Cost Risk Assessment and Value Engineering Workshop Report

TH 101 Floodplain Bridge
SP 1009-24

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 CRAVE™ study. These opinions were based on the information provided to the team at the time of the study. 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 study and unless otherwise noted are in current year (CY) dollars.

HDR

HDR Engineering, Inc.
701 Xenia Ave. S
Suite 600
Minneapolis, MN 55416

Table of Contents

Executive Summary

This Executive Summary provides an overview of the project, key findings, and the recommendations developed by the Cost Risk Assessment and Value Engineering (CRAVE™) Team during the workshop. CRAVE™ is a unique innovative process developed by HDR. It combines the proven process and tools of a Cost Risk Assessment with Value Engineering. Detailed documentation and exhibits of the study's analysis are provided in the CRAVE™ Study Report.

Workshop Statistics

Original Cost:
$43.2 million

Number of Recommendations:
8

Recommended Cost Savings:
$10.3 million

Recommended Value Added:
N/A

Number of Accepted Recommendations:
5

Accepted Recommended Cost Savings:
$4.2 million

Total Number of Team Members:
11

Federal Employees:
0

MnDOT Employees:
7

Others:
4

Facilitator:
Consultant

Introduction

A CRAVE™ Study, sponsored by the Minnesota Department of Transportation and facilitated by HDR Engineering, Inc., was conducted for the improvements to the TH 101 Floodplain Bridge project (SP 1009-24).

The study was conducted at less than 30% level of design and the project is currently funded for construction. This CRAVE™ Workshop was conducted from November 5-9, 2012.

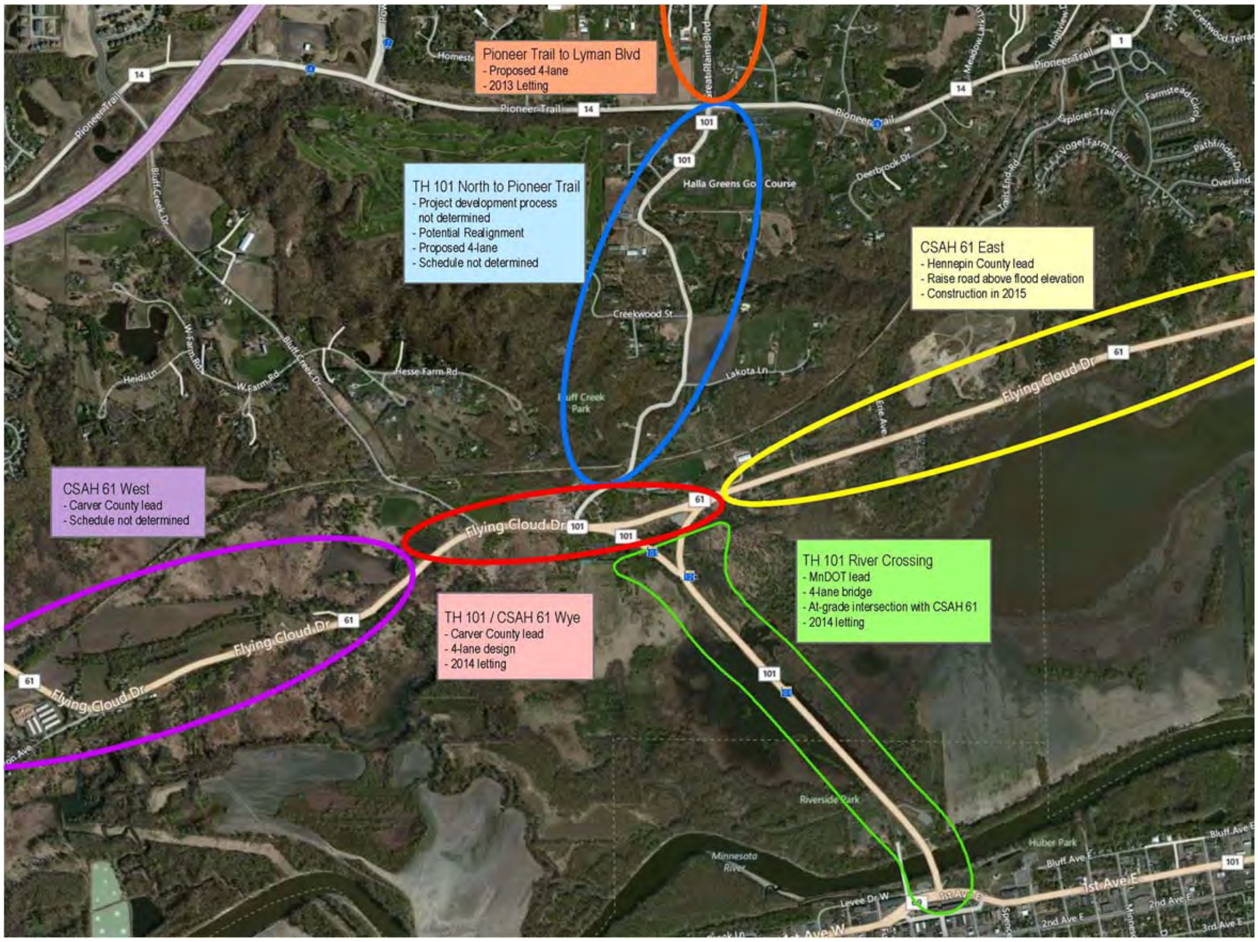
Project Overview

TH 101 is a two-lane facility (county highway south of the river; state highway north of the river) that connects downtown Shakopee and Flying Cloud Drive (CSAH 61). In Shakopee, TH 101 tees into CSAH 69 at a signalized intersection; CSAH 69 connects to TH 169 at an at-grade signalized intersection at the western edge of Shakopee. From its intersection with CSAH 61, TH 101 continues north on a winding alignment up the river bluff, crossing US 212 in the vicinity of CSAH 18 and eventually connects to TH 5 in Chanhassen.

In this stretch of the Minnesota River, TH 101 is a primary transportation route which has been closed frequently in recent years due to flooding. MnDOT closes this route when flood waters reach an elevation of approximately two feet below the low road elevation at the crossing. Based on this policy, closure of TH 101 takes place when the water level reaches an elevation of approximately 709.4 feet.

In 2011, TH 101 was closed on March 23rd. TH 101 reopened forty-three days later on May 5th. Overall, the TH 101 Minnesota river crossing has closed due to flooding six times between spring 1993 and spring 2011 with closure times varying from several days to several weeks. When TH 101, along with TH 41, are closed, the value of the additional time and miles traveled (using the Metropolitan Council's 2030 Regional Model to calculate the daily cost of closures) is $670,000 per day in the year 2009 and is forecasted to be $1,675,000 per day in the year 2030.

When the Highway 101 and 41 river crossings closed due to flooding, much of the traffic utilizes the U.S. Highway 169 and State Highway 25 Minnesota River crossings which cause a cascading effect of congestion that affects regional travel and costs travelers time and money.



Projects in the TH 101 / CSAH 61 Area

Purpose and Need

- 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.

The preferred concept and baseline design for the CRAVE™, at TH 101 involves constructing a 3,000' +/- land bridge within the existing MnDOT right-of-way. The proposed bridge width is 82.5'; which includes four 12' travel lanes, 4' inside and outside shoulders with a median barrier separating traffic.

The existing bridge on the north end of the crossing (MnDOT Bridge No. 10007) would be removed for the construction of the land bridge. The existing road immediately north of the proposed land bridge would be raised to a minimum centerline elevation of 724.0 feet. With this new bridge, the roadway closure elevation for TH 101 increases from 709.4 feet to 722.0 feet.

Additional Project Benefits include:

- Provide pedestrian and bike facilities between Shakopee and Chanhassen along the crossing (a 12' trail with barrier separation from traffic is on the west side of the bridge)
- Reconnect the floodplain and wetlands on either side of TH 101
- Provide additional capacity on TH 101
- Possible realignment of TH 101 at the Wye
- Replace Bluff Creek box culverts in Wye

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 Floodplain Bridge project
- Improve the value of the project through innovative measures aimed at improving 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 to CSAH 61, 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

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 16 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 $61.38 M.

Pre-Response Risk Based Estimate (Millions $)			
Available Funding	10%	60%	90%
$40.49	$52.60	$61.38	$67.27

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 $42.96 M, for a net reduction in projected costs of $18.42 M.

Post-Response Risk Based Estimate (Millions $)			
Available Funding	10%	60%	90%
$40.49	$35.95	$42.96	$47.34

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 41 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 VE Team. For a complete definition of performance see the Appendix A of this report.

From the various concepts the CRAVE™ Team developed eight recommendations. Three VE recommendations were accepted, resulting in cost savings of $4,510,000. These recommendations reduced the amount of pile supported embankment by lengthening the bridge and reducing the amount of embankment needed by reducing the width of the trail and bridge typical section.

Two additional recommendations were conditionally accepted pending further review. The first recommendation is to conduct a test pile program to determine the length of piles needed for the project; if accepted this is will save the project $670,000. The other recommendation is to use stage construction instead of closing the bridge. This will add $1,000,000 to the cost of the project but result in lower highway user costs (undetermined amount).

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 Floodplain Bridge*				
#	**Description**	**Accepted/ Rejected**	**Cost Avoidance**	**Performance Improvement**
1	Test Pile Program	Accept for further review	$0.67 M	3%
2	Procurement	Reject	N/A	3%
3	TH 101 Staged Construction	Accept for further review	$0.95 M	4%
4a	Reduce Width of Trail	Accept	$0.62 M	1%
4b	Bridge Typical Section	Accept	$1.17 M	26%
5	Construct One-Way Wye	Reject	$3.71 M	4%
6	Extend Bridge through Bluff Creek	Accept	$2.72 M	6%
7	Pedestrian Railing	Reject	$0.45 M	2%
	Total		**$10.29 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	Assistant Team Leader
Sara Maninga	Soils/Hydraulics
Kate Miner	Traffic
Dave Nyquist	Design
Ryan Rohne	Bridge
Ken Smith	CRAVE™ Team Leader
Brian Wifler	Design

The Project Manager for this project is Nicole Danielson-Bartell, Mn/DOT.

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

Ken L. Smith, PE, CVS
CRAVE™ Team Leader

Project Analysis

The following items and tools were used to assist the CRAVE™ Team in 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 items were provided to the CRAVE™ Team for their use during the workshop:

Reports/Drawings/Maps	Date
Various Construction Cost Estimates	October 2012
Various Layouts & Maps (alternatives)	October 2012
Profiles	October 2012
Meeting Minutes, etc.	June 2012
Resource Agency Handout (Flood Mitigation)	September 2012
Early Notification Memo	August 2012
Chanhassen City Council Meeting	September 2012
Minnesota River Flood Mitigation Study - Final Report	September 2011
Typical Bridge and Roadway Sections	October 2012
Stakeholder List	Current

Project Issues

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

- Flood Mitigation Study completed September 2011:
  - Looked at providing a lower-cost, near term improvement to local and regional mobility during seasonal flooding in the Minnesota River Valley
  - TH 101 land bridge was preferred alternative selected
  - Project selected to receive $20M Flood Mitigation Bonding money
- Complex and extensive geotechnical:
  - Very poor soils, especially in bridge area
  - Muck depth of ~15-90 ft across the project
  - Better as you move north
  - Estimated pile length of 120’ for bridge foundations
  - Considering bridge, pile supported embankment, and mucking out throughout the project

  - Geotechnical investigations are ongoing
- Damage to roadway, especially downstream shoulder and slope
- No right of way impacts
- Right-of-way constraints:
  - US Fish and Wildlife property to the east
  - DNR property to the west
  - All temporary and permanent impacts are to the west to avoid USFW land
    - Avoid complicated 4f process
- Voluntary EAW
- Expected Permits:
  - US Army Corps Wetlands
  - DNR Wetlands
  - Lower MN River Watershed District
  - Possible DNR Public Waters Permit
- Cultural Resources
- Hazardous Waste and Asbestos Investigation
- Waterway analysis/modeling completed in Flood Mitigation Study
- Stormwater Treatment:
  - Entire project is in the floodplain
  - Difficult to meet treatment requirements onsite
  - Exploring alternative treatment options
  - Difficult to carry water off of the bridge
  - Current bridge design does not meet spread criteria
- Construction Traffic Impacts:
  - Currently assuming full closure of TH 101 for one year (July 2014-July 2015)
  - Constructability Review scheduled for Nov 20
  - Advanced Mitigation planned on TH 169:
    - Restriping TH 169 similar to an emergency restriping project in March 2011 (Flood related)
    - Long-term temporary condition, 1-year
- Cost Estimate:
  - Base layout
  - $24M for land bridge (includes $1.2M excavation)
  - $12.8M for wye area:
    - Assumes pile supported embankment
    - Includes bridge at Bluff Creek
  - $2.25M for TH 169 restriping (advanced mitigation)
- 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

- o Current funding gap of $4-6M (MnDOT proposal)
- Project Schedule:
  - o May 2014 Letting
  - o Plan turn-in Feb 2014
  - o Environmental and ROW documents required prior to letting
  - o Dec 2012 need to select layout to proceed and meet schedule
- Partners:
  - o Scott County
  - o Carver County
  - o Hennepin County
  - o City of Chanhassen
    - o City of Shakopee

