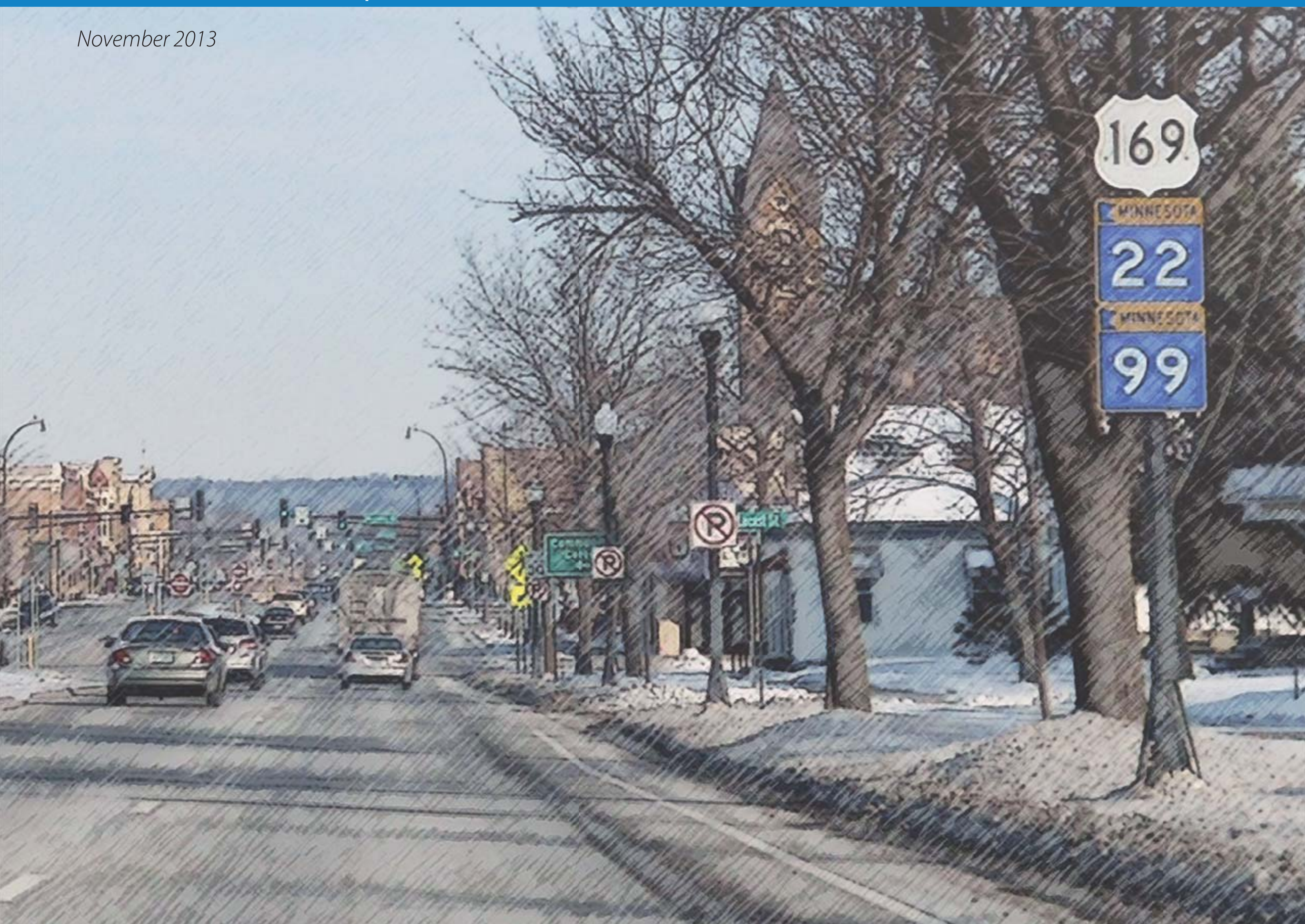
Assessing Return on Investment in Minnesota's State Highway Program

Technical Report

November 2013



Minnesota Department of Transportation
Smart Growth America
Making Neighborhoods Great Together

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. . . transportation investment options that . . . move people and goods . . .

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Assessing Return on Investment in Minnesota's State Highway Program

Technical Report

Introduction

The Minnesota Department of Transportation (MnDOT) updated the Minnesota 20-Year State Highway Investment Plan (MnSHIP) in 2012-2013. Through the MnSHIP planning process and based on system performance targets, the plan identified total state highway system needs of $30 billion and projected revenue of $18 billion over the next 20 years resulting in a funding gap of approximately $12 billion. The needs and funding gap primarily reflect mounting pressure from an aging highway system, rising construction costs, and slow revenue growth. Based on analysis in MnSHIP, underinvestment will result in a steady decline in performance of the state highway system, including:

- Pavement in poor condition will double from approximately 750 miles to 1,500 miles, or between 11-13% of non-interstate highways. Poor pavement conditions result in slower travel times, higher vehicle operating costs, and additional safety hazards.
- More than 200 bridges on state principal arterials will be in poor condition. Weight restrictions and closures will interfere with freight movement.
- With increasing travel times, performance targets on the Interregional Corridor System - carrying about 30 percent of all statewide travel on Greater Minnesota's most heavily traveled roads – will not be met.
- Congestion will worsen in the Twin Cities area and the Minnesota Department of Transportation (MnDOT) will have little-to-no ability to address local concerns, add capacity, or support economic development at the regional and community level.

In 2012, the Minnesota Transportation Finance Advisory Committee (TFAC) was formed to develop recommendations for funding and financing the state highway system over the next 20

MnDOT has developed . . . a strong set of investment decision making tools . . .

years. TFAC recommended meeting the full needs of the state highway system in order for Minnesota to remain economically competitive and provide a high quality of life. Following the completion of TFAC's work in December 2012, MnDOT partnered with Smart Growth America (SGA) to evaluate and understand the potential return on investment (ROI) of TFAC's recommendations. SGA works with state departments of transportation across the country to identify transportation policies and programs that enable flexible, efficient ways to increase the capacity to move people, goods, and services on state transportation systems while supporting and expediting job creation and economic development. MnSHIP served as the foundation for both TFAC's recommendations and this study.

The project team conducted the study over a period of three months, beginning in August 2013. The study process was organized around three technical memoranda and three working meetings with a Project Stakeholder Group (PSG). The PSG, consisting of 63 representatives from the public and private sectors (see Appendix A), initially met in early August to discuss different approaches for evaluating transportation investment options summarized in the first technical memorandum. The PSG then convened again in late September to discuss and comment on a draft ROI analysis methodology, the subject of the second technical memorandum. Based on the comments and findings from the first two rounds of technical memoranda and PSG meetings, the PSG met for a final time at the end of October to review the results of the ROI assessment. The PSG served as a sounding board throughout the study and provided invaluable input to the ROI assessment.

