Cost Risk Assessment and Value Engineering Workshop Report

TH 101 / CSAH 61 Connection

November 5-9, 2012

Minnesota Department of Transportation
Office of Project Management and Technical Support
395 John Ireland Blvd. MS 696
St. Paul, MN 55155

Disclaimer

The information contained in this report is the professional opinions of the team members during the cost risk assessment and value engineering workshop or CRAVE™. These opinions were based on the information provided to the team at the time of the workshop. As the project continues to develop, new information will become available, and this information will need to be evaluated on how it may affect the recommendations and findings in this report. All costs displayed in the report are based on best available information at the time of the workshop and unless otherwise noted are in current year (CY) dollars.

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Executive Summary

Introduction

This Executive Summary provides an overview of the project, key findings, and the recommendations developed by the Cost Risk Assessment & Value Engineering CRAVE™ Team during the Workshop. Detailed documentation and exhibits of the workshop's analysis are provided in the CRAVE™ Workshop Report.

Workshop Statistics

Original Cost:
$18.8 million

Number of Recommendations:
4

Recommended Cost Savings:
$5.52 million

Recommended Value Added:
N/A

Number of Accepted Recommendations:
3

Accepted Recommended Cost Savings:
$3.78 million

Total Number of Team Members:
11

Federal Employees:
0

MnDOT Employees:
7

Others:
4

Facilitator:
Consultant

A CRAVE™ Workshop, sponsored by the Minnesota Department of Transportation and facilitated by HDR Engineering, Inc., was conducted for the improvements to the Carver County TH 101 / CSAH 61 Connection project. The workshop was conducted at a 30% level of design and Carver County is working on a funding plan. This CRAVE™ Workshop was conducted from November 5-9, 2012.

Project Overview

Carver County along with MnDOT and the City of Chanhassen has been working to improve the TH 101 corridor since 2004. In 2007 the City partnered with MnDOT and Carver County on a scoping workshop to look at issues and opportunities from Lyman Blvd. to the Minnesota River crossing. This workshop highlighted the need, from a local and regional perspective, to improve TH 101 arterial continuity.

The City of Eden Prairie, the community to the east of Chanhassen says CSAH 61 or Flying Cloud Dr. currently has a traffic capacity issues around their shopping center. The more commuter trips that can be directed up the bluff will help the region's transportation network. Also improving the continuity of TH 101 up the bluff will help the regions transportation system when other Minnesota River crossings flood since most of the redirected trips are heading north/south in this area and to a great extent onto TH 212.

The baseline design for this workshop is the South Leg T Alternative.

This alternative shifts the alignment of TH 101 to the east side of the existing wye and widens the roadway to four 12' lanes and 4' inside and outside shoulders. The inside shoulders are separated by a raised median.

CSAH 61 alignment is shifted to the north and straightened out between Bluff Creek Drive and TH 101 south. Within the project CSAH 61 is widened to a four lane roadway with a raised median to separate opposing traffic. CSAH 61 has four 12' lanes, 8' outside shoulders and a raised median. There is a 10' trail on both sides with a 6' grass boulevard separating it from the roadway.

South Leg T (baseline)

The baseline design includes three signalized intersections along CSAH 61 (Bluff Creek Drive, TH 101 north, and TH 101 south).

There are dual left turn lanes for northbound TH 101 to westbound CSAH 61 and a free right to eastbound CSAH 61. Two dual turn lanes are constructed for westbound CSAH 61 to SB TH 101. Dual right turn lanes are designed for eastbound CSAH 61 to southbound TH 101.

The trail along TH 101 would use the existing west leg of the wye. Additional 12' trails would be constructed on both sides of CSAH 61.

Focus of the CRAVE™ Workshop

The CRAVE™ Team focused on the following areas to achieve the most value relative to the needs of the project:

- Verify or improve upon the various concepts for the TH 101 / CSAH 61 Connection Project
- Improve the value of the project through innovative measures aimed at increasing the performance while reducing costs of the project
- Identify high risk areas in delivering this project
- Perform a cost risk assessment on both the baseline design and the VE-recommended design
- Individual objectives included:
    - Identifying ways to minimize the cost of the pile supported embankment
    - Investigating ways to construct the project with the least amount of impacts to the traveling public

Project Analysis

The CRAVE™ Team analyzed the project using the VE Job Plan (Appendix) and associated tools. The Team benefited from discussions with the Project Team and was given constraints and controlling decisions from the Project Manager and the Design Team.

By using functional analysis and Functional Analysis System Technique (FAST) diagramming, the Team defined the basic function of the project as *Reduce Closures*. Key secondary functions included *Connect Roadway, Span Bluff Creek* and *Span Floodplain*.

Focusing the team on the functional elements (basic and secondary) of the project allowed them to recommend alternative concepts that satisfied the requirements.

Cost Risk Assessment Summary

In performing the cost risk analysis a risk based modeling tool was incorporated to model the pre-response to the overall risk of the project. The CRAVE™ Team identified 19 independent risks that pose both potential schedule and cost threats and opportunities. In the workshop a likely range of impact and probability of occurrence was identified for each risk. Prior to the development of risk response and value engineering recommendations, the project had a 60% confidence level of $20.84 M.

Pre-Response Risk Based Estimate (escalated Millions $)			
Base Cost	10%	60%	90%
$18.80	$18.55	$20.84	$24.02

The CRAVE™ Team speculated on ways to reduce risk as part of the workshop. The next step was to develop response strategies and VE recommendations for the active risks. These were then added into the risk based modeling tool. After responding to risks and incorporating VE recommendations with an anticipated probability of acceptance the final 60% confidence level was $15.76 M, for a net reduction in projected costs of $5.08 M.

Post-Response Risk Based Estimate (Millions $)			
Base Cost	10%	60%	90%
$18.80	$13.17	$15.76	$18.96

These tables illustrate the power of proactive management and implementation of the value engineering recommendations to respond to the potential project risk. In summary, implementing the value engineering recommendations can offer an additional expected value cost reduction beyond the cost of the items themselves.

VE Study Results

The CRAVE™ Team generated 30 different ideas for this project. These concepts were compared against the baseline that was developed by the project team.

Value = Performance/Cost

As the CRAVE™ Team developed the recommendations the performance of each was rated against the original design concept or baseline. Changes in performance are always based upon the overall impact to the total project.

Once performance and cost data were developed by the CRAVE™ Team, the net change in value of the VE recommendations can be compared to the baseline. The concepts that performed the best were further developed by the CRAVE™ Team. For a complete definition of performance see the Appendix A of this report.

From the various concepts the CRAVE™ Team developed four recommendations. Two VE recommendations were accepted, resulting in cost savings of $2,840,000. These recommendations reduce the width of the roadway section for CSAH 61 and construct the roundabout at the intersection of south leg of TH 101 and CSAH 61.

One additional recommendation was conditionally accepted pending further review, which result in additional savings of $940,000. This recommendation shortens the length of the proposed Bluff Creek Bridge on CSAH 61.

See the VE Recommendation Approval Form in Appendix B for additional information on the acceptance/rejection of the individual recommendations. The individual recommendations are summarized below:

Summary of Recommendations

TH 101 / CSAH 61 Connection

#	Description	Accepted/ Rejected	Cost Avoidance	Performance Improvement
1	Reduce ROW Acquisition	Reject	$1.74 M	6%
2	CSAH 61 - Roadway Section	Accept	$1.34 M	1%
3	CSAH 61 - Bluff Creek Bridge	Accept for further review	$0.94 M	3%
4	TH 101 / CSAH 61 Connection	Accept	$1.50 M	42%
	Total		**$5.52 M**	

After the conclusion on the VE Workshop, it was determined that this project along with the TH101/CSAH 61 Connection project would be combined into one larger project, and Carver County will be the lead agency and let the project. This was decided for a number of reasons, primarily because the TH 101 will be turned back to Carver County immediately prior to construction, and the State Aid delivery process is shorter than the standard MnDOT Trunk Highway process.

CRAVE™ Team Members

Jackie Borman	Design/Construction
Mohammad Dehdashti	Design
Bill Gilmore	Construction
Blane Long	CRAVE™ Team Leader
Sara Maninga	Soils/Hydraulics
Kate Miner	Traffic
Dave Nyquist	Design
Ryan Rohne	Bridge
Ken Smith	Assistant Team Leader
Brian Wifler	Design

The Project Manager for this project is Lyndon Robjent, Carver County, Public Works Director.

The CRAVE™ Team wishes to express its appreciation to the project design managers for the excellent support they provided during the workshop. Hopefully, the recommendations and other ideas provided will assist in the management decisions necessary to move the project forward through the project delivery process.

Blane Long, CVS
CRAVE™ Team Leader

This project is left intentionally blank

Project Analysis

The following items and tools were provided to the CRAVE™ Team and used to assist them in the analysis of this project:

- Information provided to the CRAVE™ Team
- Project Issues
- Constraints and Controlling Decisions
- Cost Model
- Performance Attributes
- Performance Attribute Matrix
- Functional Analysis
- FAST Diagram

Information Provided to the CRAVE™ Team

The following project documents were provided to the CRAVE™ Team for their use during the workshop:

Reports/Drawings/Maps	Date
Various Construction Cost Estimates	October 2012
CSAH 61 Contour Layout	October 2012
CSAH 61 Contour Layout	October 2012
East Leg T Alternative Layout	October 2012
Roundabout Alternative Layout	October 2012
South Leg T Alternative Layout	October 2012

Project Issues

The first day of the workshop included meeting with the project stakeholders and a site visit. The following summarizes the key project issues identified during these sessions:

- Complex and extensive soil correction
- Complex geometrics
- Significant right of way impacts
- Construction staging and traffic impacts during construction
- Project development schedule
- Cost
- Funding sources
- Traffic study - complete
- Alternatives analysis – in progress
- Geotechnical investigation – mostly complete
- Archaeological investigation – underway
- Select build option - end of December 2012

- Cost estimate and funding plan - December 2012
- Final design, permits and ROW – 2013
- Construction 2014.

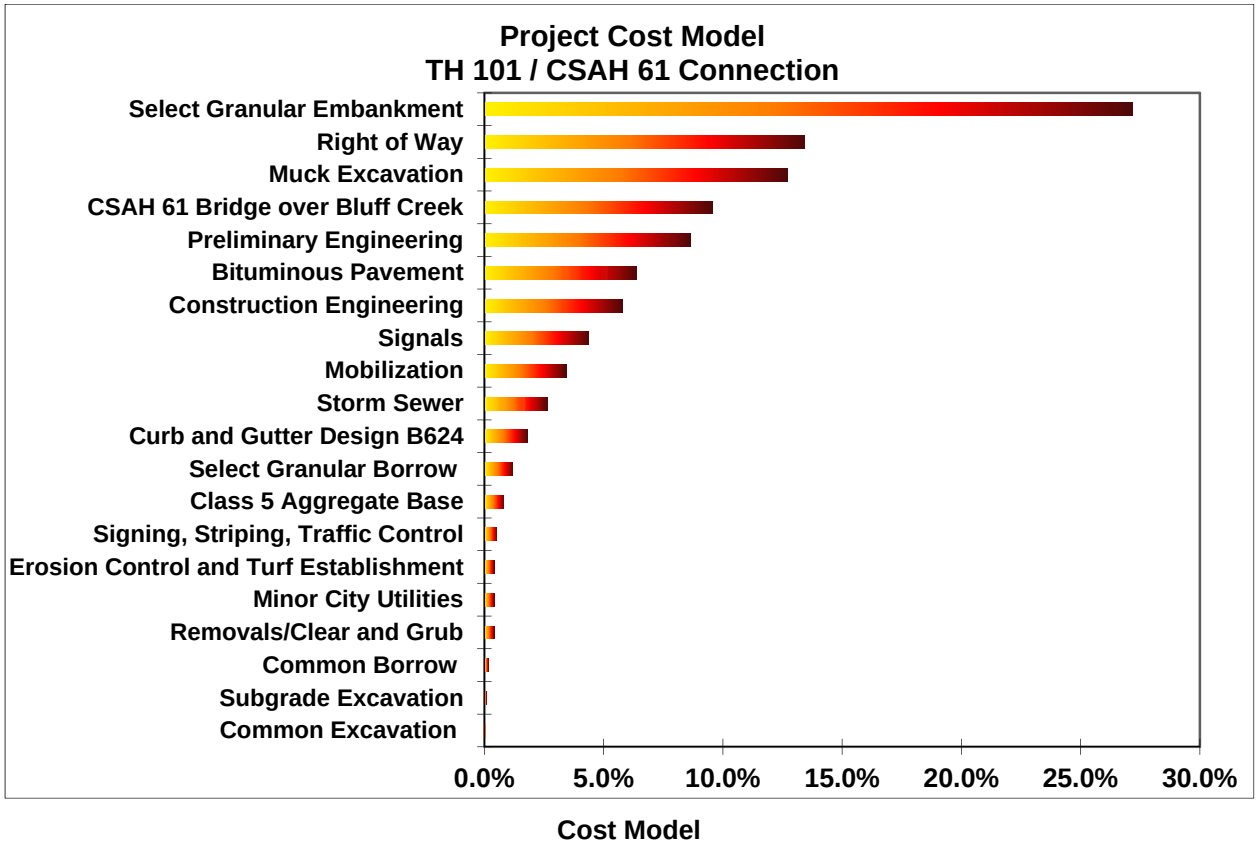
Constraints and Controlling Decisions

The Project Team presented the following constraints and controlling decisions during the Information Phase of the workshop to the CRAVE™ Team.

- Construct improvements on CSAH 61 (Flying Cloud Dr.) in the "Y" area to accommodate the new TH 101 river crossing and future traffic growth.
- Construct CSAH 61 to accommodate future improvements to TH 101 north of CSAH 61 up the bluff.
- Build long term, as opposed to temporary improvements on CSAH 61 if possible while the river crossing is being constructed.
- Implement the Carver County and City of Chanhassen Transportation Plan for TH 101 & CSAH 61.

Cost Model

The CRAVE™ Team Leader prepared a cost model for each project from the cost estimates provide by the Project Team of the baseline. The model is organized by the following major project elements:



Performance Attributes

Performance attributes are integral part of the value engineering process. The performance of each project must be properly defined and agreed upon by the Project Team, CRAVE™ Team and stakeholders at the beginning of the workshop. These attributes represent those aspects of a project's scope and schedule that possess a range of potential values.

The CRAVE™ Team, along with the Project Team, identified and defined the performance attributes for this project and then defined the baseline concept as it pertains to these attributes. The following performance attributes were used throughout the workshop to identify, evaluate, and document ideas and recommendations.

Evaluation of Baseline Project		
Standard Performance Attribute	**Description of Attribute**	**Baseline Design**
Mainline Operations	An assessment of traffic operations and safety on TH 101. Operational considerations include level of service relative to the 20-year traffic projections as well as geometric considerations such as design speed, sight distance, lane and shoulder widths.	4 - 12' lanes 4' inside & outside shoulders Minimum edge of pavement elevation of 722.7 (2' above 100 year event) Design Speed 45 MPH
Local Operations	An assessment of traffic operations and safety on the local roadway infrastructure. Operational considerations include level of service relative to the 20 year traffic projections; geometric considerations such as design speed, sight distance, lane and shoulder widths; bicycle and pedestrian operations and access.	4 - 12' lanes & 8' outside shoulders 6' - 12' raised median 10' trail with a 6' separation on both sides of roadway left turn & right turn channelization at all intersections Design Speed 45 MPH 9' grade raise at intersection of TH 101 north leg 3:1 slopes
Maintainability	An assessment of the long-term maintainability of the transportation facility(s). Maintenance considerations include the overall durability, longevity and maintainability of pavements, structures and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel.	Bituminous pavement 3 signalized intersections Bridge over Bluff Creek on CSAH 61 (replaces box culvert)
Construction Impacts	An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours and delays; impacts to businesses and residents relative to access, visual, noise, vibration, dust and construction traffic; environmental impacts.	Full closure of CSAH 61 with local access provided Use 2:1 slopes to excavate muck Utility impacts

Evaluation of Baseline Project		
Standard Performance Attribute	**Description of Attribute**	**Baseline Design**
Environmental Impacts	An assessment of the permanent impacts to the environment including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts (i.e., environmental justice, business, residents); impacts to cultural, recreational and historic resources.	Right of way impacts Cultural resource impacts Hazardous waste (risk) Possible wetland impacts
Project Schedule	An assessment of the total project delivery from the time as measured from the time of the CRAVE™ Workshop to completion of construction.	July 2014 begin construction 12 months for construction

Performance Attribute Matrix

A matrix was used to determine the relative importance of the individual performance attributes for the project. The Project and CRAVE™ Team evaluated the relative importance of the performance attributes that would be used to evaluate the creative ideas.

These attributes were compared in pairs, asking the question: "Which one is more important to the purpose and need of the project?" The letter code (e.g., "A") was entered into the matrix for each pair. After all pairs were discussed they were tallied (after normalizing the scores by adding a point to each attribute) and the percentages calculated.

PERFORMANCE ATTRIBUTE MATRIX

TH 101 / CSAH 61 Connection

Which attribute is more important to the projects purpose and need?

								TOTAL	%
Mainline Operations	**A**	A	A	A	A	A		6.0	29%
Local Operations		**B**	B	B	B	B		5.0	24%
Maintainability			**C**	C/D	C	C		3.5	17%
Construction Impacts				**D**	E	F		1.5	7%
Environmental Impacts					**E**	E		3.0	14%
Project Schedule						**F**		2.0	9%
								21.0	100%

A	More Important
A/B	Equally Important

Performance Attribute Matrix

Functional Analysis

Functional analysis results in a unique view of the project. It transforms project elements into functions, which moves the CRAVE™ Team mentally away from the original design and takes it toward a functional concept of the project.

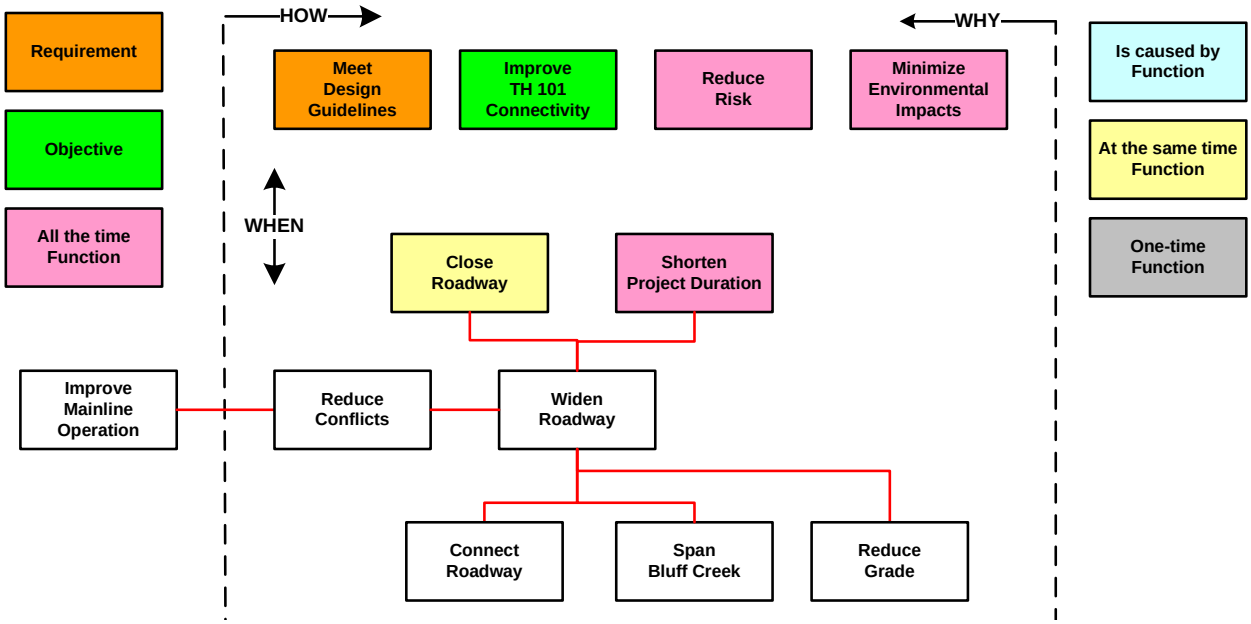
Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level. Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions.

Span Bluff Creek	Improve Mainline Operations	Widen Roadway
Close Roadway	Reduce Conflicts	Connect Roadway

FAST Diagram

The FAST diagram arranges the functions in logical order so that when read from left to right; the functions answer the question "How?" If the diagram is read from right to left, the functions answer the question "Why?" Functions connected with a vertical line are those that happen at the same time as, or are caused by, the function at the top of the column.

The FAST Diagram for this project shows ***Reduce Conflicts*** as the basic function of this project. Key secondary functions included ***Widen Roadways*** and ***Reduce Grade***. This provided the CRAVE™ Team with an understanding of the project design rationale and which functions offer the best opportunity for cost or performance improvement.



FAST Diagram

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Speculation

During the speculation or creative phase of the workshop, the CRAVE™ Team as a group, generated ideas on how to perform the various functions. The ideas were generated based the available information given at the time of the study, taking into consideration the constraints and controlling decisions that were given to them.

The ideas are grouped by function and/or major project element.

Creative Idea List

Widen Roadway

- Construct a Roundabout alternative
- Construct the East Leg T alternative
- Construct a folded diamond interchange
- Partial acquisition for only the needed right-of-way
- Land bridge instead muck removal only CSAH 61
- Keep CSAH 61 on existing horizontal alignment
- Slab on grade
- Half separated T (flyover)
- Use pile supported embankment
- Use lightweight file or geogrid
- Do a load test
- Construct one-way wye (modified)
- Do nothing until needed
- 11’ lanes
- 4’ shoulders
- Add guardrail to 3:1 slopes
- Flatten slopes to 4:1
- Break slope to reduce impacts
- Reduce bridge length over Bluff Creek on TH 101
- Use con span to span Bluff Creek (either)
- Eliminate the median
- Remove 6’ trail separation from roadway
- Construct roundabout at TH 101 north and eliminate east leg of wye (eliminate all signals)
- Eliminate signal at bluff creek drive
- Construct 8’ trail
- Eliminate north trail

Reduce Grade (TH 101 North)

- Keep CSAH 61 on existing profile grade
- Construct left turn modifications and defer ultimate until needed
- Staged roundabout interchange
  - Stage 1 – keeps CSAH 61 on current alignment and use roundabouts and one-way wye
  - Stage 2 – grade separate CSAH 61 and TH 101 (over) still using roundabouts
- Conduct corridor study for the north leg of TH 101

Evaluation

All of the ideas generated during the creative phase using brainstorming techniques were recorded on the following evaluation pages.

Performance Criteria

The CRAVE™ Team used the paired comparison method to prioritize the key performance criteria for this project:

- Mainline Operations
- Local Operation
- Maintainability
- Construction Impacts
- Environmental Impacts
- Project Schedule

The team enlisted the assistance of the project team and designers (when available) to develop these criteria so that the evaluation would reflect their specific requirements. Refer to the ***Project Analysis – Performance Attribute Matrix*** section of the report for further details.

Deposition of Ideas

The CRAVE™ Team as a group, generated and evaluated ideas on how to perform the various functions. The idea list was grouped by function or major project element. While ideas on the overall project were evaluated as a group, ideas relating to a specific technical discipline may have been evaluated by the team member(s) representing that discipline.

The team compared each of the ideas with the baseline concept for each of the performance criteria to determine whether it was better than, equal to, or worse than the original concept. The team reached a consensus on the rating of the idea. After the advantages and disadvantages were determined for an idea, the CRAVE™ Team reached a consensus on the overall rating of the idea (0 through 5). High-rated ideas would be developed further; low-rated ones would be dropped from further consideration. The rating values are shown below:

5 = Significant Value Improvement
4 = Good Value Improvement
3 = Equivalent or Similar to Baseline
2 = Minor Value Degradation
1 = Significant Value Degradation
0 = Fatally Flawed or doesn't meet the Purpose & Need of the Project

Based on the available information, along with the constraints and controlling decisions that were given to the CRAVE™ Team, many ideas were not advanced to recommendations or design considerations after the initial evaluations were analyzed and discussed by the team. These ideas were either fatally flawed or the baseline concept or other ideas proved to be a higher value improvement.

