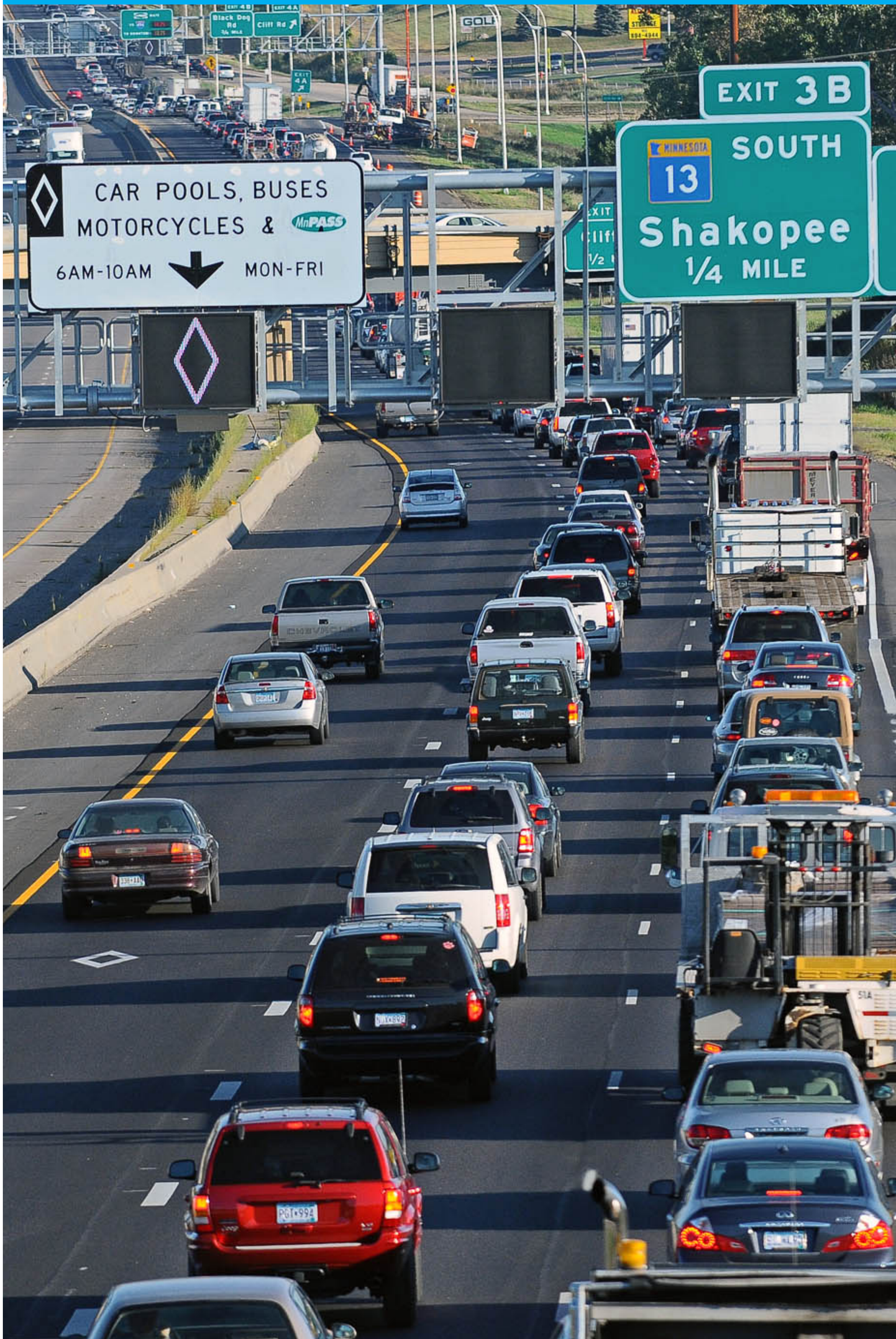
MINNESOTA DEPARTMENT OF TRANSPORTATION



MnPASS Study II

September 2010

Your Destination...Our Priority

final report

MnPASS System Study Phase 2

prepared for

Minnesota Department of Transportation

prepared by

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date

August 2010

Minnesota Department of Transportation
395 John Ireland Boulevard
Saint Paul, MN 55155

September 24, 2010

Dear Citizens of Minnesota:

I am pleased to share with you the MnPASS System Study Phase 2 Report, which provides analysis and recommendations for the next generation of MnPASS managed lane projects in the Twin Cities metropolitan region.

The study was conducted by a consultant team and a joint Mn/DOT-Metropolitan Council technical advisory committee. The committee originally identified 19 sections of road and recommended several projects that can be built early and in conjunction with other planned construction. The team also looked for roads that have strong transit services, provide direct links to downtown areas, provide regional equity and build on the existing MnPASS Express Lane system. Eight routes are recommended, ranging from highest priority projects that could move forward in two to 10 years to more long-term opportunities.

The report recognizes several policy issues that will need careful consideration and analysis as the MnPASS Express Lane system expands. These issues include establishing a regional consensus on the purpose of the MnPASS Express Lanes; ensuring equitable treatment of travelers across the region, working with the state's partners at the Federal Highway Administration to develop safe and cost-effective designs, developing strategies for financing new lanes, considering freight and how it will be affected by the MnPASS system; and ensuring continued advantages for transit.

MnPASS Express Lanes currently operate on I-394 between Wayzata and downtown Minneapolis and in two segments on I-35W, from Highway 13 in Burnsville to I-494 and from I-94 to downtown Minneapolis. MnPASS Express Lanes between I-494 and 42nd Street will open in November 2010. Additional MnPASS Express Lanes on I-35W in Burnsville will open in late 2011.

The MnPASS Express Lanes have successfully provided motorists with safe, predictable travel while providing transportation choices. We believe expanding the MnPASS system is a cost-effective strategy to manage congestion in the Twin Cities. The lanes build on existing management strategies and can provide relief to traffic problem areas throughout the system. The technology allows us to maximize efficiency by managing all elements of the system. The result is a 21st century solution that is technology-based, multi-modal and problem-focused.

Sincerely,

Thomas K. Sorel
Commissioner

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Executive Summary and Recommendations

The purpose of this study was to analyze and make recommendations for the next generation of MnPASS managed lane projects in the Twin Cities metropolitan region.

Traffic congestion is a growing problem in the Twin Cities region. The Texas Transportation Institute's 2009 Urban Mobility Report ranks the region 19th for congestion cost, which is estimated to cost the region $1.5 billion in lost time and excess fuel consumption. Despite proactive investments in transportation infrastructure, congestion is expected to trend upward as the region is forecasts to add one million additional inhabitants by 2030. Priced lane projects are one potential way to manage system congestion and generate needed revenue, along with travel demand management strategies, transit investments, and limited investments in general purpose new highway capacity.

Mn/DOT has been a leader in the innovative use of technology and road pricing to manage congestion, and in the use of bus-only shoulder lanes to provide travel time advantages for transit users. The implementation of the I-394 and I-35W MnPASS managed lanes has proven that congestion pricing is a viable and publicly acceptable congestion management strategy. The continued implementation of MnPASS-type facilities has been supported in the Metropolitan Council's (Met Council)[1] Transportation Policy Plan, Mn/DOT's Metro District Transportation System Plan, and the Metropolitan Highway System Investment Study (MHSIS),[2] jointly sponsored by the Met Council and Mn/DOT and taking place concurrently with this study. The support of MnPASS is due to its proven ability to safely provide increased trip reliability as well as user choice in a cost-effective manner.

With the only two High-Occupancy Vehicle (HOV) corridors in the region now converted to managed lanes (I-394 and I-35W), future MnPASS facilities will need to be new capacity (i.e., addition of new lanes) or use the existing shoulders (i.e., priced dynamic shoulder lanes or PDSL).

While HOVs continue to travel without charge in the existing MnPASS lanes, single occupant vehicles (SOVs) are permitted to choose to bypass congested general purpose lanes by paying tolls during peak periods. Mn/DOT provided

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[1] The Metropolitan Planning Organization (MPO) for the Twin Cities urbanized region.

[2] The MHSIS study considered a wider range of investment strategies including not only MnPASS lanes, but also some limited new general purpose capacity lanes, and other traffic management strategies.

direction to this study to assume that all users (except transit vehicles and riders) of any new MnPASS lanes would pay a toll equal to that paid by all other uses, but that carpoolers and motorcyclists would continue to be able to use the two existing HOV to managed lane conversions (I-394 and I-35W) for free. A final policy decision on this and other operational issues awaits further discussion with stakeholders, agency partners, and the public.

In 2005, Mn/DOT completed the MnPASS Phase 1 study identifying the next set of roadways to be considered for managed lanes. That study assumed that the first MnPASS lanes would be conversions of the existing HOV lanes on I-394, and perhaps later, on I-35W. Any further MnPASS lanes would have to be created from scratch as there are no other HOV lanes for conversion in the Twin Cities Metropolitan region. Whereas the MnPASS Phase 1 study assumed that any new MnPASS lanes would have to involve construction of new capacity to full highway standards, this Phase 2 study assumed a smaller envelope (i.e., corridor width) could be used to develop a MnPASS corridor. This change grew out of Mn/DOT's experience with the I-35W managed lane in which Mn/DOT used a priced dynamic shoulder lane (PDSL) to develop the additional lanes with minimal impacts and changes in the overall roadway footprint. Given this new ability to reduce impacts and costs, Mn/DOT wanted to reevaluate potential corridors to determine the best candidates for the next MnPASS facilities.

In this MnPASS Phase 2 study Mn/DOT is reassessing its priorities for short-term (2 to 10 years) MnPASS lane implementation in light of evolving Federal policies, actual experience with the two existing MnPASS lanes, and in close coordination with the MHSIS study. An important change in this MnPASS Phase 2 study is the desire to avoid the need for costly road widening and right-of-way takings – factors which contributed to the high price tag of potential projects in MnPASS Phase 1.

As in the MnPASS System Study Phase 1, this Phase 2 study assumed that new MnPASS lanes would be managed toll lanes that provide new capacity parallel to general purpose traffic lanes, in which all vehicles (except transit), are required to pay a toll. The MnPASS lanes would be dynamically priced so that free-flow uncongested operation is always maintained by increasing the price as volume in the managed lane increases.[3]

This study compares managed lanes options against each other, but not to other types of transportation investments. A broader analysis of the costs and benefits of managed lanes versus other types of investments is included in the MHSIS study. The MHSIS also included a community outreach process, which was not repeated in this MnPASS System Study Phase 2.

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3 Managed lanes of this type are also often referred to as HOT lanes or High-Occupancy Toll Lanes.

CORRIDOR ANALYSIS

This study began with 19 alternative corridors that emerged from a working session between the consultant team and a joint Mn/DOT-Met Council technical advisory committee that oversaw both this study and the MHSIS. Six alternatives were eliminated prior to detailed analysis because of engineering challenges, lack of congestion, and professional judgment (see Section 2.0 for a description of the corridor screening process and the eliminated corridors).

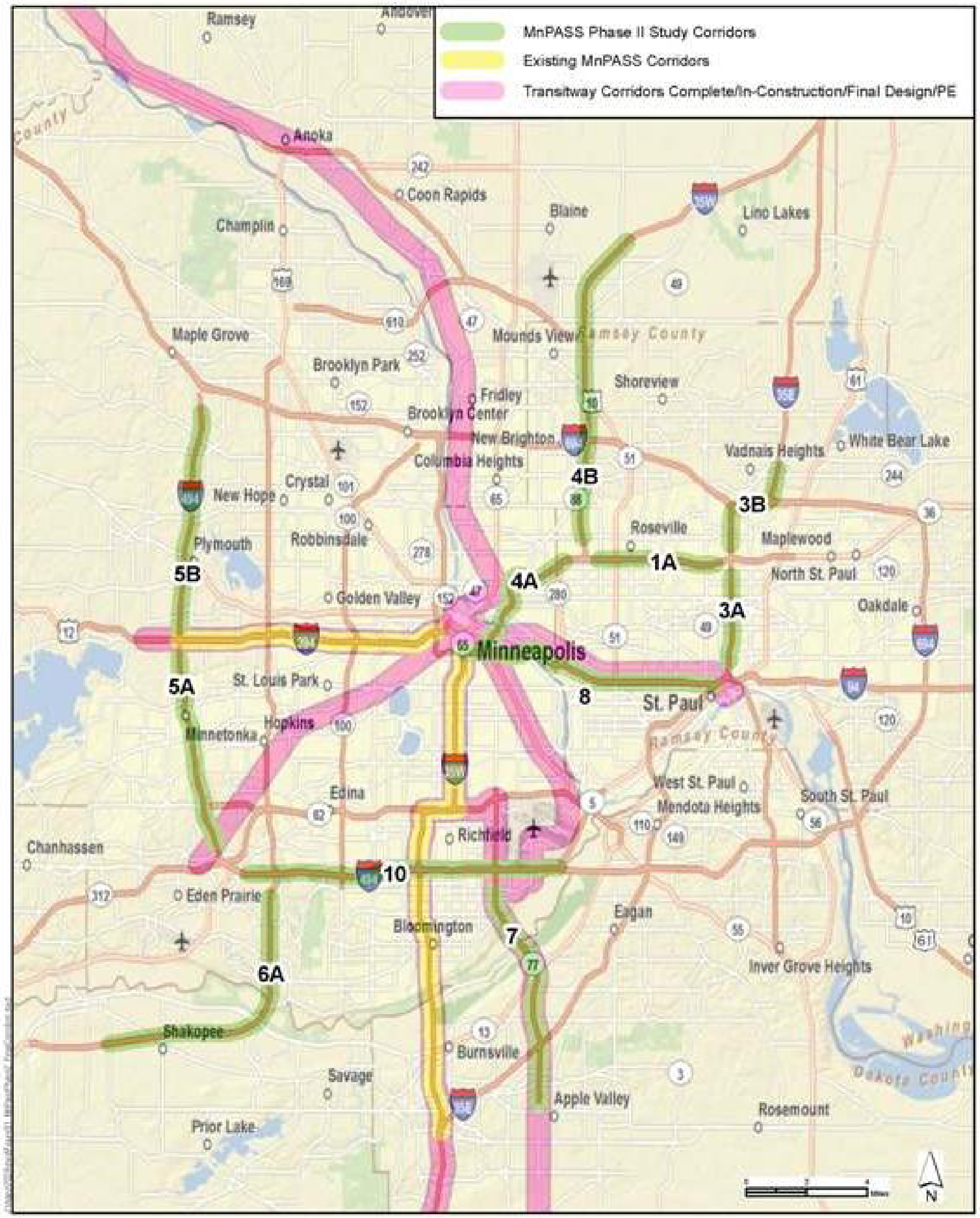
Conceptual managed lane engineering designs were developed for each remaining corridor, a range of low and high construction costs estimated, traffic and revenue forecasts developed, operating and maintenance costs estimated, performance measures analyzed, and financing and benefit/cost estimates prepared. An overview of policy, technical, and legal issues associated with the development of new managed lanes in the region was performed.

This filtering process resulted in 13 corridors proceeding through the full analysis in various combinations of individual and combined subsections. Corridor 13 (I-280) was eliminated early in the full analysis due to engineering complexity and redundancy with Alternative 4A (I-35W). It is recommended that one of the remaining fully analyzed corridors – Corridor 2 (I-94 TH 101 to I-494) be dropped from further consideration for short-term implementation due to relatively poor performance across most of the analytical metrics. For example, it is the only corridor which is forecast not to cover its own operating costs. Corridor 2 might benefit from a more detailed analysis of the potential to toll seasonal weekend recreational travel which was not captured in the broad average daily traffic analysis methodology used in this study.

Thus, 11 of the original 19 corridors were eliminated, leaving 8 corridors, which have considerable merit for further consideration to move forward in the short term (2 to 10 years) depending on available financing. Of these 8 corridors, 3 (I-35E, I-35W and I-94) were analyzed in 2 sections each.

Following is a summary of the pros and cons of the remaining eight corridors (see Figure ES.1) (the corridor designation number does not imply priority):

Figure ES.1 Corridor Location Map



Source: SRF.

- **Corridor 1A TH 36 Eastbound (I-35W to I-35E) –** This corridor has moderate benefits, but is relatively inexpensive and easy to build, and can be linked to the planned replacement of the Lexington Avenue bridge. It has strong transit service, and can be connected to Corridor 4 (I-35W see below) as part of a powerful MnPASS system serving the northern part of the metro region.
- **Corridor 3 I-35E (A: I-94 to TH 36; B: TH 36 to CR E) –** This corridor has moderate benefits, but is relatively easy to build, can be built in two subsections with independent utility, and can be linked to the planned replacement of the Cayuga Bridges. It has moderately strong transit service, and can be connected directly to downtown St. Paul. It provides regional equity by extending MnPASS to the eastern part of the metro region.
- **Corridor 4 I-35W (A: Downtown Minneapolis to TH 36; B: TH 36 to Blaine) –** This corridor has strong benefits and among the strongest transit service. It can be connected directly to downtown Minneapolis. It can be built in two subsections with independent utility and can be connected to Corridor 1A, thereby creating a strong MnPASS system serving the northern part of the Metro region. There is an active corridor stakeholder group that is advocating for improvements to this corridor. However, this corridor is expensive to build with considerable engineering risks to be resolved.
- **Corridor 5 I-494 (A: TH 212 to I-394 B:I-394 to I-94) –** This corridor has moderate benefits but is relatively inexpensive and easy to build, and it could be the first step in a larger MnPASS beltway system (see below) and could eventually connect to the I-394 MnPASS lane. It does not have strong transit service. Part A is a peak period-only PDSL operation due to lack of median width to add an inside lane.
- **Corridor 6A TH 169 (TH 101 to I-494) –** This corridor is consistently one of the highest scoring corridors. However, it is expensive and has significant risk (i.e., it could be determined that the bridge over the Minnesota River may require widening). It is a stand-alone project on the edge of the Metro region, but could become part of a larger MnPASS beltway system in the future. It currently has low levels of transit service. It is a trunk highway as opposed to an interstate.
- **Corridor 7 TH 77 Northbound (141st Street to Old Shakopee Road) –** This corridor is a strong performer and has strong transit service. Like Corridor 6A, it is a stand-alone project on the edge of the Metro region, but could become part of a larger beltway system in the future. It is a trunk highway as opposed to an interstate. This alternative is currently the subject of a separate Mn/DOT study expected to be completed later in 2010.

- **Corridor 8 (I-94 between the Downtowns) –** This corridor has been studied as both two stand-alone sections, and as a combined corridor. It is only as one combined corridor that its benefits can be optimized. It is a strong performer with strong transit service, and connections to both downtowns. It has expensive connections to the downtowns and requires a solution to the TH 280 left lane entrance and exits (i.e., this solution has a high element of risk – a complicated and potentially expensive fix). In addition, to implement MnPASS on this corridor, the temporary lane between TH 280 and I-35W must be converted to MnPASS as planned.
- **Corridor 10 I-494 (TH 212 to MSP Airport) –** This corridor is consistently among the strongest performers, even taking into account that the methodology used underestimates the likely benefits to airport travelers who place a high value on travel time reliability and have a higher than average value of time. However, this corridor is expensive and risky (particularly regarding issues such as expansion of roadway width, rail bridge replacement, and roadway hydrology), and has little transit service. It has a challenging mix of short and long trips which could complicate operations when subject to a more detailed microsimulation analysis.