This technical report documents the ROI assessment undertaken in the study. Building on the recommendation made by TFAC to invest an additional $12 billion in the state highway system over the

. . . reports the dollar value of societal benefits for a dollar of investment . . .

next 20 years, the ROI assessment specifically addresses three questions:

1. Maintaining the current performance of Minnesota's state highway system would require an investment of an additional $5 billion over the next 20 years. *What would be the return on that investment?*

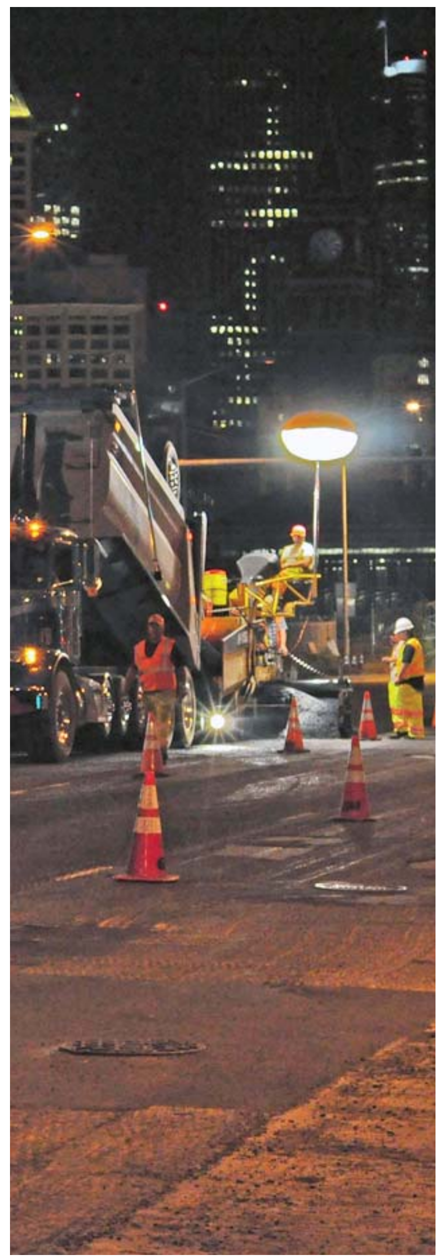
2. Improving Minnesota's state highway system to help the state become more economically competitive through technology and operational innovations and through high return on investment projects to reduce congestion and delays would require the investment of an additional $7 billion over the next 20 years. *What would be the return on that investment?*

3. Within the proposed investments over the next 20 years, some projects and programs will necessarily have a higher return on investment and some will have a lower return on investment. *Which kinds of projects and programs offer the highest ROI?*

The next section of this report describes the ROI methodology, including the major assumptions and investment categories. The report then presents the findings of the ROI assessment. The results of this study indicate that there is a sound business case for making the $12 billion investment recommended by TFAC. In total, a $12 billion investment in the state highway system over the next 20 years would deliver between $21 billion and $42 billion in benefits, with an average ROI of 2.5 – or, for every dollar Minnesota invests in the state highway system, it can expect to receive two-and-a-half dollars in benefits.

. . . methodology calls for developing a composite return on investment . . .

Return on Investment Analysis Methodology



Methodology Overview

As discussed in the preceding section, the goal of the ROI analysis is to answer three questions underpinning the state highway system investment recommendations made by TFAC in its 2012 report. While there is no single "recipe" for analyzing transportation impacts, MnDOT has developed over time a strong set of investment decision making tools and criteria that mirror and represent national best practices. These investment decision making tools and criteria rely on two widely recognized techniques – benefit-cost analysis (BCA) and life-cycle cost analysis (LCCA) – that support sound economic evaluations of alternative investment options.

Briefly, BCA serves as the principal tool for analyzing the return on investment of public sector programs and projects. Measuring direct benefits and costs associated with a program or project, BCA differentiates itself from private sector ROI analysis by addressing and monetizing a broad set of societal benefits, including economic (e.g., travel time and operating cost savings), environmental (e.g. air quality and noise), and social benefits (e.g., safety), and not simply revenue streams. One tool in the investment decision making process, BCA analysis reports the dollar value of societal benefits for a dollar of investment.

Effectively the cost component of BCA, life-cycle cost analysis captures all future costs over a project's usable life. LCCA differs from BCA in that it assumes a constant level of benefits across alternatives and then identifies the alternative that minimizes costs to achieve those benefits. Accordingly, alternatives can be compared on a cost basis and expressed as a benefit-cost ratio as well. This technique is particularly useful for evaluating different system preservation strategies that yield essentially the same benefits (e.g., maintaining pavement or bridges in good condition), but have different costs

. . . proactive approach in maintaining our existing highways . . .

during a given analysis period. Taken together, benefit-cost analysis and life-cycle cost analysis serve as the foundation for the ROI methodology in this technical memorandum, allowing us to evaluate the value of an additional dollar of investment across a series of investment categories and options.