Widen Roadway

#	Description	Advantages	Disadvantages
1	Construct the Roundabout alternative	▪ Municipal consent ▪ Removes signals ▪ Best traffic operations in 2034 ▪ Reduce conflicts ▪ Less ROW impacts ▪ Provides more opportunity for future improvements	▪ May require realignment or retaining walls adjacent to Bluff Creek

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍	👍	👍👎		👎	

Cost: 👍	*Justification/Comments: Moved to further development*
Rating: 4	

#	Description	Advantages	Disadvantages
2	Construct the East Leg T alternative	▪ Slight improvements to traffic operations ▪ Better TH 101 connectivity ▪ Only one crossing of Bluff Creek	▪ Removes access to golf course ▪ Total acquisition of golf course ▪ Realignment of Bluff Creek needed ▪ Environmental Documentation needed

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍	👎	👍		👎	👎

Cost: 👎	*Justification/Comments: Moved to further development*
Rating: 3.5	

#	Description	Advantages	Disadvantages
3	Construct a folded diamond interchange	▪ Better for future needs ▪ Improved traffic operations on CSAH 61	▪ More costly ▪ Doesn't connect to TH 101 north at this time ▪ Would require multiple crossings of Bluff Creek (4)

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍	👍			👎	

Cost: 👎	*Justification/Comments: Moved to further development*
Rating: 4	

#	Description	Advantages	Disadvantages
4	Partial acquisition for only the needed right of way	▪ Reduces cost ▪ Reduces impact to property owners	

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
				👍	

Cost:	*Justification/Comments: Moved to further development*
Rating: 5	

#	Description	Advantages	Disadvantages
5	Use land bridge instead muck removal along the new CSAH 61 alignment	▪ Reduce ROW impacts ▪ Construction Impacts ▪ Removes risk of hazardous material and muck removal	▪ Intersections may be on structure

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👍	👍	

Cost: 👎	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
6	Keep CSAH 61 on existing horizontal alignment	▪ Minimizes roadway foundation issues ▪ Reduces risk of cultural resources ▪ Reduces wetland impacts ▪ Reduces muck removal/may require some stabilization	▪ May reduce sight distance

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
			👍	👍	

Cost:	*Justification/Comments: Combine with other recommendations as needed*
Rating: 4	

#	Description	Advantages	Disadvantages
7	Slab on grade to support embankment	▪ Does not remove muck ▪ Reduces risk of hazardous materials ▪ Reduces risk of cultural resources	▪ Increased cost ▪ Unknown maintenance impacts

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎	👍	👍	

Cost: 👎	*Justification/Comments: Dropped from further consideration*
Rating: 2.5	

#	Description	Advantages	Disadvantages
8	Half separated T (flyover)	▪ Free flow both directions on CSAH 61	▪ Increase cost ▪ Adds one bridge ▪ May require moving TH 101 north intersection further to the west ▪ Golf course would lose access ▪ No compatibility with future

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍	👍	👎		👎	

Cost: 👎	*Justification/Comments: Not possible under the current constraints of the project*
Rating: 1	

#	Description	Advantages	Disadvantages
9	Use pile supported embankment		

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Not enough current geotechnical information - Combine with other ideas as needed*
Rating:	

#	Description	Advantages	Disadvantages
10	Use lightweight file or Geogrid		

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Not enough current geotechnical information - Combine with other ideas as needed*
Rating:	

#	Description	Advantages	Disadvantages
11	Do a load pile test		

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Design Consideration*
Rating:	

#	Description	Advantages	Disadvantages
12	Construct one-way wye (modified)	▪ Uses existing pavements ▪ Reduced cost ▪ Does not remove muck ▪ Reduces risk of hazardous materials ▪ Reduces risk of cultural resources ▪ CSAH 61could remain open	▪ Slight decrease in LOS ▪ No increase to grade on CSAH 61 ▪ Municipal consent

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👎			👍	👍	

Cost: 👍	*Justification/Comments: Dropped from further consideration*
Rating: 1	

#	Description	Advantages	Disadvantages
13	Do nothing until needed		

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Doesn't meet the purpose and need of the project*
Rating: 0	

#	Description	Advantages	Disadvantages
14	Use 11' lanes on CSAH 61	▪ Cost ▪ May reduce ROW ▪ May reduce cultural resource impacts ▪ Reduces muck excavation	▪ Reduces operations ▪ Route compatibility

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍		👍	

Cost: 👍	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
15	Use 4' shoulders on CSAH 61	▪ Cost ▪ May reduce ROW ▪ May reduce cultural resource impacts ▪ Reduces muck excavation	▪ Requires design variance ▪ Eliminates emergency parking

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍👎		👍	

Cost: 👍	*Justification/Comments: Moved to further development*
Rating: 4	

#	Description	Advantages	Disadvantages
16	Add guardrail to 3:1 slopes		

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Design Standard/Clear Zone requirements issue*
Rating:	

#	Description	Advantages	Disadvantages
17	Flatten slopes to 4:1		

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Design Standard/Clear Zone requirements issue*
Rating:	

#	Description	Advantages	Disadvantages
18	Break slope to reduce impacts	▪ Less material ▪ Reduces ROW impact	

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👎		👍	

Cost: 👍	*Justification/Comments: Moved to further development*
Rating: 5	

#	Description	Advantages	Disadvantages
19	Reduce bridge length over Bluff Creek on TH 101	▪ Save costs ▪ Less maintenance ▪ Less environmental impacts	

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
		👍		👍	

Cost: 👍	*Justification/Comments: Moved to further development, reduce bridge length to minimum needed to span high water*
Rating: 5	

#	Description	Advantages	Disadvantages
20	Use con span or larger box culvert to span Bluff Creek	▪ Reduce cost ▪ Easier to construct	▪ None noted

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
			👍	👍	

Cost: 👍	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
21	Eliminate the median on CSAH 61	▪ Reduces square feet of pavement/ smaller foot print/ less ROW impact ▪ Improve snow removal operations	▪ Removes channelization ▪ Does not meet County standards for minor arterial roadway

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍		👍	

Cost: 👍	*Justification/Comments: Dropped from further consideration*
Rating: 2	

#	Description	Advantages	Disadvantages
22	Reduce 6' trail separation to 2'	▪ Reduces project footprint ▪ Reduces cost	▪ Brings trail closer to roadway

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎				

Cost: 👍	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
23	Construct roundabout at TH 101 north and eliminate east leg of wye (eliminate all signals)	▪ Eliminates one crossing of Bluff Creek on TH 101 ▪ Municipal consent ▪ Removes signals ▪ Best traffic operations in 2034 ▪ Reduce conflicts ▪ Provides more opportunity for future improvements	▪ Increased ROW impacts ▪ Adds additional conflict with Bluff Creek on CSAH 61 ▪ May require realignment or retaining walls adjacent to Bluff Creek

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍	👍	👍		👎	

Cost: 👎	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
24	Eliminate signal at Bluff Creek Drive	▪ Reduces cost	▪ Potential increase in delay for SB Bluff Creek traffic ▪ Does not accommodate future need

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍			

Cost: 👍	*Justification/Comments: Design Consideration - Potential to just install underground conduits, etc. for future need*
Rating: 3	

#	Description	Advantages	Disadvantages
25	Construct 8' trails	▪ Reduces costs/footprint/ROW	▪ Increases conflicts with user

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎			👍	

Cost: 👍	*Justification/Comments: Moved to further development*
Rating: 4	

#	Description	Advantages	Disadvantages
26	Eliminate north trail	▪ Reduces cost/footprint	▪ Does not connect with adjacent project

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎	👍		👍	

Cost: 👍	*Justification/Comments: Dropped from further consideration*
Rating: 2	

Raise Profile

#	Description	Advantages	Disadvantages
27	Keep CSAH 61 on existing profile grade	▪ Reduces excavation ▪ Reduces ROW impacts	▪ Municipal consent

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
				👍	

Cost: 👍	*Justification/Comments: Dropped from further consideration*
Rating: 2	

#	Description	Advantages	Disadvantages
28	Construct left turn modifications and defer ultimate until needed	▪ Possible way to stage project until full funding available	▪ Traffic operations only work until 2024, do not work in design year 2034 ▪ Municipal consent ▪ Bluff Creek bridge my be throw away if not constructed at future elevation needed

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
	👎				

Cost: 👍	*Justification/Comments: Dropped from further consideration*
Rating: 2	

#	Description	Advantages	Disadvantages
29	Staged roundabouts interchange: Stage 1 – keeps CSAH 61 on current alignment and use roundabouts and one-way wye Stage 2 – grade separate CSAH 61 and TH 101 (over) still using roundabouts	▪ Better for future needs ▪ Uses existing CSAH 61 alignment ▪ Maintains vertical alignment of CSAH 61 ▪ TH 101 goes over in future to improve grades up the hill ▪ Reduce conflicts	▪ May require multiple crossings or realignment of Bluff Creek ▪ Environmental documentation ▪ Municipal consent

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
👍		👎👍		👎	👎

Cost: 👎	*Justification/Comments: Design Consideration*
Rating: 3	

#	Description	Advantages	Disadvantages
30	Conduct corridor study for the north leg of TH 101	▪ Determines alignment and CSAH 61 geometry needs	▪ Timely completion restricts coordination with MnDOT TH101 Floodway Project

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule
					👎

Cost: 👎	*Justification/Comments: Design Consideration*
Rating: 3	

Recommendations

Introduction

The results of this workshop are presented as individual recommendations to the baseline project. Each VE recommendation in this section is presented as written by the team during the CRAVE™ Workshop. While they have been edited from the draft CRAVE™ Report to correct errors or better clarify the recommendation, they represent the CRAVE™ Team's findings during the workshop.

The VE Team generated 30 different ideas for this project. These ideas or concepts were then compared against the baseline that was developed by the project team. The concepts that performed the best were further developed by the CRAVE™ Team. Those that showed a value improvement over the baseline became a VE Recommendation.

Summary of VE Recommendations

Each recommendation consists of a summary of the original concept, a description of the suggested change, a listing of its advantages and disadvantages, a cost comparison, change in performance*, and a brief narrative comparing the original design with the recommendation. Sketches, calculations, and performance measure ratings are also presented. The cost comparisons reflect a comparable level of detail as in the original estimate.

* Please refer to the Project Analysis section of this report for an explanation of how the performance measures are calculated.

Summary of Recommendations

TH 101 / CSAH 61 Connection

#	Description	Cost Avoidance	Performance Improvement
1	Reduce ROW Acquisition	$1.74 M	6%
2	CSAH 61 - Roadway Section	$1.34 M	1%
3	CSAH 61 - Bluff Creek Bridge	$0.94 M	3%
4	TH 101 / CSAH 61 Connection	$1.50 M	42%
	Total	**$5.52 M**	

The cost comparisons reflect a comparable level of detail as in the original estimate. The values shown above and on the recommendation pages are for illustration purposes only. As the project progresses, these values can be updated to reflect actual implemented results. The values shown are adjustments to base construction costs only. These values shown have been adjusted by 28.5% to reflect the additional cumulative costs of:

- Miscellaneous Item Allowance (2%)
- Mobilization (5%)
- Preliminary Engineering (12%)
- Construction Engineering (8%)

Performance Assessment

As the CRAVE™ Team developed recommendations; the performance of each was rated against the baseline concept. Changes in performance are always based upon the overall impact to the total project. Once performance and cost data were been developed by the CRAVE™ Team, the net change in value of the VE recommendations can be compared to the baseline concept.

In order to compare and contrast the potential for value improvement, individual recommendations are then compared to the baseline project for all attributes. For this exercise the baseline was given a score of 5. The resulting value improvement scores allow a way for MnDOT to assess the potential impact of the VE recommendations on total project value.

VALUE MATRIX													
TH 101 / CSAH 61 Wye													
Attribute	**Attribute Weight**	**Concept**	**Performance Rating**										**Total Performance**
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Mainline Operations	29	Baseline					**5**						**145**
		1					**5**						**145**
		2					**5**						**145**
		3					**5**						**145**
		4									**9**		**261**
Local Operations	24	Baseline					**5**						**120**
		1					**5**						**120**
		2				**4**							**96**
		3					**5**						**120**
		4									**9**		**216**
Maintainability	17	Baseline					**5**						**85**
		1					**5**						**85**
		2					**5**						**85**
		3						**6**					**102**
		4					**5**						**85**
Construction Impacts	7	Baseline					**5**						**35**
		1					**5**						**35**
		2					**5**						**35**
		3					**5**						**35**
		4					**5**						**35**
Environmental Impacts	14	Baseline					**5**						**70**
		1							**7**				**98**
		2							**7**				**98**
		3					**5**						**70**
		4					**5**						**70**
Project Schedule	9	Baseline					**5**						**45**
		1					**5**						**45**
		2					**5**						**45**
		3					**5**						**45**
		4					**5**						**45**

Value Matrix

Understanding the relationship of cost, performance, and value of the project baseline and VE concepts is essential in evaluating VE recommendations. Comparing the performance and cost suggests which recommendations are potentially as good as or better than, the project baseline concept in terms of overall value.

OVERALL PERFORMANCE		Performance (P)	% Change Performance	Cost (C)	% Change Cost	Value Index (P/C)	% Value Improvement
	Baseline	**500**		$17.12		29.21	
1	Right of Way	**528**	6%	$15.38	10%	34.33	18%
2	CSAH 61 Roadway Section	**504**	1%	$16.08	6%	31.34	7%
3	CSAH 61 Bluff Creek Bridge	**517**	3%	$16.18	5%	31.95	9%
4	CSAH 61 Alignment	**712**	42%	$15.62	9%	45.58	56%

Performance Comparison of Recommendations

VE Recommendation Approval

The Project Manager shall review and evaluate the CRAVE™ Team's recommendation(s) that are included in the Final Report. The Project Manager shall complete the VE Recommendation Approval form that is included in this report.

For each recommendation that is not approved or is modified by the Project Manager, justification needs to be provided. This justification shall include a summary statement containing the Project Manager's decision not to use the recommendation in the project.

The completed VE Recommendation Approval form including justification for any recommendations not approved or modified shall be sent to the State Value Engineer by October 1 of each year so the results can be included in the annual Value Engineering Report to the Federal Highway Administration (FHWA).

Design Considerations

The CRAVE™ Team generated several ideas for consideration by the Project Team. These items represent ideas that are relatively general in nature, and are listed below. Please refer to the Idea Evaluation Forms for more detail.

- Use land bridge instead muck removal along the new CSAH 61 alignment
- Use 11' lanes on CSAH 61
- Use con span or larger box culvert to span Bluff Creek
- Reduce 6' trail separation to 2'
- Construct roundabout at TH 101 north and eliminate east leg of wye (eliminate all signals)
- Eliminate signal at Bluff Creek Drive

- Staged roundabouts interchange:
  - Stage 1 – keeps CSAH 61 on current alignment and use roundabouts and one-way wye
  - Stage 2 – grade separate CSAH 61 and TH 101 (over) still using roundabouts
- Conduct corridor study for the north leg of TH 101.

Muck Alternatives

Alternatives to consider other than full depth excavation or pile supported embankment in areas of muck are:

- Geogrids work well with 5' of fill or less…if more than 5' of fill, consider using light weight fill such as shredded tires or wood chips.
- Fill heights greater than 5': Consider removing only the pavement and gravel….place a fabric and light weight fill on top, up to an elevation which is 4' from the proposed centerline elevation, upon which Select Granular may be used.
- Surcharges (depending on your time restraints).

Example projects:

- Shoulders by Lake Pepin (SE Minnesota)
  - Placed approximately 5' of fill
  - 1 summer worth of time required for surcharge
  - Placed surcharge in lifts
- TH 64 (?) Kabekona corner in Beltrami county (South of Bemidji, MN)
  - Built in 1990 or 1991
  - New alignment over 35' of muck/peat
  - Used fabric with loaded surcharge
    - Approximately 7' of fill
    - The material started sinking…most likely due to construction methods
      - Lessons learned: To prevent the loss of material…would recommend slower placement of surcharge or light weight fill material
    - Settlement is not an issue today
- County Road 11 near Pine City
  - Fill height 8'-10' over swamp
  - Staged surcharge
  - Settlement is not an issue today.

VE RECOMMENDATION NO. 1
Reduce Right-of-Way Acquisition

Function: Widen Roadway	**IDEA NO(s).** 4

Baseline:

The baseline estimate assumes total parcel acquisitions.

Recommendation:

Only purchase the minimum amount of right of way needed.

Advantages:

- Reduces project cost
- Reduces relocation costs
- Reduces impacts to property owners

Disadvantages

- None noted

COST SUMMARY	ESTIMATE
Baseline	$2.30 M
Recommendation	$0.56 M
Cost Avoidance	$1.74 M

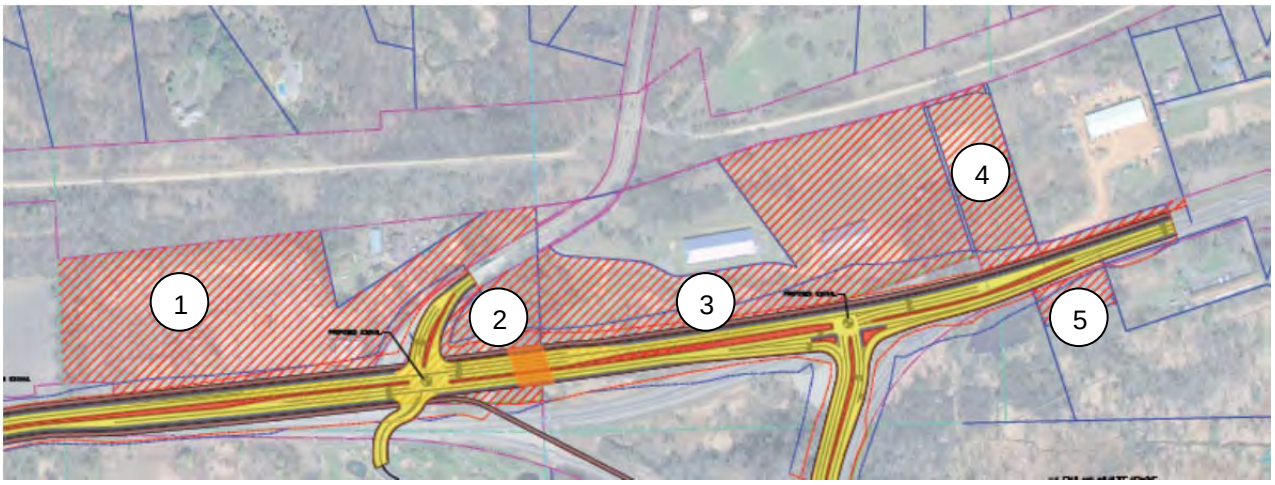
FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
		👍		

VE RECOMMENDATION NO. 1
Reduce Right-of-Way Acquisition

Discussion/Justification/Sketches/Photos:

The baseline estimate assumes the total acquisition of parcels. This recommendation is to only purchase the amount of right of way needed to construct the new roadway.



Baseline Right of Way needs

Affected Parcels

1) Parcel 019-250351700 – Agricultural – 9.81 acres $300,400
2) Parcel 019-250351300 – Commercial – 2.14 acres $213,300
3) Parcel 019-256010020 – Commercial – 9.99 acres $332,200
4) Parcel 019-250361300 – Commercial – 1.99 acres $145,900
5) Parcel 019-250363700 – Commercial – 0.53 acres $89,700

The assessed property values for these parcel total to $1.08 M. The baseline estimate assumes $2.3 M for right-of-way.

Design/Estimate Assumptions:

Based on parcel 019-250361300 which has no structures the cost per acre of commercial property is $73,317/acre use $75,000/acre

Parcel 019-250351700 is the only agricultural property $30,621/acre use $35,000/acre

The amount of right of way needed from each parcel is:

Parcel 019-250351700 (40+140) / 2 x 710 = 63,900 SF or 1.47 acres $51,450

Parcel 019-250351300 (180+210) / 2 x 270 = 52,650 SF

(150+0) / 2 x 350 = 26,250 SF

78,900 SF or 1.81 acres $135,750

Parcel 019-256010020 (150+0) / 2 x 1,300 = 97,500 SF or 2.24 acres $168,000

Parcel 019-250361300 (80+40) / 2 x 170 = 10,200 SF or 0.23 acres $17,250

Parcel 019-250363700 (50 + 20 / 2 x 210 = 73,500 SF or 0.17 acres $12,750

Total value of ROW acreage needed is $385,200

Parcel 019-250351700 has 1 structure that would need to be relocated or purchased. Unknown what the structure is used for. Assume $100,000.

Parcel 019-250351300 has 3 “cabins” that would need to be relocated or purchased. Assume $25,000 for each for a total of $75,000

Total value of ROW acreage needed is $175,000

Total ROW needed = $560,200

VE RECOMMENDATION NO. 1
Reduce Right-of-Way Acquisition

PERFORMANCE MEASURES Criteria and Rating Rationale for Recommendation	Performance	Base	Recommendation
Mainline Operations No change to baseline	Rating	5	5
	Weight	29	
	Contribution	145	145
Local Operations No change to baseline	Rating	5	5
	Weight	24	
	Contribution	120	120
Maintainability No change to baseline	Rating	5	5
	Weight	17	
	Contribution	85	85
Construction Impacts No change to baseline	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts Reduce the amount of impacts to the property owners	Rating	5	7
	Weight	14	
	Contribution	70	98
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
Total Performance:		**500**	**528**
Net Change in Performance:			**6%**

VE RECOMMENDATION NO. 2
CSAH 61 – Roadway Section

Function: Widen Roadway	**IDEA NO(s).** 15, 18, 25

Baseline:

The typical section for mainline CSAH 61 consists of a 4-lane divided section with 12' through lanes and an outside shoulder width of 8'.

Recommendation:

The typical section for this recommendation modifies the original concept by reducing the outside shoulder width to 4' as well as reducing the width of the multi-use path to 8'.

The inslope is modified to a 1:4 slope to the edge of the clear zone and breaks to a 1:2 slope to existing ground.

Advantages:

- Reduces ROW
- May reduce cultural resource impacts
- Reduces muck excavation
- Less impervious surface
- Reduces the amount of fill material
- Reduce cost

Disadvantages

- May require a design variance
- Eliminates emergency parking
- Less snow storage

COST SUMMARY	ESTIMATE
Baseline	N/A
Recommendation	N/A (calculated as a reduction in quantity)
Cost Avoidance	$1.04 M x 28.5% markup = $1.34 M

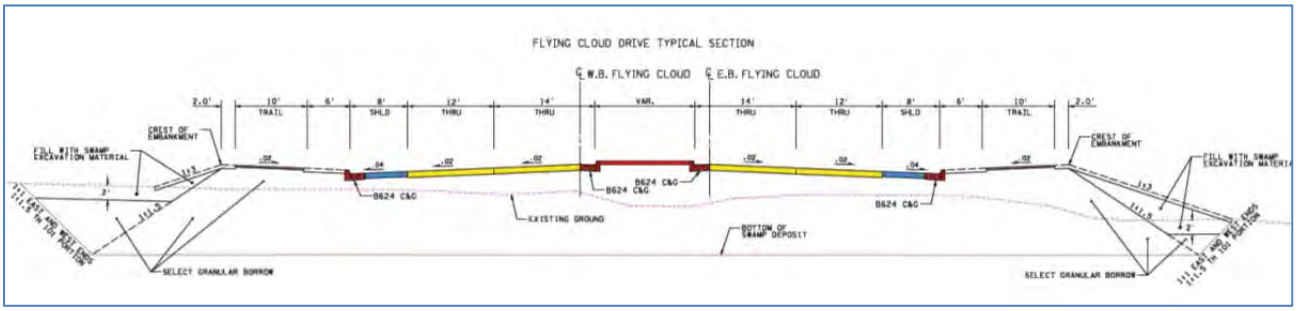
FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
	👎	👍		

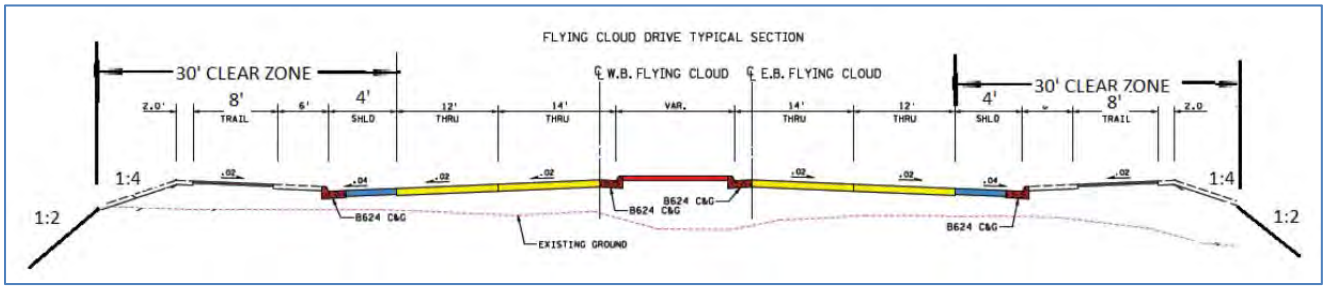
Discussion/Justification/Sketches/Photos:

The typical section for mainline CSAH 61 consists of a 4-lane divided section with 12' through lanes and an outside shoulder width of 8'. The inside lanes utilize a 2' reaction to a variable width raised median.

A 10' paved multi-use trail is proposed on both the north and south sides of CSAH 61, which consists of a 6' buffer or boulevard between the trail and the back of the curb. The proposed inslope consists of a 1:3 slope to the existing ground.



Baseline CSAH 61 Typical Section



VE Recommended CSAH 61 Typical Section

The reduction in widths of the shoulder (8' to 4') and trail (10' to 8') are recommended to help reduce the right-of-way acquisition needed, as well as reducing the amount of muck excavation and embankment

The 1:3 inslope on the baseline may not meet the State Aid standard. Based on this assumption, the slope was adjusted to a 1:4 inslope to the edge of the clear zone, with a break slope of 1:2 to tie in to the existing ground.

