

# USER GUIDE: Process for Quantifying the Benefits of Research



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The Minnesota Department of Tra	ansportation Research Services	has adopted a process	for quantifying the				
monetary benefits of research pro	pjects, such as the dollar value	of particular ideas whe	n implemented across the				
state's transportation system. Thi	s process is adaptable to a vari	ety of research topics a	and benefit categories.				
Research Services has incorporate	ed the potential benefit-cost ra	tio of proposed researd	ch projects into the				
selection process for new projects	5.						
The purpose of this user guide is t	o explain the seven-step benef	it quantification proce	ss and use of Research				
Services' benefit quantification sp	readsheet tool. The tool calcul	ates the potential bene	efit of research				
recommendations in terms of the	notential cost savings that cou	lld he realized by their	implementation and				
estimates a benefit-cost ratio. The	tool performs the calculation	s with user input values	s and serves as a repository				
for the data, assumptions, and so	urces included in the quantifica	tion process.					
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## User Guide: Process for Quantifying the Benefits of Research

#### **USER GUIDE**

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## **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.

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

#### **Table 1. Applicable Templates for Benefit Categories**

# 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 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 Title: Project Number: Principal Investigator: Project Cost: Technical Liaison: Administrative Liaison:	Project Information								Given Values Benefit Time Frame = Interest Rate = Average Labor Rate =	
		-		Entered Values				Perform	nance Measurement	S
Determination of Dire	ect Labor Savings									
Change in number of labor hours Recommendations	to complete activity	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="">&gt;</add>										
Percent reduction in number of lai Recommendations	bor hours to complete activity	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 \$
Data Documentation										
Benefit - Cost Ratio I	Estimation									
Calculation Components		Benefit Sum \$	Research Cost \$	Ratio						
Sum of Benefits from all Categories Cost of Research Project										