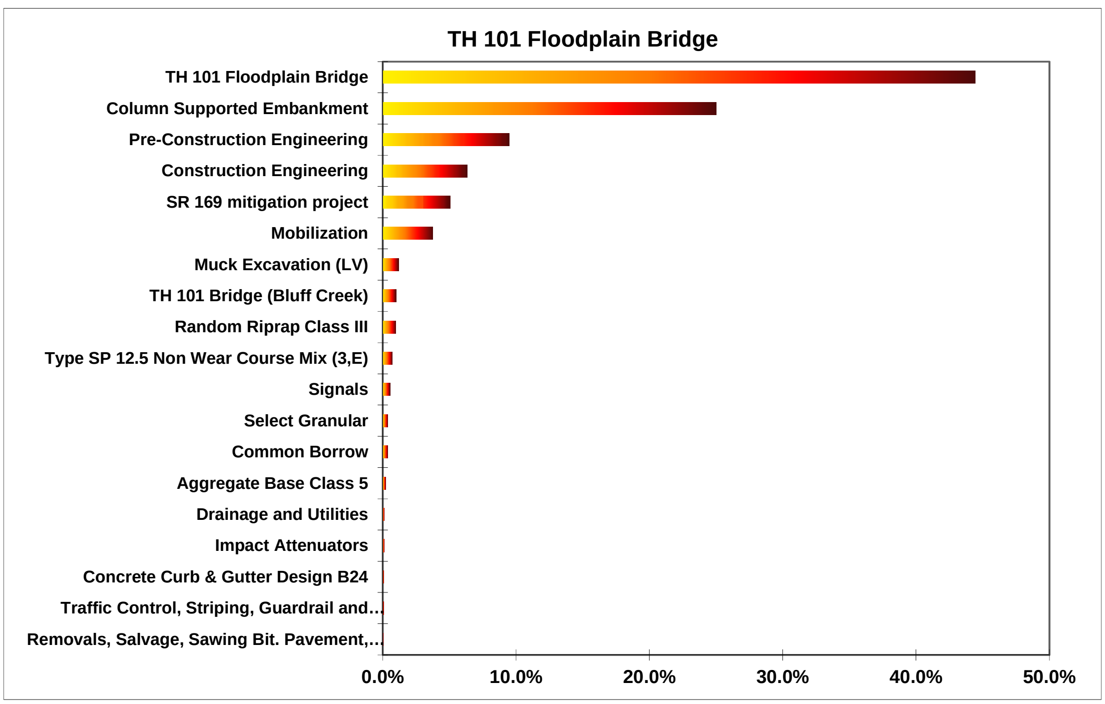
Constraints and Controlling Decisions

The CRAVE™ Team was presented with the following constraints and controlling decisions from the Project Team during the Information Phase of the workshop:

- Minimum edge of pavement elevation of 722.7 (2' above 100 year event)
- Limited Funding
- Avoid all impacts to USFW

Cost Model

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



Project Cost Model

Performance Attributes

Performance attributes are integral part of the value engineering process. The performance of each attribute 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™, 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.	Barrier separated 4 - 12' lanes 4' inside & outside shoulders Minimum edge of pavement elevation of 722.7 (2' above 100 year event) 0.5% grade across bridge 4' raised median and 3' inside shoulders off of bridge Design Speed/Posted 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.	12' trail on outside separated from lanes by barrier (separate alignment using existing pavement north of bridge) Simple T connection to CSAH 61 Signalized intersection at T right turn lane north to east (yield) right turn lane east to south (free) single left north to west single left west to south
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 3:1 slope with guardrail Replacement of box culverts with bridge at Bluff Creek No snow storage available 52 bridge drains 4' shoulders requires lane closures for bridge inspection Impact Attenuators at barrier ends
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 during construction (TH 101) Pile Driving noise impacts Impacts to local roadways due to hauling materials in and out of project CSAH 61 will be constructed under intermittent lane closures Some utility impacts within wye

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.	No right-of-way impacts Reconnection of the flood plain. Recreation of wetlands (removal of existing embankment) Boat ramp remains open during construction
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 Floodplain Bridge

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

Paired Comparison Weighting

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.

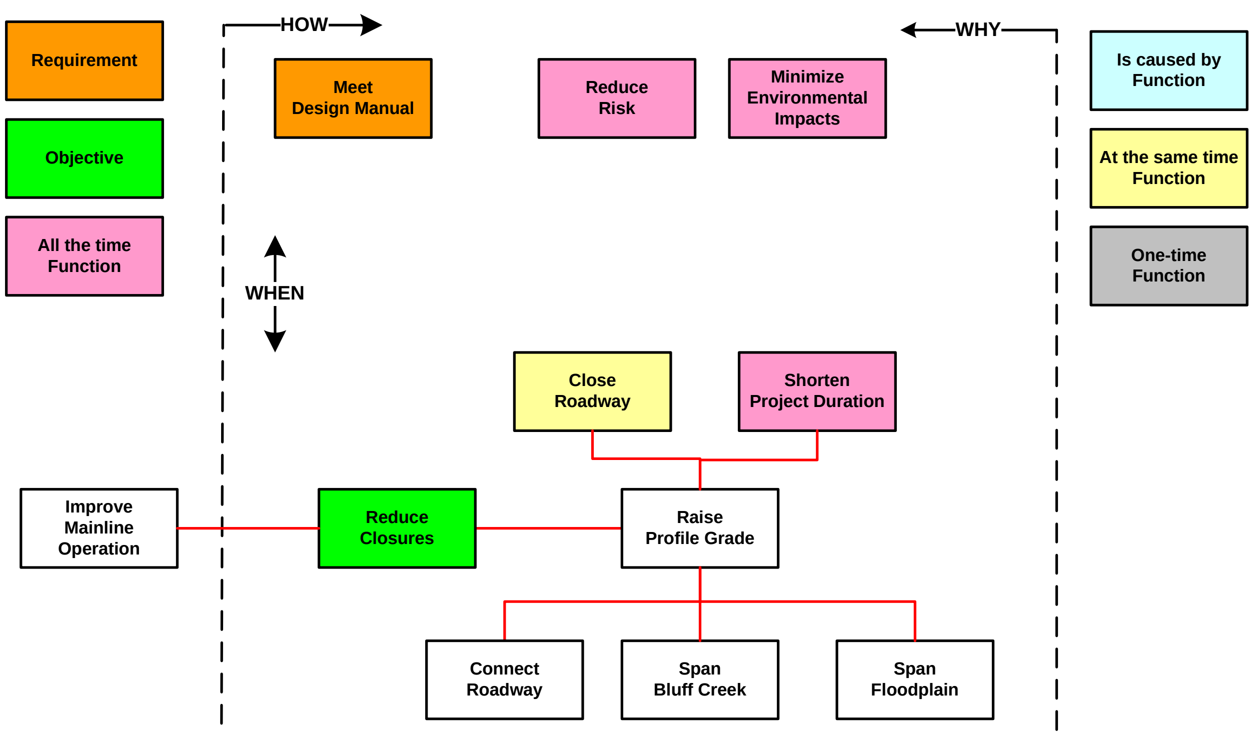
Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level. Identifying the functions of the major design elements of the project allows a broader consideration of alternative ways to accomplish the functions.

Span Roadway	Improve Mobility	Raise Profile Grade
Close Roadway	Reduce Closures	Span Bluff Creek

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 Closures* as the basic function of this project. Key secondary functions included *Connect Roadway, Span Bluff Creek* and *Span Floodplain*. 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

Speculation

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

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

Creative Idea List

Span Floodplain

- Reduce trail to 10' wide
- Reduce trail to 8' wide
- Increase shoulders to 6' wide
- Increase shoulders to 8' wide
- Remove median barrier and use double yellow stripe
- Use concrete barrier for pedestrian rail
- Reduce inside shoulder to 2'
- Use ABC methods to reduce bridge construction time (precast or composite for deck)
- Use 2-lane bridge
- Increase to 6-lane bridge
- Construct a 2-lane bridge on top of the existing embankment
- Widen the TH 169 bridges to there fullest extent to add capacity
- Extend bridge through Bluff Creek
- Do a load test
- Construct a floating bridge
- Series of con-span units
- Signature bridge
- 11' lanes
- Fewer but larger piles
- Eliminate the trail portion of the structure and leave the existing roadway for pedestrians
- Construct the bridge as far west as possible to maintain traffic during construction
- Construct a 2-lane bridge with the ability to widen in the future.

Span Bluff Creek

- Salvage the north bridge and use it to span Bluff Creek
- Box Culverts – a bunch of them
- Three Sided Box
- Con Span
- Reroute Bluff Creek
- Construct bridge at the elevation needed for any future improvements.

Connect Roadway

- Raise profile to match county design
- Use the west leg to construct the T
- Construct a one-way Wye (modified Wye)
- Construct a roundabout to replace signalized intersection
- Do not construct anything beyond the grade tie-in (flood plain bridge connection)
- Use 2 “Green” T intersections
- Construct a T intersection through the middle of the Wye
- Use dual left turn lanes
- Use lightweight fill or in conjunction with geogrid
- Construct intersection to work with 2034 traffic volumes
- Half separated T (flyover)
- Construct an interchange
- Construct a tunnel under the muck.

Shorten Project Duration

- Let the project in the Fall so that pile driving could occur during the winter months
- Early procurement for beams or pilings
- Do not close the roadway during construction.

Evaluation

All of the ideas that were generated during the creative phase using brainstorming techniques and then 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 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 at the time of the study, many ideas were not advanced to recommendations or design considerations after the initial evaluation using advantages and disadvantages was made 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.

Span Floodplain

#	Description	Advantages	Disadvantages
1	Reduce trail to 10' wide across TH 101 Floodplain bridge	▪ Reduces square footage of bridge	▪ Increases conflicts between users

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

Cost: 👍	*Justification/Comments: Regional trail standard is 10' but bridge is 12' - Moved to further development*
Rating: 4	

#	Description	Advantages	Disadvantages
2	Increase the outside shoulders to 8' wide on TH 101	▪ Would meet CSAH rural standard ▪ Provides a place to pull off roadway ▪ Snow storage ▪ Could reduce risk by providing additional width for stage construction.	▪ Increase cost ▪ More structure to maintain ▪ Additional substructure

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

Cost: 👎	*Justification/Comments: Combine with other ideas as needed*
Rating: 3	

#	Description	Advantages	Disadvantages
3	Remove median barrier and raised median and used a double yellow stripe	▪ Reduces SF of bridge ▪ Eliminates impact attenuators ▪ Improves snow operations ▪ Improves sight distance for those exiting boat ramp ▪ Improves emergency vehicle access	▪ Increases conflicts ▪ Driver discomfort ▪ May require a design variance

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

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

#	Description	Advantages	Disadvantages
4	Use concrete barrier for pedestrian rail	▪ Lower cost ▪ Procurement (can be cast with other barriers	▪ Aesthetics ▪ Still need to have a rail on top to meet height requirements

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

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

#	Description	Advantages	Disadvantages
5	Reduce inside shoulder to 2’	▪ Reduced cost ▪ Reduced deck surface	▪ Encroaches on shy distance ▪ Standard for curb reaction distance is 4’

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

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

#	Description	Advantages	Disadvantages
6	Use ABC methods to reduce bridge construction time (precast or composite for deck)	▪ Reduced construction schedule	▪ Added cost ▪ Local contractors prefer conventional construction

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

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

#	Description	Advantages	Disadvantages
7	Use 2-lane bridge	▪ Reduced cost ▪ May improve constructability ▪ Municipal consent not needed for a two lane bridge	▪ Governor has said this will be a 4 lane bridge ▪ Will not meet traffic needs

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

Cost: 👍	*Justification/Comments: Current traffic is over 20,000 ADT – Dropped from further consideration*
Rating: 1	

#	Description	Advantages	Disadvantages
8	Increase to 6-lane bridge	▪ None noted	▪ Cost ▪ Not required by traffic projections

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

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

#	Description	Advantages	Disadvantages
9	Construct a 2-lane bridge on top of the existing embankment (viaduct) leave	▪ May be able to build under traffic	▪ Will not remove floodplain barrier ▪ Would require straddle bents ▪ Complicated tie in with poor geometrics ▪ Only two lanes open during flood conditions

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

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

#	Description	Advantages	Disadvantages
10	Widen the TH 169 bridges to there fullest extent to add capacity		

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: Will not meet purpose and need of this project*
Rating: 0	

#	Description	Advantages	Disadvantages
11	Extend bridge through Bluff Creek	▪ Eliminates pile supported fill ▪ Extends flood plain opening ▪ Eliminate maintenance of cleaning debris from Bluff creek	▪ May add cost ▪ Added bridge maintenance cost ▪ May extend schedule ▪ Additional drainage from bridge

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

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

<table>
<tr><th>#</th><th colspan="2">Description</th><th colspan="2">Advantages</th><th colspan="2">Disadvantages</th></tr>
<tr><td>12</td><td colspan="2">Do piling load test</td><td colspan="2">▪ Can reduce pile length
▪ Reduces risk</td><td colspan="2">▪ Could add time to the preconstruction schedule</td></tr>
<tr><td colspan="2">Mainline Operations</td><td>Local Operations</td><td>Maintainability</td><td>Construction Impacts</td><td>Environmental Impacts</td><td>Project Schedule</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Cost: 👎</td><td colspan="5" rowspan="2">Justification/Comments: Moved to further development</td></tr>
<tr><td colspan="2">Rating: 5</td></tr>
</table>

<table>
<tr><th>#</th><th colspan="2">Description</th><th colspan="2">Advantages</th><th colspan="2">Disadvantages</th></tr>
<tr><td>13</td><td colspan="2">Construct a floating bridge</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Mainline Operations</td><td>Local Operations</td><td>Maintainability</td><td>Construction Impacts</td><td>Environmental Impacts</td><td>Project Schedule</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Cost: 👎👎</td><td colspan="5" rowspan="2">Justification/Comments: Not feasible</td></tr>
<tr><td colspan="2">Rating: 0</td></tr>
</table>