Recommendations

The Mn/DOT-Met Council technical stakeholder committee developed a set of recommendations for the best MnPASS opportunities moving forward for short-term implementation, divided into three tiers, from highest short-term priority (Tier 1) to more long-term opportunities (Tier 3):

- **Tier 1: Corridor 3 I-35E –** A great opportunity exists to build this lane coincident with the replacement of the Cayuga Bridges, a project which is going forward now. As noted above, this corridor has moderately strong transit service, directly serves downtown St. Paul, can be built in two sections without major challenges, and extends MnPASS to the northern and eastern sections of the metro region.
- **Tier 2: Corridors 1A, 4 and 8 –** Corridor 1A is also opportunistic in that it can be easily and inexpensively built coincident with the replacement of the Lexington Avenue bridge. It can later become part of a powerful northern metro region MnPASS system combined with Corridor 4 serving downtown Minneapolis. Alternative 8 can provide direct connections to both Minneapolis and St. Paul and eventually connect to the existing MnPASS system. All of these corridors are differentiated from the Tier 3 corridors described below by providing direct service to the downtown cores, and having strong transit services. All of these corridors should move forward into further study, and be built opportunistically as financing and approvals are obtained, and engineering challenges resolved.

- **Tier 3: Corridors 5A, 5B, 6A, 7, and 10 –** These corridors form the basis of a powerful MnPASS beltway system with service to growing outlying markets, the MSP airport, and the Bloomington employment corridor. However, with the exception of 7, they do not currently have strong transit services and do not serve the downtown cores. The key Corridor 10 (I-494), which could serve as the linchpin of this system, has high costs and risks.

The fundamental recommendation of the technical steering committee for early implementation is to give priority to the Tier 1 and Tier 2 corridors some of which can be built early, easily, and opportunistically with other planned projects, have strong transit services, provide direct linkages to the downtowns, provide regional equity, and build on the existing MnPASS system. The Tier 3 "beltway system" corridors should continue to be advanced with the expectation that they are more likely to be implemented in the mid- to long-range.

Table ES.1 highlights the results of the analysis. The more filled in the circle, the higher ranking the corridor in each category. Figures ES.2 and ES.3 show the highest ranking corridors graphically by performance measure and benefit/cost financing criteria respectively.

While there are no major legal or technical barriers to the development of new MnPASS lanes, several issues warrant careful consideration and analysis as the program moves forward. These include:

- Establishing a regional consensus on the purpose of the lanes, particularly balancing the traditional goal of managing traffic congestion against the possible goal of revenue generation, and the permitted uses of any future revenues;
- Ensuring equitable treatment of travelers across the region, particularly if, as defined for the technical analysis in this study, HOVs will have to pay to use any new MnPASS lanes while continuing to use the existing lanes for free;
- Working with the State's partners at the Federal Highway Administration (FHWA) to develop safe and cost-effective designs;
- Developing strategies for financing new lanes including the use of system revenue, state bonding authority, Federal grants, FHWA Surface Transportation Program (STP) funds, County Board Transit Investment (CBIT) funds, and public private partnerships; and
- Ensuring continued advantages for transit.

Table ES.1 MnPASS Corridor Short-Term Evaluation Summary

	Performance Measures					Other Model Outputs			Financial Analysis				
Corridor	Travel-Time Reliability	Throughput	Travel-Time Reduction	Change in Congested VMT	Transit Suitability	Managed Lane Daily Vehicles	Corridor Daily Vehicles	Change in Speed	Percent of Total Capital Funding Requirement	Additional Investment Required	B/C	Annual Revenue	Capital Cost
1A. TH 36: I-35W to I-35E (EB only)	◑	◔	○	○	●	◑	○	◔	◑	●	◔	$1.0	$47.5
2. I-94: TH 101 to I-494	◔	○	◔	◑	○	◔	◔	◑	○	◑	○	$0.4	$82.5
3A. I-35E: I-94 to TH 36	◑	●	◔	◑	◑	●	◕	◔	◑	◕	◑	$1.9	$82.5
3B. I-35E: TH 36 to CR E	○	○	○	◔	◑	◔	◑	○	○	●	◔	$0.3	$35.0
4A. I-35W: DT Minneapolis to TH 36	◑	●	◑	◑	●	●	●	◑	◑	◑	◑	$2.3	$105.0
4B. I-35W: TH 36 to Blaine	◕	◑	◕	◑	●	◕	◑	◕	◑	◔	◕	$3.3	$155.0
5A. I-494: TH 212 to I-394 (peak only)	◔	◔	◔	◑	○	◑	◑	◑	◔	◑	◔	$1.0	$97.5
5B. I-494: I-394 to I-94	◑	◑	◑	◔	○	◕	◑	◕	◔	◕	◕	$1.6	$61.0
6A. TH 169: CR 17 to I-494	●	◑	●	◕	◑	◑	◔	●	◕	◑	●	$3.1	$97.5
7. TH 77: 141st Street to Old Shakopee Road (NB only)	◑	○	○	◔	●	○	○	◕	◔	●	◕	$0.6	$41.0
10. I-494: TH 212 to MSP Airport	◕	●	●	●	○	●	●	◑	●	◔	●	$5.9	$167.5
2. I-94: TH 101 to I-494 5B. I-494: I-394 to I-94	◑	◑	◕	◕	○	◑	◔	◑	◔	◔	◑	$2.2	$192.5
1A. TH 36: I-35W to I-35E 4B. I-35W: TH 36 to Blaine 4A. I-35W: DT Minneapolis to TH 36	◕	◑	●	●	●	◕	◑	◑	◑	○	◑	$7.3	$377.5
8A. I-94: DT Minneapolis to TH 280 8B. I-94: TH 280 to DT St. Paul	◑	◔	◕	◕	●	●	●	◔	●	◔	◕	$4.8	$140.0
3A. I-35E: I-94 to TH 36 3B. I-35E: TH 36 to CR E	◔	◕	◑	◑	◑	◕	◕	◔	◑	◑	◑	$2.5	$117.5

Ratings Key:
○ = Low.
◔ = Low Medium.
◑ = Medium.
◕ = Medium High.
● = High.

Figure ES.2 Top Performing Corridors for Each of the Performance Metric

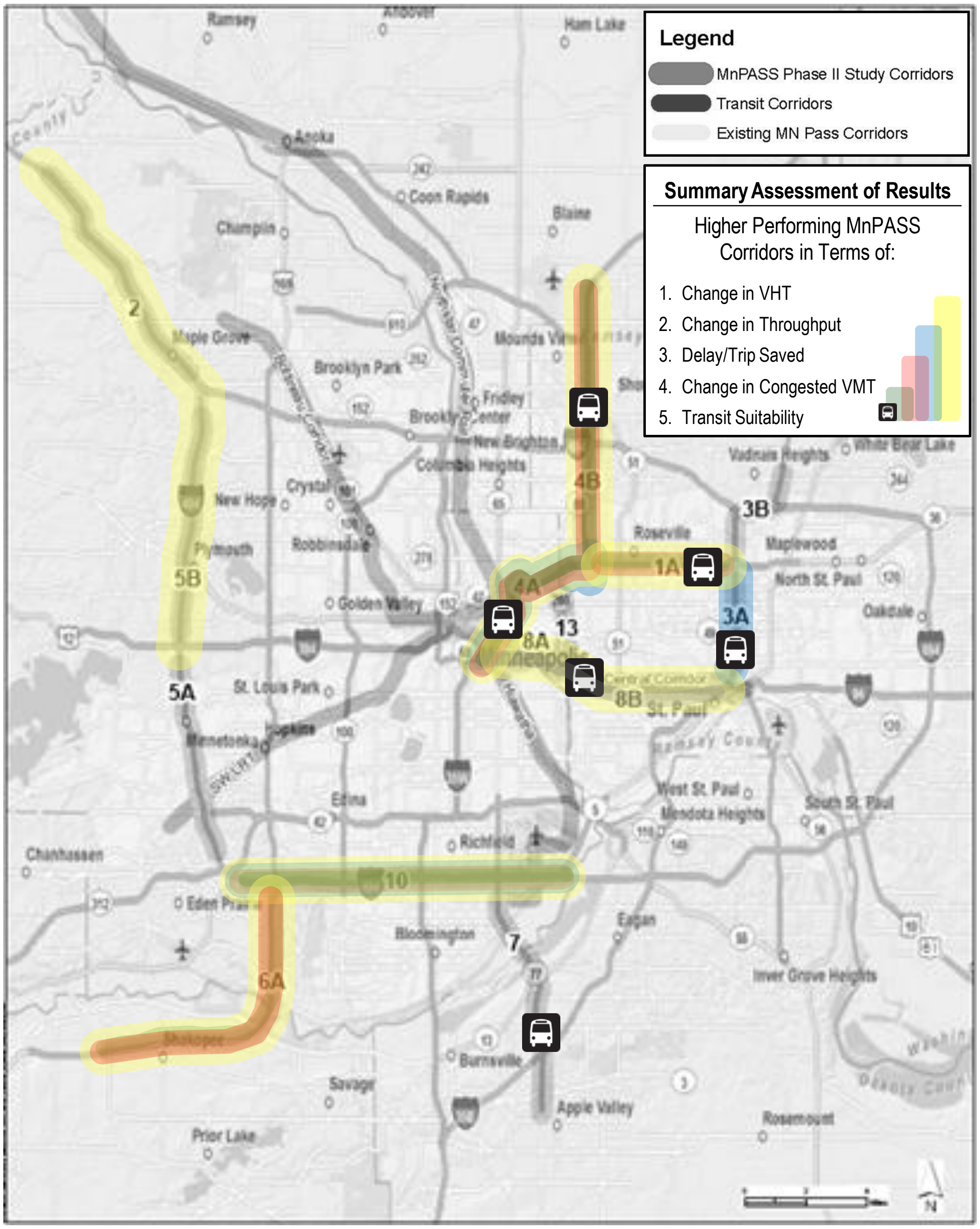
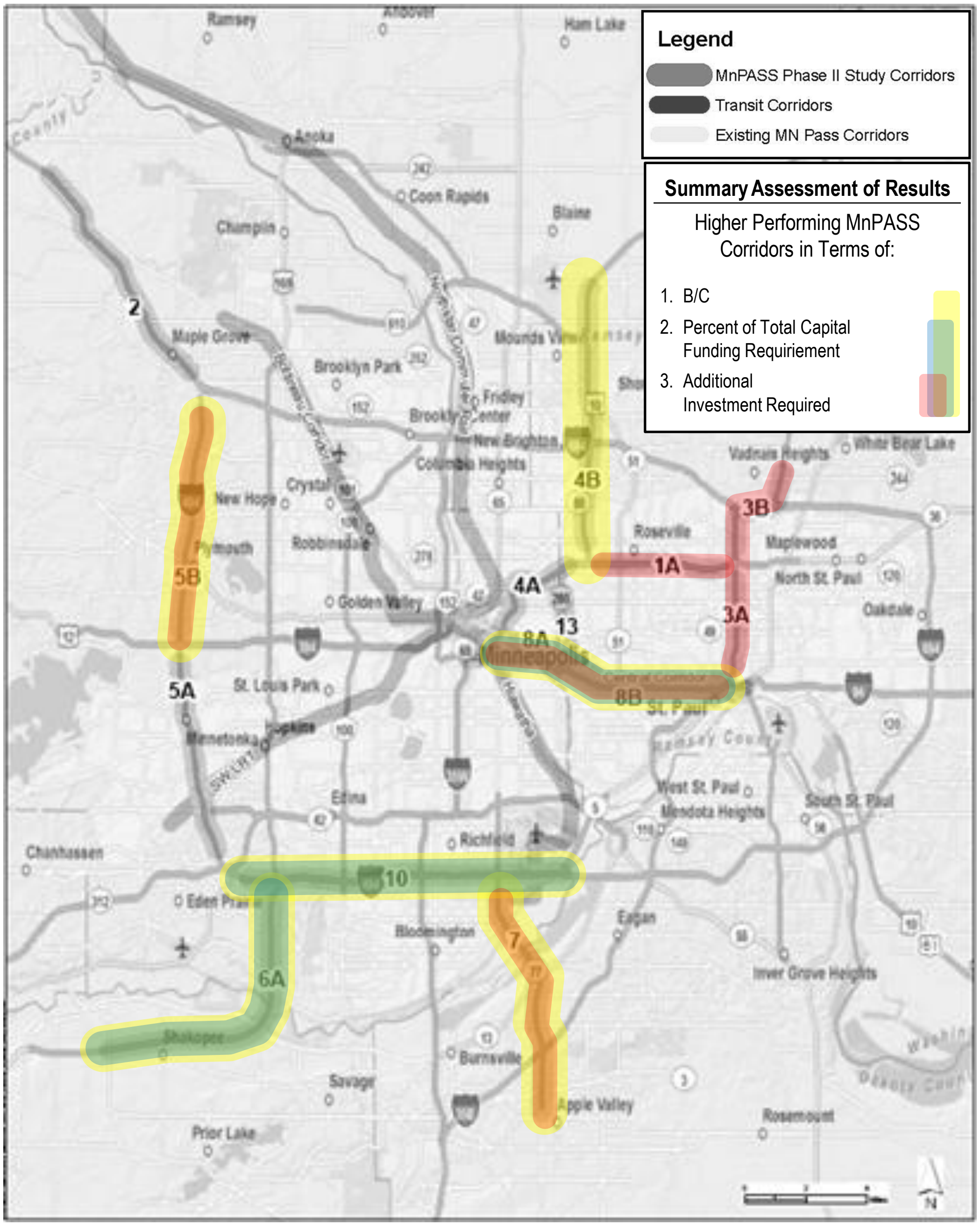


Figure ES.3 Top Performing Corridors – Benefit/Cost Analysis and Financial Analysis



1.0 Introduction

Traffic congestion is a growing problem in the Twin Cities region. The Texas Transportation Institute's 2009 Urban Mobility Report ranks the region 19th for congestion cost, which is estimated to cost the region $1.5 billion in lost time and excess fuel consumption. There are potentially large benefits to using priced lane projects to manage system congestion and generate revenue.

Road pricing has been used for centuries to finance highways in the United States. The earliest turnpike in the U.S. was the Philadelphia and Lancaster Turnpike Road, built in 1795. Traditionally, road pricing was seen purely as a means to get new bridges, tunnels, and roads built by leveraging the revenue stream from the user fees over many years. With the emergence of open road tolling technologies, road pricing not only can generate a revenue stream, it can also be used to manage demand and provide drivers with a choice for more reliable travel times.

Despite proactive investments in transportation infrastructure, congestion is expected to trend upward as the region expects one million additional inhabitants by 2030. The Minnesota Department of Transportation (Mn/DOT), in cooperation with its regional and local partners, has diligently worked to slow the rate of congestion growth during the past decade through a variety of strategies including the following:

- Capacity expansion projects such as on I-694, I-494, and TH 100 north of I-394;
- System management tools such as ramp metering, intelligent transportation systems (ITS), the regional traffic management center, and quick incident clearance procedures;
- Expansion of multimodal options such as light rail, commuter rail, and bus-only shoulder lanes; and
- Innovative demand management strategies such as the conversion of the High-Occupancy Vehicle (HOV) lanes on I-394 and I-35W into "MnPASS" High-Occupancy Toll (HOT) lanes, henceforth referred to by the overall term of "managed lanes."

1.1 Existing MnPASS System

The implementation of the I-394 and I-35W MnPASS managed lanes has proven that congestion pricing is a viable and publicly acceptable congestion management strategy. On these existing MnPASS corridors, HOVs travel without charge in the MnPASS managed lanes, and single occupant vehicles (SOVs) can pay to use the lanes. The lanes operate only in the peak periods in the peak direction. Toll rates are dynamically set in response to real-time congestion levels in the managed lanes, such that tolls rise when traffic increases. In this way, the optimal number of drivers are encouraged to use the MnPASS lanes while maintaining free-flow uncongested operation in the lanes. All tolls are paid by means of in-vehicle electronic transponders.

1.2 Future MnPASS Opportunities

The continued implementation of MnPASS-type facilities, along with transit and demand management strategies, has been supported in the Metropolitan Council's (Met Council)[4] Transportation Policy Plan, Mn/DOT's Metro District Transportation System Plan, and the Metropolitan Highway System Investment Study (MHSIS),[5] jointly sponsored by the Met Council and Mn/DOT and taking place concurrently with this study. The support of MnPASS is due to its proven ability to safely provide increased trip reliability as well as user choice in a cost-effective manner.

In 2005, Mn/DOT completed the MnPASS Phase 1 study identifying the next set of roadways to be considered for managed lanes. Any new MnPASS lanes would have to be created from scratch as there are no other HOV lanes for conversion in the Twin Cities Metropolitan region.

Both the I-394 and I-35W MnPASS projects were implemented with the primary purpose being congestion management.[6] With the only two HOV corridors in the region now converted to managed lanes, future MnPASS facilities will need to be new capacity (i.e., addition of new lanes) or use the existing shoulders (i.e., priced dynamic shoulder lanes or PDSL). Thus, with limited capital funds for expansion projects, the revenue streams from future MnPASS lanes are an important evaluation factor in addition to congestion management in terms of supporting project implementation. Thus, forecasts of revenue streams from specific projects are included in this study.

Mn/DOT and the Met Council have also pioneered in the use of highway shoulder lanes for express bus operation. The combination of the MnPASS lanes and bus shoulder use creates opportunities for synergistic development of new managed lane capacity which could benefit carpoolers, SOV drivers willing to pay, transit riders, and the rest of the traveling public using less congested general purpose lanes. Mn/DOT provided technical direction to this study to assume that all users (except transit vehicles and riders) of any new MnPASS

[4] The Metropolitan Planning Organization (MPO) for the Twin Cities urbanized region.

[5] The MHSIS study considered a wider range of investment strategies including not only MnPASS lanes, but also some limited new general purpose capacity lanes, and other traffic management strategies.

[6] The I-35W project was funded in part by an Urban Partnership grant from the Federal Highway Administration (FHWA).

lanes would pay a toll equal to that paid by all other uses, but that carpoolers and motorcyclists would continue to be able to use the two HOV to managed lane conversions (I-394 and I-35W) for free.

In 2010, Mn/DOT decided to reassess its priorities for short-term (2 to 10 years) MnPASS lane implementation in light of evolving Federal policies, actual experience with the two existing MnPASS lanes and in close coordination with the Met Council's MHSIS study. The MHSIS is a joint effort between the Metropolitan Council and Mn/DOT to create short-term and long-term visions for the highway system in the Twin Cities region. The goal of the study is to identify methods and improvements to achieve the greatest efficiency out of the region's highway system and manage congestion from a systemwide perspective. The MHSIS also includes a public outreach component.

A series of monthly technical committee meetings were held to coordinate the MHSIS and MnPASS Phase 2 studies. While the two studies converged on a common set of priority projects, there are some differences in the recommendations and results due to the following factors:

- Short-term (MnPASS) versus long-term (MHSIS) perspective of the two studies;
- Differences in project limits and definitions;
- The context of the two studies in that MnPASS compared only managed lanes against each other, while MHSIS also considered some general purpose capacity expansion and other operational strategies; and
- Differences in travel demand forecasting methodologies used given the focus of the MnPASS study on estimating toll revenue, which was not included in the MHSIS scope of work.

This report describes the process of screening potential MnPASS corridors (Section 2.0), methodologies used for travel demand forecasting and cost estimating (Section 3.0), traffic and revenue forecasts (Section 4.0), cost estimates and conceptual engineering designs (Section 5.0), performance measures (Section 6.0), benefit/cost and financing (Section 7.0), and policy, legal, and technical issues (Section 8.0). This material is supported by the following more detailed technical memoranda:

- *Technical Memorandum 1 – Modeling Approach and Geometric Screening*, March 22, 2010;
- *Technical Memorandum 2 – Cost Estimates and Model Results*, May 21, 2010;
- *Technical Memorandum 3 – Policy, Technical, and Legal Issues*, May 28, 2010; and
- *Technical Memorandum 4 – Performance Measures and Benefit/Cost Analysis*, July 13, 2010.