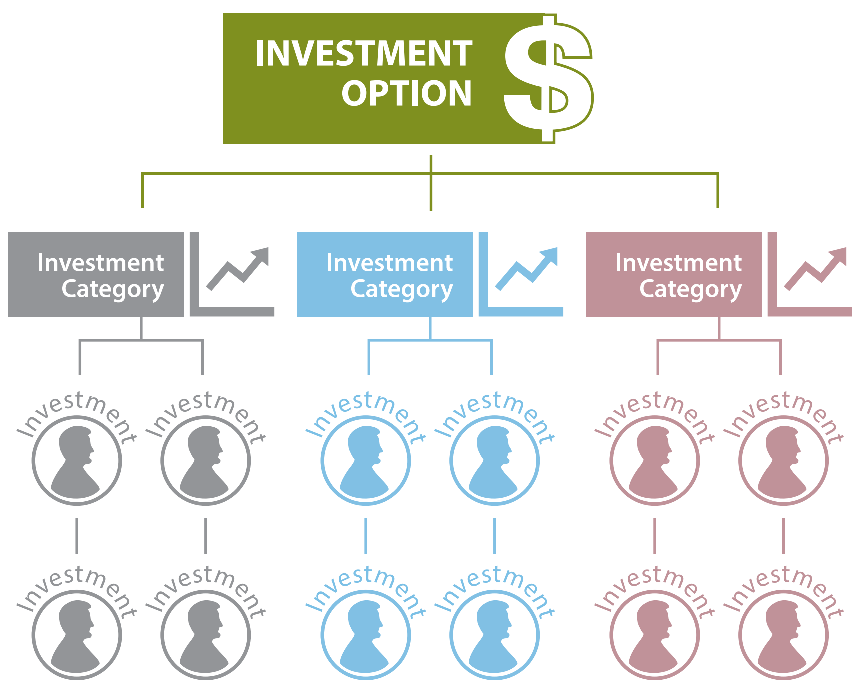
Major Assumptions

Responding to anticipated population growth and aging transportation infrastructure in Minnesota, the TFAC recommendations are organized around two proposed, incremental levels of investment over the next 20 years: (1) a $5.4 billion investment beyond projected revenue to maintain the current performance of the state highway system, and (2) an additional $7.1 billion investment to build, maintain, and operate an economically competitive and world class system. Similar to an individual's retirement account that contains different investment funds (e.g., technology stocks, global stocks, Treasury bonds), each representing a diverse range of individual stocks and bonds, the TFAC investment options consist of different investment classes or categories (e.g., pavement preservation, bridge replacement, highway safety, highway reconstruction) that include a wide variety of potential individual programs and projects (see Figure 1).

Extending the retirement account analogy, the ROI methodology calls for developing a composite return on investment based on the relative benefits generated by each investment category in the different investment options – much as one would for any investment account. The following assumptions describe in greater detail the key concepts supporting the ROI analysis.

- For each investment category, the ROI analysis relies on a range of benefit-cost ratios derived from either benefit-cost or life-cycle cost analysis of a representative sample of projects or programs. Relying

Figure 1. Investment Option Framework



. . . the right treatment to the right pavement at the right time . . .

Table 1. Benefit-Cost Factors (PRISM)

Social	Economic	Environmental
• Safety • Bicycle/Pedestrian Health Effects • Noise	• Travel Time • Travel Time Reliability • Vehicle Operating Costs • Life Cycle Costs • Loss of Agricultural Land	• Emission (CO_2 + Criteria Pollutants) • Wetland Effects • Runoff

on a range of benefit-cost ratios is particularly important given the diversity of investment categories and sample projects and programs within a category. While underlying parameters, such as timing or phasing of improvements, usable life of a facility, and analysis period, vary among the investment categories, utilizing a range of benefit-cost ratios allows the ROI analysis to draw informative comparisons across categories and ultimately investment options.

- MnDOT has long had valuable guidance, "Benefit-Cost Analysis for Transportation Projects," in place for conducting benefit-cost analysis. The ROI analysis in this memorandum applies that guidance in tandem with a proprietary tool called PRISM that MnDOT uses in its new Corridor Investment Management Strategy (CIMS) program to develop benefit-cost ratios. PRISM factors multiple social, economic, and environmental variables, summarized in Table 1, into the benefit-cost ratios.

- Building on MnSHIP, the ROI analysis defines ten investment categories within the TFAC recommendations. Table 2 shows the relationship among the MnSHIP investment categories and unmet needs, the ROI categories, and the TFAC recommendations. As illustrated in the table, the MnSHIP unmet needs, defined as either the costs necessary to meet performance-based targets or achieve key system goals, are the basis for the TFAC investment amounts. Detailed descriptions of the ROI categories are provided in the next section of this document.

Return on Investment Categories

Following are descriptions of the ten investment categories included in the ROI analysis. The descriptions include a brief overview of the investment category and the approach for calculating a benefit-cost ratio. Again, due to the diversity of investment categories, available information varies among categories. Table 3 summarizes the ten investment categories and the information used to develop

Table 2. MnSHIP Investment Category and ROI Category Translation Matrix

MnSHIP Investment Category	TOTAL Unmet MnSHIP Need ($M)	ROI Category: Safety-Spot Improvement at High-Risk Locations	Pavement Preservation-Corridor	Pavement Reconstruction-Corridor	Pavement Reconstruction-Urban/Main Street	Bridge Repair	Bridge Replacement	Congestion Mitigation-General	Capacity Development	Active Traffic Management (ATM)	MnPASS
Pavement Condition	$2,800		X	X	X						
Bridge Condition	$1,860					X	X				
Roadside Infrastructure	$250		X	X	X						
Safety	$820	X									
Interregional Corridor Mobility	$920								X		
Twin Cities Mobility	$3,860							X	X	X	X
Bicycle Infrastructure	$390			X	X	X	X				
Accessible Pedestrian	$210		X		X	X	X				
Regional & Community Priorities	$1,400	X			X				X		
Total	$12,510										
Gap Level ($B)	**Amount ($B)**		**TFAC Investment Amounts ($M)**								
Performance Preservation	$5.4	$662	$1,377	$106	$275	$171	$399	$553	$1,146	$79	$632
Economically Competitive	$7.1	$578	$1,264	$288	$408	$451	$1,052	$798	$1,246	$114	$912
Total	$12.5	$1,240	$2,641	$394	$683	$622	$1,451	$1,351	$2,392	$193	$1,544

. . . the benefits can be far reaching . . .

the benefit-cost ranges, and representative projects are drawn from the illustrative project list in the TFAC report where applicable. Specific benefit-cost ratio ranges for each investment category will be discussed under the ROI findings in the last section of the report.

Safety – Spot Improvement/ High Risk Locations

Provision of safe travel is the ultimate contribution made by a transportation system to broader quality of life priorities. While a safe arrival relies on many factors outside the direct influence of MnDOT (e.g., driver behavior), infrastructure investments promote a safe driving environment and innovations in safety treatments make this a dynamic area for research and implementation.

Regulatory agencies, including USDOT, base decision making about the cost effectiveness of safety-related investments on the "value of a statistical life" (VSL) economic concept. This measure reflects the comprehensive value an individual has demonstrated and a willingness to pay to avoid a fractional increase in the risk of death from participating in an activity. The value placed on avoiding a fatal outcome also determines the proportional cost to society of injury crashes (graded in three severities). MnDOT has adopted the well-documented federal guidance for VSL and injury per-person costs, further tailoring the crash values by applying the latest statewide crash profile showing the average number of occupants involved in a given crash type.

