DEPARTMENT OF TRANSPORTATION

USER GUIDE:
Process for Quantifying the Benefits of Research

Authors: Howard Preston and
Jacqueline Dowds Bennett, CH2M Hill

Report Number: 2017-13A
Date Published: July 2017

Minnesota Department of Transportation
Research Services & Library
395 John Ireland Boulevard , MS 330
St. Paul, Minnesota 55155-1899

To request this document in an alternative format, such as braille or large print, call 651-366-4718 or 1-800-657-3774 (Greater Minnesota) or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.
MN/RC 2017-13A		

4. Title and Subtitle	5. Report Date
User Guide: Process for Quantifying the Benefits of Research	July 2017
	6.

7. Author(s)	8. Performing Organization Report No.
Howard Preston and Jacqueline Dowds Bennett	

9. Performing Organization Name and Address	10. Project/Task/Work Unit No.
CH2M Hill 1295 Northland Drive, Suite 200 Mendota Heights, MN 55120	11. Contract (C) or Grant (G) No. (C) 05794

12. Sponsoring Organization Name and Address	13. Type of Report and Period Covered
Minnesota Department of Transportation Research Services & Library 395 John Ireland Boulevard, MS 330 St. Paul, Minnesota 55155-1899	User Guide
	14. Sponsoring Agency Code

15. Supplementary Notes

http:// mndot.gov/research/reports/2017/201713A.pdf

Related Materials:

- Final report: http:// mndot.gov/research/reports/2017/201713.pdf
- Final presentation: http:// mndot.gov/research/reports/2017/201713B.pdf
- Spreadsheet tool: http:// mndot.gov/research/reports/2017/201713C.pdf

16. Abstract (Limit: 250 words)

The Minnesota Department of Transportation Research Services has adopted a process for quantifying the monetary benefits of research projects, such as the dollar value of particular ideas when implemented across the state's transportation system. This process is adaptable to a variety of research topics and benefit categories. Research Services has incorporated the potential benefit-cost ratio of proposed research projects into the selection process for new projects.

The purpose of this user guide is to explain the seven-step benefit quantification process and use of Research Services' benefit quantification spreadsheet tool. The tool calculates the potential benefit of research recommendations in terms of the potential cost savings that could be realized by their implementation, and estimates a benefit-cost ratio. The tool performs the calculations with user input values and serves as a repository for the data, assumptions, and sources included in the quantification process.

17. Document Analysis/Descriptors	18. Availability Statement
benefit cost analysis, research, benefits	No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312

19. Security Class (this report)	20. Security Class (this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	73	

User Guide: Process for Quantifying the Benefits of Research

USER GUIDE

Prepared by:

Howard Preston
Jacqueline Dowds Bennett
CH2M Hill

July 2017

Published by:

Minnesota Department of Transportation
Research Services & Library
395 John Ireland Boulevard, MS 330
St. Paul, Minnesota 55155-1899

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

The Minnesota Department of Transportation's (MnDOT) Research Services follows a detailed process of evaluation that includes quantifying the benefits of research projects in absolute terms, such as the dollar value of particular ideas when implemented across the state's transportation system. The process compares the potential monetary benefit to be gained by the implementation of the research recommendations to the cost of the research effort and results in a benefit-cost ratio. The process is adaptable to a variety of research topics and benefit categories. Research Services incorporates the potential benefit-cost ratio of proposed research projects into its selection process for new projects. This process acknowledges that research-generated recommendations will likely have qualitative benefits that cannot be captured solely in economic terms through a process that calculates monetary benefit.

The purpose of this user guide is to explain the seven-step benefit quantification process and use of the Research Services' spreadsheet tool. The tool calculates the potential benefit of research recommendations in terms of the potential cost savings that could be realized by their implementation, and estimates a benefit-cost ratio. The tool performs the calculations with user input values and serves as a repository for the data, assumptions, and sources included in the quantification process.

CHAPTER 2: RESEARCH BENEFIT QUANTIFICATION PROCESS

Figure 1 depicts the seven-step process for comparing the potential monetary benefit to be gained by the implementation of the research recommendations to the cost of the research effort. Most of the steps should be completed in order since the information gained in these steps informs a subsequent step, but a few steps can be performed simultaneously (Steps 3/4/5). The remainder of this section documents the application of each step in the seven-step quantification process:

1. Determine Benefit Category
2. Build Benefit Estimation Tool
3. Collect Input Data
4. Document Implementation of Recommendations
5. Populate Benefit Estimation Tool
6. Determine Benefit
7. Compare Benefit to Cost

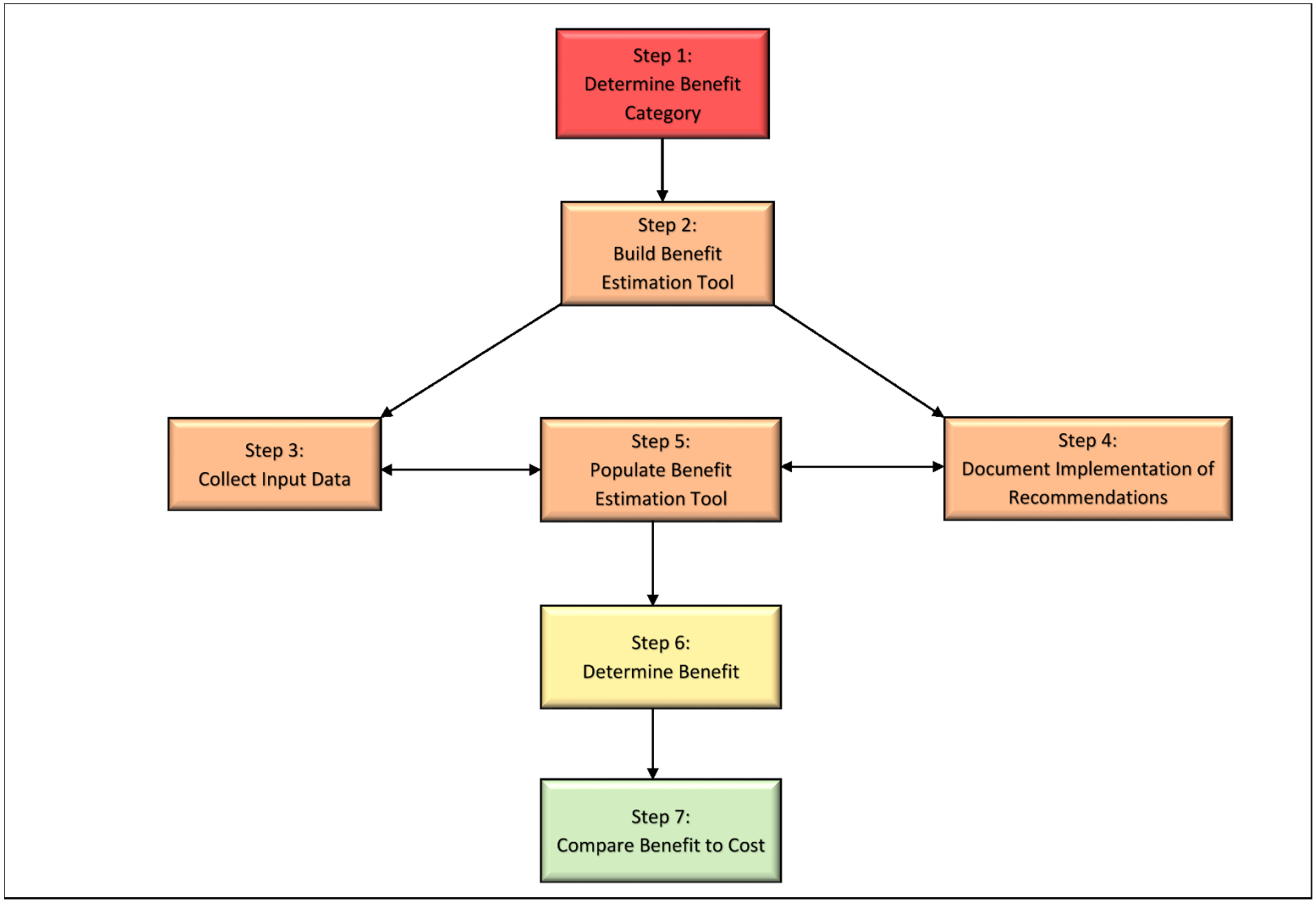


Figure 1. Benefit Quantification Process Flowchart

Step 1: Determine Benefit Category

The first step in the quantification process is to select the applicable benefit category to include in the evaluation. Multiple benefit categories may be applicable to a research project, so the user should select all appropriate benefit categories from the following list:

- Construction Saving (materials, labor/time, equipment)
- Decrease Engineering/Administrative Costs (planning/design costs, paperwork)
- Decrease Lifecycle Costs
- Environmental Aspects (pollution, hazardous waste reductions, recycling)
- Increase Lifecycle
- Operation and Maintenance Saving (materials, labor/time, equipment)
- Safety (reduction of crash frequency and/or severity)
- User Benefits (time/dollars)
- Risk Management (tort liability, environmental fines)

Step 2: Build Benefit Estimation Tool

The second step in the quantification process is to assemble the applicable templates into one spreadsheet file for use in calculating all of the potential benefits. The user selects the templates based on the benefit categories identified in Step 1.

This tool includes 6 template spreadsheets that capture the 9 benefit categories (listed in Step 1) thought to be quantifiable. The template spreadsheets are formatted as follows:

- Blue cells – indicate user input for project information (title, number, principal investigator, and cost) and given values (standard values that are not unique to the project, such as benefit time frame, interest rate, labor rates, and societal crash costs)
- Orange cells – indicate user input for values that are unique to the project recommendations (such as, material quantities, labor hours required to conduct an activity, and frequency of strategy deployment)
- White cells – output values of the benefit calculations (such as, Annual Benefit, Net Present Value of the strategy over the benefit time frame); the formulas are locked down such that the user cannot alter the formulas that calculate the output values

- Columns - the columns are ordered from left to right such that the inputs are toward the left and the resultant output is toward the right of each row

- Output – the benefits are in the far right column, expressed as the Net Present Value of the annual benefit of implementing the recommendations over the stated time frame

- Blank cells – if there is a calculation error or a cell does not contain an entry, white cells will not populate output values of the benefit calculations, indicating a missing input value

Each template spreadsheet consists of two tabs: one that explains each of the components of the calculation spreadsheet, and one for the inputs and calculations. The following details the components of each of the six template spreadsheets and quantification calculations. These template spreadsheets collectively represent the benefit estimation tool. Appendix A contains the template spreadsheets.

- **Direct Labor Savings** – The direct labor benefit is expressed as the cost savings achieved by a reduction in labor hours achieved by the implementation of research findings. The spreadsheet provides two options to calculate the benefit – one is to input the number of hours for the current and proposed methods and the other is to input the current number of hours and the estimated percentage of time saved through use of the proposed method. The benefit calculation involves multiplying the hours saved by the applicable hourly labor rate.

- **Safety** – The safety benefit is expressed as the societal cost savings achieved by a reduction in the frequency and severity of crashes attributed to the improvements recommended by the research findings. The spreadsheet provides two options to calculate the benefit– one is to input a known change in annual crashes to represent crash reduction and the other is to input before crash data along with published crash reduction factors which the spreadsheet uses to calculate crash reduction. The benefit calculation involves multiplying the annual crash reduction (the change in crashes attributed to the improvements) by severity level by the respective MnDOT values for crash cost by severity. To calculate the potential annual benefit across the state, the sum of the savings for all severity levels is then multiplied by the estimated deployment across the state. The spreadsheet includes an input value for Level of Confidence, which can be used as a sensitivity analysis based on the likelihood that the entered deployment value will be achieved.

- **Traffic Operations/User Benefits** – The traffic operations/user benefit is calculated for both roadway users and the Department of Transportation. Occupancy is included in the calculations to compute the savings per person. The calculations are separate for passenger vehicles and commercial trucks to reflect the different values of delay for these two user groups. The user benefit is expressed as the monetary savings achieved by a reduction in travel time delay. The Department of Transportation benefit is expressed as the savings achieved from reduced maintenance requirements due to fewer stops and/or the savings in labor hours due to the elimination of tasks no longer required because of the recommendations. The spreadsheet includes an input value for Level of Confidence, which can be used as a sensitivity analysis based on the likelihood that the entered deployment value will be achieved.

- **Materials and Activities** – The materials and activities benefit is expressed as the cost savings realized from a reduction in materials or time. The spreadsheet provides three options to calculate the benefit–a reduction in material quantity due to a different installation practice, a cost savings achieved by use of a lower cost material, or a revised method of completing an activity which requires fewer labor hours. The material quantity savings calculations can be based on the change in quantity or percent reduction in quantity. The material cost savings are based on the change in price for the proposed material. The activity cost savings are based on the percent reduction in cost with use of the proposed method.

- **Lifecycle** – The lifecycle benefit is expressed the cost savings realized from using a product with a longer lifecycle, thus requiring fewer purchase and installation expenditures over time. The spreadsheet can assess the benefit of a one-time investment or annual investments to realize a cost savings due to changing the lifecycle of an item. The spreadsheet also provides the ability to analyze the savings that could be achieved by reducing inventory and increasing lifecycle.

- **Risk Management** – The risk management benefit is expressed as the cost savings realized from a reduction in fines due to implementation or research recommendations for changing actions or practices that result in fines.

Modifications. As necessary, the user can save a separate version of a template spreadsheet and modify it to more accurately calculate a potential benefit. The modified formulas should maintain an industry-standard methodology for calculating cost savings. Any modifications should be approved through the Research Services prior to completing the benefit quantification estimate and cost comparison. A separate version of the template is required because the formulas in the standard templates are locked and not subject to modification.

Table 1. Applicable Templates for Benefit Categories

Benefit Category	Template Spreadsheets
Construction Saving	Direct Labor Savings, Materials and Activities
Decrease Engineering/Administrative Cost	Direct Labor Savings
Decrease Lifecycle Costs	Lifecycle Costs
Environmental Aspect	Direct Labor Savings, Materials and Activities, Risk Management
Increase Lifecycle	Lifecycle Costs
Operation and Maintenance Saving	Direct Labor Savings, Materials and Activities
Safety	Safety
User Benefits	Traffic Operations User Benefits
Risk Management	Risk Management

Step 3: Collect Input Data

The second step in the quantification process to select the applicable templates should be completed prior to initiating the third step, so the user knows what input data are required. The colored cells in the template spreadsheet indicate which values are required to be input by the user. For the given values to be input into the blue cells, the most currently available values should be obtained from MnDOT or from published resources at either the state or national level (refer to Appendix C for examples of MnDOT published resources). The values input into the orange cells will typically be specific to the research project recommendations and could be obtained from the research report or from MnDOT personnel; however, the crash reduction factors are orange-cell inputs that should be identified through published state or national resources. Steps 3 and 5 can be performed simultaneously so the user is entering the input data as it is collected.

