

North/West Passage Pooled Fund Study

TPF-5(190)

Project 5.2: Benefit/Cost ITS Tool - Phase 1



FINAL

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1.0 Introduction

The [North/West Passage Transportation Pooled Fund Study TPF-5\(190\)](#) includes the states of Washington, Idaho, Montana, Wyoming, North Dakota, South Dakota, Minnesota and Wisconsin. These eight states work together to develop effective methods for sharing, coordinating, and integrating traveler information and operational activities along the I-90 and I-94 corridor.

During 2010, the North/West Passage states recognized the increased need for a mechanism to conduct benefit/cost analyses of Intelligent Transportation Systems (ITS) devices in order that they may assess ITS deployments and expenditures within their states. The North/West Passage states have also individually submitted Transportation Investments Generating Economic Recovery (TIGER) applications on a variety of ITS projects to the United States Department of Transportation (USDOT) for consideration. With each application, a benefit/cost analysis was required. With the increased need of benefit/cost analyses, the North/West Passage states wanted to identify what tools were available and if the benefit/cost tools would provide a valid approach for the typical rural ITS projects that the North/West Passage states pursue.

The North/West Passage Steering Committee approved this benefit/cost tool evaluation project in their [2010 Annual Work Plan](#). The initial goal of this project was to evaluate the New York State DOT Evaluation Model for Freeway ITS Scoping (EMFITS) and determine if the tool could be expanded to permit evaluation of ITS rural projects. Based on that evaluation, the group decided to develop a custom tool with emphasis on transparency, ease-of-use and the rural applications most commonly used among the North/West Passage states. This report presents the results of the EMFITS evaluation, the approach used, an overview of the tool developed for North/West Passage, and recommendations for further enhancement of the tool.

2.0 North/West Passage Benefit/Cost Tool Needs

The North/West Passage states identified the following needs for a benefit/cost tool that could be used when considering typical rural ITS projects that the North/West Passage states pursue.

- Need 1 A concise spreadsheet style tool that is compatible with MS Excel and can be opened and used by anyone.
- Need 2 The tool needs to allow users to answer questions with minimal details for future and existing ITS deployments.
- Need 3 Based on the answers typed into the tool, the tool needs to compute the anticipated benefit of the device. This benefit value will then be compared against planned costs for the deployment.
- Need 4 The assumptions and logic behind the decision process need to be completely transparent to users of the spreadsheet and sources need to be cited. The assumptions and logic also need to be modifiable by users of the spreadsheet.
- Need 5 The spreadsheet needs to focus on typical ITS deployments in rural areas.

3.0 Benefit/Cost Tools

The North/West Passage states were aware of Evaluation Model for Freeway ITS Scoping (EMFITS) through Washington State's review of the tool and wanted to identify if the tool would meet the needs identified in Section 2.0 of eight states.

In order to not duplicate efforts, other benefit/cost tools were also reviewed to determine the best fit for the needs of the North/West Passage Corridor. This section presents the key points of each tool evaluated.

3.1 Evaluation Model for Freeway ITS Scoping (EMFITS)

[EMFITS](#) was developed for the New York State Department of Transportation (NYSDOT) to estimate benefits of ITS deployments on freeways. The uses of the tool include:

- Congestion management
- Ramp metering
- Road Weather Information Systems (RWIS)
- Service Patrol

EMFITS is a spreadsheet (MS Excel) based model and all fields are unlocked and adjustable. The model is based on a 'Thread' structure, where multiple concurrent ITS deployments impact an outcome and can be traced by each 'Thread'. At the core of EMFITS is a set of parameters that effectively help to compute benefits. These parameters are (in the simplest explanation) assumptions based on the experiences of NYSDOT and other projects and agencies. Whenever possible, references for the parameters are cited in the report.

EMFITS computes the reduction in vehicle-hours per year, gallons of fuel per year, hydrocarbons, carbon monoxide, oxides of nitrogen, accident, agency operating cost, and ton-hours (freight measure of delay) that can be used to determine the financial benefits of different levels of ITS deployment.

After reviewing EMFITS, the North/West Passage Program determined that the tool was not appropriate for rural ITS applications since the uses of the tool are more urban and system focused. For example DMS, CCTV and detection are typically evaluated together as a congestion management system. In contrast, the North/West Passage states may deploy only one of these devices in an isolated rural environment and it would likely be for safety vs. congestion management purposes.