Safety improvements then seek to lower these expected costs by reducing total crash frequency and/or minimizing the severity of the crash distribution (e.g., averting injuries even if property damage-only crashes rise modestly). Return

Table 3. ROI Categories - Data Sources

ROI Category	Data Source
Safety-Spot Improvement at High-Risk Locations	Representative MnDOT projects – rural intersection conflict warning systems, diverging diamond interchanges, and passing lanes
Pavement Preservation-Corridor	Results from MnDOT's Transportation Asset Management Plan
Pavement Reconstruction-Corridor	Generalized LCCA framework
Pavement Reconstruction-Urban/ Main Street	Representative projects in MnDOT CIMS program
Bridge-Repair	Results from MnDOT's Transportation Asset Management Plan
Bridge-Replacement	Generalized LCCA framework
Congestion Mitigation-General	Projects included in the Metro District Congestion Management and Safety Plan
Capacity Development	Current scoring of projects in Corridors of Commerce process
Active Traffic Management (ATM)	MnDOT's recent four-year work plan of ATM investments and average BCRs from USDOT
MnPASS	Opened, programmed, and potential MnPASS corridors

. . . would include a broad range of bridges on different types of highway facilities . . .

on investment can be evaluated against this objective by reference to a sample of recently completed, planned, or analyzed projects across Minnesota characterized by:

- Relatively low construction costs – compared with a traditional solution
- Limited extent – compared with a major corridor expansion that may deliver significant benefits beyond safety enhancement

The representative sample of projects includes rural intersection conflict warning systems, diverging diamond interchanges, and passing lanes. Based on six representative projects, the average benefit-cost ratio is approximately four-to-one.

Pavement Preservation – Corridor

According to the U.S. Department of Transportation (USDOT), "pavement preservation represents a proactive approach in maintaining our existing highways, reducing costly and time consuming rehabilitation and reconstruction projects and the associated traffic disruptions." Beyond the obvious importance and desirability of well maintained roadways, poor pavement – and bridge – conditions can also potentially jeopardize a state's bonding rating resulting in higher borrowing costs for state and local governments.

Transportation agencies typically rely on life-cycle cost analysis to quantify savings associated with pavement preservation programs. The goal is to apply the right treatment to the right pavement at the right time, and in doing so, avoid or delay more expensive improvements such as major roadway rehabilitation or reconstruction (see Figure 2). The cost savings associated with preservation are then expressed as a cost reduction per lane mile or as a ratio between the cost of rehabilitation and reconstruction compared to preservation.

As part of its Transportation Asset Management Plan, MnDOT is currently developing life-cycle cost analyses for various pavement and bridge preservation strategies. For pavement, the LCCA includes routine and reactive maintenance costs, and compares a desired pavement preservation strategy with a worst-first strategy that reconstructs the worst facilities in any given year. The LCCA results

Return on investment is listed as the first objective criterion . . .

indicate that the worst-first strategy costs approximately two times as much as the desired pavement preservation strategy over the period of analysis.

Pavement Reconstruction – Corridor

The pavement reconstruction–corridor investment category involves reconstruction projects on corridors in Greater Minnesota outside of urban areas. Measuring the benefits of pavement reconstruction investments in this context presents unique challenges. Because these types of investments do not typically increase facility capacity or involve new alignments, comparing proposed projects against a "base case" does not easily translate into conventional benefit-cost analysis highlighting common user benefits (travel time savings, vehicle operating costs, safety) and relying on changes in vehicle-hours traveled (VHT) and vehicle-miles traveled (VMT).

Utilizing a life-cycle cost analysis framework, however, one can define the "base case" as the existing facility and compare it with the reconstructed facility over the analysis period. In effect, the benefit-cost argument is that by reconstructing a facility that is currently in poor condition, one can avoid frequent and expensive treatments and activities over the life of the reconstructed facility. Of course, as discussed above, pavement preservation strategies are a cost-effective strategy for delaying reconstruction, but at some point, all pavements reach the end of their service life. For the purposes of the ROI analysis, the assumption is that conservatively and on average the life-cycle cost of reconstruction is equal to the life-cycle cost of maintaining pavement that is already in poor condition.

Figure 2. Pavement Preservation, Rehabilitation and Reconstruction

Pavement Preservation	Pavement Rehabilitation	Pavement Reconstruction
Preventive Maintenance – Nonstructural treatments to prevent deterioration **Routine Maintenance –** Work performed on a routine basis to maintain and preserve the condition of the highway or to respond to specific conditions **Minor Rehabilitation –** Nonstructural enhancements to eliminate surface cracking.	Structural enhancements that extend the service life of an existing pavement and/or improve its load carrying capacity.	Replacement of the entire existing pavement structure by the placement of the equivalent or increased pavement structure.

. . . reflecting the multi-dimensional impacts from these major projects . . .

Pavement Reconstruction – Urban/Main Street

This category captures highway reconstruction projects in cities and towns, including main street projects. The full reconstruction of highways in urban settings allows MnDOT and local partners to make major improvements and changes to both the road itself as well as the underground utilities. Urban/main street reconstruction projects may involve improvements to how stormwater runoff is handled, changes in access points (access management), lane reconfigurations, new lighting, additions of green space, new medians, new or reconstructed sidewalks, and other modifications. Given the complexity of urban reconstruction projects, the benefits can be far reaching and include both traditional transportation measures such as travel time and safety, but also health and environmental factors.

Many applications to MnDOT's recent CIMS solicitation requested funding for urban/main street reconstruction projects and as part of the project selection process were evaluated on a benefit-cost basis using the PRISM tool. Although the resulting ROI estimates included many factors, there is a strong correlation between traffic volume and ROI for these types of projects. Using representative projects with a range of traffic volumes allows one to estimate an approximate ROI for urban reconstruction projects without the need to conduct in-depth analysis of the many potential project elements. Based on a sample of 34 representative projects, the average benefit-cost ratio tends to fall between one and two.

Bridge Repair

Similar to the pavement–preservation category, the life-cycle cost analysis for bridge repair investments is currently being evaluated as part of MnDOT's Transportation Asset Management Plan. The bridge repair analysis considers substructures, superstructures, and decks, and compares the LCCA results of a worst-first strategy to a typical repair and maintenance strategy. For this category, the worst-first strategy costs average approximately one-and-a-half times more than the

…maximizes the effectiveness and efficiency of the facility …

typical maintenance strategy for the given period of analysis.