The necessary data to estimate potential benefits will ideally be included in the research report. If this is not the case, the user should pursue the data through other means such as meeting with the MnDOT staff and university researchers involved with the project or staff with outside sources such as local agency engineers and industry representatives. These meetings should be held to discuss potential benefits categories, sources of potential data, the extent of potential implementation, and installation and maintenance costs. If these methods do not prove fruitful, then substitutes for actual data should be generated using relevant assumptions based on industry practice.

Step 4: Document Implementation of Recommendations

The fourth step, documentation, should include the number of potential locations for implementation, but not necessarily specific locations (with the exception of a safety benefit calculation for a designated location). Data from the existing condition before implementation should be representative of the cost/quantity/activity prior to the start of construction or be representative of the current practices. Crash data should be gathered for a three-year period prior to construction to implement the recommendations. Steps 4 and 5 can be performed simultaneously so the user is entering the input data as it is collected. This information is entered in the *Data Documentation* section of the spreadsheet.

Step 5: Populate Benefit Estimation Tool

The fifth step involves entering all the required input data into the blue and orange cells. Steps 3, 4, and 5 can be performed simultaneously so the user is entering the input data as it is collected and stored in the spreadsheet.

Step 6: Determine Benefit

The user determines the benefit during this sixth step by referring to the value presented in the Net Present Value column of the template spreadsheet. If more than one type of benefit is likely from a set of recommendations, the user can document the applicable benefit category and corresponding Net

Present Value along with the total benefit on one of the benefit calculation tabs in the quantification spreadsheet.

Step 7: Compare Benefit to Cost

In this seventh step, the template spreadsheet automatically performs the benefit-to-cost calculation after the user enters all necessary data and information in the Benefit-Cost Ratio Estimation section of the spreadsheet.

CHAPTER 3: SUBMISSION OF DOCUMENTATION

The end result of the seven-step process is a spreadsheet that documents the estimation of benefits, the research cost, and the resultant benefit-cost ratio. If all steps are followed as described in this guide, the spreadsheet represents a complete record of the benefit quantification process for a given research project. The spreadsheet should be submitted to Research Services, where it will be stored as part of the project record. Research Services will use this documentation during on-going evaluations of the research program to determine effectiveness and to inform improvements to processes for project selection and implementation of recommendations.

CHAPTER 4: USER GUIDE PRESENTATION

A presentation has been developed to assist researchers with the application of the benefit quantification process and use of the spreadsheet tool to estimate the potential benefit of a specific research project. Appendix B contains the PowerPoint presentation that depicts this user's guide. Both files are available for download from Research Services' website.

APPENDIX A: TEMPLATE SPREADSHEETS

The Excel spreadsheet tool is available at mndot.gov/research/reports/2017/2017B.xlsx

Appendix A1
Direct Labor Savings

Project Information	
Project Title:	
Project Number:	
Principal Investigator:	
Project Cost:	
Technical Liaison:	
Administrative Liaison:	

Given Values	
Benefit Time Frame =	
Interest Rate =	
Average Labor Rate =	

Determination of Direct Labor Savings

Entered Values | **Performance Measurements**

Change in number of labor hours to complete activity Recommendations	Average Labor Rate $	BEFORE --- Number of Hours No.	AFTER --- Number of Hours No.	Annual Frequency of Activity No. Unit	Benefit Time Frame Yrs.	Annual Labor Savings No.	Total Labor Savings No.	Annual Benefit of Labor Savings $	Net Present Value of Labor Savings $
<<Add Description>>									
<<Add Description>>									

Percent reduction in number of labor hours to complete activity Recommendations	Average Labor Rate $	BEFORE --- Number of Hours No.	AFTER --- Percent Reduction in Labor Hours %	Annual Frequency of Activity No. Unit	Benefit Time Frame Yrs.	Annual Labor Savings No.	Total Labor Savings No.	Annual Benefit of Labor Savings $	Net Present Value of Labor Savings $
<<Add Description>>									
<<Add Description>>									

Data Documentation

Benefit - Cost Ratio Estimation

Calculation Components	Benefit Sum $	Research Cost $	Ratio
Sum of Benefits from all Categories			
Cost of Research Project			

Appendix A2
Safety

Safety Template Spreadsheet

Project Information	
Project Title:	
Project Number:	
Principal Investigator:	
Project Cost:	
Technical Liaison:	
Administrative Liaison:	

Crash Definitions & Distributions		
Fatal		1%
Type A Injury	Serious	1%
Type B Injury	Moderate	8%
Type C Injury	Minor	20%
Property Damage		70%

Injury Crash Definitions & Distributions		
Type A	Serious	5%
Type B	Moderate	26%
Type C	Minor	69%

Given Values	
Benefit Time Frame =	
Interest Rate =	
Fatal Crash =	
Type A Injury Crash =	
Type B Injury Crash =	
Type C Injury Crash =	
Property Damage Only Crash =	

User Input – Historical Crash Data

		Related Crashes						Road System Data			Crash Reduction Factors						Service Life	Treatment Deployment		
		Fatal Crashes	Injury Type A Crashes	Injury Type B Crashes	Injury Type C Crashes	Property Damage Crashes	Years of Crash Data	Feature Count		Traffic Growth Rate	Fatal	A Injury	B Injury	C Injury	Property Damage	Unit	Service Life	Amount Deployed		Level of Confidence
Recommendations	Related Crash Types	No.	No.	No.	No.	No.	No.	No.	Unit	%	%	%	%	%	%		Years	No.	Unit	≤1.0
<<Add Description of Recommendation>>																	0			
<<Add Description of Recommendation>>																	0			

Projected Recommendation Effectiveness and Benefits

		Annual Projected Crash and Injury Reductions												Benefits	
		Fatal Crashes		Type A Injury		Type B Injury		Type C Injury		Property Damage		Annual Reduction Fatal and Type A Injury	Annual Reduction Fatal, Injury, & Property Damage	Annual Benefit of Implementation	Net Present Value of Annual Benefit of Implementation
		Density	Number	Density	Number	Density	Number	Density	Number	Density	Number				
Recommendations	Related Crash Types	Crashes/year/unit	Reduced Crashes	Crashes/year/unit	Reduced Crashes	Crashes/year/unit	Reduced Crashes	Crashes/year/unit	Reduced Crashes	Crashes/year/unit	Reduced Crashes	Reduced Crashes	Reduced Crashes	$	$
<<Add Description of Recommendation>>															
<<Add Description of Recommendation>>															

Projected Recommendation Effectiveness and Benefits – Change in Crashes

		Change in Annual Related Crashes					Road System Data			Treatment Deployment		Benefits	
		Fatal Crashes	Injury Type A Crashes	Injury Type B Crashes	Injury Type C Crashes	Property Damage Crashes	Feature Count		Traffic Growth Rate	Amount Deployed		Annual Benefit of Implementation	Present Value of Annual Benefit of Implementation
Recommendations	Related Crash Types	No.	No.	No.	No.	No.	No.	Unit	%	No.	Unit	$	$
<<Add Description of Recommendation>>												$0	
<<Add Description of Recommendation>>												$0	

Data Documentation

Benefit - Cost Ratio Estimation

Calculation Components	Benefit Sum $	Research Cost $	Ratio
Sum of Benefits from all Categories			
Cost of Research Project			

Appendix A3
Traffic Operations/User Benefits

Traffic Operations/User Benefits Template Spreadsheet

Project Information	
Project Title:	
Project Number:	
Principal Investigator:	
Project Cost:	
Technical Liaison:	
Administrative Liaison:	

Given Values	
Benefit Time Frame =	
Interest Rate =	
Auto - Value of Time (per person-hour) =	
Truck - Value of Time (per person-hour) =	
Value of Vehicle Stop =	
Design Labor (per person-hour) =	

User Input

		Automobile Change in Travel Hours				Truck Change in Travel Hours				Total Change in Number of Stops		Design Labor		Treatment Deployment		
		BEFORE --- Veh. Hours of Delay (per weekday)	AFTER --- Veh. Hours of Delay (per weekday)	Auto Occupancy		BEFORE --- Veh. Hours of Delay (per weekday)	AFTER --- Veh. Hours of Delay (per weekday)	Truck Occupancy		BEFORE --- Number of Stops (per weekday)	AFTER --- Number of Stops (per weekday)	Total Hours		Amount Deployed		Level of Confidence
Recommendations	**Location**	No.	No.	No.	Unit	No.	No.	No.	Unit	No.	No.	No.	Unit	No.	Unit	≤1.0
<<Add Description>>	*<<Add Location>>*				persons per veh.				persons per veh.				per location			
<<Add Description>>	*<<Add Location>>*				persons per veh.				persons per veh.				per location			

Projected Recommendation Effectiveness - User Benefits

		Automobile Travel Time Savings				Truck Travel Time Savings				Automobile and Truck Total Time Savings		
		Percent Reduction in Hours of Delay	Annual Time Savings (person-hour)	Annual Benefit of Implementation	Total Time Savings (person-hour)	Percent Reduction in Hours of Delay	Annual Time Savings (person-hour)	Annual Benefit of Implementation	Total Time Savings (person-hour)	Annual Time Savings (person-hour)	Annual Benefit of Implementation	Total Time Savings (person-hour)
Recommendations	**Location**	%	No.	$	No.	%	No.	$	No.	No.	$	No.
<<Add Description>>	*<<Add Location>>*											
<<Add Description>>	*<<Add Location>>*											

Projected Recommendation Effectiveness - DOT Benefits

		Reduction in Stops			Design Labor Savings	
		Annual Reduction in Stops	Annual Benefit of Reduced Stops	Total Reduction in Stops	Labor Hours Saved	Value of Labor Hours Saved
Recommendations	**Location**	No.	$	No.	No.	$
<<Add Description>>	*<<Add Location>>*					
<<Add Description>>	*<<Add Location>>*					

Annual Benefit of Implementation

		Total Annual Benefit of Implementation	Present Value of Total Annual Benefit of Implementation
Recommendations	**Location**	$	$
<<Add Description>>	*<<Add Location>>*		
<<Add Description>>	*<<Add Location>>*		

Data Documentation

Benefit - Cost Ratio Estimation

Calculation Components	Benefit Sum $	Research Cost $	Ratio
Sum of Benefits from all Categories			
Cost of Research Project			

Appendix A4
Materials and Activities

Project Information	
Project Title:	
Project Number:	
Principal Investigator:	
Project Cost:	
Technical Liaison:	
Administrative Liaison:	

Given Values	
Benefit Time Frame =	
Interest Rate =	

Determination of Savings in Materials or Activity

Entered Values | **Performance Measurements**

Change in cost due to reduction in material quantity Recommendations	Average Material Cost $	Unit	BEFORE --- Number of Units of Material No.	AFTER --- Number of Units of Material No.	Annual Frequency of Projects with Material Savings No.	Unit	Benefit Time Frame Yrs.	Annual Material Savings No.	Total Material Savings No.	Annual Benefit of Material Reduction $	Net Present Value of Material Reduction $
<<Add Description>> *<<Add Description>>*											

Percent reduction in material quantity Recommendations	Average Material Cost $	Unit	BEFORE --- Number of Units of Material No.	AFTER --- Percent Reduction in Units of Material %	Annual Frequency of Projects with Material Savings No.	Unit	Benefit Time Frame Yrs.	Annual Material Savings No.	Total Material Savings No.	Annual Benefit of Material Reduction $	Net Present Value of Material Reduction $
<<Add Description>> *<<Add Description>>*											

Change in cost due to lower cost material Recommendations	Number of Units of Material No.	Unit	BEFORE --- Average Material Cost $	AFTER --- Average Material Cost $	Annual Frequency of Projects with Material Savings No.	Unit	Benefit Time Frame Yrs.	Annual Cost Savings No.	Total Cost Savings No.	Annual Benefit of Lower Cost Material $	Net Present Value of Lower Cost Material $
<<Add Description>> *<<Add Description>>*											

Percent reduction in activity cost Recommendations	BEFORE --- Average Activity Cost $	Unit	AFTER --- Percent Reduction in Activity Cost %	Annual Frequency of Activity No.	Unit	Benefit Time Frame Yrs.	Annual Benefit of Activity Savings $	Net Present Value of Activity Savings $
<<Add Description>> *<<Add Description>>*								

Data Documentation

Benefit - Cost Ratio Estimation

Calculation Components	Benefit Sum $	Research Cost $	Ratio
Sum of Benefits from all Categories			
Cost of Research Project			

Appendix A5
Lifecycle

Lifecycle Template Spreadsheet

Project Information		Given Values	
Project Title:		Benefit Time Frame =	
Publication Number:		Interest Rate =	
Principal Investigator:			
Project Cost:			
Technical Liaison:			
Administrative Liaison:			

Change in Life Cycle

	Entered Values							Performance Measurements
Increase in Life Cycle - Occurs Annually **Recommendations**	**Average Activity Cost** $	Unit	**BEFORE ---Lifecycle** Yrs.	**AFTER ---Lifecycle** Yrs.	**Annual Frequency of Projects With Increased Lifecycle** No.	Unit	**Benefit Time Frame** Yrs.	**Net Present Value of Lifecycle Cost Savings (years)** $
<<Add Description>>								$ -
<<Add Description>>								$ -

Increase in Life Cycle - Occurs Once	**Average Activity Cost** $	Unit	**BEFORE ---Lifecycle** Yrs.	**AFTER ---Lifecycle** Yrs.	**Annual Frequency of Projects With Increased Lifecycle** No.	Unit	**Benefit Time Frame** Yrs.	**Net Present Value of Lifecycle Cost Savings (years)** $
<<Add Description>>								$ -
<<Add Description>>								$ -

Increase in Life Cycle & Decrease in Quantities - Occurs Once **Recommendations**	**Average Activity Cost** $	Unit	**BEFORE ---Lifecycle** Yrs.	**AFTER ---Lifecycle** Yrs.	**Annual Frequency of Projects With Increased Lifecycle** No.	Unit	**AFTER ---Percent Reduction in Items** %	**Benefit Time Frame** Yrs.	**Net Present Value of Lifecycle Cost Savings (years)** $
<<Add Description>>									$ -
<<Add Description>>									$ -

Data Documentation

Benefit - Cost Ratio Estimation

Calculation Components	**Benefit Sum** $	**Research Cost** $	**Ratio**
Sum of Benefits from all Categories			
Cost of Research Project			

Appendix A6
Risk Management

Risk Management Template Spreadsheet

Project Information	
Project Title:	
Project Number:	
Principal Investigator:	
Project Cost:	
Technical Liaison:	
Administrative Liaison:	