The width of the CSAH 61 bridge over Bluff Creek was adjusted to meet the typical section in this recommendation.

8820.9920 MINIMUM DESIGN STANDARDS; RURAL AND SUBURBAN UNDIVIDED; NEW OR RECONSTRUCTION PROJECTS.

New or reconstruction projects for rural and suburban undivided roadways must meet or exceed the minimum dimensions indicated in the following design chart.

Projected ADT (a)	Lane Width	Shoulder Width	In-slope (b)	Clear Zone (c)	Design Speed (d)	Sur-facing	Structural Design Strength	Bridges to Remain (e) Width Curb to Curb
	feet	feet	rise: run	feet	mph		tons	feet
0-49	11	1	1:3	7	30-60	Agg.		22
50-149	11	3	1:4	9	40-60	Agg.		22
150-299	12	4	1:4	15	40-60	Agg./ Paved	7-ton/ 10-ton Staged (g)	28
300-749	12	4	1:4	15	40-60	Paved	10-ton Staged (g)	28
750-1499	12	4	1:4	25	40-60	Paved	10-ton Staged (g)	28
1500 and over	12	6(f)	1:4	30	40-60	Paved	10	30

Engineering judgment may be used to choose a lane-width or shoulder-width dimension other than the widths indicated in the chart for roadways. Factors to consider may be safety, speed, population/land use, benefit/cost analysis, traffic mix, peak hourly traffic, farm equipment, environmental impacts, terrain limitations, bicycle traffic, pedestrian traffic, other nonmotorized uses, functional classification, or other factors. Widths less than those indicated in the chart require a variance in accordance with parts 8820.3300 and 8820.3400.

For rural divided roadways, use the geometric design standards of the Mn/DOT Road Design Manual, with a minimum ten tons structural design and minimum 40 mph design speed.

(a) Use the existing traffic for highways not on the state-aid system.

(b) Applies to slope within the clear zone only.

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(c) Culverts with less than 30-inch vertical height allowed without protection in the clear zone.

Guardrail is required to be installed at all bridges where the design speed exceeds 40 mph, and either the existing ADT exceeds 400 or the bridge clear width is less than the sum of the lane and shoulder widths.

Mailbox supports must be in accordance with chapter 8818.

For roadways in suburban areas as defined in part 8820.0100, the clear zone may be reduced to a width of ten feet for projected ADT under 1,000 and to 20 feet for projected ADT of 1,000 or over. Wherever the legal posted speed limit is 40 mph or less, the clear zone may be reduced to a width of ten feet.

(d) Subject to terrain. In suburban areas, the minimum design speed may be equal to the current legal posted speed where the legal posted speed is 30 mph or greater.

(e) Inventory rating of H 15 is required. A bridge narrower than these widths may remain in place if the bridge is not deficient structurally or hydraulically.

(f) Shoulders are required to be a minimum width of eight feet for highways classified as minor arterials and principal arterials with greater than 1,500 ADT projected, at least two feet of which must be paved.

(g) Except within municipal corporate limits, ten-ton staged structural design must be able to carry ten-ton axle loads except during spring load-restriction periods, or year-round if needed for system continuity. Roadbed width must accommodate ultimate ten-ton pavement overlay thickness and ultimate 1:4 sideslope. Within municipal corporate limits, minimum structural design must support nine-ton axle strength.

Approach sideslopes must be 1:4 or flatter when the ADT exceeds 400.

HS 25 loading with AASHTO Standard Specifications or HL-93 loading with load and resistance factor design (LRFD) is required for new or reconstructed bridges. HS 18 loading is required for all rehabilitated bridges. The curb-to-curb minimum width for new or reconstructed bridges must be no less than either the minimum required lane plus shoulder widths or the proposed lane plus shoulder widths, whichever is greater, but in no case less than the minimum lane widths plus four feet, and in no case less than required per Minnesota Statutes, section 165.04.

For roundabout design, the design criteria of the current edition of the Minnesota State Aid Roundabout Guide are recommended.

Statutory Authority: *MS s 14.389; 162.02; 162.09*

History: *20 SR 1041; 23 SR 1455; 24 SR 1885; 29 SR 449; 32 SR 608; 36 SR 925*

Posted: *February 22, 2012*

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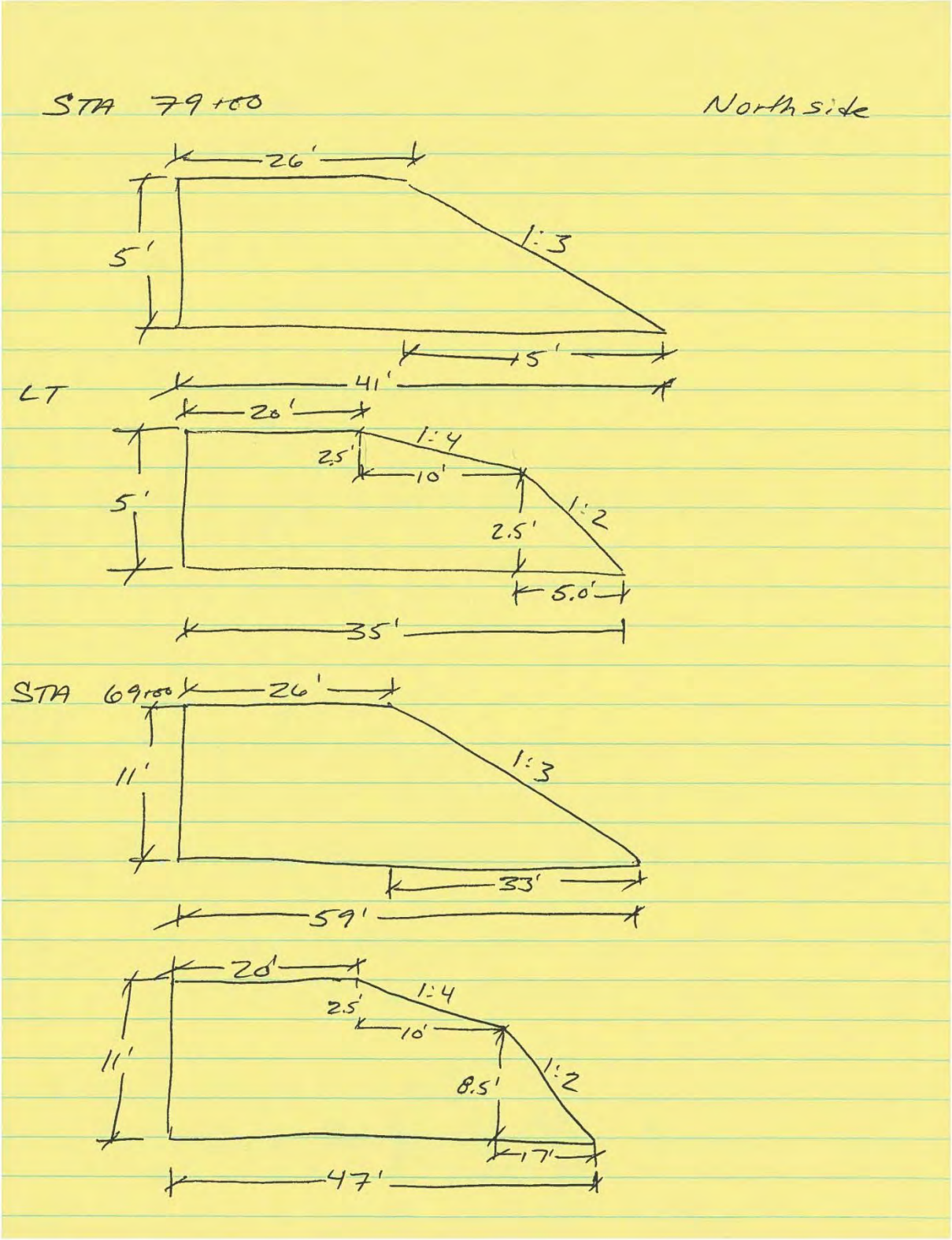
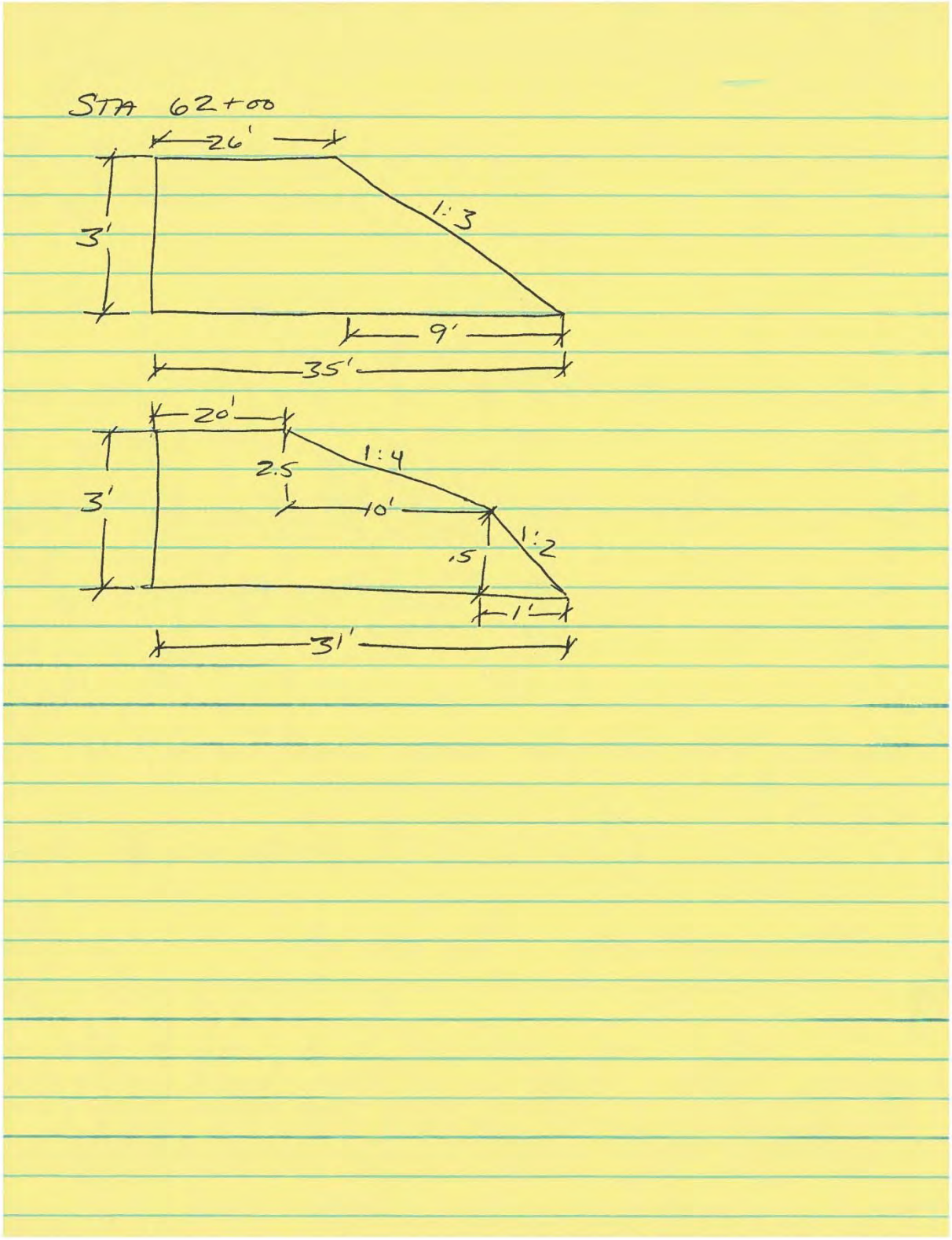
Design/Estimate Assumptions:

- Project length = 4000’
- Estimate includes work on CSAH 61 only, excludes TH101 south leg
- Original estimate was adjusted based on calculated quantities for this recommendation
- Assumed the clear zone distance to be 30’ from the edge of traveled lane
- The Average End Area method was used for the excavation and embankment quantities, based on an average width and height
- The CSAH 61 bridge over Bluff Creek width was adjusted based on the reduced typical section. (The length of the bridge was unchanged)
- The 4’ shoulder may require a design exception
- The 1:3 inslope does not meet standard
- 12 month complete closure during construction, except for local access to residents and businesses
- See quantity calculations on the following pages


STA 79+00
North side
26'
5'
1:3
5'
LT
41'
20'
1:4
2.5'
10'
5'
1:2
2.5'
5.0'
35'
STA 69+00
26'
11'
1:3
33'
59'
20'
1:4
2.5'
10'
11'
8.5'
1:2
17'
47'


STA 62+00
26'
1:3
3'
9'
35'
20'
1:4
2.5
3'
10'
1:2
.5
1'
31'

Northside

STA. 79+00 (1:3)

$(26' \times 5') = 130\ ft^2$
$(1/2)(15')(5') = 37.5\ ft^2$
$167.5\ ft^2$

STA. 69+00

$(11' \times 26') = 286\ ft^2$
$(1/2)(33' \times 11') = 181.5\ ft^2$
$467.5\ ft^2$

$(167.5\ ft^2 + 467.5\ ft^2)/2 = 317.5\ ft^2 (1000\ ft) = 317{,}500\ ft^3$

STA. 62+00

$(3' \times 26') = 78\ ft^2$
$(1/2)(9' \times 3') = 13.5\ ft^2$
$91.5\ ft^2$

$(467.5\ ft^2 + 91.5\ ft^2)/2 = 279.5\ ft^2 (700\ ft) = 195{,}650\ ft^3$

$317{,}500\ ft^3 + 195{,}650\ ft^3 = 513{,}150\ ft^3 / 27 = \boxed{19{,}006\ yd^3}$

Northside

STA 79+00 (1:4)

$(5' \times 20') + (1/2)(2.5')(10') + (2.5')(10') + (1/2)(2.5')(5') = 143.75 ft^2$

STA 69+00

$(11' \times 20') + (1/2)(2.5')(10') + (10')(8.5') + 1/2(8.5')(17') = 389.75 ft^2$

STA. 62+00

$(20' \times 3') + (1/2)(2.5')(10') + (10')(.5') + (1/2)(.5')(1') = 77.75 ft^2$

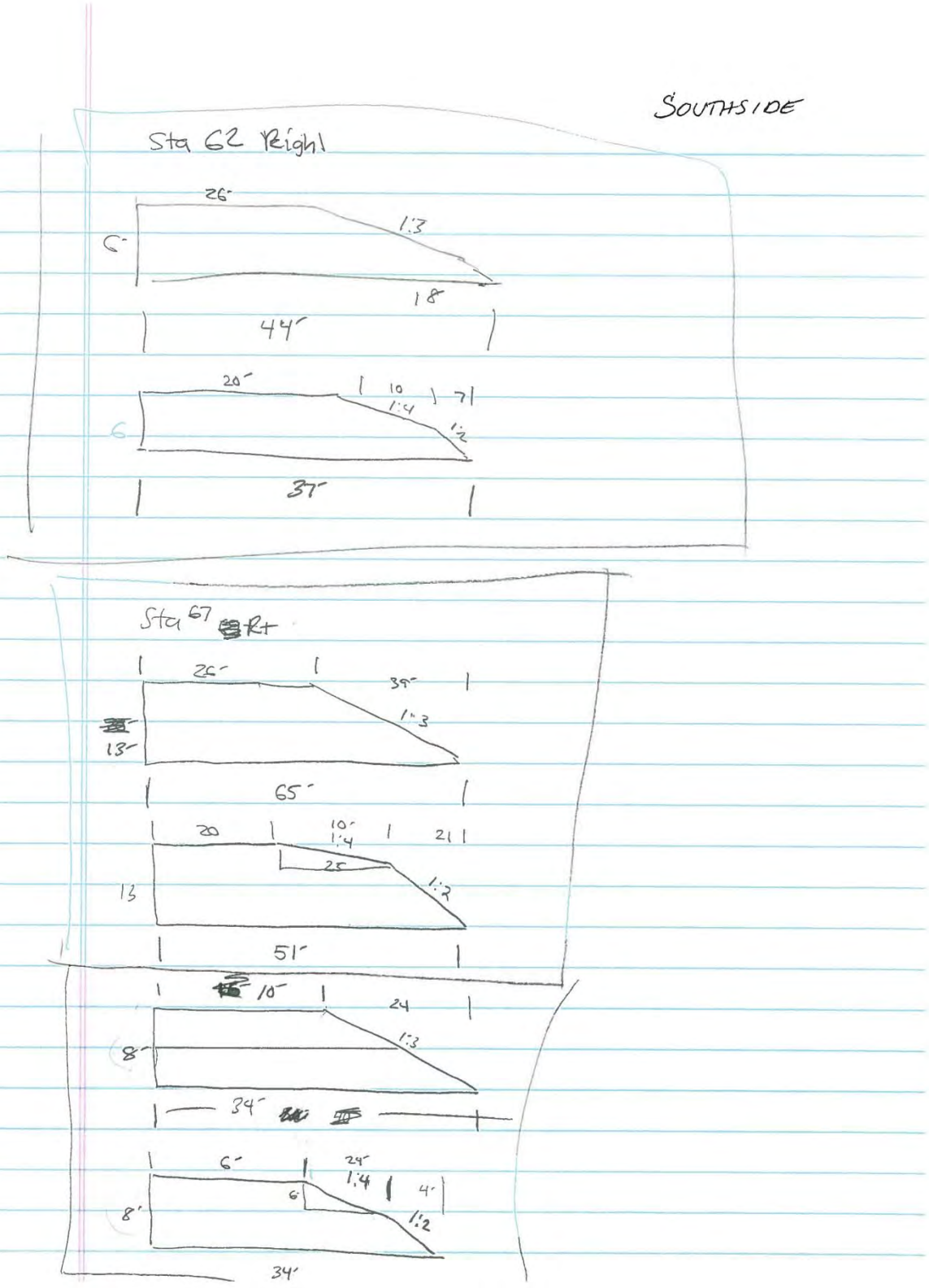
$((143.75 ft^2) + 389.75 ft^2)/2 = 266.75 ft^2 (1000 ft) = 266,750 ft^3$

$(389.75 ft^2 + 77.75 ft^2)/2 = 233.75 ft^2 (700 ft) = 163,625 ft^3$

$(266,750 ft^3 + 163,625 ft^3)/27 = \boxed{15,939.8 \ yd^3}$

Difference between 1:3 & 1:4 =

$19,006 yd^3 - 15,939.8 yd^3 = \boxed{3067 \ yd^3}$


SOUTHSIDE
Sta 62 Right
26'
1:3
6'
18
44'
20'
10
1:4
7
1:2
6
37'
Sta 67 Rt
26'
39'
1:3
13'
65'
20
10'
1:4
21
25
1:2
13
51'
10'
24
1:3
8'
34'
6'
24'
1:4
4'
6'
1:2
8'
34'

Southside

STA 62+00 (1:3)

$(26' \times 6') + (1/2)(6')(18') = 210\ ft^2$

STA 67+00

$(13' \times 26') + 1/2(13')(39') = 591.5\ ft^2$

STA 79+00

$(8' \times 10') + 1/2(24')(8') = 176\ ft^2$

$[(210\ ft^2 + 591.5\ ft^2)/2]\ \cancel{700}\ 580\ ft = \cancel{286{,}525}\ 200{,}375 / 27 = \cancel{10390}\ 7422\ yd^3$

$[(591.5\ ft^2 + 176\ ft^2)/2]\ 1200\ ft = 460500 / 27 = \cancel{170{,}56}\ 17{,}056\ yd^3$

$\cancel{10390}\ 7422\ yd^3 + 17056\ yd^3 = \boxed{\cancel{27446\ yd^3}}$

$\boxed{24478\ yd^3}$

Southside

STA 62+00 (1:4)

$(6' \times 20') + (1/2)(10')(2.5') + (10')(3.5') + (1/2)(3.5')(7') = 179.75 ft^2$

STA 67+00

$(13' \times 20') + (1/2)(2.5')(10') + (10.5')(10') + (1/2)(10.5)(21) = 487.75 ft^2$

STA 79+00

$(8' \times 6') + (1/2)(6')(24') + (2')(24') + (1/2)(2')(4') = 172 ft^2$

$[(179.75 ft^2 + 487.75 ft^2)/2]\ 500 ft = 166875 ft^3$

$[(487.75 ft^2 + 172 ft^2)/2]\ 1200 ft = 395,850 ft^3$

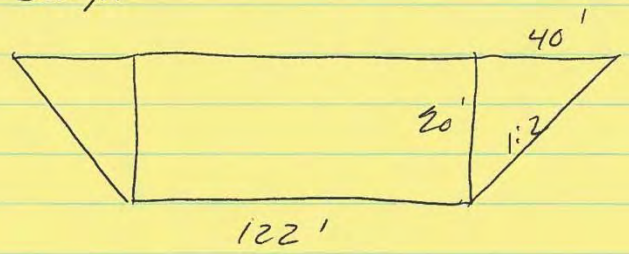
$(166875 ft^3 + 395850 ft^3)/27 = \boxed{20\ 842\ yd^3}$

Difference between 1:3 & 1:4 =

$24478\ yd^3 - 20842\ yd^3 = \boxed{3636\ yd^3}$

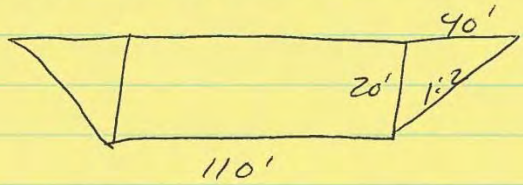
Muck Excavation

Base Design



122' x 20' x 1700'/27 ft³ = 153630 yd³
20' x 40' x 1700'/27 ft³ = 50371 yd³
204,000 yd³

Reduction in Excavation.



110' x 20' x 1700'/27 ~~yd³~~ ft³ = 138,519 yd³
20' x 40' x 1700'/27 ft³ = 50371 yd³
188,890 yd³

Difference is 7.4% from original estimate

Baseline Est. = 1.7 M
1.7M (0.074) = 1.575 M

Bituminous: Reduces trail from 10' to 8'
Reduces shldr from 8' to 4'
Total pavement width reduction = 12'

$(6'')(4{,}000\,ft)(\cancel{12'}\ 8')/9 \times (110\,lb/yd^2)/2000 = \cancel{1760}\ 1174$ tons
$(2.5'')(4{,}000\,ft)(4')/9 \times (110\,lb/yd^2)/2000 = 245$ tons

~~Select Granular:~~ 1419 tons

Typical ~~M~~	Trail
6" bit.	2.5" bit.
9" Cl. 5	4" Cl. 5
9" Select Granular	

Select Granular:
$(8')(4{,}000')(9''/12'')/27\,ft^3 = 889\,yd^3$

$(15''/12'')(4{,}000\,ft)(12')/27 = 2{,}223\,yd^3$

VE RECOMMENDATION NO. 2
CSAH 61 – Roadway Section

PERFORMANCE MEASURES Criteria and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Mainline Operations No change to baseline	Rating	5	5
	Weight	29	
	Contribution	145	145
Local Operations Reduced shoulder width Design exception needed Reduced footprint	Rating	5	4
	Weight	24	
	Contribution	120	96
Maintainability Less snow storage Less pavement to maintain	Rating	5	5
	Weight	17	
	Contribution	85	85
Construction Impacts Road closed during construction Maintains local access	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts Reduced impact to Bluff Creek Reduced impact to cultural resource site Reduced wetland impact	Rating	5	7
	Weight	14	
	Contribution	70	98
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
Total Performance:		**500**	**504**
Net Change in Performance:			**1%**

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VE RECOMMENDATION NO. 3
CSAH 61 – Bluff Creek Bridge

Function: Widen Roadway	**IDEA NO(s).** 19

Baseline:

The base concept utilizes a bridge 100' long and 110' wide to span Bluff Creek. The proposed bridge appears to be constructed as a clear span structure over the creek channel.

Recommendation:

The recommended concept would reduce the overall clear span bridge length by 50' while maintaining the same bridge width based on the proposed typical section of CSAH 61.