<table>
<tr><th>#</th><th colspan="2">Description</th><th colspan="2">Advantages</th><th colspan="2">Disadvantages</th></tr>
<tr><td>14</td><td colspan="2">Series of con-span units</td><td colspan="2">▪ Constructability
▪ Possible to stage construction</td><td colspan="2">▪ May reduce the opening size under the bridge
▪ May not work hydraulically
▪ Will require more piles
▪ May increase cost</td></tr>
<tr><td colspan="2">Mainline Operations</td><td>Local Operations</td><td>Maintainability</td><td>Construction Impacts</td><td>Environmental Impacts</td><td>Project Schedule</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td>👎</td><td></td></tr>
<tr><td colspan="2">Cost: 👍👎</td><td colspan="5" rowspan="2">Justification/Comments: Dropped from further consideration</td></tr>
<tr><td colspan="2">Rating: 2.5</td></tr>
</table>

#	Description	Advantages	Disadvantages
15	Signature bridge	▪ None noted	▪ Added cost ▪ Not requested by stakeholders

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

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

#	Description	Advantages	Disadvantages
16	Use 11’ lanes	▪ Reduced cost ▪ Traffic calming	▪ Would require a design exception

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

Cost: 👍	*Justification/Comments: Less than 3% truck traffic – Moved to further development*
Rating: 3.5	

#	Description	Advantages	Disadvantages
17	Use fewer but larger diameter piles (Bridge)	▪ Shorter construction time ▪ May reduce cost	▪ May require larger equipment

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

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

#	Description	Advantages	Disadvantages
18	Eliminate the trail portion of the structure and leave the existing roadway for pedestrians	▪ Decrease width of bridge ▪ Reduces excavation	▪ Would not have reconnection of the wetlands ▪ Would not work with geometry of roadway ▪ Bridge longer ▪ Risk of not getting the environmental permits

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

Cost: 👍	*Justification/Comments:* Use fewer but larger diameter piles (Bridge)
Rating: 2	

#	Description	Advantages	Disadvantages
19	Construct the bridge as far west as possible to maintain traffic during construction	▪ Maintains traffic during construction	▪ Would require ROW ▪ May extend construction schedule ▪ Limits construction staging and laydown areas

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

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

#	Description	Advantages	Disadvantages
20	Construct a 2-lane bridge with the ability to widen in the future	▪ Better fit for funding ▪ Less Environmental impacts	▪ May have small throw away for second bridge ▪ Could cost more in the future ▪ May not meet political objective at opening of first phase ▪ Will not meet traffic needs

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

Cost: 👍	*Justification/Comments: Consider building abutments in Phase 1 – Design Consideration*
Rating: 3	

Span Bluff Creek

#	Description	Advantages	Disadvantages
21	Salvage the north bridge and use it to span Bluff Creek	▪ May be able to salvage the steel girders (40 girders)	▪ 30 year old bridge ▪ Need to design around girders ▪ May damage girders during demo

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

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

#	Description	Advantages	Disadvantages
22	Box Culverts – a bunch of them		▪ May reduce the opening size under the bridge ▪ May not work hydraulically ▪ Will require more piles ▪ May increase cost ▪ May require dewatering

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

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

#	Description	Advantages	Disadvantages
23	Three Sided Box or "ConSpan" for Bluff creek same span width	▪ Reduced cost ▪ Faster construction ▪ Less maintained	▪ Will require more extensive foundation or in water work

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

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

#	Description	Advantages	Disadvantages
24	Reroute Bluff Creek	▪ No bridge	▪ Environmental impacts and documentation

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

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

<table>
<tr><th>#</th><th colspan="2">Description</th><th colspan="2">Advantages</th><th>Disadvantages</th></tr>
<tr><td>25</td><td colspan="2">Construct Bluff Creek bridge at the elevation needed for any future improvements</td><td colspan="2">▪ Meets county expectations</td><td>▪ Added cost
▪ Not sure what the elevation needs to be
▪ Added embankment
▪ May increase pile support fill limits</td></tr>
<tr><td>Mainline Operations</td><td>Local Operations</td><td>Maintainability</td><td>Construction Impacts</td><td>Environmental Impacts</td><td>Project Schedule</td></tr>
<tr><td></td><td>👍</td><td></td><td>👎</td><td>👎</td><td>👎</td></tr>
<tr><td>Cost: 👎</td><td colspan="5" rowspan="2">Justification/Comments: Dropped from further consideration</td></tr>
<tr><td>Rating: 2</td></tr>
</table>

Connect Roadways

<table>
<tr><th>#</th><th colspan="2">Description</th><th colspan="2">Advantages</th><th>Disadvantages</th></tr>
<tr><td>26</td><td colspan="2">Raise profile to match county design</td><td colspan="2">▪ Meets county expectations</td><td>▪ Added cost
▪ Not sure what the elevation needs to be
▪ Added embankment
▪ May increase pile support fill limits</td></tr>
<tr><td>Mainline Operations</td><td>Local Operations</td><td>Maintainability</td><td>Construction Impacts</td><td>Environmental Impacts</td><td>Project Schedule</td></tr>
<tr><td></td><td>👍</td><td></td><td>👎</td><td>👎</td><td>👎</td></tr>
<tr><td>Cost: 👎</td><td colspan="5" rowspan="2">Justification/Comments: Dropped from further consideration</td></tr>
<tr><td>Rating: 2</td></tr>
</table>

<table>
<tr><th>#</th><th colspan="2">Description</th><th colspan="2">Advantages</th><th>Disadvantages</th></tr>
<tr><td>27</td><td colspan="2">Use the west leg to construct the T</td><td colspan="2">▪ Eliminates one structure across Bluff creek</td><td>▪ Signal timing with TH 101 North intersection
▪ May require retaining wall along Bluff Creek
▪ ROW impacts at golf course</td></tr>
<tr><td>Mainline Operations</td><td>Local Operations</td><td>Maintainability</td><td>Construction Impacts</td><td>Environmental Impacts</td><td>Project Schedule</td></tr>
<tr><td>👎</td><td>👎</td><td></td><td></td><td>👎</td><td>👍</td></tr>
<tr><td>Cost:</td><td colspan="5" rowspan="2">Justification/Comments: Dropped from further consideration</td></tr>
<tr><td>Rating: 1</td></tr>
</table>

#	Description	Advantages	Disadvantages
28	Construct a one-way Wye (modified Wye)	▪ Utilize existing pavement ▪ Reduced cost ▪ Reduced environmental impacts ▪ Free right turns improve operations ▪ Smaller structure over Bluff Street	▪ May not meet county expectations ▪ Need to relocate trail to the west

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

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

#	Description	Advantages	Disadvantages
29	Construct a roundabout to replace signalized intersection	▪ Less maintenance and life cycle cost ▪ May improve traffic operations	▪ May require ROW ▪ May have more wetland impact ▪ May cost more

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

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

#	Description	Advantages	Disadvantages
30	Do not construct anything beyond the grade tie-in (flood plain bridge connection)	▪ None noted	▪ Grades to stay out of flood plain run across Bluff creek

Mainline Operations	Local Operations	Maintainability	Construction Impacts	Environmental Impacts	Project Schedule

Cost:	*Justification/Comments: This idea is covered under evaluation of construct a* one-way wye (modified wye)
Rating:	

#	Description	Advantages	Disadvantages
31	Use 2 "Green" T intersections	▪ Improved operations	▪ Would require relocate of Bluff creek ▪ Added pavement ▪ Added cost

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

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

#	Description	Advantages	Disadvantages
32	Construct a T intersection through the middle of the Wye	▪ Better TH 101 South Geometrics ▪	▪ Increased wetland impacts ▪ Additional fill ▪ Closer signal spacing to TH 101 North ▪ May require a wall along Bluff Creek ▪ Added cost

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

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

#	Description	Advantages	Disadvantages
33	Use dual left turn lanes	▪ Improves traffic operations	▪ Added cost ▪ May increase environmental impacts

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

Cost: 👎	*Justification/Comments: Add to other ideas as needed*
Rating: 3.5	

#	Description	Advantages	Disadvantages
34	Use lightweight fill or in conjunction with geogrid (not geofoam)	▪ Less cost than pile supported embankment	▪ May settle in the future ▪ May require a surcharge

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

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

#	Description	Advantages	Disadvantages
35	Construct intersection to work with 2034 traffic volumes	▪ 20 year design verses the 10 year design in the base	▪ Add cost

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

Cost: 👎	*Justification/Comments: Combine with other intersection ideas*
Rating: 4	

#	Description	Advantages	Disadvantages
36	Half separated T (flyover)	▪ Better traffic operations ▪ Eliminates a signal ▪	▪ Added costs ▪ May conflict with TH 101 North ▪ More structure to maintain

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

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

#	Description	Advantages	Disadvantages
37	Construct an interchange	▪ Better traffic operations ▪ Eliminates a signal	▪ Added cost and impacts

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

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

#	Description	Advantages	Disadvantages
38	Construct a tunnel under the muck		

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

Cost: 👎	*Justification/Comments: Not feasible*
Rating: 0	

Shorten Project Duration

#	Description	Advantages	Disadvantages
39	Let the project in the Fall so that some preliminary work could occur during the winter months prior to the flood season	▪ Maximizes the 12 month construction schedule ▪ May get more competitive pricing due to letting time of year with contractors scheduling for upcoming	▪ Could delay to Fall of 2014

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

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

#	Description	Advantages	Disadvantages
40	Early procurement for beams or pilings	▪ Maximizes the 12 month construction schedule ▪ Early purchase of materials could mitigate potential increase in material costs	▪ Added risk for storage of materials on hand prior to utilization in the project

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

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

#	Description	Advantages	Disadvantages
41	Do not close the roadway during construction	▪ Keeps the roadway open ▪ May assist with municipal consent ▪ Will not have do the TH 169 improvements	▪ Will increase the construction schedule ▪ May increase cost ▪ Limited staging area ▪ May have ROW impacts ▪ May require temporary widening

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

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

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.

Minnesota Department of Transportation	**Summary of Recommendations** ***TH 101 Floodplain Bridge***		HDR
#	**Description**	**Cost Avoidance**	**Performance Improvement**
1	Test Pile Program	$0.67 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	$1.17 M	26%
5	Construct One-Way Wye	$3.71 M	4%
6	Extend Bridge through Bluff Creek	$2.72 M	6%
7	Pedestrian Railing	$0.45 M	2%
	Total	**$10.29 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 Floodplain Bridge

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
		4a					5						145
		4b						6					174
		5						6					174
		6					5						145
		7					5						145
Local Operations	24	Baseline					5						120
		1					5						120
		2					5						120
		3					5						120
		4a				4							96
		4b						6					144
		5						6					144
		6					5						120
		7					5						120

VALUE MATRIX

TH 101 Floodplain Bridge

Attribute	Attribute Weight	Concept	Performance Rating										Total Performance
			1	2	3	4	5	6	7	8	9	10	
Maintainability	17	Baseline					5						85
		1					5						85
		2					5						85
		3					5						85
		4a						6					102
		4b								8			136
		5				4							68
		6						6					102
		7						6					102
Construction Impacts	7	Baseline					5						35
		1							7				49
		2							7				49
		3									9		63
		4a					5						35
		4b					5						35
		5					5						35
		6					5						35
		7						6					42
Environmental Impacts	14	Baseline					5						70
		1					5						70
		2					5						70
		3					5						70
		4a						6					84
		4b							7				98
		5				4							56
		6						6					84
		7				4							56
Project Schedule	9	Baseline					5						45
		1						6					54
		2					5						45
		3				4							36
		4a					5						45
		4b					5						45
		5					5						45
		6					5						45
		7					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**		$44.5		11.23	
1	Pile Test	**523**	5%	$43.9	2%	11.92	6%
2	Procurement	**514**	3%	$44.5	0%	11.54	3%
3	Staged Construction	**519**	4%	$43.6	2%	11.91	6%
4a	Reduce Trail Width	**507**	1%	$43.9	1%	11.54	3%
4b	Typical Section	**632**	26%	$43.4	3%	14.57	30%
5	One-Way Wye	**522**	4%	$41.9	6%	12.47	11%
6	Extend Bridge	**531**	6%	$41.8	6%	12.69	13%
7	Barrier for pedestrian Rail	**510**	2%	$44.2	1%	11.54	3%

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 the Appendix of 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 ABC methods to reduce bridge construction time (precast or composite for deck)
- Use fewer but larger diameter piles (Bridge)
- Construct a 2-lane bridge with the ability to widen in the future
- Salvage the north bridge and use it to span Bluff Creek
- Three Sided Box or "ConSpan" for Bluff creek same span width
- Use dual left turn lanes
- Use lightweight fill or in conjunction with geogrid (not geofoam).

VE RECOMMENDATION NO. 1
Test Pile Program

Function: Span Floodway	**IDEA NO(s).** 11

Original Concept:

There is no pre-testing of piles scheduled for this project.

The baseline structure includes 28 bents of 18 -16" steel pipe, concrete filled piles. The assumed length is 140' with 120' buried.

Recommended Concept:

Perform a design phase (pre-construction) load test program to reduce the conservative design and limit project risk.

Develop a preconstruction contract to load test the expected foundation type(s).This test program would be developed after the soil borings and 30% design is complete. The program would be done prior to completion of final design and results incorporated into final bid documents.

