact with agency staff and learn more about specific projects. Comments made by individuals during the stakeholder interviews noted the effectiveness of these workshops. Local and state officials and representatives from special interest groups gave the local agencies high marks for conducting these workshops.
- **Meetings.** Representatives from MnDOT, the Metropolitan Council, Metro Transit, MVTA, and other agencies and communities met individually or in small groups with state legislators, local elected officials, businesses, and other organizations. These smaller meetings provided the opportunity to brief key stakeholders on projects and address potential questions or concerns. These meetings were viewed positively by the

local and state officials and interest groups participating in the stakeholder interviews and workshops.

- **Presentations.** Representatives from MnDOT and Metro Transit gave numerous presentations on the UPA projects. These presentations provided a general overview of the Minnesota UPA and focused on the projects or elements of interest to the specific group or area. Presentations were given on an almost weekly basis throughout the development and implementation phases of the UPA projects. The policy makers, officials, and interest group representatives participating in the stakeholder interviews and workshops indicated these meetings were very effective at communicating information on the UPA projects and keeping diverse groups updated on their progress.
- **MARQ2 Project Updates.** The City of Minneapolis and URS, the consulting firm responsible for the MARQ2 project, issued regular electronic project updates to communicate with downtown businesses, policy makers, the public, and other stakeholders during the construction of the MARQ2 lanes in downtown Minneapolis. The updates included information on current activities and planned efforts for the MARQ2 lanes. A total of 34 one-page updates were issued over the 18-month period from June 2008 to November 2009. Figure I-2 presents an example of an update distributed toward the end of the project. These project updates were very well received by the downtown business community and other groups according to the stakeholder interviews and workshops.
- **Mn/DOT E-Mail Construction Updates.** Individuals could register to receive weekly e-mail updates from MnDOT on I-35W construction activities and traffic impacts. These weekly e-mails highlighted lane restrictions and closures, ramp closures, and other activities that impacted travelers, residents, and businesses. Stakeholders noted that these regular e-mail updates were well received by travelers in the corridor.
- **Corridor and Project Tours.** Metro Transit equipped one of its buses with video screens and an audio system. Metro Transit, MnDOT, MVTA, and other partners used the bus for tours of the I-35W corridor and projects. PowerPoint slides were displayed on the video monitors and staff provided commentary on the projects. Tours were provided to members of the legislature, local elected officials, the press, federal agency staff, and other groups. Stakeholders noted these tours were effective in developing an understanding of the UPA projects and in building support for the different projects.
- **UPA and MnPASS Internet Sites.** Information on the UPA projects was available on the Minnesota UPA Internet site. The Mn/DOT MnPASS Internet site included information on the I-35W HOT lanes and PDSL and frequently asked questions on using the lanes. A video tour was available to acquaint potential users with the facilities. Individuals can register for a MnPASS account on-line. As noted in Appendix B, approximately 90 percent of I-35W MnPASS accounts were opened on-line, indicating the positive impact of the Internet sites.



MARQ2 PROJECT UPDATE NO. 28—09/21/09
IMPROVING TRANSIT SERVICE WITH THE MARQ2 TRANSIT PROJECT

Thanks for your patience as we work to build a better Minneapolis!
PLEASE PLAN EXTRA TIME FOR YOUR COMMUTE.

Shelter Prototype

A prototype of the transit shelter is scheduled to be installed on Marquette between 3rd Street and Washington Avenue on Wednesday, September 23rd. Comments on the shelter prototype should be sent by Tuesday, September 29th, to Tim Drew at 612.673.2152 or tim.drew@ci.minneapolis.mn.us. Tim will also be on-site to accept comments on Monday, September 28th from 4-6 p.m.

Transit Service

- Two bus stops per block
- Routes split into four groups resulting in stops every other block
- Real time information signs
- Significant increase in transit speeds
- For more information go to: metrotransit.org/tripplanner/marq2.aspx

Shelter Design

- Steel frame anchored to sidewalk
- Heaters
- Lighting
- Transparent – clear glass
- No benches (could be added later)
- Small/medium shelters: one ad panel, one info panel
- Large shelters: two ad panels, two info panels
- Tamper and vandal-proof design elements

New Bus Stop Areas

New Shelters

Pedestrians – Please use caution crossing each intersection and observe all signage.

For more information on the MARQ2 project, contact:
Bill Fellows, City of Minneapolis • 612.673.5661 • bill.fellows@ci.minneapolis.mn.us
Brad Henry, URS • 612.373.6850 • Brad.Henry@urscorp.com
Dial 311 (MARQ2) or visit: http://www.ci.minneapolis.mn.us/public-works/marq2

Minneapolis City of Lakes
UPA
MARQ2

City of Minneapolis

Figure I-2. Example of MARQ2 Project Update

- **Telework Promotions.** A number of methods were used to promote the telework program, eWorkPlace, and to recruit employers and employees to participate. These techniques included the eWorkPlace Internet site, radio advertisements, newspaper advertisements, and meetings with employers and employer groups. Representatives from MnDOT and the Humphrey School noted that these methods were effective in recruiting employer and employee participation in the eWorkPlace program.
- **Press Releases.** Participating agencies used press releases to highlight the opening of the various UPA projects. These press releases were provided to local media and were listed on the various websites. Stakeholders noted that these press releases were effective in generating media coverage of the initial selection of Minnesota for the UPA and the individual projects.

The review of the Minnesota UPA public information and outreach activities indicates that the methods and techniques were well received and viewed positively by local stakeholders. Local officials, policy makers, and interest group and business representatives provided positive feedback on all the techniques, especially the workshops, meetings, presentations, and MARQ2 project updates. As noted in the next section, the press releases resulted in positive coverage of the Minnesota UPA projects in the print media.

I.4 Print News Media Content Analysis

News media coverage of the Minnesota UPA was tracked to understand its role in both providing information to the public, as well as in shaping public opinion. Newspaper articles were monitored from 2007 to 2011. This time period corresponds with the U.S. DOT selection notice of the Minnesota UPA through one year of the post-deployment period.

The analysis focused on news articles highlighting the Minnesota UPA application, selection, and projects. Articles on more general topics such as congestion and tolling, as well as articles on the collapse and rebuilding of the I-35W bridge, and the I-35W expansion and reconstruction of the Crosstown Commons section, were excluded for the analysis. A total of 42 articles were reviewed. All of the articles were from mainstream local media. The majority of articles were in the two daily newspapers – the Minneapolis Star Tribune and the St. Paul Pioneer Press. Additional articles were in the Legal Ledger (St. Paul) and Finance & Commerce (Minneapolis). One article was from TendersInfo.

The LexisNexis Academic database, a full text database for news, business, and legal research was used to assist in the analysis. The content analysis of the news media coverage included both deductive and inductive processes. The deductive process focused on organizing the articles into positive, negative, balanced, and neutral categories. This categorization was used to assess whether the media was shaping opinion in a certain attitudinal direction based on the assumption that the news media both informs and influences its readership. A definition of each category is as follows.

- Positive: The coverage presents an overwhelmingly positive case for the Minnesota UPA projects, typically giving detailed information about the benefits of the projects (e.g., reduced congestion, enhanced bus throughput in downtown Minneapolis, and innovative use of technology). Sources and quotations come from only a positive perspective.
- Negative: The coverage presents an overwhelmingly negative case for the Minnesota UPA projects, typically giving detailed information about the risks of the project (e.g., new construction projects cause confusion among residents and travelers). Sources and quotations come from a negative perspective, or are put into a negative context.
- Balanced: The coverage presents a balanced story of both the potential benefits and risks of the Minnesota UPA projects. Sources and quotations may come from positive and negative perspectives and the article does not present a final verdict on whether the project is a net positive or negative.

- Neutral: The article presents information simply to inform the reading audience of some phenomenon or event without giving any perspective (e.g., announcement of selection of the Minnesota UPA by the U.S. DOT).

The inductive process included identifying major themes issues and perspectives from the news media coverage. It examines the focus of the coverage to help gauge the importance and the interest of different elements of the Minnesota UPA. These overall themes include bringing federal funding to the state, enhancing transit in the corridor and in downtown Minneapolis and promoting its use, and addressing traffic congestion in the corridor.

As highlighted in Table I-2, approximately 60 percent of the news media coverage of the Minnesota UPA projects occurred in 2008 and 2009. Minnesota received the federal grant in late 2007, so many of the articles in 2008 highlighted initiation of the UPA projects. Most of the stories that provided comprehensive overviews of the UPA were written at this time, as were most of the stories on the City of Lakeville joining the transit taxing district. The stories in 2009 highlighted the implementation of various projects, including the MARQ2 lanes, the park-and-ride lots, the HOT lanes, and the PDSL. Articles in 2010 covered the opening of the new HOT lanes in the completed Crosstown Commons Section, the Apple Valley Transit Center, and a national award for eWorkplace. The 2011 articles included stories on the MVTA driver assist system, the Lakeville park-and-ride lot and express bus service, and enforcement of the MnPASS HOT lanes.

Table I-2. Minnesota UPA News Media Coverage by Year

Year	Number of Print Media	Percent of Total
2007	6	14%
2008	11	26%
2009	15	36%
2010	5	12%
2011	5	12%
Total	**42**	**100%**

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Table I-3 shows the results of the deductive analysis of the news media coverage categorized as positive, negative, balanced, or neutral by media type. A total of 52 percent of the media coverage was positive, 31 percent was neutral, and 12 percent was balanced. Only two articles, or 5 percent, reflected a negative perspective.

Table I-3. Categorization News Media as Positive, Negative, Balanced, or Neutral Type

Media Type	Positive	Negative	Balanced	Neutral	Total
Mainstream	16	2	4	11	**33**
Industry	6	0	1	2	**9**
Total	**22**	**2**	**5**	**13**	**42**
Percent of Total	**52%**	**5%**	**12%**	**31%**	**100%**

Battelle

Most articles presented the UPA projects in a positive light, even if they noted some problems during the opening phases. Benefits related to congestion relief and reduced travel times were highlighted. Only two articles came across more negatively. One underscored the confusion of some commuters who did not know what projects were being constructed or when they would be finished. It was entitled "COMING 'SOON,' CONFUSING NOW: Thanks to a gigantic windfall, the Twin Cities area is in line to get bus rapid transit, or BRT. But many residents don't know what it is or how it will work, and full-fledged service could be years away." The other article categorized as "negative" highlighted the funding gap faced by Dakota County in constructing the Cedar Avenue BRT even with the UPA supported transit stations and park-and-ride lots.

As noted previously, many of the articles presented basic information on the Minnesota UPA. For example, four of the six articles in 2007 covered the announcement by U.S. Transportation Secretary Mary Peters, that Minnesota had been selected as one of the six UPA sites. These articles highlighted the $133.3 million in funding and the projects. The HOT lanes, PDSL, the downtown bus lanes, the park-and-ride lots, the transit stations, and the telecommuting program were mentioned. Most of the coverage analyzed did not deliberate on the pros and cons of UPA. Rather, most coverage focused on describing the projects. In some cases, individual projects were discussed without explaining they were a part of the UPA until the end of the article. In a few cases, a comprehensive overview of the UPA projects was provided. This coverage was labeled as "positive" because it presented the purpose and benefits of the UPA projects, without any negative comments.

The majority of the print news media coverage on the Minnesota UPA was descriptive. These articles described the projects, funding, and schedule. Additional information on specific projects, such as the MARQ2 lanes in downtown Minneapolis, the park-and-rides lots, and the HOT lanes were included in some articles. Individual projects were the focus of other articles. One article focused on the park-and-ride lot in Lakeville, without mentioning any of the other UPA projects. A few articles described the UPA more holistically, including one article in the Minneapolis Star Tribune that interviewed MnDOT's Nick Thompson.