Advantages:

- Reduced length = reduced cost
- Shorter span length reduces depth of structure needed
- Allows for more flexibility on roadway profile
- Reduced maintenance costs over the life of the bridge

Disadvantages

- May not handle maximum flood event
- Possible realignment of Bluff Creek to fit shorter span length (skewed crossing)

COST SUMMARY	ESTIMATE
Baseline	$1.47 M
Recommendation	$0.74 M
Cost Avoidance	$0.73 M x 28.5% markup = $0.94 M

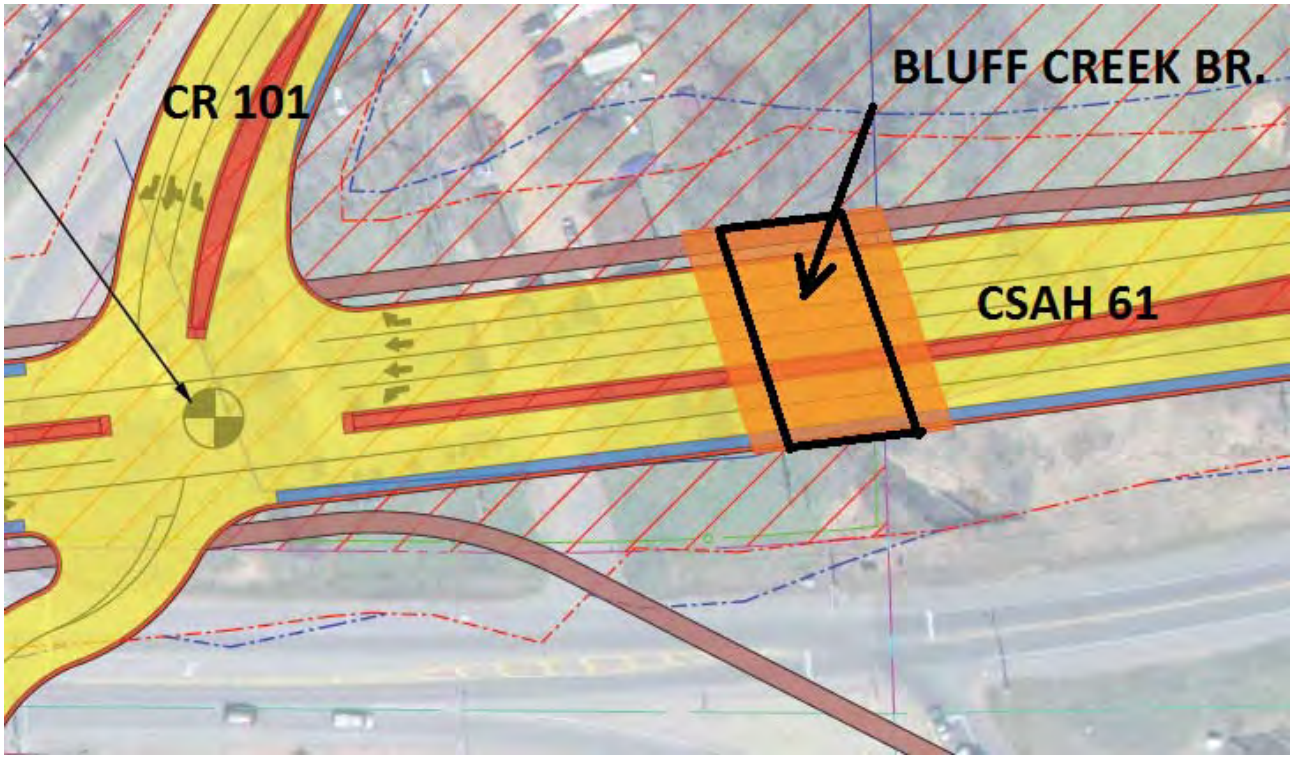
FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
		👍	👍	

VE RECOMMENDATION NO. 3
CSAH 61 – Bluff Creek Bridge

Discussion/Justification/Sketches/Photos:

The proposed recommendation would reduce the bridge length needed to span Bluff Creek by 50'. This would result in a bridge length of 50' (clear span).



CSAH 61 at Bluff Creek

Design/Estimate Assumptions:

- Assumed the bridge length in the base option was based on a clear span structure over the creek
- Assumed that the length needed to span the creek and allow for floodway would require 50'.
- Estimate of recommended bridge was based on per square foot cost given in the base estimate.
- Assumed the same profile of CSAH 61 and clearance over the creek remained the same.
- Assumes savings in right of way and embankment is equivalent to additional retaining wall needed.

Baseline = 100 LF x 98' wide = 9,800 SF x $150/SF = $1,470,000

VE Recommendation = 50 LF x 98' wide = 4,900 SF x $150/SF = $735,000

VE RECOMMENDATION NO. 3
CSAH 61 – Bluff Creek Bridge

PERFORMANCE MEASURES Criteria and Rating Rationale for Recommendation	Performance	Baseline	Recommendation
Mainline Operations No Change to baseline	Rating	5	5
	Weight	29	
	Contribution	145	145
Local Operations No Change to baseline	Rating	5	5
	Weight	24	
	Contribution	120	120
Maintainability Shorter bridge to maintain over the life of the bridge. Less bridge length where maintenance forces need to remove snow from the bridge during clean-up operations	Rating	5	6
	Weight	17	
	Contribution	85	102
Construction Impacts No Change to baseline	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts No Change to baseline	Rating	5	5
	Weight	14	
	Contribution	70	70
Project Schedule No Change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
	Total Performance:	**500**	**517**
	Net Change in Performance:		**3%**

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VE RECOMMENDATION NO. 4
TH 101 / CSAH 61 Connection

Function: Widen Roadway	**IDEA NO(s).** 1, 2, 3, 6

Baseline:

The baseline design for this recommendation is called the "South Leg T" alternative. It is assumed that TH 101 Floodplain project will construct TH 101 up to the intersection with CSAH 61.

Recommendation:

This recommendation includes three options based on funding availability:

1) Simplified One-Way Wye
2) Roundabout Alternative
3) Folded diamond interchange with phased construction

Advantages:

- See individual options on the following pages

Disadvantages

- See individual options on the following pages

COST SUMMARY	ESTIMATE
Baseline	$12.7 M (Construction) + $2.3 M (ROW)
Recommendation	1) No Cost 2) $11.9 M (Construction) + $1.8 M (ROW) 3) $9.1 M (Construction + $2.3 M (ROW) Phase 1 *$19.0 M current year ($29.3 M escalated to 2024) Phase 2*
Cost Avoidance	1) $12.7 M x 26.5% markup = $16.3 M + $2.3 M (ROW) 2) $0.8 M x 26.5% markup = $1.0 M + $0.5 M (ROW) 3) $3.6 M x 26.5% markup = $4.6 M (no ROW savings)

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
👍	👍			

Discussion/Justification:

The baseline design for this recommendation is called the South Leg T alternative. With this layout TH 101 is shifted to the east side of the existing wye and is widened to a four lane roadway with a median 12' lanes and 4' inside and outside shoulders.

CSAH 61 is widened to a four lane roadway with median and has 12' lanes, 8' shoulders, 6' boulevards and 10' trails.

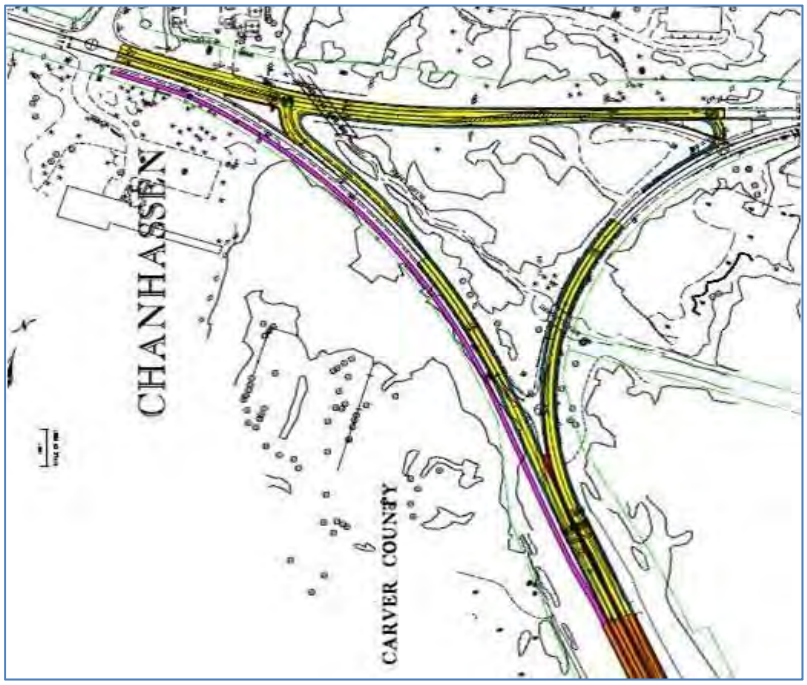
There are two left turn lanes for northbound TH 101 to westbound CSAH 61 and a free right to eastbound CSAH 61. Two left turn lanes are constructed for westbound CSAH 61 to SB TH 101. Two right turn lanes are designed for eastbound CSAH 61 to southbound TH 101. CSAH 61 alignment is shifted to the north and straightened out between Bluff Creek Drive and TH 101 south.

The baseline design included three signalized intersections on CSAH 61 (Bluff Creek Drive, TH 101 north, and TH 101 south).

The trail on TH 101 south of CSAH 61 would use the existing west leg of the wye.

Baseline (South T)

Option #1 is the Modified Wye alternative proposed by MnDOT. This option is if the TH 101 Floodplain Bridge project moves forward before the necessary funding is secured for the TH 101 / CSAH 61 Connection project.



Option #1 Modified Wye

This design will operate at an acceptable level for the next 10 years. One advantage of this design is that it would allow Carver County's project to connect to TH 101 with the least amount of rework at a later date when additional funding is available.

This option adds dual lefts from TH 101 northbound to CSAH 61 westbound. It also widens CSAH 61 in the westbound direction to include dual lefts to TH 101 southbound.

This option allows the county time to obtain funding and/or complete studies to determine the appropriate location for the TH 101 connection from the north.

The advantages of **Option #1** include:

- No cost to locals
- Allows for future TH101/CSAH 61connection/realignment

Disadvantages are:

- Obtaining Municipal Consent
- Only a 10 year traffic solution
- Some CSAH 61 work may be throw away

Option #2 would be to construct the Roundabout alternative.

Option #2 (Roundabout)

This option widens CSAH 61 to four lanes with a median. Two roundabouts are constructed, one at Bluff Creek Road and the other at the intersection of TH 101 to the south.

The roundabout at TH 101 south is centered over the existing wye. New bridges on CSAH 61 and TH 101 are constructed over respective Bluff Creek crossings. Retaining walls along the west side of the roundabout may be needed to keep the embankment out of Bluff Creek.

The future connection with TH 101 to the north would create the fourth leg of the roundabout. The profile of CSAH 61 would be raised approximately 5' at the roundabout to aid the connection to TH 101 north.

The advantages of **Option #2** include:

- Municipal Consent
- Accommodates 2034 Traffic Forecasting (LOS A)
- Allows for future TH101 Connection/Realignment
- Improves traffic operations on CSAH 61
- Less ROW impact

Disadvantages are:

- May have environmental impacts (Bluff Creek)

Option #3 would be to construct a folded diamond interchange as a whole or in stages.

Option #3 (Folded Diamond Interchange)

With **Option #3** CSAH 61 is widened to four lanes with medians along a similar horizontal alignment as the baseline. The profile grade is not raised but remains close to the existing CSAH 61 grade. The alignment of TH 101 is continued over CSAH 61 and up the bluff. A bridge is constructed over CSAH 61 along with ramps for connection.

This option could be constructed in phases depending on the availability of funding. Phase 1 would be to construct CSAH 61 in its final configuration and use the Modified Wye option to connect with TH 101. Phase 2 would construct the overpass, inside loop ramps, and reconstruct the wye into outside ramps.

The advantages of **Option #3** include:

- Municipal Consent
- Accommodates 2034 Traffic Forecasting
- Allows for future TH101 Connection/Realignment
- Improves traffic operations on CSAH 61
- Minimizes throw away costs

Disadvantages are:

- Escalated interchange/bridge costs in the future

Design & Estimate Assumptions:

Baseline Estimate for the South Leg T

Item	Unit	Unit Cost	Quantity	Total
Mobilization		5%		$604,803
Bituminous Pavement	ton	$70	15,603	$1,092,219
4" Concrete Walk	sq ft	$4	59,090	$236,360
Class 5 Aggregate Base	cu yd	$20	6,941	$138,826
Subgrade Excavation	cu yd	$6	2,100	$12,600
Common Excavation	cu yd	$5	2,100	$10,500
Common Borrow	cu yd	$4	7,350	$29,398
Select Granular Borrow	cu yd	$12	17,029	$204,353
Curb and Gutter Design B624	lin ft	$14	22,136	$309,904
Removals/Clear and Grub		4.0%		$81,366
Minor City Utilities		4.0%		$81,366
Signing, Striping, Traffic Control		5.0%		$101,708
Erosion Control and Turf Establishment		4.0%		$81,366
Storm Sewer		25.0%		$508,540
Select Granular Embankment	cuyd	$12	387,346	$4,648,152
Muck Excavation	cuyd	$6	362,651	$2,175,906
CSAH 61 Bridge over Bluff Creek	sqft	$150	10,890	$1,633,500
Signals	each	$250,000	3	$750,000
Construction Total				**$12,700,870**

$2.3 million in Right-of-Way

Option #2 – Roundabout Alternative

Item	Unit	Unit Cost	Quantity	Total
Mobilization	LS	5%		$ 566,263
Bituminous Pavement (1)	TON	$70	13,262	$ 928,317
4" Concrete Walk	SF	$4	72,070	$ 288,280
6" Concrete Walk	SF	$4	8,934	$ 35,736
Class 5 Aggregate Base (1)	CY	$20	15,961	$ 319,226
Subgrade Excavation (1)	CY	$6	2,000	$ 12,000
Common Excavation	CY	$5	2,000	$ 10,000
Common Borrow	CY	$4	11,037	$ 44,146
Select Granular Borrow	CY	$12	37,360	$ 448,326
Curb and Gutter Design B624	LF	$14	22,046	$ 308,644
Removals/Clear and Grub	EST	4%		$ 95,787
Minor City Utilities	EST	4%		$ 95,787
Signing, Striping, Traffic Control	EST	5%		$ 119,734
Erosion Control and Turf Establishment	EST	4%		$ 95,787
Select Granular Embankment	CY	$12	362,898	$ 4,354,776
Muck Exc.	CY	$6	335,719	$ 2,014,314
CSAH 61 Bridge (Bluff Creek)	SF	$150	11,296	$ 1,694,400
Roundabout Lighting	each	$75,000	2	$ 150,000
Roundabout Landscaping	each	$30,000	2	$ 60,000
Signal	each	$250,000	1	$ 250,000
Construction Total				**$ 11,891,523**

$1.8 million in right-of-way is needed

Option #3 – Folded Diamond Interchange

Phase 1 – Construct CSAH 61

Item	Unit	Unit Cost	Quantity	Total
Mobilization		5%		$434,202
Bituminous Pavement	ton	$70	15,603	$1,092,219
4" Concrete Walk	sq ft	$4	59,090	$236,360
Class 5 Aggregate Base	cu yd	$20	6,941	$138,826
Subgrade Excavation	cu yd	$6	2,100	$12,600
Common Excavation	cu yd	$5	2,100	$10,500
Common Borrow	cu yd	$4	7,350	$29,398
Select Granular Borrow	cu yd	$12	17,029	$204,353
Curb and Gutter Design B624	lin ft	$14	22,136	$309,904
Removals/Clear and Grub		4.0%		$81,366
Minor City Utilities		4.0%		$81,366
Signing, Striping, Traffic Control		5.0%		$101,708
Erosion Control and Turf Establishment		4.0%		$81,366
Storm Sewer		25.0%		$508,540
Select Granular Embankment	cuyd	$12	193,673	$2,324,076
Muck Excavation	cuyd	$6	181,326	$1,087,953
CSAH 61 Bridge over Bluff Creek	sqft	$150	10,890	$1,633,500
Signals	each	$250,000	3	$750,000
Construction Total				**$9,118,239**

$2.3 million in right-of-way needed

Phase 2 – Complete interchange by constructing overpass and ramps

Item	Unit	Unit Cost	Quantity	Total
Mobilization		5%		$904,239
Bituminous Pavement	TON	$70	4,000	$280,000
4" Concrete Walk	SF	$4		$0
Class 5 Aggregate Base	CY	$20	1,500	$30,000
Subgrade Excavation	CY	$6	1,000	$6,000
Common Excavation	CY	$5	1,000	$5,000
Common Borrow	CY	$4	2,000	$8,000
Select Granular Borrow	CY	$12	15,000	$180,000
Curb and Gutter Design B624	LF	$14		$0
Removals/Clear and Grub	EST	4.0%		$20,360
Minor City Utilities	EST	4.0%		$20,360
Signing, Striping, Traffic Control	EST	5.0%		$25,450
Erosion Control and Turf Establishment	EST	4.0%		$20,360
Storm Sewer	EST	25.0%		$127,250
Select Granular Embankment	CY	$12	123,500	$1,482,000
Muck Excavation	CY	$6	50,000	$300,000
Column Supported Embankment	SF	$100	136,000	$13,600,000
TH 101 Bridge over CSAH 61	SF	$150	13,200	$1,980,000
Signals	EACH	$250,000		$0
Construction Total				**$18,989,019**

Right of way purchased during Phase 1

Escalation:

2012 - 2%

2013 - 4%

2014 - 5%

2015 - 5%

2016 and beyond - 4%

Assume 10 years to Phase 2 (2024) = $19.0 M x 1.54 = $29.3 M

VE RECOMMENDATION NO. 4
TH 101 / CSAH 61 Connection

PERFORMANCE MEASURES OPTION #1 Simplified One-Way Wye Criteria and Rating Rationale for Recommendation	Performance	Baseline	Option #1
Mainline Operations One-way Wye provides only a 10-year solution	Rating	5	4
	Weight	29	
	Contribution	145	116
Local Operations No additional through lanes on CSAH 61	Rating	5	4
	Weight	24	
	Contribution	120	96
Maintainability No change to baseline	Rating	5	5
	Weight	17	
	Contribution	85	85
Construction Impacts Can be constructed without closing CSAH 61	Rating	5	8
	Weight	7	
	Contribution	35	56
Environmental Impacts Reduced impacts to cultural resources and wetlands No right of way impacts	Rating	5	8
	Weight	14	
	Contribution	70	112
Project Schedule Constructed as part of the TH 101 Floodplain Bridge project	Rating	5	5
	Weight	9	
	Contribution	45	45
Total Performance:		**500**	**510**
Net Change in Performance:			**2%**

VE RECOMMENDATION NO. 4
TH 101 / CSAH 61 Connection

PERFORMANCE MEASURES Criteria and Rating Rationale for Recommendation OPTION #2 Roundabout	Performance	Baseline	Option #2
Mainline Operations LOS A in Design Year	Rating	5	9
	Weight	29	
	Contribution	145	261
Local Operations LOS A in Design Year	Rating	5	9
	Weight	24	
	Contribution	120	216
Maintainability No change to baseline	Rating	5	5
	Weight	17	
	Contribution	85	85
Construction Impacts No change to baseline	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts Reduces impacts to cultural resources Reduces impacts to right of way Increases impacts to wetlands	Rating	5	5
	Weight	14	
	Contribution	70	70
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
Total Performance:		**500**	**712**
Net Change in Performance:			**42%**

VE RECOMMENDATION NO. 4
TH 101 / CSAH 61 Connection

PERFORMANCE MEASURES Criteria and Rating Rationale for Recommendation OPTION #3 Folded Diamond Interchange Evaluated for Phase 1 only	Performance	Original	Alternative
Mainline Operations One-way Wye provides only a 10-year solution	Rating	5	4
	Weight	29	
	Contribution	145	116
Local Operations Same as baseline	Rating	5	5
	Weight	24	
	Contribution	120	120
Maintainability Same as baseline	Rating	5	5
	Weight	17	
	Contribution	85	85
Construction Impacts Same as baseline	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts Reduces amount of embankment needed Reduces impacts to cultural resources	Rating	5	7
	Weight	14	
	Contribution	70	98
Project Schedule Same as baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
Total Performance:		**500**	**499**
Net Change in Performance:			**0%**

Cost Risk Assessment

Introduction

The cost risk assessment portion of the CRAVE™ process was used to identify the range of unexpected project costs as it related to total project cost. Also identified were potential delays in schedule that might arise.

The risk assessment process includes identifying high risk areas and risk elements as threats (or opportunities where appropriate) to the project, quantifying the identified risk elements, developing appropriate risk response strategies, and quantifying the effects of the risk response strategies to be employed.

The risk assessment process quantified risk events by establishing the expected probability of occurrence and range of impacts through elicitation of information from the CRAVE™ Team. The range of impacts defines the representative distribution to be used when modeling the risk. The probability determines the relative frequency (or likelihood) of an event transpiring.

Base Cost Adjustments

Base Cost Estimate

One of the objectives of the cost risk assessment is to validate the base cost estimate using both expert opinion and team consensus. The base cost estimate represents the project cost that can reasonably be expected if the project materializes as planned and there is no occurrence of risk.

The base cost estimate is unbiased and neutral - it is neither optimistic nor conservative. The base cost includes the known and quantified items and the known but not yet quantified (miscellaneous item allowance). The base cost estimate does not include any risks, unknown/unknowns or contingencies.

A LWD Estimate dated 11/02/12 was provided by Carver County for the baseline project. The estimate was reviewed by the CRAVE™ Team during the workshop. The adjusted base cost estimate was prepared in current year dollars and exclude future cost escalation.

Uncertainty

Estimating is not an exact science; a cost estimate is only an approximation of the costs and is made up of many elements that may not be completely or equally defined at the time the estimate is prepared. As a result, there is variability or uncertainty associated with any estimate. When applied to the project estimate, this uncertainty establishes the range that the base cost could fall within. A numerical value of uncertainty is, in essence, an estimate of the error or tolerance within the quantity or unit price of each item within the estimate.

For any given project, the level of uncertainty is directly related to its position in the project life cycle, i.e., the earlier in the project development process, the greater the uncertainty; conversely, the closer to completion, the less uncertainty.

In establishing the uncertainty ranges for each item, consideration was given to factors that might affect quantities or bid prices, such as project location (rural vs. urban), quantities (large or small), items that are difficult to construct or site constraints, methods of payments, timing of advertisement, specialty work, geotechnical and project delivery methods.

Uncertainty was established for the base cost estimate based upon the available information at the time of the study.

Project Escalation Assumptions

To account for increases in prices between the date the base cost estimate was created and when the actual work will be performed and completed, the model requires escalation rate forecasts for construction, preliminary engineering, and right-of-way costs incurred by a project.

Escalation rate forecasts are generated using a combination of probability and trend analysis to estimate probability distributions of annual growth rates for each component. These distributions are fundamental to the forecasting process because they determine the growth rates that may be observed in the future.

The escalation rates shown below were provided by MnDOT.

Year	Construction	ROW - Residential	PE
2012	2.00%	2.00%	2.00%
2013	4.00%	4.00%	4.00%
2014	5.00%	5.00%	5.00%
2015	5.00%	5.00%	5.00%
2016 & beyond	4.00%	4.00%	4.00%

Risk Elicitation

Next the CRAVE™ Team along with the Project Team performed a baseline risk assessment of the project. They discussed the potential risk events and elements facing the project. During the discussion of the project, the team identified high risk elements or potential events which may occur that would impact the project. For each risk element identified, it was determined whether the risk would affect cost, schedule, or simultaneously both cost and schedule.

The CRAVE™ Team identified 16 independent risks that pose both potential schedule and cost threats and opportunities:

- Relocation/ Condemnation
- Stormwater Treatment
- Roundabout Alternative
- Unanticipated Cultural or Archaeological Findings
- Hazardous waste preliminary site investigation required
- Subgrade Issues
- Bluff Creek Bridges

- Delay in Acquisition due to Design Change
- Less ROW may be needed (opportunity)
- Power Relocation
- Delayed Utility Relocations
- Different Site Conditions
- Weather Related Interruptions to Construction
- Buried Man-Made Objects /Unidentified Hazardous Waste Found in Construction
- Material Availability
- Interference from Other Projects
- Maintaining local access
- Lack of Sufficient Number of Bidders
- Delay of funding
- Finding Cultural Resources during construction
- Having the road open for Festivals, etc.
- Roundabout needs less ROW
- Value Engineering.

The CRAVE™ Team also discussed the likelihood of an event occurring in order to establish the probable nature of the risk. The range of cost and schedule impacts were then quantified as the team discussed impacts in the context of what the best case scenario would be (the low end of the range), the worst case scenario (the high end of the range), and what the expected impact (best guess or most likely) is for each risk element.

By establishing the probability of an event's occurrence and the range of impact, the expected impact to the project cost and schedule was assessed. In the workshop a likely range of impact and probability of occurrence was identified for each risk.

Figure 1 details the probabilistic total project cost results. These results represent all costs to the project, as well as the impacts of project risks and schedule escalation. The estimated base cost for this project is $17.54 million in current year (2012) dollars, which includes construction costs (including construction engineering (CE)), pre-construction costs (design & environmental) and right-of-way costs, was used in this Risk Review. Escalated to the year of expenditure (YOE) the base cost is $18.80 M.

These results show that with 60-percent confidence the total project cost will not exceed $20.84 million. The 80-percent confidence interval, described by the 10th percentile and 90th percentile reveals that the total project cost will fall between $18.55 million and $24.02 million.