Bridge Replacement

The bridge replacement category poses the same challenges as the pavement reconstruction–corridor investment category since a bridge replacement typically does not increase facility capacity or involve a new alignment. For an individual bridge replacement project, it is possible to evaluate a replacement facility with a "base case" that assumes closure of the existing facility. The proposed investments for bridge replacement, however, would include a broad range of bridges on different types of highway facilities in different locations. Consequently, the ROI analysis utilizes a generalized life-cycle cost analysis approach to frame the trade-off between ongoing maintenance of a bridge in poor condition and replacing it. Reconstruction also results in a long-term continuation of maximum user benefits, contrasted with the progressive deterioration in accessibility and reliability (e.g. forced/discretionary detours, load posting restrictions affecting truck routing) anticipated when routine maintenance practices are performed on a facility late in its life cycle. The assumption, as with corridor pavement reconstruction investments, is that on average the life-cycle cost of replacing a bridge is equal to the life-cycle cost of ongoing maintenance of a bridge in poor condition.

Congestion Mitigation – General

Because of the level of detail provided in the Metro District Congestion Management and Safety Plan, this category lends itself more easily to a benefit-cost analysis. Investments in general congestion mitigation are intended to identify lower cost, higher benefit improvements that reduce travel time and crash risk. These improvements have short time frames for implementation, attempt to maximize the use of existing pavement and right-of-way, and are typically less than one mile in length.

For each project location, a dollar value of the total benefits that

MnPASS users receive benefits in the form of faster and more reliable trip times . . .

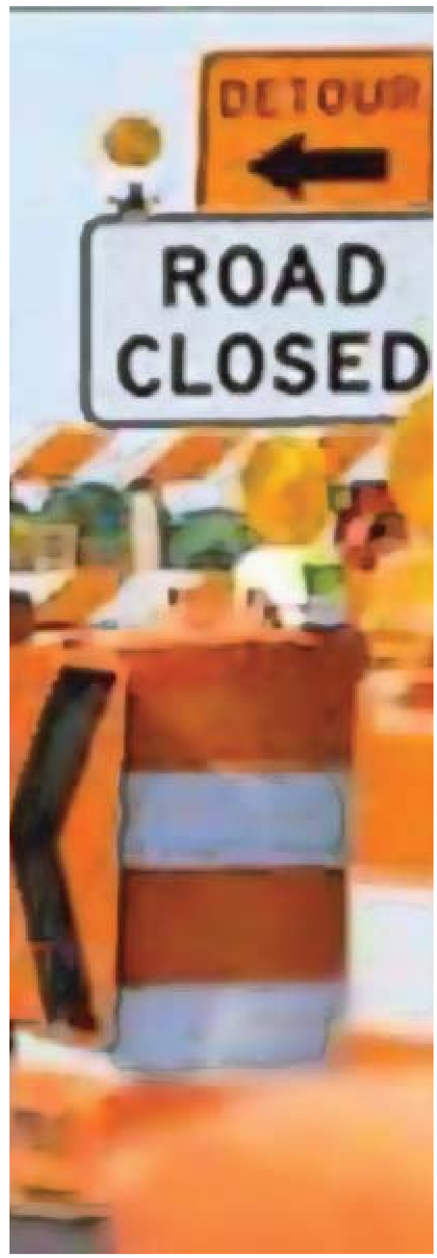
could be realized was assigned as the magnitude of the problem. Recognizing that any project has a point of diminishing returns, the proposed solutions were not expected to solve 100 percent of the problem. Project effectiveness was estimated as a percentage of the problem addressed. This ranges from 0 percent to 79 percent for the 60 projects with quantified attributes. Cost estimates were developed based on unit costs and engineering judgment, and range from $4,000 to $26 million, with the majority under $4 million.

The projects were categorized into three tiers based on the return period, defined as the time after construction at which the travel time and crash savings equal the project cost. Tier 1 projects have a return period of less than 2 years, Tier 2 projects have a return period of 2 to 6 years, and Tier 3 projects 7 to 11 years. The annual benefit of each project was calculated by multiplying the effectiveness by the magnitude of the problem. To calculate a return on investment, 20 years of discounted benefits were compared to the project cost. Based on the representative sample of projects, the overall return on investment can be calculated by averaging the median return for each tier for a ratio of approximately five to one.

Capacity Development

Return on investment is listed as the first objective criterion for project evaluation and prioritization under the Corridors of Commerce bonding program created by the Minnesota Legislature in the spring of 2013 (chapter 117, article 3). With $300 million in new bonding authority, the initial Corridors of Commerce appropriation is expected to finance only a fraction of the large-scale capacity development proposals generated statewide, including the eligible projects identified in the TFAC report as "congested sections of roadway that contain chokepoints that hamper commuting or commerce"– alone totaling $571 million using the lower end of current cost estimate ranges.

Through calculations supported by the PRISM benefit-cost model, MnDOT has drafted a return on investment measure incorporating safety benefits, travel time savings, environmental externalities, and operating and life-cycle costs,



. . . infrastructure investments promote a safe driving environment . . .

reflecting the multi-dimensional impacts from these major projects. In all cases, a Capacity Development (CD) scenario is compared against a No Build (NB) baseline. At this early evaluation stage, when candidate projects lack detailed studies for benefit components and construction scope and expense, the ROI estimates that enable a preliminary ranking must rely on key assumptions – which may be refined in the future with expert office review:

TRAFFIC

- AADT (and VMT) does not change between NB and CD.
- The future AADT trend for both scenarios is projected as a continuation of the segment compound annual growth rate for the 2002-2011 period.
- Travel time savings for auto and truck users reflect increased speeds under CD.

SAFETY

- NB crash frequencies and severity are taken from the latest 10-year actuals.
- CD crash modification factors are sourced from historical benefit-cost analyses or FHWA's Crash Modifications Factor Clearinghouse.
- Future crash counts track with AADT growth.

COSTS

- Unless otherwise indicated by available project documents, construction costs are allocated as:
  - 70% structures, grading, sub/base, surface (40-year average life)
  - 10% Right-of-Way (100-year expected life)
  - 20% engineering and all other purposes (no residual value)
- Incremental annual operations and maintenance expense for CD is $10,000 per added lane-mile.
- NB major rehabilitation/ replacement timing is estimated based on current pavement condition.
- The benefit from smoother pavement with CD (for the years prior to NB rehab/replace) is derived from modeling conducted by the national research organization TRIP, linking vehicle operating costs to the pavement condition differential.

. . . maintain the current performance of the state highway system . . .

GENERAL

- Construction duration is estimated as a function of total project costs (i.e. more expensive projects require multiple seasons).
- Analysis represents 20 years of benefits following the opening of the CD facility, converted to the present value equivalent at a 2.2% discount rate.

Applying this procedure to a representative sample of projects, the average benefit-cost ratio tends to be slightly greater than one.