Positive elements included in the various articles highlighted the congestion reduction benefits from the projects and expanding travel options for commuters. The bipartisanship support among politicians was also noted in a few articles. The UPA projects were also seen as a needed improvement after the I-35 bridge collapse. An example of the overall positive tone of the media coverage is reflected in the following quote from Minneapolis City Council Member Sandy Colvin Roy. "Just two years after adopting our 10-year transportation plan for downtown, we're already seeing many of our planned improvements become reality. This project is a key piece of a dramatic reshaping of transportation that takes into account drivers, bicyclists, pedestrians and bus and train riders."

The biggest controversy mentioned in the news media coverage was the issue in Lakeville over joining the transit taxing district. The proposal to expand the transit taxing district to include Lakeville and Farmington was controversial. These articles were categorized as neutral rather than negative, however, because all sides of the situation were presented.

The results of content analysis indicate that the local print media played a role of informing the public about the UPA projects, rather than influencing public perception. The UPA projects were not controversial for the most part and the media reflected a positive or neutral attitude. The editorial supporting the MARQ2 lanes provides an exception, as it was influencing in tone. The descriptive nature of most articles did not appear to attempt to influence public opinion, however.

I.5 Stakeholder Interviews and Workshops

Two sets of stakeholder interviews and two stakeholder workshops were conducted as part of the Minnesota UPA national evaluation non-technical success factor analysis. The purpose of the stakeholder interviews and workshops was to gain additional insights into the institutional arrangements, partnerships, outreach methods, and other activities contributing to successfully planning, deploying, and operating the Minnesota UPA projects. The results are of benefit to other areas seeking to enhance existing or develop new multi-agency/multi-jurisdictional partnerships to promote innovative transportation solutions addressing traffic congestion.

The first set of interviews was conducted in June, July, and August 2009. The first workshop followed in October 2009, prior to the deployment of the Minnesota UPA projects. The second set of interviews was conducted in May and June of 2011, approximately six months after completion of the HOT lanes in the Crosstown Commons section. The second Stakeholder Workshop was held December 1, 2011.

Members of the national evaluation team conducted the stakeholder interviews. The questions used in the interviews were developed by the national evaluation team with input from the local partners and federal agency representatives. The questions were included in the *Minnesota UPA Surveys, Interviews, and Focus Group Test Plan*.

The first set of interviews was coordinated with a project funded by the University of Minnesota's ITS Institute, which also included interviewing key stakeholders associated with the Minnesota UPA. This approach leveraged resources and allowed for the completion of 34 interviews with 43 individuals in 2009. A smaller set of 11 interviews with 17 people was conducted in 2011, with funding from just the national UPA evaluation. Table I-4 identifies the number of individuals from different agencies and organizations participating in the different sets of interviews and workshops.

A number of methods was used to identify individuals to be interviewed. An initial list was developed with input from the Minnesota UPA Partners Outreach Subcommittee. This list was expanded and revised based on review by members of the UPA national evaluation team, input from representatives from the Minnesota UPA partnership agencies, and comments from U.S. DOT representatives. As highlighted in Table I-4, the individuals interviewed represented a mix of elected officials, including state senators and representatives, appointed officials, agency and community staff, University of Minnesota researchers, and representatives from private non-profit organizations and special interest groups.

Table I-4. Stakeholders Interviewed and Workshop Participants

Organization	Number of Participants			
	First Stakeholder Interviews	Second Stakeholder Interviews	First Stakeholder Workshop	Second Stakeholder Workshop
Minnesota State Legislature	6	1		
MnDOT	3	2	2	3
Metro Council – Staff and Policy Board	5	2		
Metro Transit Staff	3	5	2	1
MVTA Staff	2	2	1	1
University of Minnesota[1]	6		4	3
City and County Staff and Officials[2]	10	3	1	
Public Interest Groups[3]	3		1	
TMOs[4]	2			
Consultants	1		1	
FHWA – Minnesota Division	2	2	4	2
FHWA – U.S. DOT Washington			4	2
TOTAL	43	17	20	12

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[1]Includes Humphrey School of Public Affairs, CTS, and ITS Institute.

[2]Includes cities of Minneapolis, Bloomington, Burnsville, Apple Valley, and Lakeville; and Dakota County.

[3]Includes Citizen's League, 35W Solutions Alliance, and Value Pricing Task Force.

[4]Includes Downtown Minneapolis TMO and 494 Commuter Solutions.

Each interview took between 60 to 90 minutes to complete. Two researchers from the Humphrey School participated in each interview. One individual led the interview, asking the questions, and taking notes. The second individual took notes using a laptop computer. The interview transcripts were stored, organized, and analyzed using NVivo, a qualitative data analysis software. The software provides document coding and tracking capabilities based on key words and other characteristics.

The first Stakeholder Workshop was held October 8, 2009 at the Hubert H. Humphrey School of Public Affairs at the University of Minnesota. The second Stakeholder Workshop was conducted December 1, 2011 at the MVTA Burnsville Bus Garage. A total of 20 individuals participated in the first workshop and 12 individuals attended the second workshop. These figures do not include members of the national evaluation team facilitating the workshops.

All of the individuals interviewed were invited to the workshops, as well as other agency, community, and interest group representatives. It was realized that policy makers would probably not be able to take most of a day to participate in the workshop, but they were still invited. In addition, U.S. DOT personnel managing the UPA National Evaluation attended both workshops.

The workshops provided the opportunity for dialog among the Minnesota UPA stakeholders and additional discussion of common themes and unique perspectives from the interviews. Participants were encouraged to provide additional comments, including highlighting new points, clarifying previous topics, and reinforcing prior perspectives.

To facilitate discussion during the workshop, the common themes from the interviews were summarized by topic areas. The four topic areas for the first workshop were institutional arrangements and partnerships, processes, outreach activities, and expectations. The topic areas for the second workshop were the conceptual framework, institutional arrangements, project processes, project structure and governance, constraints and challenges, power and politics, expectations, keys to collaboration, and lessons learned. Summaries of both workshops were prepared by the national evaluation team. The key themes from the interviews and workshops are summarized next.

- The Minnesota UPA built on strong existing partnerships among the local agencies. New and expanded partnerships were also developed through the Minnesota UPA. The major agencies involved in the Minnesota UPA – MnDOT, the Metropolitan Council, Metro Transit, the MVTA, and the City of Minneapolis – had strong existing working relationships. These relationships allowed the agencies to come together on the initial application and to work together to implement and operate the different projects. The roles of public interest groups, including the Citizens League and the 35W Solutions Alliance, and the Humphrey School and CTS at the University of Minnesota, as neutral conveners and facilitators were also important in reaching agreement among the agencies and policy makers on the approach and the projects in the initial application. New and expanded relationships were also developed with local communities, agencies, and other groups, including businesses in the eWorkPlace telecommuting project.
- There was a strong commitment from all agencies at all levels throughout the process. There was strong support from the top administrators and policy boards within each agency in the application stage, throughout implementation, and in the ongoing operation of the projects. There was bi-partisan support for the application from the Minnesota Legislature, and the needed funding was appropriated. The key personnel within the agencies remained the same for the most part throughout the deployment process, although some were promoted or given additional responsibilities for new initiatives. Personnel from the various agencies and groups enjoyed working together.

- Clear authority and responsibilities existed both between and within agencies. The project managers had decision-making authority, which helped ensure timely project delivery. Project managers did not have to seek approval from higher levels within the agency for the vast majority of items. They had the authority to make decisions needed to keep projects on schedule and on budget.
- The amount of federal funds, and the threat of losing those funds, was clearly a driver. The significant amount of funding available through the UPA was key in bringing the agencies together in the initial application. The threat of losing those funds, especially after New York and Chicago were eliminated from the program when deadlines were not met, was a key motivator for the local partners. The mix of funding and the flexibility in applying the funds were also important factors in the deployment process.
- The real and meaningful deadlines associated with the UPA created motivation for all the local partners. No one individual or agency wanted to let the team down. Everyone was working toward a common goal and the same end. This interdependence was an important element in the successful deployment of the UPA projects.
- Multimodal solutions do work. The Minnesota UPA projects represent a mix of highway, transit, telecommuting, and technology approaches. This mix was important for building agency and political support from the Minnesota UPA applications. It reflects that no one mode or technology alone can address congestion in major travel corridors. The preliminary assessment of the UPA projects reflects that this multimodal approach works. It also supports the need to provide people with travel and mobility options. The flexible funding provided by the UPA for this multimodal approach was also important.
- Simple solutions, such as the Transit Advantage bus by-pass ramp, were as important as major solutions such as the MARQ2 and MnPASS lanes. The Minnesota UPA represented a mix of small, medium, and large projects. Relatively small and simple approaches, such as the Transit Advantage project, provide benefits, as do the larger projects such as the MARQ2 lanes and MnPASS lanes.
- Good planning does not just sit on a shelf – it prepares an agency and a community for opportunities. Many of the Minnesota UPA projects were part of existing adopted or endorsed plans. For example, the MARQ2 lanes were a key element of the recently adopted plan for downtown Minneapolis. The consensus and support that existed for this project and other UPA projects allowed the local partnership agencies to quickly move forward with implementation once the application was selected by the U.S. DOT.
- Constant and open communications were critical throughout the process, across all groups, and with policy makers and the public. Agency staff at all levels worked to communicate up, down, and within their agency and with other agencies. Communication with the public and with stakeholders was accomplished through meetings and workshops in the corridor, one-on-one meetings with key stakeholders, and presentations to numerous groups. A regular newsletter was used to communicate with downtown businesses and bus riders on the MARQ2 project. MnDOT sent a regular e-mail notice on the I-35 construction. A common logo was used to brand the UPA

projects, but the decision was made by the agencies to market and promote the projects individually.

- The expectations of the local partners were met. The Minnesota UPA projects were delivered on-time and under budget. The reaction to the projects has been positive. The projects meet current needs and provide capacity for future growth.

The results of the stakeholder interviews and workshops highlight the key elements of the successful deployment of the Minnesota UPA projects. As summarized in this section, these elements, include building on existing workshop relationships among the local partners and developing new working relationships among agencies, strong commitments at all levels within the partnership agencies, clear authority and responsibility between and within agencies, meaningful deadlines, a team spirit with a desire not to let others down, and a pride in being part of an innovative and significant program.

I.6 Public Reaction to the UPA Projects

Public reaction to the UPA strategies and projects was assessed using data collected by the local partners. As part of the national evaluation, MnDOT conducted an on-line survey of I-35W MnPASS customers. This survey is described in more detail in Appendix B – Tolling Analysis. These surveys are described in more detail in Appendix B – Tolling Analysis. The Metro Transit on-board passenger survey discussed in Appendix C – Transit Analysis included questions related to support for the UPA transit projects. MnDOT also sponsored focus groups and interviews with Minnesota State Patrol Officers, FIRST Operators, and Metro Transit and MVTA Operators. As summarized in this section, the survey results indicated support among the different user groups for the UPA strategies as effective and appropriate methods for reducing traffic congestion, although some strategies are viewed more favorably than others.

I.6.1 I-35W MnPASS Customer Survey

As discussed in Appendix B – Tolling Analysis, MnDOT, through its MnPass contractor Cofiroute USA, administered an on-line survey of I-35W MnPASS customers in January 2012. Although there was not a specific question addressing their perspective on the MnPASS lanes as an appropriate congestion reduction strategy, a few questions focused on related topics. As summarized below, the responses to these questions indicate support for the MnPASS lanes on I-35W. The survey results have a 2.26 percent margin of error at the 95 percent confidence interval.

- A total of 63 percent of the respondents agreed to strongly agreed that the MnPASS lanes give them value for the money, 22 percent neither agreed or disagreed, and 15 percent disagreed or strongly disagreed.
- A total of 70 percent of the respondents indicated that the I-35W MnPASS toll lanes provide a fast, safe, reliable commute every time, 10 percent neither agreed or disagreed, and 12 percent disagreed or strongly disagreed.

- A total of 84 percent respondents indicated that, overall, they were satisfied with their experience using the I-35W MnPASS toll lanes, 10 percent neither agreed or disagreed, and 6 percent disagreed or strongly disagreed.