## Appendix A2 Safety

#### Safety Template Spreadsheet

	Filipettimormation				_				Crash Defi		5		injury crash Definitions	S Distributions		
Project Title:									Fatal		1%		Туре А	Serious	5%	
Project Number:									Type A Injury	Serious	1%		Type B	Moderate	26%	
Principal Investigator:					-				Type B Injury	Moderate	8%		Type C	Minor	69%	
Project Cost									Type C. Injury	Minor	20%		.)po o			
Technical Liaison					-				Proporty Domog		70%					
Administrative Liaison					-				F TOPETTy Damay	5	1070	1				
Automotive Elabori.					-											
User Input – Historical Cra	ash Data															
oser input – materiour en	agn dam			Relate	d Crashes					Road System Data	1				Crash Redu	ction Factors
		Fatal		Injury		Property Damage	Years of Crash Data					-				
		Crashes	Type A Crashes	Type B Crashes	Type C Crashes	Crashes			Featu	e Count	Traffic Growth Rate		Fatal	A Injury	B Injury	C Injury
Recommendations	Related Crash Types	No.	No.	No.	No.	No.	No.		No.	Unit	%	_	%	%	%	%
< <add description="" of="" recommendation="">&gt;</add>																
< <add description="" of="" recommendation="">&gt;</add>																
Projected Recommendation	on Effectiveness and Benefits															
		Fatal	Crashes	Type	A Iniury	A Type	nnual Projected Crash a 3 Iniury	nd Injury Reduction Type	ns C Iniurv	Proper	v Damage	Annual Reduction	Annual Reduction			Benefits
		Density	Number	Density	Number	Density	Number	Density	Number	Density	Number	Fatal and Type A	Fatal, Injury, & Property		Annual Benefit of Implementation	Net Present Value Benefit of Impler
Recommendations	Related Crash Types	Crashes/vear/unit	Reduced Crashes	Crashes/vear/unit	Reduced Crashes	Crashes/vear/unit	Reduced Crashes	Crashes/vear/unit	Reduced Crashes	Crashes/vear/unit	Reduced Crashes	Injury Reduced Crashes	Damage Reduced Crashes		s	s
				oraonoo, joan, ann		onaonoo, joanann		oraonoo, joan ann		oraonoo, joan ant					•	Ť
< <add description="" of="" recommendation="">&gt; &lt;<add description="" of="" recommendation="">&gt;</add></add>																
Projected Pecommendati	on Effectiveness and Renefits - Chan	go in Crachoe														
Projected Recommendation	on Effectiveness and Benefits – Chan	ge in Crashes	Chang	je in Annual Related (	Crashes				Road System Data			Treatmen	t Deployment			Benefits
Projected Recommendation	on Effectiveness and Benefits – Chan	ge in Crashes Fatal	Chanç	ge in Annual Related ( Injury	Crashes	Property Damage	-		Road System Data			Treatmen	t Deployment		Annual Renefit of	Benefits Present Value o
Projected Recommendation	on Effectiveness and Benefits – Chan	ge in Crashes Fatal Crashes	Chang Type A Crashes	je in Annual Related ( Injury Type B Crashes	Crashes Type C Crashes	Property Damage Crashes	_	Featu	Road System Data	Traffic Growth Rate		Treatmen	t Deployment		Annual Benefit of Implementation	Benefits Present Value c Benefit of Impler
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Projected Recommendations Commendations Commendations Commendations	on Effectiveness and Benefits – Chan Related Crash Types	ge in Crashes Fatal Crashes No.	Chang Type A Crashes No.	ge in Annual Related ( Injury Type B Crashes No.	Crashes Type C Crashes No.	Property Damage Crashes No.	-	Featu No.	Road System Data	Traffic Growth Rate %		Treatmen Amoun No.	t Deployment t Deployed Unit		Annual Benefit of Implementation \$ \$0 \$0	Benefits Present Value o Benefit of Impler \$
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Projected Recommendation         Recommendations         < <add description="" of="" recommendation="">&gt;         &gt;<add description="" of="" recommendation="">&gt;         Data Documentation         Benefit - Cost Ratio Estimation         Calculation Components         Sum of Benefits from all Categories</add></add>	on Effectiveness and Benefits – Chan Related Crash Types	ge in Crashes Fatal Crashes No. Benefit Sum S	Chang Type A Crashes No.	ge in Annual Related ( Injury Type B Crashes No.	Crashes Type C Crashes No.	Property Damage Crashes No.		Featu No.	Road System Data	Traffic Growth Rate %		Treatmen Amoun No.	t Deployment		Annual Benefit of Implementation \$ \$0 \$0	Benefits Present Value o Benefit of Impler \$
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#### Appendix A2 Safety

		Given Values								
			Benefit T	ïme Frame =						
			Interest Rate =							
				Fatal Crash =						
			Type A Injury Crash =							
			Type B Injury Crash =							
			Туре С І	njury Crash =						
			Property Damage	Only Crash =						
			Service Life		Treatment Deploym	ent				
Ŋ	Property Damage	Unit	Service Life	Amou	nt Deployed	Level of Confidence				
	%		Years	No.	Unit	≤1.0				
			0							
			0							
e of Annual										
mentation										
of Annual										
menialivii										