Active Traffic Management

The rapidly evolving application of computer and communication technologies to transportation systems offers a number of opportunities to maximize existing assets and new investments. According to FHWA, Active Traffic Management (ATM) is, "the ability to dynamically manage recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions. Focusing on trip reliability, it maximizes the effectiveness and efficiency of the facility." Strategies include but are not limited to speed harmonization, temporary shoulder use, junction control, and dynamic signing and rerouting. To date, national research on the benefits of ATM strategies has been reported under the larger umbrella of Transportation Systems Management and Operations (TSM&O).

TSM&O can include physical and non-physical investments and address a broad array of project and system issues and needs. Some of these strategies are often referred to as Intelligent Transportation Systems (ITS), but include much broader activities. An important resource for assessing the benefits and cost of investment in TSM&O is, Investment Opportunities for Managing Transportation Performance through Technology, a USDOT 2009 report of the Intelligent Transportation Systems

. . . the benefit-cost ratio results . . . are all based on the average investment levels . . .

Joint Program Office. Table 4 is based on information contained in the USDOT ITS benefits database.

Although the benefit-cost ratios reported in the USDOT table vary by application, it is reasonable to define a range of benefit-cost ratios for a specific set of ATM techniques. Using average benefit-cost ratios from USDOT and MnDOT's most recent four-year work plan of ATM investments (25% signal optimization, 60% information/ detection, and 15% ramp metering), the average benefit-cost ratio for ATM investments tends toward nine-to-one.

Table 4. USDOT: ITS Upgrades for New, Rehabilitated or Existing Infrastructure

Category/Project		B/C Ratio
	TRAFFIC SIGNAL OPTIMIZATION/ RETIMING	17:1 to 62:1
Traffic Incident Management	SAFETY SERVICE PATROLS	2:1 to 42:1
Traffic Incident Management	SURVEILLANCE/ DETECTION	6:1
	ROAD WEATHER INFORMATION SYSTEMS	2:1 to 10:1
	RAMP METERING SYSTEMS	15:1

MnPASS

MnPASS is the high-occupancy/toll (HOT) lane network operated by MnDOT. The system allows single-occupant vehicles to travel on express lanes adjacent to general purpose lanes with the payment of a variable fee that is collected electronically. MnPASS charges are dynamically set based on the level of congestion experienced in the express lane with a maximum toll of $8. MnPASS users receive benefits in the form of faster and more reliable trip times, as well as safer driving conditions given the controlled access to the express lanes. Traffic also flows more freely on the non-tolled general purpose lanes when a fraction of their volume chooses to divert to the MnPASS alternative.

A formal benefit-cost analysis was conducted on one existing MnPASS facility (I-394, west of Minneapolis) in February 2012 by the Center for Transportation Studies at the University of Minnesota. MnDOT is planning to expand the MnPASS network next to I-35E north of St. Paul (ending at Little Canada Road), with construction scheduled to begin in 2014 and continuing through 2015. Cambridge

. . . the value of delivering higher performance . . .

Systematics completed a benefit-cost analysis for this segment in August 2012. Additionally, a survey of travel time and vehicle operating cost savings was performed in June 2010 for 14 other candidate future MnPASS corridors, including the six identified as congestion chokepoints by TRIP:

- MN 36
- I-94, between the downtowns
- I-35W, north from Minneapolis to Blaine
- I-494, from I-94 to MSP Airport
- US 169
- MN 77

The median benefit-cost statistic across these eight opened, programmed, and potential MnPASS corridors serves as the average value of the category ROI estimate range.

. . . to meet all performance targets . . .

Return on Investment Findings

Recognizing the fundamental role transportation facilities and services play in the state's quality of life and business climate, the TFAC report focused on the investment levels necessary to maintain and modernize Minnesota's aging transportation infrastructure for the state's growing population. The two investment options recommended in the TFAC report are briefly described below followed by the return on investment analysis.

Investment Scenarios

Maintain Current Performance

Given forecasts of future conditions and system performance levels, the TFAC report identified an additional $5 billion needed over the next 20 years to maintain the current performance of the state highway system. According to the TFAC report, the additional funding would result in the following outcomes:

- Pavement and bridge conditions would not change
- Fatalities would continue to drop
- Congestion would increase, but a few spot improvement projects could be undertaken in isolated locations. Very few expansion projects would occur.

Economically Competitive & World Class System

Complementing the investment required to maintain the current system performance, TFAC also recommended $7 billion in added revenue to meet all performance targets and deliver an economically competitive and world class system. The additional funding would allow the state to achieve these important results:

- Pavement and bridge conditions targets are met
- The rate of decline in traffic fatalities and injuries is increased
- The MnPASS vision for the Twin Cities Metro area is completed. Also, a modest number of high priority expansion projects are completed.

. . . the congestion mitigation category contributes the greatest amount of total benefits.

Investment Scenarios: Return on Investment

The return on investment analysis for the TFAC investment options compares the sum of the average benefits across all categories to the incremental investment levels found in Table 2, i.e., the total average costs. The average benefit for each category is the product of multiplying the proposed investment level by the average benefit-cost ratio. Additionally, a range of low-to-high benefit-cost ratios was developed based on a sample standard deviation of the representative projects with two exceptions. As discussed earlier, it is assumed that the pavement reconstruction–corridor and bridge replacement average benefit-cost ratios will tend toward a value of one from a life-cycle cost perspective, and accordingly, the low and high values will be approximately 0.5 and 1.5. It should be emphasized that the low, high, and average benefit-cost ratio results reported in the following three summary tables (Table 5, 6, and 7) are all based on the average investment levels. Low and high investment levels are subsequently used to determine the ROI range for each investment category (Table 8).

The first question posed at the outset of this memorandum focused on the initial investment scenario, the recommendation to invest $5 billion over 20 years to maintain the current performance of the state highway system. It asked:

1. Maintaining the current performance of Minnesota's state highway system would require an investment of an additional $5 billion over the next 20 years. *What would be the return on that investment?*

Table 5, summarizes the results of the ROI analysis for the first scenario. The proposed investment of $5 billion over 20 years would yield an average benefit-cost ratio of 3.1 to 1, within a range of 1.9 to 4.2. While the pavement preservation-corridor and capacity development categories represent the largest investments, the congestion mitigation category contributes the greatest amount of total benefits. Other substantial benefit amounts would be derived from the pavement preservation-corridor, safety – spot improvement, and MnPASS investment categories.

. . . the diversity of potential investments . . .