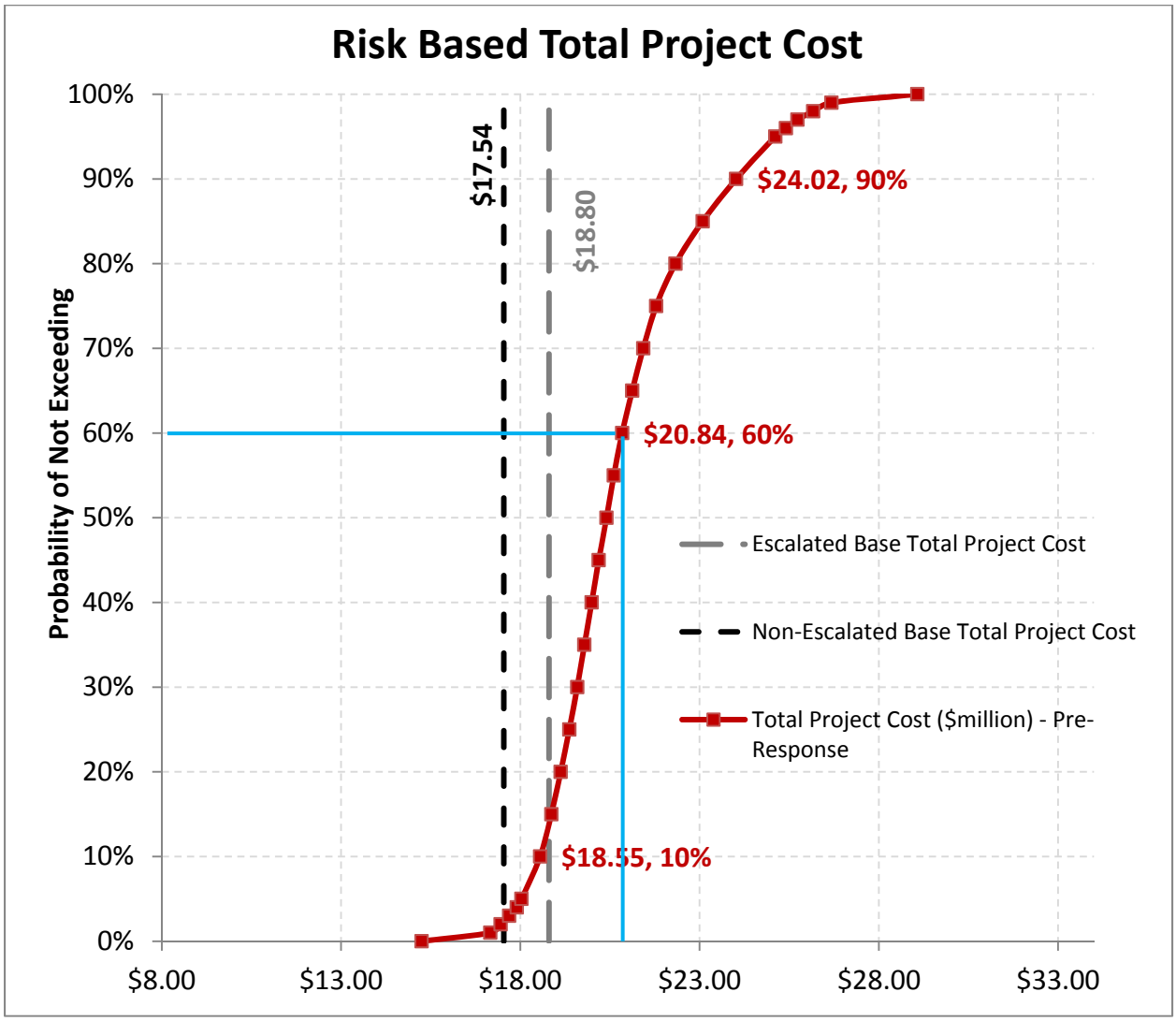


Figure 1 – Risk Based Total Project Cost – YOE (Pre-Response)

The probabilistic Project Completion Date distribution is shown in Figure 2. The Project Completion Date, using the base schedule, is estimated to be May 2015. There is a 60-percent probability that this project will be complete by November 2016. The probabilistic Project Completion Date distributions, as represented by the red line, indicate a completion date ranging between April 2015 and December 2015, with 80-percent confidence. This represents a range of approximately 8 months.

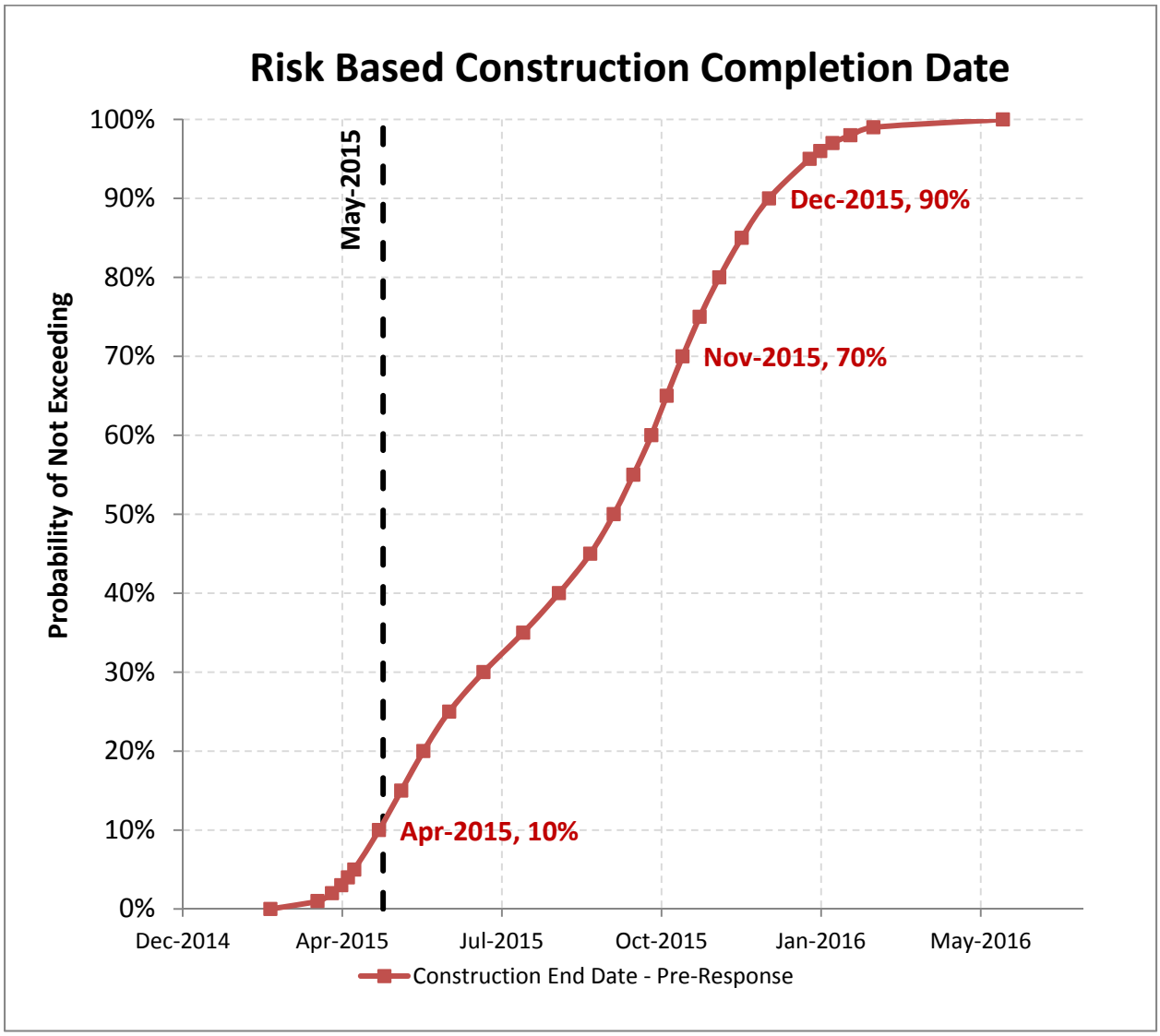


Figure 2 – Risk Based Project Completion Date (Pre-Response)

In summary, the CRAVE™ Team identified high risk areas and elements of the project and then quantified them to determine the likely impacts on project cost and schedule.

Reduce the Risk

The next step was to determine the appropriate risk response strategies for the identified high risk areas. In terms of appropriate risk response strategies, four distinct strategies were the basis of the risk buffering recommendations. Those strategies were to avoid, accept, transfer, or mitigate the risk. Avoiding a risk may cost more money up front, but may prevent more extensive impact later on. Accepting a risk means that there is not much that can be done to lessen the risk, except to know how to deal with it when it arises. The transferring of a risk allows for the risk owner to move the liability of the risk to another party, which usually comes with an associated cost incurred to the project. The mitigation of a risk allows for the risk owner to buffer or reduce the likely impacts through preventive action.

The CRAVE™ Team focused on responding to those risks that were the most likely to happen and which held a significant impact if the risk event occurs. After identifying the appropriate risk response strategies for the highest risk areas, the project was again evaluated in a post-response manner.

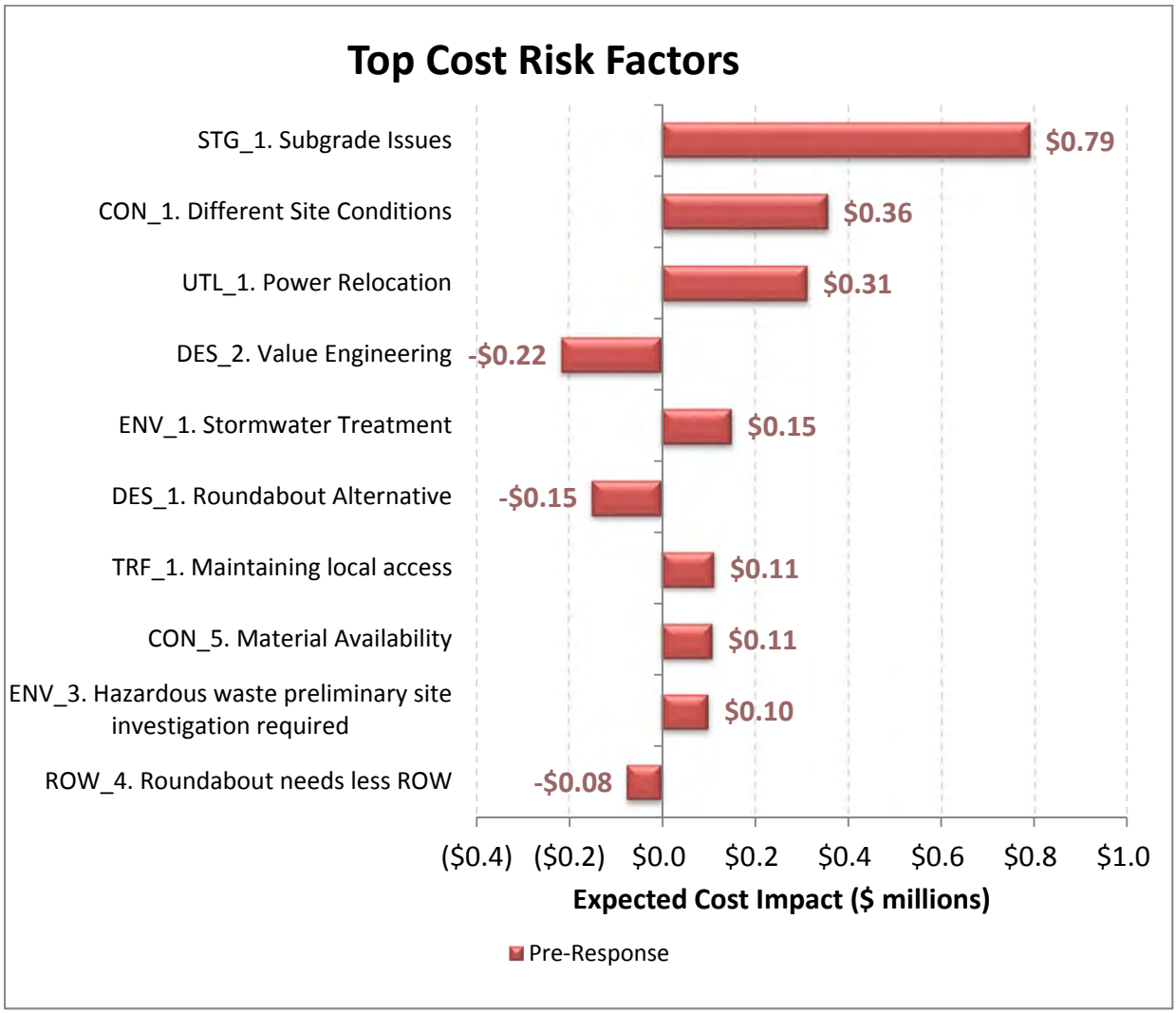


Figure 3 – Top Cost Risk Tornado Diagram (Pre-Response)

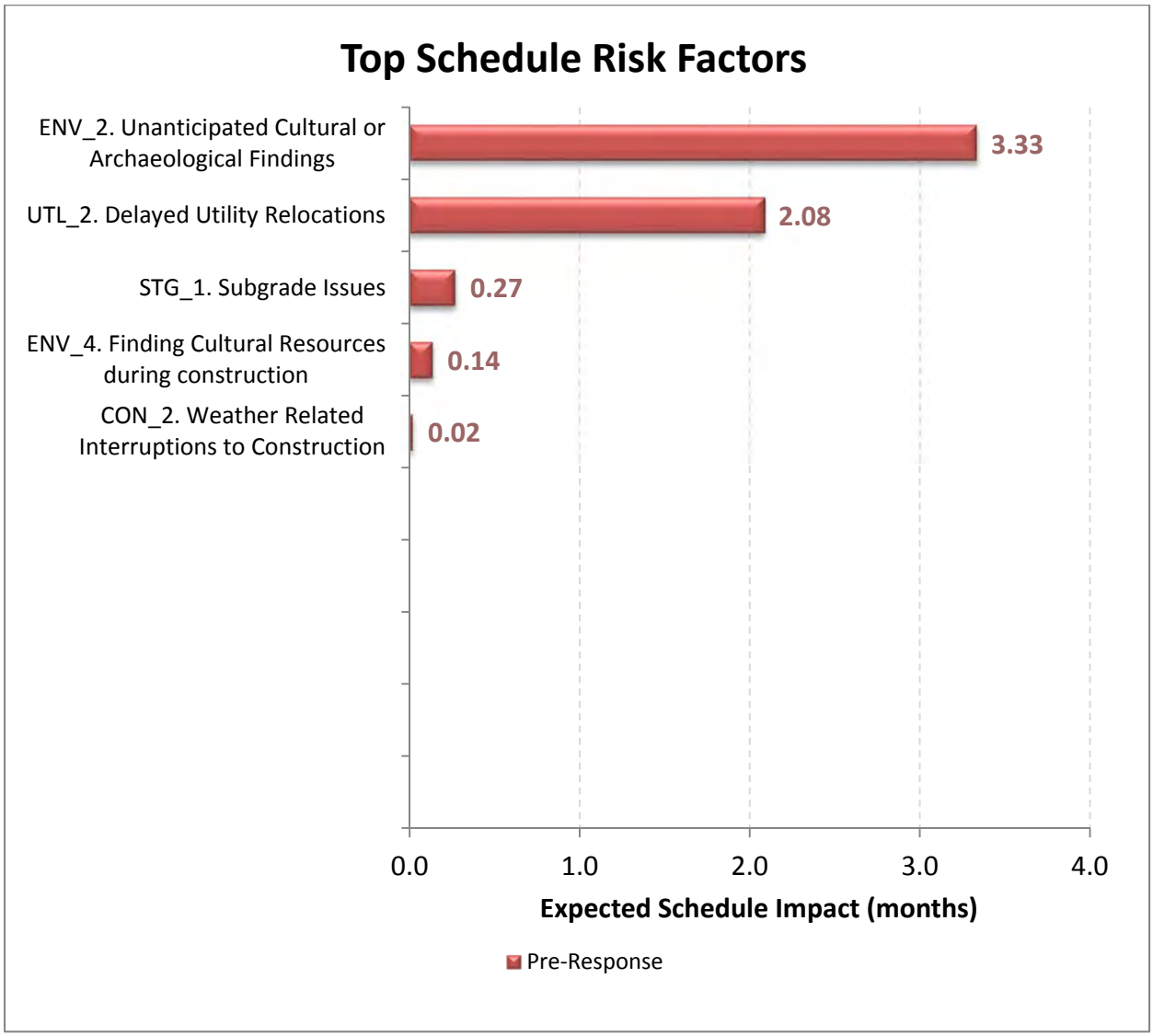


Figure 4 – Top Schedule Risk Tornado Diagram (Pre-Response)

Using the information portrayed in the tornado diagrams, the highest risk elements received the most focus. The next step was to determine the appropriate risk response strategies for the identified high risk areas.

Four distinct risk response strategies were the basis of the risk buffering recommendations. Those strategies were to avoid, accept, transfer, or mitigate the risk.

Avoiding a risk may cost more money up front, but may prevent more extensive impact later on. Accepting a risk means that there is not much that can be done to lessen the risk, except to know how to deal with it when it arises. The transferring of a risk allows for the risk owner to move the liability of the risk to another party, which usually comes with an associated cost incurred to the project. The mitigation of a risk allows for the risk owner to buffer or reduce the likely impacts through preventive action.

The CRAVE™ Team focused on responding to those risks that were the most likely to happen and which held a significant impact if the risk event occurs, as illustrated in the tornado diagrams. Each of the highest risks identified had a unique risk response strategy developed to address it, as well as the identification of the risk owner. The frequencies of review for those risks were also established. By identifying how to handle a risk, who owns it, and how often to review the risk, the framework for a risk management plan (RMP) was laid out. This concept allows for the proactive management of risk throughout the project lifecycle by using the RMP as a guide.

Risk Response Plan		Monitoring and Control		
Strategy	ACTION TO BE TAKEN Response Actions including advantages and disadvantages include date	Risk Owner	Risk Review Dates	Date, Status and Review Comments (Do not delete prior comments, therefore providing a history)

After identifying the appropriate risk response strategies for the highest risk areas, the project was again evaluated in a post-response manner. The CRAVE™ Team again discussed the risk response strategies for each risk and re-evaluated the probabilities and range of impacts for each risk element based on the desired risk management action and risk response strategy to be employed. The focus was to again evaluate the project in the context of the value of a RMP in order to better manage project cost and schedule. By proactively managing risk and responding appropriately, a risk event's likelihood of occurrence may decline, the range of impact may decline, or both the likelihood and range of impact may simultaneously decline.

In addition to quantifying the impacts to project cost and schedule of the related risk elements in both a pre- and post-response manner, the project was again re-evaluated to reflect the impacts of implementing the value engineering recommendations generated by the CRAVE™ Team. The VE recommendations were input into the model as an opportunity in terms of their likely impact, as well as the probability of implementing the recommendations. Once again a new cumulative cost curve was generated that represented both the impacts of responding to the risk elements and implementing the VE recommendations. By treating the VE recommendations as an opportunity to increase value through performance increases and cost reductions, it was demonstrated that further cost and schedule efficiencies could be obtained for the project.

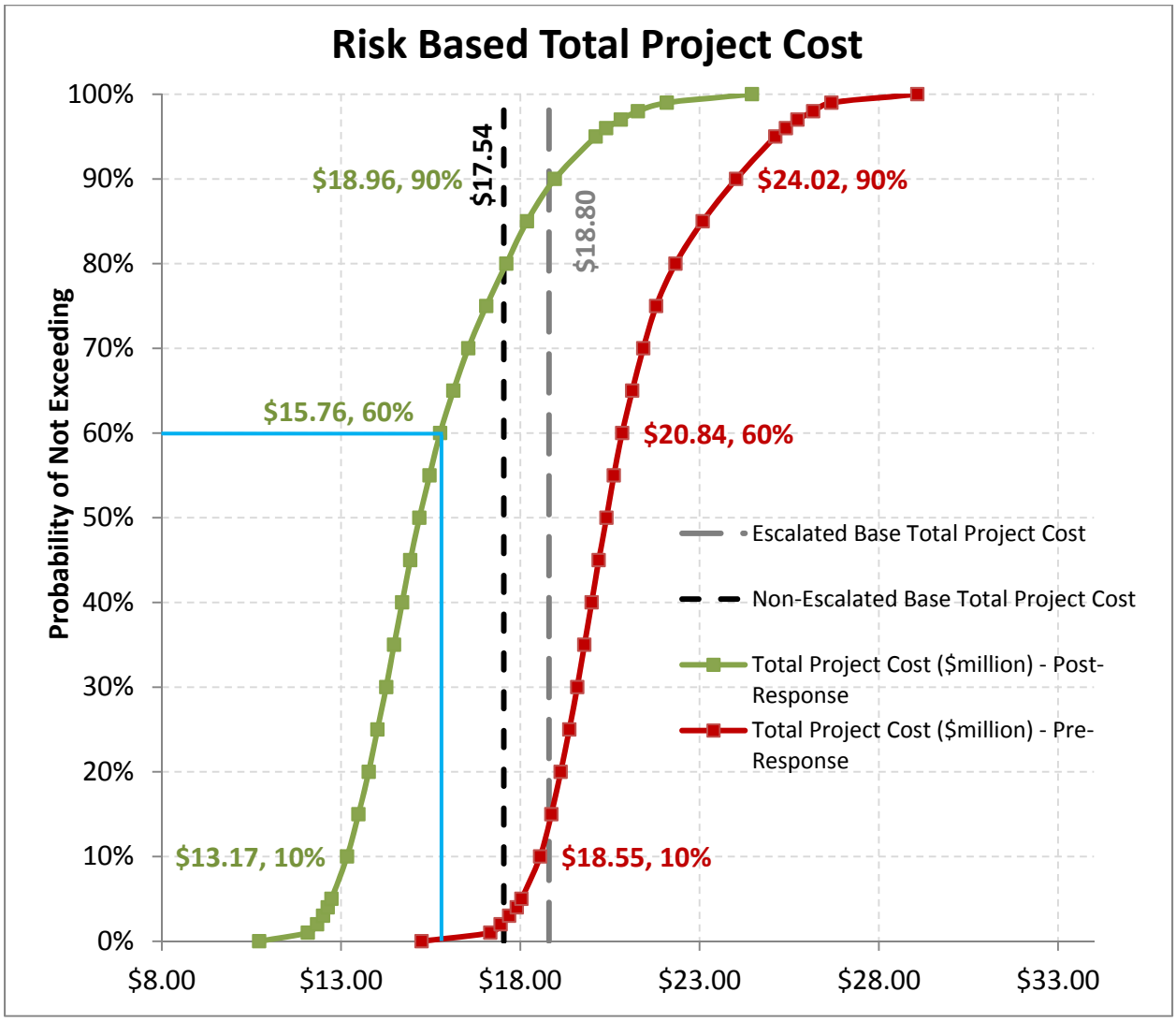


Figure 5 – Risk Based Total Project Cost – YOE (Post-Response)

The total estimated project cost in YOE dollars prior to responding to the risk and the implementation of the VE recommendations is $20.84 million at the 60% confidence level. After responding to the risks and implementing the value engineering recommendations the project has an estimated cost of $15.76 million at the 60% confidence level, or a reduction of $5.08 million in CY dollars.

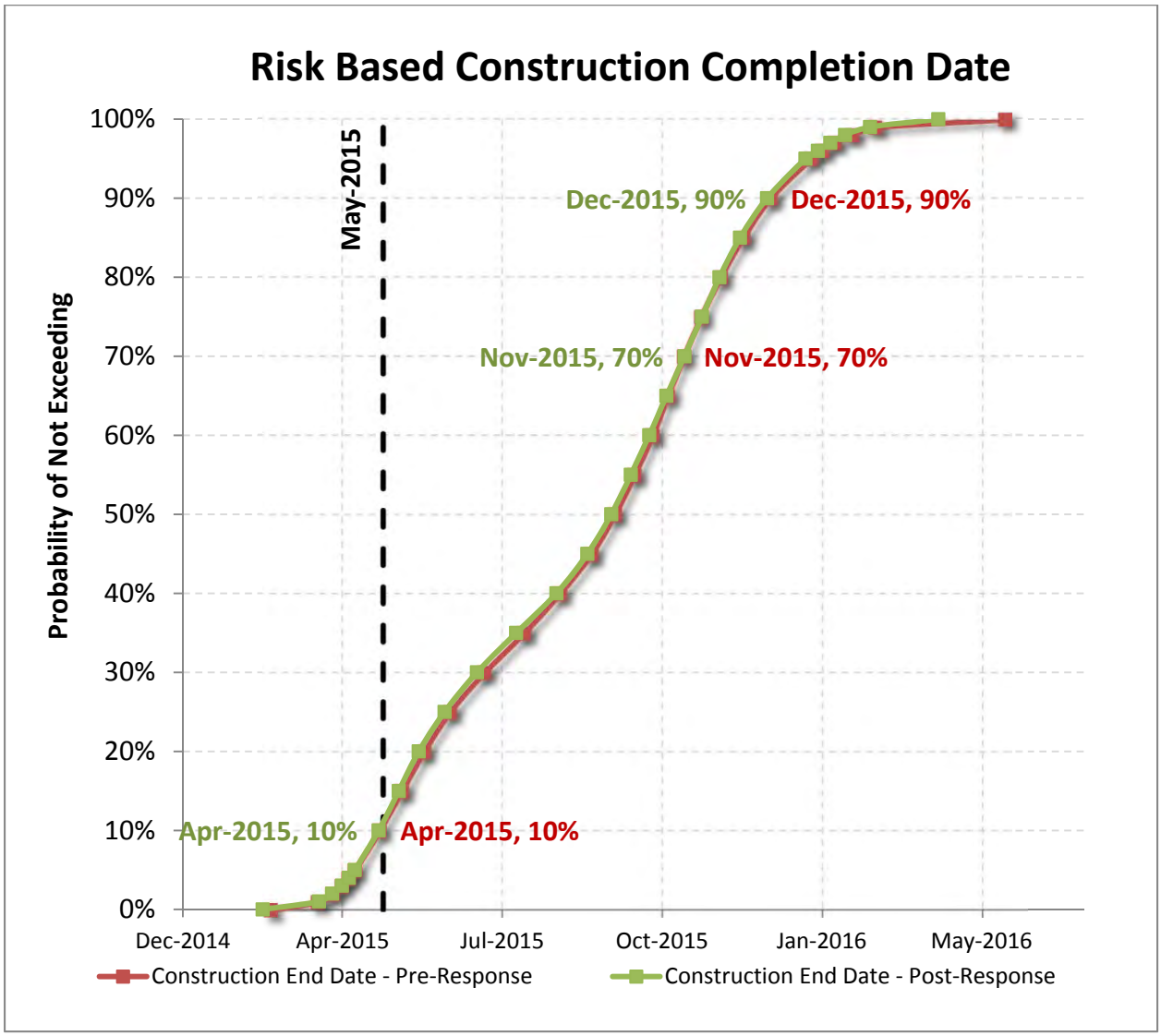


Figure 6 – Risk Based Total Project Cost – YOE (Post-Response)

The project completion date prior to response to the risk and implementation of the VE recommendations is November 2015 at the 60% confidence level. After responding to the risks and implementing the value engineering recommendations the project completion date showed only a slight improvement and remains November 2015.