Given Values	
Benefit Time Frame =	
Interest Rate =	

Determination of Savings from Reduced Fines

		Entered Values				Performance Measurements			
Change in cost due to reduction in actions that result in fines	Average Cost of Fines	BEFORE --- Number of Actions Resulting in Fines	AFTER --- Number of Actions Resulting in Fines	Annual Frequency of Implemented Actions	Benefit Time Frame	Annual Reduction in Actions Resulting in Fines	Total Reduction in Actions Resulting in Fines	Annual Benefit of Action Reduction	Net Present Value of Action Reduction
Recommendations	$ Action	No.	No.	No. Unit	Yrs.	No.	No.	$	$
<<Add Description>>									
<<Add Description>>									

Data Documentation

Benefit - Cost Ratio Estimation

Calculation Components	Benefit Sum $	Research Cost $	Ratio
Sum of Benefits from all Categories			
Cost of Research Project			

APPENDIX B: USER GUIDE PRESENTATION

The PowerPoint slide presentation file is available at mndot.gov/research/research/reports/2017/201713C.pptx

Slide 1

Minnesota Department of Transportation

Research Services

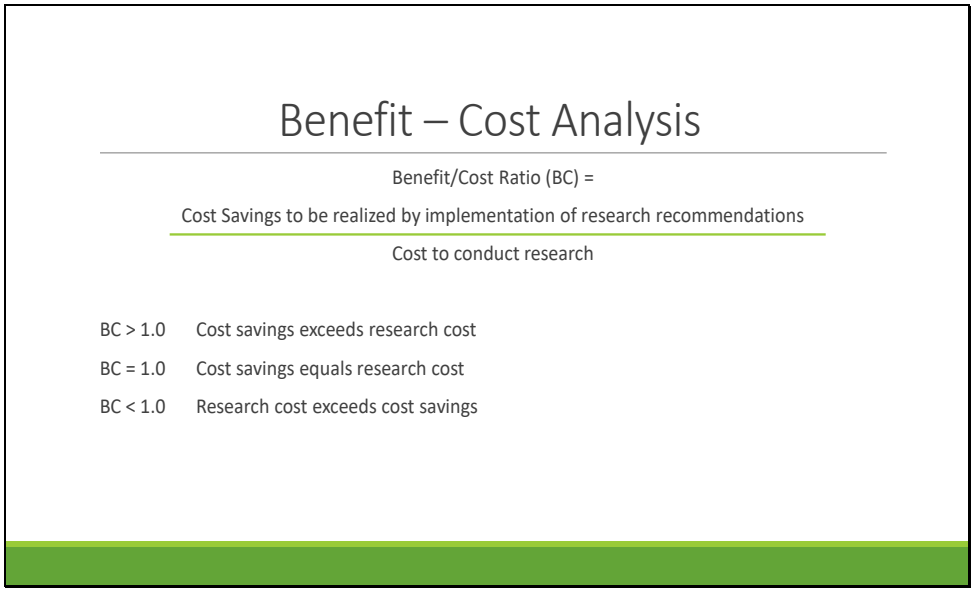
BENEFIT QUANTIFICATION PROCESS

Slide 2

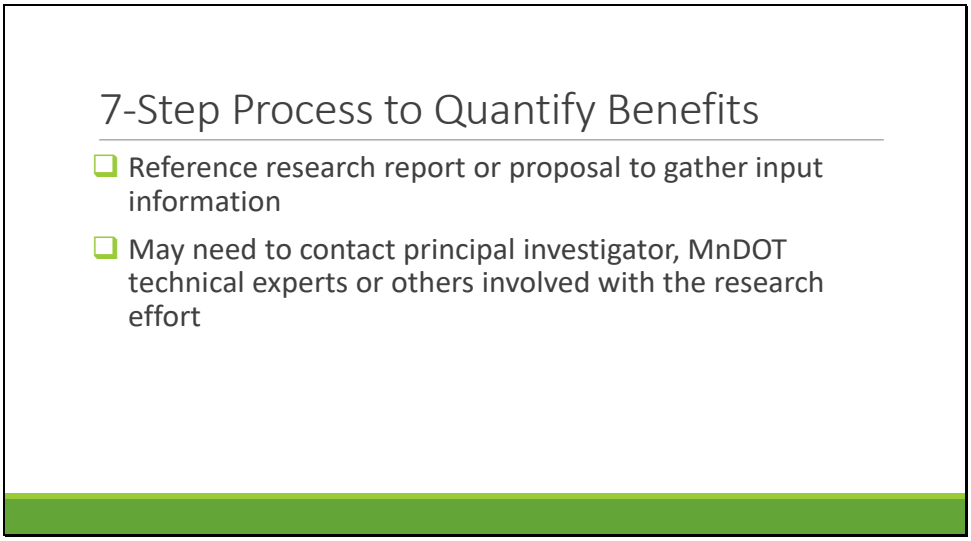
What is it?

- Step-by-step process to estimate research project benefits
- Justifiable means to estimate monetary benefits
- Traditional benefit-cost analysis
- Benefits are defined as cost savings achieved by implementation of research-generated recommendations

Slide 3



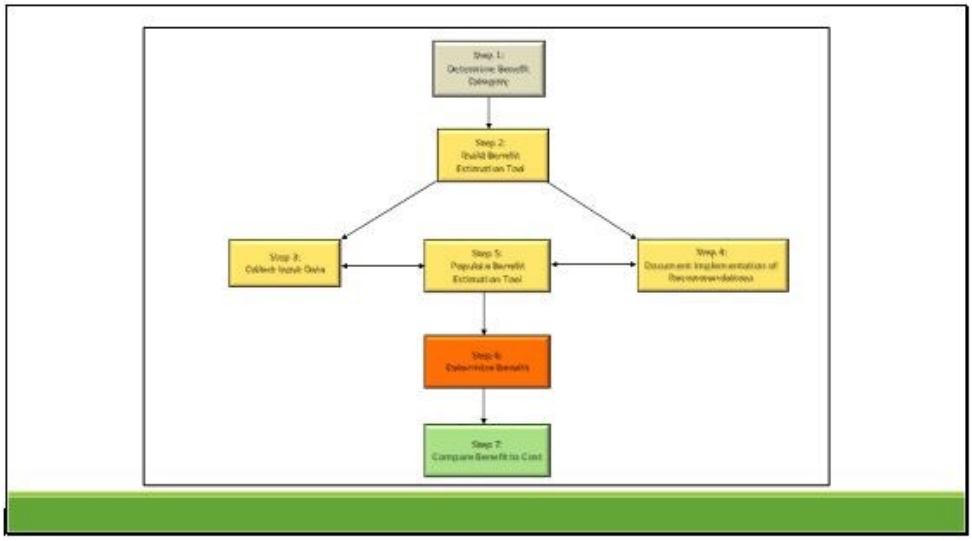
Slide 4



Ideally, the research proposal or report includes a plan for identifying the type of benefit and data to be gathered as part of the benefit quantification process.

If all the information is not available in these documents, the user may need to contact the researcher or technical experts within MnDOT to obtain data.

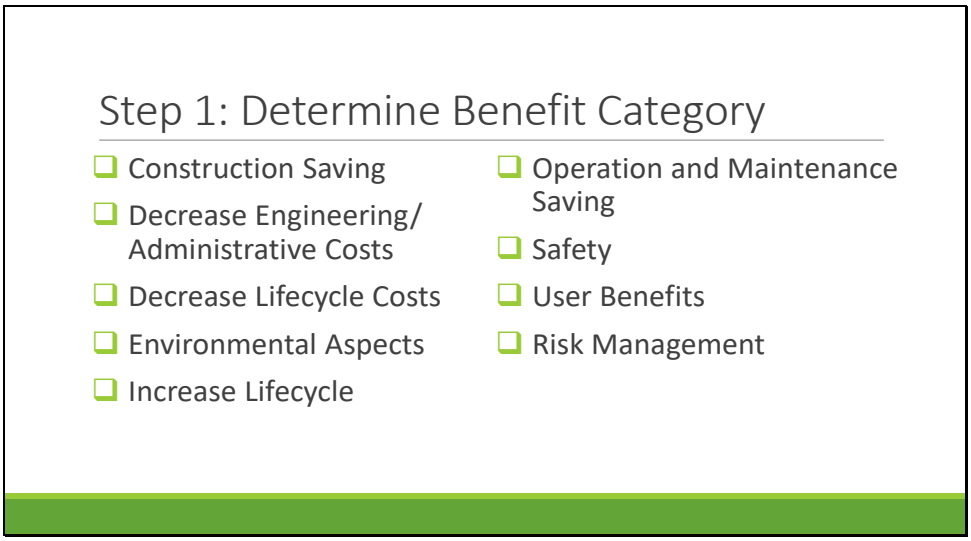
Slide 5



This flowchart depicts the seven-step process for quantifying research benefits. The methodology is based on estimating potential cost savings to calculate a benefit-cost ratio. The process is adaptable to a variety of research topics and benefit categories. As the process flowchart shows, most of the steps should be completed in order since the information gained in these steps informs a subsequent step, but a few steps can be performed simultaneously (Steps 3/4/5).

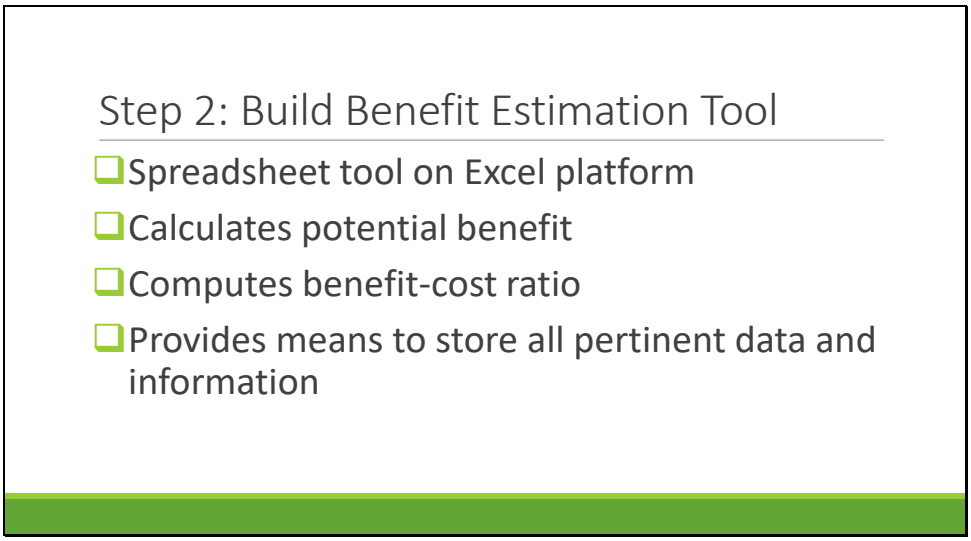
Each step will be discussed individually.

Slide 6



The first 8 benefit categories in this list are based on the topic areas and benefit categories included in Research Service's Automated Research Tracking System (ARTS) database. The need for a Risk Management benefit category was identified during this project. These benefit categories generally capture the nature of the recommendations resulting from the conduct of the research. MnDOT staff felt that recommendations from these categories could be quantified with data that is reasonable to collect. The benefits are expressed in terms of dollars saved over a defined time period.

Slide 7



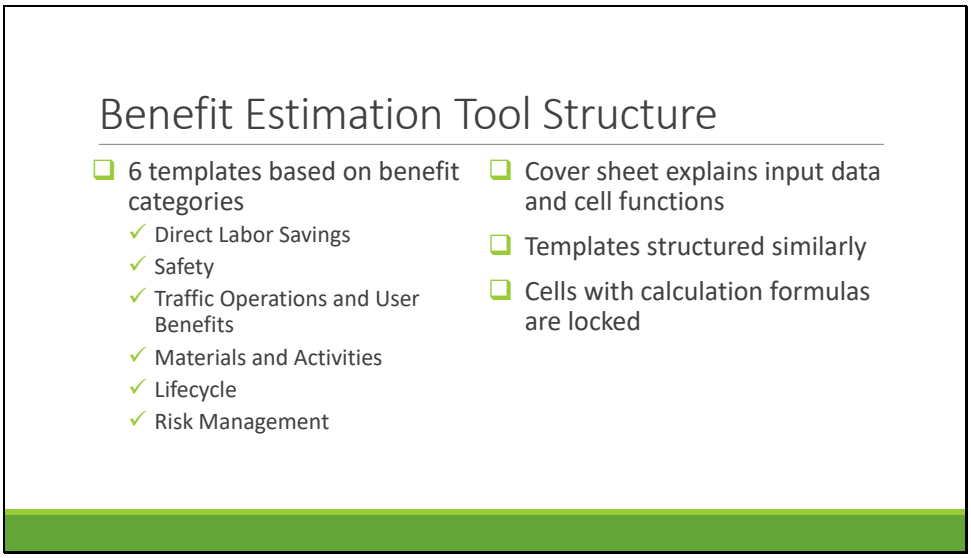
The tool encompasses all 7 steps in the benefit quantification process.

Use of the tool is mandatory for researchers requesting grants or funding.

Ideally, the tool and benefit quantification process should be incorporated into the research effort from the beginning.

The research effort should be structured such that the effectiveness of the recommendations can be quantified with data that is readily obtained.

Slide 8

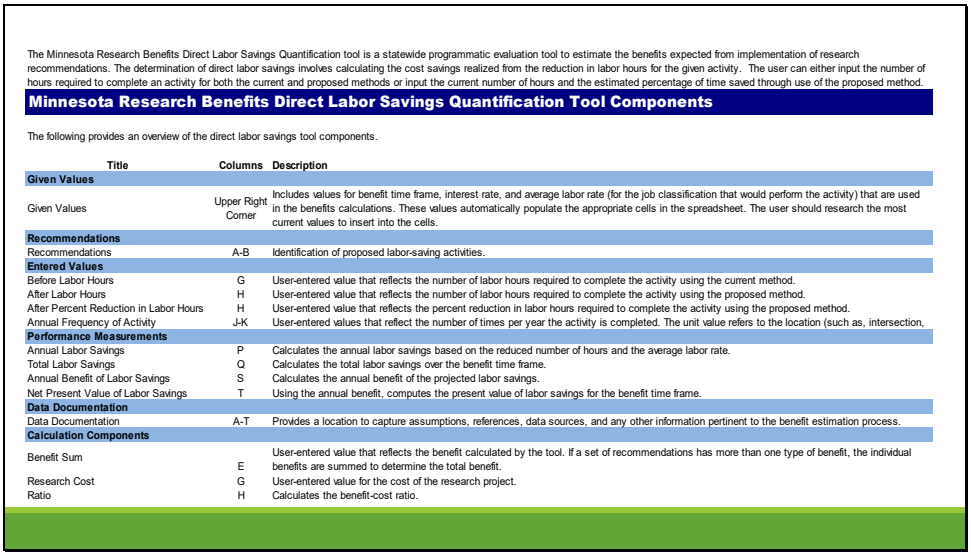


The file contains 6 template spreadsheets that represent the 9 benefit categories.