2.0 Corridor Screening

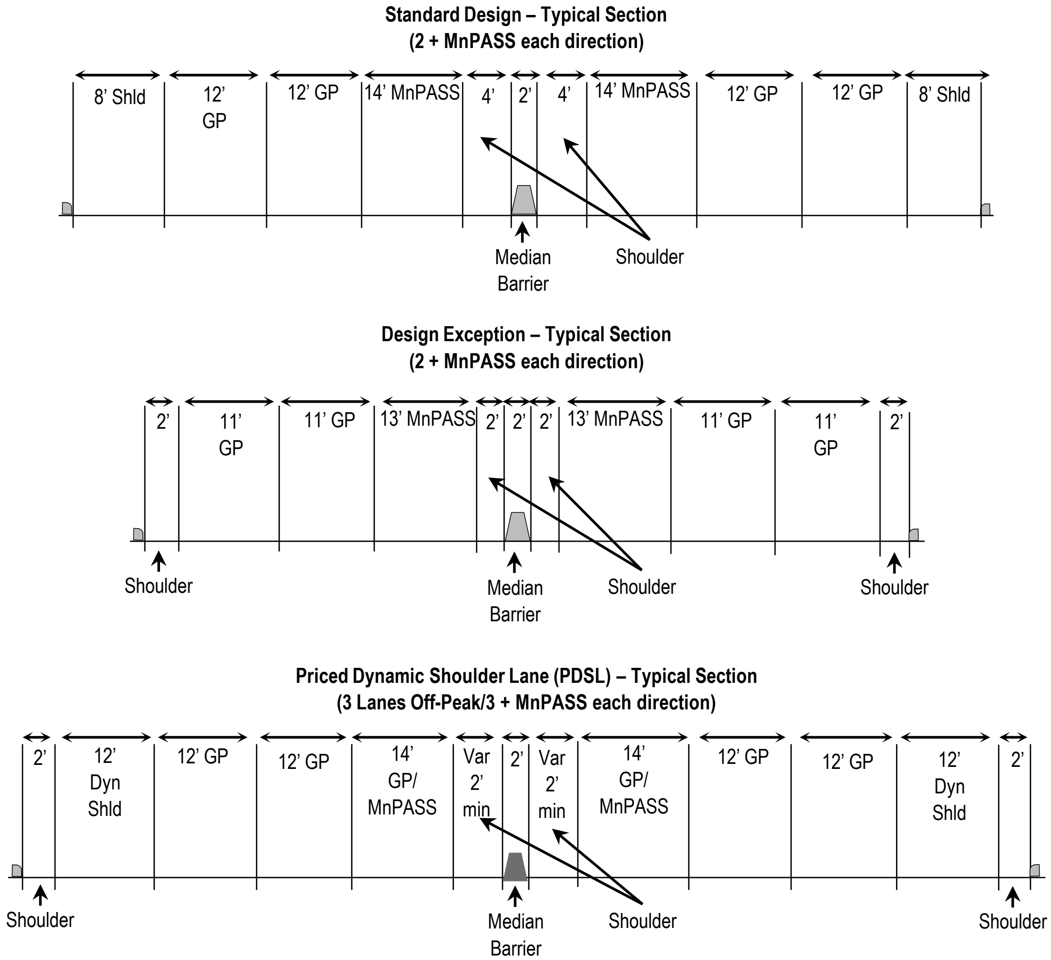
An initial set of 19 corridors were considered for analysis. These corridors were identified during joint technical steering committee meetings among MnPASS and MHSIS project staff from Mn/DOT and the Met Council and their respective consultant teams. Priority was given to the following factors:

- Previous MnPASS Phase 1 system study corridors;
- Locations of current congestion on the metropolitan freeway system;
- Logical connectivity to employment centers and/or other MnPASS corridors; and
- Corridors with significant transit use and with existing bus-only shoulder lanes.

Whereas the MnPASS Phase 1 study assumed that any new MnPASS lanes would have to involve construction of new capacity to full highway standards, this Phase 2 study assumed a smaller envelope (i.e., corridor width) could be used to develop a MnPASS corridor. This change grew out of Mn/DOT's experience with the I-35W managed lane in which Mn/DOT used a priced dynamic shoulder lane (PDSL) to develop the additional lanes with minimal impacts and changes in the overall roadway footprint. Given this new ability to reduce impacts and costs, Mn/DOT wanted to reevaluate potential corridors to determine the best candidates for the next MnPASS facilities.

The initial screening process applied to the potential MnPASS corridors focused on high-level assessments of physical challenges in each corridor. These included structural issues with bridges, available pavement widths, and issues where major corridors intersect (i.e., need for connections). Corridors were analyzed based on the following hierarchy (see also the typical cross sections in Figure 2.1):

Figure 2.1 Typical MnPASS Cross Sections



1. If possible, MnPASS lanes should be developed as new lanes using the median or inside shoulders. The desirable section would include a median barrier, a 4-foot inside shoulder, a 14-foot MnPASS lane, 12-foot mixed use lanes and a 10-foot right shoulder. To accommodate this section, the distance between left edge lane lines needs to be a minimum of 38.5 feet (to accommodate new MnPASS lanes in each direction). Corridors that largely met these qualifications were classified as "Standard Design" corridors, and were assumed to meet state and Federal design requirements in most locations throughout the corridor. Bridge and/or pavement widening was quantified for the additional MnPASS lanes throughout each corridor by visual inspection of aerial maps.

2. Many corridors were quickly identified as poor candidates for application of standard design criteria, primarily due to insufficient median width or restrictive widths under overpasses, thereby requiring significant costly bridge replacements and/or widening work. These corridors were then evaluated using a modified design methodology. The minimum design criteria (i.e., envelope) included a median barrier, 2-foot inside shoulder, a 13-foot MnPASS lane, 11-foot general purpose lanes, and a 2-foot outside shoulder. These corridors would have sections that range between the desired section and the minimum section. Based on this criteria, bridge and pavement widening, as well as roadway resurfacing to accommodate realignment, was quantified for the addition of MnPASS lanes throughout each corridor.
3. Finally, there were some special cases identified where corridors possessed unique characteristics including full-depth concrete pavement with joints aligned with existing lane markings along with median and left shoulder widths that are insufficient for the addition of MnPASS lanes. In order to accommodate MnPASS lanes in these corridors without removal and replacement of costly infrastructure, a Priced Dynamic Shoulder Lane (PDSL) approach was used. These corridors assume that full gantries are constructed approximately every half-mile and that through lanes would shift to the right shoulder and the MnPASS lane would take over the inside mixed use lane. These routes are identified with the PDSL designation. Shoulder widening to provide adequate width for driving, as well as parallel acceleration/deceleration lanes at ramps, was quantified for the conversion to PDSL design throughout each corridor.

Following the evaluation of each corridor, categories were assigned reflecting the feasibility of MnPASS expansion. Category 1 corridors were required to have been evaluated with the Standard Design approach (i.e., no design modifications and/or PDSLs), and they also require relatively modest investments in magnitude and scope to accommodate the addition of MnPASS lanes. Category 2 corridors included all evaluation approaches (i.e., Standard Design, Modified Design, and PDSL), and typically required more substantial widening, replacement, and resurfacing improvements to accommodate MnPASS lanes. Category 2 was further subdivided into 2a and 2b to differentiate between some corridors that may have difficulty with making system to system connections and/or had other physical challenges. Category 3 corridors were those with significant physical challenges which likely make MnPASS expansion infeasible at this point in time. A detailed description of each corridor is provided in Technical Memorandum 1.

Using this approach, the following corridors were eliminated from further consideration:

- **Corridor 1B – TH 36: I-35E to I-694**
  - Existing at-grade intersections make this corridor too problematic for short-term implementation. This may be a corridor that can be studied further in the future.
- **Corridor 6B – TH 169: I-494 to I-394**
  - Significant bridge widening and mainline reconstruction required narrower right-of-way, and problem crossing Nine Mile Creek.
- **Corridor 6C – TH 169: I-494 to I-394**
  - Lack of continuity due to 6B not being carried forward; I-494 is a parallel route and has less physical constraints.
- **Corridor 9 – I-394: I-494 to I-94**
  - As a modification to an existing MnPASS corridor, this corridor was not evaluated as part of this study; it is recommended that it be studied as part of the Mn/DOT's Congestion Management System Plan (CMSP) Phase 3.
- **Corridor 11 – TH 212/TH 62: TH 5 to TH 77**
  - Limitations at the Crosstown commons and other physical challenges.
  - I-494 provides greater opportunity for connections to other MnPASS corridors and the MSP Airport.
- **Corridor 12 – I-94: Downtown Saint Paul to I-694**
  - Few existing traffic congestion issues along the corridor.

The following corridors (shown in Figure 2.2 and evaluated in Table 2.1) were advanced into full analysis, and evolved in definition over the course of the study.

Figure 2.2 Corridor Location Map

Source: SRF.

Table 2.1 Initial Corridor Screening Summary

Corridor		Length (Miles)	MnPASS Design	Major Physical Issues: Overpass Bridge Widening (Square Feet)		Underpass Bridge Replacements		Construction (In Miles)			Interchange Modifications	Connectivity	Category
				Current	2018	Current	2018	MnPASS	Mainline	Shoulder			
1. TH 36	1A: I-35W to I-35E	5	Std.	13,000	13,000	None	None	10	2	None	1	I-35W South: Complicated	1
1. TH 36	1B: I-35E to I-694	6.7	Exc.	7,000	5,000	Ped Only	Ped Only	14	10	None	None	N/A	2b
2. I-94	2: TH 101 to I-494	9	Std.	None	None	None	None	18	None	None	1	I-494: Moderate/Complicated	1
3. I-35E	3A: I-94 to TH 36	3.9	Exc.	5,000	None	None	None	8	23	None	1	DT St. Paul: Simple	2a
3. I-35E	3B: TH 36 to CR E	3.8	Std.	None	None	None	None	8	None	None	None	N/A	1
4. I-35W	4A: Downtown Minneapolis to TH 36	5.3	Exc.	4,000	4,000	None	None	11	19	None	3	DT Minneapolis: Complicated TH 36: Complicated	2a
4. I-35W	4B: TH 36 to Blaine	10.8	Exc.	9,000	9,000	None	None	22	16	None	3	N/A	2b
5. I-494	5A: TH 212 to I-394	7.6	PDSL	18,000	18,000	None	None	None	None	16	None	I-394: Complicated	2b
5. I-494	5B: I-394 to I-94	8.5	Std.	12,000	12,000	None	None	17	None	None	None	I-394: Complicated	1
6. TH 169	6A: CR 17 to I-494	6.2	Exc.	3,000	3,000	None	None	13	None	None	1	N/A	2a
6. TH 169	6B: I-494 to I-394	8.1	Std.	202,000	202,000	None	None	17	32	None	None	I-394: Complicated	3
6. TH 169	6C: I-394 to I-94	7.5	Exc.	10,000	10,000	1	1	15	30	None	1	I-394: Complicated	2b
7. TH 77	7: 141st Street to Old Shakopee Road	6.9	Exc.	None	None	None	None	22	6	None	None	TH 62: Moderate	2b
8. I-94	8: Downtown Minneapolis to Downtown St. Paul	8.1	Exc.	None	None	None	None	17	65	None	11	DT Minneapolis: Moderate DT St. Paul: Moderate	2b
9. I-394	9: TH 100 to I-94	2.7	Exc.	None (67,000)	None (67,000)	None	None	6	9	None	1	DT Minneapolis: Moderate TH 100: Simple	2a
10. I-494	10: TH 212 to MSP Airport	10.6	Exc.	11,000	11,000	1	None	22	68	None	2	MSP Airport: Moderate	2b
11. TH 212/ TH 62	11: TH 5 to TH 77	10.3	Exc.	8,000	8,000	None	None	21	12	None	5	N/A	2b
12. I-94	12: Downtown St. Paul to I-694	6.7	PDSL	28,000	28,000	None	None	1	3	14	3	DT St. Paul: Simple	2b
13. TH 280	13: I-94 to I-35W	3.3	Std.	72,000	72,000	None	None	7	11	None	None	I-94: Complicated I-35W: Complicated	3

Source: SRF.

- **Corridor 1A – TH 36: I-35W to I-694**
  - This corridor was subsequently made eastbound only due to challenges with connecting a westbound managed lane into the I-35W/TH 280 commons interchange, and the preference for giving priority access to I-35W southbound traffic due to the much larger number of buses operating in that corridor.
- **Corridor 2 – I-94: TH 101 to I-494**
- **Corridor 3 – I-35E: I-94 to CR E**
  - This corridor was divided into 3A (I-94 to TH 36) and 3B (TH 36 to CR E).
- **Corridor 4 – I-35W: Minneapolis to Blaine**
  - This corridor was divided into 4A (Minneapolis to TH 36) and 4B (TH 36 to Blaine).
- **Corridor 5 – I-494: TH 212 to I-94**
  - This corridor was divided into 5A (TH 212 to I-394) and 5B (I-394 to I-94).
- **Corridor 6 – TH 169: CR 17 to I-94**
- **Corridor 7 – TH 77: 141st Street to Old Shakopee Road**
  - This corridor was made northbound only.
- **Corridor 8 – I-94: Downtown Minneapolis to Downtown Saint Paul**
  - This corridor was tested as two separate corridors divided at TH 280, but then recombined because it appeared that the corridor needed to be considered in whole to maximize benefits.
- **Corridor 10 – I-494: TH 212 to MSP Airport**
- **Corridor 13 – TH 280: I-94 to I-35W**
  - This corridor was subsequently eliminated as being redundant to I-35W (4A) and more challenging to construct.

Corridors 3A and 3B (I-35E), 4A and 4B (I-35W), 2 (I-94) and 5B (I-494), and 8A and 8B (I-94) were tested both individually and combined. All continue to have merit as individual corridors except for Corridor 8.

3.0 Travel Demand and Cost Estimation Methodology

3.1 Travel Demand Forecasting

A modified version of the Met Council travel demand model was used to evaluate the impacts of short-term investments in new MnPASS facilities. The following describes key aspects of the current Met Council model tolling procedures, the toll revenue forecast by the current model compared to actual revenue collected on the I-394 MnPASS lane, and the modifications implemented to the model for evaluating new MnPASS facilities. The base year model (2009) was modified and the changes were then applied to the 2015 forecast year model. The MHSIS project used model years 2030 and 2050.

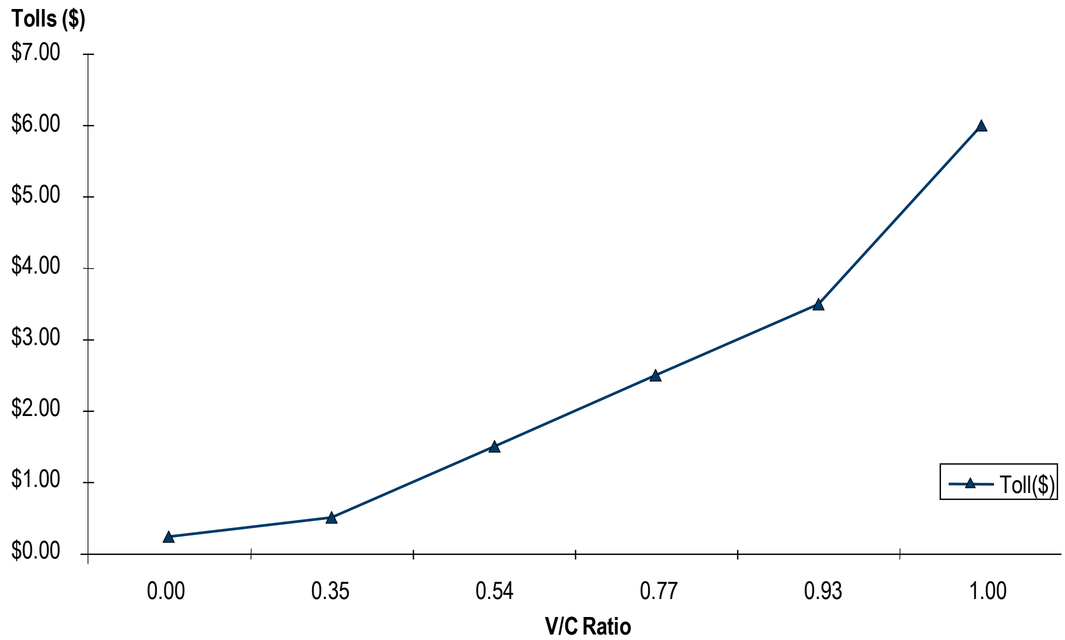
3.1.1 Met Council Model Treatment of Tolling

The toll model is only used during the assignment routine, therefore the trip distribution and mode choice model steps are NOT sensitive to tolls. This means that regardless of the toll being applied, the model will not capture mode shifting and the auto trip table will remain fixed. It was agreed among the participants in the project's technical steering committee that for the purposes of the high-level analysis reflected in this study, this limitation was acceptable. The MHSIS project used the same approach.

The Met Council model includes tolls for SOVs for the existing MnPASS managed lanes in the a.m. (6:00-8:30 a.m.) and p.m. (2:30-5:30 p.m.) peak time periods, with each of these periods consisting of three subsidiary time periods.

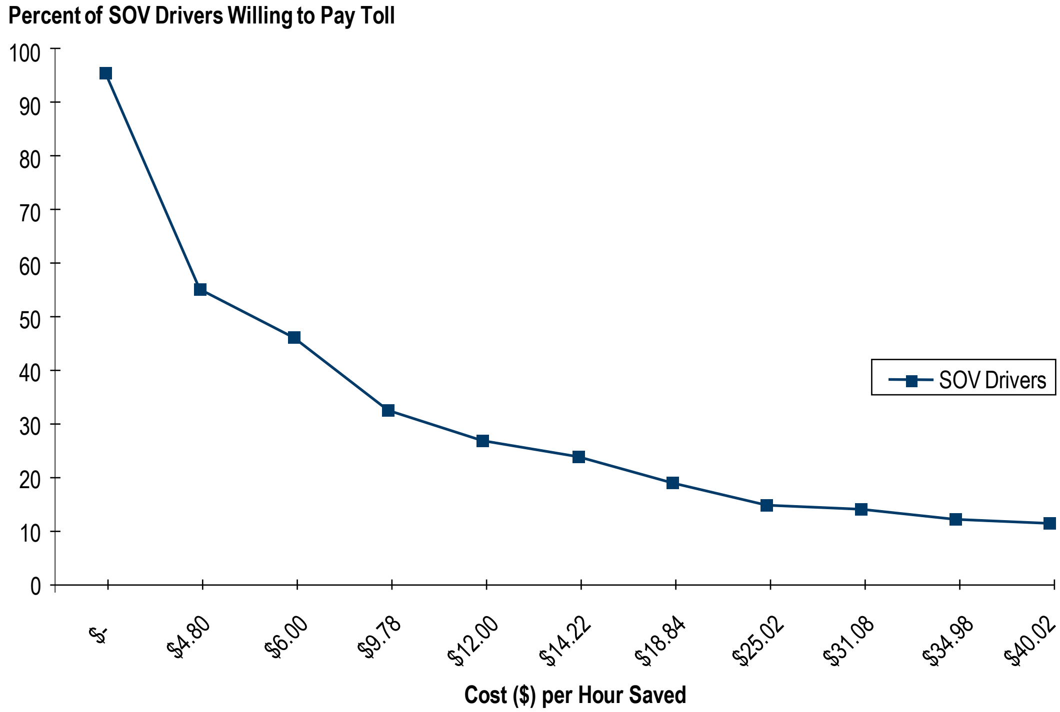
The tolls used in the model are variable, ranging from $0.25 to $8.00 depending on the level of congestion as determined by the volume to capacity ratio in the MnPASS lanes and the cost curve shown in Figure 3.1. This procedure reflects the dynamic tolling approach used on the existing MnPASS lanes. For example, at a v/c ratio of 0.54 (relatively uncongested), the toll would be set at slightly more than $1.00; while at a v/c ratio of 1.0 (saturation flow), the toll would be increased to almost $6.00. As congestion on the MnPASS lane increases, the toll for using the lane also increases. Each vehicle (except transit vehicles) that uses any portion of a tolled roadway will incur the toll for that modeled segment. The toll that is incurred by each segment in the model is NOT a function of the distance traveled on the tolled segment. Whether the trip uses only a small portion of the tolled segment or the entire segment, the same toll is realized. If a trip uses multiple tolled facilities, the total toll paid is the sum of the toll on each facility.