The preceding figures illustrate the power of proactive management and implementation of the VE recommendations to mitigate potential project risk.

Risk Process Summary

Overall, the cost risk analysis process employed to evaluate the project total cost and schedule included four major steps. The first step was to identify and quantify the major risk elements and how they impact cost and schedule. The second step was to identify how to respond to the highest likelihood and impact risk elements. The third step was to quantify the effects of

implementation of the risk response strategies. The final step was to quantify the effects on project cost and schedule by implementing the VE recommendations.

The expected value (likelihood multiplied by expected risk outcome) tornado diagrams below depict the actual expected values of the identified risks and help summarize the evolution the project has gone through by engaging in the CRAVE™ process. Within the diagrams, the risks have the expected values plotted prior to responding to the risks and implementing the VE recommendations (red bars) and after responding to the risks and implementing VE recommendations at their expected likelihood (green bars).

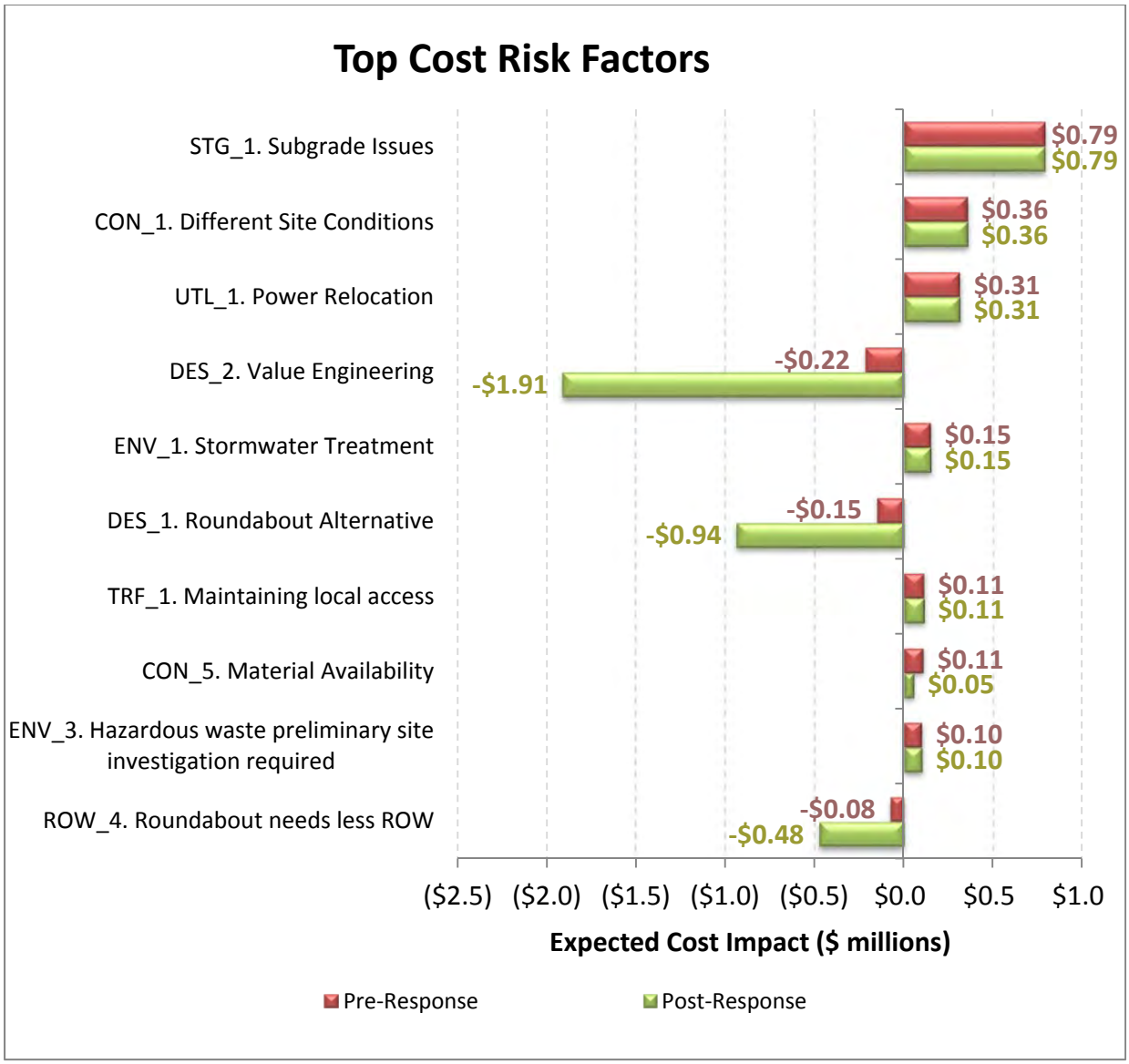


Figure 7 – Top Cost Risk Tornado Diagram (Post-Response)

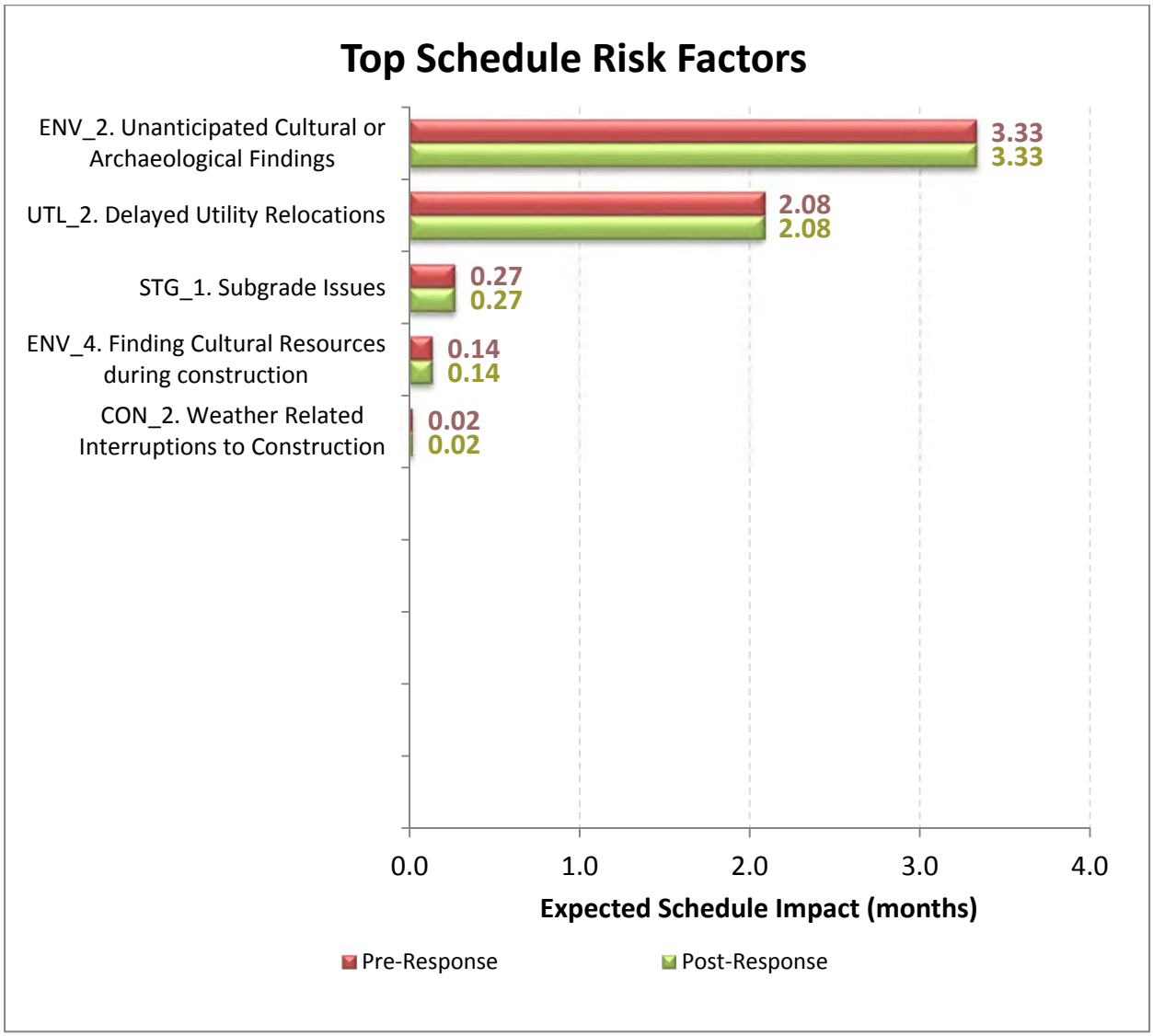


Figure 8 – Top Schedule Risk Tornado Diagram (Post-Response)

By engaging in this cost risk analysis process to evaluate the project, the overall expectations of cost and schedule were quantified in relation to identified risks, the associated impacts of those risk elements, the use of a Risk Management Plan to respond to those risk elements, and impacts to the project bottom line of creating value for the project. Through this process value can simultaneously be created for the project through the VE portion of the study, while risks can be proactively monitored and controlled to reduce potential impacts to the project cost and schedule.

The information provided by a CRAVE™ Workshop gives valuable tools to project managers to help them deliver a successful project on time and within budget. When a multi-disciplined team of experts is assembled in a workshop environment, maximum benefit can be achieved by using this combined Cost Risk Assessment/Value Engineering process.

Appendix A

Value Engineering Process

Value Engineering (VE) is a systematic process using a multidisciplinary team to improve the value of a project through the analysis of its functions. The VE process incorporates, to the extent possible, the values of design; construction; maintenance; contractor; state, local and federal approval agencies; other stakeholders; and the public.

The primary objective of a VE Workshop is value improvement. The value improvements might relate to scope definition, functional design, constructability, coordination (both internal and external), or the schedule for project development. Other possible value improvements are reduced environmental impacts, reduced public (traffic) inconvenience, or reduced project cost.

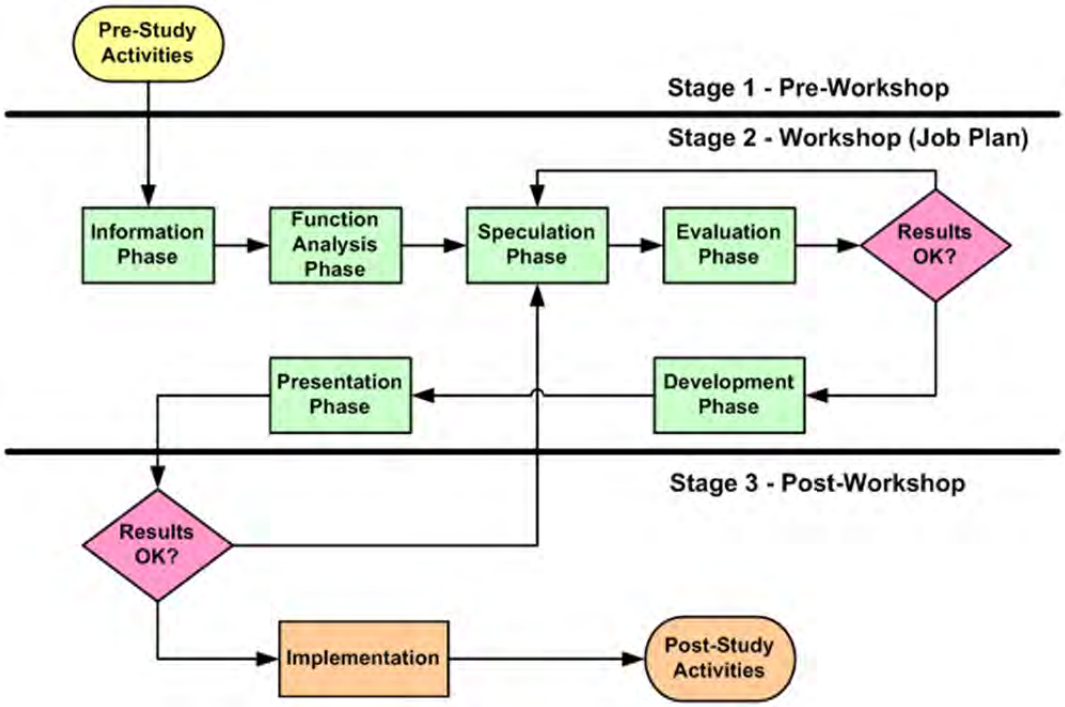
Pre-CRAVE™ Workshop

Prior to the start of a CRAVE™ Workshop, the Project Manager, CRAVE™ Team Leader and the MnDOT Value Engineer carry out the following three activities:

- Initiate Study
  - Prepare Workshop Request
  - Define workshop scope, objective and goals
  - Define workshop timing
- Organize Study
  - Conduct Pre-Workshop meeting
  - Select team members
  - Pre-elicit risks
  - Identify performance attributes (if applicable)
- Prepare Data
  - Collect and distribute data
  - Prepare cost models
  - Prepare risk modeling tool

All of the information gathered prior to the CRAVE™ Workshop is given to the team members for their use.

Value Engineering Job Plan



The six-phase Value Engineering Job Plan was employed in analyzing the project. This process is recommended by SAVE International and is composed of the following phases:

Information - The objective of this phase was to obtain a thorough understanding of the project's design criteria and objectives by reviewing the project's documents and drawings, cost estimates, and schedules.

Function Analysis - The purpose of this phase was to identify and define the primary and secondary functions of the project. A Functional Analysis System Technique (FAST) was used to quickly define the functions of the project.

Speculation/Creative - During this phase the team employed creative techniques such as team brainstorming to develop a number of alternative concepts that satisfy the project's primary functions.

Evaluation - The purpose of this phase was to evaluate the alternative concepts developed by the VE Team during the brainstorming sessions. The team used a number of tools to determine the qualitative and quantitative merits of each concept.

Development - Those concepts that ranked highest in the evaluation were further developed into VE recommendations. Narratives, drawings, calculations, and cost estimates were prepared for each recommendation.

Presentation - The VE Team presented their finding in the form of a written report. In addition, an oral presentation was made to the owner and the design team to discuss the VE recommendations.

CRAVE™ Process

Step 1: Baseline Risk Assessment

a) Review baseline cost
b) Review baseline schedule
c) Identify risks related to baseline project
d) Assess and quantify risks in terms of project's cost and schedule

Step 2: Value Engineering & Risk Response

a) Develop value engineering recommendations that further mitigate or avoid high risk elements
b) Develop recommendations that add value by modifying project scope and/or schedule

Step 3: Risk Analysis on Response Strategies

a) Identify risks related to response strategies
b) Assess and quantify threats and opportunities in terms of project's cost and schedule

Step 4: Tracking, Monitoring, and Control

a) Identify risk owners, monitoring frequency
b) Continuously update risk management plan
c) Document and report progress
d) At key milestones, update cost and schedule

Performance Based Results

Weighing the performance of a VE Recommendation to the baseline project is an integral part of the Value Engineering Process. This process provides the cornerstone of the VE process by providing a systematic and structured means of considering the relationship of a project's performance and cost as they relate to value. Project performance must be properly defined and agreed upon by the stakeholders at the beginning of the VE Study. The performance attributes and requirements developed are then used throughout the study to identify, evaluate, and document alternatives.

Introduction

The methodology described herein measures project value by correlating the performance of project scope and schedule to the project costs. The objective of this methodology is to prescribe a systematic, structured approach to study and optimize a project's scope, schedule, and cost.

Value Engineering has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that VE can play with regard to improving project performance. Project costs are fairly easy to quantify and compare through traditional estimating techniques. Performance is not so easily quantifiable.

The VE Team Leader will lead the team and external stakeholders through the methodology, using the power of the process to distill subjective thought into an objective language that everyone can relate to and understand. The dialog that develops forms the basis for the VE team's understanding of the performance requirements of the project and to what degree the current design concept is meeting those requirements. From this baseline, the VE team can focus on developing alternative concepts that will quantify both performance and cost and contribute to overall project value.

Performance based VE yields the following benefits:

- Builds consensus among project stakeholders (especially those holding conflicting views)
- Develops a better understanding of a project's goals and objectives
- Develops a baseline understanding of how the project is meeting performance goals and objectives
- Identifies areas where project performance can be improved through the VE process
- Develops a better understanding of a VE alternative's effect on project performance
- Develops an understanding of the relationship between performance and cost in determining value
- Uses value as the true measurement for the basis of selecting the right project or design concept
- Provides decision makers with a means of comparing costs and performance (i.e., costs vs. benefits) in a way that can assist them in making better decisions.

Methodology

The application of performance based VE consists of the following steps:

1. Identify key project (scope and delivery) performance attributes and requirements for the project
2. Establish the hierarchy and impact of these attributes upon the project
3. Establish the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts
4. Identify the change in performance of alternative project concepts generated by the study
5. Measure the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement

The primary goal of Value Engineering is to improve project value. A simple way to think of value in terms of an equation is as follows:

$$Value = \frac{Performance}{Cost}$$

Assumptions

Before embarking on the details of this methodology some assumptions need to be identified:

- The methodology described in the following steps assumes the project functions are well established. Project functions are "the what" the project delivers to its users and stakeholders; a good reference for the project functions can be found in the environmental document's purpose and need statement. Project functions are generally well defined prior to the start of the VE Study. In the event that project functions have been substantially modified, the methodology must begin a new from the beginning (Step 1).

Step 1 – Determine the Major Performance Attributes

Performance attributes can generally be divided between Project Scope components (Highway Operations, Environmental Impacts, and System Preservation) and Project Delivery components. It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory and are binary in nature. All performance requirements MUST be met by any VE alternative concept being considered. Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance requirement might be that the bridge must meet all current seismic design criteria. In contrast, a performance attribute might be Project Schedule which means that a wide range of alternatives could be acceptable that had different durations.

The VE Team Leader will initially request that representatives from project team and external stakeholders identify performance attributes that they feel are essential to meeting the overall need and purpose of the project. Usually four to eight attributes are selected. It is important that all potential attributes be thoroughly discussed. The information that comes out of this discussion will be valuable to both the VE team and the project owner. It is important that the attribute be discretely defined, and they must be quantifiable in some form. By quantifiable, it is meant that a useable scale must be delineated with values given on a scale of 0 to 10. A "0" indicates unacceptable performance, while a "10" indicates optimal or ideal performance. The vast majority of performance attributes that typically appear in transportation VE studies have been standardized. This standardized list can be used "as is" or adopted with minor adjustments as required. Every effort should be made to make the ratings as objective as possible.

Step 2 – Determine the Relative Importance of the Attributes

Once the group has agreed upon the project's performance attributes, the next step is to determine their relative importance in relation to each other. This is accomplished through the use of an evaluative tool termed in this report as the "Performance Attribute Matrix." This matrix compares the performance attributes in pairs, asking the question: "An improvement in which attribute will provide the greatest benefit to the project relative to purpose and need?" A letter code (e.g., "a") is entered into the matrix for each pair, identifying which of the two is more important. If a pair of attributes is considered to be of essentially equal importance, both letters (e.g., "a/b") are entered into the appropriate box. This, however, should be discouraged, as it has been found that in practice a tie usually indicates that the pairs have not been adequately discussed. When all pairs have been discussed, the number of "votes" for each is tallied and percentages (which will be used as weighted multipliers later in the process) are calculated. It is not uncommon for one attribute to not receive any "votes." If this occurs, the attribute is given a token "vote", as it made the list in the first place and should be given some degree of importance.

Step 3 – Establish the Performance "Baseline" for the Original Design

The next step in the process is to evaluate how well the original design is addressing the project's performance attributes. This step establishes a "baseline" against which the VE alternative concepts can be compared. The Performance Rating Matrix is used to assist the VE team in determining the performance ratings for the original design concept. Representatives from the design team and external stakeholders next begin assigning a 0 to 10 rating for each attribute, using the definitions and scales developed in Step 1.

Once the 0 to 10 ratings for the various attributes have been established, their total performance should be calculated by multiplying the attribute's weight (which was developed in Step 2) by its rating. Once the total performance for each attribute has been determined, the original design's total performance can be calculated by adding all of the scores for the attributes. The concept's total performance will be somewhere between 0 and 1,000 points. A concept scoring 1,000 would represent a hypothetically "optimal" design concept, with all performance attributes being addressed to their theoretical maximum. This numerical expression of the original design's performance forms the "baseline" against which all alternative concepts will be compared.

Step 4 – Evaluate the Performance of the VE Alternative Concepts

Once the performance baseline has been established for the original design concept, it can be used to help the VE team develop performance ratings for individual VE alternative concepts as they are developed during the course of the VE Study. The Performance Measures form is used to capture this information. This form allows a side-by-side comparison of the original design and VE alternative concepts to be performed.

It is important to consider the alternative concept's impact on the entire project, rather than on discrete components, when developing performance ratings for the alternative concept

Step 5 – Compare the Performance Ratings of Alternative Concepts to the "Baseline" Project

The last step in the process completes the Value Matrix that was initially begun to develop the performance ratings for the original design concept. The VE team groups the VE alternatives into a strategy (or strategies) to provide the decision makers a clear picture of how the alternatives fit together into possible solutions. At least one strategy is developed to present the VE team's consensus of what should be implemented. Additional strategies are developed as necessary to present other combinations to the decision makers that should be considered. The strategy(s) of VE alternatives are rated and compared against the original concept. The performance ratings developed for the VE Strategies are entered into the matrix, and the summary portion of the Value Matrix is completed. The summary provides details on net changes to cost, performance, and value, using the following calculations.

- % Performance Improvement = Δ Performance VE Strategy / Total Performance Original Concept
- Value Index = Total Performance / Total Cost (in Millions)
- % Value Improvement = ΔValue Index VE Strategy / Value Index Original Concept

Report

Following the CRAVE™ Workshop, the Team Leader assembles all study documentation into the final report.

- Publish Results – Prepare a Draft and Final CRAVE™ Workshop Report; distribute electronic copies.
- Close Out CRAVE™ Workshop - Provide final deliverables to the MnDOT Value Engineer.

The CRAVE™ Workshop is complete when the report is issued as a record of the CRAVE™ Team's analysis and development work, as well as the project development team's implementation dispositions for the recommendations.

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Appendix B

- VE Recommendation Approval Form
- VE Workshop Agenda
- VE Workshop Attendees
- VE Report Out Presentation

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Value Engineering Recommendation Approval Form

Project: TH 101 / CSAH 61 Connection
VE Study Date: November 5-9, 2012

	Recommendation	Accept / Reject / Accept for further review	Reason (Or use the pages at the end of this memo)	FHWA Functional Benefit: Safety	Operation	Environment	Construction	Other	Estimated Savings	Added Cost
1	Reduce Right of Way Acquistion	Reject	Looking at reducing ROW as much as possible, but some landowners appear to be interested in being bought out. Carver County and Chanhassen are leading this effort. No ROW cost savings anticipated.			1			$ 1,740,000	
2	Roadway Section	Accept	Accepted the recommendation, may require a design variance for the outside shoulder width. Meets minimum trail width recommendations.			1			$ 1,340,000	
3	Bluff Creek Bridge	Accepted for further review	Carver Co is considering replacing the box culverts with box culverts (replace "in-kind"), rather than a bridge structure. It will depend on a number of factors, including cost, environmental considerations, and soils considerations.			1	1		$ 940,000	
4	TH 101 / CSAH 61 Connection	Accept	Selected the Roundabout alternative (which was the alternative with a $1.5M estimated cost savings in the CRAVE #4 recommendation).	1	1				$ 1,500,000	
			Total for 4 recommendations	1	1	3	1	0	$ 5,520,000	$ -
			Total for 3 accepted recommendations	1	1	2	1	0	$ 3,780,000	$ -

Please provide justification if the value engineering study recommendations are **not** approved or are implemented in a modified form.
MnDOT is required to report Value Engineering results annually to FHWA. To facilitate this reporting requirement, a Value Engineering Recommendation Approval Form is included in the Appendix of this report. If the region elects to reject or modify a recommendation, please include a brief explanation of why. Please complete the form and return it to Minnie Milkert, MnDOT State Value Engineer, MS 696

Signature Project manager

Date

Name (please print)

Value Engineering Recommendation Approval Form

Project: TH 101 / CSAH 61 Connection
VE Study Date: November 5-9, 2012

Recommendation	Accept / Reject / Accept for further review	Reason (Or use the pages at the end of this memo)	FHWA Functional Benefit: Safety	Operation	Environment	Construction	Other	Estimated Savings	Added Cost

FHWA Functional Benefit Criteria

Each year, State DOT's are required to report on VE recommendations to FHWA. In addition to cost implications, FHWA requires the DOT's to evaluate each approved recommendation in terms of the project feature or features that recommendation benefits. If a specific recommendation can be shown to provide benefit to more than one feature described below, count the recommendation in **each category that is applicable**.