Each template has a corresponding cover sheet to explain the content of the cells and the structure of the calculations.

The templates perform the BC calculations and provide the means to document/store input data, output results, assumptions, and BC ratio.

Slide 9



The Minnesota Research Benefits Direct Labor Savings Quantification tool is a statewide programmatic evaluation tool to estimate the benefits expected from implementation of research recommendations. The determination of direct labor savings involves calculating the cost savings realized from the reduction in labor hours for the given activity. The user can either input the number of hours required to complete an activity for both the current and proposed methods or input the current number of hours and the estimated percentage of time saved through use of the proposed method.

Minnesota Research Benefits Direct Labor Savings Quantification Tool Components

The following provides an overview of the direct labor savings tool components.

Title	Columns	Description
Given Values		
Given Values	Upper Right Corner	Includes values for benefit time frame, interest rate, and average labor rate (for the job classification that would perform the activity) that are used in the benefits calculations. These values automatically populate the appropriate cells in the spreadsheet. The user should research the most current values to insert into the cells.
Recommendations		
Recommendations	A-B	Identification of proposed labor-saving activities.
Entered Values		
Before Labor Hours	G	User-entered value that reflects the number of labor hours required to complete the activity using the current method.
After Labor Hours	H	User-entered value that reflects the number of labor hours required to complete the activity using the proposed method.
After Percent Reduction in Labor Hours	H	User-entered value that reflects the percent reduction in labor hours required to complete the activity using the proposed method.
Annual Frequency of Activity	J-K	User-entered values that reflect the number of times per year the activity is completed. The unit value refers to the location (such as, intersection,
Performance Measurements		
Annual Labor Savings	P	Calculates the annual labor savings based on the reduced number of hours and the average labor rate.
Total Labor Savings	Q	Calculates the total labor savings over the benefit time frame.
Annual Benefit of Labor Savings	S	Calculates the annual benefit of the projected labor savings.
Net Present Value of Labor Savings	T	Using the annual benefit, computes the present value of labor savings for the benefit time frame.
Data Documentation		
Data Documentation	A-T	Provides a location to capture assumptions, references, data sources, and any other information pertinent to the benefit estimation process.
Calculation Components		
Benefit Sum	E	User-entered value that reflects the benefit calculated by the tool. If a set of recommendations has more than one type of benefit, the individual benefits are summed to determine the total benefit.
Research Cost	G	User-entered value for the cost of the research project.
Ratio	H	Calculates the benefit-cost ratio.

This is the cover sheet for the Direct Labor Savings template spreadsheet.

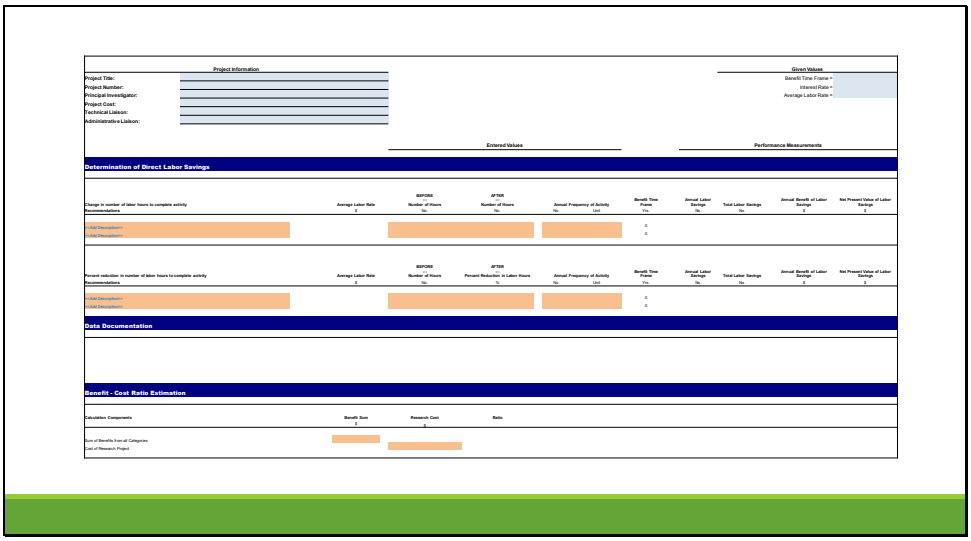
There is an explanation of what type of benefit this template would be used for at the top.

The left column shows the title or name of each component of the spreadsheet.

The middle column shows the column letter in the spreadsheet that contains the title and corresponding input/output cells for each component.

The description explains the function of the component within the benefit-cost calculation process. It also explains if the user input is required or if the spreadsheet calculates and displays the value.

Slide 10



This is a picture of the Labor Savings template. All the templates look similar.

Notice the different cell colors:

- ❑ Blue cells – indicate user input for project information (title, number, principal investigator, and cost) and given values (standard values that are not unique to the project, such as benefit time frame, interest rate, labor rates, and societal crash costs)
- ❑ Orange cells – indicate user input for values that are unique to the project recommendations (such as, material quantities, labor hours required to conduct an activity, and frequency of strategy deployment)
- ❑ White cells – output values of the benefit calculations (such as, Annual Benefit, Net Present Value of the strategy over the benefit time frame); the formulas are locked down such that the user cannot alter the formulas that calculate the output values
- ❑ Columns - the columns are ordered from left to right such that the inputs are toward the left and the resultant output is toward the right of each row
- ❑ Output – the benefits are in the far right column, expressed as the Net Present Value of the annual benefit of implementing the recommendations over the stated time frame

- ❑ Blank cells – if there is a calculation error or a cell does not contain an entry, white cells will not populate output values of the benefit calculations, indicating a missing input value

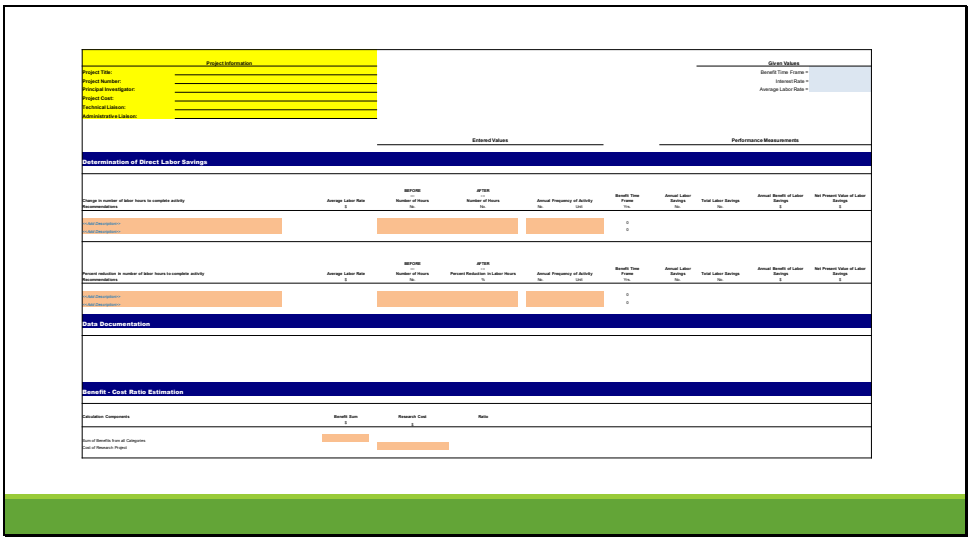
The formulas built into the calculation cells reference the colored cells to incorporate the input data into the benefit calculations.

Given Values:

Determination of Direct Labor Savings:

Recommendations:

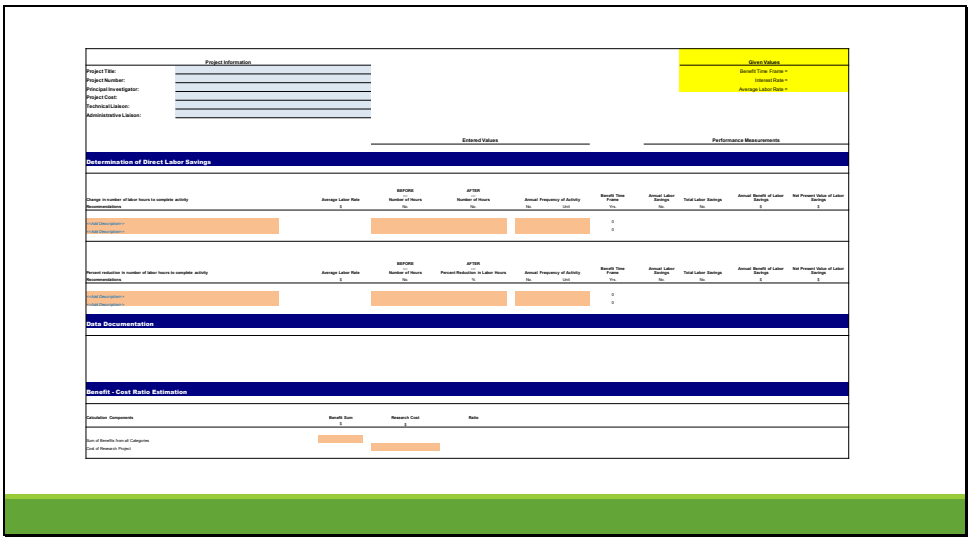
Slide 11



Now each section will be reviewed in turn.

Project Information: title, number, principal investigator, cost, MnDOT liaisons

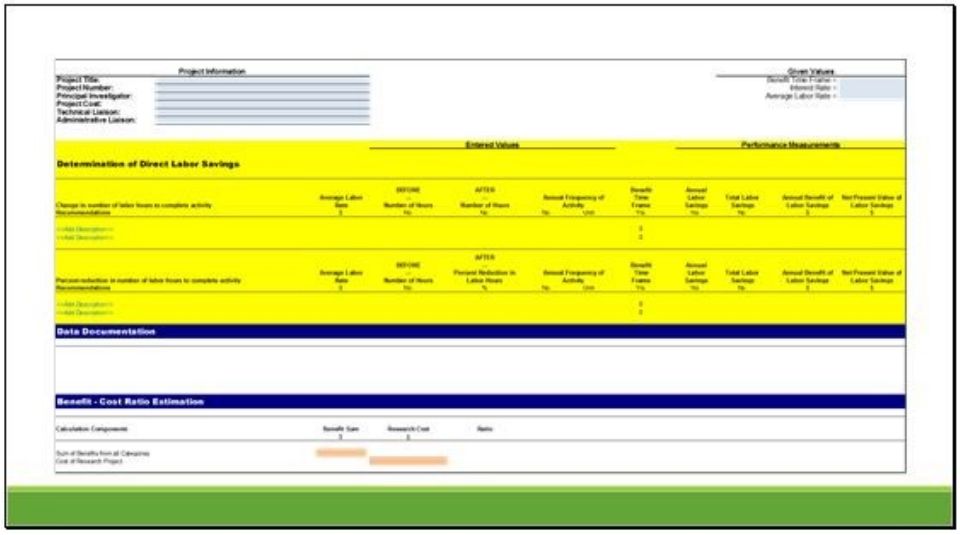
Slide 12



Given values: standard values that are not unique to the project, such as benefit time frame, interest rate, labor rates, and societal crash costs.

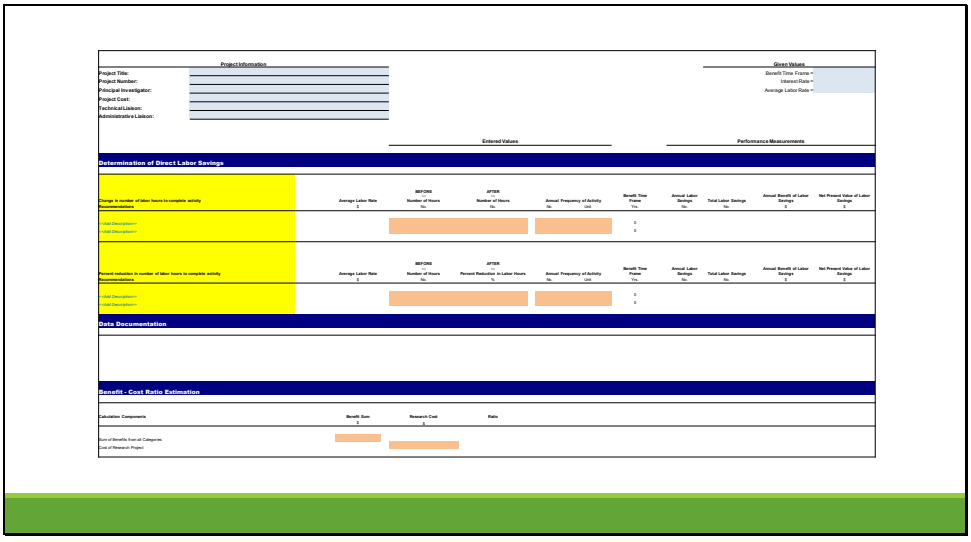
The user should enter the most current values, most of which can likely be found on the MnDOT Office of Planning and Program website or from published resources at either the state or national level.

Slide 13



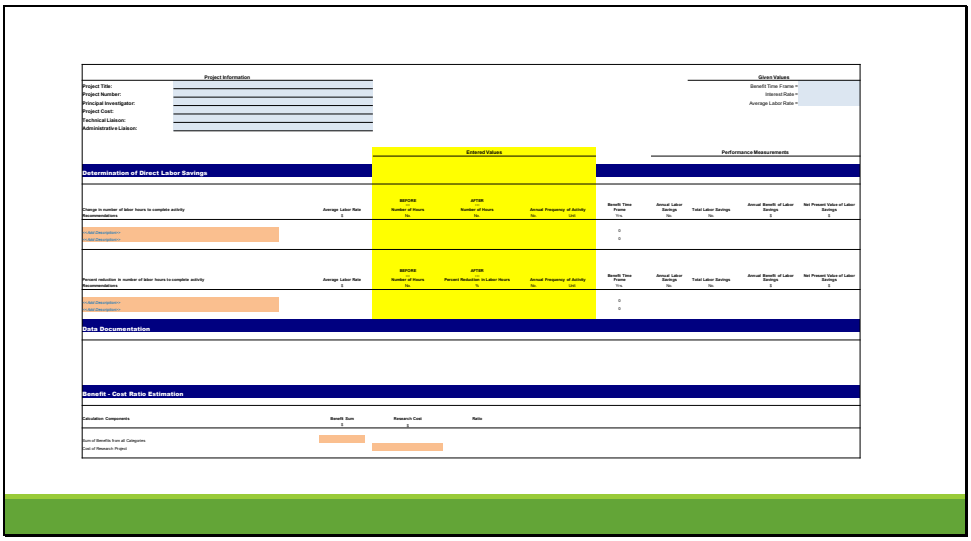
Determination of Direct Labor Savings: the benefit calculations are performed in this section.