Figure 3.1 Toll Rate by Volume to Capacity Ratio



The value of time used in the model is represented by the curve (see Figure 3.2) which shows that as the toll increases, the number of people willing to pay the toll decreases. The curve was developed using the a.m. peak time period and is applied to all vehicles regardless of the purpose of the trip; therefore, it represents the average vehicle mix for the a.m. peak. Work trips tend to have a higher value of time than nonwork trips. During the a.m. peak, the vehicle mix on the roadways has a higher concentration of work trips, which implies that the value of time during the a.m. peak should be higher than other times of the day. However, the same value of time curve is applied in the model to both peak time periods. The only direct comparison that can be made between the model and the observed MnPASS revenue, therefore, is for the a.m. peak period and peak direction.

Figure 3.2 Value of Time Distribution



According to the values of time used in the model, at a cost per hour saved of $4.80, 50 percent of the SOV drivers would be willing to pay the toll.

The toll model operates in an iterative manner as follows:

- As congestion increases on the tolled MnPASS lanes, the toll rate increases;
- As the toll rate increases the number of SOVs diverted from the MnPASS lanes back to the general purpose lanes increases; and
- As the number of trips diverted increases, the congestion in the MnPASS lanes decreases and the tolls decrease.

This process is repeated, within the trip assignment procedure, for 30 iterations or until an equilibrium is reached. The ultimate goal of the process is to maximize the number of SOVs in the HOT lanes while still maintaining free-flow conditions.

Revenue Estimates

The total weekday revenue estimated by the MetCouncil model on I-394 is $5,342 for the a.m. peak and $9,440 for the p.m. peak, for a total of $14,782 daily. We compared this model estimate to reported data for the I-394 MnPASS lanes from the *MnPASS Express Lanes Yearly Status Report FY 2009* report. Similar data for I-35W was not available. The purpose of this comparison was to determine how accurately the model is in estimating revenue from current MnPASS lane operation in order to assess whether modifications should be made for estimating revenue for new MnPASS lanes.

The a.m. peak period inbound revenue estimated by the model is within 16 percent of the observed revenue. The p.m. revenue predicted by the model is 303 percent greater than the observed revenue due to the a.m. value of time being applied to the p.m. peak. Since the p.m. peak has more than double the number of trips (2,278,831) on the road as the a.m. peak (912,451), the impact on the revenue estimate is even more extreme in the p.m. than in the a.m. This issue of p.m. revenue overestimation in the model is addressed in the model updates described below.

3.1.2 Model Updates for the MnPASS II Study

The current tolling procedure was updated to allow for the testing of new MnPASS lanes within the region. These new tolling lanes would require any vehicle using them to pay the toll. This is different from the current MnPASS lanes that allow vehicles (HOVs) with two or more persons to use the lanes without paying a toll. Therefore, it was necessary to update the model so that the existing MnPASS lanes would still perform in their current manner of allowing HOVs for free, while testing the possibility of charging these same vehicles if they use the new MnPASS lanes. The modeling changes described below were not made to the model used for the MHSIS since that study analyzed a variety of investment scenarios (not just managed lanes) and was not tasked with estimating revenue. In the MHSIS analysis, all HOVs were assigned free use of any managed lanes. These differences in modeling approach account for some of the differences in results between the two studies.

Following are the major model changes developed for this study:

- HOVs traveling on any corridors with proposed new MnPASS lanes are now put through the same toll/no-toll procedure as SOVs, while still allowed to use the existing MnPASS lanes for free.
- The Metropolitan Council's tolling model assumes tolls are in effect during the a.m. and p.m. peak periods only, reflecting the current time periods for which tolls are collected on the MnPASS lanes. Tolls are also only active in the peak direction. The new MnPASS lanes would be available all day. Therefore, the model was modified so that tolls are applied all day to the new MnPASS lanes, while tolls on the existing MnPASS lanes were assumed to be active only in the peaks. While actual operations might vary, this simplified approach was viewed as adequate to support this high-level analysis.
- The Metropolitan Council's tolling model produces revenues during the p.m. peak period that greatly exceed the observed values. For this study, the toll model was updated so that correction factors were applied to the model output. It should be noted that the model still appears to overestimate revenue relative to actual 2009 MnPASS lane performance. Some of this differential can be accounted for by growth in traffic volumes in the forecast year of 2015

(an increase in revenue of 10 percent); daily rather than peak period only tolling (an increase of 8 percent), and the inclusion of HOVs in tolling (an increase of 18 percent).

3.2 Cost Estimation Methodology

Cost estimates were developed for potential MnPASS corridors. Unit costs for corridor improvements are consistent with those developed for the MHSIS. These unit costs include categories of structures, roadway construction, advanced traffic management (ATM), roadway connections, and risk. Cost estimates for each corridor are provided as a range of low and high estimates. Various structure and roadway construction unit costs included low- and high-range estimates to account for unforeseen conditions influencing project costs. The average of the high- and low-range cost estimate was used to support other analyses such as financing and benefit/cost. The treatment of each cost element is described below.

3.2.1 Structures

Bridge Widening – Low-Range: $200 per square foot; High-Range: $5,000,000 per location

Low-range estimates include existing bridges assumed to be suitable for widening. Standard design corridors were widened to the full extent to provide adequate lane and shoulder widths. Other corridors were widened to minimum required amounts to provide specified lane and shoulder widths. High-range estimates include all bridge widening locations in case widening is not practical and the entire structure must be replaced.

Replacement – $5,000,000 per location

Existing overpasses were assumed to require replacement in locations with insufficient width for addition of MnPASS lanes. A single unit cost was applied to replacement locations.

3.2.2 Roadway Construction

Widen to Inside – $3,400,000 per mile (both directions)

Pavement costs were included for the addition of MnPASS lanes in the median of the freeway segment. This cost includes the new lane and left shoulder. This cost is typically applied to Standard Design corridors with sufficient median width to accommodate MnPASS lanes.

Widen to Outside – $2,100,000 per mile (both directions)

Pavement costs were included for reconstruction and widening of shoulders to accommodate traffic. This cost includes full-depth pavement and additional width. This cost is typically applied to other than standard design and PDSL corridors requiring lane alignment shifts extending onto the existing right shoulder. In both cases, no right-of-way takes were assumed.

Resurface Existing Pavement – $2,400,000 per mile (both directions)

This cost assumed a mill and overlay of the full roadway cross section. This cost was typically applied to corridors where lanes will be shifted and potentially narrowed to accommodate the addition of MnPASS lanes.

Interchange Ramp Realignment – $1,400,000 per location (one exit and one entrance in one direction)

This cost assumed modification of ramp alignments due to lane alignment shifts. General cost estimate includes taper modifications, acceleration/deceleration distances, and other associated costs. This cost is typically applied to PDSL and other corridors where lanes will be shifted affecting ramps within the corridor.

Grading, Drainage, and Overhead Sign Relocation – $1,150,000 per mile (both directions)

This cost assumed improved grading and drainage due to additional pavement width and potential lane alignment shifts. Overhead sign relocation is included when required due to shifting of signs to potential new ATM sign structures or relocation due to increased roadway width.

Median Barrier – $350,000 per mile (both directions)

This cost assumed the addition of a concrete median barrier to corridors with no barrier in place. This cost is typically applied to Standard Design corridors with sufficient median width to accommodate MnPASS lanes.

Miscellaneous – Low-Range: None; High-Range: $1,000,000 per mile (each direction)

This cost assumed noise walls were required to be constructed along the corridor and additional ponding/drainage was needed.

3.2.3 Advanced Traffic Management (ATM)

ATM and MnPASS Equipment for Six- to Eight-Lane Freeway – $1,200,000 to $1,600,000 per mile (both directions)

This cost is required for corridors with dedicated full-time MnPASS lanes. This cost includes tolling equipment, signs, sign structures, and communications infrastructure.

MnPASS Equipment Only – $1,000,000 per mile (both directions)

This cost is required for corridors with existing ATM in place. This cost includes tolling equipment for MnPASS operations only.

3.2.4 Roadway Connections

Location-Specific Cost Estimates

Various corridors include new roadway connections providing direct access from MnPASS lanes to downtown Minneapolis and St. Paul. Cost estimates were developed for each location individually based on a review of design concepts and site characteristics. Estimates include roadway, bridge and retaining wall costs consistent with roadway construction unit cost estimates.

3.2.5 Risk

Corridors Assigned Risk Level from Three Categories: Low – 15 percent; Medium – 25 percent; High – 35 percent

Risk categories were assigned to each corridor based on existing conditions and challenges to MnPASS corridor expansion including proximity of existing pavement to right-of-way and the availability/cost of right-of-way for ponding. Risk percentages for each corridor were applied to both low- and high-range cost estimate subtotals. Risk assessments and costs were assigned in close coordination with Mn/DOT engineers and the MHSIS team.

3.2.6 Operating and Maintenance Cost

When the MnPASS lane on I-394 was opened, the total cost for roadway operations and maintenance and back office functions (processing payments, record keeping, etc.) was about $1.2 million annually, or about $120,000 per mile. With the addition of the I-35W MnPASS lane, total costs increased to about $1.3 million, since the administrative and back office functions could be shared across both roadways. Thus, the per mileage cost was reduced to $55,000 (regardless of whether the MnPASS lane is in one direction or both, since the total number of individual users will be similar in either direction). With the further expansion of the MnPASS system, continued economies of scale should be realized in back office operations, and so a conservative estimate of $50,000 per mile was assumed.[7]

[7] For this analysis, O&M costs were assumed to include back office transactions, maintenance of all transponder readers, and electricity to operate the system. It does not include typical roadway pavement or snow/ice type of maintenance.

4.0 Cost and Engineering Results

Cost estimates and engineering designs considered the corridor length and general design features. Risk calculations were applied to the subtotals for each corridor to develop total corridor cost estimates and a low- and high- cost per mile for each corridor was developed. Section 4.1 summarizes the cost estimates for each individual corridor while Section 4.2 addresses combined corridors.

4.1 Individual Corridors

Table 4.1 provides a summary of corridor cost estimates including cost subtotals by unit cost category. Total cost estimates for the corridors ranged from $30 million to $185 million. On a cost per mile basis, the cost estimates ranged from $6.0 million to $27.0 million. These costs are intended to provide comparative estimates for total corridor investments and relative costs reflecting challenges to development of new MnPASS corridors.

Table 4.1 Cost Estimation Summary: Individual Corridors
In Millions

Corridor	Length (miles)	MnPASS Design	Grade Separations		Roadway Construction		ATM	Roadway Connections	Sub-Total		Risk		Risk		Total		Cost per Mile	
			Low	High	Low	High			Low	High	Category	Percent	Low	High	Low	High	Low	High
1A. TH 36: I-35W to I-35E	5.0	Add MnPASS Lane on Left	$3	$15	$21	$31	$6	–	$30	$52	Low	15%	$5	$8	$35	$60	$7.0	$12.0
2. I-94: TH 101 to I-494	9.0	Add MnPASS Lane on Left	–	-	$47	$68	$14	–	$61	$82	Low	15%	$9	$13	$70	$95	$8.0	$10.5
3A. I-35E: I-94 to TH 36	3.9	Left MnPASS Lane Reduced Shoulder/Lane	$1	$5	$34	$41	$6	$15	$56	$67	High	35%	$19	$23	$75	$90	$19.0	$23.0
3B. I-35E: TH 36 to CR E	3.8	Add MnPASS Lane on Left	–	-	$19	$29	$6	–	$26	$35	Low	15%	$4	$5	$30	$40	$8.0	$10.5
4A. I-35W: DT Minneapolis to TH 36	5.3	Left MnPASS Lane Reduced Shoulder/Lane	$1	$5	$46	$57	$8	$15	$70	$85	High	35%	$25	$30	$95	$115	$18.0	$21.5
4B. I-35W: TH 36 to Blaine	10.8	Left MnPASS Lane Reduced Shoulder/Lane	$2	$20	$86	$108	$16	–	$104	$144	Medium	25%	$26	$36	$130	$180	$12.0	$16.5
5A. I-494: TH 212 to I-394	7.6	PDSL MnPASS Lane on Left	$6	$35	$38	$53	$12	–	$56	$100	Medium	25%	$14	$25	$70	$125	$9.0	$16.5
5B. I-494: I-394 to I-94	8.5	Add MnPASS Lane on Left	$50 (provided by Mn/DOT)				$11	–	$61								$7.0	

Table 4.1 Cost Estimation Summary: Individual Corridors (continued)
In Millions

Corridor	Length (miles)	MnPASS Design	Grade Separations		Roadway Construction		ATM	Roadway Connections	Sub-Total		Risk		Risk		Total		Cost per Mile	
			Low	High	Low	High			Low	High	Category	Percent	Low	High	Low	High	Low	High
6A. TH 169: CR 17 to I-494	10.0	Left MnPASS Lane Reduced Shoulder/Lane[a]	$1	$10	$49	$68	$14	–	$64	$92	Medium	25%	$16	$23	$80	$115	$8.0	$11.5
7. TH 77: 141st Street to Old Shakopee Road	6.9	Left MnPASS Lane Reduced Shoulder/Lane	$41 (provided by Mn/DOT)														$6.0	
8A. I-94: DT Minneapolis to TH 280	3.0	Left MnPASS Lane Reduced Shoulder/Lane	$22 (based on Mn/DOT estimate)				$9	$10	$41								$13.5	
8B. I-94: TH 280 to DT Street Paul	5.1	Left MnPASS Lane Reduced Shoulder/Lane	$37 (based on Mn/DOT estimate)				$15	$10	$62								$12.0	
10. I-494: TH 212 to MSP Airport	10.6	Left MnPASS Lane Reduced Shoulder/Lane	$7	$10	$87	$110	$17	–	$111	$137	High	35%	$39	$48	$150	$185	$14.0	$17.5

Add Lane on Left: MnPASS lanes added in median, existing roadway alignment not shifted or narrowed.

Reduced Shoulder/Lane: Lane and/or shoulder widths potentially reduced to accommodate addition of MnPASS lanes.

PDSL: Existing left lane converted to dynamic MnPASS lane, right shoulder converted to dynamic general purpose lane.

[a] TH 169 has adequate median width for MnPASS lanes in all locations except Minnesota River Bridge. This segment requires reduced shoulder and lane width design.

Corridor 1A – TH 36: I-35W to I-35E eastbound only

- Segment Length: 5.0 miles.
- New Managed Lane added in median in eastbound direction only.
- No roadway connections assumed.
- Risk Category: Low (15 percent).
- Total Cost Estimate: $35,000,000 to $60,000,000.
- Cost per mile: $7,000,000 to $12,000,000 per mile.

Corridor 2 – I-94: TH 101 to I-494

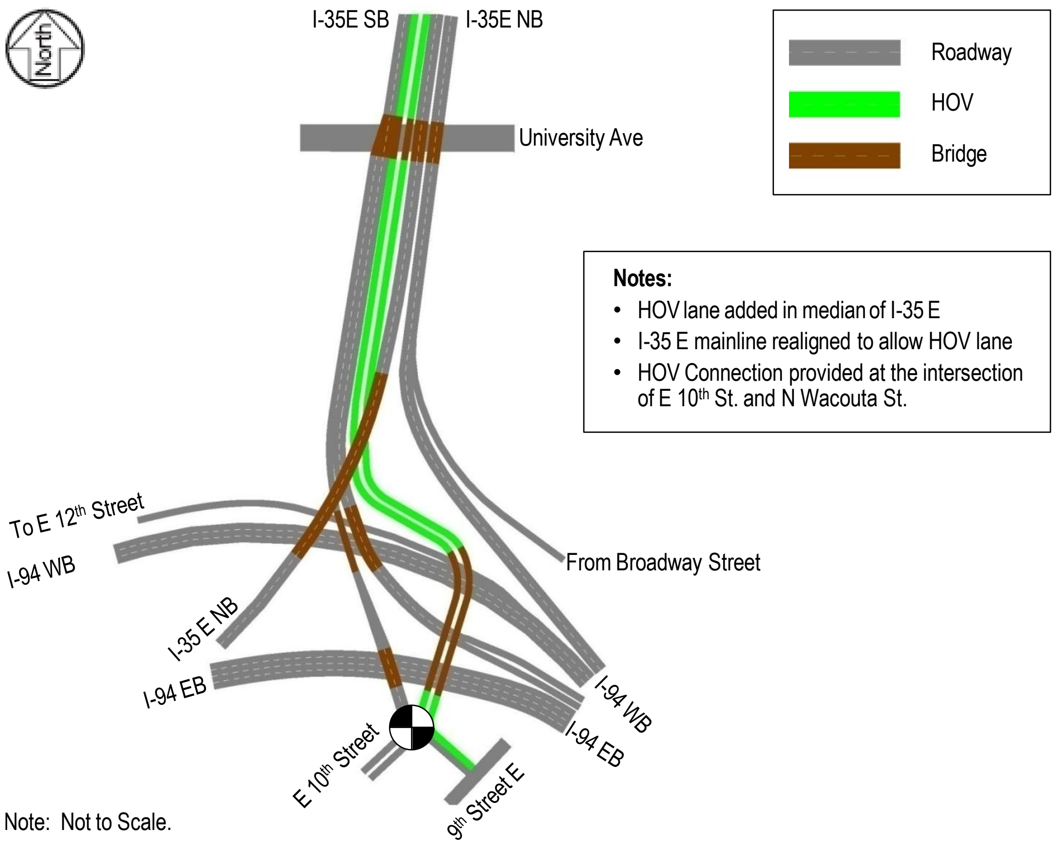
- Segment Length: 9.0 miles.
- New Managed Lane added in median throughout corridor.
- No roadway connection assumed.
- Risk Category: Low (15 percent).
- Total Cost Estimate: $70,000,000 to $95,000,000.
- Cost per Mile: $8,000,000 to $10,500,000 per mile.

Corridor 3A – I-35E: I-94 to TH 36

See Figure 4.1 for design of connection to downtown St. Paul.

- Segment Length: 3.9 miles.
- Mainline realignment with narrow shoulder and lane widths required.
- Roadway connections assumed to Downtown St. Paul, Cost: $15,000,000.
- Risk Category: High (35 percent).
- Total Cost Estimate: $75,000,000 to $90,000,000.
- Cost per Mile: $19,000,000 to $23,000,000 per mile.