Safety: Recommendations that mitigate or reduce hazards on the facility
Operations: Recommendations that improve real-time service and/or local, corridor, or regional levels of service of the facility.
Environment: Recommendations that successfully avoid or mitigate impacts to natural and or cultural resources.
Construction: Recommendations that improve work zone conditions, or expedite the project delivery.
Other: Recommendations not readily categorized by the above performance indicators.

SP 1009-24
Cost Risk Assessment + Value Engineering Study
November 5th-9th, 2012
CRAVE Agenda

Objective: The team will identify improvement opportunities and quantity & develop response strategies for high risk areas that can effect schedule and budget for the TH101 Floodplain mitigation project.

Monday: Scott County Law Enforcement Center; 301 Fuller St S – Shakopee, MN 55379 (Room LA 240-241 in AM and LB 303 in PM);

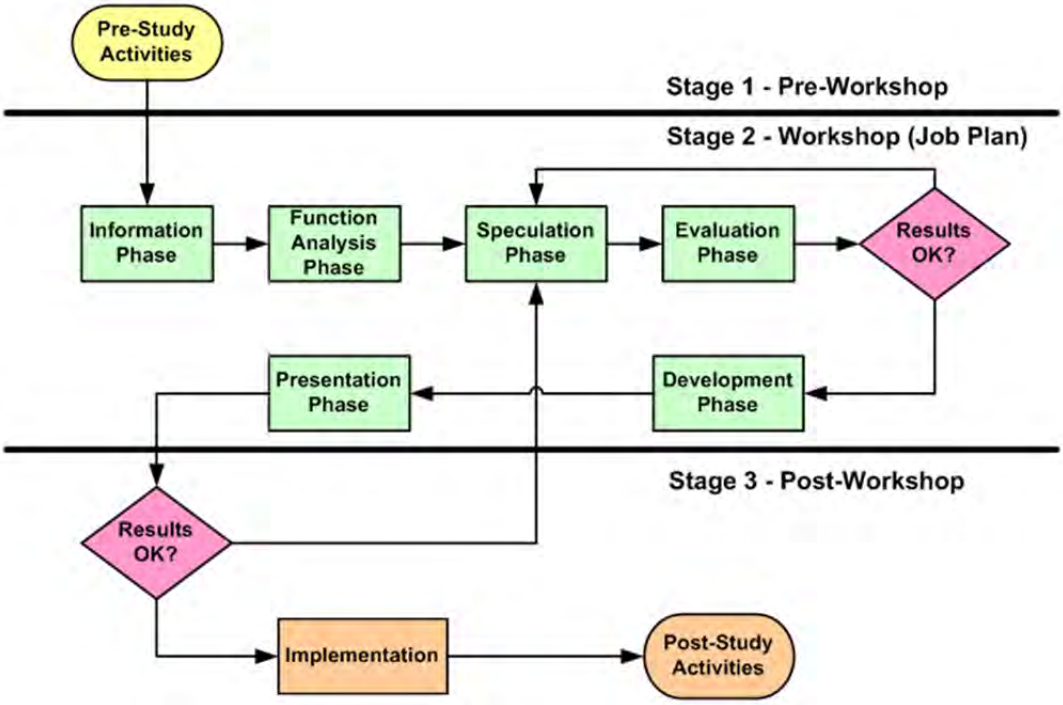
Tuesday thru Friday: Arden Hills Training Center; 1900 West County Road I; Shoreview, MN 55126, Room 10.

CRAVE™ Workshop - Agenda

Monday, November 5 Room LA 240-241		**Attendees**
8:00 pm	Welcome and Introductions	Everyone
8:15 am	Overview of CRAVE™ process and the agenda	Everyone
Information Phase		
8:30 pm	Project Team presentation of the project • What are the goals and objectives? • What are the constraints and controlling decisions? • What are the assumptions? • What are the identified risks of the project?	Everyone = Subject Matter Experts, Project Team & CRAVE™ Team
9:15 am	Base Cost Estimate and Schedule Validation	Everyone
9:45 am	Risk Elicitation 1. Design 2. Environmental/Hydraulics 3. Right of Way 4. Utilities	Everyone
Noon	Lunch (Provided)	
1:00 pm	Site Visit	Everyone
4:00 pm	Return from Site Visit and capture observations Room LB 303	Everyone
Functional Analysis Phase		
4:30 pm	Functional Analysis – Define functions	CRAVE™ Team
5:00 pm	Adjourn for the day	

	Tuesday, November 6 Arden Hills Training Center 1900 West County Road I; Shoreview, MN 55126, Room 10	
8:00 am	Continue Risk Elicitation 5. Structures/Geotechnical 6. Construction 7. Contracting and Procurement 8. Management and Funding 9. Partnerships and Stakeholders	Everyone
11:00 am	Define & Weigh Performance Attributes	Project Team & CRAVE™ Team
Noon	Lunch (Provided)	
	Speculation Phase	
1:00 pm	Brainstorm ideas to improve the value of the project	CRAVE™ Team
5:00 pm	Adjourn for the day	
	Wednesday, November 7 Arden Hills Training Center – Room 10	
8:00 am	Complete Speculation	CRAVE™ Team
	Evaluation Phase	
10:00 am	Evaluate the ideas from the brainstorming session	CRAVE™ Team
Noon	Lunch (Provided)	
1:00 pm	Complete Evaluation	
	Development Phase	
3:00 pm	Develop the ideas that evaluated the best into recommendations	CRAVE™ Team
5:00 pm	Adjourn for the day	
	Thursday, November 8 Arden Hills Training Center – Room 10	
8:00 am	Continue Development	CRAVE™ Team
Noon	Lunch (Provided)	
1:00 pm	Complete Development	
3:00 pm	Define and evaluate the performance of the VE Recommendations	CRAVE™ Team
4:00 pm	Define Risk Response Strategies for remaining risks	CRAVE™ Team
5:00 pm	Adjourn for the day	
	Friday, November 9 Arden Hills Training Center – Room 2 (SMART Board)	
	Presentation Phase	
8:00 am	Preparation for presentation	CRAVE™ Team
9:00 am	CRAVE™ Team practice walk-through presentation	CRAVE™ Team
10:00 am	Report out of CRAVE™ Recommendations	Everyone
12:00	Adjourn for the week	

Value Engineering Job Plan



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CRAVE™ Process

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a) Review baseline cost
b) Review baseline schedule
c) Identify risks related to baseline project
d) Assess and quantify risks in terms of project's cost and schedule

Step 2: Value Engineering & Risk Response

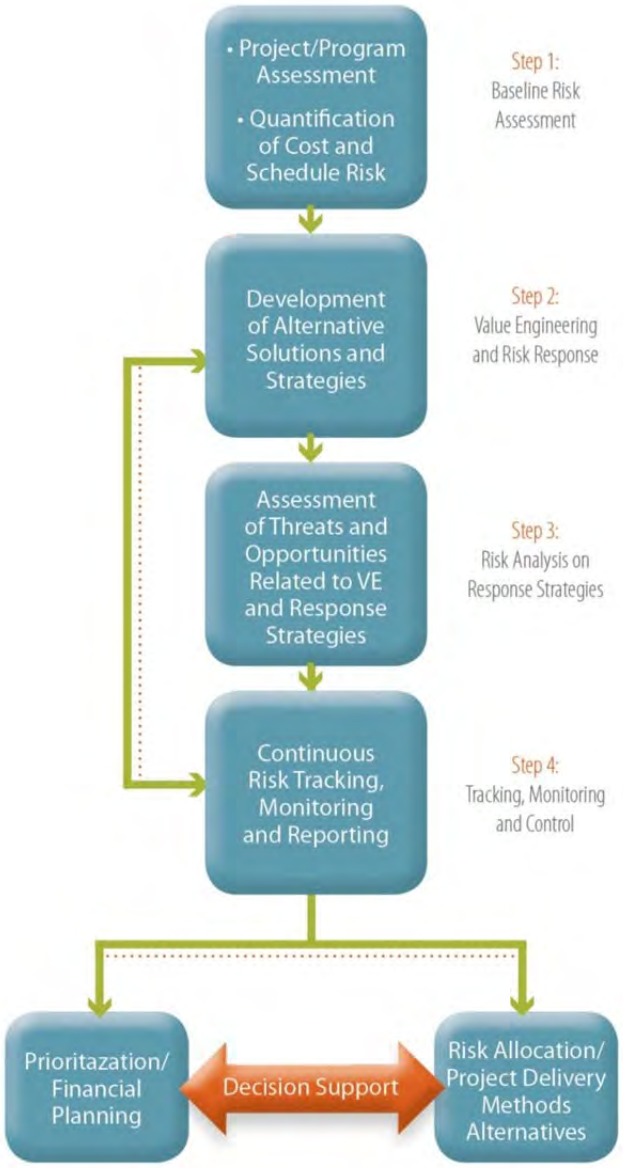
a) Develop value engineering recommendations that further mitigate or avoid high risk elements
b) Develop recommendations that add value by modifying project scope and/or schedule

Step 3: Risk Analysis on Response Strategies

a) Identify risks related to response strategies
b) Assess and quantify threats and opportunities in terms of project's cost and schedule

Step 4: Tracking, Monitoring, and Control

a) Identify risk owners, monitoring frequency
b) Continuously update risk management plan
c) Document and report progress
d) At key milestones, update cost and schedule



CRAVE™ Study Attendees

TH 101 / CSAH 61 Connection

2012 November					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
								Office	Cell
5	6	7	8	9				E-MAIL	
✓				✓	Mark Benson	SEH	Highway Design	(651) 490-2000	(612) 201-1609
								mbenson@sehinc.com	
✓	✓	✓	✓	✓	Jackie Borman	HDR	Construction	(775) 842-0192	(775) 857-8262
								Jackie.borman@hdrinc.com	
✓	✓	✓	✓	✓	Nicole Danielson-Bartel	MnDOT	South Area Engineer		
								nicole.danielson-bartel@state.mn.us	
✓	✓	✓	✓	✓	Mohammad Dehdashti	MnDOT	Metro Design	(651) 234-7606	
								mohammad.dehdashti@state.mn.us	
✓				✓	Ron Farmer	SEH	Geotechnical	(651) 990-2139	(651) 247-5218
								rfarmer@sehinc.com	
✓					Lisa Freese	Scott County	Program Delivery Director	(952) 496-8363	
								lfreese@co.scott.mn.us	
✓	✓	✓	✓	✓	Bill Gilmore	Gimore Consulting	Construction/Cost	(801) 824-5701	
								BGilmoreGCS@gmail.com	
✓					Brigid Gombold	MnDOT	Project Doc. Metro	(651) 234-7466	
								brigid.gombold@state.mn.us	
✓					Andy Hingeveld	Scott County	Planner	(952) 496-8839	
								ahingeveld@co.scott.mn.us	
	✓				Craig Johnson	MnDOT	Archaeologist	(651) 366-3614	
								craig.johson@state.mn.us	

CRAVE™ Study Attendees

TH 101 / CSAH 61 Connection

2012 November					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
								Office	Cell
5	6	7	8	9				E-MAIL	
✓					Graham Johnson	SEH	Traffic	(952) 912-2641	
								grjohnson@sehinc.com	
✓				✓	Sheila Kauppi	MnDOT	Area Manager	(651) 234-7718	
								sheila.kauppi@state.mn.us	
					Kevin Kosbud	MnDOT		(218) 828-5822	
								Kevin.kosbud@state.mn.us	
✓	✓				Rich Lamb	MnDOT	Geotech	(651) 366-5595	
								rich.lamb@state.mn.us	
✓					Diane Langenbach	MnDOT	Metro South Area	(651) 234-7721	
								diane.langenbach@state.mn.us	
✓	✓	✓	✓	✓	Blane Long	HDR	Co-Team Leader/ Documentation	(360) 570-4411	(360) 742-7682
								Blane.Long@hdrinc.com	
✓					Bruce Loney	City of Shakopee	Public Works Director/City Engineer	(952) 227-1169	(952) 292-8247
✓	✓	✓	✓		Sara Maninga	MnDOT	Soil/Hydraulics	(952) 496-8054	
								sara.maninga@state.mn.us	
✓			✓	✓	Minnie Milkert	Mn/DOT	State Value Engineer	(651) 366-4648	
								minnie.milkert@state.mn.us	

CRAVE™ Study Attendees

TH 101 / CSAH 61 Connection

2012 November					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
								Office	Cell
5	6	7	8	9				E-MAIL	
✓	✓	✓	✓	✓	Kate Miner	Carver County	Traffic Engineer	(952) 466-5208	
								kminer@co.carver.mn.us	
✓					Paul Neslon	Scott County	Natural Resources/Watershed	(952) 496-8054	
✓	✓	✓	✓	✓	Dave Nyquist	MnDOT	Geometrics	(651) 366-4711	
								dave.nyquist@state.mn.us	
✓				✓	Paul Oehme	City of Chanhassen	Public Works Director	(952) 227-1169	(952) 292-8247
✓					Daniel Prather	MnDOT Bridge Office	Engineer Prelim Design	(851) 366-4457	
								Dan.prather@state.mn.us	
✓				✓	Lyndon Robjent	Carver County	Public Works Director	(952) 466-5206	(612) 247-6348
✓	✓	✓	✓	✓	Ryan Rohne	MnDOT	Bridge	(651) 366-4453	
								ryan.rohne@state.mn.us	
✓					David Sheen	MnDOT	Traffic	(651) 234-7824	
								david.sheen@state.mn.us	
✓					Hailu Shekur	MnDOT	WRE-MnDOT	(651) 234-7521	
								hail.shakur@state.mn.us	
✓					Ken Slama	MnDOT	Construction	(651) 775-0736	
								kenneth.slama@state.mn.us	

CRAVE™ Study Attendees

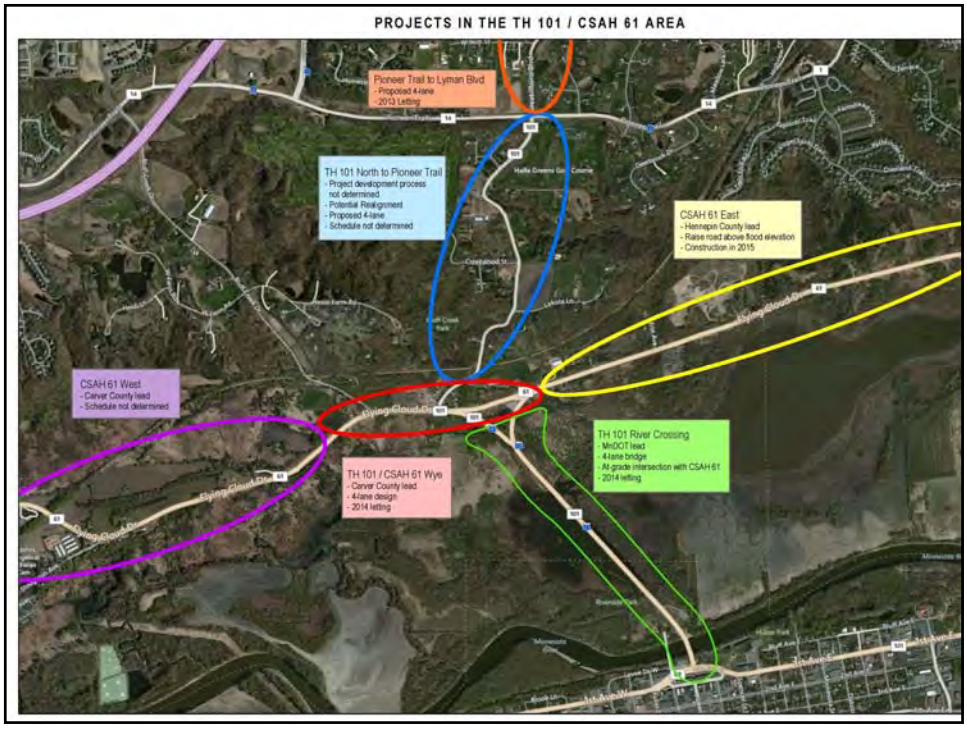
TH 101 / CSAH 61 Connection

2012 November					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE	
								Office	Cell
5	6	7	8	9				E-MAIL	
✓	✓	✓	✓	✓	Ken L. Smith	HDR	Team Leader/Facilitation	(360) 570-4415	(360) 451-2527
								Ken.L.Smith@hdrinc.com	
✓	✓	✓	✓	✓	Brian Wifler	MnDOT	Pre-design	(651) 234-7668	
								brian.wifler@state.mn.us	
✓					Lee Williams	Mn/DOT	R/W	(651) 234-7599	
✓					Tony Winiecki	Scott County	Traffic Engineer	(952) 496-8008	
								twiniecki@co.scott.mn.us	

TH 101 Flood Mitigation and CSAH 61 Project

CRAVE Study
November 5, 2012

Your Destination...Our Priority



What is CRAVE™

- CRAVE™ is used to assist project delivery as well as minimize and mitigate quantified risks
- CRAVE™ - innovative unique process
  - Cost Risk Analysis + Value Engineering
    - Combines these two tools to assist with project delivery
- Outputs are:
  - Risk management plan
  - Value Engineering recommendations

Addressing Cost and Schedule Concerns

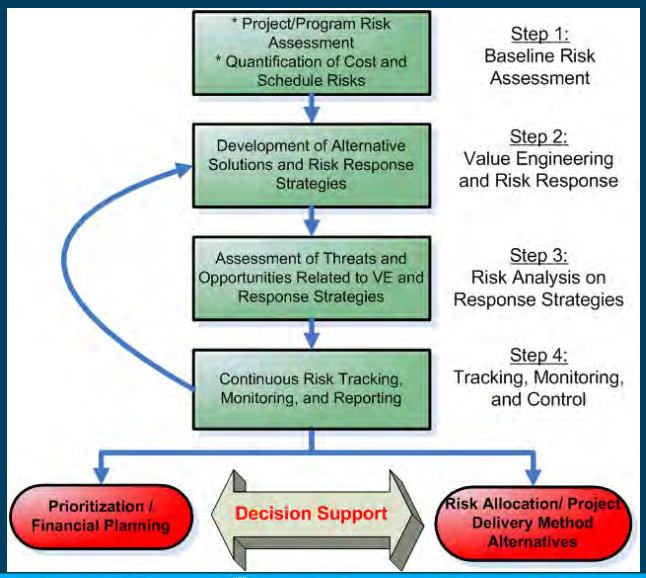
Usual Questions

- How much will it cost?
- How long will it take?
- Why does it cost that much?
- Why does it take that long?

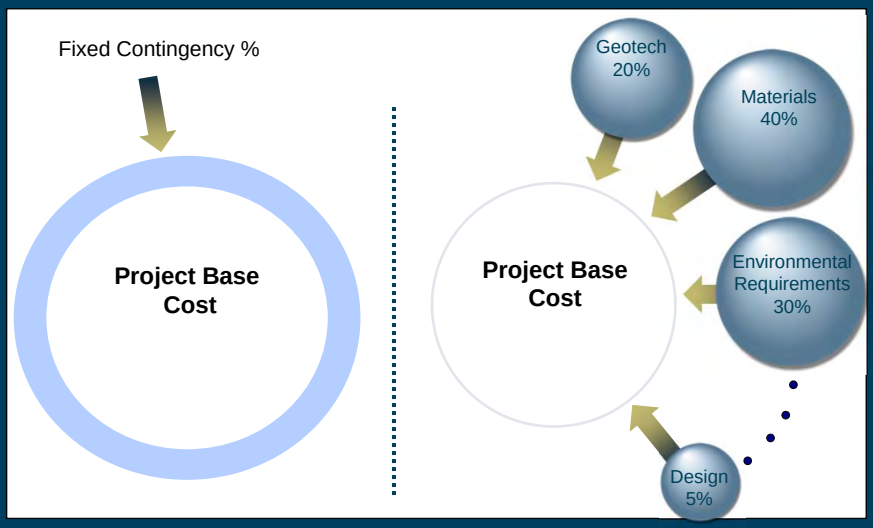
Analysis Needs

- Risk Identification
- Qualitative and Quantitative Risk Analysis
- Value Engineering &Mitigation Strategies
- Risk Monitoring & Control

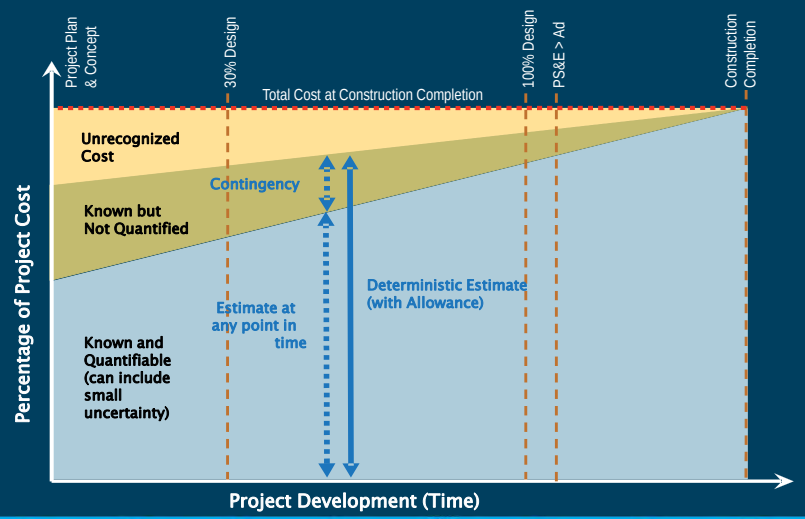
CRAVE™ Process



Traditional Vs. Risk-Based Approach



Assessment of Baseline Cost



7

CRAVE™ Team Members

- Jackie Borman Design/ Construction
- Nicki Danielson – Project Management
- Mohammad Dehdashti – Design
- Bill Gilmore – Construction
- Blane Long – Facilitator
- Sara Maninga – Soils/ Hydraulics
- Dave Nyquist – Geometrics
- Kate Miner – Traffic
- Ryan Rohne – Structures
- Ken Smith Team leader
- Brian Wifler – Design

Purpose and Need TH-101

- Provide a lower-cost, near term improvement to local and regional mobility during seasonal flooding in the Minnesota River Valley
- Provide a safe and reliable crossing during flooding (up to the 100-yr event) without causing an increase in the 100-yr floodplain elevation.