I.6.2 Metro Transit Bus Rider Survey

The results from the Metro Transit on-board passenger ridership survey of I-35W rules were discussed in Appendix C – Transit Analysis. The survey had a margin of error +/- 1.2 percent at the 95 percent confidence interval. Overall, passengers responding to the survey rated service reliability travel time, speed of commute, and safety between good and very good. These factors relate to the UPA projects including the MnPASS lanes and MARQ2 lanes. Riders were also asked specific questions on the MARQ2 lanes. Approximately 56 percent indicated speedy service was better, 47 percent responded that on-time performance was better, and 53 percent reported their overall satisfaction was better with the MARQ2 lanes.

I.6.3 Focus Groups and Interviews with Minnesota State Patrol Officers, FIRST Operators, and Bus Operators

As part of the Minnesota UPA National Evaluation, MnDOT sponsored focus groups and interviews with transit operators, Minnesota State Patrol officers, and FIRST operators. The interviews and focus groups were conducted by William & Kaye, Inc. Personnel from MnDOT's Market Research Group assisted with arranging the focus groups and interviews and participated in some interviews. A total of five Metro Transit and three MVTA operators, 12 State Patrol officers, and four FIRST operators participated in the interviews and focus groups.

The purpose of the interviews and focus groups was to obtain insights about the UPA projects and their impact on traffic congestion on I-35W from professional users of the freeway. Questions covered the HOT lanes and the PDSL, the ATM signs, the in-pavement lighting, transit projects, and other elements.

In general, all of the UPA projects were viewed favorably, although some concerns were raised with the PDSL. Minnesota State Patrol officers and the FIRST operators provided positive feedback on the ATM signs. They noted the benefits of the signs in quickly notifying motorists of problems ahead and directing them to move out of a lane. The HOT lanes were viewed favorably by all groups, but concerns over single-occupant vehicles violating the requirements were voiced by transit operators. State Patrol and FIRST operators voiced concerns about the lack of a shoulder when the PDSL is in operation. They noted the difficulty in enforcing the PDSL, as there is no place to pull violators over, other than following them all the way into downtown Minneapolis. All groups noted that the in-pavement lighting was difficult to see on sunny days and that it had not been working recently.

I.7 Summary of Non-Technical Success Factors

As highlighted in Table I-5, people, process, structures, the media, and competencies all played supporting roles in the successful implementation, deployment, and operation of the Minnesota UPA projects. The multi-agency organizational structure supported the initial implementation of the UPA projects. Support from agency leaders, clear authority for staff to make decisions, and the roll of neutral conveners played by the Citizens League, 35W Solutions Alliance, the Humphrey School, and CTS were also important. The local agencies used a wide variety of outreach approaches – workshops, forums, one-on-one meetings, presentations to groups, and newsletters and e-mails – to provide information to the public, commuters, and policy makers. These techniques were viewed as effective and beneficial by the policy makers, local officials, and interest groups included in the stakeholder interviews and workshops. The agencies built on a foundation of strong working relationships to successfully implement and operate the UPA projects. The media presented information on the UPA projects in a positive and descriptive manner. As such, the media played the role of informing the public, rather than attempting to influence public opinion. The results of the stakeholder interviews indicated that senior agency personnel possessed the technical expertise and project management skills needed to successfully deploy the various projects. The results from surveys and interviews indicate general support from different user groups to the UPA projects as appropriate methods to address traffic congestion, although some strategies were viewed more favorably than others.

Table I-5. Non-Technical Success Factors

Questions	Results	Evidence
What role did the following areas play in the success of the Minnesota UPA project deployment?		
1. People	Effective	Key elements included the multi-agency organization structure, support throughout the agencies, and neutral conveners.
2. Processes	Effective	Forums, workshops, meetings, presentations, and newsletters were used to communicate with different groups.
3. Structures	Effective	The strong agency working relationships supported the implementation of the UPA projects.
4. Media	Effective	Played role of informing the public, rather than attempting influencing public opinion.
5. Competencies	Effective	Agency personnel had the technical expertise and project management skills needed to successfully deploy the UPA projects.
Does the public support the UPA strategies as effective and appropriate ways to reduce congestion?	Supported	The reports from the various surveys of bus riders, commuters in the I-35W South corridor, and I-35W MnPASS customers indicate general support for the UPA strategies as effective and appropriate methods to reduce congestion.

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Appendix J. Benefit Cost Analysis

The purpose of the benefit cost analysis (BCA) is to quantify and monetize the benefits and costs of implementing the Minnesota UPA projects, with a focus on I-35W South. The net benefit from the UPA projects, which is the difference between the total benefits and the total costs, indicates the net societal benefit of this public investment. As presented in Table J-1, the BCA focuses on quantifying the overall benefits, costs, and net benefits from the Minnesota UPA projects on I-35W South. The term cost benefit analysis (CBA) was used in the Minnesota UPA test plan. The use of BCA has become the commonly accepted term in the transportation community and is used in this appendix.

Table J-1. Question for the BCA

Question
What are the overall benefits, costs, and net benefits from the Minnesota UPA projects on I-35W South?

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The timeframe used for the BCA encompasses the planning, implementation, and ten years of post-deployment operation. This approach includes all costs of the Minnesota UPA projects and the reconstruction of the Crosstown Commons section of I-35W South from their planning stages to 10-years post-implementation and all benefits of the projects for a 10-year period after implementation. It was impossible to separate the benefits from the reconstruction of the Crosstown Commons section, which included new general-purpose freeway lanes and the new HOT lanes, from the benefits from the UPA projects. As a result of including the benefits from both the UPA projects and the Crosstown Commons section, the costs associated with the reconstruction of the Crosstown Common section are also included in the BCA. Within this evaluation time frame, the BCA estimates and compares the total benefits and costs between two scenarios – with and without the implementation of the Minnesota UPA projects and the reconstruction of the Crosstown Commons section.

The remainder of this appendix includes six sections. The data sources used in the BCA are presented in Section J.1. The Minnesota UPA projects included in the BCA are discussed in Section J.2. Cost information on the UPA projects included in the BCA is presented in Section J.3. The estimation of the benefits from the projects is described in Section J.4. The computation of the BCA is presented in Section J.5. The appendix concludes with a summary of the analysis in Section J.6.

J.1 Data Sources

The BCA for the Minnesota UPA projects used several data sources. Data on the capital costs of projects were obtained from the Minnesota Department of Transportation (MnDOT), Metro Transit, and the City of Minneapolis. Data on the operation and maintenance costs associated with the projects was obtained from these same agencies. MnDOT had overall responsibility for the freeway projects and the eWorkPlace telecommuting program. Metro Transit had overall responsibility for the transit projects, although Minnesota Valley Transit Authority (MVTA) was the designated lead agency on the driver assist system (DAS) for shoulder running buses and one of the park-and-ride lots. The City of Minneapolis was the designated lead agency on the Marquette and Second Avenue (MARQ2) dual bus lanes in downtown Minneapolis.

Information on benefits, including travel-time savings, fuel savings, emissions reductions, and changes in crash rates was obtained from the analyses presented in other appendices. The trip-time savings and traffic volumes on I-35W South were obtained from the MnDOT loop detector data examined in Appendix A – Congestion Analysis. The reductions in emissions from the UPA projects were obtained from Appendix H – Environmental Analysis. The safety benefits were estimated using the Minnesota Department of Public Safety (DPS) Crash Database presented in Appendix F – Safety Analysis. The change in fuel use was based on the information in Appendix H – Environmental Analysis and gasoline prices from the U.S. Energy Information Administration monitored in Appendix K – Exogenous Factors.

J.2 Minnesota UPA Projects included in the BCA

The Minnesota UPA included 24 projects. A major focus of the Minnesota UPA was on reducing congestion on I-35W South. As a result, this BCA also focuses on the UPA projects associated with I-35W South. As presented in Table J-2, the projects associated with I-35W South include the high-occupancy toll (HOT) lanes, the Priced Dynamic Should Lane (PDSL), the two new auxiliary lanes, the active traffic management (ATM) signing and strategies, and the real-time traffic and transit signs. Other I-35W South projects included in the BCA are the four park-and-ride lots, the DAS for shoulder running buses, the dual contraflow bus lanes on Marquette and Second Avenues (MARQ2) in downtown Minneapolis, and the Transit Advantage bus bypass lane at the Highway 77/Highway 62 interchange. Some of the 27 new buses and a portion of the eWorkPlace telecommuting program are also included in the BCA. The cost of reconstruction of the Crosstown Commons section is also included. Table J-2 presents the Minnesota UPA projects and the Crosstown Commons section included in the BCA and how the portion of the costs included in the BCA were determined.

Table J-2. Minnesota UPA Projects Included in the BCA

UPA Project	Notes on Costs Included
Expanding existing high-occupancy vehicle (HOV) to high-occupancy toll (HOT) lanes, new HOT lanes, priced dynamic shoulder lane (PDSL), and auxiliary lanes	The cost of these projects are included in the BCA.
Kenrick Park-and-Ride Lot Cedar Grove Park-and-Ride Lot Apple Valley Transit Station and Park-and-Ride Lot Lakeville Park-and-Ride Lot	The cost of the projects included in the BCA were based on the percentage of routes using I-35W South. For Kenrick this is 100%, Cedar Grove it is 42% (5 of 12 routes), Lakeville it is 100%, and for Apple Valley it is 66.7% (2 of 3 routes).
27 new buses, 22 in service and 5 spares	The cost was based on the number of buses (7) assigned to the I-35W South routes. This includes 5 for Kenrick (5 of 22 = 22.7%) and 2 for Apple Valley (2 of 22 x 66.7% = 6.1%).
DAS for shoulder-running buses	All costs for the project were included in the BCA.
eWorkPlace Telecommuting Program	Partial costs determined by number of eWorkPlace telecommuters using I-35W South (14 percent).
ATM signing and real-time transit and traffic informational signs	All costs of ATM and costs for real-time traffic and transit signs on I-35W South.
MARQ2 contraflow bus lanes in downtown Minneapolis	All costs for the project were included in the BCA.
“Transit Advantage” bus bypass lane/ramp at the Highway 77/Highway 62 intersection	All costs for the project were included in the BCA
Real-time transit and next bus arrival information in downtown Minneapolis and selected park-and-ride lots	All costs for the project were included in the BCA.
Reconstruction of the Crosstown Commons section	All costs for this project were included since the benefits of the project were inseparable from the benefits of the UPA projects.

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Three Minnesota UPA projects were not included in the BCA because they are on I-35W North, outside the main UPA focus corridor of I-35W South. The projects not included in the BCA are the I-35W North and 95th Avenue park-and-ride lot expansion, the new park-and-ride lot at I-35W North and County Road C, and the real-time traffic and transit information signs along I-35W North.

J.3 Minnesota UPA Projects – Costs

Data on the capital costs, the implementation costs, the operating and maintenance costs, and the replacement and re-investment costs for the projects were obtained from MnDOT and Metro Transit. To convert any future year costs to year 2009 dollars, a real discount rate of 7 percent per year was used (based on guidance from http://www.whitehouse.gov/omb/assets/a94/a094.pdf (page 9) and current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30476)).

As outlined in the *Cost Benefit Analysis Test Plan*,[1] a 10-year post-deployment timeframe was used for the BCA since many aspects of the projects were technology- or pricing-related. Both technology and pricing systems have relatively short life spans. Thus, only expenditures prior to December of 2019 incurred as a result of implementing the UPA projects were considered. In addition, only the marginal costs associated with the UPA projects and the reconstruction of the Crosstown Commons section were included in the cost data. The BCA timeframe began with the first expenses incurred and ends in 2019, after 10 years of operations. The Minnesota UPA projects with useful lives longer than 10 years, such as new park-and-ride lots or new HOT lanes, were accounted for by including their salvage value in year 10.