Figure 4.1 I-35E Connection to Downtown St. Paul



Note: Not to Scale.

Corridor 3B – I-35E: TH 36 to CR E

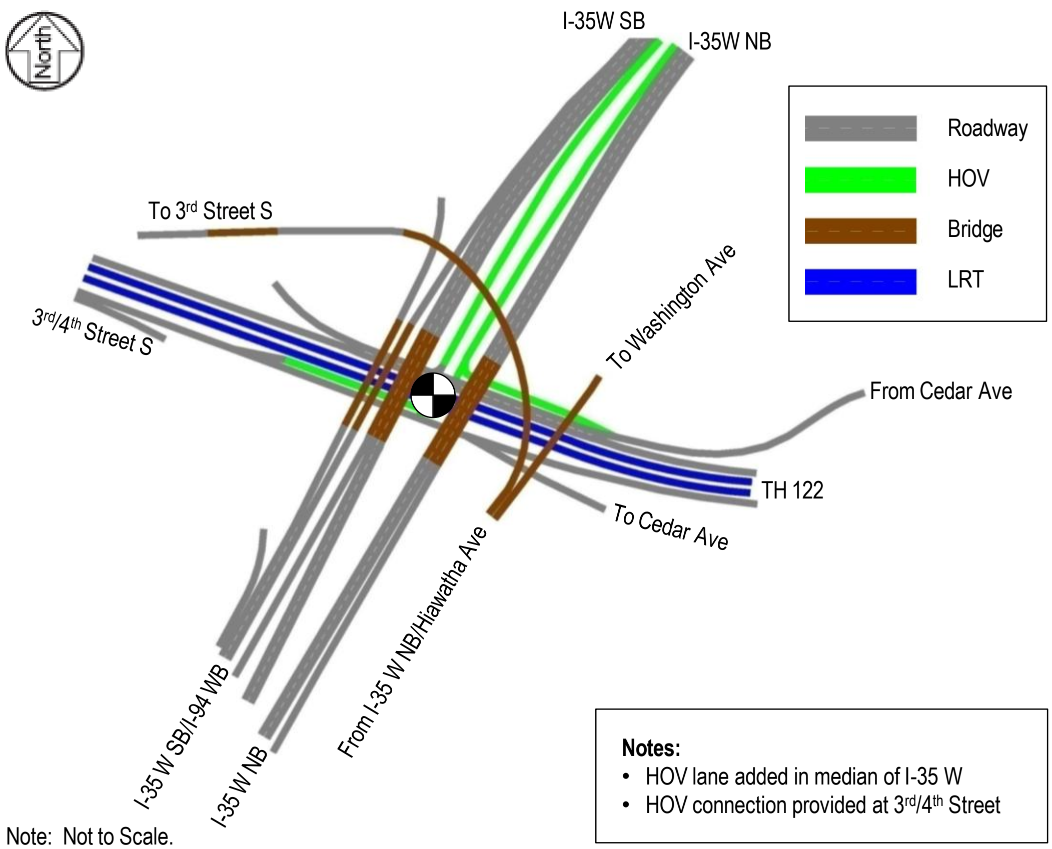
- Segment Length: 3.8 miles.
- New Managed Lane added in median throughout corridor.
- No roadway connections.
- Risk Category: Low (15 percent).
- Total Cost Estimate: $30,000,000 to $40,000,000.
- Cost per Mile: $8,000,000 to $10,500,000 per mile.

Corridor 4A – I-35W: Downtown Minneapolis to TH 36

See Figure 4.2 for design of connection to downtown Minneapolis.

- Segment Length: 5.3 miles.
- Mainline realignment with narrow shoulder and lane widths required.
- Direct roadway connections to 3rd/4th Street to Downtown Minneapolis, Cost: $15,000,000.
- Risk Category: High (35 percent).
- Total Cost Estimate: $95,000,000 to $115,000,000.
- Cost per Mile: $18,000,000 to $21,500,000 per mile.

Figure 4.2 I-35W Connection to Downtown Minneapolis



Corridor 4B – I-35W: TH 36 to Blaine

- Segment Length: 10.8 miles.
- Mainline realignment with narrow shoulder and lane widths required.
- No roadway connections.
- Risk Category: Medium (25 percent).
- Total Cost Estimate: $130,000,000 to $180,000,000.
- Cost per Mile: $12,000,000 to $16,500,000 per mile.

Corridor 5A – I-494: TH 212 to I-394

- Segment Length: 7.6 miles.
- Existing left lane converted to dynamic managed lane.
- Right shoulder converted to priced dynamic general purpose lane.
- No roadway connections.
- ATM includes Dynamic Lane Control functionality.
- Risk Category: Medium (25 percent).
- Total Cost Estimate: $70,000,000 to $125,000,000.
- Cost per Mile: $9,000,000 to $16,500,000 per mile.

Corridor 5B – I-494: I-394 to I-94

- Segment Length: 8.5 miles.
- New Managed Lanes added in median throughout corridor.
- No roadway connections.
- Total Cost Estimate (provided by Mn/DOT): $61,000,000.
- Cost per Mile: $7,000,000 per mile.

Corridor 6A – TH 169: CR 17 to I-494

- Segment Length: 10.0 miles.
- New Managed Lane added in median throughout corridor.
- Narrow lanes and shoulders over Minnesota River Bridge.
- No roadway connections.
- Risk Category: Medium (25 percent).
- Total Cost Estimate: $80,000,000 to $115,000,000.
- Cost per Mile: $8,000,000 to $11,500,000 per mile.

Corridor 7 – TH 77: 141st Street to Old Shakopee Road northbound only

- Segment Length: 6.9 miles.
- Addition of northbound MnPASS lane from CR 38 to East Old Shakopee Road.
- New auxiliary lane on northbound TH 77 from Diffley Road to East Old Shakopee Road.
- Narrow lanes and shoulders on northbound Minnesota River Bridge.
- No roadway connections.
- Total Cost Estimate (provided by Mn/DOT): $41,000,000.
- Cost per Mile: $6,000,000 per mile (northbound only).

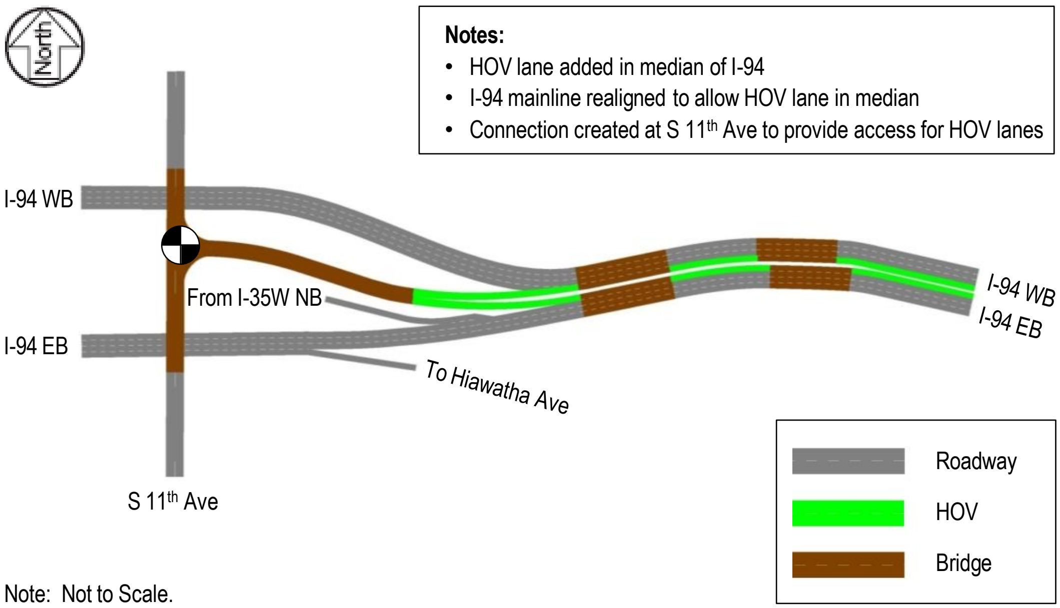
Corridor 8A – I-94: Downtown Minneapolis to TH 280

- Segment Length: 3.0 miles.
- Mainline realignment with narrow shoulder and lane widths required.
- Roadway construction cost estimate (provided by Mn/DOT): $22,000,000.
- Roadway connection assumed to 11th Street in Downtown Minneapolis, Cost: $10,000,000.
- Total Cost Estimate: $41,000,000.[8]
- Cost per Mile: $13,500,000 per mile.

Connection to downtown Minneapolis is shown in Figure 4.3. Note that it was determined that to optimize benefits, Corridors 8A and 8B should be combined.

8 Assumes completion of current Automated Traffic Management (ATM) system project.

Figure 4.3 I-94 Connection to Downtown Minneapolis



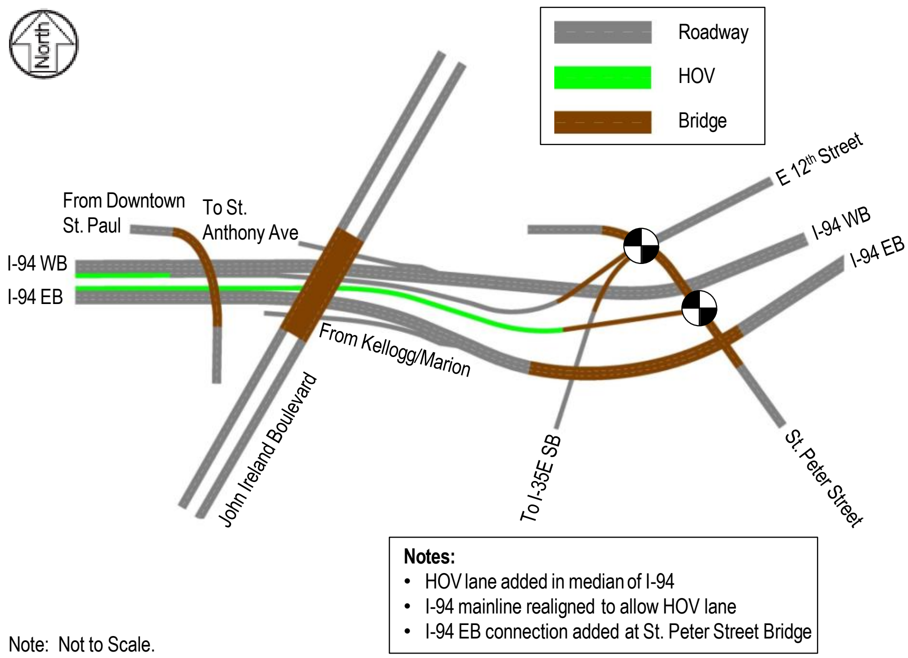
Note: Not to Scale.

Corridor 8B – TH 280 to Downtown St. Paul

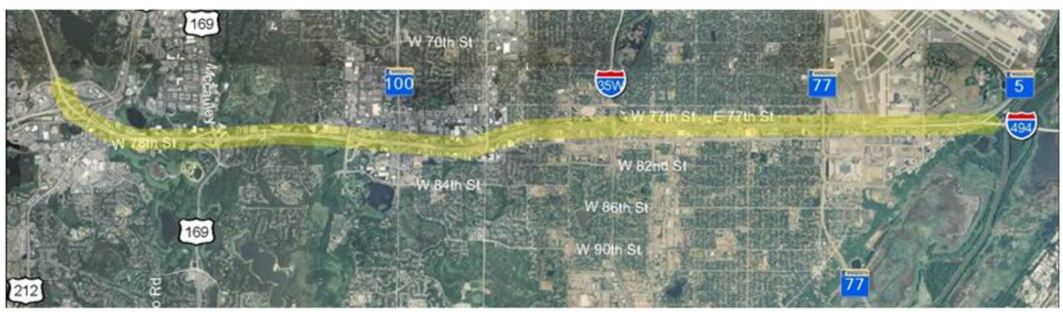
- Segment Length: 5.1 miles.
- Mainline realignment with narrow shoulder and lane widths required.
- Roadway construction cost estimate (based on Mn/DOT cost for 8A): $37,000,000.
- Roadway connection assumed to St. Peter/12th Street in Downtown St. Paul, Cost: $10,000,000.
- Total Cost Estimate: $62,000,000.
- Cost per Mile: $12,000,000 per mile.

Connection to downtown St. Paul is shown in Figure 4.4. Note that it was determined that to optimize benefits, Corridors 8A and 8B should be combined.

Figure 4.4 I-94 Connection to Downtown St. Paul



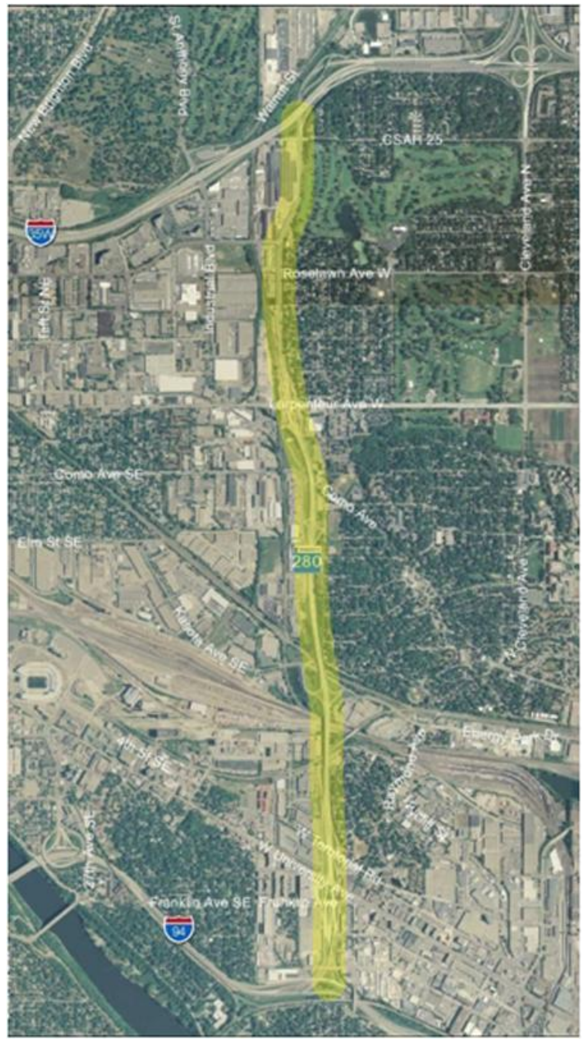
Corridor 10 – I-494: TH 212 to MSP Airport



- Segment Length: 10.6 miles.
- Mainline realignment with narrow shoulder and lane widths required.
- No roadway connections.
- Risk Category: High (35 percent).
- Total Cost Estimate: $150,000,000 to $185,000,000.
- Cost per Mile: $14,000,000 to $17,500,000 per mile.

Corridor 13 – TH 280: I-94 to I-35W

- Removed from consideration for further screening at technical steering committee meeting of April 15, 2010.



4.2 COMBINED CORRIDORS

In addition to the estimates prepared for individual MnPASS corridors, costs were also developed for adjacent corridors that provide logical connectivity for MnPASS users:

- 2 and 5B;
- 1A eastbound, 4A, and 4B;
- 3A and 3B; and
- 8A and 8B.

These locations are characterized by large system interchanges that would require significant construction to accommodate the addition of MnPASS connections between the adjoining corridors. The cost estimates prepared for each combination includes a sum of the low- and high-range estimates for each constituent corridor added to location-specific estimates for modifications to the system interchange to provide the connections. A 35 percent risk calculation was applied to the interchange connection costs in developing the totals for each corridor combination.

Table 4.2 summarizes the costs of the four combined corridors. They range in cost from $105 to $450 million.

Table 4.2 Cost Estimation Summary: Combined Corridors
In Millions

Connection Location	Constituent Corridors	Connection Cost	Risk	Total Cost Estimate Low	Total Cost Estimate High
Fish Lake Interchange	2. I-94: TH 101 to I-494 5B. I-494: I-394 to I-94	$35	$14	$180	$205
I-35W/TH 36 Commons	1A. TH 36: I-35W to I-35E 4A. I-35W: DT Minneapolis to TH 36 4B. I-35W: TH 36 to Blaine	$50	$20	$330	$450
I-94/TH 280 Interchange	8A. I-94: DT Minneapolis to TH 280 8B. I-94: TH 280 to DT St. Paul	$25	$9	$140	
None[a]	3A. I-35E: I-94 to TH 36 3B. I-35E: TH 36 to CR E	N/A	N/A	$105	$130

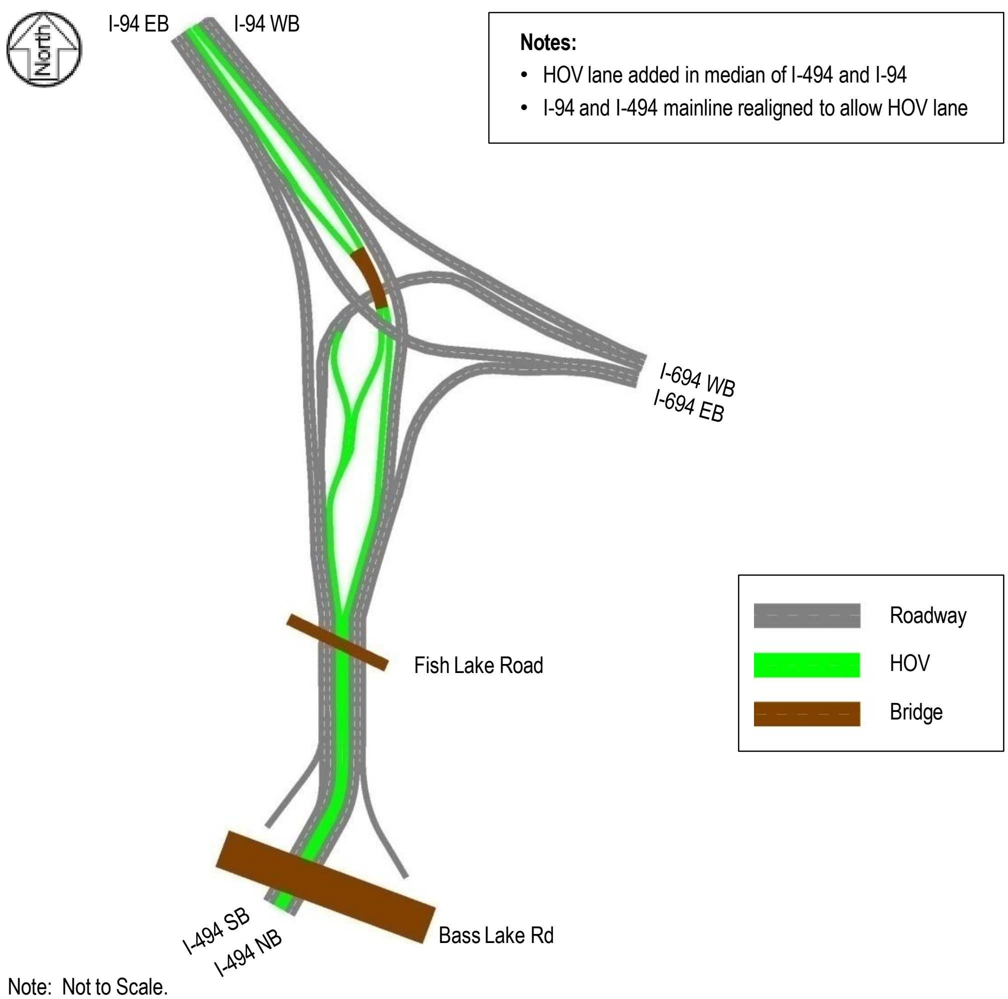
[a] These two sections are just continuations of the same highway, and can be combined without construction of a new interchange.