# Appendix A3

Traffic Operations/User Benefits

#### Traffic Operations/User Benefits Template Spreadsheet

	Project l	Information			-									Given Va	ues
Project Title:					_									Benefit Time Frar	ne =
Project Number:					_									Interest Ra	te =
Principal Investigator:					_								Auto -	Value of Time (per person-ho	ır) =
Project Cost:					_								Truck -	Value of Time (per person-ho	ır) =
Technical Liaison:					_									Value of Vehicle St	op =
Administrative Liaison:					_									Design Labor (per person-hou	r) =
User Input			Automobile Change i	n Travel Hours			Truck Change in Tr	avel Hours		Total Change in N	lumber of Stops	Design Labo	r	Treatment De	ployment
		BEFORE	AFTER			BEFORE	AFTER			BEFORE	AFTER		·		,,,
		 Veh. Hours of Delay (per weekday)	 Veh. Hours of Delay (per weekday)	Auto C	ccupancy	 Veh. Hours of Delay (per weekday)	 Veh. Hours of Delay (per weekday)	Truck	Occupancy	 Number of Stops (per weekday)	 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="">&gt; &lt;<add description="">&gt;</add></add>	< <add location="">&gt; &lt;<add location="">&gt;</add></add>				persons per veh. persons per veh.				persons per veh. persons per veh.				per location per location		
<b>Projected Recommen</b>	dation Effectiveness - User Be	nefits													
			Automobile Travel T	Time Savings			Truck Travel Time	Savings		Automo	obile 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="">&gt; &lt;<add description="">&gt;</add></add>	< <add location="">&gt; &lt;<add location="">&gt;</add></add>														
Projected Recommen	Idation Effectiveness - DOT Ber	nefits													
			Reduction in Stops		-	Design Lat	oor 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="">&gt; &lt;<add description="">&gt;</add></add>	< <add location="">&gt; &lt;<add location="">&gt;</add></add>														
Annual Benefit of Imp	lementation														
		Total Annual Benefit of Implementation	Present Value of Total Annual Benefit of Implementation												
Recommendations	Location	\$	\$												
< <add description="">&gt; &lt;<add description="">&gt;</add></add>	< <add location="">&gt; &lt;<add location="">&gt;</add></add>														
Data Documentation															
														_	
Benefit - Cost Ratio Es	stimation														
Calculation Components		Benefit Sum	Research Cost	Ratio										_	
Sum of Benefits from all Categories Cost of Research Project		Ÿ	Ŷ											_	

#### Appendix A3 Traffic Operations/User Benefits

# Appendix A4

Materials and Activities

#### Materials and Activities Template Spreadsheet

	Project Information							
Project Title:								
Project Number:								
Principal Investigator:								
Project Cost:								
Technical Liaison:								
Administrative Liaison:								
			E	ntered Values				
Determination of Sav	vings in Materials or Activity							
Change in cost due to reduction in Recommendations	n material quantity	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 Materi Savings No.
< <add description="">&gt; &lt;<add description="">&gt;</add></add>								
Percent reduction in material qua Recommendations	intity	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 Materi Savings No.
< <add description="">&gt; &lt;<add description="">&gt;</add></add>						I		
Change in cost due to lower cost Recommendations	material	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.
< <add description="">&gt; &lt;<add description="">&gt;</add></add>						l i		
		BEFORE		AFTER		Benefit		
Percent reduction in activity cost Recommendations		Average Activity Cost \$ Unit		Percent Reduction in Activity Cost %	Annual Frequency of Activity No. Unit	Time Frame Yrs.		
< <add description="">&gt; &lt;<add description="">&gt;</add></add>						1		
Data Documentation	1							
Benefit - Cost Ratio	Estimation							
Calculation Components		Benefit Sum Research Cost \$ \$	Ratio					
Sum of Benefits from all Categories Cost of Research Project								

	Given Values	
	Benefit Time Frame =	
	Interest Rate =	
	De récome con Managemente	
	Performance measurements	
erial Is	Annual Benefit of Material Reduction \$	Net Present Value of Material Reduction \$
erial Is	Annual Benefit of Material Reduction \$	Net Present Value of Material Reduction \$
ost Is	Annual Benefit of Lower Cost Material \$	Net Present Value of Lower Cost Material \$
	Annual Benefit of Activity	Net Present Value of Activity
	Savings \$	Savings