Slide 14



Recommendations: the quantifiable recommendations from the research report are entered in this section.

Slide 15



Entered Values: the user inputs the data pertinent to the recommendations.

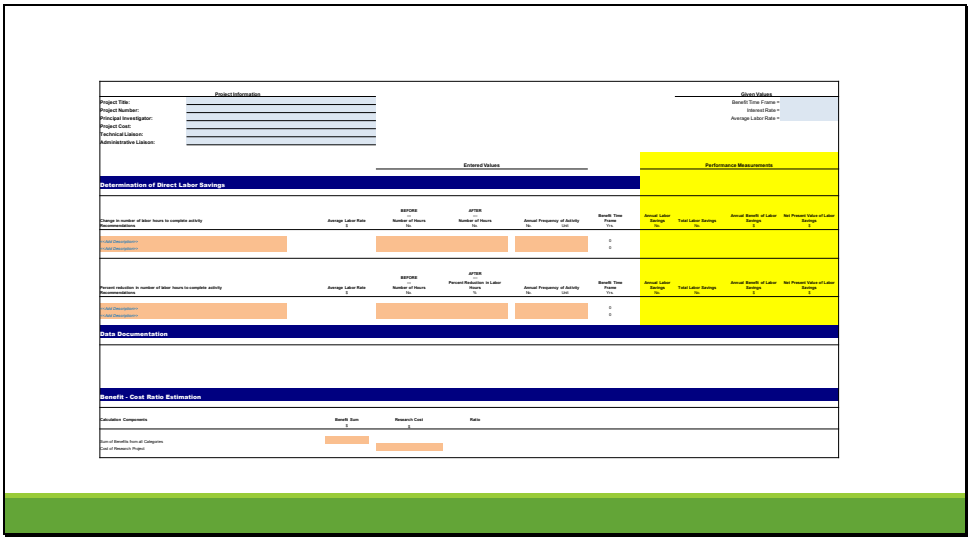
Before data represents the existing conditions or the current practices that are the subject of the research effort.

In some of the templates such as this one, the after data can be in the form of the new value or a percent reduction of the before/existing value.

Annual frequency of activity represents the number of applications in a typical year. For example, number of lane-miles constructed or number of times a sign is replaced.

The average labor rate and benefit time frame cells are not orange because they are automatically populated from the Given Values in the upper right corner.

Slide 16

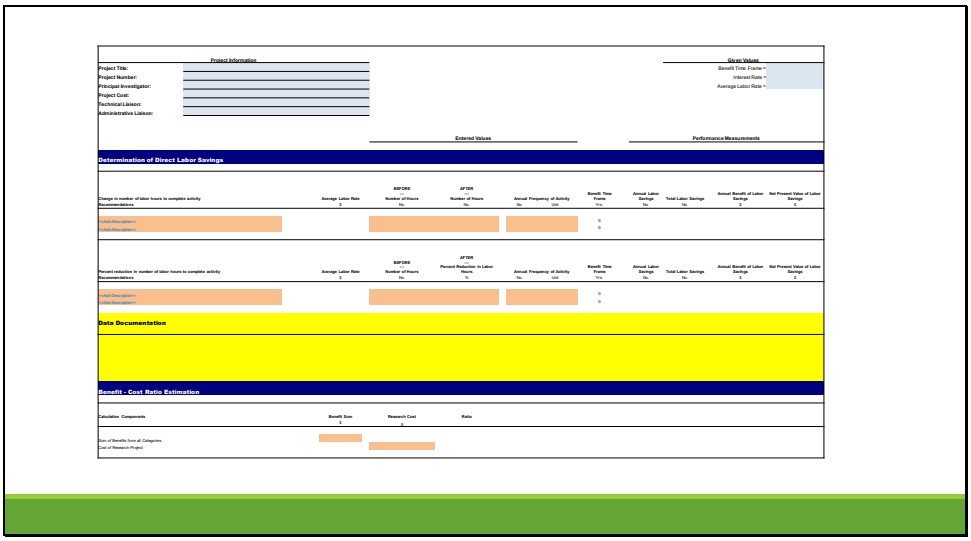


Performance Measurements: these cells provide the result of the benefit estimation calculations.

The results show the annual cost savings expected based on implementation of the research recommendations.

The results also show the net present benefit of the savings, based on the interest rate and benefit time frame. This value represents the total savings expected over the benefit time period, taking into account time value of money.

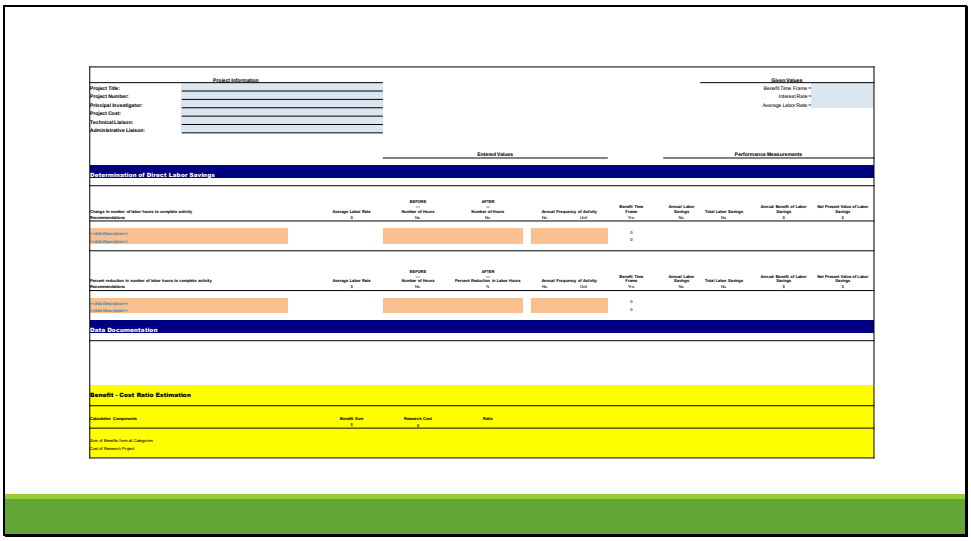
Slide 17



Data Documentation: the assumptions and collected data are entered into this section. Contacts, results of conversations, any information that supports the values entered into the spreadsheet as part of the BC calculation process should be stored here to document the conduct of the benefit quantification process.

If the project uses more than one benefit template, the data and assumptions specific to each type of benefit should be entered only on the appropriate tab.

Slide 18

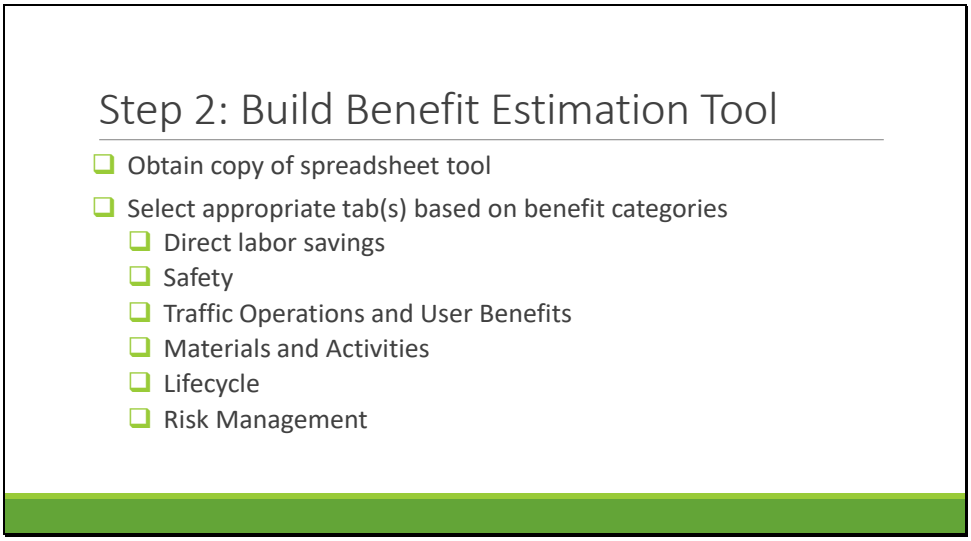


Benefit-Cost Ratio Estimation: the user enters the benefit values from the cells in the Performance Measurements section and the project cost value from the Project Information section. The benefit should be the sum of the benefit from each tab, if Step 1 identified more than one type of benefit.

The BC ratio automatically calculates.

If the project uses more than one benefit template, this section only needs to be populated one time.

Slide 19



The second step in the quantification process is to assemble the applicable templates into one spreadsheet file for use in calculating all of the potential benefits.

After downloading the spreadsheet tool from the MnDOT website, the user selects the template(s) based on the benefit categories identified in Step 1.

Spreadsheet file is renamed/saved with the relevant template spreadsheet(s).

Ideally, the research report or proposal states the type of benefit provided by the recommendations.

Slide 20

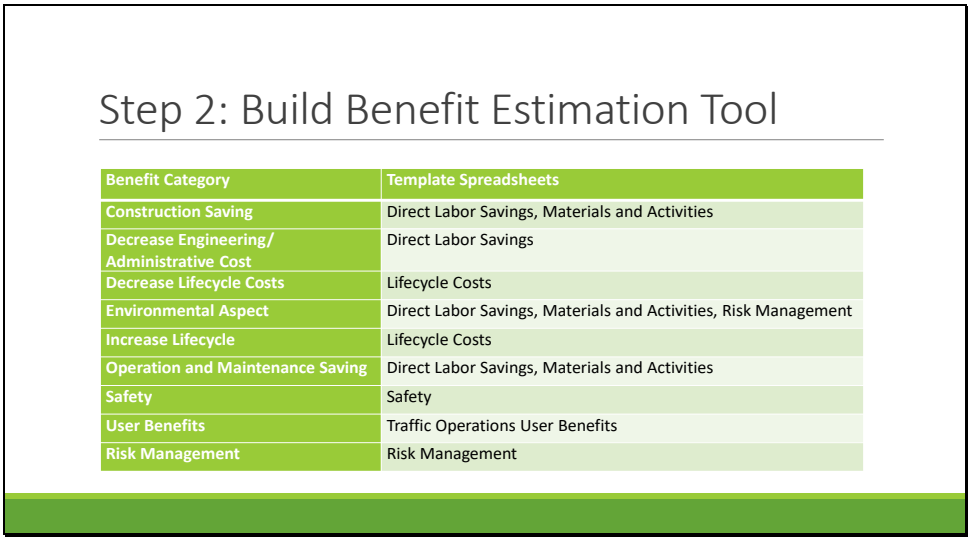
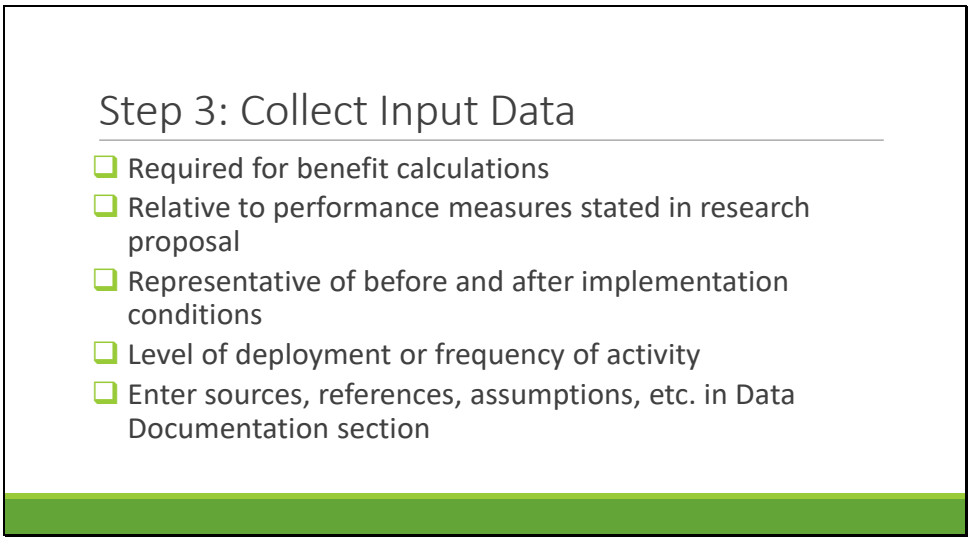


Table shows the applicable template for each benefit category.

Multiple benefit categories may be applicable to a research project, so the user should select all appropriate benefit categories.

Slide 21



The benefit estimation tool requires several input values to perform the benefit calculations. The second step in the quantification process to select the applicable templates should be completed prior to initiating the third step, so the user knows what input data are required.

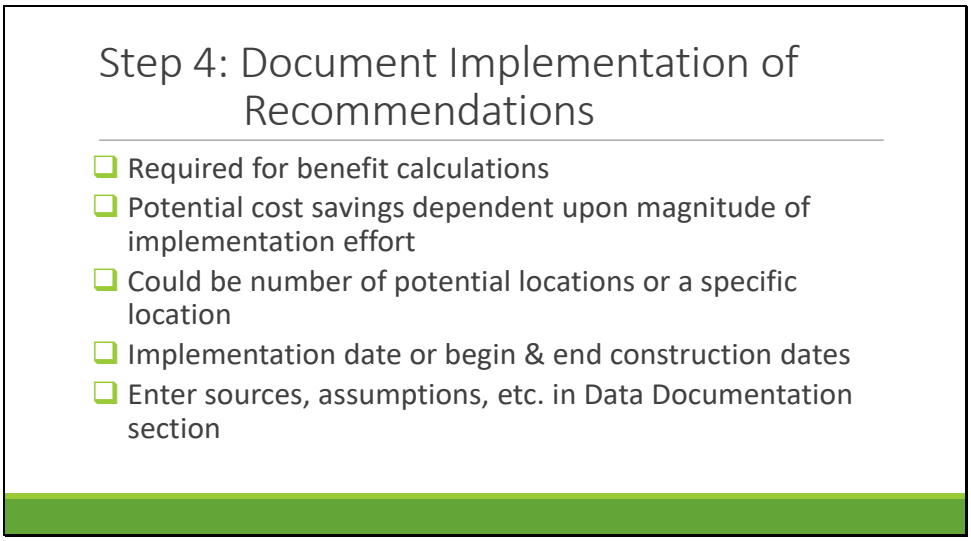
The input data will be entered into the Project Information, Given Values, Recommendations, and Entered Values sections of the spreadsheet. The Recommendations will be from the research report.