The U.S. DOT allocated $133.3 million for the Minnesota UPA projects. The state of Minnesota funded the eWorkPlace telecommuting program. The funding was used to plan, design, and construct the various projects. Operating and maintaining the projects over the BCA timeframe of 10 years requires additional funding. To address costs incurred in years other than 2009, those costs are adjusted to a common year using a discount rate of 7 percent. Therefore, determining the costs of the UPA projects is more difficult than simply assuming that the costs total $133 million. The following section, along with Table J-3, provides details regarding the cost estimate of the Minnesota UPA projects in 2009 dollars for the purpose of the BCA.

[1] Minnesota Urban Partnership Agreement National Evaluation: Cost Benefit Analysis Test Plan, FHWA-JPO-10-008, November 17, 2009. Available at http://www.upa.dot.gov/docs/fhwajpo10008/index.htm.

Table J-3. Minnesota UPA Project Costs included in the BCA

UPA Project Component	Planning, Design, and Construction/Purchase Costs (2009 dollars)	Operation and Maintenance Costs (years 2010 to 2019 in 2009 dollars)
HOT lanes, PDSL, and auxiliary lanes	$39,616,038	$836,600 per year for years 2010-2019 = $5,875,928
Four new or expanded park-and-ride facilities	Krenick ($12,515,367) + Lakeville ($2,263,590) + Cedar Grove (0.42x$2,521,227) + Apple Valley (0.667x$22,791,796) + MnDOT Project 2716-67 ($533,528) = $31,707,815	$40,000 per year for 10 years = $300,609
27 new buses	5 of the 22 (68%) were for Krenick and 2 were for Apple Valley (x 0.667) plus 5 were spares. Cost = 28.8% x $12,743,259 = $3,668,514	Annual figures provided by METRO, converted to 2009 dollars = $5,548,871
Lane guidance system (DAS) for shoulder-running buses[1]	$5,315,573	Annual figures provided by METRO, converted to 2009 dollars = $106,215
eWorkPlace Telecommuting Program	$3,304,355 x 14% = $462,610 Estimated 14% of travelers were on I-35W south of town.	
ATM signing and real-time traffic and transit informational signs	$22,558,642	$300,000 per year for 5 years starting in 2015 = $877,015
Double contraflow bus lanes on Marquette and 2nd Avenues (MARQ2) in downtown Minneapolis	$33,405,610	Annual figures provided by METRO, converted to 2009 dollars = $724,602
"Transit Advantage" bus bypass lane/ramp at the Highway 77/Highway 62 intersection	$714,779	$0
Real-time transit and next bus arrival information	$14,114,219	Annual figures provided by METRO, converted to 2009 dollars = $1,526,918
Crosstown Commons	$228,000,000	$632,122
TOTALS	$379,563,800	$15,592,281

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[1]There will be a small reinvestment cost ($2,400) for lane guidance equipment in the year 2015. For simplicity this has been added to the O&M costs.

In December 2019 some of the above items will still have value, which is known as salvage value. The salvage value will be subtracted from the total cost above (approximately $395,156,082) to determine the cost over the 10 year BCA timeframe. The electronic components of the DAS for shoulder-running buses, real-time transit and next bus arrival information, transit signal priority along Central Avenue, the telework program, and the real time traffic informational signs were assumed to have negligible salvage value at the end of 10 years. For the physical infrastructure (HOT lane, PDSL, P&R lots, MARQ2, and Transit Advantage Lane) Minnesota's BCA guidance was used (http://www.dot.state.mn.us/planning/program/benefitcost.html) to obtain the salvage value using the following formula:

$$\text{Salvage Value} = \frac{(1+r)^n \times \left[\left(\frac{(1+r)^L - 1}{r(1+r)^L}\right) - \left(\frac{(1+r)^n - 1}{r(1+r)^n}\right)\right]}{\left(\frac{(1+r)^L - 1}{r(1+r)^L}\right)}$$

Where r = the discount rate (0.07)

n = number of years in the analysis period (10)

L = useful life of the asset

This same guidance suggests the useful life of surface (pavement) is 25 years, sub-base and base are 40 years, and major structures have longer timeframes. Since many of these items are additional lanes or parking lots, a life span of 40 years was chosen. The salvage value is therefore:

$$\text{Salvage Value} = \frac{(1+0.07)^{10} \times \left[\left(\frac{(1+0.07)^{40} - 1}{0.07 \times (1+0.07)^{40}}\right) - \left(\frac{(1+0.07)^{10} - 1}{0.07 \times (1+0.07)^{10}}\right)\right]}{\left(\frac{(1+0.07)^{40} - 1}{0.07 \times (1+0.07)^{40}}\right)} = \frac{1.97 \times (13.33 - 7.02)}{13.33} = 0.931 = 93.1\%$$

$$\text{Salvage Value} = 93.1\% \times (\$39,616,038 + \$31,707,815 + \$33,405,610 + \$714,779 + \$228,000,000) =$$
$$93.1\% \times \$333,444,242 = \$310,367,064$$

The one remaining item is the salvage value of the 27 new buses after 10 years of service. Assuming that the buses have a useful life of 12 years then the salvage value equals: $3,668,514 x 22.8% = $835,075.

Therefore, the resulting 10-year costs from the Minnesota UPA projects were $395,156,082-$310,367,064 - $835,075= $83,953,942.

J.4 Minnesota UPA Projects – Benefits

The benefits of the Minnesota UPA projects are similar to benefits from many transportation infrastructure projects and the calculation methodology will follow standard practice (http://bca.transportationeconomics.org/). This section highlights how the benefits were calculated for the UPA projects.

The preferred option to estimate the impacts, and therefore benefits, of the UPA projects was to use the Metropolitan Council's urban planning model. Unfortunately, the output from the model for the year 2010 for I-35W South was considerably different than results recorded in the field based on data from Minnesota's extensive loop detector system. For example, the model output showed considerable congestion during the morning and evening peak period where actual data showed only minor congestion. Travel speeds in the model were between 10 mph to 30 mph slower than actual speeds (depending on direction, segment of I-35W and time of day). Thus, the model could not be expected to accurately capture the change in travel conditions caused by the UPA projects. Additionally, the amount of modifications and calibrations that would have been required to adjust model outputs to real world results would have yielded a model that was so altered that it could no longer be expected to properly estimate the impacts of the UPA projects.

Using actual data to estimate the impact of the UPA projects has one main advantage – it is the true data but has several disadvantages. The main disadvantages are (1) the impact of exogenous factors, for example the price of gas impacting travel or the new cross town connector, cannot be properly excluded and (2) actual data is good only for the year it was collected and impacts in future years must be estimated. The exogenous factors are presented in Appendix K. The BCA analysis did not attempt to consider how these factors might influence results. For example, improvements to other highways or changes in gas prices may both have had a significant influence on travel behavior. However, this analysis assumes changes in traffic from before the UPA projects were built to after they were implemented, was due to the UPA projects and not the exogenous factors. An assumption was made that the impacts observed in the first year post-deployment will remain constant over the 10-year timeframe. In theory, using year one changes would represent a conservative estimate of benefits since many key benefits of the UPA projects would increase over time given the expected continued increase in regional traffic volumes and health care costs (which will equate to greater benefits associated with emissions reductions).

Finally, since the reconstruction of the Crosstown Commons section occurred at the same time as the UPA projects, it was impossible to separate the impacts (benefits) of the UPA projects from the Crosstown Commons section reconstruction. Therefore, the benefits outlined below are likely due to the UPA projects and the Crosstown Commons section reconstruction. As a results, the costs of both the UPA projects and the Crosstown Commons section were included in the previous Section J.3.

J.4.1 Benefits – Travel Time Savings

For most transportation projects the largest societal benefits are a result of the travel time savings gained through reduced congestion. The amount of time saved by travelers was converted to monetary benefits based on FHWA guidance (Table 4 in http://ostpxweb.dot.gov/policy/reports/vot_guidance_092811c.pdf). The value of time for the year 2009 was $12.50 based on local travel, weighted by the average of both business and other travel. This value is adjusted for future values of time by increasing it by 1.6 percent per year (prior to applying the discount rate) as outlined in the FHWA document http://ostpxweb.dot.gov/policy/reports/vot_guidance_092811c.pdf.

As discussed in the cost section of this report, the travel times for I-35W South from the traffic data analysis in Appendix A and the travel times for transit riders from the transit data analysis in Appendix D were used in this analysis.

J.4.1.1 Travel Time Savings Benefits for I-35W South

Travel time data for travelers on I-35W South was obtained from MnDOT's extensive system of loop detectors and analyzed as part of the traffic data analysis presented in Appendix A – Congestion Analysis. These detectors provided a reliable source of data to determine travel speeds pre- and post-deployment of the UPA projects. As presented in Appendix A, the pre-deployment data used in the congestion analysis covered the period from October 2008 to April of 2009 and the post-deployment data covered the period from December 2010 to October 2011. The loop detector data was obtained from the following three sections of I-35W South for the congestion analysis.

- From Burnsville Parkway to north of I-494 where the existing HOV lanes were expanded to HOT lanes. This section is referred to as the "HOT" section in the following tables.
- From 76th Street to 42nd Street through the Crosstown Commons section, where a new HOT lane and a new general-purpose freeway lane was added in each directions of travel. This section is referred to as the "XTOWN" in the following tables.
- From 42nd Street to 26th Street, where the new PDSL is located. This section is referred to as the "PDSL" section in the following tables.

Average travel times for these sections of I-35W South are shown in Table J-4. Only peak periods travel times were included in the analysis. The UPA projects were expected to have minimal to no impact on travel times in off peak periods as those travel times were already free-flow.

Table J-4. Travel Time Savings on I-35W South in Minutes

Direction	Lane	Section	Time of Day (half hour ending time)									
			06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00		
NB	GPL	HOT	0.7	0.87	2.515	4.465	3.2	1.995	1.12	1.06		
NB	GPL	XTOWN	1.155	2.17	3.065	4.98	4.735	5.13	3.695	2.57		
NB	GPL	PDSL	-0.135	-0.205	-0.435	-1.76	-1.36	-0.93	-0.395	-0.2		
NB	HL	HOT	0.08	0.3	0.33	0.38	0.485	0.41	0.76	0.625		
NB	HL	XTOWN	0.715	1.88	2.89	6.44	6.115	5.835	4.13	2.9		
NB	SL	PDSL	-0.44	-0.375	-0.56	-0.83	-0.69	-0.38	-0.16	-0.04		
			14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00
SB	GPL	PDSL	1.34	1.6	2.61	2.355	2.71	2.715	2.43	2.175	1.605	1.07
SB	GPL	XTOWN	1.55	1.81	2.015	2.405	2.73	2.495	2.52	2.85	2.715	1.835
SB	GPL	HOT	0.08	0.08	0.155	0.69	2.535	4.58	5.035	3.195	0.09	0.92
SB	HL	XTOWN	1.72	1.88	1.995	2.38	2.555	2.38	2.38	2.61	2.33	1.555
SB	HL	HOT	0.21	0.12	0.2	0.35	0.2	1.685	1.095	3.87	2.145	1.455

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Note: Negative values indicate an increase in travel time after the UPA projects.

The next step in the BCA is to determine the number of vehicles that obtained these travel time savings. Existing (before UPA projects) travelers will receive the travel time savings shown above in Table J-4. Those vehicle volumes (which include both passenger cars and heavy vehicles) are shown in Table J-5. The volumes are also obtained from MnDOT loop detectors as part of the traffic analysis for this project.