Funding

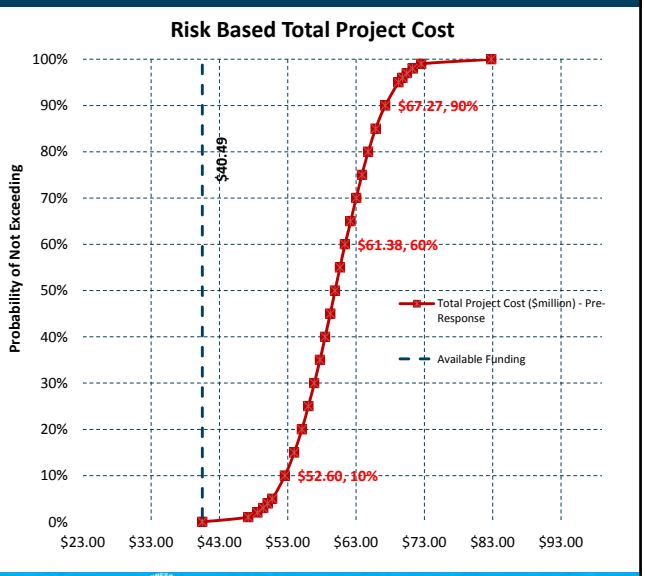
- All State Funds
  - $20M Flood Mitigation bonding
  - $9M Local Road Improvement Program (LRIP)
  - $5M Local match (Carver and Scott Counties)
  - $3.84M Preliminary Engineering Costs (MnDOT)
  - $2.65M Construction Engineering Cost (MnDOT)
- **$40.49M total**
  - Cash flow considerations
- Current funding gap of $4-6M (MnDOT proposal)

Goals CSAH 61

1. Construct improvements on CSAH 61 (Flying Cloud Dr) in the "Y" area to accommodate the new 101 river crossing and future traffic growth.
2. Construct CSAH 61 to accommodate future improvements to 101 north of 61 up the bluff.
3. Build long term as opposed to temporary improvements on CSAH 61 if possible while the river crossing is being constructed.
4. Implement the Carver County and City of Chanhassen Transportation Plan for 101 & 61

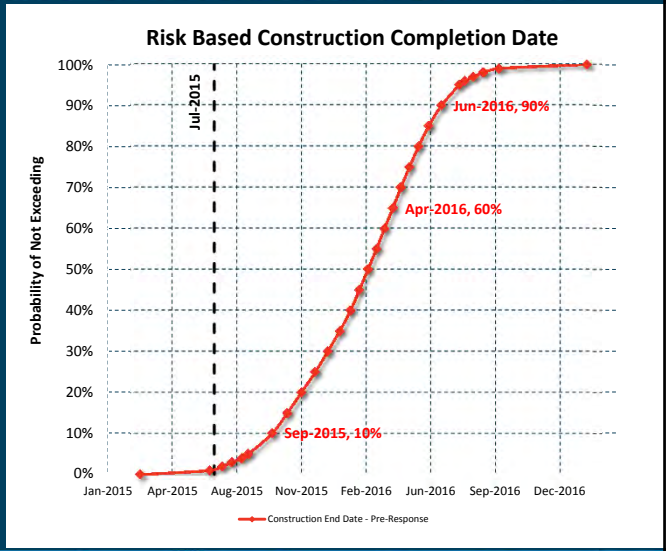
Pre-Response Risk TH 101

Risk Reserve @ 60%
$20.9M or 52%



Pre-Response Schedule TH 101

60% chance of completion by April 2016



Candidates for Cost Mitigation TH 101

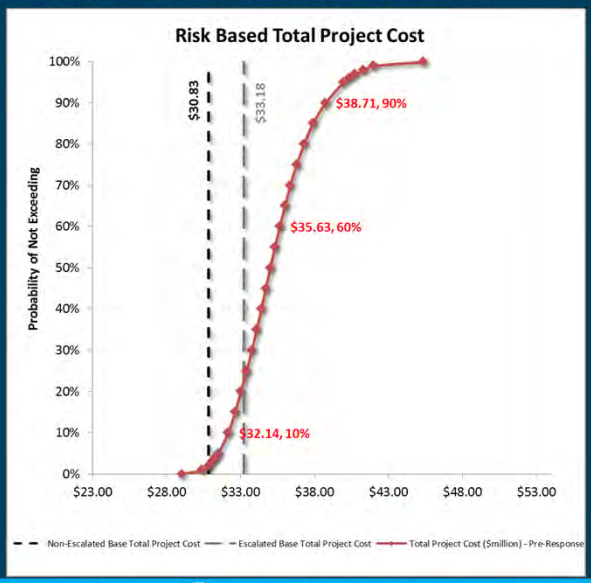
"What gets measured, gets managed"

14

Canaidates fo Schedule Mitigation TH 101

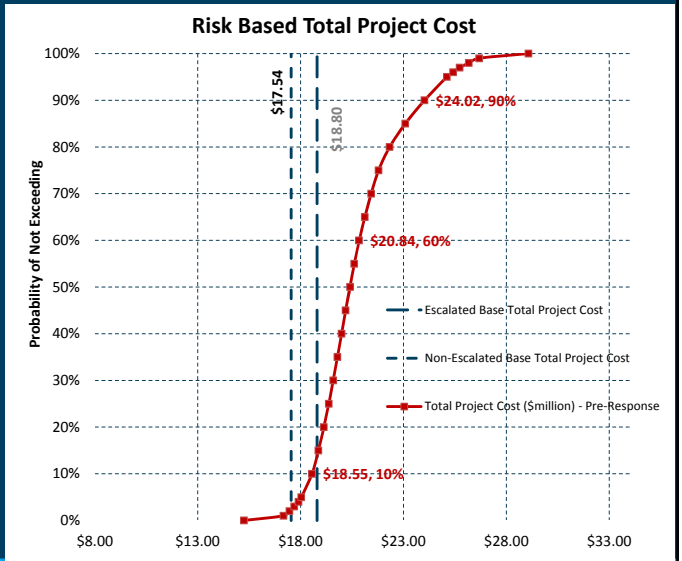
Pre-Response Risk CSAH 61

Risk Reserve @ 60%
$2.45M or 7.4%



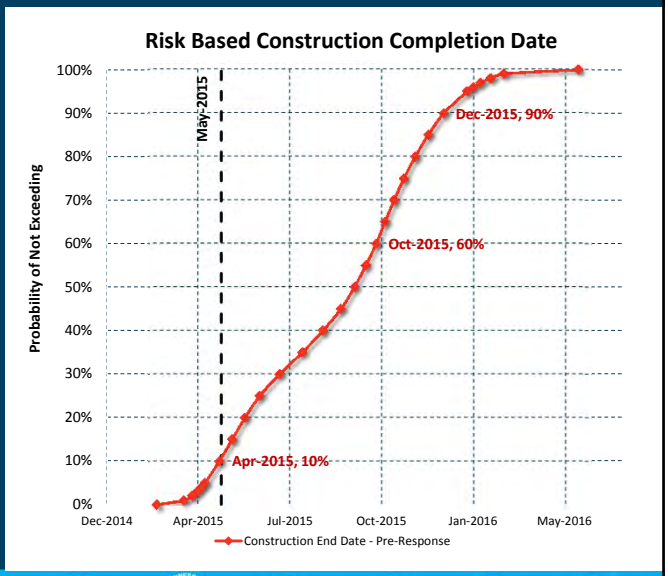
Pre-Response Risk CSAH 61

Adjusted to remove double counting from TH-101
Risk Reserve @ 60%
$2.04 M or 10.9%



Pre-Response Schedule CSAH 61

60% chance of completion by October 2015

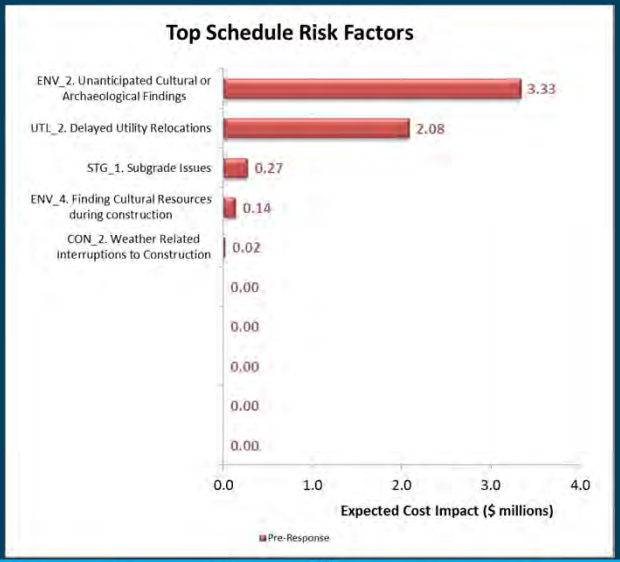


Candidates for Cost Mitigation CSAH 61

"What gets measured, gets managed"

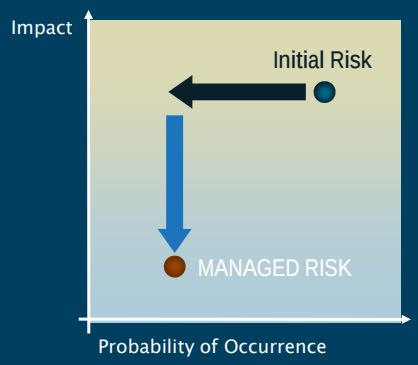
19

Candidates for Schedule Mitigation CSHA 61



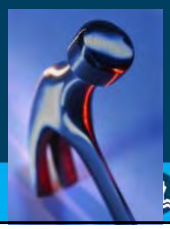
Goal of Risk Management

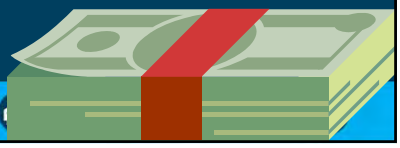
- Risk Assessment's aim is to assess potential impact of various scope, event, and budget risks on the project's cost and schedule.
- Risk Management's aim is to identify opportunities and mitigation strategies to reduce both the likelihood of an event occurrence and the potential effect if it occurs.



Remember:

Contractors do not take risks.
They price it!
You can avoid or mitigate some of these risk by implementing the following recommendations





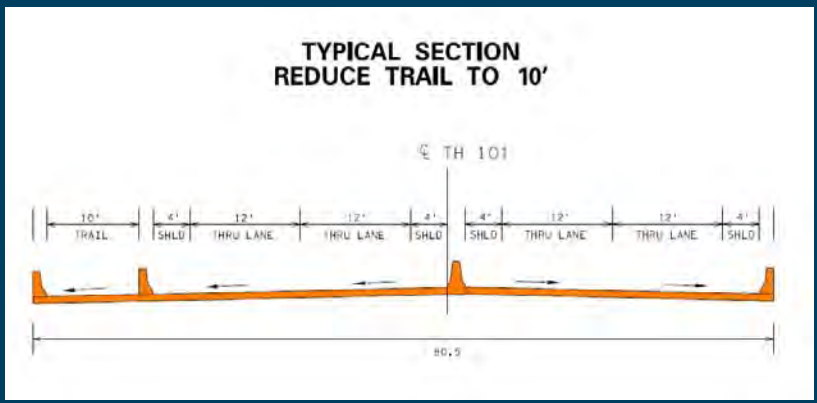
TH 101 #1 Test Pile Program

TH-101 # 2 Procurement Schedule

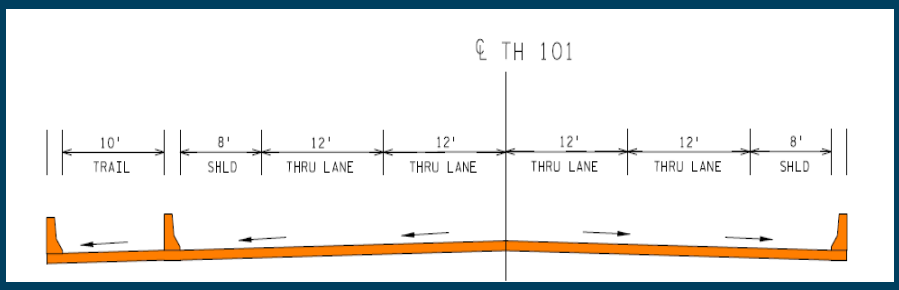
By advertising and letting the contract in the fall it will be possible for a contractor to procure piling and girders in the fall.

TH-101 # 3 Staging

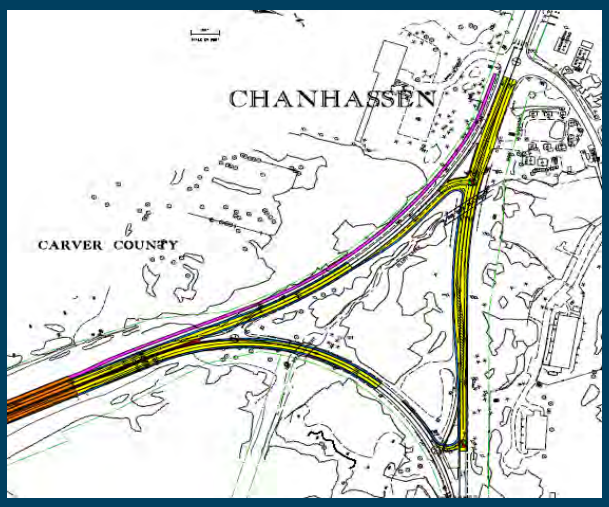
TH-101 #4a Trail on Bridge



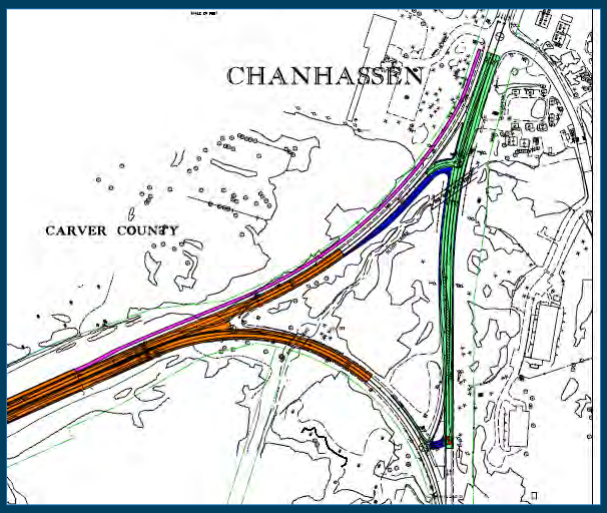
TH-101 # 4b Median Width



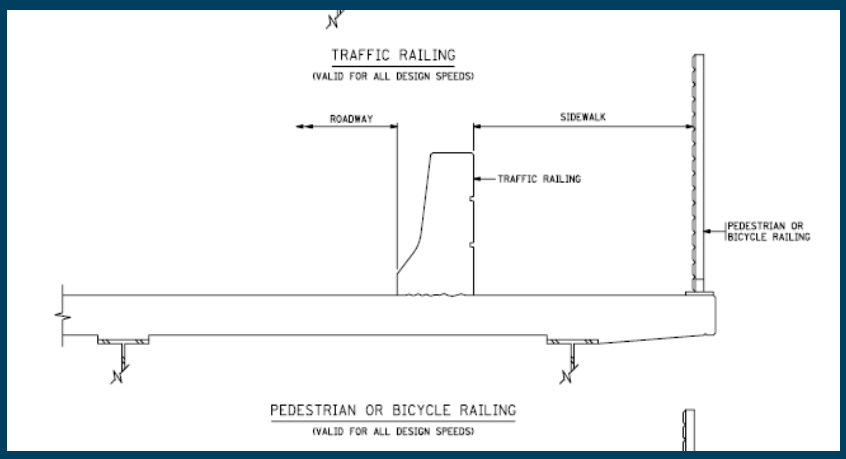
TH-101 # 5 One Way Wye



TH-101 # 6 Extend Bridge



TH-101 # Pedestrian Railing



TH-101 Recommendation Summary

Minnesota Department of Transportation

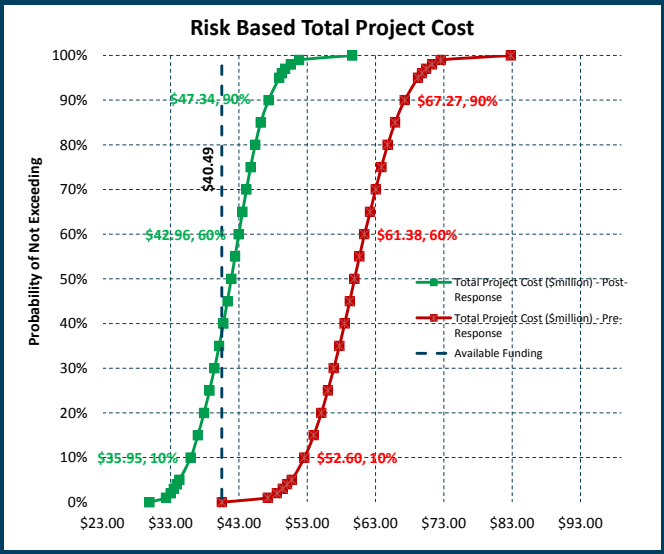
Summary of Recommendations

TH 101 Floodplain Bridge

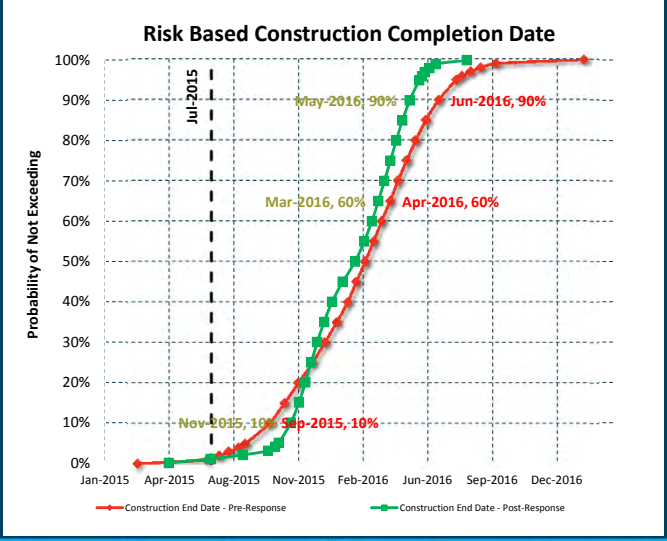
HDR

#	Description	Cost Avoidance	Performance Improvement
1	Load Pile Testing	$0.52 M	3%
2	Procurement	N/A	3%
3	TH 101 Staged Construction	$0.95 M	4%
4a	Reduce Width of Trail	$0.62 M	1%
4b	Bridge Typical Section	$1.09 M	26%
5	Construct One-Way Wye	$3.71 M	4%
6	Extend Bridge through Bluff Creek	$1.50 M	6%
7	Pedestrian Railing	$0.45 M	2%
	Total	$8.84 M	

TH-101 # Mitigated Cost



TH-101 # Mitigated Schedule



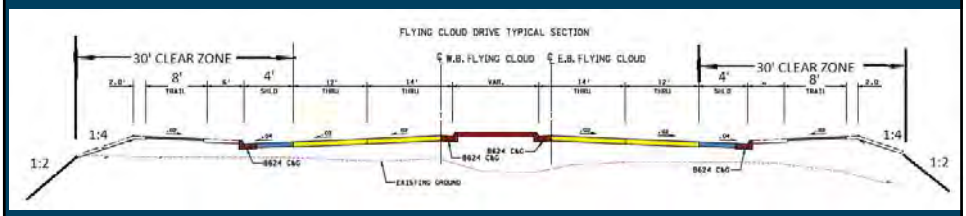
TH-101 # Mitigated Cost

TH-101 # Mitigated Schedule

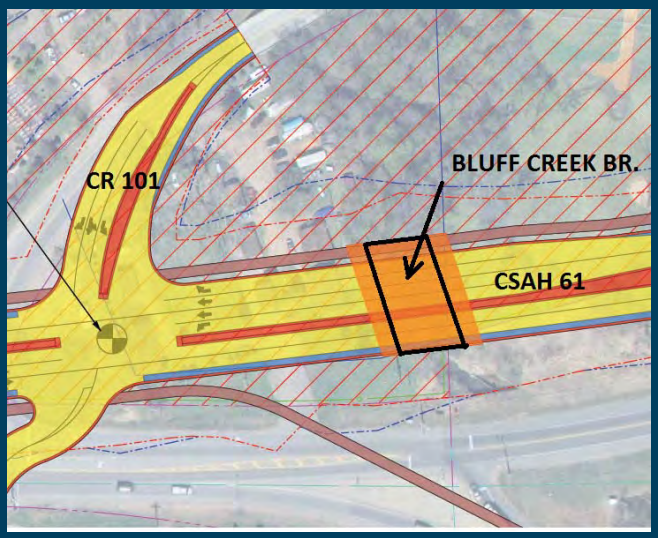
CSAH 61 Base Case

CSAH 61 #1Reduce Right of Way Acquisition

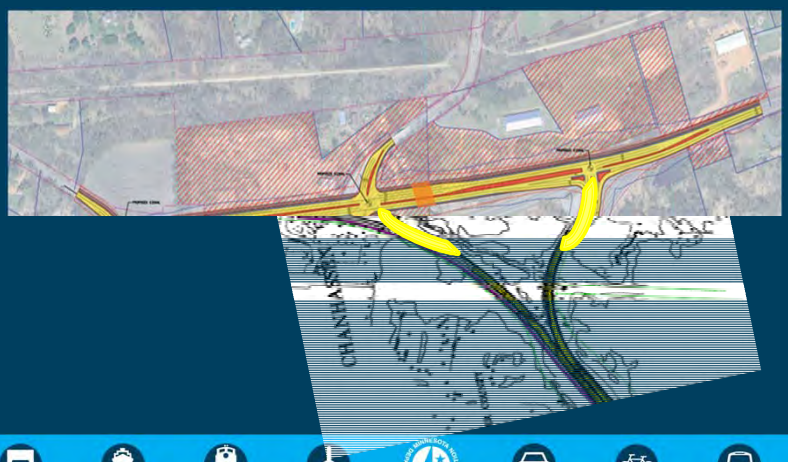
CSAH 61 #2 Roadway Section



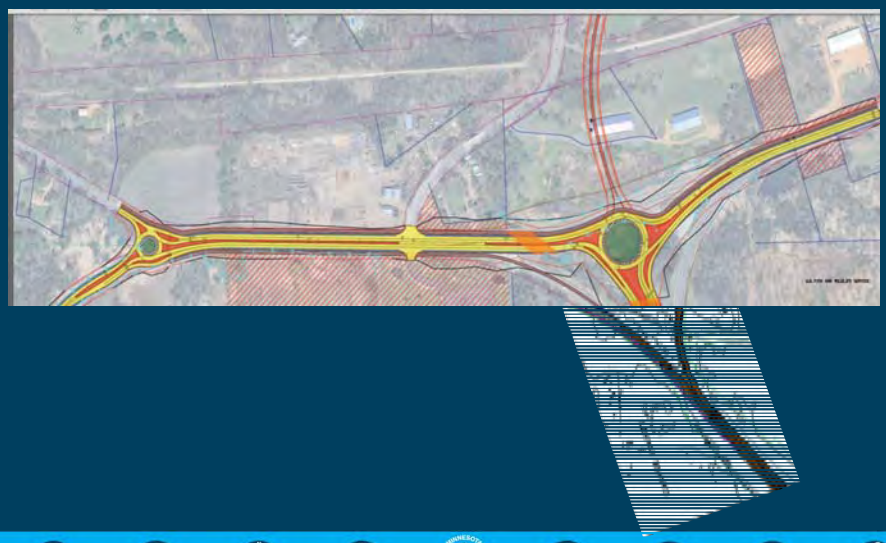
CSAH 61 #3 Bluff Creek Bridge



CSAH 61 #4a Modified Wye with full CSAH 61 section, construction potential for future (staged phases)



CSAH 61 #4b Roundabout, bridge tie in build, roundabout construction now



CSAH 61 #4c Modified Wye interchange tie in

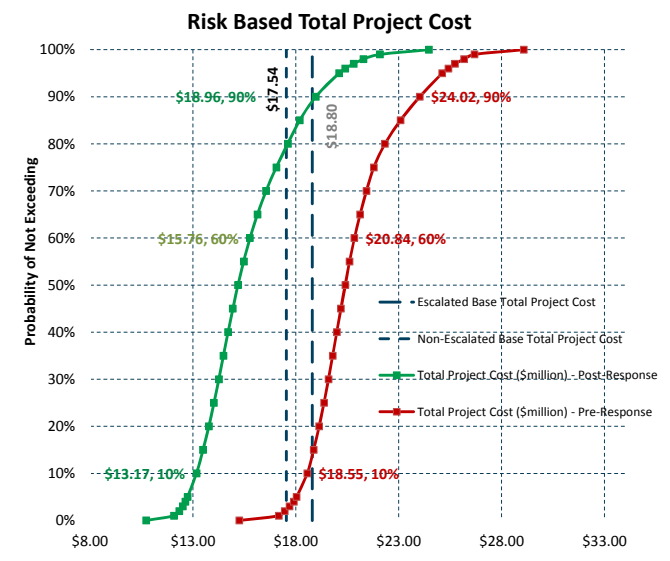
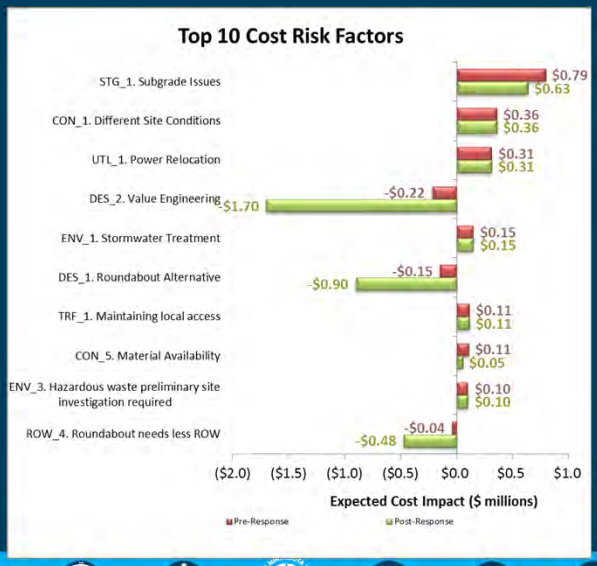
CSAH 61 Recommendation Summary

Summary of Recommendations

TH 101 / CSAH 61 Connection

#	Description	Cost Avoidance	Performance Improvement
1	Reduce ROW Acquisition	$1.74 M	6%
2	CSAH 61 - Roadway Section	$1.34 M	1%
3	CSAH 61 - Bluff Creek Bridge	$0.94 M	3%
4	TH 101 / CSAH 61 Connection	$1.50 M	42%
	Total	$5.52 M	

CSAH 61 Mitigated cost



CSAH 61 Mitigated Cost