Fish Lake Interchange

See Figure 4.5 for design of connection between I-94 and I-494.

- Constituent corridors:
  - 2 – I-94: TH 101 to I-494.
  - 5B – I-494: I-394 to I-94.
- Roadway Connection Cost: $35,000,000.
  - Risk: $14,000,000.
- Total Cost Estimate: $180,000,000-$200,000,000.

Figure 4.5 Design of Connection between I-94 and I-494
Fish Lake Interchange

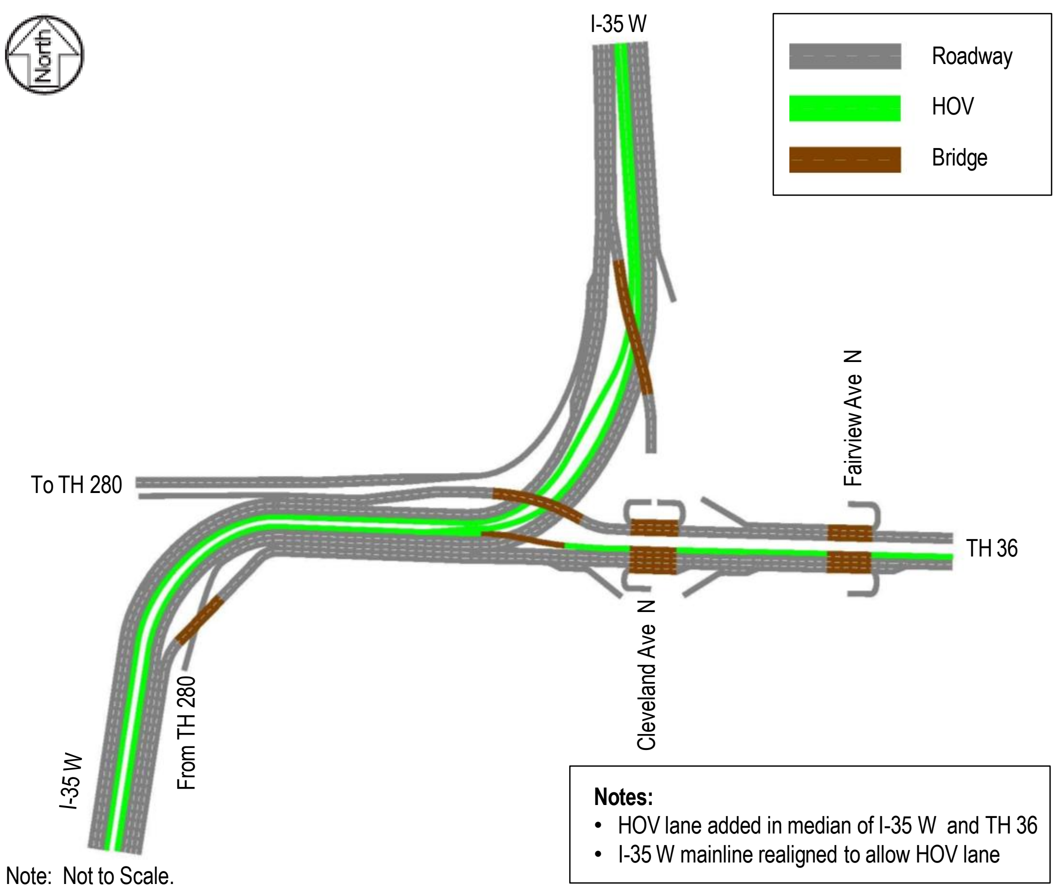


I-35W/TH 36 Commons

See Figure 4.6 for design of connection between I-35W northbound and TH 36 eastbound.

- Constituent corridors:
  - 1A – TH 36: I-35W to I-35E eastbound.
  - 4A – I-35W: Downtown Minneapolis to TH 36.
  - 4B – I-35W: TH 36 to Blaine.
- Roadway Connection Cost: $50,000,000.
  - Risk: $20,000,000.
- Total Cost Estimate: $330,000,000 to $450,000,000.

Figure 4.6 Design of I-35W and TH 36 Interchange

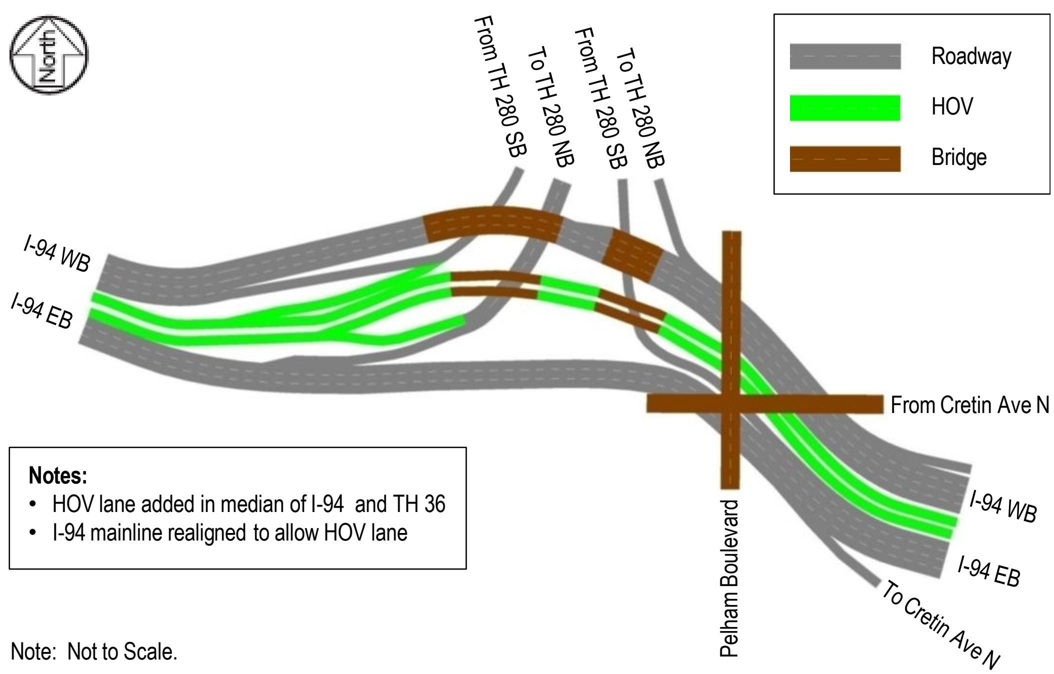


I-94/TH 280 Interchange

See Figure 4.7 for design of this interchange.

- Constituent corridors:
  - 8A – I-94: Downtown Minneapolis to TH 280.
  - 8B – I-94: TH 280 to Downtown Saint Paul.
- Roadway Connection Cost: $25,000,000.
  - Risk: $9,000,000.
- Total Cost Estimate: $140,000,000.

Figure 4.7 Design of I-94/TH 280 Interchange



The MHSIS study was conducted in parallel to this MnPASS Phase 2 study, and separate cost estimates were developed for some of the corridors. To ensure consistency, the two project teams reviewed each others' cost estimates and reconciled the differences. The results of this reconciliation are shown in Table 4.3.

Table 4.3 Comparison of MnPASS and MHSIS Cost Estimates
In Millions

MnPASS Corridor	Length (Miles)	MnPASS Design	MnPASS Estimate		MHSIS Estimate		Comment
			Low	High	Low	High	
1A. TH 36: I-35W to I-35E	5.0	Add Lane on Left	$35	$60	$35	$60	
2. I-94: TH 101 to I-494	9.0	Add Lane on Left	$70	$95	$70	$95	
3A. I-35E: I-94 to TH 36	3.9	Reduced Shoulder/Lane	$75	$90	$35	$48	MHSIS limits: North of Maryland Avenue to south of TH 36, Length 2.3 miles (1.6 miles shorter) MnPASS roadway connection not included in MHSIS ($15M)
3B. I-35E: TH 36 to CR E	3.8	Add Lane on Left	$30	$40	$7	$12	Corridor design different between studies (MHSIS = Lane conversion)
4A. I-35W: DT Minneapolis to TH 36	5.3	Reduced Shoulder/Lane	$95	$115	$47	$60	MHSIS limits: North of 4th Street to south of TH 280, Length 3.1 miles (2.2 miles shorter) MnPASS roadway connection not included in MHSIS ($15M)
4B. I-35W: TH 36 to Blaine	10.8	Reduced Shoulder/Lane	$130	$180	$140	$190	MHSIS limits: TH 280 to 95th Avenue, Length 9.9 miles (0.9 miles shorter) MHSIS estimate includes additional work in I-35W/TH 36 common segment
5A. I-494: TH 212 to I-394	7.6	PDSL	$70	$125	$123	$161	MHSIS limits: TH 169 to I-394, Length 9.4 miles (1.8 miles longer)
5B. I-494: I-394 to I-94	8.5	Add Lane on Left	$61		$61		
6A. TH 169: CR 17 to I-494	10.0	Add Lane on Left[a]	$80	$115	$93	$116	MHSIS limits: Minnesota River to TH 62, Length 6.6 miles (3.4 miles shorter); Corridor design different between studies (MHSIS = Reduced Shoulder/Lane with Mill and Overlay)
7. TH 77: 141st Street to Old Shakopee Road	6.9	Reduced Shoulder/Lane	$41 (provided by Mn/DOT)		$41 (provided by Mn/DOT)		

Table 4.3 Comparison of MnPASS and MHSIS Cost Estimates (continued)

In Millions

MnPASS Corridor	Length (Miles)	MnPASS Design	MnPASS Estimate		MHSIS Estimate		Comment
			Low	High	Low	High	
8A. I-94: DT Minneapolis to TH 280	3.0	Reduced Shoulder/Lane	$41		$41		
8B. I-94: TH 280 to DT St. Paul	5.1	Reduced Shoulder/Lane	$62		$62		
10. I-494: TH 212 to MSP Airport	10.6	Reduced Shoulder/Lane	$150	$185	$130	$155	MHSIS limits: TH 169 to TH 5, Length 9.0 miles (1.6 miles shorter)

Add Lane on Left: MnPASS lanes added in median, existing roadway alignment not shifted or narrowed.

Reduced Shoulder/Lane: Lane and/or shoulder widths potentially reduced to accommodate addition of MnPASS lanes.

PDSL: Existing left lane converted to dynamic MnPASS lane, right shoulder converted to dynamic general purpose lane.

[a] TH 169 has adequate median width for MnPASS lanes in all locations except Minnesota River Bridge. This segment requires reduced shoulder and lane width design.

5.0 Travel Demand Forecasting Results

This section describes the results of the travel demand forecasting, providing information on traffic volumes, vehicle miles traveled, and speeds, both with and without the proposed MnPASS lanes for each of the alternatives. Section 6.0 (the next section) provides a more nuanced evaluation of alternatives through several performance measures.

Tables 5.1 through 5.3 summarize these metrics:

- Vehicle miles traveled (VMT) in Table 5.1;
- Average daily volume in Table 5.2; and
- Change in speed in the general purpose lanes and all lanes in Table 5.3.

In each table, results for the stand-alone corridors are presented at the top, and those for the combined corridors are presented at the bottom. The most critical data column is highlighted in yellow. The corridors with the largest impact are highlighted in green.

As shown in Table 5.1, the two longest individual corridors 4B (I-35W) and 10 (I-494), and the two longest combined corridors 2 (I-94 and 5B I-494), and 4A and 4B (I-35W and 3A TH 36) have by far the highest amount of VMT in the managed lanes. A more nuanced view of managed lane usage is shown by the volume figures in Table 5.2. The highest forecast usage is for corridors 10 (I-494), 4A (I-35W), and 3A (I-35E). The highest use combined corridor is 8 (I-94).

In both the case of VMT and volume, the total volume in the corridor with the managed lanes is generally somewhat higher than the total volume in the No Build corridor without the managed lanes. This means that trips are being diverted into the corridors from other congested routes in response to the improved travel conditions. Without this diversion, the improvements in average speed shown in Table 5.3 might be even greater, but it also means that there are likely improvements in traffic operations on other roadways that are not being captured by this analysis.

As shown in Table 5.3, improvements in average speeds range from approximately 1.0 to 4.5 mph. Improvements are greater in the "total" columns which reflect average speeds in both the general purpose and managed lanes (which by definition are kept at free-flow conditions through the pricing mechanism), than they are in just the general purpose lanes alone. However, it is important to note that even drivers who chose to remain in the general purpose lanes will experience an increase in average speed as a result of the managed lanes. In general, improvements in speed are greatest in the peak periods relative to daily as one would hope and expect to be the case. The biggest improvements on a daily basis including both the GP and managed lanes are on Corridors 4B (I-35W), 5B (I-494), 6A (TH 169) and 7 (TH 77).

Table 5.1 Average Daily Vehicle Miles Traveled (VMT) Comparison
2015

MnPASS Alternative			VMT			
			Base	MnPASS Alternative		
Corridor	Length (Miles)	Corridor Description	Mainline	Mainline	Managed	Corridor Total
1A	4.63	TH 36: I-35W to I-35E (EB Only)	242,500	231,800	24,100	255,900
2	8.53	I-94: TH 101 to I-494	847,100	823,800	31,500	855,300
3A	3.56	I-35E: I-94 to TH 36	519,200	501,500	39,900	541,400
3B	3.29	I-35E: TH 36 to CR E	416,400	407,100	11,700	418,800
4A	4.15	I-35W: Downtown Minneapolis to TH 36	668,700	640,200	57,400	697,600
4B	12.21	I-35W: TH 36 to Blaine	1,367,000	1,300,400	121,600	1,422,000
5A	6.82	I-494: TH 212 to I-394 (Peak Only)	747,400	724,100	45,400	769,500
5B	7.77	I-494: I-394 to I-94	748,100	711,300	75,500	786,900
6A	9.49	TH 169: CR 17 to I-494	750,300	721,000	69,200	790,200
7	5.98	TH 77: 141st Street to Old Shakopee Road (NB Only)	260,700	250,900	16,300	267,200
10	10.73	I-494: TH 212 to Minneapolis-Saint Paul Airport	1,665,600	1,598,900	163,400	1,762,300
Combined Corridors						
2 + 5B	16.30	2 + 5B	1,635,100	1,574,500	113,100	1,687,600
4A + 4B + 1A	21.64	4A + 4B + 1A	2,351,900	2,259,100	210,200	2,469,300
3A + 3B	6.85	3A + 3B	987,900	961,300	60,600	1,021,900
8A + 8B	7.77	I-94: Downtown Minneapolis to Downtown Saint Paul	1,293,500	1,241,400	98,900	1,340,300

Table 5.2 Average Daily Volume Comparison
2015

MnPASS Alternative			Average Daily Volume			
			Base	MnPASS Alternative		
Corridor	Length (Miles)	Corridor Description	Mainline	Mainline	Managed	Corridor Total
1A	4.63	TH 36: I-35W to I-35E (EB Only)	52,400	50,100	5,200	55,300
2	8.53	I-94: TH 101 to I-494	99,300	96,600	3,700	100,300
3A	3.56	I-35E: I-94 to TH 36	145,800	140,900	11,200	152,100
3B	3.29	I-35E: TH 36 to CR E	126,600	123,700	3,600	127,300
4A	4.15	I-35W: Downtown Minneapolis to TH 36	161,100	154,300	13,800	168,100
4B	12.21	I-35W: TH 36 to Blaine	112,000	106,500	10,000	116,500
5A	6.82	I-494: TH 212 to I-394 (Peak Only)	109,600	106,200	6,700	112,800
5B	7.77	I-494: I-394 to I-94	96,300	91,500	9,700	101,300
6A	9.49	TH 169: CR 17 to I-494	79,100	76,000	7,300	83,300
7	5.98	TH 77: 141st Street to Old Shakopee Road (NB Only)	43,600	42,000	2,700	44,700
10	10.73	I-494: TH 212 to Minneapolis-Saint Paul Airport	155,300	149,100	15,200	164,300
Combined Corridors						
2 + 5B	16.30	2 + 5B	96,600	93,100	6,700	99,700
4A + 4B + 1A	21.64	4A + 4B + 1A	108,700	104,400	9,700	114,100
3A + 3B	6.85	3A + 3B	136,500	132,800	8,400	141,200
8A + 8B	7.77	I-94: Downtown Minneapolis to Downtown Saint Paul	166,500	159,800	12,700	172,500

Table 5.3 Change in Average Speed: MnPASS Alternative Compared to Base in the General Purpose (GP) Lanes and in Total A.M and P.M. Peak Periods and Daily

2015

MnPASS Alternative			Change in Average Speeds (miles per hour)					
			General Purpose Lanes			Total All Lanes		
Corridor	Length (Miles)	Corridor Description	a.m.	p.m.	Day	a.m.	p.m.	Day
1A	4.63	TH 36: I-35W to I-35E (EB Only)	1.6	0.9	1.0	2.9	2.9	2.5
2	8.53	I-94: TH 101 to I-494	2.8	3.3	2.6	3.5	4.1	3.0
3A	3.56	I-35E: I-94 to TH 36	1.4	1.6	1.5	2.9	3.0	2.7
3B	3.29	I-35E: TH 36 to CR E	2.3	1.9	1.6	2.8	2.5	2.0
4A	4.15	I-35W: Downtown Minneapolis to TH 36	1.9	1.8	1.7	3.4	3.2	3.0
4B	12.21	I-35W: TH 36 to Blaine	2.6	2.4	2.4	4.0	3.9	3.6
5A	6.82	I-494: TH 212 to I-394 (Peak Only)	2.2	2.5	2.3	3.5	4.1	3.1
5B	7.77	I-494: I-394 to I-94	2.3	2.6	2.2	4.0	4.4	3.7
6A	9.49	TH 169: CR 17 to I-494	2.8	2.9	3.2	4.5	4.6	4.4
7	5.98	TH 77: 141st Street to Old Shakopee Road (NB Only)	2.7	0.6	3.1	4.3	1.0	3.9
10	10.73	I-494: TH 212 to Minneapolis-Saint Paul Airport	1.9	1.7	1.9	3.6	3.2	3.3
Combined Corridors								
2 + 5B	16.30	2 + 5B	2.2	2.5	2.2	3.4	3.9	3.1
4A + 4B + 1A	21.64	4A + 4B + 1A	1.8	1.7	1.6	3.2	3.2	2.9
3A + 3B	6.85	3A + 3B	1.4	1.5	1.3	2.6	2.7	2.3
8A + 8B	7.77	I-94: Downtown Minneapolis to Downtown Saint Paul	1.0	1.2	1.2	2.3	2.6	2.4

6.0 Performance Measures

The performance measures in this study were selected to be consistent with the MHSIS as well as with Mn/DOT's Long-Range Transportation Plan. However, some variation in results between this study and the MHSIS may exist due to additional model refinements done as part of the MnPASS System Study Phase 2, as well as different forecast years between the studies, as discussed previously.

The corridors and combination corridors were evaluated with the following performance measures:

- Travel-Time Reliability, measured through vehicle-minutes of delay saved per trip both daily and during the peak period and for both managed and general purpose lanes;
- Throughput, measured as the change in vehicle throughput in a corridor as well as the change divided by the total centerline miles of the corridor;
- Travel-Time Reduction,, measured by the reduction in vehicle-hours traveled for both general purpose and managed lanes in a corridor;
- Change in Congested Vehicle-Miles Traveled, measured directly systemwide and as a percentage of total vehicle-miles traveled; and
- Transit Suitability.