Table J-5. Pre-UPA Traffic Volumes on I-35W South

Direction	Lane	Section	Time of Day (half hour ending time)									
			06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00		
NB	GPL	HOT	1430	1733	1747	1712	1633	1464	1061	994		
NB	GPL	XTOWN	1398	1899	1847	1738	1674	1647	1637	1628		
NB	GPL	PDSL	1773	2774	3081	3333	3224	3098	2662	2483		
NB	HL	HOT	190	270	371	317	272	292	512	455		
NB	HL	XTOWN	0	0	0	0	0	0	0	0		
NB	SL	PDSL	0	0	0	0	0	0	0	0		
			14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00
SB	GPL	PDSL	2615	2719	2760	2738	2743	2791	2835	2774	2639	2401
SB	GPL	XTOWN	1675	1706	1760	1778	1765	1750	1744	1665	1588	1511
SB	GPL	HOT	1000	1093	1445	1527	1419	1217	1162	1152	984	873
SB	HL	XTOWN	0	0	0	0	0	0	0	0	0	0
SB	HL	HOT	472	564	314	331	369	421	450	410	600	471

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New vehicles (induced demand due to improved traffic flow) would not necessarily gain the entire time shown in Table J-4 based on their previous travel. To induce these new travelers, this route may save them anywhere from almost no time up to almost the full time savings shown in Table J-4. It is generally assumed that a reasonable estimate is that half the time shown in Table J-4 is saved by additional vehicles to the roadway. The additional vehicles on I-35W South is shown in Table J-6.

Table J-6. Additional Vehicle Volumes on I-35W South After the UPA Projects were Implemented

Direction	Lane	Section	Time of Day (half hour ending time)									
			06:30	07:00	07:30	08:00	08:30	09:00	09:30	10:00		
NB	GPL	HOT	187	239	210	243	224	290	524	506		
NB	GPL	XTOWN	600	1033	1266	1243	996	978	768	770		
NB	GPL	PDSL	175	334	427	186	172	198	156	245		
NB	HL	HOT	5	108	163	192	136	14	-298	-260		
NB	HL	XTOWN	83	183	302	441	379	268	153	140		
NB	SL	PDSL	48	136	292	513	478	367	152	94		
			14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00
SB	GPL	PDSL	1342	1455	1687	1979	2200	2275	2237	2025	1594	1224
SB	GPL	XTOWN	1986	2182	2308	2529	2514	2535	2442	2280	2000	1562
SB	GPL	HOT	977	1103	869	895	995	1121	1131	1069	1085	874
SB	HL	XTOWN	118	131	164	213	283	355	337	278	173	109
SB	HL	HOT	-190	-244	64	169	255	325	304	234	-176	-174

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Note: Negative values indicate fewer vehicles in the after period.

Finally, the total vehicle hours of travel time savings was obtained using the method described above:

> Travel Time Saved = (Before Volumes J.5) x (Travel Time Savings J.4) + (Volume Change J.6) x (0.5 x Travel Time Savings J.4)

Total time savings for all time periods shown in Table J-4 to J-6 amounted to 1,255 vehicle-hours in the morning and 2,987 vehicle hours in the afternoon. This figure was multiplied by the number of days per year with congestion (Monday through Friday minus holidays, approximately 254 per year) resulting in 1,077,324 vehicle-hours per year saved on I-35W South.

These 1,077,324 vehicle-hours were then split into trucks (heavy vehicles) and automobiles. According to MnDOT, during the peak periods trucks represent 8.1 percent of traffic on I-35W South. Therefore, there were 87,263 truck-hours of delay and 990,061 automobile-hours of delay. The automobile delay was then adjusted to person-hours based on an average vehicle occupancy (AVO) on I-35W of 1.1 during the peak periods. This figure was provided by MnDOT. The resulting total savings of 1,089,067 person-hours of delay was for automobiles. These savings were assumed to continue from 2010 to 2019. The saved travel times were then multiplied by the value of time for trucks ($24.70/hour) and automobile travelers ($12.50/hour) (adjusted to 2009 values), resulting in a total benefit of $139,474,650 (in 2009 dollars).

J.4.1.2 Travel Time Savings of Transit Riders

The methodology to calculate the value of travel time savings obtained by transit riders is similar to that of automobile travelers as described in Section J.4.1.1. Additionally, the value of their time is identical to what was outlined in Section J.4.1.1. In this case the number of transit riders before and after the UPA projects, along with their travel time savings, was obtained from the transit analysis in Appendix C – Transit Analysis.

As noted in the transit analysis in Appendix C, there was almost no change in the number of riders from 2009 to 2011 on I-35W South. The morning peak period increased from 4,814 riders per day to 4,859 riders per day. The afternoon peak increased from 4,592 riders per day to 4,602 riders per day. For existing (2009) riders, it was assumed they received the full travel time savings presented in Appendix C, which are 4 minutes and 26 seconds in the morning peak period and 1 minute and 15 seconds in the afternoon peak period. For new riders, it was assumed riders average half of those travel-time savings. This amounts to 21,441 rider minutes in the morning peak period and 5,746 rider minutes in the afternoon peak period. Multiplying by 254 days per year results in a total travel-time savings for transit riders of 115,095 rider hours per year on I-35W South.

Transit riders also saved considerable travel time in downtown Minneapolis from the MARQ2 lanes. Data from Metro Transit on travel-time savings are presented in Table J-7. Combining all of the travel-time savings results in a total of 71,203 person minutes per day from the MARQ2 lanes. Assuming 254 work days per year where these travel-time savings occur results in a total of 301,426 person-hours per year of travel time savings. Combining both the I-35W South and the MARQ2 lanes travel-time savings for transit riders results in a savings of 416,521 passenger-hours per year. Assuming:

- The amount of travel time savings remains constant at 416,521 passenger-hours per year from 2010 to 2019;
- The inflation rate for the value of time is 1.6 percent;
- The discount rate for BCA is 7 percent; and
- The in-vehicle value of time for a transit rider is $12.50/hour (in 2009 dollars).

The resulting benefits from travel-time savings for transit riders is $45,332,821 in 2009 dollars.

Table J-7. Travel Time Savings for Transit Riders from the MARQ2 Lanes

Location	Time of Day	Travel Time (minutes)		Ridership		Travel Time Savings (min/day)	
		Before UPA (March 2008)	With UPA (Feb 2011)	Before UPA (March 2008)	With UPA (Feb 2011)	Existing Riders	New Riders
Marquette Avenue	AM Peak	8.0	6.1	6,380	8,294	12,182	1,827
	PM Peak	10.7	7.3	3,487	6,169	12,023	4,624
Second Avenue	AM Peak	7.7	4.4	5,195	6,132	16,928	1,527
	PM Peak	8.1	5.1	7,160	7,896	21,013	1,080

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J.4.2 Benefits – Safety

Crash data for I-35W South was obtained from Appendix F – Safety Analysis. Any changes in crashes on I-35W South were monetized based on the values shown in Table J-8. Table J-9 presents the pre- and post-deployment crash data for I-35W South from Appendix F – Safety

Analysis. The analysis assumes that any changes in the number of crashes were attributed to the UPA projects. These values were adjusted for future years using an inflation rate of 0.877 percent (http://ostpxweb.dot.gov/policy/reports/vsl_guidance_072911.pdf page 2, based on 1.6 percent inflation rate raised to the power of .55 income elasticity) and a discount rate of 7 percent. Due to the small sample size of crashes in some categories (such as 0 fatal crashes and 2 incapacitating injury crashes), the number of crashes were combined into two categories: (1) no injury crashes and (2) possible/definite injury/fatality. To determine the monetary cost of a possible/definite injury/fatality crash a weighted average cost was developed using the following formulas (see Appendix F for the number of crashes in each category):

> Weighted Cost of a possible/definite injury/fatality crash = (Fatal Crashes (0) x $6,339,701 + Incapacitating Crashes (2) x $4,778,463 + Non-Incapacitating Crashes (40) x $741,925 + Possible Injury Crashes (153) x $307,037) / (0+2+40+153) = $442,106.

Table J-8. Unit Costs for Police-Reported Injury Scale (KABCO) (2008 $)

Police-Reported Injury		Economic Cost		Comprehensive Cost*	
		Crashworthiness	Crash Avoidance	Crashworthiness	Crash Avoidance
O	No Injury	$68,185	$74,129	$198,819	$204,764
C	Possible Injury	$109,001	$115,088	$300,950	$307,037
B	Non Incapacitating	$263,973	$273,270	$732,628	$741,925
A	Incapacitating	$1,663,924	$1,701,826	$4,740,561	$4,778,463
K	Killed	$1,248,086	$1,272,912	$6,314,875	$6,339,701
U	Injury Severity Unknown	$100,776	$102,832	$291,925	$293,982

KABCO, 2008

*Based on $6.0 million value of a statistical life (http://ostpxweb.dot.gov/policy/reports/vsl_guidance_072911.pdf)

Table J-9. I-35W South DPS Crash Data

Accident Severity	Time Period		Percent change in crashes (from before to after time periods) accounting for VMT change
	Pre-Deployment Period (Nov 2008 – April 2009)	Post-Deployment Period (Nov 2010-Apr 2011)	
Fatal plus Injury[1]	90	105	-9.4 (12.1)[2]
Property Damage Only	338	322	**-25.6*** (5.5)[2]
Monthly average VMT	418,768	534,722	
6-month average VMT (exposure in VMT for 6 months)	2,512,608	3,208,332	

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[1]Combines fatal, incapacitating injury, non-incapacitating injury, and possible injury.

[2]Standard errors are given in parentheses.

*Statistically significant results at 95 percent are presented in bold.

The 9.4 percent reduction in possible/definite injury/fatality crashes represents a decrease of 16.92 of these types of crashes per year. The 25.6 percent decrease in property damage only crashes represents a decrease of 173.06 of these types of crashes per year. Assuming that the number and severity of the crashes does not change from 2010 to 2019, the change in crash rates is due to the UPA projects, and the cost of crashes as outlined in Table J-8, the total benefit of the reduced crashes was $317,582,808 in 2009 dollars.

J.4.3 Benefits – Fuel

A reduction in congestion has the potential to change the vehicle operating cost of passenger vehicles and trucks. These operating costs are comprised of items such as maintenance, reduced wear and tear on a vehicle, reduced fuel use, and other factors due to reduced congestion and a smoother driving cycle. The reduction in fuel use is often the largest change from a monetary perspective. For this analysis, the change in fuel use was the only vehicle operating cost calculated, since the urban planning model could not be used to calculate any other changes. Although not ideal, the amount of costs or benefits not included will be very small in comparison to travel time and safety benefits and would have had little to no impact on the BCA.

The change in fuel use was calculated as part of the environmental analysis in Appendix H. As noted in Appendix H, the change on I-35W South was estimated to be a reduction of 363.89 gallons per day. Assuming 254 days per year when this savings occurs, this yields a total reduction in fuel use of 92,428 gallons per year. This was the assumed to be the amount of fuel saved for all years from 2010 to 2019. Again, this is likely a conservative assumption since fuel savings due to the UPA projects should increase as traffic congestion increases on the highway.

The cost of fuel (minus taxes) for 2010 and 2011 was obtained from the U.S. Energy Information Administration and is for all grades of gasoline for an entire year for Minnesota (http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_smn_a.htm). Taxes of 18.4 cents (federal) and 27.1 cents (State of Minnesota on gasoline) were then removed from the final amount shown in Table J-10. The estimated cost of fuel (minus taxes) for future years was obtained from Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks (Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, National Highway Transportation Safety Administration, March 2009 (http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf).

Table J-10 also presents actual and estimated future year gas prices based on the CAFE document. Multiplying the amount of fuel saved per year (92,428 gallons) by the cost of the fuel (in 2009 dollars as shown in Table J-10) resulted in a total benefit of $2,866,642.

Table J-10. Gasoline Prices

Year	Actual Gasoline Price Excluding Taxes	Actual Gasoline Price Excluding Taxes Adjusted to 2009 $/gallon
2010	2.330 (2010 $/gallon)	2.493
2011	3.095 (2011 $/gallon)	3.543
Year	**Forecast Gasoline Price Excluding Taxes in 2007 $/gallon**	**Forecast Gasoline Price Excluding Taxes Adjusted to 2009 $/gallon**
2012	2.558	2.929
2013	2.611	2.989
2014	2.668	3.055
2015	2.688	3.077
2016	2.736	3.132
2017	2.801	3.207
2018	2.846	3.258
2019	2.909	3.331

Battelle

J.4.4 Benefits – Emissions

A reduction in congestion has the potential to change the amount of emissions from vehicles. These emissions are harmful to humans and the environment and as such, a reduction or increase in emissions results in a societal benefit or cost. The volume of emissions reduced from the Minnesota UPA projects was calculated in Appendix H and summarized in Table J-11. Note that these values were calculated only for I-35W south of town.