Advantages:

- Potential to reduce foundation costs
- Added schedule efficiencies
- Better geotechnical data
- Increase design confidence
- More economical design
- Potential to accelerate construction schedule
- Risk reduction on cost
- Gives ability to evaluate different foundation types/sizes

Disadvantages

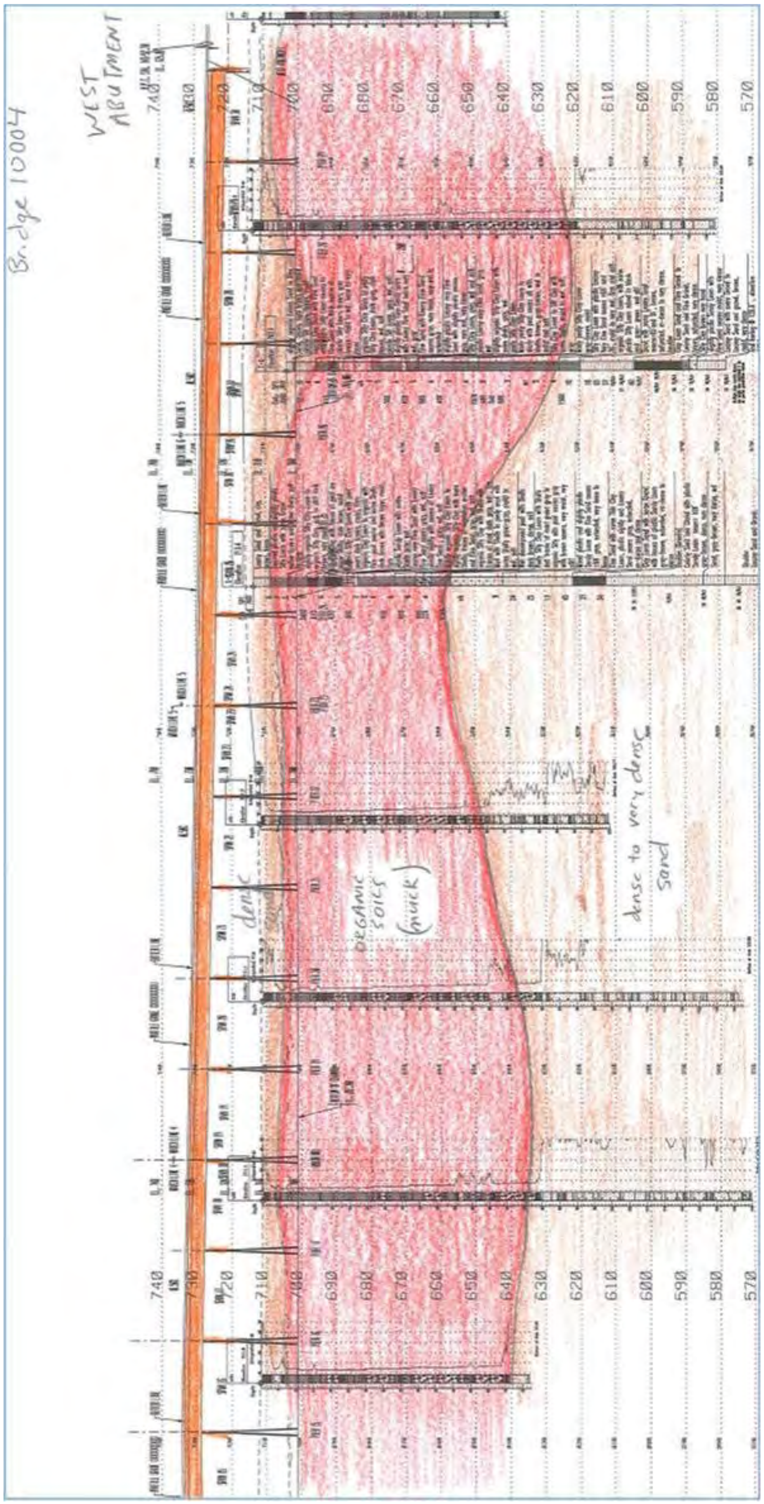
- Add additional engineering costs
- Another contract for project
- May need environmental permit for separate contract

COST SUMMARY	ESTIMATE
Original Concept	$3.18 M
Recommended Concept	$2.86 M
Cost Avoidance/Added	$0.52 M X 28.5% markup = $0.67 M

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
			👍	👍

Discussion/Justification/Sketches/Photos:



Soil Boring Log

Design/Estimate Assumptions:

The base cost is $45 per foot for the 16” pile.

504 piles at 140’ x $45 per ft = $3,175,200

A pile test program can reduce the length of pile by 10% by proving out the increase in capacity with time (pile setup). In addition, another 10% savings can be realized by using an increased LRFD Resistance factor of 0.8 (SLT) vs. 0.65 (PDA).

Assume savings of $635,000 (3.175M x 0.2)

To adequately characterize the site, it is assumed that three Static Load Tests would need to be performed. The estimated cost for these three Static Load Tests (SLT) is $100,000 based on the following:

- Load frame provided by MnDOT ($0)
- SLT instrumentation and PDA work provided by consultant hired by contractor ($35,000)
- Three test pile and twelve reaction pile ($65,000)

Cost of load test is $100,000 so the net savings is $535,000

Picture of a load test being performed

VE RECOMMENDATION NO. 1
Test Pile Program

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 No change to baseline	Rating	5	5
	Weight	17	
	Contribution	85	85
Construction Impacts Potential to reduce foundation costs Better geotechnical data Increase design confidence Gives ability to evaluate different foundation types/sizes	Rating	5	7
	Weight	7	
	Contribution	35	49
Environmental Impacts No change to baseline	Rating	5	5
	Weight	14	
	Contribution	70	70
Project Schedule Added schedule efficiencies Potential to accelerate construction schedule	Rating	5	6
	Weight	9	
	Contribution	45	54
	Total Performance:	**500**	**516**
	Net Change in Performance:		**3%**

VE RECOMMENDATION NO. 2
Procurement

Function: Procure Contract	**IDEA NO(s).** 39, 40

Baseline:

The original concept assumes that the Contract Plans will be completed by February of 2014. The bid letting would take place in May of 2014, with the Contract start-up in July 2014 and Contract completion in July of 2015. Due to right-of-way and environmental documentation requirements, Fall 2013 will not work.

Recommendation:

To maximize the entire work year this recommendation proposes that the project would be advertised and let in the Fall of 2014 so that some material procurement (piling, girders and/or precast members) could be completed. The current schedule has the procurement time in the prime work season. Pile driving could start during the winter months along with bent cap placement prior to the potential flood season. With this work completed to a point, girder erection and bridge superstructure construction could continue from the top during the 1 to 2 month flooding period thus minimizing any major work shutdown periods.

Advantages:

- Maximizes the 12 month construction schedule
- May get more competitive pricing due to letting time of year with contractors scheduling for upcoming season
- Early purchase of materials could mitigate potential escalation impacts

Disadvantages

- Will delay to Fall of 2014 letting schedule which increases the risk of one more year of flooding
- Added risk for storage of materials on hand prior to utilization in the project

DURATION SUMMARY	SCHEDULE
Baseline	Letting in May 2014
Recommendation	Letting in Fall 2014
Avoidance	Reduces closure of TH 101 by 2 months

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
			👍	👍

Discussion/Justification/Sketches/Photos:

By advertising and letting the contract in the fall it will be possible for a contractor to procure piling and girders in the fall. He can then drive piling and place bent caps and girders prior to the flood season of early April through late May. This will allow continued work on the bridge superstructure from the top during the flood season. This will maximize the full 12 month project duration.

Actual TH-101 road closure would not occur until piling and equipment were mobilized to the project and ready to be placed. Traffic could remain on the existing roadway during the procurement period.

There would be minimal cost increase as most materials would still be purchased in 2014.

There is a potential schedule advantage as work could continue during the anticipated 2 month flood season.


Concrete filled pipe pile can be driven during the winter months

Girders can be pre-cast and stock piled

	VE RECOMMENDATION NO. 2 Procurement			
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 No change to baseline		Rating	5	5
		Weight	17	
		Contribution	85	85
Construction Impacts This reduces the time the road is closed by 2 months		Rating	5	7
		Weight	7	
		Contribution	35	49
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**	**514**
			Net Change in Performance:	**3%**

This page is left intentionally blank

VE RECOMMENDATION NO. 3
TH 101 Staged Construction

Function: Span Floodplain	**IDEA NO(s).** 19, 20, 41

Baseline:

The original concept assumes that TH 101 will be closed to traffic during the construction timeframe of 1 year from July 2014 to July 2015. To mitigate for this road closure MnDOT has budgeted $2.25 million to restripe, modify bridge drainage and complete miscellaneous shoulder paving to handle the additional traffic on TH 169.

Recommendation:

To maintain local traffic on TH 101 during construction this recommendation assumes that the new structure and connecting approaches will be constructed in stages. The first stage would be to build the west half of the structure first while maintaining traffic on the original roadway.

The baseline schedule of 12 months may not be enough time to build this project.

Advantages:

- Maintains traffic throughout construction
- May or may not assist with municipal consent
- Will save the costs of the TH 169 improvements

Disadvantages

- May increase construction schedule
- Will increase cost due to maintenance of traffic and inherent added cost created by expanded schedule
- May require temporary widening and minor impacts to ROW (any impacts along the east side of the ROW may delay the project)
- Limits contractor staging areas

COST SUMMARY	ESTIMATE
Baseline	$2.25 M
Recommendation	$1.51 M
Cost Avoidance	$0.74 M X 28.5% markup = $0.95 M

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
			👍	👍

VE RECOMMENDATION NO. 3
TH 101 Staged Construction

Discussion/Justification/Sketches/Photos:

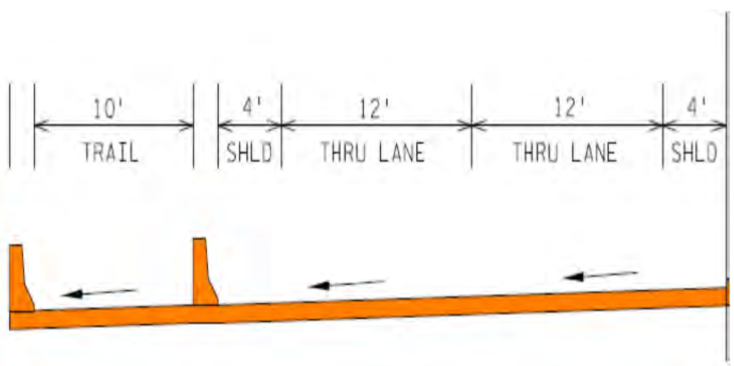
Building this project in 2 stages facilitates maintaining traffic during the total construction period with limited nighttime and weekend closures for work operations such as girder erection or material delivery (piling).

The west portion of the structure and approach embankments could be completed while traffic remains on the existing roadway. This will require adding temporary barrier to separate the traffic from the work zone. Travel lanes will be reduced to 11' lanes and 4' shoulders and will require an approximate 6' temporary shoulder widening on the east side of the existing roadway.

This option will also require a temporary wall (rag wall) to retain the embankment on the north end of the structure while the embankment is built in stage 1.

During stage 1 the west leg of the existing wye connection will be closed and a temporary signalized intersection will be added to handle traffic at TH-101 and CSAH-61, slightly east of the designed intersection.

The Bluff Creek structure will also be built half at a time, in 2 stages, and the existing box culvert could be removed after stage 1 completion.



Stage 1

Stage 2

Minnesota Department of Transportation

VE RECOMMENDATION NO. 3
TH 101 Staged Construction

HDR

Design/Estimate Assumptions:

Credit for elimination of TH-169 modifications	($2,250,000)
Shoulder widening 3900lf @ $40/lf	$156,000
Temporary Barrier 4000lf @ $15/lf	$60,000
Temporary signalized intersection (incl minor grading/paving)	$100,000
Increase in misc traffic maintenance (signs, flagging, TCS)	$275,000
Temporary embankment wall 4500sf @ $15/sf	$67,500
Construction impacts created by limited work space (2.5% direct labor cost)	$250,000
Extended contractor indirect and overhead 4 months @ $100,000/month	$400,000
Added escalation for 4 months @ 4%/year (assume $15 million)	$200,000
Cost of recommendation	$1,508,500
Recommendation savings	($741,500)

VE RECOMMENDATION NO. 3
TH 101 Staged Construction

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 No change to baseline	Rating	5	5
	Weight	17	
	Contribution	85	85
Construction Impacts Keeps TH 101 open during construction	Rating	5	9
	Weight	7	
	Contribution	35	63
Environmental Impacts No change to baseline	Rating	5	5
	Weight	14	
	Contribution	70	70
Project Schedule Adds 4 months to construction schedule	Rating	5	4
	Weight	9	
	Contribution	45	36
Total Performance:		**500**	**519**
Net Change in Performance:			**4%**

VE RECOMMENDATION NO. 4a
Reduce Width of Trail

Function: Span Floodplain	**IDEA NO(s).** 1

Baseline:

The baseline has a 12’ trail on the bridge, and a 10’ trail off of the bridge.

Recommendation:

The VE recommendation is to reduce the overall width of the trail by 2’. This would create a 10’ wide trail on bridge, and an 8’ wide trail off of the bridge. This meets LRFD and the bike facility design manual standards.