6.1 Performance Results

As shown in Table 6.1, Corridor 6A performs the best in terms of vehicle-minutes of delay saved per trip, with over 10 minutes per trip saved for users of the managed lanes compared to the no-build travel times for those trips. Corridor 10, Combined Corridor 1A+4A+4B, and Corridor 4B also perform well with this metric.

Table 6.1 Travel-Time Reliability
Daily Vehicle-Minutes of Delay Saved per Trip (2015)

Corridor		Daily		Peak	
		General Purpose	Managed	General Purpose	Managed
1A	TH 36: I-35W to I-35E (EB Only)	0.14	3.87	0.22	5.14
2	I-94: TH 101 to I-494	0.17	3.33	0.3	3.58
3A	I-35E: I-94 to TH 36	0.18	3.7	0.29	4.6
3B	I-35E: TH 36 to CR E	0.03	1.55	0.04	1.69
4A	I-35W: Downtown Minneapolis to TH 36	0.17	3.82	0.27	5.09
4B	I-35W: TH 36 to Blaine	0.26	5.86	0.42	8.04
5A	I-494: TH 212 to I-394 (Peak Only)	0.17	3.55	0.29	3.71
5B	I-494: I-394 to I-94	0.21	4.4	0.34	5.53
6A	TH 169: CR 17 to I-494	0.81	8.91	1.31	10.24
7	TH 77: 141st Street to Old Shakopee Road (NB Only)	0.18	3.81	0.29	4.21
10	I-494: TH 212 to MSP Airport	0.33	7.41	0.53	10.01
Combined Corridors					
2 + 5B	2 + 5B	0.24	5.32	0.4	6.36
4A + 4B + 1A	4A + 4B + 1A	0.29	6.74	0.46	9.09
3A + 3B	3A + 3B	0.12	4.54	0.2	5.55
8A + 8B	I-94: Downtown Minneapolis to Downtown St. Paul	0.22	5.46	0.36	7.27

As shown in Table 6.2, MnPASS lanes in Corridor 10 create the greatest change in total vehicle throughput among the corridors, though Corridors 3A and 4A have the largest change in vehicle throughput when normalized for corridor length. Combined Corridor 8A+8B performs well both in terms of absolute and normalized throughput.

As shown in Table 6.3, Corridor 10, Combined Corridor 1A+4A+4B, and Corridor 6A perform the best in terms of reduction in total vehicle-hours traveled. Corridor 4B and Combined Corridors 8A+8B and 2+5B are in the next tier.

As shown in Table 6.4, Corridor 10 and Combined Corridor 1A+4A+4B result in the greatest reduction of congested VMT, with values nearly double those of the next highest corridors. Corridor 6A and Combined Corridors 2+5B and 8A+8B are the next highest performers according to this metric.

Table 6.2 Change in Average Daily Vehicle Throughput
2015

Corridor		Change in Vehicle Throughput	Vehicle Throughput/ Centerline Mile
1A	TH 36: I-35W to I-35E (EB Only)	2,900	626
2	I-94: TH 101 to I-494	1,000	117
3A	I-35E: I-94 to TH 36	6,300	1,770
3B	I-35E: TH 36 to CR E	700	213
4A	I-35W: Downtown Minneapolis to TH 36	7,000	1,687
4B	I-35W: TH 36 to Blaine	4,500	369
5A	I-494: TH 212 to I-394 (Peak Only)	3,200	469
5B	I-494: I-394 to I-94	5,000	644
6A	TH 169: CR 17 to I-494	4,200	443
7	TH 77: 14st Street to Old Shakopee Road (NB Only)	1,100	184
10	I-494: TH 212 to MSP Airport	9,000	839
Combined Corridors			
8A + 8B	I-94: Downtown Minneapolis to Downtown St. Paul	3,100	190
2 + 5B	2 + 5B	5,400	250
4A + 4B + 1A	4A + 4B + 1A	4,700	686
3A + 3B	3A + 3B	6,000	772

Table 6.3 Average Daily Reduction in Vehicle Hours Traveled
2015

Corridor		General Purpose	Managed
1A	TH 36: I-35W to I-35E (EB Only)	232	354
2	I-94: TH 101 to I-494	472	233
3A	I-35E: I-94 to TH 36	551	700
3B	I-35E: TH 36 to CR E	103	95
4A	I-35W: Downtown Minneapolis to TH 36	750	828
4B	I-35W: TH 36 to Blaine	1,401	1,345
5A	I-494: TH 212 to I-394 (Peak Only)	468	410
5B	I-494: I-394 to I-94	623	755
6A	TH 169: CR 17 to I-494	2,337	1,402
7	TH 77: 141st Street to Old Shakopee Road (NB Only)	237	190
10	I-494: TH 212 to MSP Airport	2,498	2,400
Combined Corridors			
2 + 5B	2 + 5B	1,171	1,021
4A + 4B + 1A	4A + 4B + 1A	2,527	2,555
3A + 3B	3A + 3B	649	850
8A + 8B	I-94: Downtown Minneapolis to Downtown St. Paul	1,228	1,521

Table 6.4 Average Daily Change in Systemwide Congested VMT
System Level (2015)

Corridor		Daily	Percent of Total VMT	Peak	Percent of Total VMT
1A	TH 36: I-35W to I-35E (EB Only)	8,288	0.01%	11,354	0.02%
2	I-94: TH 101 to I-494	35,137	0.03%	41,596	0.06%
3A	I-35E: I-94 to TH 36	37,720	0.04%	41,765	0.06%
3B	I-35E: TH 36 to CR E	21,556	0.02%	27,729	0.04%
4A	I-35W: Downtown Minneapolis to TH 36	47,469	0.05%	53,398	0.08%
4B	I-35W: TH 36 to Blaine	45,465	0.04%	51,395	0.08%
5A	I-494: TH 212 to I-394 (Peak Only)	32,383	0.03%	32,383	0.05%
5B	I-494: I-394 to I-94	22,546	0.02%	27,661	0.04%
6A	TH 169: CR 17 to I-494	88,250	0.09%	90,953	0.14%
7	TH 77: 141st Street to Old Shakopee Road	24,167	0.02%	30,530	0.05%
10	I-494: TH 212 to MSP Airport	203,291	0.20%	187,114	0.29%
Combined Corridors					
2 + 5B	2 + 5B	84,284	0.08%	87,909	0.14%
4A + 4B + 1A	4A + 4B + 1A	165,106	0.16%	166,802	0.26%
3A + 3B	3A + 3B	43,196	0.04%	44,001	0.07%
8A + 8B	I-94: Downtown Minneapolis to Downtown St. Paul	88,773	0.09%	91,114	0.14%

6.2 Transit Suitability Results

Candidate corridors were evaluated on the basis of transit suitability, including the amount of transit use along each corridor, existing transit facilities, and future transit plans. In order to determine which corridors would have the highest benefit to transit, corridors were evaluated based on the following criteria:

- Total number of daily bus trips;
- Total number of peak-period bus trips;
- Existing bus-only shoulder (BOS) facilities;
- Amount of short bus trips (impact of BOS usage);
- Future planned transit facilities (park-and-ride, bus rapid transit, and express bus); and
- Future planned BOS facilities.

Information for each corridor was compiled with input from Metro Transit and is summarized in Table 6.5. Based on input from transit stakeholders during the study process, MnPASS lanes were felt to provide a higher benefit than BOS overall to transit due to shorter and more reliable travel times, though shorter bus trips that currently use the BOS would not benefit from MnPASS lanes if they have to weave across several lanes of general purpose traffic to reach the MnPASS left lanes.

Table 6.5 Transit Suitability Summary

Corridor	Bus Routes	A.M. Trips	P.M. Trips	Total Daily Trips	Percent of Trips in Peaks	B.O.S. Existing	Future Plans	Transit Benefit
1A. TH 36: I-35W to I-35E	260, 261, 270, 272	41	39	108	74%	√	Transit way	High
2. I-94: TH 101 to I-494	783, 784	12	11	23	100%	√ Partial	B.O.S.	Low
3A. I-35E: I-94 to TH 36 3B. I-35E: TH 36 to CR E	275, 860, 265	21	17	39	97%	√ Partial	Transit way	Medium
4A. I-35W: DT Minneapolis to TH 36 4B. I-35W: TH 36 to Blaine	118, 250, 252, 260, 261, 264, 270, 272 250, 252, 261, 264, 288	138	132	302	89%	√	Transit way	High
5A. I-494: TH 212 to I-394	None	–	–	–	–	–	–	Low
5B. I-494: I-394 to I-94	None	–	–	–	–	–	–	Low
6A. TH 169: CR 17 to I-494	490, 491, 680	11	11	22	100%	√ Partial	B.O.S.	Low
7. TH 77: 141st Street to Old Shakopee Road	440, 441, 442, 444, 472, 476, 478, 479, 480	54	65	200	60%	√	Transit way	High
8A. I-94: DT Minneapolis to TH 280 8B. I-94: TH 280 to DT St. Paul	94, 134, 144, 353, 355, 365, 375, 452	97	96	266	73%	no	B.O.S.	High
10. I-494: TH 212 to MSP Airport	None	–	–	–	–	–	–	Low

The evaluation was based on the number of daily bus trips and separated corridors into three categories. Corridors are considered of high benefit to transit if there are 100 or more buses using the corridor daily, mid-level benefit if there are less than 40 buses per day, and low benefit if there is low or no transit use along the corridor.

Corridors 1A, 4A and 4B, and 7, as well as Combined Corridor 8A+8B, exhibit the greatest benefit to transit with the highest existing bus volumes, followed by corridor 3. These high-benefit corridors also have transit service outside of just the peak periods, indicating that operating the managed lanes outside of only the peak periods could be beneficial for transit in these corridors. Further, Metro Transit is already planning transitways in three of the four high-benefit corridors, creating further synergies with transit.

7.0 Benefit/Cost and Financial Analysis

7.1 Approach to Benefit/Cost Analysis

A sketch-level benefit/cost analysis was performed in a manner consistent with the MHSIS, and with Mn/DOT standard benefit/cost methodologies. The analysis covered a 20-year period, assuming the opening year of the lanes is 2015 and the capital costs are incurred in 2014. Beyond 2015, the benefits were assumed to grow at a modest rate of 1.2 percent per year, reflecting assumed increases in traffic.

Two types of benefits were included in the analysis: vehicle operating and maintenance benefits (calculated from the system VMT changes output from the travel demand model), and travel time savings (calculated from the system VHT changes from the model). Mn/DOT values for vehicle operating costs, values of time, and vehicle occupancy are shown in Table 7.1. The benefits were estimated for 2015, but are assumed to grow as traffic grows at 1.2 percent.

Table 7.1 Benefit/Cost Assumptions

Benefit Description	Value	Cost Categories	Useful Life (Years)
Auto Value of Time (per hour)	$13.59	Major Structures	60
Truck Value of Time (per hour)	$17.08	Grading and Drainage	50
Auto Vehicle Operating Cost (per mile)	$0.26	Sub-Base and Base	40
Truck Vehicle Operation Cost (per mile)	$0.71	Surface	25
Vehicle Occupancy (per vehicle)	1.35		
Discount Factor	2.9%		
Inflation Rate	3.0%		
Evaluation Period	20 years		
Annual O&M Costs	$50,000/mile		

Source: Mn/DOT.

Three types of costs were included in the analysis: 1) capital costs 2), operating and maintenance costs, and 3) salvage costs. Operating and maintenance costs reflect the costs of operating the toll collection and enforcement systems (not roadway maintenance) and were estimated by Mn/DOT at $50,000 per mile annually based on experience with I-394 and I-35W MnPASS lanes and assuming some level of back office efficiencies associated with operating multiple MnPASS facilities.

The salvage costs are based on standard Mn/DOT benefit/cost methodologies. The remaining life for different elements of MnPASS lane construction, based on the useful life shown in Table 7.1, was applied to the different costs constituting the capital costs estimated in Section 4.0. Salvage costs are added back in the final year of analysis. Salvage costs, as with the other costs and benefits, are discounted back to 2010 dollars assuming a 2.9 percent discount rate; each are summed, and benefits are divided by costs to create the benefit/cost ratio.

As in any benefit/cost analysis involving toll payments, the value of the toll itself is considered neither a benefit nor a cost. This is because it is a transfer from individuals to government, and does not affect the economic value of the investment.

7.2 BENEFIT/COST ANALYSIS FINDINGS

Table 7.2 summarizes the results of the benefit/cost analysis. The benefits of the proposed MnPASS lanes are primarily driven by the systemwide travel time savings, and the costs are primarily driven by the capital costs. Corridors 6A (U.S. 169 from CR 17 to I-494) and 10 (I-494 from TH 212 to MSP) have the highest benefit/cost ratios. Both are relatively long (10 or more miles) and result in large travel time benefits relative to other corridors; Corridor 10 has a high up-front capital cost, however, and both corridors have relatively high elements of risk in terms of engineering issues and cost. Corridor 5B (I-394 to I-94) does better in the benefit/cost analysis than in the performance analysis in Section 6.0, primarily because of its relatively low cost.

Corridors 4B (I-35W from TH 36 to Blaine) and 7 (TH 77 northbound from 141st Street to I-494) also have relatively high benefit/cost ratios: 4B because of its relatively high time savings, and 7 because of its relatively low cost. Corridors 8A and 8B (I-94 between downtown Minneapolis and downtown St. Paul) have the highest ratio among the combined corridors.

Table 7.2 Benefit/Cost Analysis Results

Corridor	Length	Costs (2010 Dollars) Capital	Annual Operating	Salvage	Total 20-Year Costs (Discounted)	Benefits Time Savings (2015)	Vehicle Operating Costs (2015)	Total 20-Year Benefits (Discounted)	B/C
1A. TH 36: I-35W to I-35E	5.0	$47.5	$0.25	$(19.0)	$36.2	$4.8	$(0.3)	$67.4	1.9
2. I-94: TH 101 to I-494	9.0	$82.5	$0.45	$(30.1)	$64.4	$5.0	$(0.4)	$68.6	1.1
3A. I-35E:I-94 to TH 36	3.9	$82.5	$0.20	$(33.1)	$59.5	$11.2	$(0.5)	$158.5	2.7
3B. I-35E: TH 36 to CR E	3.8	$35.0	$0.19	$(13.3)	$27.1	$3.0	$(0.2)	$41.0	1.5
4A. I-35W: DT Minneapolis to TH 36	5.3	$105.0	$0.27	$(42.9)	$75.6	$15.2	$(1.1)	$209.6	2.8
4B. I-35W: TH 36 to Blaine	10.8	$155.0	$0.54	$(58.6)	$116.0	$29.8	$(1.5)	$420.1	3.6
5A. I-494: TH 212 to I-394	7.6	$97.5	$0.38	$(35.8)	$74.0	$11.3	$(1.1)	$151.3	2.0
5B. I-494: I-394 to I-94	8.5	$61.0	$0.43	$(27.1)	$46.4	$15.0	$(1.0)	$208.2	4.5
6A. TH 169: CR 17 to I-494	10.0	$97.5	$0.50	$(34.7)	$76.2	$42.1	$0.1	$627.4	8.2
7. TH 77: 141st Street to Old Shakopee Rd	6.9	$41.0	$0.35	$(22.3)	$30.0	$7.0	$(0.2)	$101.7	3.4
10. I-494: TH 212 to MSP Airport	10.6	$167.5	$0.53	$(58.1)	$127.3	$55,6	$(2.1)	$795.8	6.3
2. I-94: TH 101 to I-494 5B. I-494: I-394 to I-94	17.5	$192.5	$0.88	$(76.3)	$145.0	$23.3	$(1.8)	$319.8	2.2
1A. TH 36: I-35W to I-35E 4B. I-35W: TH 36 to Blaine 4A. I-35W: DT Minneapolis to TH 36	21.1	$377.5	$1.06	$(139.5)	280.6	$54.1	$(3.7)	$750.0	2.7
8A. I-94: DT Minneapolis to TH 280 8B. I-94: TH 280 to DT St. Paul	8.1	$140.0	$0.41	$(69.5)	$95.3	$25.9	$(2.0)	$355.1	3.7
3A. I-35E: I-94 to TH 36 3B. I-35E: TH 36 to CR E	7.7	$117.5	$0.39	$(38.3)	$86.6	$14.0	$(0.9)	$195.2	2.2

7.3 Approach to Financial Analysis

A sketch-level financial analysis was performed to provide a relative comparison of projects. The analysis is not adequate to support project financing. A more refined and detailed analysis of traffic, revenue, costs and financial structures should be performed in future studies after corridors are selected.

The assumptions used in the financial analysis are consistent with standard practice and typical Mn/DOT values (Table 7.3). The operating and maintenance costs and capital costs are consistent with those used in the benefit/cost analysis, and are assumed to increase by 3 percent per year. Revenues, estimated using the model and current MnPASS data, were estimated for 2015 but are assumed to grow as traffic grows at 1.2 percent annually, with a 10 percent increase in the price of tolls assumed for every five years. A toll evasion rate of 3 percent is assumed and removed from the total estimated revenues.

Table 7.3 Financial Assumptions

Description	Value
Debt Service Coverage	1.5x
Interest Rate	6.25%
Maturity	20 years
Tolls increase every	5 years
Tolls increase by	10%
Inflation Rate	3.0%
Annual O&M Costs	$50,000/mile

The analysis assumes the issuance of tax-exempt toll revenue bonds amortized over 20 years. The debt has a senior claim on net toll revenue after payment of operating expenses (i.e., annual revenues are first used to cover annual operating and maintenance costs) and is structured to achieve minimum annual debt service coverage of 1.50x (i.e., 67 percent of the remainder in revenues is used for debt payment on the bonds, allowing for variability in actual revenue generation). The assumed interest rate for current toll revenue bonds is 6.25 percent, a conservative (high side) assumption.

The total present value of the 20 years of maximum debt payments is calculated, removing capitalized interest, a 10 percent reserve account, and 3 percent for expenses. This final value represents "the proceeds from project revenue bonds," and is subtracted from the total capital costs for a project to estimate the additional investment required that could not be covered by bonds. In keeping with standard conservative assumptions, this analysis does not consider revenue generated by the projects after the 20-year analysis period.

7.4 RESULTS

Table 7.4 shows the relative potential debt capacity for each corridor. Most corridors (with the exception of Corridor 2) will fully cover O&M costs with surplus revenue available to cover up to 25 percent of capital costs. Corridor 10 (I-494 from TH 212 to MSP) generates the most revenue and is able to cover the largest percentage (25 percent) of its capital funding requirements with the revenues; however, with the highest capital and operating and maintenance costs and a high degree of risk, it also has one of the highest amounts of additional investment required. Corridor 6A generates enough revenue to pay for 21 percent of total capital funding requirements, and is average relative to other corridors in terms of additional investment required. Combined Corridor 8A and 8B has the best cost recovery ratio of the combined corridors. Projected revenues in Corridor 1A cover 12 percent of capital funding but results in one of the lower absolute amounts of additional investment required.