# Appendix A5

Lifecycle

#### Lifecycle Template Spreadsheet

	Project Information		_				
Project Title:			_				
Publication Number:							
Principal Investigator:							
Project Cost:							
Technical Liaison:							
Administrative Liaison:			_				
				Entered Value	es		
Change in Life Cycle							
			BEFORE	AFTER	Annual Frequency of		Benefit
Increase in Life Cycle - Occurs Annu	ally	Average Activity Cost	Lifecycle	Lifecycle	Lifecycle		Frame
Recommendations		\$ Unit	Yrs.	Yrs.	No. Unit		Yrs.
< <add description="">&gt; &lt;<add description="">&gt;</add></add>							
			BEFORE	AFTER	Annual Frequency of		Benefit
Increase in Life Cycle - Occurs Once		Average Activity Cost	 Lifecycle	 Lifecycle	Projects With Increased Lifecycle		Time Frame
		\$ Unit	Yrs.	Yrs.	No. Unit		Yrs.
< <add description="">&gt; &lt;<add description="">&gt;</add></add>							
						AFTER	
			BEFORE	AFTER	Annual Frequency of	Percent	Benefit
Increase in Life Cycle & Decrease in	Quantities - Occurs Once	Average Activity Cost	 Lifecycle	 Lifecycle	Projects With Increased Lifecycle	Reduction in Items	Time Frame
Recommendations		\$ Unit	Yrs.	Yrs.	No. Unit	%	Yrs.
< <add description="">&gt; &lt;<add description="">&gt;</add></add>							
Data Documentation							
Benefit - Cost Ratio Es	stimation						
Calculation Components		Benefit Sum Research Cost \$ \$	Ratio				
Sum of Benefits from all Categories Cost of Research Project							
L							

#### Appendix A5 Lifecycle

Given Values						
Benefit Time Frame =						
Interest Rate =						
Performance Measurements						
	Not Prosont Valu	: of				
	Lifecycle Cost Sav	/ings (				
	years) \$					
	\$	-				
	\$	-				
	Net Present Valu Lifecycle Cost Sav	ie of /ings (				
	years) \$					
	\$	-				
	\$	-				
	Not Drocont Volu					
	Net Present Value of Lifecycle Cost Savings					
	s					
	\$	-				
	\$	-				

Appendix A6 Risk Management Risk Management Template Spreadsheet

Project Information		-			
Project Title:		_			
Project Number:		_			
Principal Investigator:		_			
Project Cost:		_			
Technical Liaison:		_			
Administrative Liaison:					
		Entered Values			
Determination of Savings from Reduced Fines					
Change in cost due to reduction in actions that result in fines Recommendations	Average Cost of Fines	BEFORE AFTER  Number of Actions Resulting in Fines in Fines No No	Annual Frequency of Implemented Actions	Benefit Time Frame Yrs	Annual Reduction in Actions 1 Resulting in Fines
< <add description="">&gt; &lt;<add description="">&gt;</add></add>					
Data Documentation					
<b>Benefit - Cost Ratio Estimation</b>					
Calculation Components	Benefit Sum Research Cost \$ \$	Ratio			
Sum of Benefits from all Categories Cost of Research Project					

#### Appendix A6 Risk Management

Given Values					
	Benefit Time Frame =				
	Interest Rate =				
Performance Measur	ements				
Total Reduction in Actions Resulting in Fines No.	Annual Benefit of Action Reduction \$	Net Present Value of Action Reduction \$			

## **APPENDIX B: USER GUIDE PRESENTATION**

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



#### Slide 2





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.



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.



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.

Step 2: Build Benefit Estimation Tool
Spreadsheet tool on Excel platform
Calculates potential benefit
Computes benefit-cost ratio
Provides means to store all pertinent data and information

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.