Advantages:

- Reduce cost
- Reduces impervious surface

Disadvantages

- May increase conflicts between users

COST SUMMARY	ESTIMATE
Baseline	N/A
Recommendation	Reduce bridge cost by $0.48 M
Cost Avoidance	$0.48 * 28.5% mark-up = $0.62 M

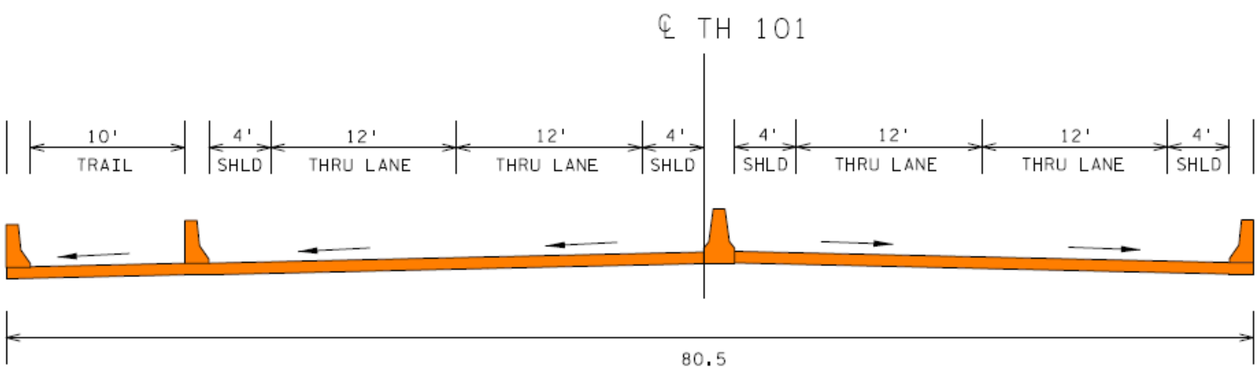
FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
		👍		

VE RECOMMENDATION NO. 4a
Reduce Width of Trail

Discussion/Justification/Sketches/Photos:

- Reduce Cost
- Meets desirable width for bike facilities per LRFD manual, and acceptable width per Bike Facility Design Manual
- Still allows access for snow removal and inspection equipment on the trail (10' minimum)
- May need a variance for SA Rule 8820.9995. The minimum bike path width required is 8', with an extra 2' shy to barriers. Per the rule, wherever practicable, carry the trail width plus shy across the bridge, or 12'.



10' trail bridge section

8820.9995 MINIMUM BICYCLE PATH STANDARDS.

Minimum Bicycle Path Standards[a]

For Off-Road Bike Path Design, the following shall apply:	
Minimum Surface Width (two-way)	8 ft (b)
Shoulder/Clear Zone	2 ft (c) (d)
Inslope	Maximum 1:2 (rise:run)
Design Speed	20 mph (e)
Vertical Clearance over lane and shoulder	9 ft-9 in (7 ft-9 in if passage of emergency or maintenance vehicles is not required)

(a) For on-road bicycle facilities, the current Minnesota Department of Transportation bicycle design guidelines are recommended for design purposes.

(b) Ten feet is desired for a combined bicycle/pedestrian path. Five feet is required for a one-way bicycle path.

(c) Whenever practicable, the shoulder/clear zone of an off-road bike path should be carried across bridges and through underpasses. Minimum structure clear width must be 12 feet. When the full width of the approach bike path (surface width plus shoulder/clear zone) is greater than the proposed clear width of the structure, then lead-in bicycle safety railing is required at each end of the bridge or underpass. As an alternative to lead-in bicycle safety railing, the surface width of the approach bike path may be narrowed at a 1:50 taper while maintaining minimum surface width and shoulder/clear zone through the structure.

(d) Clear zone is measured from the edge of the bicycle travel lane.

(e) Use a 30 mph design speed for grades longer than 500 feet and greater than four percent, from the uphill point where the grade equals four percent to 500 feet beyond the downhill point where the grade becomes less than four percent. The maximum allowable grade is 8.3 percent.

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*

VE RECOMMENDATION NO. 4a
Reduce Width of Trail

Design/Estimate Assumptions:

Assume $80/SF for bridge cost, per MnDOT Bridge Office preliminary cost estimate

2 ft less width * 3,000 ft long = 6,000 SF reduction

Savings = $80/SF * 6,000 SF = $480,000

Minimal savings off of structure under baseline assumption. This recommendation will have additional savings if VE Recommendation 5 is also accepted.

VE RECOMMENDATION NO. 4a
Reduce Width of Trail

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 Reduces trail width by 2'	Rating	5	4
	Weight	24	
	Contribution	120	96
Maintainability Less bridge width to maintain, still can get snow removal and inspection operations onto the trail	Rating	5	6
	Weight	17	
	Contribution	85	102
Construction Impacts No change to baseline	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts Less impervious surface	Rating	5	6
	Weight	14	
	Contribution	70	84
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
	Total Performance:	**500**	**507**
		Net Change in Performance:	**1%**

This page is left intentionally blank

VE RECOMMENDATION NO. 4b
Bridge Typical Section

Function: Widen Roadway	**IDEA NO(s).** 2 & 3

Baseline:

The bridge section has 4-ft inside and outside shoulders and the opposing lanes of traffic are separated by median barrier.

Recommendation:

Revise the typical section to maximize the outside shoulder for drainage, snow storage, inspection, and emergency pull-off. This can be accomplished by removing the inside shoulders and increasing the outside shoulders to 8-ft which matches the rural section with 8-ft shoulders off the bridge, increased shoulder x-slope to 2.5%.

With an 8-ft outside shoulder and no median barrier (double yellow line) along with break shoulder cross slope to 2.5% on bridge deck to aid in drainage. A centerline structural rumble stripe would be added.

Advantages:

- Reduce Cost
- Meets CSAH rural roadway shoulder standards (would remove C&G and drainage structures north of the bridge)
- Allows for snow storage on the bridge
- Meet spread criteria with no deck drains on the bridge
- Improves sight distance for traffic from boat ramp heading SB on TH 101
- May reduce risk by providing additional width for stage construction
- Matches CSAH 101 MN River main channel bridge with no barrier

Disadvantages

- Increases conflicts
- Driver discomfort

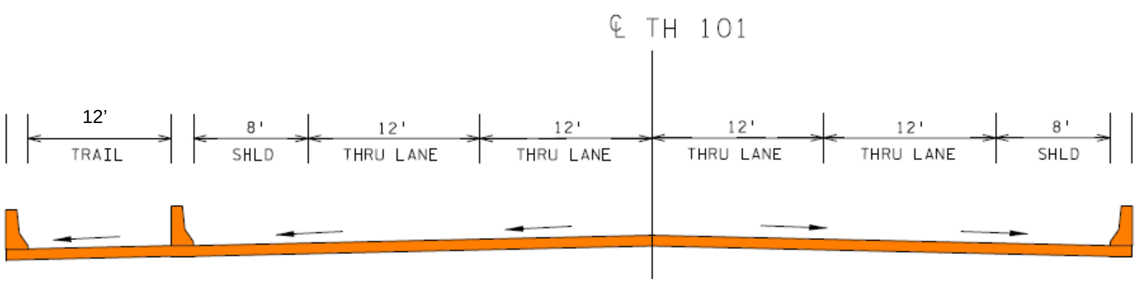
COST SUMMARY	ESTIMATE
Baseline	N/A
Recommendation	Savings of $0.88 M
Cost Avoidance	$0.91 M * 28.5% mark-up = $1.17 M

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
	👍	👍		👍

Discussion/Justification/Sketches/Photos:

- Reduce Cost
- No defined standard for median barrier requirement on rural 4-lane undivided roadways (either bridge, state aid, or MnDOT Roadway Design Manual Section 4-5.0)
- Existing Minnesota River Bridge (No. 70002) to the south does not have a median barrier
- Allows for snow storage in the shoulder, although shoulder width would likely not be available if used for snow storage
- In conjunction with an increase in the cross slope on the shoulder to 2.5%, eliminate deck drains and meet spread criteria (base design assumed either a design exception for spread, or over 50 deck drains on the bridge).
- Add rumble stripes to assist in the prevention of cross overs
- Similar typical (no median barrier) to many high speed rural undivided roadways in the state and nation.
- May need to add a buffer (1') for the centerline rumble stripe.



Revised Bridge Section

The VE Team also looked at reducing the 12' lanes to 11' but rejected the idea It reduced cost but it did not improve performance enough to give a positive value improvement.

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.

(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*

VE RECOMMENDATION NO. 4b
Bridge Typical Section

Design/Estimate Assumptions:

		Inlet Spacing		Comps by:	NDB		Date:	11/8/2012		Bridge:	10004		
		Br 10004		Design Frequency =		10	yr						
Calculated Spread	Allowable Spread	Catch Basin Number	Station	Pavement width between Inlets	Length	Drainage Area (ac)	V	Tt	to	tc	Time of Conc Tc	Rain Intensity (in/hr)	Q (cfs)
		Starting Sta	13000.00										
13.766	14.00	1	14550.00	32.000	1550.000	1.139	2.458	10.509	0.989	11.498	11.5	5.55	5.688
#DIV/0!	**End of Bridge, NO DECK DRAINS NEEDED**				########	0.000	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!			0.000

C =	0.9 (concrete pavement)							Inlet Discharge					Comments
Long Slope, SL (ft/ft)	Cross Slope, Sx (ft/ft)	Prev. Bypass flow	Total Gutter Flow	Depth, d	Grate or Gutter width	Spread T (ft)	W/T	Inlet Type	Efficiency	Grate Efficiency	Intercept Flow	Bypass Flow	
													Allowable Spread
0.0050	0.025	0.000	5.688	0.344	1.410	13.766	0.102	B701	0.251	1.000	1.425	4.262	8 ft shoulder + 1/2
													Assume CB in app
		4.262	4.262	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	1.000	#DIV/0!	#DIV/0!	

Deck Drain Calculations

Assume approximately $2,500 for each deck drain, per MnDOT Bridge Office preliminary cost estimate

No deck drains needed, compared to base estimate of 52 deck drains

Savings = $2,500 * 52 = $130,000

Assume $80/SF for bridge cost, per MnDOT Bridge Office preliminary cost estimate

Savings of the 2' reduction of bridge width for the median barrier

2 ft wide * 3000 ft long = 6100 SF reduction

Savings = $80/SF * 6000 SF = $480,000

Assume $215,000 cost for median barrier on the bridge, per MnDOT Bridge Office preliminary cost estimate Savings = $215,000

Base Estimate assumed 8-ft urban shoulder (including curb and gutter).

Change from urban to rural section with 8-ft shoulder removes the curb and gutter

Savings 7270 LF curb and gutter @ $11/LF = $79,970

365 tons of bituminous will be needed to replace the curb and gutter @ $70/ton = ($57,000).

3000 LF of rumble stripe @ $1/LF = $3,000

Savings of 2 impact attenuators @ $30,000 each = $60,000

Total savings = $910,970

VE RECOMMENDATION NO. 4b
Bridge Typical Section

<table>
<tr><th>PERFORMANCE MEASURES
Criteria and Rating Rationale for Recommendation</th><th>Performance</th><th>Baseline</th><th>Recommendation</th></tr>
<tr><td rowspan="3">Mainline Operations
Trade-off between increased shoulder width and removal of the median barrier. Emergency pull-off available on bridge with wider shoulders.</td><td>Rating</td><td>5</td><td>6</td></tr>
<tr><td>Weight</td><td colspan="2">29</td></tr>
<tr><td>Contribution</td><td>145</td><td>174</td></tr>
<tr><td rowspan="3">Local Operations
Better sight distance leaving the boat ramp (no median barrier)</td><td>Rating</td><td>5</td><td>6</td></tr>
<tr><td>Weight</td><td colspan="2">24</td></tr>
<tr><td>Contribution</td><td>120</td><td>144</td></tr>
<tr><td rowspan="3">Maintainability
Snow storage available, less bridge deck to maintain, and no deck drains required with 8' outside shoulders on bridge</td><td>Rating</td><td>5</td><td>8</td></tr>
<tr><td>Weight</td><td colspan="2">17</td></tr>
<tr><td>Contribution</td><td>85</td><td>136</td></tr>
<tr><td rowspan="3">Construction Impacts
No change to baseline</td><td>Rating</td><td>5</td><td>5</td></tr>
<tr><td>Weight</td><td colspan="2">7</td></tr>
<tr><td>Contribution</td><td>35</td><td>35</td></tr>
<tr><td rowspan="3">Environmental Impacts
Smaller bridge footprint, no deck drains (all water off the end of the bridge, concentrated)</td><td>Rating</td><td>5</td><td>7</td></tr>
<tr><td>Weight</td><td colspan="2">14</td></tr>
<tr><td>Contribution</td><td>70</td><td>98</td></tr>
<tr><td rowspan="3">Project Schedule
No change to baseline</td><td>Rating</td><td>5</td><td>5</td></tr>
<tr><td>Weight</td><td colspan="2">9</td></tr>
<tr><td>Contribution</td><td>45</td><td>45</td></tr>
<tr><td colspan="2">Total Performance:</td><td>500</td><td>632</td></tr>
<tr><td colspan="3">Net Change in Performance:</td><td>26%</td></tr>
</table>

VE RECOMMENDATION NO. 5
Construct One-Way Wye

Function: Connect Roadways

IDEA NO(s). 28, 33, 35

Baseline:

If the county project on CSAH 61 is delayed then construct a single T design intersection with one left turn (10 year design life).

Recommendation:

Convert the existing wye intersection into a one-way wye. Only place a single lift of bituminous on CSAH 61.