3.2 Intelligent Transportation System Deployment Analysis System (IDAS)

[IDAS](#) is a sketch-planning software analysis tool to estimate the benefits and cost of ITS investments. The software evaluates a number of benefits. These are determined by changes attributable to the deployment of ITS in vehicle miles traveled (VMT), vehicle hours traveled (VHT), volume-capacity (v/c) ratios, and vehicle speeds throughout a given network.

IDAS requires the output of a regional demand model to operate. Since there are no regional demand models for most of the rural areas of the North/West Passage Corridor it was determined that this tool would not work for the North/West Passage Corridor.

3.3 Tool for Operations Benefit/Cost (TOPS-BC)

[TOPS-BC](#) is a spreadsheet-based tool that is currently being developed to provide benefit/cost information related to Transportation System Management and Operations (TSM&O) by providing four key capabilities.

- Provides the ability for users to investigate the expected range of impacts associated with previous deployments and analyses of many TSM&O strategies.
- Provides a screening mechanism to help users identify appropriate tools and methodologies for conducting a B/C analysis based on their analysis needs.
- Provides a framework and default cost data to estimate the lifecycle costs of various TSM&O strategies, including capital, replacement, and continuing operations and maintenance (O&M) costs.
- Provides a framework and suggested impact values for conducting simple B/C analysis for selected TSM&O strategies.

TSM&O Strategies covered in TOPS-BC include:

- Arterial Coordination
- Arterial Transit Signal Priority
- Transit Automatic Vehicle Location
- Ramp Metering
- Incident Management
- Pretrip Traveler Information
- En-route Traveler Information
- Work Zone Management
- HOT Lanes
- Speed Harmonization
- Hard Shoulder Running
- Travel Demand Management
- Traffic Surveillance
- Traffic Management Centers
- Communications

A final version of the TOPS-BC will be available in late 2012. Similar to the limitations of the EMFITS tool, the strategies available in TOPS-BC did not include options to conduct a benefit/cost analyses for the individual ITS devices that the North/West Passage states typically deploy in more isolated, rural areas.

3.4 Other Benefit/Cost Resources

The North/West Passage states are aware that there are a number of other benefit/cost resources available to assist in assessing existing and future ITS deployments. Some of these tools and resources include:

- [USDOT Research and Innovative Technology Administration – ITS Benefits Database](#)
This site provides access to the benefits of ITS deployments to assist transportation professions in making information planning and investment decisions.
- [Intelligent Transportation Systems Benefits, Costs, Deployment, and Lessons Learned: 2011 Update](#)
This report is a continuation of a series of reports providing a snapshot of the information collected by the USDOT ITS Joint Program Office on the impact that ITS projects have on the operation of the surface transportation network.

4.0 Benefit/Cost Approaches

After the review of the benefit/cost tools and resources available in Section 3.0 the North/West Passage states concluded that there is no one tool that can fulfill each need identified in Section 2.0. The group agreed to move forward with developing a new tool, but capturing the concepts and ease of EMFITS in order to create a tool that meets the needs of the corridor. The following subsections briefly describe a typical benefit/cost approach and the approach used for the North/West Passage Corridor.

4.1 Typical Benefit/Cost Approach

Benefit/cost analysis is an economic analysis tool to help decide whether benefits of a project outweigh associated costs. There are a number of standard costs and benefits (e.g. travel times savings, vehicle operating cost savings, safety benefits) that are generally accounted for in a traditional benefit/cost approach for transportation projects. The Minnesota DOT has completed a [Benefit-Cost Analysis for Transportation Projects](#) document that summarizes the traditional approach of a benefit-cost analysis.

4.2 North/West Passage Benefit/Cost Approach

The North/West Passage spreadsheet tool includes all of the standard costs and benefits but adds in a DOT cost-savings as a benefit. The DOT cost-savings takes into account actual operational costs (e.g. personnel, supplies, vehicle operation costs) that the transportation agencies will save if the ITS project is deployed. For example, when crashes are prevented, the DOT cost-savings benefit would include the additional mileage/staff time to drive to and manage the crash scene as well as any clean-up and infrastructure repairs.

5.0 North/West Passage Benefit/Cost Tool ITS Device Focus Areas

Infrastructure deployments are critical to the North/West Passage states and having a tool that can provide quantitative benefit/cost analyses will assist in planning for future ITS deployments along I-90/I-94 as well as state and corridor-wide. The eight states identified the following ITS devices as most valuable to be included in this first version of a benefit/cost tool for the corridor.

- Dynamic Message Signs (DMS)
- Road/Weather Information Systems (RWIS)
- Closed Circuit Television (CCTV)
- Traffic Detection (speed, volume, detection)

The North/West Passage states realize there are other devices used in rural areas, however as the first step to assessing the use of a rural focused benefit/cost tool agreed on the ITS devices listed above.