The Entered Values will typically be specific to the research project recommendations and could be obtained from the research report or from MnDOT personnel. For the safety template, the crash reduction factors are orange-cell inputs that should be identified through published state or national resources. The required input values for each template were determined based on industry standard procedures for estimating the dollar values associated with the various benefit categories.

Examples of input data are labor rates, amount of time required to complete an activity, material quantity required to perform an activity, material costs, and societal crash costs.

Steps 3 and 5 can be performed simultaneously so the user is entering the input data as it is collected. The process to gather the data and sources consulted should be recorded in the Data Documentation section.

Slide 22



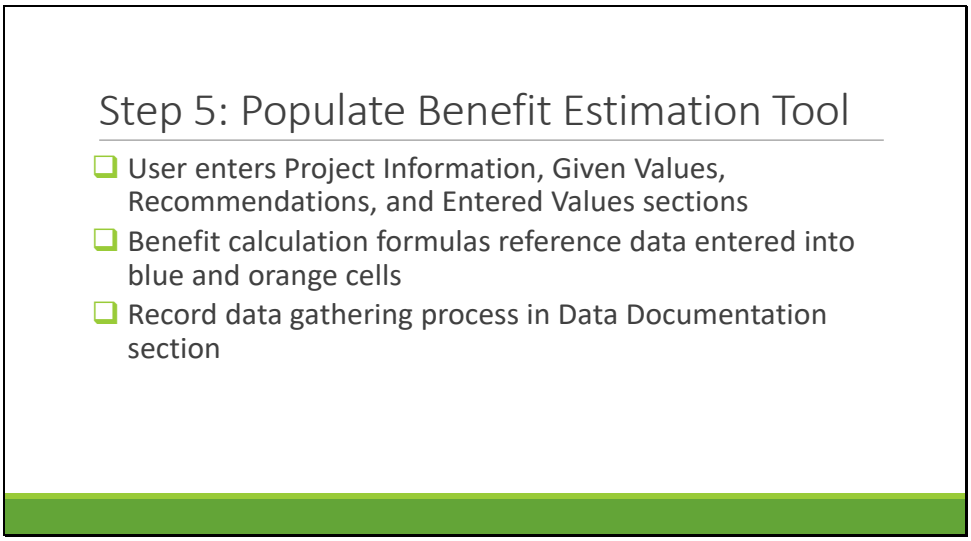
The potential cost savings associated with implementing the recommendations is dependent upon the magnitude of the implementation effort. Thus, the benefit calculations require a number of locations or a frequency for performing the activity.

Documentation should include the number of potential locations for implementation, but not necessarily specific locations (with the exception of a safety benefit calculation for a designated location).

Data from the existing condition before implementation should be representative of the cost/quantity/activity/crash history prior to the start of construction or be representative of the current practices. Data representing the after condition should be gathered for the time period after construction is complete. Data that represents conditions during the construction period should not be used. Crash data should be gathered for a three-year period prior to construction to implement the recommendations.

Steps 4 and 5 can be performed simultaneously so the user is entering the input data as it is collected. This information is entered in the *Data Documentation* section of the spreadsheet.

Slide 23

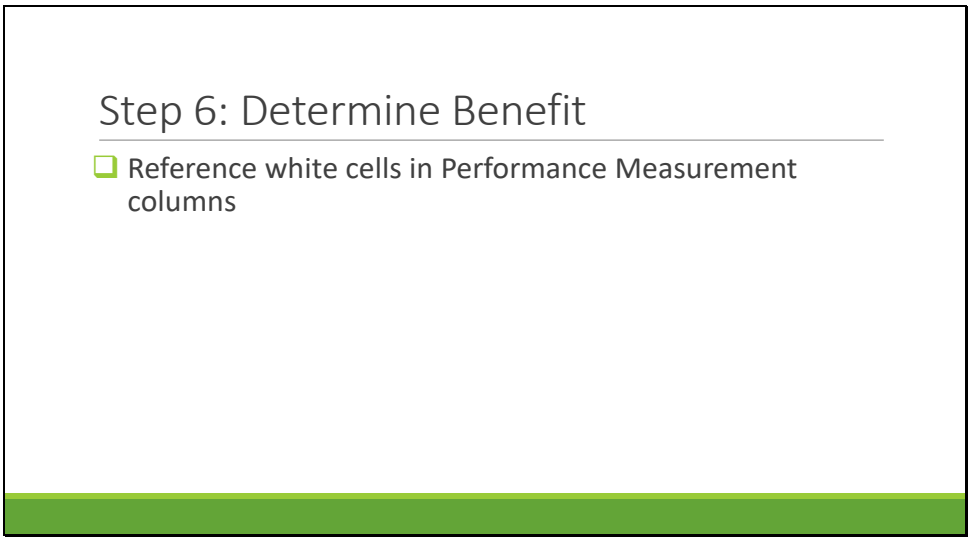


This fifth step involves entering all the required input data into the blue and orange cells, and completing documentation.

All the supporting documentation should be completed at the end of this step.

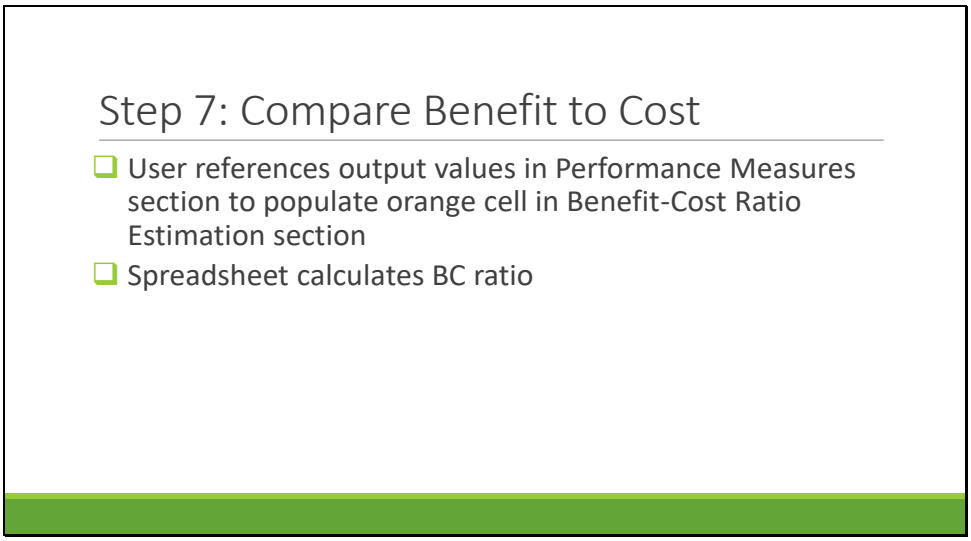
Steps 3, 4, and 5 can be performed simultaneously so the user is entering the input data as it is collected and stored in the spreadsheet.

Slide 24



The white cells in the Performance Measurements spreadsheet columns show the calculated benefit.

Slide 25



The white cells in the Performance Measurements spreadsheet columns show the calculated benefit.

If more than one benefit type is identified, the value entered into the Benefit Sum column will be the sum of the benefits calculated on each template.

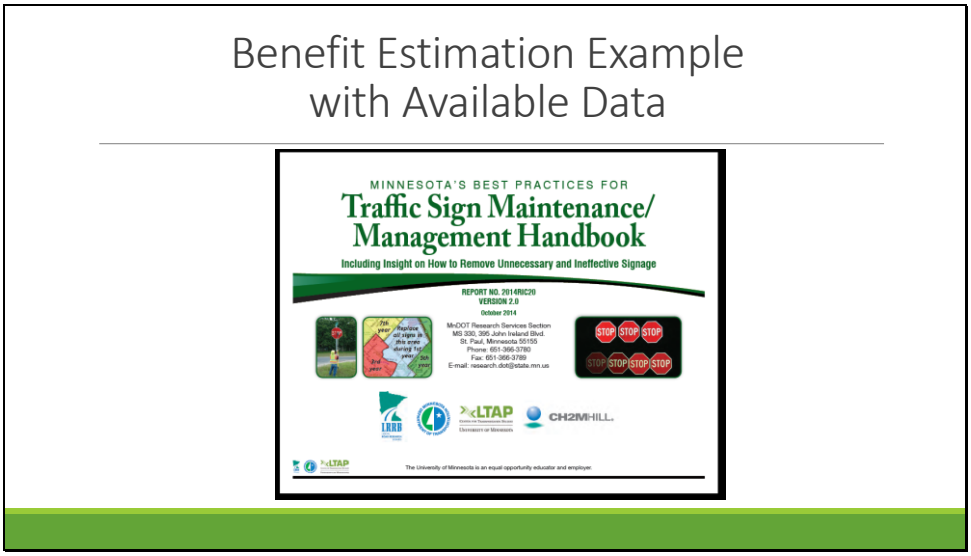
Cost value is automatically populated from the blue cell in the Project Information section.

The formula built into the template spreadsheet divides the estimated cost savings to be gained through implementation of the recommendations by the cost of conducting the research effort to develop the recommendations.

A ratio of less than 1.0 indicates the research costs are greater than the potential monetary benefits whereas a ratio greater than 1.0 indicates the potential benefits outweigh the research costs.

The benefit quantification process is complete.

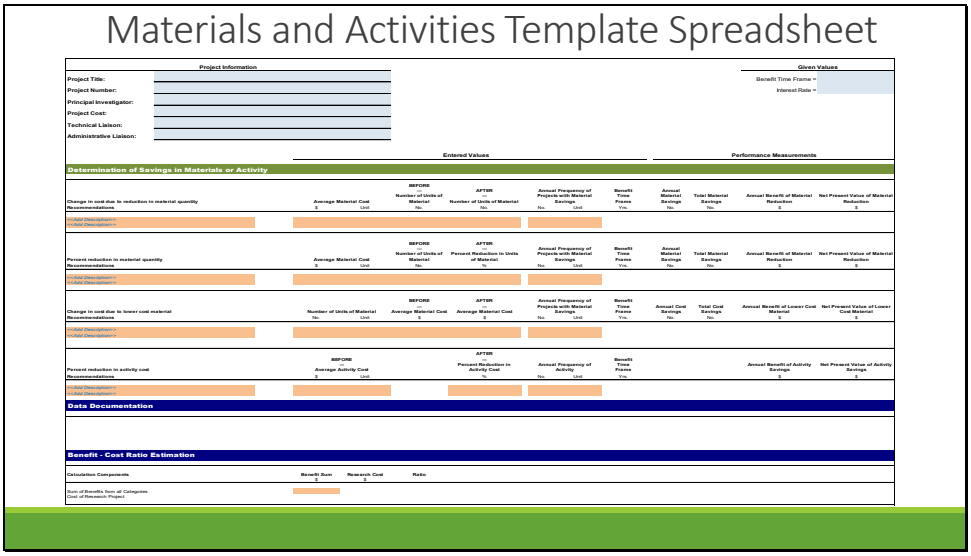
Slide 26



We will run through an example of using the tool in two ways. First will be an example in which the necessary data is available from the research report. This example is from one of the ten research projects that were part of the pilot study conducted to develop this benefit estimation tool.

The project was a combination of two related projects conducted by MnDOT: Traffic Sign Life Expectancy and Traffic Sign Maintenance/Management Handbook. This research effort analyzed traffic sign retroreflectivity degradation for the purposes of determining the actual service life of signs and then incorporating these findings into a handbook for managing sign inventories to meet retroreflectivity requirements. The handbook also included guidance for removing unnecessary and ineffective signage.

Slide 27

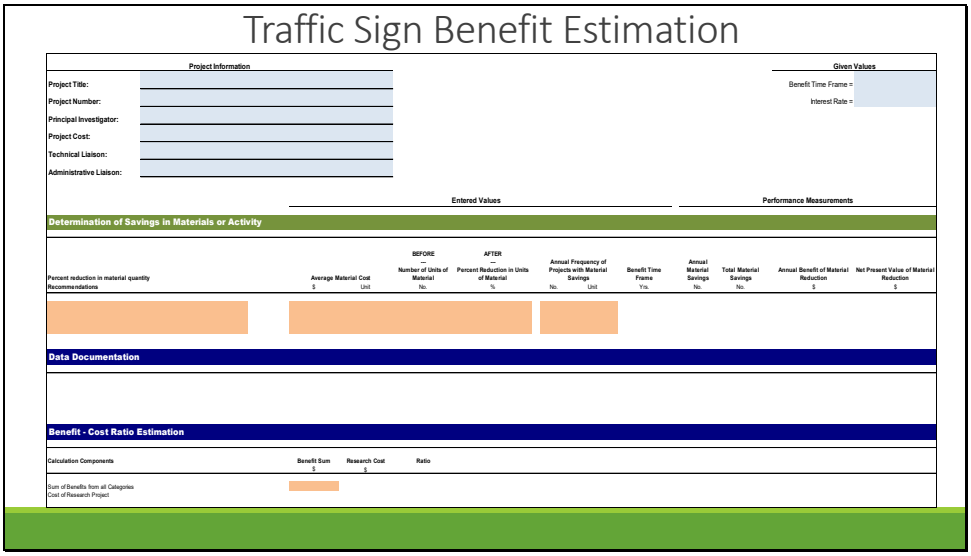


For purposes of developing the quantification tool, the benefit of this research effort is expressed in terms of a reduced cost achieved by decreasing sign inventory and increasing sign service life, so the benefit calculation involved two parts.

This example will focus on the benefits of reducing sign inventory, which requires estimating the number of signs that can be decreased in agency inventories and the corresponding procurement cost savings.

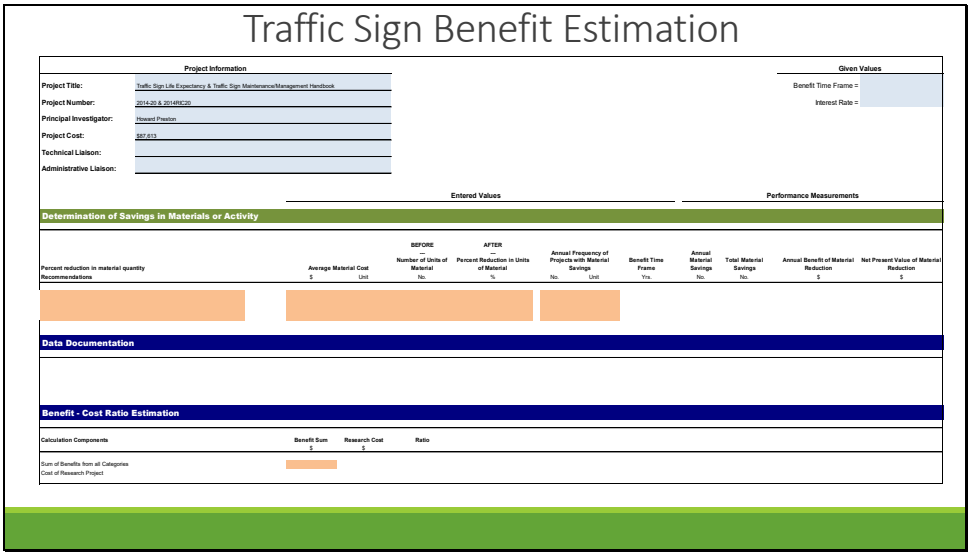
The appropriate template for this project is the Materials and Activities template.