The second question for the ROI analysis centered on the value of delivering higher performance levels across all investment categories and an economically competitive and world class highway system. It asked:

2. Improving Minnesota's state highway system to help the state become more economically competitive through technology and operational innovations and through high return on investment projects to reduce congestion and delays would require the investment of an additional $7 billion over the next 20 years. *What would be the return on that investment?*

To achieve the higher performance levels, increased investment in several categories would be necessary, particularly highway reconstruction, bridge repair and replacement, and MnPASS. Importantly, the congestion mitigation-general category would also receive a significant increase in investment, but experience diminishing returns compared to the initial round of investment. A conservative estimate of the benefit-cost ratio for the bridge

Table 5. Maintain Current Performance - Return on Investment

ROI Category	Average Investment (millions)	Percentage of Total Investment	Average Benefit (millions)	Low Benefit (millions)	High Benefit (millions)
Safety-Spot Improvement at High-Risk Locations	$662	12%	$2,701	$1,684	$3,718
Pavement Preservation – Corridor	$1,377	26%	$2,754	$2,203	$3,305
Pavement Reconstruction – Corridor	$106	2%	$93	$53	$133
Pavement Reconstruction – Urban/Main Street	$275	5%	$395	$206	$583
Bridge-Repair	$171	3%	$248	$222	$273
Bridge-Replacement	$399	7%	$399	$199	$598
Congestion Mitigation – General	$553	10%	$5,546	$2,546	$8,545
Capacity Development	$1,146	21%	$1,526	$847	$2,204
Active Traffic Management (ATM)	$79	1%	$703	$608	$798
MnPASS	$632	12%	$2,180	$1,661	$2,700
Total Benefit	n/a	n/a	$16,544	$10,230	$22,858
Total Investment	$5,400	n/a	$5,400	$5,400	$5,400
Return on Investment	**n/a**	**n/a**	**3.1**	**1.9**	**4.2**

. . . delivering higher performance levels across all investment categories . . .

replacement category also limits the overall return for this additional investment. Consequently, as shown in Table 6, the average return on investment for the second scenario is 2.1 to 1, within a range of 1.5 to 2.7.

Combining the two increments of additional investment, the total $12 billion recommended by TFAC would generate the estimated return on investment shown in Table 7. Six of the ten investment categories account for 85% of the proposed investment, with pavement preservation-corridor and capacity development totaling 40%. Four investment categories – pavement preservation-corridor, congestion mitigation-general, MnPASS, and safety-spot improvements – provide nearly 75% of the total benefits.

The ROI ranges in Table 8 are based primarily on the sample standard deviation of the analyzed representative projects, and address the third question posed in the introduction. It asked:

3. Within the proposed investments over the next 20 years, some projects and programs will necessarily have a higher return on investment and some will have a lower return on investment. *Which kinds of projects and programs offer the highest ROI?*

Table 6. Economically Competitive and World Class System - Return on Investment

ROI Category	Average Investment (millions)	Percentage of Total Investment	Average Benefit (millions)	Low Benefit (millions)	High Benefit (millions)
Safety-Spot Improvement at High-Risk Locations	$578	8%	$2,324	$1,454	$3,195
Pavement Preservation – Corridor	$1,264	18%	$2,528	$2,022	$3,034
Pavement Reconstruction – Corridor	$288	4%	$252	$144	$359
Pavement Reconstruction – Urban/Main Street	$408	6%	$585	$305	$864
Bridge-Repair	$451	6%	$654	$586	$721
Bridge-Replacement	$1,052	15%	$1,052	$526	$1,578
Congestion Mitigation – General	$798	11%	$1,836	$1,296	$2,375
Capacity Development	$1,246	18%	$1,297	$772	$1,821
Active Traffic Management (ATM)	$114	2%	$1,015	$878	$1,151
MnPASS	$912	13%	$3,146	$2,397	$3,896
Total Benefit	n/a	n/a	$14,688	$10,379	$18,996
Total Investment	$7,111	n/a	$7,111	$7,111	$7,111
Return on Investment	**n/a**	**n/a**	**2.1**	**1.5**	**2.7**

. . . competing funding demands . . . influence transportation investments.

Table 7. Total TFAC Recommendations - Return on Investment

ROI Category	Average Investment (millions)	Percentage of Total Investment	Average Benefit (millions)	Low Benefit (millions)	High Benefit (millions)
Safety-Spot Improvement at High-Risk Locations	$1,240	10%	$5,025	$3,137	$6,913
Pavement Preservation – Corridor	$2,641	21%	$5,282	$4,226	$6,338
Pavement Reconstruction – Corridor	$394	3%	$344	$197	$492
Pavement Reconstruction – Urban/Main Street	$683	5%	$979	$511	$1,447
Bridge-Repair	$622	5%	$902	$808	$995
Bridge-Replacement	$1,451	12%	$1,451	$725	$2,176
Congestion Mitigation – General	$1,351	11%	$7,381	$3,842	$10,921
Capacity Development	$2,392	19%	$2,823	$1,620	$4,026
Active Traffic Management (ATM)	$193	2%	$1,718	$1,486	$1,949
MnPASS	$1,544	12%	$5,327	$4,057	$6,596
Total Benefit	n/a	n/a	$31,232	$20,609	$41,854
Total Investment	$12,510	n/a	$12,510	$12,510	$12,510
Return on Investment	**n/a**	**n/a**	**2.5**		

As one might expect, the highest ROI point estimates are found in those categories targeting high traffic volume related investments. A simple ordering of the point estimates, however, would show that half of the values fall between 1.2 and 4.1. It is important also to underscore again the diversity of potential investments in each category, reflected in the ROI ranges. To capture as much of the diversity as possible, the low and high estimates of benefits were calculated with the high and low cost estimates, respectively – i.e., the ranges attempt to define the worst and best case estimates within each category. Finally, the ROI range for the total investment of $12.5 billion assumes that the categories are mostly independent of one another.

Of course, ROI analysis is only one of several important pieces of information in the transportation investment decision making process. Geographic and social equity, economic development, resilience to natural and manmade emergencies, and competing funding demands are some of the many other factors that influence transportation investments. Regional and local economic

. . . involve short-term job creation, as much as 13,000 jobs per $1 billion . . .

development, in particular, often play a significant role in the decision making process.

Although the ROI analysis contained in this document does not attempt to quantify wider economic development impacts, several general observations can be made. First, the ROI analysis and benefit-cost ratios do incorporate direct user or economic benefits, including travel time, travel reliability, and vehicle operating cost savings. These direct user benefits, in turn, form the basis for wider, long-term economic impacts generating what are commonly referred to as "multiplier" effects – e.g., gains in business output, personal income, and jobs.