6.0 North/West Passage Benefit/Cost Spreadsheet Tool

The purpose of the North/West Passage MS Excel spreadsheet tool is to calculate the benefit cost ratio associated with typical ITS deployments (DMS, Traffic Detection, RWIS or CCTV) within the North/West Passage states. The tool is intended to be transparent and easily modifiable for instances when a benefit cost analysis is required and when multiple ITS projects must be prioritized.

ITS Devices and Uses of Device Included in North/West Passage Spreadsheet Tool

The spreadsheet provides a benefit/cost analysis for the four ITS devices (DMS, Traffic Detection, RWIS, and CCTV) that were identified for this first phase of the project. The spreadsheet also identifies selected uses from the devices and the desired impact with deployment of the ITS device as shown in the table below. The North/West Passage states are aware that there may be other uses for the four ITS devices selected for this project and if the project moves into future phases these will be enhanced.

Table 1: ITS Device, Intended Uses of Device and Desired Impact included in North/West Passage Spreadsheet Tool

ITS Device	Use of Device	Desired Impact
DMS	Variable Speed Limits (VSL) to reduce crashes in High Wind Zones	Reduce Crashes
	Variable Speed Limits to reduce crashes in mountain pass zones	
	Variable Speed Limits to reduce crashes due to visibility	
	Display of Weather / Road Conditions to reduce Crashes and Delays	
	Display of Weather Information based on Manual observations	
	Display of Travel Times or Speeds	Reduce Delay
Traffic Detection	Automated Traffic data to replace manual data gathering	Reduce DOT Resource Needs
RWIS	Monitor Conditions at key Locations to Reduce DOT Resource Needs	Reduce DOT Resource Needs
	Monitor and warn travelers of impending road closures	Reduce Delay
	Remote monitoring to assist winter operations and reduce crashes	Reduce Crashes
	Collect data for model aggregation to reduce DOT operations resources	Reduce DOT Resource Needs
CCTV	Observe traffic, devices, and/or incidents to reduce DOT field time	Reduce DOT Resource Needs
	Prevent secondary crashes by viewing/responding to crashes	Reduce Crashes
	Travelers observe winter conditions to reduce crashes	
	Travelers observe traffic conditions to reduce delays	Reduce Delays

Expected Impact with deployment of ITS Device

For each of the intended uses included in Table 1 the North/West Passage states documented sources and cited references for reducing crashes, reducing delays or reducing DOT resource needs with deployment of a device. For example, if Montana is considering deploying Variable Speed Limits (VSL) to reduce crashes in a high wind zone they could assume a 38% reduction of crashes based on the results of the Wyoming DOT’s Variable Speed Limit efforts. Wyoming DOT Deployment of VSL on I-90 noted a reduction in crashes from 402/year to 248/year. However if Montana DOT has another verifiable source of what percentage of crashes could be reduced with deployment of VSL, the spreadsheet allows the user to adjust the percent reduction value as shown in Table 2.

Table 2: Source, Citation and Adjustable Values included in North/West Passage Spreadsheet

ITS Device	Use of Device	Desired Impact	Source/Citation	Percent Reduction
DMS	VSL to reduce crashes in High Zone	Reduce Crashes	<i>Source 1</i> Wyoming DOT deployment of VSL on I-90 noted a reduction in crashes from 402/year to 248/year. Wyoming DOT’s success factors included enforcement and calculation approach.	38%
			<i>Source 2</i> Verifiable source to be added to spreadsheet by user and sent to the North/West Passage program to add to the spreadsheet template.	Percent inserted by user

It is the vision of the North/West Passage members that as the tool continues to be used, the sources and cited references will continue to grow and provide additional data to justify the assumed reductions with deployment.

Monetary Benefits with deployment of ITS Device

The spreadsheet also determines monetary benefits for each crash prevented with the deployment of device(s). Societal benefits per crash are calculated using crash data by injury type entered by the user. Per Crash DOT Personnel and Infrastructure Costs are calculated from users’ input of the typical response distance to the proposed device location, typical response and scene time, and typical repairs incurred.

Travel time monetary benefits are calculated using Average Annual Daily Traffic (AADT) and clearance time entered by the user.