Slide 28



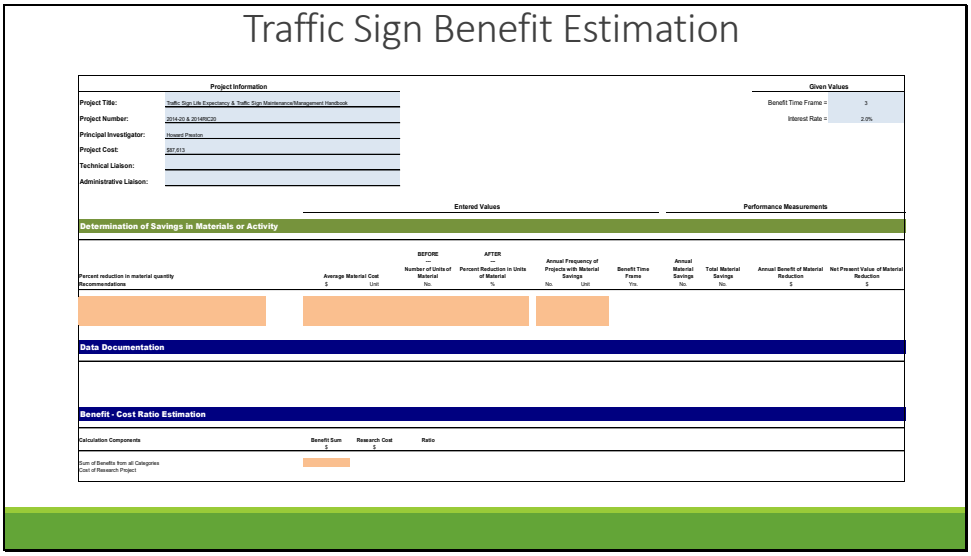
This graphics shows how the template can be modified to match the required calculations. In this case, we need to focus on the percent reduction in material quantity to estimate the benefit of decreasing inventory and the corresponding procurement cost savings. We will insert data and information into the blue and orange cells.

Slide 29



The project information is entered in the upper left corner.

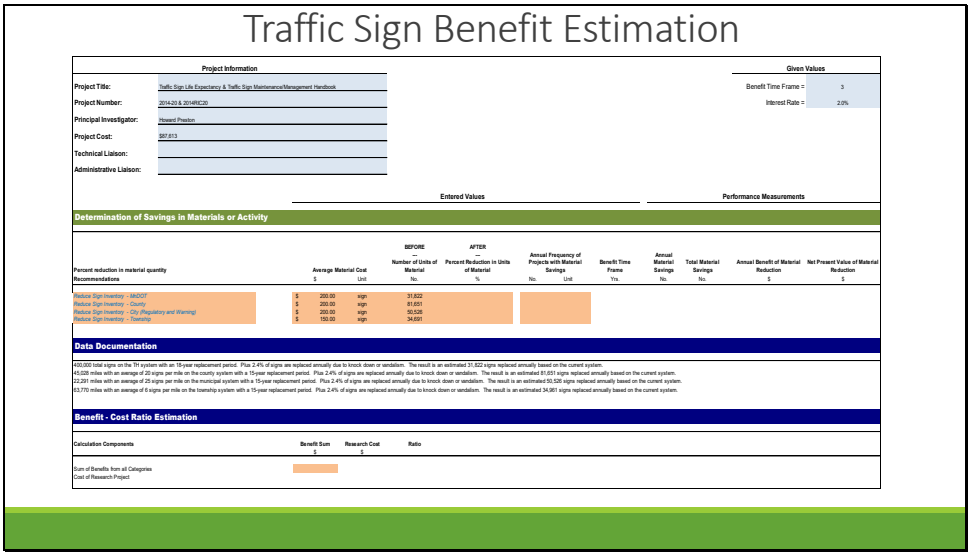
Slide 30



The given values are entered in the upper right corner.

The interest rate should match the currently-published MnDOT value.

Slide 31



Next, the recommendation or strategy is entered, which in this case is to reduce the number of signs in an agency's inventory and thereby reduce the annual number of signs that need to be replaced. This project considered state, county, local, and township signs separately due to the varying sizes of inventory for each type of agency.

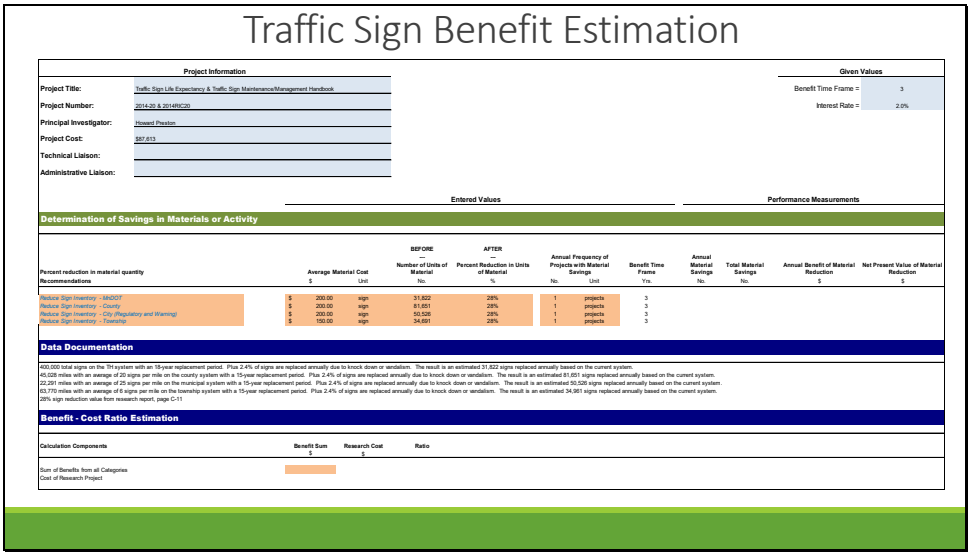
The average sign costs are entered, which are necessary for the cost savings estimation. The average sign cost and number of signs needing replacement each year were estimated based on conversations with agency employees and database records.

The documentation of these assumptions is entered in the "Data Documentation" section.

Slide 32

The next required entry is the percent reduction in signs per agency inventory. The research report is reviewed to obtain this information. The research identified that 28% of this agency's signs are candidates for removal. This assumption is applied to each type of agency.

Slide 33



Traffic Sign Benefit Estimation

Project Information

Project Title:	Traffic Sign Life Expectancy & Traffic Sign Maintenance/Management Handbook
Project Number:	2014-20 & 2014RIC20
Principal Investigator:	Howard Preston
Project Cost:	$87,613
Technical Liaison:	
Administrative Liaison:	

Given Values

Benefit Time Frame =	3
Interest Rate =	2.0%

Entered Values | **Performance Measurements**

Determination of Savings in Materials or Activity

Percent reduction in material quantity Recommendations	Average Material Cost $		BEFORE — Number of Units of Material No.	AFTER — Percent Reduction in Units of Material %	Annual Frequency of Projects with Material Savings No.		Benefit Time Frame Yrs.	Annual Material Savings No.	Total Material Savings No.	Annual Benefit of Material Reduction $	Net Present Value of Material Reduction $
Reduce Sign Inventory - MnDOT	$ 200.00	sign	31,822	28%	1	projects	3				
Reduce Sign Inventory - County	$ 200.00	sign	81,651	28%	1	projects	3				
Reduce Sign Inventory - City (Regulatory and Warning)	$ 200.00	sign	50,526	28%	1	projects	3				
Reduce Sign Inventory - Township	$ 150.00	sign	34,991	28%	1	projects	3				

Data Documentation

400,000 total signs on the TH system with an 18-year replacement period. Plus 2.4% of signs are replaced annually due to knock down or vandalism. The result is an estimated 31,822 signs replaced annually based on the current system.
45,026 miles with an average of 20 signs per mile on the county system with a 15-year replacement period. Plus 2.4% of signs are replaced annually due to knock down or vandalism. The result is an estimated 81,651 signs replaced annually based on the current system.
22,291 miles with an average of 25 signs per mile on the municipal system with a 15-year replacement period. Plus 2.4% of signs are replaced annually due to knock down or vandalism. The result is an estimated 50,526 signs replaced annually based on the current system.
63,770 miles with an average of 6 signs per mile on the township system with a 15-year replacement period. Plus 2.4% of signs are replaced annually due to knock down or vandalism. The result is an estimated 34,991 signs replaced annually based on the current system.
28% sign reduction value from research report, page C-11

Benefit - Cost Ratio Estimation

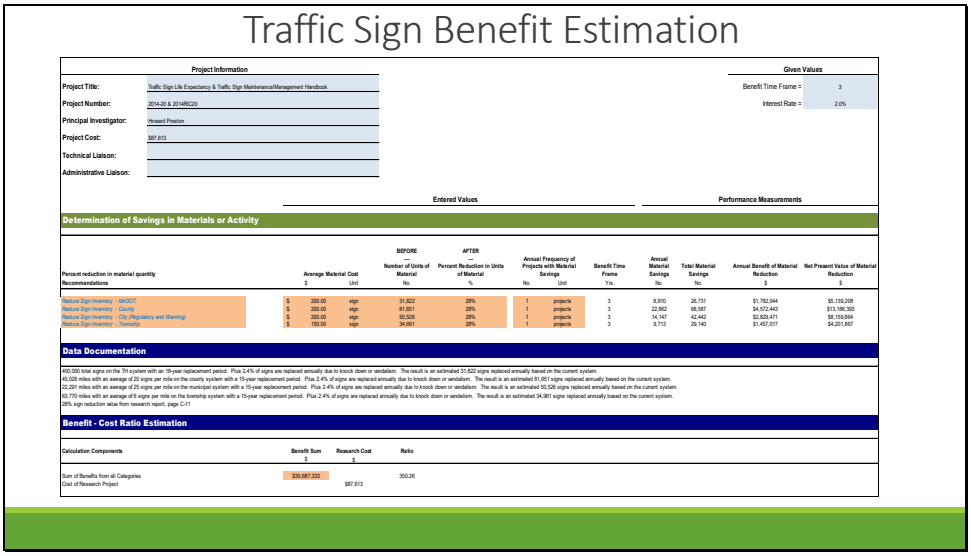
Calculation Components	Benefit Sum $	Research Cost $	Ratio
Sum of Benefits from all Categories			
Cost of Research Project			

The 28% reduction is entered into the “Percent Reduction in Units of Material” column and the source of the value is entered in the “Data Assumptions”.

In this case, each sign is considered “one project”.

The benefit time frame is automatically populated based on the given value in the upper right corner.

Slide 34



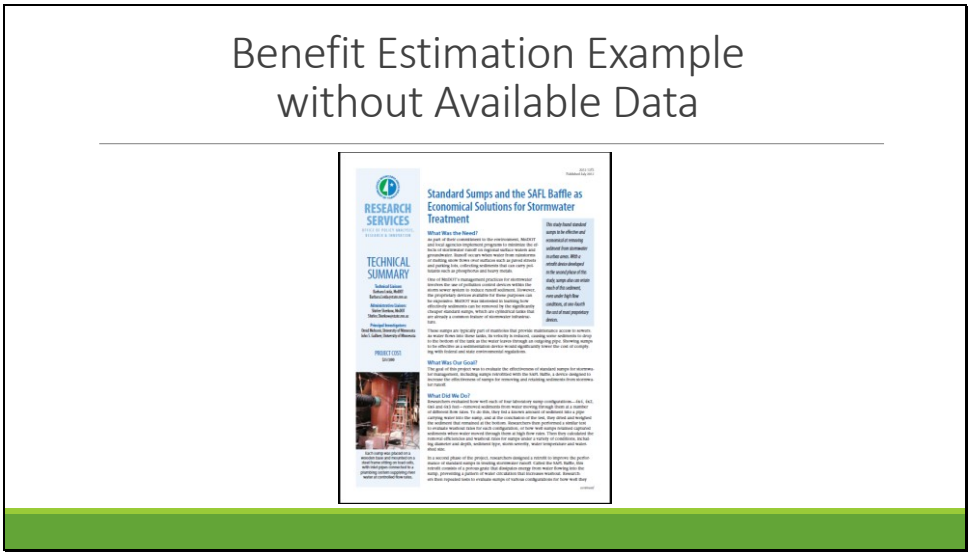
Once all the input data is entered in the orange cells, the white cells in the Performance Measures section automatically populate.

The user enters the sum of the benefits for each agency into the Benefit Sum cell in the Benefit-Cost Ratio Estimation section.

The research cost and benefit-cost ratio automatically populate.

The Benefit Sum value is a user-entered value rather than an automatically populated cell. Some projects may require the use of multiple templates to estimate all the quantitative benefits. In these cases, multiple template worksheets may be combined into one spreadsheet to represent the benefit estimation documentation. The benefit and cost values need only be entered into one of the worksheets.

Slide 35



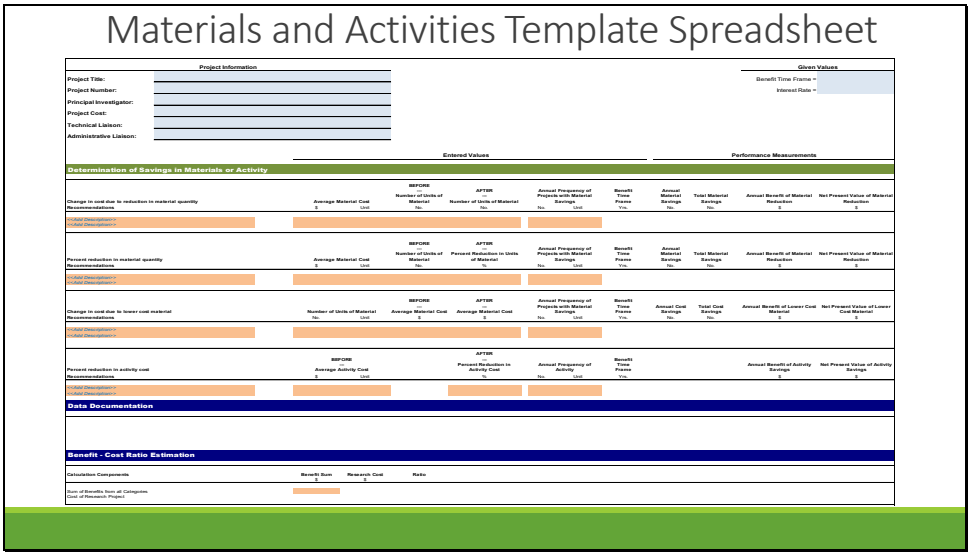
This will be an example of the benefit estimation process in which the necessary data is not available in the research report. This example is from one of the ten research projects that were part of the pilot study conducted to develop this benefit estimation tool.