Table 7.4 Financial Analysis Results

	Length	Costs (Millions of 2010 Dollars)		Annual Revenue (2015)	Proceeds from Project Revenue Bonds (Millions)	Percent of Total Capital	Capital Cost Not Covered by Bonds (Millions)
		Capital Costs	Annual Operating Costs				
1A. TH 36: I-35W to I-35E	5.0	$47.5	$0.25	$1.0	$6.0	12%	$42.8
2. I-94: TH 101 to I-494	9.0	$82.5	$0.45	$0.4	–	–	$82.5
3A. I-35E: I-94 to TH 36	3.9	$82.5	$0.20	$1.9	$14.3	17%	$71.1
3B. I-35E: TH 36 to CR E	3.8	$35.0	$0.19	$0.3	$0.7	2%	$34.4
4A. I-35W: DT Minneapolis to TH 36	5.3	$105.0	$0.27	$2.3	$17.1	16%	$91.4
4B. I-35W: TH 36 to Blaine	10.8	$155.0	$0.54	$3.3	$22.7	14%	$137.0
5A. I-494: TH 212 to I-394	7.6	$97.5	$0.38	$1.0	$4.7	5%	$93.8
5B. I-494: I-394 to I-94	8.5	$61.0	$0.43	$1.6	$4.0	6%	$58.2
6A. TH 169: CR 17 to I-494	10.0	$97.5	$0.50	$3.1	$21.8	21%	$80.2
7. TH 77: 141st Street to Old Shakopee Road	6.9	$41.0	$0.35	$0.6	$1.6	4%	$39.7
10. I-494: TH 212 to MSP Airport	10.6	$167.5	$0.53	$5.9	$45.0	25%	$131.7
2. I-94: TH 101 to I-494 5B. I-494: I-394 to I-94	17.5	$192.5	$0.88	$2.2	$9.3	5%	$185,2
1A. TH 36:I-35W to I-35E 4B. I-35W: TH 36 to Blaine 4A. I-35W: DT Minneapolis to TH 36	21.1	$377.5	$1.06	$7.3	$51.6	13%	$336.5
8A. I-94: DT Minneapolis to TH 280 8B. I-94: TH 280 to DT St. Paul	8.1	$140.0	$0.41	$4.8	$37.2	25%	$110.5
3A. I-35E: I-94 to TH 36 3B. I-35E: TH 36 to CR E	7.7	$117.5	$0.39	$2.5	$17.7	15%	$103.4

8.0 Policy, Technical, and Legal Issues

8.1 Policy

Policy decisions for consideration include the purpose of the lanes, equity considerations, treatment of transit, and uses of revenue.

8.1.1 Purpose of Future MnPASS Lanes

A fundamental policy decision is the purpose of future MnPASS lanes. The broadly communicated purpose for development of the I-394 and I-35W MnPASS lanes was to manage congestion by providing drivers with a new choice for more reliable travel times, while preserving free-flow speeds for transit and carpoolers. Some may also desire that future MnPASS lanes generate revenue to help pay for highway or transit improvements.

8.1.2 Should HOVs Pay?

Early on, Mn/DOT had to make a policy decision on whether HOVs would get to use the MnPASS lanes for free. In the MnPASS System Study Phase 1, Mn/DOT had decided that all drivers, including HOV (but excluding transit vehicles) would pay. There were two main reasons for this. First, new MnPASS lanes would be new capacity that did not have pre-existing rules about HOV use. Second, part of the reason for using the MnPASS approach was to generate revenue to help pay for the improvement, even if that revenue was not sufficient to pay for the entire cost. Third, enforcement is significantly easier (and less costly) if there is no need to distinguish HOVs in the MnPASS lanes. As a result, Mn/DOT decided to continue assuming that all vehicles would have to pay in future MnPASS lanes to guide the analysis in this study. A final policy decision will still have to be made as new lanes are developed.

8.1.3 Equity

Nationally, the equity issue is continually raised by opponents of road pricing and some see road pricing as universally unfair. How equity issues are handled by the public sector directly correlates to political and public will and eventually to the potential for MnPASS projects to be successful. A discussion of the various aspects of equity and how they can be mitigated is presented below.

There are two types of equity issues – horizontal and vertical. Horizontal equity deals with the issue of how people of the same income level are impacted by a particular public policy or decision. In the case of MnPASS lanes, the question is whether there is any equity issue for users of the facility regardless of their income level. By definition, MnPASS facilities are priced lanes operating within a defined corridor where toll free "general purpose" lanes are operating as well. Horizontal inequity would be expressed by the difference between how users of the general purpose lanes and MnPASS lanes are treated.

Nationally, there has been no great outcry regarding horizontal equity. HOT and express lane projects across the country (e.g., SR 91 in California and I-95 express in Florida) offer alternatives to paying the toll to use the priced lanes (e.g., meeting occupancy requirements, operating special vehicles such as motorcycles or hybrids, or riding transit) which typically satisfy concerns regarding horizontal equity. In cases where underutilized HOV lanes are converted to managed toll lanes, typically the adjacent general purpose lanes see an operational benefit, such as has occurred on I-394 (and as are forecast for this project in Section 5.0). This choice helps to address horizontal equity concerns since even drivers who chose to remain in the free general purpose lanes realize a benefit in improved travel times.

The Mn/DOT technical direction for this study was to assume that HOVs will have to pay to use any new MnPASS lanes is likely to raise horizontal equity concerns if implemented as a policy. Such a policy would diverge from occupancy exemptions provided in the existing MnPASS lanes and create inconsistencies within the MnPASS system. There will likely be concerns from the environmental and transportation demand management (TDM) communities who traditionally support and advocate for carpooling, transit, and VMT reduction. A deviation in the occupancy requirement for existing or future MnPASS facilities would have technical, operational, and enforcement implications. This policy will avoid the potential equity problem of "taking away" a benefit long enjoyed by carpoolers on the I-394/I-35W MnPASS (and earlier HOV) lanes. However, it creates another potential issue of horizontal equity since carpoolers in different parts of the region will be treated differently. Incentives will still exist in the new MnPASS lanes for carpool formation in order to share the cost of the toll.

Motorcycles are a class of vehicles that are allowed to use the I-394 and I-35W MnPASS facilities without a transponder and are not subject to the user fee. Any requirement to obligate motorcyclists to pay a fee also could be seen as a take-away, but such exemptions complicate Mn/DOT's ability to manage the MnPASS system and to collect revenue.

Some regions of the country, including Washington, D.C. and Atlanta, Georgia allow hybrid and other vehicles that are deemed environmentally friendly to use managed lanes. While allowing such vehicles nontolled use of MnPASS lanes has been discussed in the Twin Cities, this exemption has not been enacted. Such exemptions would dilute Mn/DOT's ability to manage demand in the MnPASS lanes and reduce future revenue potential. As the hybrid vehicle population increases, the demand could threaten to overwhelm the capacity of the managed lane, as has been the case in Washington, D.C. Also, the definition of "hybrid" covers a wide range of vehicles. Is a large SUV hybrid which gets 20 mpg a "greener" vehicle than a conventional subcompact which gets 40 mpg?

Another facet of equity is geographical in nature. Some communities along prospective MnPASS corridors could express concern that they are being treated unfairly because other communities received freeway capacity expansion projects in the past in the form of new general purpose lanes. This issue is likely to be mitigated by the fact that the proposed direction of MHSIS shows few non-MnPASS capacity expansions; therefore, the choice is between adding some capacity with a MnPASS-type project versus doing nothing.

Vertical equity is the issue of how people with different income levels are impacted by a public policy or decision. Vertical equity is the primary equity issue debated and dealt with during the planning and implementation of managed lanes. The claim that managed lanes are "Lexus lanes" is derived from the opinion held by some that they are by their nature vertically inequitable since wealthier people are by definition more able to pay the toll. Through extensive market research and evaluation of I-394 MnPASS users, the idea that MnPASS lanes are only used by the wealthy has not proven to be the case. This finding is consistent with studies of other managed lanes around the country.

8.1.4 Transit Advantages

The Twin Cities region has about 300 miles of bus-only shoulder lanes, which provide a transit advantage to buses during congested travel times. Bus-only shoulder lanes built before 2004, which total about 230 miles, qualify for FTA fixed guideway funding. Bus-only shoulder lanes typically are less than 12 feet in width and located on the outside shoulder. In order for a shoulder to accommodate bus usage during congested times, the shoulder pavement is strengthened, runoff drains shifted and special operating procedures and training provided for their use. The application of MnPASS lanes on corridors with existing bus-only shoulder lanes has various funding, design, and operational implications that need to be addressed. These include the following:

- The definition of new MnPASS lanes as fixed guideways by FTA is pending. Based on current FTA policy,[9] an HOV lane needs to operate as such for more than three years prior to its conversion to a managed lane to remain eligible for fixed guideway funding. Thus, I-394 MnPASS and sections of I-35W MnPASS continue to qualify for fixed guideway funding. The section of I-35W northbound from 76th Street to 66th Street was previously a bus-only shoulder lane and is now a managed lane. The Met Council has formally

[9] *Final Policy Statement on When High-Occupancy Vehicle (HOV) Lanes Converted to High-Occupancy Toll (HOT) Lanes Shall Be Classified as Fixed Guideway Miles for FTA's Funding Formulas and When HOT Lanes Shall Not Be Classified as Fixed Guideway Miles for FTA's Funding Formulas.*

submitted a request to FTA that this segment continues to qualify for fixed guideway designation.

- Buses using bus-only shoulders typically use the right shoulder, while the concurrent flow MnPASS lanes on I-394 and I-35W are located on the inside (i.e., left) lanes. Special design considerations need to be taken into account in order to ensure safe and efficient transit operations.
- The bus-only shoulders are only used when general purpose lane speeds are less than 35 mph. At these times, buses may use the right shoulder and should not travel more than 15 mph faster than the adjacent general purpose lanes, with a maximum allowable speed of 35 mph. To access the current MnPASS lanes, buses must weave across the general purpose lanes. While the need to weave into mainline traffic is not required for use of bus-only shoulders, once in the MnPASS lane, buses are not restricted to speeds up to 15 mph faster than the adjacent general lanes and thus can achieve faster and more reliable travel times. In addition, buses do not encounter merging on-ramp traffic conflicts associated with the bus-only shoulder lanes.

8.1.5 Revenue Use

Revenues from I-394 and I-35W MnPASS projects are nominal and cover repayment of capital costs as well as the operating costs for the fee collection system. The use of revenues for managed lanes is defined in Minnesota Statute Section 160.93. Subdivision 2 of Section 160.93 states:

> **"Subd. 2. Deposit of revenues; appropriation.**
>
> (a) Except as provided in subdivision 2a, money collected from fees authorized under subdivision 1 must be deposited in a high-occupancy vehicle lane user fee account in the special revenue fund. A separate account must be established for each trunk highway corridor. Money in the account is appropriated to the commissioner.
>
> (b) From this appropriation the commissioner shall first repay the trunk highway fund and any other fund source for money spent to install, equip, or modify the corridor for the purposes of subdivision 1, and then shall pay all the costs of implementing and administering the fee collection system for that corridor.
>
> (c) The commissioner shall spend remaining money in the account as follows:
>
> (1) One-half must be spent for transportation capital improvements within the corridor; and
>
> (2) One-half must be transferred to the Metropolitan Council for expansion and improvement of bus transit services within the corridor beyond the level of service provided on the date of implementation of subdivision 1."

In item (c), the statute requires that any excess funds be used for improvements (roadway and transit) within the same corridor. While the current MnPASS facilities do not generate substantial excess revenues, at some point in the future these facilities or other proposed MnPASS facilities may generate excess revenues that could support building new capacity. At such time, the question of whether Mn/DOT should have the flexibility to use these excess revenues to build-out a system of MnPASS lanes in the region will need to be addressed.

Typically, excess toll revenues from other priced lanes around the United States are distributed in three ways:

1. Cross-subsidizing other users (e.g., SOVs pay and HOVs do not);
2. Cross-subsidizing transit (excess toll revenues used to improve transit); and
3. Cross-subsidizing other transportation projects.

Based on the traffic and revenue forecasts in this study, future MnPASS projects are not likely to generate adequate excess revenue to subsidize other major transportation projects. As MnPASS lane projects evolve from single-lane corridor projects into multilane networks, there may be excess revenues that could be allocated for other highway improvements; however, in the short term this should not be expected. In addition, legislative authority would be needed to use revenues generated within one MnPASS corridor to subsidize improvements on other MnPASS corridors. This geographic cross-subsidy has been a hotly debated issue in places like the Dallas/Fort Worth region and the San Francisco Bay Area that have developed regional policies relating to systems of toll lanes and toll roads.

8.2 Legal and Institutional Issues

Tolling of Federal-aid highways is illegal, except under the provisions of Title 23, Sections 129 and 166, and certain pilot programs (i.e., value pricing, express lanes, and two interstate toll programs). With that said the legal issues surrounding the conversion of HOV to HOT lanes (e.g., I-394 and I-35W MnPASS projects) are well defined at the Federal level and today such conversions are mainstream Federal policy.

The potential for other types of tolling projects, such as proposed in MnPASS Phase 2, on the Federal Interstate System or any roadway constructed with Federal dollars would require Federal approval. Those projects seeking to convert existing shoulders to PDSLs or add tolled lanes would most likely be considered by the Federal government under the Express Lanes Demonstration Program. What type of tolled project is being considered (e.g., managed lane versus express lane with no occupancy discount or waiver), how it will be constructed (e.g., converting any existing shoulder, adding a new tolled lane or converting an existing general purpose lane) and where it is being constructed (e.g., on a Federal Interstate or on a roadway constructed with Federal aid) are all factors in determining what type of Federal program may be available to allow for tolling and what Federal requirements must be met.

From an institutional perspective, Mn/DOT is the sole public road pricing authority in Minnesota. Mn/DOT has been the lead agency for planning, design, project delivery, and overseeing operations of the two MnPASS corridors. As plans to expand the MnPASS system are realized, an institutional framework is needed to maintain accountability and to ensure that the pricing program is developed to meet the agency's policy objectives. Most public toll entities in the United States are organized in one of the following three ways:

1. Specific-purpose statewide toll authorities;
2. Regional toll authorities; or
3. Divisions within the state DOT.

8.3 Technical and Implementation Issues

There are a variety of technical issues associated with the construction and operation of priced lanes, and how they are addressed impacts the financial feasibility of the priced lanes and their safe operation. The key technical issues for the development of a MnPASS System include how to design the lanes in the most cost-effective and safest way, treatment of freight vehicles, hours of operations, system continuity and consistency, interoperability, and funding.

8.3.1 System Design

System design should seek to minimize capital costs associated with future MnPASS projects while ensuring safety of operation. For example, the I-95 express lanes in Miami, Florida involved converting the inside HOV lane of Interstate 95 to a managed lane, and also converted the inside shoulder to a second managed lane. The inside shoulder was constructed to be an 11-foot lane, while the existing 12-foot HOV lane and general purpose lanes were restriped to 11-foot lanes. Both the inside and outside shoulders were narrowed below Federal design guidelines, thus allowing the project to deliver a multilane managed facility without taking any additional right-of-way. These design approaches were not without controversy and a mitigation plan was developed to address the less than optimal design standards of the new roadway. An "Incident Management Plan" was developed to help mitigate for the below standard lane widths.

MnPASS lanes are typically designed as the leftmost travel lanes that are buffer separated by a four-inch stripe, four-inch space, and another four-inch stripe. The MnPASS System Study Phase 2 made significant assumptions with respect to system design in order to build-out the system in a cost-effective manner without ROW takings. These designs will require more detailed operational analysis and FHWA approval. Limiting shoulder and lane widths was assumed as the preferred option if significant structural widening and/or bridge replacements were needed and/or there was insufficient space in the corridor to accomplish normal widening. It is likely that Mn/DOT will need to go through some process to justify these designs along with some enhanced operational strategies to mitigate issues.

8.3.2 Freight

When considering freight and how it is impacted by implementation of a MnPASS system, the primary consideration is safety and whether large commercial vehicles can operate safely within these special purpose lanes. The national examples of managed lanes reflects Minnesota's approach, which excludes heavy commercial vehicles from the facility. Commercial trucks over 26,000 pounds are not allowed on the I-394 or I-35W MnPASS lanes. Other similar commercial truck restrictions exist for the SR 91 express lanes in California (e.g., maximum vehicle weight of 10,000 lbs), I-95 express lanes in Florida (e.g., only two-axle trucks are allowed), and the SR 167 HOT lanes in Washington State (e.g., maximum vehicle weight of 10,000 lbs). An additional consideration is how design standards for future MnPASS lanes may impact freight movement in the general purpose lanes. For instance, if designs seek to narrow the general purpose lanes (e.g., from 12 feet to 11 feet) in order to accommodate future MnPASS lanes, then there could be a freight impact in the corridor regardless of whether commercial vehicles are allowed to travel in the MnPASS lanes.

8.3.3 Business Rules

The hours of operation for the I-394 and I-35W MnPASS lanes are inbound to downtown Minneapolis from 7:00 to 10:00 a.m. and outbound from 3:00 to 7:00 p.m. These hours of operation are a legacy of the HOV lane operating hours. When the I-394 MnPASS facility first opened in May 2005, the concept of operations was for 24 hours, 7 days per week. Due to strong outcry from legislators and businesses along the I-394 corridor, the hours of operations were changed to reflect the peak direction and peak-period hours of operations within its first month of operations. As the MnPASS system expands, providing consistency for hours of operations needs to be addressed. For forecasting purposes, it was assumed in this study that hours of operation would be 24/7 on the new lanes.

While future MnPASS facilities need not follow the I-394 and I-35W business rules, providing consistency systemwide will make it easier to explain and seek public acceptance. In certain areas, it may be necessary to convert short segments of the roadway to MnPASS lanes in order to achieve system continuity. As the number of MnPASS users grow, consideration should be given to making the MnPASS transponder interoperable with other electronic toll collection (ETC) devices, such as the I-PASS in Illinois and E-ZPass in the Northeast and Mid-Atlantic states, and for other transportation functions in the Twin Cities metro area such as parking ramps and transit services.

8.3.4 Financing

Road pricing projects vary in their financial feasibility based on the type and location of the pricing project. While HOV to managed lane conversion projects are relatively inexpensive to get started, they may not generate large revenue streams. Managed lane projects require significant amounts of congestion in the adjacent general purpose lanes and enough SOV capacity to sell in order to have potential profitability.

Current MnPASS lane policy calls for surplus revenues to be used as dictated in Minnesota Statute 160.93 – half to capital improvements in the corridor and the other half to bus transit improvements. The Legislature and Governor would have to approve of any deviations to this policy.

In most cases when discussing the financial strategies for managed lanes, the discussion does not revolve around how to spend surplus revenues but rather identifying additional funding streams to make managed lane projects financially whole. To date the majority of managed lane projects have been subsidized by revenues beyond tolls collected in the lane. The sketch-level financial analysis presented in Section 7.0 indicates a need for gap funding. Gap funding from the County Transit Investment Board (CTIB) and development of a Surface Transportation Program (STP) category that would further prepare or address critical infrastructure issues in future MnPASS corridors could bring together state, regional, and local efforts to systematically address key hurdles.

The use of Public-Private Partnerships (PPP) to help finance transportation projects and bring private equity into the financial mix is being explored aggressively across the country and already is widely used in Europe, Asia, Australia, and South America. PPPs may be as simple as design-build contracts or as complex as full concessionaire contracts (e.g., design-build-finance-operate-maintain) where nearly all construction and financial risk is allocated to the private sector in exchange for a return on investment.

Increasingly, a middle ground of PPP is emerging whereby a developer agrees to design, build, operate, maintain, and sometimes finance (or partially finance) a highway in exchange for an "availability payment" for successfully keeping the highway operating at an acceptable standard. This creates an incentive for the developer to deliver a pre-determined level of performance at lower life-cycle cost, with the cost savings representing additional profit to the developer. These kinds of PPP are effective project-delivery vehicles, but the responsibility for finding a revenue stream falls to the public sector.