Table J-11. Volume of Reduced Emissions

Pollutant	Reduction in Emissions (pounds per day)	Reduction in Emissions (tons per year)
VOC	7.98	1.0
NO_X	22.29	2.8
CO	228.71	29.0
CO_2	7320.95	845.2

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The current year value of the societal benefit from reduced pollution was derived from the U.S. Environmental Protection Agency estimates of the value of health and welfare-related damages (incurred or avoided) and are recommended for use in current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30479). The values are found in the report Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks (Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, National Highway Transportation Safety Administration, March 2009 (http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf, Table VIII-5, page VIII-60 and are shown in Table J-12.

Future year values are taken from the Highway Economic Requirements System documentation (Highway Economic Requirements System, Federal Highway Administration http://www.fhwa.dot.gov/infrastructure/asstmgmt/hersdoc.cfm) and are also shown in Table J-12. Note that neither of these references provides a value per ton of CO and therefore CO will not be included in this calculation. These values were interpolated (assuming a linear change in values per year) to obtain the monetary benefit of the three pollutants in each year from 2010 to 2019. Multiplying these values by the amount of pollution reduced (Table J-11), then adjusting the 2007 dollars to 2009 dollars using a discount rate of 7 percent, results in a total benefit of $154,110 from NO_x, $228,864 from CO_2 and $15,606 from VOC. Combining these, results in a total environmental benefit of $398,580.

Table J-12. Values of Reduced Emissions (in 2007 $)

Pollutant	Cost in 2009	Cost in 2015	Cost in 2020
CO			
VOC	$1,700 per ton	$1,200 per ton	$1,300 per ton
CO_2	$21 per metric ton	$24 per metric ton	$26 per metric ton
NO_X	$4,000 per ton	$4,900 per ton	$5,300 per ton

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J.5 I-35W South and MARQ2 BCA Calculation

The total planning, construction, operation, and maintenance cost (in 2009 dollars) for the I-35W and MARQ2 UPA projects, along with the Crosstown Commons section reconstruction, was $395,156,082. Components of the UPA projects will have salvage value at the end of the 10-year BCA timeframe and this salvage value is subtracted from the total cost. The calculation method is identical to that shown in Section J-3. For the physical infrastructure the salvage value was found to be:

$$\text{Salvage Value} = 93.1\% \times (\$39,616,038 + \$31,707,815 + \$33,405,610 + \$714,779 + \$228,000,000) =$$
$$93.1\% \times \$333,444,242 = \$310,367,064$$

For the buses, the salvage value was found to be:

$$\text{Salvage Value} = 22.8\% \times \$3,668,514 = \$835,075$$

Therefore, the resulting 10-year costs from the Minnesota UPA projects, along with the Crosstown Commons section reconstruction, were $395,156,082- $310,367,064 - $835,075= $83,953,942. The benefits are identified in previous sections for I-35W South and the MARQ2 lanes include:

- Travel time savings: $139,474,650 + $45,332,821 = $184,807,471
- Reduced auto fuel use: $2,866,642
- Reduced emissions: $398,580
- Reduced crashes: $317,582,808
- TOTAL: $505,655,501

The benefit-to-cost ratio for the Minnesota UPA I-35W South and MARQ2 projects, along with the Crosstown Commons section reconstruction, was 6.0 ($505,655,501 / $83,953,942).

J.6 Summary of BCA

This BCA examined the net societal costs and benefits of the Minnesota UPA projects and the Crosstown Commons section reconstruction. As presented in Table J-13, the result was a benefit-to-cost ratio of 6.0 and a net benefit of $421,701,558. The analysis had several limitations and required numerous assumptions. None of these would change the overall conclusion of a benefit to cost ratio above 1.0, although the exact value of that ratio could change.

For example, the reduction in crashes by VMT on I-35W South represent a major benefit in the BCA. The estimated BCA would be lower if the crash reduction by VMT had not occurred. Crash data over a longer period of time is needed to fully assess possible changes in crashes by VMT, which would influence the BCA. In addition, vehicle operating costs included only reduced fuel consumption for automobile travel. Data on possible reduction in fuel used by buses was not available. The future year costs and benefits represent the best estimates available, but they are only estimates, and the actual costs and benefits may vary. Possible costs and benefits associated with Highway 77 were also not included in the BCA due to lack of data.

Table J-13. Question for the BCA

Hypotheses/Questions	Result	Evidence
What are the overall benefits, costs, and net benefits from the Minnesota UPA projects?	Positive	Benefits: $505,601,501 Costs: $83,953,942 Net Benefits: $421,701,558 Benefit-to-cost ratio of 6.0 The costs and benefits of the Crosstown Commons section reconstruction are included in these figures.

Battelle

Appendix K. Exogenous Factors

The effectiveness of the UPA strategies may have been affected by influences external to the projects themselves. To account for these factors, the national evaluation team monitored exogenous factors throughout the pre- and post-deployment periods. Information on unemployment rates, gasoline prices, downtown Minneapolis parking rates, parking spaces and rates at the University of Minnesota, roadway construction, and non-typical weather conditions, and major special events were examined. The shutdown of the Minnesota state government in July 2011 was also documented. Information in this appendix provided a resource for use in the other analysis areas.

This appendix is divided into five sections. Unemployment rates in the Minneapolis-St. Paul metropolitan area and the state, which reached record highs during 2009 and 2010, before declining in 2011 are described in Section K.1. Gasoline prices, which increased over the course of deploying the UPA projects, are discussed in Section K.2. Information on parking rates, which increased slightly in downtown Minneapolis and remained constant at the University of Minnesota, is presented in Section K.3. Major roadway construction, weather, and special events are described in Section K.4. Included is roadway construction in the I-35W South corridor, which was completed in November 2010. Also noted is the heavy snowfall that was experienced in the metropolitan area in the winter of 2010-2011. The shutdown of the Minnesota state government for 20 days from July 1 to July 21, 2011, due to the inability of the state legislature and the governor to agree on a state budget for the next biennium, is discussed in Section K.5.

K.1 Unemployment Rates

Unemployment rates were monitored throughout the pre- and post-deployment as the change in the number of people traveling to and from work influences traffic levels and bus ridership. Fewer people working also mean fewer potential telecommuters. The recession began as most of the Minnesota UPA projects became operational. Information on unemployment rates was used to help examine the potential effects of the economic downturn on the UPA projects in the different analyses.

The Minnesota Department of Employment and Economic Development (DEED) tracks unemployment rates at the state, metropolitan, and county levels. The information is posted on the DEED website. For the Minnesota UPA National Evaluation, the seasonally-adjusted state unemployment rate and the not-seasonally-adjusted unemployment rate for the state and the Minneapolis-St. Paul-Bloomington Metropolitan Statistical Area (MSA) were monitored. The not-seasonally-adjusted unemployment rate was used for the MSA, as it is the only available data from the DEED at the MSA level. Data from 2000 to December 2011 was recorded and analyzed.

Table K-1 presents the annual average state seasonally-adjusted unemployment rates for 2000 through 2011 from the DEED. Table K-2 contains the monthly state seasonally-adjusted unemployment rate for January 2008 through December 2011. Data for every other month is presented to make the table manageable. As shown in Table K-1, the annual seasonally-adjusted rate increased from 3.1 percent in 2000 to 8.1 percent in 2009, and declined to 7.3 percent in 2010 and to 6.4 percent in 2011. The monthly seasonally-adjusted unemployment rate increased from 4.8 percent in January 2008 to 8.3 percent in June 2009 and then declined to 6.8 percent in January 2011 and to 5.7 percent in December 2011.

Table K-1. Minnesota Annual Average Unemployment Rate, Seasonally-Adjusted

Year	Percentage
2011 Annual Ave.	6.4
2010 Annual Avg.	7.3
2009 Annual Avg.	8.1
2008 Annual Avg.	5.4
2007 Annual Avg.	4.6
2006 Annual Avg.	4.1
2005 Annual Avg.	4.2
2004 Annual Avg.	4.6
2003 Annual Avg.	4.9
2002 Annual Avg.	4.6
2001 Annual Avg.	3.9
2000 Annual Avg.	3.1

Minnesota Department of Employment and Economic Development.

Table K-2. Minnesota Monthly Unemployment Rate Seasonally-Adjusted

Month/Year	Percentage
December 2011	5.7
November 2011	5.9
September 2011	6.3
July 2011	6.6
May 2011	6.6
March 2011	6.6
January 2011	6.8
November 2010	7.1
September 2010	7.2
July 2010	7.2
May 2010	7.4
March 2010	7.6
January 2010	7.3
November 2009	7.7
July 2009	8.2
June 2009	8.3
May 2009	8.1
March 2009	8.2
January 2009	7.5
November 2008	6.1
September 2008	5.4
July 2008	5.4
May 2008	5.3
March 2008	5.1
January 2008	4.8

Minnesota Department of Employment and Economic Development.

Table K-3 presents the not-seasonally-adjusted annual average unemployment rate for the Minneapolis-St. Paul-Bloomington MSA from 2000 to 2011. Table K-4 highlights the monthly not-seasonally-adjusted unemployment rate for the Minneapolis-St. Paul-Bloomington MSA for January 2008 through December 2011. The not-seasonally-adjusted annual average unemployment rate increased from 2.7 percent in 2000 to 7.9 percent in 2009, before declining to 7.2 percent in 2010 and to 6.4 percent in 2011. The monthly not-seasonally-adjusted unemployment rate for the MSA increased from 4.9 percent in January 2008 to a high of 8.5 percent in June 2009. The rate declined to 6.4 percent in May 2010, increased to 7.4 percent in January 2011, and declined to 5.5 percent in December 2011.

Table K-3. Minneapolis-St. Paul-Bloomington MSA Annual Average Unemployment Rate, Not-Seasonally-Adjusted

Year	Percentage
2011 Annual Avg.	6.4
2010 Annual Avg.	7.2
2009 Annual Avg.	7.9
2008 Annual Avg.	5.1
2007 Annual Avg.	4.3
2006 Annual Avg.	3.8
2005 Annual Avg.	3.9
2004 Annual Avg.	4.4
2003 Annual Avg.	4.7
2002 Annual Avg.	4.4
2001 Annual Avg.	3.5
2000 Annual Avg.	2.7

Minnesota Department of Employment and Economic Development.

Table K-4. Minneapolis-St. Paul-Bloomington MSA Monthly Unemployment Rate, Not-Seasonally-Adjusted

Month/Year	Percentage
December 2011	5.5
November 2011	5.2
September 2011	6.0
July 2011	7.4
May 2011	6.3
March 2011	6.8
January 2011	7.0
November 2010	6.6
September 2010	6.9
July 2010	7.1
May 2010	6.4
March 2010	7.8
January 2010	7.7
November 2009	7.0
September 2009	7.4
July 2009	7.9
June 2009	8.5
May 2009	7.9
March 2009	8.4
January 2009	7.7
November 2008	5.6
September 2008	5.4
July 2008	5.2
May 2008	4.7
March 2008	4.9
January 2008	4.9

Minnesota Department of Employment and Economic Development.

K.2 Gasoline Prices

Gasoline prices were monitored by the national evaluation team as changes in price may influence the demand for travel, which in turn influences vehicles miles of travel (VMT) and total trips. Increases in gasoline may also influence commuters who typically drive alone to take transit or to telecommute.