Advantages:

- Utilize some of existing pavement
- Reduced cost
- Reduced environmental impacts
- Free right turns improve operations
- Improves traffic operations
- Reduces width of Bluff Creek bridge by half
- Reduces length of paving on CSAH 61

Disadvantages

- May not meet city or county expectations

COST SUMMARY	ESTIMATE
Baseline	$43.21 M (includes markups)
Recommendation	$39.50 M (includes markups)
Cost Avoidance	$3.71 M (includes markups)

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
	👍	👍	👍	

Minnesota Department of Transportation

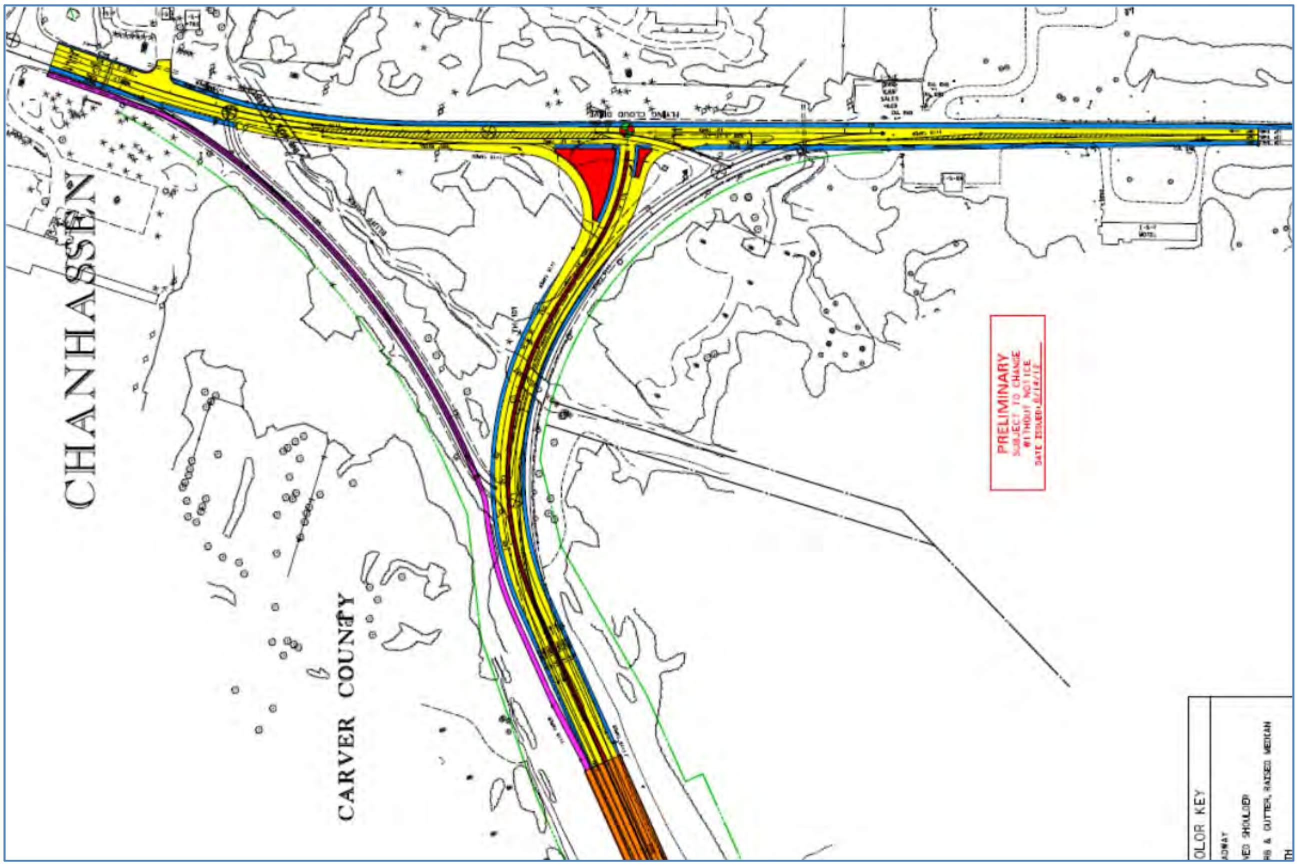
VE RECOMMENDATION NO. 5
Construct One-Way Wye

HDR

Discussion/Justification/Sketches/Photos:

The baseline design constructs a simple T intersection along the east leg of the existing wye. This design does minimal work to CSAH 61 and is intended to give a 10 year design life.

The proposed trail is routed along the existing west leg of the wye.



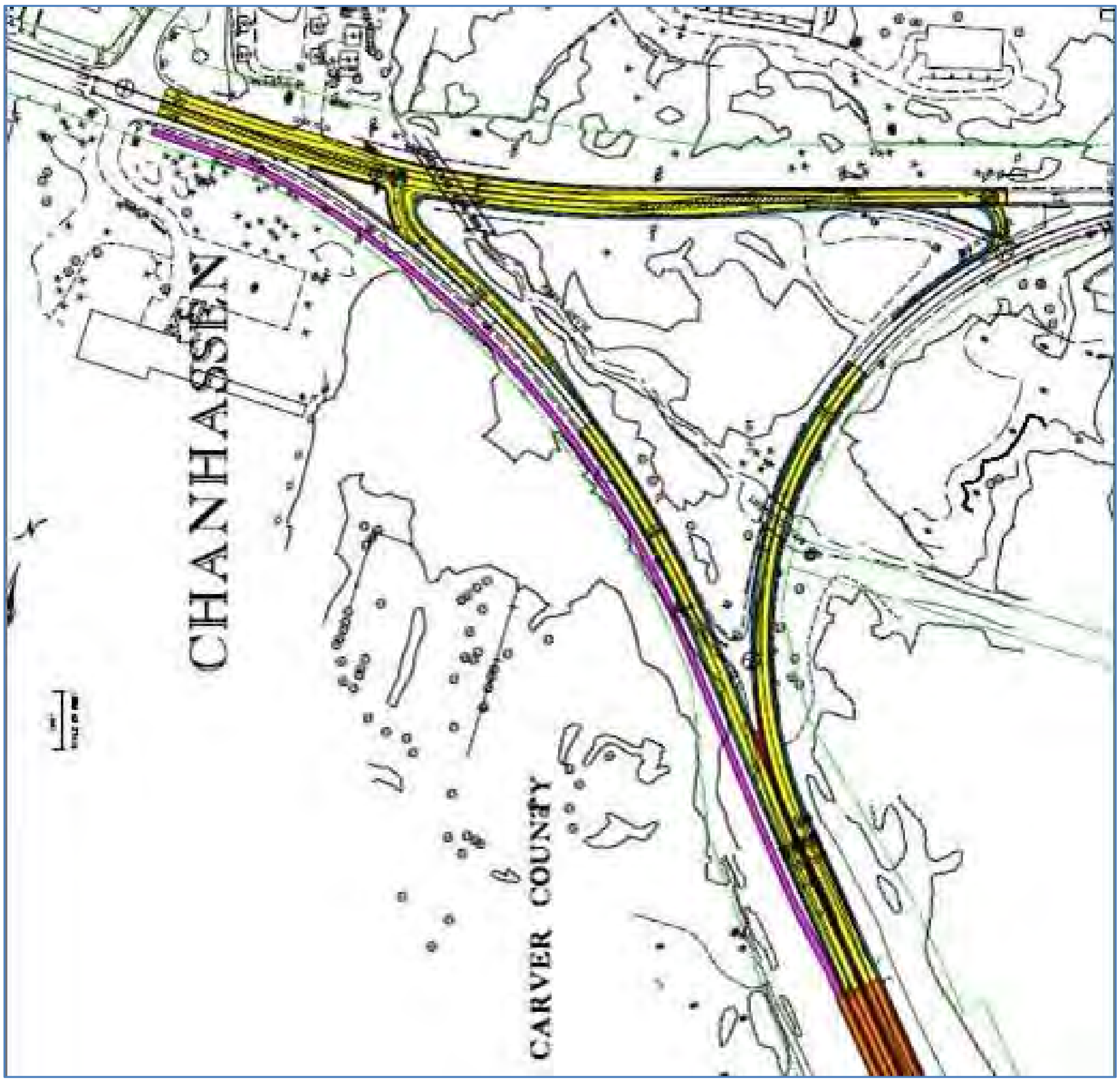
Baseline Design

VE RECOMMENDATION NO. 5
Construct One-Way Wye

The VE Recommendation is to construct a one-way wye. This design would utilize the existing TH 101 wye roadways. It also would widen CSAH 61 to accommodate for a dual left turn to southbound TH 101.

This design will improve traffic operation (it should operate at an acceptable level for the next 10+ years) and lessens the environmental impact of footprint and is less expense. This design. It will also have less throw-away when a future Carver County's project is constructed.

CSAH 61 will be 2" mill and overlay with pile supported embankment in the widened portion. The widening area is to allow for two left turn lanes at southbound mainline ramp of TH 101 with CSAH 61.



Design/Estimate Assumptions:

From the ***Cost Risk Assessment – Base Cost Estimate*** section the baseline project costs is $43.21 million including markups.

Item	Unit	Unit Bid Price	Quantity	Total
Mobilization		5.0%	1	**$132,091**
Removals, Salvage, Sawing Bit. Pavement, etc.	EST	4.0%	1	**$46,311**
4" Concrete Walk (Islands & Medians)	SF	$3.50	3,185	**$11,148**
Concrete Curb & Gutter Design B24	LF	$11	935	**$10,285**
Type SP 12.5 Non Wear Course Mix (3,E)	TON	$65	9,075	**$589,875**
Aggregate Base Class 5	CY	$20	7,330	**$146,600**
Select Granular	CU YD	$12	14,654	**$175,848**
Drainage and Utilities	EST	10.0%	1	**$115,777**
Traffic Control, Striping, Guardrail and Devices	EST	5.0%	1	**$57,889**
Turf / Erosion	EST	2.0%	1	**$23,155**
TH 101 Bridge (Bluff Creek)	SF	$120	0	**$0**
TH 101 Floodplain Bridge	SF	$80	247,500	**$19,800,000**
Random Riprap Class III	CY	$52	8,300	**$431,600**
Muck Excavation (LV)	CY	$6	88,890	**$533,340**
Column Supported Embankment	SF	$100	84,700	**$8,470,000**
Signals	EACH	$250,000	2	**$500,000**
Sub-Total				**$31,043,919**
Pre-Construction Engineering		12%		**$3,725,270**
Construction Engineering		8%		**$2,483,513**
SR 169 mitigation project				**$2,250,000**
Project Total				**$39,502,702**

One-Way Wye costs

PERFORMANCE MEASURES **Criteria and Rating Rationale for Recommendation**	**Performance**	**Baseline**	**Recommendation**
Mainline Operations The signals perform better	Rating	5	6
	Weight	29	
	Contribution	145	174
Local Operations Small improvement in traffic operation	Rating	5	6
	Weight	24	
	Contribution	120	144
Maintainability Only achieves a 10 year life from pavement	Rating	5	4
	Weight	17	
	Contribution	85	68
Construction Impacts No change to baseline	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts May require right of way	Rating	5	4
	Weight	14	
	Contribution	70	56
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
	Total Performance:	**500**	**522**
		Net Change in Performance:	**4%**

This page intentionally left blank

VE RECOMMENDATION NO. 6
Extend Bridge 250' north of Bluff Creek

Function: Span Floodplain	**IDEA NO(s).** 11

Baseline:

The baseline has 800+ ft of pile supported embankment between Bluff Creek and end of the land bridge. The baseline assumes a simple T configuration for the intersection of TH 101 and CSAH 61.

Recommendation:

Extend the land bridge 250 ft past bluff creek to eliminate all pile supported embankment. This extends the bridge an additional 1400 ft. This option assumes the one-way-wye configuration would be used to connect TH 101 with CSAH 61 (Recommendation 5).

Advantages:

- Eliminates pile supported fill
- Extends flood plain crossing
- Eliminate maintenance of cleaning debris from Bluff Creek
- Reduced cost compared to pile supported fill
- Restores more of the flood plain
- Reduces risk of weather delay

Disadvantages

- Adds bridge maintenance cost
- Adds drainage from bridge/more water to design
- May need to modify vertical curve on bridge

COST SUMMARY	ESTIMATE
Baseline	$9.67 M
Recommendation	$7.55 M
Cost Avoidance	$2.12 M x 28.5% markup = $2.72 M

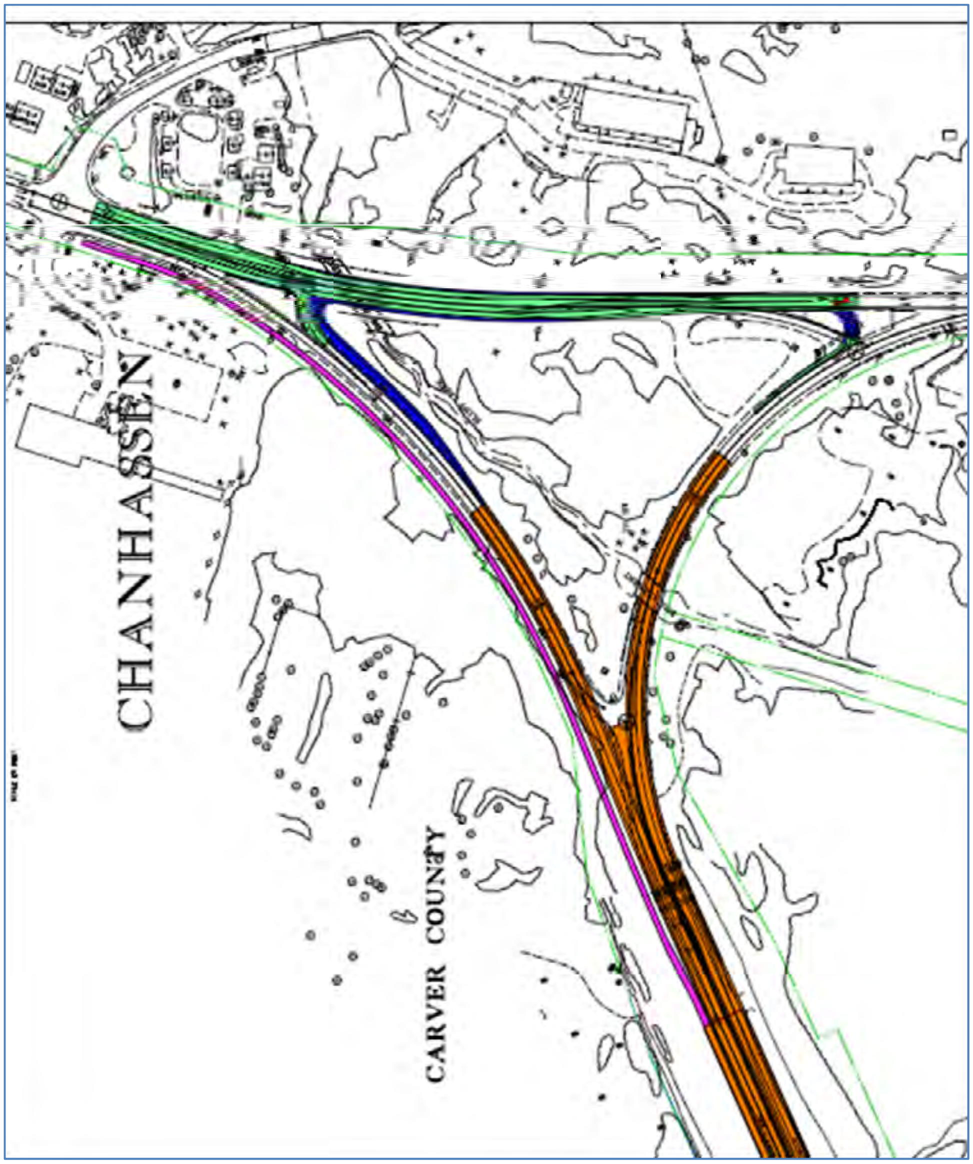
FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other
		👍	👍	

Minnesota Department of Transportation	**VE RECOMMENDATION NO. 6** Extend Bridge 250' north of Bluff Creek	HDR

Discussion/Justification/Sketches/Photos:

Extending the bridge, and eliminating the pile supported embankment, will save money because the estimate for the square foot cost of bridge ($80/SF) on this project is less than the square foot cost for pile supported embankment ($100/SF) although the costs for the Y section of this bridge will be increased.