Because multiplier effects involve a large degree of uncertainty related to context, it can be more generally observed that transportation investments that do not significantly reduce travel time, improve reliability, or reduce vehicle operating costs will not have a significant long-term, economic development impact.

Table 8. Return on Investment Categories – ROI Ranges

ROI Category	Average Investment (millions)	ROI Point Estimate	Low/High ROI Range
Safety-Spot Improvement at High-Risk Locations	$1,240	4.1	2.2 to 6.6
Pavement Preservation – Corridor	$2,641	2.0	1.4 to 2.8
Pavement Reconstruction – Corridor	$394	0.9	0.4 to 1.5
Pavement Reconstruction – Urban/Main Street	$683	1.4	0.6 to 2.5
Bridge-Repair	$622	1.5	1.1 to 1.9
Bridge-Replacement	$1,451	1.0	0.4 to 1.8
Congestion Mitigation – General	$1,351	5.5	2.5 to 9.6
Capacity Development	$2,392	1.2	0.6 to 2.0
Active Traffic Management (ATM)	$193	8.9	6.7 to 12.0
MnPASS	$1,544	3.5	2.3 to 5.1
TOTAL	**$12,510**	**2.5**	**2.0 to 3.2**

. . . investment in the state highway system over the next 20 years . . .

While transportation investment will always involve short-term job creation, as much as 13,000 jobs per $1 billion according to USDOT, investments should be geared toward those that result in higher productivity and support economic growth. The ROI analysis in this memorandum then can serve as both a useful tool for evaluating the TFAC recommendations and as a proxy for understanding the overall economic impact potential of the proposed investment.

Conclusion

The ROI assessment answers the three key questions posed in this study. In particular, the results, summarized below, define the estimated range of benefits expected for each investment option and the anticipated return on investment.

1. Maintaining the current performance of Minnesota's state highway system would require an investment of an additional $5 billion over the next 20 years. *What would be the return on that investment?*

   Answer: A $5 billion investment over the next 20 years to maintain current system performance would deliver between $10 billion and $23 billion in benefits, with an average ROI of 3.1.

2. Improving Minnesota's state highway system to help the state become more economically competitive through technology and operational innovations and through high return on investment projects to reduce congestion and delays would require the investment of an additional $7 billion over the next 20 years. *What would be the return on that investment?*

   Answer: An additional $7 billion investment over the next 20 years to have an economically competitive and world class state highway system would deliver between $10 billion and $19 billion in benefits, with an average ROI of 2.1.

3. Within the proposed investments over the next 20 years, some projects and programs will necessarily have a higher return on investment and some will have a lower return on investment. *Which kinds of projects and programs offer the highest ROI?*

   Answer: All ten of the highway investment categories, e.g., pavement preservation and congestion mitigation, evaluated in this study deliver ROI ranges that include economically feasible investments, i.e., the ROI is greater than 1.0. Investment categories with the highest ROIs tend to require less right-of-way acquisition and other physical inputs.

Based on the results of this study, there is a sound business case for making the $12 billion investment recommended by TFAC. In total, a $12 billion investment in the state highway system over the next 20 years would deliver between $21 billion and $42 billion in benefits, with an average ROI of 2.5 – or, for every dollar Minnesota invests in the state highway system, it can expect to receive two-and-a-half dollars in benefits.

Appendix A – Project Stakeholder Group

Table 9. Project Stakeholder Group

Organization	Name
ACEC	Randy Geerdes
ACTT / Minnesota Department of Transportation	Barb Brodeen
AFL- CIO	Shar Knutson
Alliance for Metropolitan Stability	Russ Adams
Anoka County Government Center	Jon Olson, Doug Fischer, Jack Forslund
Association of Minnesota Counties	Abby Bryduck
Bicycle Alliance of Minnesota	Dorian Grilley, Nick Mason
Blue Cross Blue Shield	Jill Chamberlain, Sam Rockwell
Chicano Latino Affairs Council	Hector Garcia
Citizen	Ron Biss
City of Bemidji	Rita Albrecht
Coalition of Greater Minnesota Cities	Amanda Duerr
Council on Asian-Pacific Minnesotans	Kao Ly Ilean Her
Council on Black Minnesotans	Edward McDonald
Department of Public Safety	Susie Palmer
Explore Minnesota	John Edman, Julie Ramer, Colleen Tollefson
Flint Hills Resources	Matthew Lemke
Fed Ex	Bill Goins
Fresh Energy	Michael Noble
Great Plains Institute	Brendan Jordan, Rolf Nordstrom
Hennepin County	Peter McLaughlin
IUOE - Local 49	Glen Johnson
Kandiyohi County	Harlen Madsen
Marshall Chamber of Commerce	Cal Brink
Metropolitan Council	Susan Haigh, Pat Born, Adam Dunnick
Metropolitan Airport Commission	Jeff Hamiel, Mitch Kilian
Minnesota Agri-Growth Council	Perry Aasness
Minnesota Center for Environmental Advocacy	Jim Erkel, Emily Parks
Minnesota Chamber of Commerce	Doug Fulton
Minnesota Department of Agriculture	Charlie Poster
Minnesota Department of Employment and Economic Development	Kevin McKinnon
Minnesota Department of Health	Amber Dallman
Minnesota Department of Natural Resources	Emmett Mullin
Minnesota Department of Transportation	Charles Zelle
Minnesota House of Representatives	Michael Beard
Minnesota House of Representatives	Andy Leer
Minnesota House of Representatives	Frank Hornstein
Minnesota Housing Finance Agency	Tonja Orr

Organization	Name
Minnesota Non-Motorized Transportation Advisory Committee	Dan Breva
Minnesota Public Transit Association	Tony Kellen
Minnesota Senate	John Pederson
Minnesota Senate	Scott Dibble
Minnesota Transportation Alliance	Margaret Donahoe
Minnesota Trucking Association	John Hausladen, Dan Savaloja
Murphy Warehouse Company	Richard Murphy
Polaris	Jan Rintamaki, J.R. Burke
Minnesota Pollution Control Agency	David Thornton
Quality Bicycle Products of Minnesota	Steve Flagg
RBC Capital	Cory Hoeppner, Laura Janke
Region 9 Regional Development Commission	Ronda Allis
Rochester Olmstead Council of Governments	Phil Wheeler, Mitzi Baker
St. Louis County	Chris Dahlberg
Target Corporation	Meredith Beeson, Dan Riley
Transit for Livable Communities	Barb Thoman
University of Minnesota Center for Transportation Studies	Gina Baas
University of Minnesota Humphrey School of Public Affairs	Art Rolnick
Urban Land Institute	Caren Dewar, Aubrey Austin