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.
The Minnesota Research Benefits Direct recommendations. The determination of	: Labor Saving direct labor s	s Quantification tool is a statewide programmatic evaluation tool to estimate the benefits expected from implementation of research avings involves calculating the cost savings realized from the reduction in labor hours for the given activity. The user can either input the number c
hours required to complete an activity fo	r both the cur	ent 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 E	Benefits	Direct Labor Savings Quantification Tool Components
The following provides an overview of the	direct labor s	avings tool components.
51		
Title	Columns	Description
Given Values		
	Linner Right	Includes values for benefit time frame, interest rate, and average labor rate (for the job classification that would perform the activity) that are used
Given Values	Corner	in the benefits calculations. These values automatically populate the appropriate cells in the spreadsheet. The user should research the most
	001101	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	н	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	н	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	Т	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		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
Benefit Sum	E	benefits are summed to determine the total benefit.
Research Cost	G	User-entered value for the cost of the research project.
	- ii	Calculates the herefit east 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.



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 1	1
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And the second of t		Project Information								Given Values	
	Project Title:									Benefit Time Frame	
	Project Number:									Interest Rate	
Name of the second s	Principal Investigator:									Average Labor Rate	
Second State       Exercise       Definition of the second state	Project Cost:										
Name       Interview       Protocol         Interview       Interview       Interview       Interview         Secondariant       Interview       Interview       Interview       Interview         Secondariant       Interview       Interview       Interview       Interview       Interview         Secondariant       Interview       Interview </th <th>Fechnical Liaison:</th> <th></th>	Fechnical Liaison:										
Exercises         Sectore         Sectore         Sectore         Sectore           Control Sectore	Administrative Liakon:										
Image: Control of Control o											
Second states of Area Lakes Songer     Second states of Area Lake Songer       Second states of Area Lake Songer     Second Social Soc					Entered Values				Pedar	mance Measurements	
An example of the field being factor of the											
Series     Series <td>Determination of Direct Labor Savin</td> <td><b>a</b>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Determination of Direct Labor Savin	<b>a</b> 1									
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Mark											
Register line     Array of and the line     Array o				BEFORE	#758		Barrelli Time	Annual Later		Annual Bernelli of Labor	Net Present Value of Labor
And and a set of the back hand of the back hand of the back hand of the back hand hand hand hand hand hand hand hand	Change in number of bloor hours to complete activity		Average Labor Rate	Number of Hours	Number of Hours	Annual Programmy of Activity	Frame	Zavings	Total Labor Eavings	Envirops	Lavings
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Antonizania Anton	And December 2										
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Non- transmission     Non- transmiss											
Name     Nam     Name     Name     Name											
Analas dar				MIPONE	17188						
Amendaman ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '	Percent reduction in marries of kiner hours to complete activ		Average Labor Sale	Number of Hours	Personi Reduction in Later Neura	Annual Pressence of Artholy	Bandii Tine Frans	Annual Labor Zenines	Total Labor Bayloon	Annual Barnelli of Labor Zenimen	Net Present Value of Labor Eastman
And Andream Andre Andream Andream Andr	Recommendations	-		Ne.		Ne. Del	Tin.	No.	No.	1	1
Service Call Solid Science International Science Internatione International Science International Science Inte											
An Agenerated Hite	- Add Decorption										
No Presentation Present Case Bala Estimation 											
Sanda Cagana And Lagrana And L	Data Documentation										
Service Card Acto Estimation Service Carpone Note Note Note Activities to a family Note Note Note Activities to a family Note Activities Note Note Note Activities Note Note Note Note Note Note Note Note Note Note Note Note Note Note Note Note											
Strafe Cell Ballis Scienting Scient Copyright Series											
Secular Set Bala Estimation Secular Secular S											
Sector Cod Balls Solination											
Servite Cuil Ball Solitestime Salat Capanin Ball Salat Sa											
Section Conference Section Sec											
Andre Sander S Sander Sander	Benefit - Cost Ratio Estimation										
Radiati regionali de la construit de la constr											
Radian Carpan In Anna I I I I In Radian Carpan La Radian Ragan											
	Education Components		Earth Lan	Research Cost	Ratio						
har Jahofa Ing Singan Kara Mangal											
Sa Anga	fam of Benefits have all Galegories				_						
	Coll of Research Project										

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.