This option also reduces the risk of weather delay since driving pile is less dependent on dry conditions than soil grading and compaction. The bridge option will also restore more of the flood plain and have less of an impact on Bluff Creek which will have a positive environmental affect.

There could be further cost savings by shifting the bridge side north and potentially using fill on the south side of the bridge if the soils are better there.

VE RECOMMENDATION NO. 6
Extend Bridge 250' north of Bluff Creek

Design/Estimate Assumptions:

Roadway width assumptions

Mainline = 4 – 12' lanes, 4' inside and outside shoulders, barrier separated, 12' trail. – 82.5' bridge width

Ramps = 2 – 12' lanes, 4' inside shoulders, 8' outside shoulders, 10' trail on southbound leg, 6' grass median.

Pile Supported Fill Assumptions:

350' long mainline, 700' south bound ramp, 750' north bound ramp (minus 50' for Bluff Creek bridge)

It's assumed that the north end of the baseline bridge is 15' above grade so the average amount of fill needed from the north end of the bridge to the TH 61 connection is 7'

Mainline: 350' x 82.5' = 28,875 SF

S.B. Ramp: 700' x 52' = 36,400 SF

N.B. Ramp: 750' x 36' = 27,000 SF

Total = 92,275 SF

At $100 per SF

$9.23 M + $0.44 M Bluff = $9.67 M

Bridge Assumptions:

350' long mainline, 700' south bound ramp, 800' north bound ramp

Mainline: 350' x 82.5' = 28,875 SF

S.B. Ramp: 700' x 49' = 34,300 SF

N.B. Ramp: 800' x 39' = 31,200 SF

Total = 94,375 SF

At $80 per SF

$7.55 M

$9.67 M - $7.55 M = $2.12 M

VE RECOMMENDATION NO. 6

Extend Bridge 250' north of Bluff Creek

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 This recommendation requires the acceptance of recommendation No. 5	Rating	5	5
	Weight	24	
	Contribution	120	120
Maintainability Increase the life cycle of the roadway	Rating	5	6
	Weight	17	
	Contribution	85	102
Construction Impacts Bridge construction is more predictable and weather has less impact than on soils	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts Less footprint, restores more wetlands	Rating	5	6
	Weight	14	
	Contribution	70	84
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
	Total Performance:	**500**	**531**
		Net Change in Performance:	**6%**

VE RECOMMENDATION NO. 7
Pedestrian Railing

Function: Span Floodplain	IDEA NO(s). 4

Baseline:

Concrete curb and ornamental fence on top of curb on outside of ped/bike trail on bridge.

Recommendation:

Concrete curb and standard chain link fence on top of curb on outside of ped/bike trail on bridge.

Advantages:

- Reduce Cost
- Ease of Construction

Disadvantages

- Aesthetics

COST SUMMARY	ESTIMATE
Baseline	$19.70 M
Recommendation	$19.35 M
Cost Avoidance	$0.35 M x 28.5% mark-up = $0.45 M

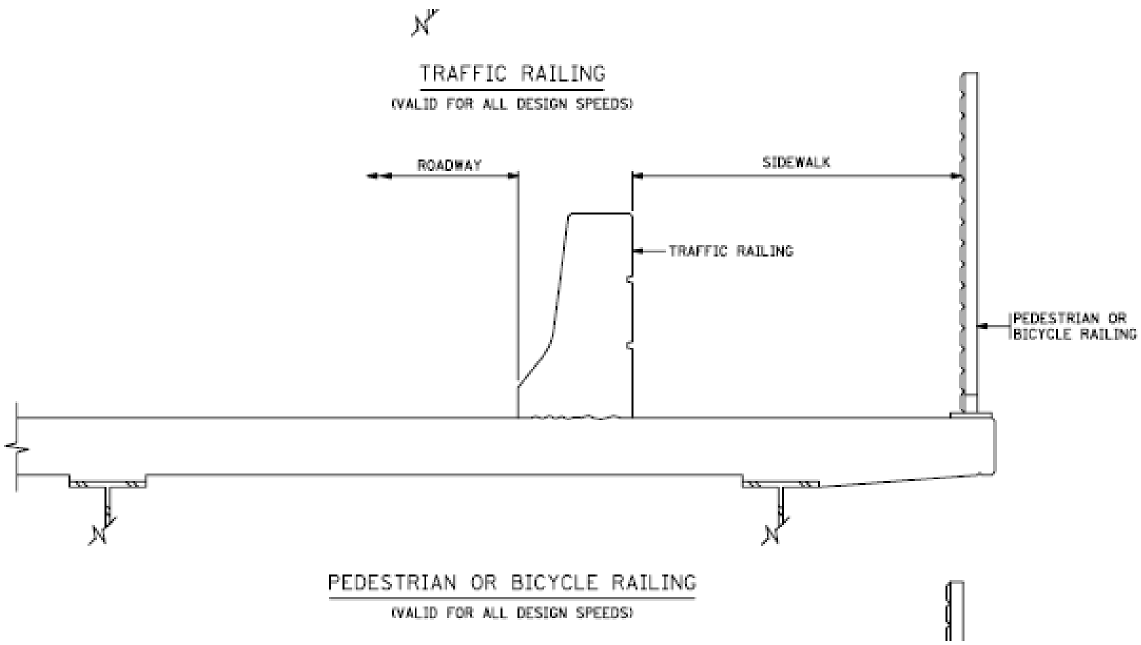
FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other

VE RECOMMENDATION NO. 7
Pedestrian Railing

Discussion/Justification/Sketches/Photos:

- Reduce Cost
- Aesthetics are less of a concern on this bridge because you don't have cross streets and paths that look at the bridge.
- Existing trail rail (BR 10007) is standard chain link fence



VE RECOMMENDATION NO. 7
Pedestrian Railing

Design/Estimate Assumptions:

Assume $150/LF for ornamental bridge rail, per MnDOT Bridge Office preliminary cost estimate

Assume $32.80/LF for 6-ft bridge mount chain link fence on similar job in Utah

Savings = ($150/LF – 32.80/LF) * 3050 ft long = $357,000

Minnesota Department of Transportation

VE RECOMMENDATION NO. 7
Pedestrian Railing

HDR

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 Easier to maintain standard chain link fence	Rating	5	6
	Weight	17	
	Contribution	85	102
Construction Impacts Easier to procure and install vs. ornamental rail	Rating	5	6
	Weight	7	
	Contribution	35	42
Environmental Impacts Aesthetically less pleasing	Rating	5	4
	Weight	14	
	Contribution	70	56
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
	Total Performance:	**500**	**510**
		Net Change in Performance:	**2%**

	VE VALIDATION Use 11-ft lanes	

Function: Change lane width to 11-ft	**IDEA NO(s).** 16

Original Concept:

The baseline has 4 – 12’ lanes, two in each direction.

Recommended Concept:

The VE Team evaluated reducing the width of the lanes to 11’.

Based on the 17% reduction in performance this idea was dropped from further consideration.

Advantages:

- Reduce cost
- Traffic calming

Disadvantages

- Increases conflicts
- Driver discomfort
- Doesn’t meet State Aid Rule 8820.9920, would require a design variance
- Likely need to add drainage structures on the bridge

COST SUMMARY	ESTIMATE
Original Concept	$19.7M for the total bridge cost
Recommended Concept	$18.85M for reduced bridge width cost
Cost Avoidance/Added	$976,000 * 28.5% mark-up = $1.25M cost avoided

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Other

VE VALIDATION
Use 11-ft lanes

Discussion/Justification/Sketches/Photos:

- Reduce Cost
- Possible traffic calming
- This doesn’t meet the required lane width per State Aid Rule 8820.9920, would require a variance. See attached figures

Design Assumptions and Calculations

Assume $80/SF for bridge cost, per MnDOT Bridge Office preliminary cost estimate

4 ft less width * 3050 ft long = 12,200 SF reduction

Savings = $80/SF * 12,2000 SF = $976,000

Possible cost additions include additional drainage structures, as the available spread is reduced (we did not cost this out).

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)	Surfacing	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.

(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*

Minnesota Department of Transportation

VE VALIDATION
Use 11-ft lanes

HDR

PERFORMANCE MEASURES Criteria and Rating Rationale for Recommendation	Performance	Original	Alternative
Mainline Operations Does not meet standards Increases risk of conflicts	Rating	5	1
	Weight	29	
	Contribution	145	29
Local Operations No change to baseline	Rating	5	5
	Weight	24	
	Contribution	120	120
Maintainability Less bridge surface to maintain	Rating	5	6
	Weight	17	
	Contribution	85	102
Construction Impacts No change to baseline	Rating	5	5
	Weight	7	
	Contribution	35	35
Environmental Impacts Reduces impervious surface	Rating	5	6
	Weight	14	
	Contribution	70	84
Project Schedule No change to baseline	Rating	5	5
	Weight	9	
	Contribution	45	45
Total Performance:		**500**	**415**
Net Change in Performance:			**-17%**

This page intentionally left blank

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 relates to total project cost, as well as 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 MnDOT 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 excluded future cost escalation. Adjustments were made to the following items:

- Floodplain Bridge - It was felt that the cost per SF was to low at $80/SF. After discussion it was decided to add a risk to the project instead of revising the unit price.
- The unit price and limits of the column supported embankment was in question. The original provided estimate had $50/SF for a total of $6.42 million. This was later increased to $100/SF for a total of $11.13 million.
- The costs of improvements to CSAH 61 were removed from estimate.

		Unit Bid Prices					Quantities					Totals			
Item	**Unit**	**Low**	**%**	**Most Likely**	**%**	**High**	**Low**	**%**	**Most Likely**	**%**	**High**	**Low**	**Most Likely**	**High**	
Mobilization		5.0%	0%	5.0%	0%	5.0%	1	0%	1	0%	1	$103,926	**$138,424**	$172,328	
Removals, Salvage, Sawing Bit. Pavement, etc.	EST	3.0%	-25%	4.0%	25%	5.0%	1	0%	1	0%	1	$25,833	**$55,495**	$72,470	
4" Concrete Walk (Islands & Medians)	SF	$3	-14%	$3.50	14%	$4	18,525	-5%	19,500	10%	21,450	$55,575	**$68,250**	$85,800	
Concrete Curb & Gutter Design B24	LF	$9	-18%	$11	18%	$13	3,145	-15%	3,700	15%	4,255	$28,305	**$40,700**	$55,315	**(minus CSAH 61 quantities)**
Type SP 12.5 Non Wear Course Mix (3,E)	TON	$60	-8%	$65	8%	$70	9,563	-15%	11,250	15%	12,938	$573,750	**$731,250**	$905,625	(minus CSAH 61 quantities)
Aggregate Base Class 5	CY	$17	-15%	$20	10%	$22	7,863	-15%	9,250	15%	10,638	$133,663	**$185,000**	$234,025	(minus CSAH 61 quantities)
Select Granular	CU YD	$10	-17%	$12	25%	$15	12,538	-15%	14,750	15%	16,963	$125,375	**$177,000**	$254,438	(minus CSAH 61 quantities)
Drainage and Utilities	EST	9.0%	-10%	10.0%	10%	11.0%	1	0%	1	0%	1	$77,498	**$138,737**	$176,844	
Traffic Control, Striping, Guardrail and Devices	EST	4.0%	-20%	5.0%	20%	6.0%	1	0%	1	0%	1	$34,444	**$69,369**	$86,964	
Impact Attenuators	EACH	$25,000	-17%	$30,000	17%	$35,000	2	100%	2	100%	2	$50,000	**$60,000**	$70,000	added item
Turf / Erosion	EST	1.5%	-25%	2.0%	50%	3.0%	1	0%	1	0%	1	$12,916	**$27,747**	$43,482	
TH 101 Bridge (Bluff Creek)	SF	$80	-11%	$90	33%	$120	3,178	-5%	3,345	10%	3,680	$254,220	**$301,050**	$441,540	(includes mobilization)
TH 101 Floodplain Bridge	SF	$75	-6%	$80	6%	$85	247,500	0%	247,500	3%	254,925	$18,562,500	**$19,800,000**	$21,668,625	(includes mobilization)
Random Riprap Class III	CY	$45	-13%	$52	6%	$55	7,470	-10%	8,300	10%	9,130	$336,150	**$431,600**	$502,150	
Muck Excavation (LV)	CY	$5	-17%	$6	17%	$7	80,001	-10%	88,890	10%	97,779	$400,005	**$533,340**	$684,453	reduced from $6.30/CY to $6.0/CY
Column Supported Embankment	SF	$90	-10%	$100	10%	$110	100,170	-10%	111,300	10%	122,430	$9,015,300	**$11,130,000**	$13,467,300	(includes mobilization)
Signals	EACH	$225,000	-10%	$250,000	10%	$275,000	1	0%	1	0%	1	$225,000	**$250,000**	$275,000	
Sub-Total												**$30,014,459**	**$34,137,963**	**$39,196,359**	
										Uncertainty		-12.1%		14.8%	
Pre-Construction Engineering				12%								$3,601,735	**$4,096,556**	$4,703,563	
Construction Engineering				8%								$2,401,157	**$2,731,037**	$3,135,709	
SR 169 mitigation project												$2,250,000	**$2,250,000**	$2,250,000	
Project Total												**$38,267,351**	**$43,215,555**	**$49,285,631**	

TH 101 Base Cost Estimate

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. The range of uncertainty is -12.1% to +14.8%.