The research proved that sumps with baffles are effective for removing and retaining sediments from stormwater runoff. The research effort developed the Saint Anthony Falls Laboratory (SAFL) baffle, a device that increases the effectiveness of sumps at retaining captured sediments during high flow rates.

For purposes of developing the quantification tool, the benefit of this research effort was expressed in terms of reduced cost for the purchase and installation of the SAFL baffle as compared to traditional methods of purchasing and installing baffles in stormwater manholes.

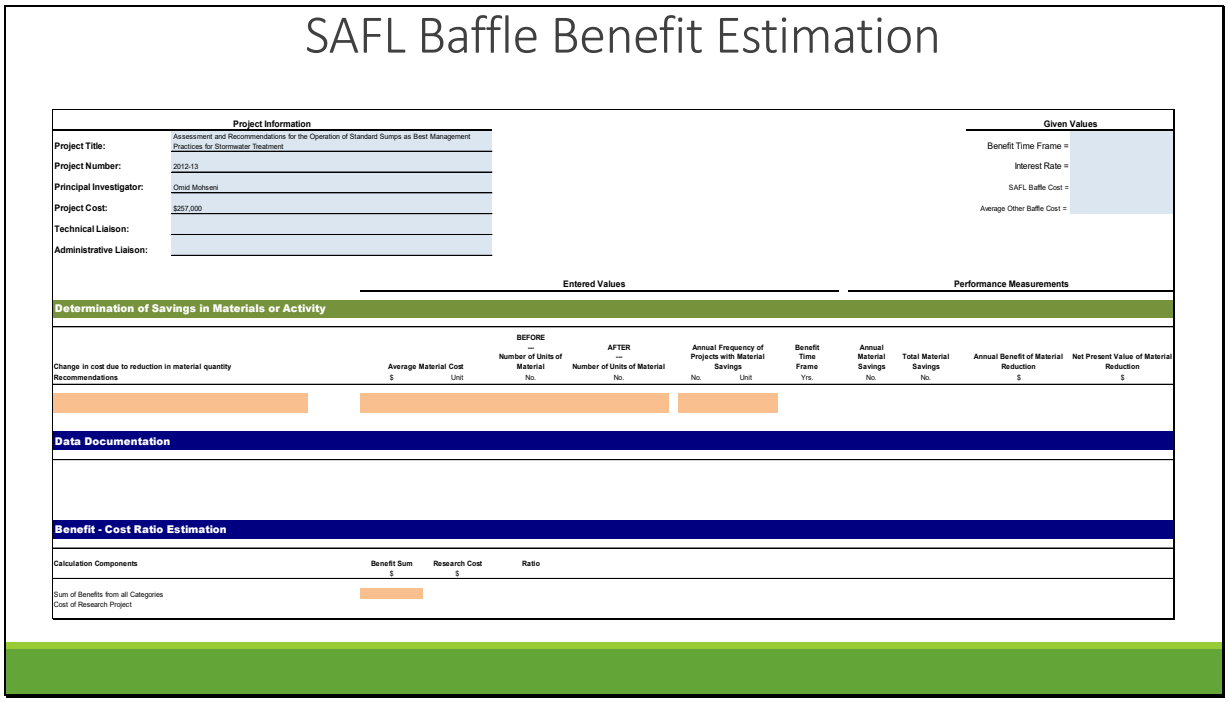
The benefit calculation involves estimating the difference between the average cost of other baffles and the SAFL baffle, and then applying the cost difference to the estimated annual number of baffle purchases.

Slide 36



The appropriate template for this project is the Materials and Activities template.

Slide 37



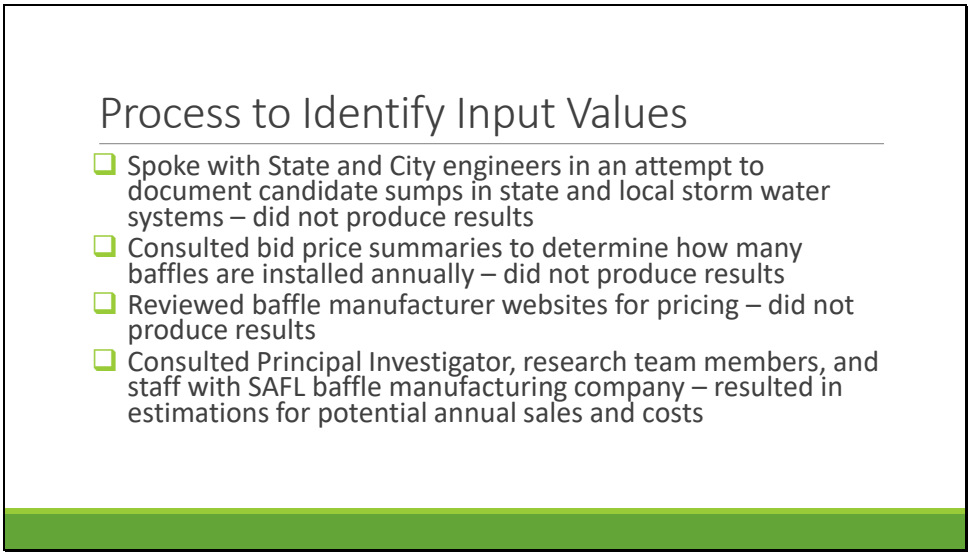
This graphics shows how the template was modified to match the required calculations.

The Project Information section has been populated with the pertinent information about the project.

The next step is to populate blue cells in the Given Values section.

Since this benefit estimation is based on the difference in cost between the baffle developed as part of this project and other baffles already on the market, these two costs must entered into the blue cells in the upper right corner.

Slide 38



The research report did not contain sufficient data to do any computation of benefits. The cost of the SAFL baffle was not provided, the cost of competing devices was not provided and an estimate of the number of storm water sumps that would potentially be candidates for installation was not provided.

Efforts were made to document the number of sumps that would be candidates for the baffle in both state and local storm water systems. However, MnDOT staff could not provide an estimate and a sample of city engineers in the Minneapolis/St. Paul metropolitan area indicated that there were no candidates in their systems (they already owned vacuum trucks and had staff assigned to clean out their sumps).

An additional effort was made to document the number of baffles MnDOT had already purchased using bid price summaries, however it was determined that the baffle did not have a unique bid number and was included in a catchall – “storm water special design”.

Ultimately, an estimate of the potential size of the market for SAFL baffles was produced using material provided by the marketing director for the manufacturer and the principal investigator.

Costs were also provided by the principal investigator and staff from the manufacturing company.

Slide 39

SAFL Baffle Benefit Estimation

Project Information

Project Title:	Assessment and Recommendations for the Operation of Standard Sumps as Best Management Practices for Stormwater Treatment
Project Number:	2012-13
Principal Investigator:	Omid Mohseni
Project Cost:	$257,000
Technical Liaison:	
Administrative Liaison:	

Given Values

Benefit Time Frame =	3
Interest Rate =	2.0%
SAFL Baffle Cost =	$4,000
Average Other Baffle Cost =	$25,000

Determination of Savings in Materials or Activity

Change in cost due to reduction in material quantity	Entered Values							Performance Measurements			
	Average Material Cost		BEFORE — Number of Units of Material	AFTER — Number of Units of Material	Annual Frequency of Projects with Material Savings		Benefit Time Frame	Annual Material Savings	Total Material Savings	Annual Benefit of Material Reduction	Net Present Value of Material Reduction
Recommendations	$	Unit	No.	No.	No.	Unit	Yrs.	No.	No.	$	$
Use of SAFL baffle instead of other baffles	4,000	baffle	0	baffle	140	baffle	3	$2,940,000	$8,820,000	$2,940,000	$8,478,617

Data Documentation

Competitor baffle price of $25,000 is based on estimate of $30,000 from Andy Erikson (SAFL) and $20,000 to $30,000 from AJ Schwibber (president of Upstream Technologies).
SAFL baffle price of $4000 was provided by AJ Schwibber of Upstream Technologies (produces the SAFL baffle) and confirmed by Omid Mohseni (Principal Investigator).
Omid Mohseni estimated that 200 SAFL baffles were sold in 2014, 70 to 80 percent of which were to agencies in Minnesota. Assume 70 percent, the lower percentage in this range, as a conservative estimate of potential benefit. 70 percent of 200 equates to 140 SAFL baffles annually purchased and installed in Minnesota.

Benefit - Cost Ratio Estimation

Calculation Components	Benefit Sum $	Research Cost $	Ratio
Sum of Benefits from all Categories	$8,478,617		33.1
Cost of Research Project		$257,000	

This graphic shows the populated spreadsheet for the benefit estimation and resultant benefit-cost ratio of 33.1.

The source of the baffle costs and quantities are entered into the Data Documentation section.

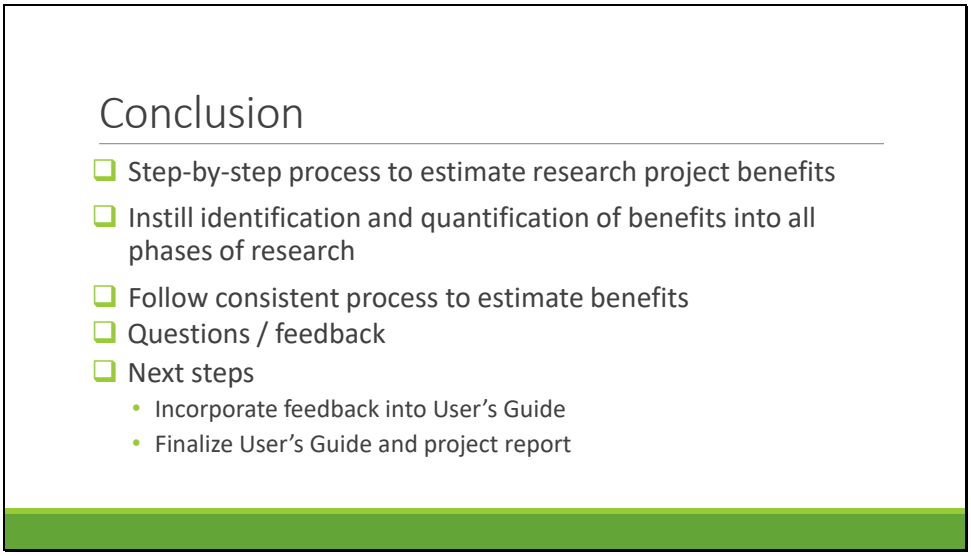
Slide 40

Contact Information

Hafiz Munir, Ph.D., P.E.
Minnesota Department Of Transportation
Research Services
395 John Ireland Blvd., MS 330
St. Paul, MN 55155
651-366-3757
Website link to where tool can be downloaded

The tool can be downloaded at this link and questions directed to Research Services.

Slide 41



This concludes the training on the benefit estimation process and use of the spreadsheet tool developed to assist with benefit – cost quantifications.

Consistent use of this process will enable the ability to document the effect of research project recommendations and justify the cost of the research efforts.

APPENDIX C: EXAMPLE MNDOT REFERENCES

2014 Benefit-Cost Analysis Standard Value Tables

http://www.dot.state.mn.us/planning/program/appendix_a.html

MnDOT Office of Transportation System Management
Benefit-Cost Analysis Standard Value Tables - July 2014

Table A.1

Recommended standard values for use in B/C analysis in SFY2015

Variables	Current Value
Real Discount Rate (1)	**2.0%**
Auto- value of travel time savings per person-hour **(2)**	**$16.00**
Truck- value of travel time savings per person-hour **(2)**	**$27.30**
Auto- variable operating cost *(dollars per mile) (3)*	**$0.31**
Truck- variable operating cost *(dollars per mile) (3)*	**$0.96**
MnDOT Crash Values *(4)*	Per crash
Fatal	**$10,300,000**
Injury Type A	**$550,000**
Injury Type B	**$160,000**
Injury Type C	**$81,000**
Property damage only	**$7,400**

(1) Determined as a five-year average for real interest rates (market rate less inflation) on 30-year Treasurys

(2) Adapted from US DOT's "Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis" published Sept. 28, 2011, with Minnesota earnings rates.

(3) Updates cost levels in Univ. of Minnesota report "The Per-Mile Costs of Operating Automobiles and Trucks" published in 2003. Variable costs include fuel, maintenance, tires, repair and depreciation.

(4) Reflects Minnesota's three-year crash history and US DOT procedures contained in "Revised Departmental Guidance 2013: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses" published May 6, 2013, and based on a VSL of $9.2 million in 2013$.

Table A.2

Recommended remaining capital value factors for use in benefit-cost analysis in SFY 2015

Expected life (years)>>	**25**	**30**	**35**	**40**	**50**	**60**	**100**
Analysis: 20 years	0.24	0.40	0.51	0.60	0.71	0.79	0.92
Analysis: 25	0.00	0.21	0.36	0.47	0.62	0.72	0.90
Analysis: 30	0.00	0.00	0.19	0.33	0.52	0.64	0.87

Example: $10 million spent on structures (60 years expected life) for an analysis period of 25 years has a remaining capital value of 0.72 x $10 million ($7.2 million) in the last year of the analysis period. (Factors reflect a real discount rate of 2.0%).

MnDOT Total Compensation (Salary + Fringe) SFY 15 Lookup Tables

Unlimited, Nonzero Salary Employees Only

Average of total	
New BU	Total
Manager (220)	$136,569
Engineer (212)	$104,467
Supervisor (216)	$98,308
Professional (214, 217, 219, 221)	$83,337
Technical (207)	$76,172
Maintenance (202)	$68,077
Clerical (206, 218)	$57,445
Service (203)	$50,782
Grand Total	$82,036

Average of hourly total	
New BU	Total
Manager (220)	$65.66
Engineer (212)	$50.22
Supervisor (216)	$47.26
Professional (214, 217, 219, 221)	$40.07
Technical (207)	$36.62
Maintenance (202)	$32.73
Clerical (206, 218)	$27.62
Service (203)	$24.41
Grand Total	$39.44

~ for questions go to John Wilson x3732 ~

Unit	New BU
202	Maintenance (202)
203	Service (203)
206	Clerical (206, 218)
207	Technical (207)
212	Engineer (212)
214	Professional (214, 217, 219, 221)
216	Supervisor (216)
217	Professional (214, 217, 219, 221)
218	Clerical (206, 218)
219	Professional (214, 217, 219, 221)
220	Manager (220)
221	Professional (214, 217, 219, 221)