The U.S. Energy Administration monitors gasoline prices by selected states, including Minnesota. Data on weekly retail gasoline prices for various grades since 2000 are available on-line on the Energy Administration website. Table K-5 presents the monthly average retail gasoline prices in the state from the Energy Administration website. Figure K-1 presents the price of a gallon of regular conventional retail gasoline in Minnesota for selected weeks from 2006 through 2012 from minnesotagasprices.com, a commercial website. Gasoline prices reached a high of $3.85 per gallon in June 2008. The major decline in gasoline prices in late 2008 reflects the decline in world crude oil prices, which dropped from a then high of $147 per barrel in July to $70 per barrel in October and to $40 per barrel in December, 2008. The price for a gallon of gasoline was $2.35 in October 2009. The price increased to $2.67 in November 2009 and ranged between $2.52 and $2.86 for December 2009 through June 2010. The price began increasing in 2011, reaching a high of $3.81 per gallon in September 2011 before declining to $3.20 in December.

Table K-5. Minnesota Weekly Regular Conventional Retail Gasoline Prices

Date	Price Per Gallon
December 5, 2011	$3.20
November 7, 2011	$3.41
October 3, 2011	$3.41
September 5, 2011	$3.81
August 1, 2011	$3.78
July 4, 2011	$3.56
June 6, 2011	$3.72
June 7, 2010	$2.63
May 3, 2010	$2.86
February 1, 2010	$2.61
January 4, 2010	$2.63
December 7, 2009	$2.52
November 2, 2009	$2.67
October 5, 2009	$2.35
September 7, 2009	$2.45
June 1, 2009	$2.28
June 2, 2008	$3.85
June 4, 2007	$3.07
June 5, 2006	$2.81
June 6, 2005	$2.01
June 7, 2004	$1.92
June 2, 2003	$1.43
June 3, 2002	$1.35
June 4, 2001	$1.77
June 5, 2000	$1.58

U.S. Energy Administration.

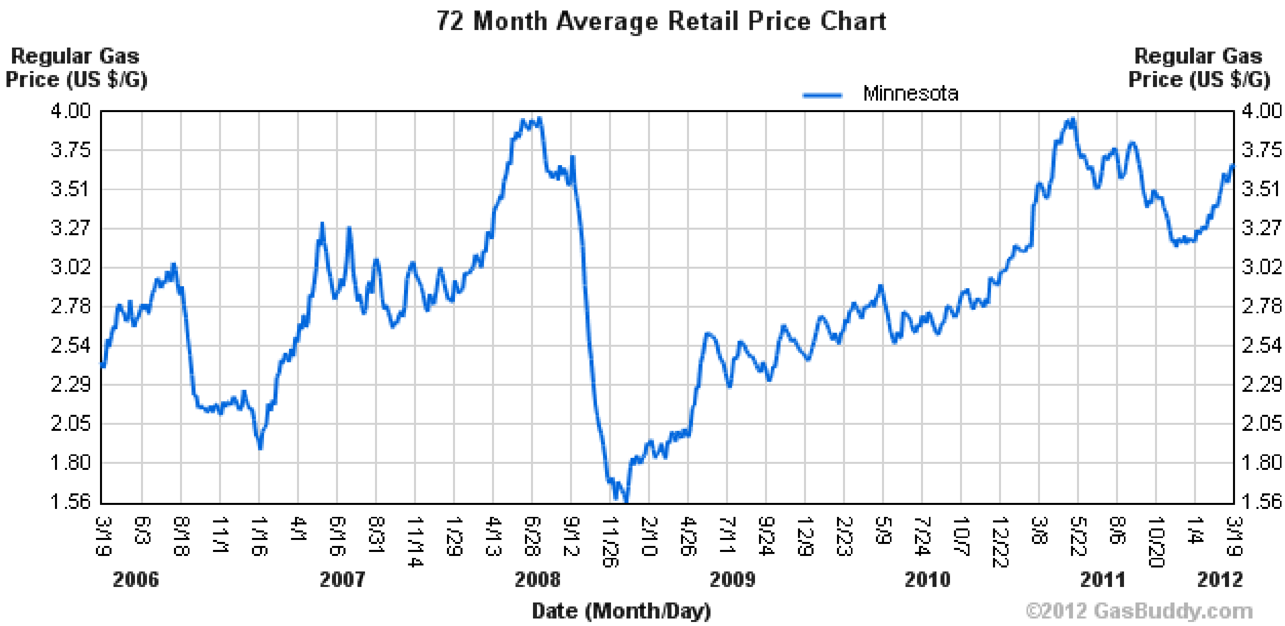


*Chart located at http://www.minnesotagasprices.com/Retail_Price_Chart.aspx.

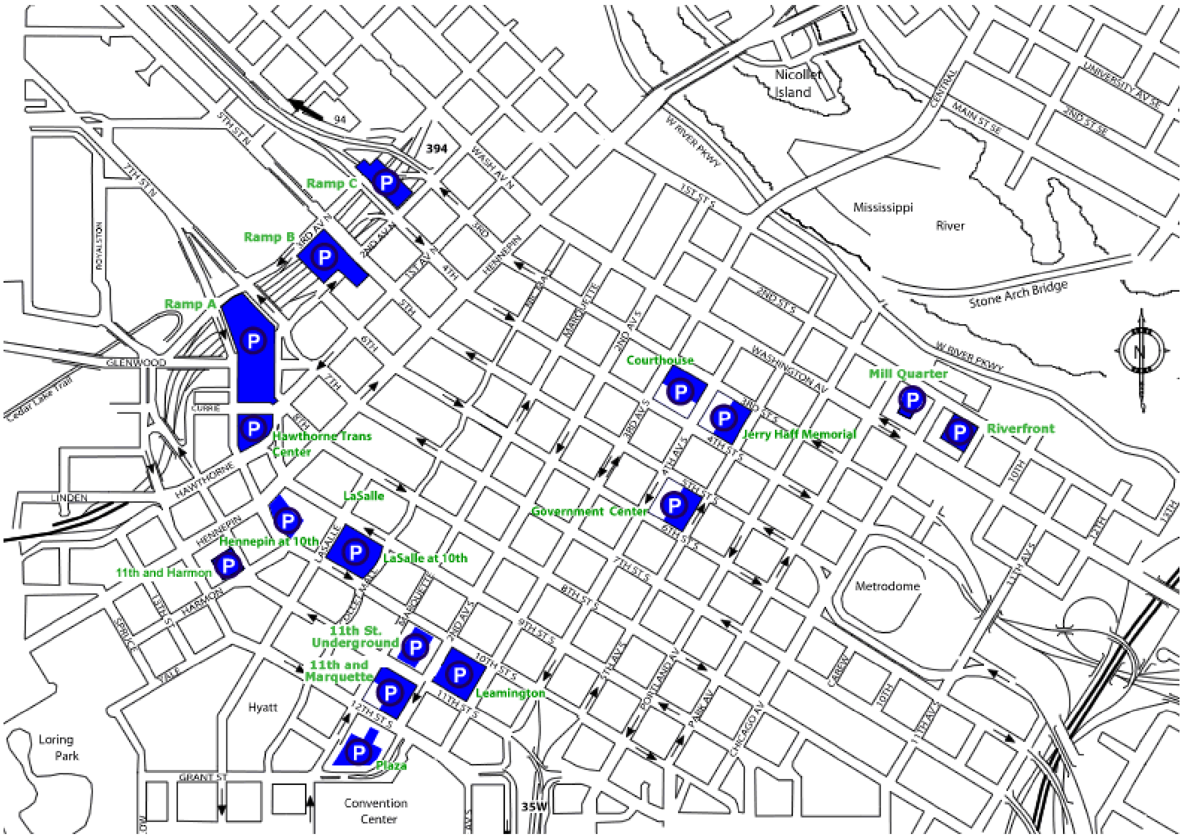
Figure K-1. Minnesota Historical Gas Price Chart – 2006 to 2012

K.3 Downtown Minneapolis and University of Minnesota Parking Availability and Prices

City of Minneapolis Downtown Parking Rates. The availability of parking spaces for commuters and the cost of parking influence mode choice. Current City of Minneapolis parking policies limit the availability of commuter parking in the downtown area to encourage use of transit and ridesharing. Discounted parking rates are also used to encourage carpooling in some corridors, including the I-394 and the I-94 corridors. Information on the City of Minneapolis Municipal Parking system is available on the city's website. Available information includes the location of downtown parking ramps (i.e., garages) and parking rates at these facilities.

The Minneapolis Municipal Parking system includes 17 parking ramps and seven surface lots in the downtown area. Figure K-2 illustrates the location of the parking ramps (i.e., garages). The parking rates at these facilities were monitored pre- and post-deployment of the UPA projects. Table K-6 presents parking rates for the municipal ramps in December 2011. Table K-7 presents the changes in rates since the summer of 2009. A few rates were increased in early 2010 and hourly rates at a few ramps were also increased in early 2011. The costs of the first hour, daily, monthly, reserved, monthly carpool, and special events are shown.

Parking rates in downtown Minneapolis did increase slightly between the pre- and post-deployment periods. The rate for the first hour increased by $0.25 at one ramp, by $0.50 at one ramp, and by $1.00 at three ramps. The daily rate increased by $0.50 at one ramp, by $1.00 at two ramps, by $2.00 at two ramps, and by $9.00 at one ramp. The monthly rate declined by $9.00-to-$10.00 at two ramps, and increased by between $3.50 and $8.00 at 12 ramps. The monthly reserved parking rate increased by $1.00 at one ramp, by $5.00 at two ramps, by $6.00 at one ramp, and by $10.00 at one ramp. A monthly carpool rate of $99.00 was implemented at three ramps. These facilities might be used by carpoolers accessing the I-35W South MnPASS lanes. The modest increases in parking rates in downtown Minneapolis probably did not have a major influence on travel behavior.



City of Minneapolis

Figure K-2. Location of Downtown Minneapolis Parking Ramps

Table K-6. Parking Rates in Downtown Minneapolis

Parking Ramp	1st Hour	Daily/Hours	Monthly	Monthly Reserved	Monthly Carpool	Events
11th & Harmon	$2.50	*$8.50/4-12 Hours*	*$175.00*	$210.00	N/A	$5.00-$10.00
11th & Marquette	$3.00	*$9.50/2½-12 Hours*	*$139.00*	*$205.00*	*$99.00*	$9.00-$12.00
A Ramp	*$3.00*	*$11.00/4-12 Hours*	*$140.00*	N/A	$20.00*	*$10.00-$15.00*
B Ramp	*$3.00*	*$11.00/4-12 Hours*	*$140.00*	N/A	$20.00*	*$10.00-$17.00*
C Ramp	*$2.50*	*$7.50/4-12 Hours*	*$123.00*	N/A	$20.00*	*$9.00-$15.00*
Courthouse	*$3.00*	$12.00/4-12 Hours	$210.00	N/A	N/A	*$5.00-$12.00*
Government Center	$3.00	$10.50/3-12 Hours	$159.50	$204.00	$99.00	*$5.00-$15.00*
Hawthorne Transportation Center	$2.75	$8.00/4-12 Hours	$130.00	N/A	N/A	$9.00-$15.00
Hennepin at 10th	$2.75	$10.50/5½-12 Hours	*$203.00*	N/A	N/A	*$7.00-$12.00*
Hilton Hotel (11th Street Underground)	$3.00	$13.00/5-24 Hours	$170.00	$225.00	N/A	*$7.00-$12.00*
Jerry Haaf Memorial	$3.00	$9.00/2½-12 Hours	$149.50	$205.00	N/A	$5.00-$20.00
LaSalle at 10th	$4.00	$15.00/6½-12 Hours	*$259.00*	N/A	N/A	N/A
Leamington	$3.00	*$9.50/2½-12 Hours*	*$160.00*	*$215.00*	*$99.00*	*$6.00-$12.00*
Mill Quarter Municipal Parking Ramp	$2.00	*$6.00/2-12 Hours*	*$85.00*	N/A	N/A	$5.00-$20.00
North Terminal	N/A	$7.50	N/A	N/A	N/A	$5.00
Plaza	*$4.00*	*$16.00/3-12 Hours*	*$190.00*	*$230.00*	N/A	*$6.00-$15.00*
Riverfront Municipal Parking Ramp	$2.00	$6.00/2-12 Hours	*$80.00*	*$150.00*	N/A	*$5.00-$20.00*
Vineland Place	$2.00	$4.00/1-12 Hours	$55.00	N/A	N/A	$4.00-$10.00

City of Minneapolis.