North/West Passage Benefit/Cost Tool User Input

Users of the tool are asked to input answers to specific questions based on the intended use of the device (e.g. RWIS deployment to monitor and warn travelers of impending road closures). The spreadsheet includes over forty five questions however, it is important to note that the only those questions related to the device and its intended use are asked when filling in the spreadsheet. See Table

3 for an example listing of questions for a RWIS deployment to monitor conditions at key location to reduce DOT resources.

Table 3: North/West Passage Spreadsheet User Input Example – RWIS deployment to monitor conditions at key location to reduce DOT resources

ITS device(s) estimated capital cost, number of devices, anticipated life
Use of the device (See Table 1)
After installation, estimated Annual Maintenance Costs for ITS device(s)
Base year date (expected year of installation)
Length of years for benefit cost analysis period
Approximate distance from the closest DOT site to the project area
Estimated time DOT personnel are typically on scene of a crash in this project area
Average hourly personnel cost (including salary and benefits) for DOT personnel responding to events
Typical number of DOT personnel on scene of crash
DOT response vehicle cost
Typical number of times annually that inclement winter weather occurs at this location
Typical number of times Roadway is treated at this location per year
What monitoring devices are included in the RWIS (e.g. pavement sensor, CCTV)
Would DOT representatives who drive to the site to observe conditions also apply treatment

The spreadsheet is designed to provide users with a simple form to fill out. Default parameters are provided for many of the questions above for use if data is not available. Figure 2 provides a screen capture of the input tab included in the North/West Passage Benefit/Cost Tool spreadsheet.

TOOL INPUTS

Enter the required information into cells highlighted this color

Cells highlighted this color are calculated or referenced and not for user input

Step 1: Enter Information about the deployment plans (Location, Devices, Costs, Intended Use)

Location description (e.g. I-80 between _____)				
	ITS Device	Estimated Capital Cost (\$)	Number of Devices	Anticipated Life (years)
ITS device estimated capital cost, number of devices and anticipated life (e.g. \$100,000 estimated capital cost, 1 unit, 5 years)	DMS			
	CCTV			
	RWIS			
	Traffic Detection			
	Other Costs			
Select the primary use of the ITS device from the drop down menu. If multiple devices are being deployed, select the primary use that best describes the problem being addressed by this project.	Primary Use			
	Variable Speed Limits to reduce crashes in High Wind Zone			

Step 2: Answer questions specific to the Intended Use Selected

=>>> After installation, estimated annual maintenance costs for all ITS device(s) entered above (e.g. _____)	\$ 50,000
=>>> Current date	April 12, 2012
=>>> Base year date (expected year of installation)	2012
=>>> Length of years for benefit cost analysis period (e.g. 10)	10

Figure 2: North/West Passage Benefit/Cost Tool User Input Tab

North/West Passage Benefit/Cost Tool Report

The final output report from the Benefit/Cost Tool is a separate tab within the spreadsheet that summarizes the benefit/cost analyses. The tab is intended as summary page that a user can print off to explain the benefit/cost analysis. The report includes:

- Summary of the project location and ITS device(s) selected for the deployment
- Capital Cost of ITS device (s)
- Base Year (expected year of installation) AADT
- Total Benefits Over Benefit/Cost Period Selected
 - DOT Operations Cost Savings
 - Societal Benefits (including Monetary Crash Values)
- Total Cost Over Benefit/Cost Period Selected
 - Deployment Costs
 - Annual Maintenance Costs to DTO with ITS Device(s) selected
- Overall Benefits and Costs (includes both societal and DOT)
 - Annual Reduction of crashes with ITS deployment
 - Annual Societal Benefits with ITS deployments
 - Annual DOT Cost Savings
 - Present Value of Benefits
 - Present Value of Costs
 - Benefit/Cost Ratio
- DOT Benefits Only B/C
- DOT and Societal Benefits B/C
- Graph of Cumulative Total Benefits and Costs (Societal and DOT)
- Graph of Cumulative DOT Costs and Benefits (excluding capital cost)

7.0 North/West Passage Benefit/Cost Spreadsheet Tool Recommended Enhancements

The initial version of North/West Passage Benefit/Cost was developed with input from the states. As the tool was developed there are a number of modifications that could be considered to further enhance the tool in a second phase of this project. Based on the review of the tool and comments from the states the following recommendation to future phases of the tool may include:

- Continuing to add 'MetaData' to the tool which would explain deployment parameters for cited references, descriptions of how each device is used, and conditions for deployment
- Developing summary pages of the 'MetaData' to provide states with an easy way to add cited references to enhance the tool
- Adding additional ITS devices to the four developed in this project
- Continuing to expand/improve the tool based on input from the North/West Passage states as well as the ITS community