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.



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.

Step 2: Build B	enefit Estimation Tool
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
<b>Operation and Maintenance Saving</b>	Direct Labor Savings, Materials and Activities
Safety	Safety
User Benefits	Traffic Operations User Benefits
Risk Management	Risk Management

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.



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.



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.



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.



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



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.



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.

Project Title: Project Number:		-						Benefit Time Frame = Interest Rate =	VALUES
Project Cost:									
		5	ntered Values			-		Performance Measurements	
Determination of Savings in Materials or Activi	ty								
Charge In cod due to reduction in material quantity Recommendations	Average Material Cost 3 Lost	BEFORE 	APTER — Number of Units of Material No.	Annual Programmy of Projects with Material Eavings No. Unit	Benefii Time Piame Ym	Aronaal Malavial Savings No.	Total Material Bavings No.	Annual Benefit of Material Medicilien I	Net Present Value of Mater Reduction 3
<ul> <li>And Description(&gt;)</li> <li>And Description(&gt;)</li> </ul>									
Percent reduction in material quantity Recommendations	Average Material Ceal 8 Sol	REPORE Number of Units of Material No.	APTER — Percent Reduction in Units of Material %	Annual Programmy of Projects with Material Earings No. Unit	Benefit Time Plame Ym.	Annual Material Basings No.	Total Material Savings No.	Annual Banafii of Malarial Reduction I	Net Present Value of Mater Reduction
Colub Description >  Colub Description >									
Change in cost due to lower cost material Recommonications	Number of Units of Material No. Unit	BEFORE 	APTER — Average Naterial Cost 3	Annual Programsy of Projects with Material Eavings No. Unit	Benefit Time Piano You	Annual Coni Bavings No.	Total Cost Ravings No.	Annual Benefit of Lower Cost Material 3	Net Present Value of Low Cost Material S
Schild Description >> Schild Description >>									
Percent reduction in activity cost	BEPONE		APTER — Pances Reduction in Autority Cost	Annual Programmy of Antivity	Benefii Time Pasme			Annual Berefit of Astroly Eavings	Not Present Value of Activ Savings
Colub Decemplance									•
Data Documentation									
Benefit - Cost Ratio Estimation									
Calculation Components	Benefit Zum Research Cost	Ratio							

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.



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.



The project information is entered in the upper left corner.

### Slide 29





The given values are entered in the upper right corner.

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





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.

	Project Information	n									Giver	n Values
Project Title:	Traffic Sign Life Expectancy & Traffic Sign	Maintenance/Managemen	4 Handbook								Benefit Time Frame	3
Project Number:	2014-20 & 2014R8C20										Interest Rate	2.0%
Principal Investigator:	Howard Preston											
Project Cost:	\$87,613											
Technical Liaison:					(							
Administrative Liaison:												
						Entered Values				P	erformance Measurement	
Determination of S	avings in Materials or Acti	vity										
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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.

Project Title: <u>Turke Sign L&amp; Exerci-</u> Project Number: 2014-30 & 33948(28) Project Number: <u>Howeld Partian</u> Project Cost: <u>807,613</u> Freinical Lisison: Administrative Lisison:	ject Information	nt Handbook							Give	n Values = 3 = 2.0%
	_			Entered Values				F	Performance Measuremen	ts
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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.

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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.

Project Information Project Information Project Number: Project Number: Project Rummer: Project Cost: Project Luison:								Given Benefit Time Frame = Interest Rate =	Values
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The appropriate template for this project is the Materials and Activities template.

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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.



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.