Rate changes since the pre-deployment phase are shown in Italics.

*Carpools traveling eastbound on I-94 or I-394 are eligible for the $20.00 carpool contract rate. The monthly parking rate for carpools traveling from outside of the I-94 or the I-394 travelsheds is $99.00.

Table K-7. Changes in Parking Rates in Downtown Minneapolis Pre- and Post-Deployment

Parking Ramp	1st Hour	Daily/Hours	Monthly	Monthly Reserved	Monthly Carpool
11th & Harmon	NC	$0.50/4-12 Hours	$3.50	NC	N/A
11th & Marquette	NC	$0.50/2½-12 Hours	$3.50	$1.00	$99.00
A Ramp	$1.00	$2.00/4-12 Hours	$5.00	N/A	NC
B Ramp	$1.00	$2.00/4-12 Hours	$5.00	N/A	NC
C Ramp	$0.25	$0.50/4-12 Hours	$3.50	N/A	NC
Courthouse	$0.50	NC	$5.00	N/A	N/A
Government Center	NC	NC	NC	NC	$99.00
Hawthorne Transportation Center	NC	NC	NC	N/A	N/A
Hennepin at 10th	NC	NC	$6.00	N/A	N/A
Hilton Hotel (11th Street Underground)	NC	$1.00/5-24 Hours	$5.00	$5.00	N/A
Jerry Haaf Memorial	NC	NC	NC	NC	N/A
LaSalle at 10th	NC	NC	($9.00)	N/A	N/A
Leamington	NC	$0.50/2½-12 Hours	$5.00	$5.00	$99.00
Mill Quarter Municipal Parking Ramp	NC	$1.00/2-12 Hours	$8.00	N/A	N/A
North Terminal	N/A	NC	N/A	N/A	N/A
Plaza	$1.00	$7.00/3-12 Hours	$10.00	$10.00	N/A
Riverfront Municipal Parking Ramp	NC	NC	$8.00	$6.00	N/A
Vineland Place	NC	NC	($10.00)	N/A	N/A

City of Minneapolis.

NC – No Change.

Rate in regular type is increased from pre-deployment to post-deployment.

Rate in parenthesis means reduction in rates.

University of Minnesota Parking Spaces and Rates. Some of the existing and the new bus routes in the I-35W corridor provide service to the University of Minnesota. The number of parking spaces available at the university and parking rates may influence the use of these bus routes. Information on parking spaces and rates is available from the University of Minnesota Parking and Transportation Services. Parking facilities at the University include those oriented toward faculty and staff, on-campus student housing, commuting students, and the public.

Information available from the University Parking and Transportation Services includes the facility name, the type of parking available (public or contract), the rate, and the number of spaces. This information was reviewed for the East Bank Campus, the West Bank Campus, and the St. Paul Campus pre- and post-deployment of the UPA projects. There are 192 separate parking facilities (some have only one or a few spaces), accounting for 19,426 total parking spaces at the university. Table K-8 highlights examples of the parking facilities on the East Bank Campus oriented toward commuting students, the target market for much of the bus service. Only one change in parking rates was recorded during the development period. The daily fee for the Maroon Lot, Lots 33 and 37, and other surface lots increased from $3.75 to $4.00 in September 2011. These small changes were unlikely to have any noticeable influence on travel behavior.

Table K-8. Examples of University of Minnesota East Bank Campus Parking Facilities

Facility Type	Type	Rate per Month	Capacity
East River Road Garage – Commuter	Contract	$127.25	75
Fourth Street Ramp – Commuter	Contract	$127.25	75
Maroon Lot	Public	$4.00 per day*	479
Minnesota Lot – Commuter	Contract	$65.50	201
C58 – Commuter	Contract	$65.50	50
Gopher Lot – C77	Contract	$65.50	103
Lot 33	Public	$4.00 per day*	237
Lot 37	Public	$4.00 per day*	690

University of Minnesota Parking and Transportation Services.

* The daily fee increased from $3.75 to $4.00 in September 2011, at the beginning of the 2011-2012 school year.

K.4 Major Road Construction and Weather

Information from the MnDOT Regional Transportation Management Center (RTMC) was used to identify major construction and the regular e-mails sent by MnDOT were used to identify construction activities on I-35W South. Information from the RTMC on major weather conditions, major special events was also examined. Table K-9 summarizes the construction and weather conditions. There were no major special events influencing peak period travel on I-35W during the pre- and post-deployment period.

The I-35W/Highway 62 Crosstown construction, which included the HOT lanes funded by the UPA, disrupted traffic in the corridor before November 2010. There were numerous lane and ramp closures as part of this project, which influenced travel patterns in the corridor and transit operating speeds and travel times. The Crosstown Commons section was completed in November 2010. Near record snowfall occurred during the winter of 2010-2011. Major snow storms occurred from November 2010 through March 2011. The winter of 2011-2012 was unseasonably mild with no major snow storms during November or December 2011.

Table K-9. Road Construction, Weather, and State Government Shutdown During the Pre- and Post-Deployment Periods

Year	Major Event Influencing I-35W
2009	• Construction on I-35W, including the Crosstown Commons section all year. • Construction by MARQ2 lanes in downtown Minneapolis completed December 2009.
2010	• Construction of the Crosstown Commons section – completed in November 2010. • Heavy snow – November (10 inches) and December (34 inches).
2011	• Heavy snow – January (17 inches), February (16 inches), and March (8 inches). • Minnesota State Government Shutdown – July 1 through July 21.

MnDOT RTMC and Various Articles in the Printed Media.

K.5 Minnesota State Government Shutdown

The Minnesota state legislature and the governor were not able to agree on a biannual budget bill during the 2011 legislative session. As a result, the Minnesota state government was shut down for 20 days from July 1 to July 21, 2011. MnDOT and other state agencies were closed during the 20-day period. Rest areas on Minnesota state highways were closed, the FIRST trucks did not operate, the MnPASS system did not operate, and the 511mn.org, traffic cameras, and other travel information systems were not in operation.

The major impact from a UPA perspective was on the MnPASS system, which was not in operation during the shutdown. Drivers were still able to access the lanes, but no tolls were collected. This loss of revenue and the ability to record vehicles using the lanes is reflected in the MnPASS data presented in Appendix B. The ATM signs on I-35W and the real-time traffic and transit signs were also not in operation during the 21-day shutdown. The shutdown did not influence Metro Transit or MVTA bus service, which continued normal operations. The shutdown would probably not have had a major impact on travel on I-35W South, as most state offices are located around the Capital north of downtown St. Paul.

Appendix L. Compilation of Hypothesis/Questions for the Minnesota UPA National Evaluation

Evaluation Analysis	Hypothesis/Question Number	Hypothesis/Question
Congestion	MNCong-1	Deployment of the UPA improvements will reduce the travel time of users in the I-35W corridor.
	MNCong-2	Deployment of the UPA improvements will improve the reliability of user trips in the I-35W corridor.
	MNCong-3	Traffic congestion on I-35W will be reduced to the extent that travelers in the corridor will experience a noticeable improvement in travel time.
	MNCong-4	Deployment of the UPA projects will not cause an increase in the extent of traffic congestion on surrounding facilities adjacent to I-35W.
	MNCong-5	Deploying the UPA improvements will result in more vehicles and persons served in the I-35W corridor during peak periods.
	MNCong-6	A majority of survey respondents will indicate a noticeable reduction in travel times after the deployment of the UPA improvements.
	MNCong-7	A majority of survey respondents will indicate a noticeable improvement in trip-time reliability after the deployment of the UPA projects.
	MNCong-8	The majority of survey respondents will indicate a noticeable reduction in the duration of congestion after deployment of the UPA projects.
	MNCong-9	A majority of survey respondents will indicate a noticeable reduction in the extent of congestion after the deployment of the UPA projects.
Tolling	MNTolling-1	Vehicle access on the HOT lanes and PDSL on I-35W will be regulated to increase vehicle throughput in the corridor.
	MNTolling-2	Some general-purpose lane travelers will shift to the I-35W HOT lanes and PDSL, while HOV lane travelers will remain in the HOT lane.
	MNTolling-3	HOV violations will be reduced.
	MNTolling-4	After ramp-up, the HOT lanes and PDSL on I-35W maintains vehicle throughput gains on the priced facility.

Evaluation Analysis	Hypothesis/Question Number	Hypothesis/Question
Transit	MNTransit-1	The HOT lanes, PDSL, MARQ2 bus lanes, Transit Advantage project, and the DAS for shoulder running buses will increase bus travel speeds, reduce bus travel times, and improve bus trip-time reliability in the I-35W South and Cedar Avenue corridors, and downtown Minneapolis
	MNTransit-2	The new park-and-ride lots and new and expanded transit services will result in ridership increases including a mode shift to transit.
	MNTransit-3	The mode shift to transit from the UPA transit strategies will reduce congestion on I-35W, downtown Minneapolis, and other roadways.
	MNTransit-4	What was the relative contribution of each of the Minnesota UPA transit strategies to mode shift to transit?
Telecommuting/ TDM	Tele/TDM-1	Use of telecommuting, ROWE, and other flexible work schedules removes trips and VMT from the I-35W corridor.
	Tele/TDM-2	Integration of telecommuting into the UPA project enhances congestion mitigation.
	Tele/TDM-3	What was the relative contribution of the telecommuting strategies to overall travel behavior changes, including secondary impacts of telecommuting
Technology	MNTech-1	Active traffic management strategies, including speed harmonization and DMS with transit and highway travel times, promoting better utilization and distribution of traffic to available capacity in the I-35W corridor.
	MNTech-2	Active traffic management strategies will reduce the number and duration of incidents that result in congestion in the I-35W corridor.
	MNTech-3	What was the relative contribution of each technology enhancement on congestion reduction on I-35W South?
Safety	MNSafety-1	Active traffic management will reduce the number of primary and/or secondary crashes.
	MNSafety-2	The HOT lanes and the PDSL on I-35W South will not adversely affect highway safety.
	MNSafety-3	The MARQ2 dual bus lanes in Downtown Minneapolis will not adversely affect safety.
	MNSafety-4	The driver assist system for shoulder running buses will not adversely affect safety.

Evaluation Analysis	Hypothesis/Question Number	Hypothesis/Question
Equity	MNEquity-1	How do the impacts from the I-35W South UPA projects affect the different user groups?
	MNEquity-2	How do the impacts from the I-35W South UPA projects differ across geographic areas?
	MNEquity-3	Are the air quality impacts from the I-35W South UPA projects different across geographic and socio-economic groups?
	MNEquity-4	How does reinvestment of revenues from the I-35W HOT lanes and PDSL impact various transportation system users?
Environmental	MNEnv-1	What are the impacts of the Minnesota UPA strategies on air quality?
	MNEnv-2	What are the impacts on perceptions of overall environmental quality?
	MNEnv-3	What are the impacts on energy consumption?
Non-Technical	MNNonTech-1	What role did factors related to “people” play in the success of the deployment? People (sponsors, champions, policy entrepreneurs, neutral conveners)
	MNNonTech-2	What role did factors related to “process” play in the success of the deployment? Process (forums, stakeholder outreach, meetings, alignment of policy ideas with favorable politics, and agreement on the nature of the problem)
	MNNonTech-3	What role did factors related to “structures” play in the success of the deployment? Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules, and procedures)
	MNNonTech-4	What role did factors related to the “media” play in the success of the deployment? Media (media coverage, public education)
	MNNonTech-5	What role did factors related to “competencies” play in the success of the deployment? Competencies (cutting across the preceding areas: persuasion, obtaining grants, conducting research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)
	MNNonTech-6	Does the public support the UPA strategies as effective and appropriate ways to reduce congestion?
Cost Benefit	MNCBA-1	What are the overall benefits, costs, and net benefits from the Minnesota UPA projects on I-35W South?

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