	Project Information										Given	Values
Project Title:	Assessment and Recommendations for the Opera Practices for Stormwater Treatment	tion of Standard Sumps as Be	est Management								Benefit Time Frame =	3
Project Number:	2012-13										Interest Rate =	2.0%
Principal Investigator:	Omid Mohseni										SAFL Baffle Cost =	\$4,000
Project Cost:	\$257,000										Average Other Baffle Cost =	\$25,000
Technical Liaison:												
Administrative Liaison:												
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Use of SAFL baffle instead of c	ther baffles	4,000	baffle	0	balle	140	baffe	3	\$2,940,000	\$8,820,000	\$2,940,000	\$8,478,617
Use of SAFL baffle instead of c	other baffles	4,000	baffle	0	balle	140	baffe	3	\$2,940,000	\$8,820,000	\$2,940,000	\$8,478,617
Use of SAFL baffle instead of o Data Documentat Competitor baffle price of \$25,01	<b>titer buffles</b>	4,000	baffle from AJ Schwibber (pr	0 esident of Upstream Ter	battle	140	baffe	3	\$2,940,000	\$8,820,000	\$2,940,000	\$8,478,617
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This graphic shows the populated spreadsheet for the benefit estimation and resultant benefitcost ratio of 33.1.

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

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



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
	\$160,000 \$24,000
Injury Type C Property demage only	\$01,000 \$7,400
Froperty damage only	Ψ1,400

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

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

(3) <u>Updates cost levels in Univ. of Minnesota report "The Per-Mile Costs of Operating</u> <u>Automobiles and Trucks" published in 2003.</u> Variable costs include fuel, maintenance, tires, repair and depreciation. (4) <u>Reflects Minnesota's three-year crash history and US DOT procedures contained in</u> <u>"Revised Departmental Guidance 2013: Treatment of the Value of Preventing Fatalities and</u> <u>Injuries in Preparing Economic Analyses" published May 6, 2013, and based on a VSL of \$9.2</u> <u>million in 2013\$.</u>

#### Table A.2

Recommended rem	aining capi	tal value fa	ctors for us	se in benefi	t-cost analy	ysis 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 structure	s (60 years	expected life	e) for an an	alysis period	l of 25 years	s 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		Average of hourly total	
New BU	Total	New BU	Total
Manager (220)	\$136,569	Manager (220)	\$65.66
Engineer (212)	\$104,467	Engineer (212)	\$50.22
Supervisor (216)	\$98,308	Supervisor (216)	\$47.26
Professional (214, 217, 219, 221)	\$83,337	Professional (214, 217, 219, 221)	\$40.07
Technical (207)	\$76,172	Technical (207)	\$36.62
Maintenance (202)	\$68,077	Maintenance (202)	\$32.73
Clerical (206, 218)	\$57,445	Clerical (206, 218)	\$27.62
Service (203)	\$50,782	Service (203)	\$24.41
Grand Total	\$82,036	Grand Total	\$39.44
~ for questions go to John Wilsor <u>Uni</u> 202	x3732 ~ <u>New BU</u> Maintenan	ice (202)	
~ for questions go to John Wilsor Uni 202 203 206 207	x3732 ~ <u>New BU</u> Maintenan Service (20 Clerical (20 Technical	nce (202) 03) 06, 218) (207)	
~ for questions go to John Wilsor Uni 202 203 206 207 212 212	x3732 ~ <u>New BU</u> Maintenan Service (20 Clerical (20 Technical Engineer (	nce (202) 03) 06, 218) (207) 212) vel (214, 217, 219, 221)	
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~ for questions go to John Wilson <u>Uni</u> 202 203 204 207 212 214 216 217 218 219 219 219 219 219 219 219 219	x3732 ~ <u>New BU</u> Maintenan Service (20 Clerical (20 Clerical (20 Technical Engineer ( Profession Supervisor Profession Clerical (20 Profession Manager (20)	nce (202) 03) 06, 218) (207) 212) nal (214, 217, 219, 221) r (216) nal (214, 217, 219, 221) 06, 218) nal (214, 217, 219, 221) 220)	