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:

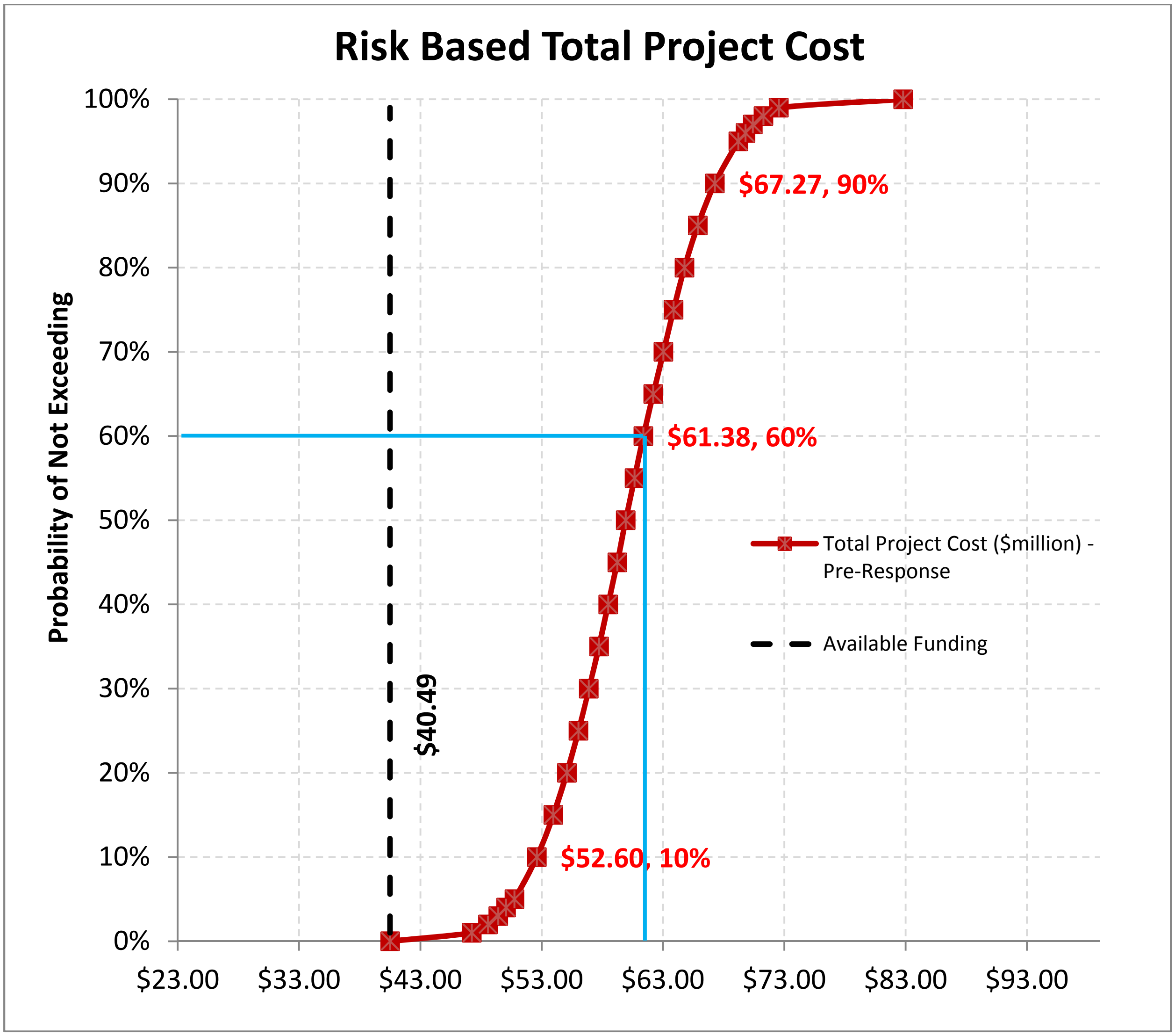
- Construction Duration/Schedule
- Bridge Cost
- Geotechnical Risks
- Wetland Impacts
- MOT
- Flooding during Construction
- Permits
- Connection with County Project
- Cost of Ground Improvements
- Bridge Design (Width)
- Construction Methods
- Pre construction Schedule & Duration
- Lack of Funding
- Letting Date
- Muck Excavation (Depth)
- Environmental Documentation
- Utility Relocations
- Construction Staging
- 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.

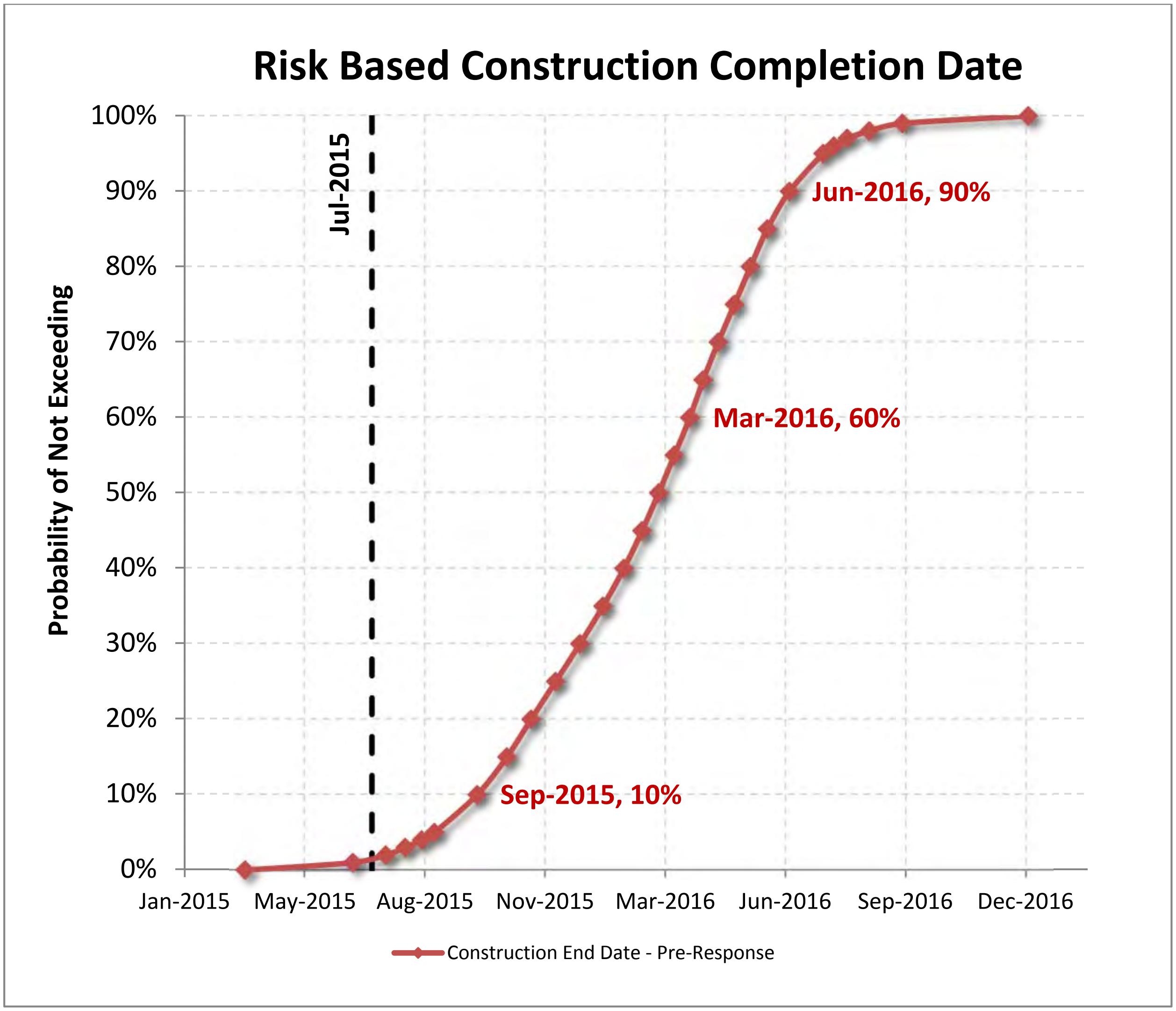
The figure below details the probabilistic total project cost results. These results represent all costs to the project, as well as the impacts of project risks and schedule escalation. The estimated base cost for Contract 1 of $38.76 million in current year (2012) dollars, which includes construction 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 $43.22 M, with the available funding for the project at $40.49 M

These results show that with 60-percent confidence the total project cost will not exceed $61.38 million. The 80-percent confidence interval, described by the 10th percentile and 90th percentile reveals that the total project cost will fall between $52.60 million and $67.27 million.



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

The probabilistic Project Completion Date distribution is shown in the figure below. The Project Completion Date, using the base schedule, is estimated to be July 2015. There is a 60-percent probability that this project will be complete by March 2016. The probabilistic Project Completion Date distributions, as represented by the red line, indicate a completion date ranging between September 2015 and June 2016, with 80-percent confidence. This represents a range of approximately 9 months.



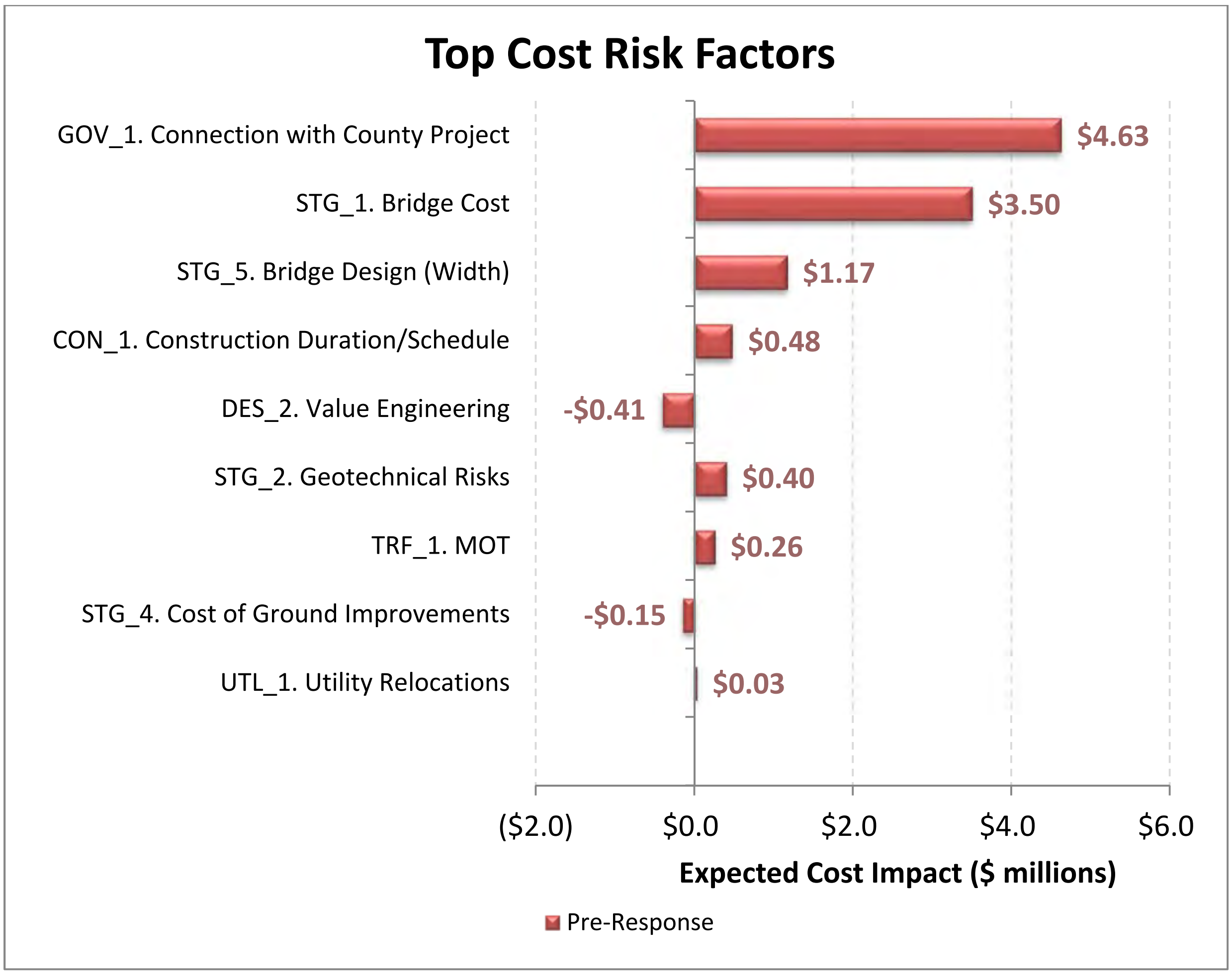
Risk Based Project Completion Date (Pre-Response)

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.

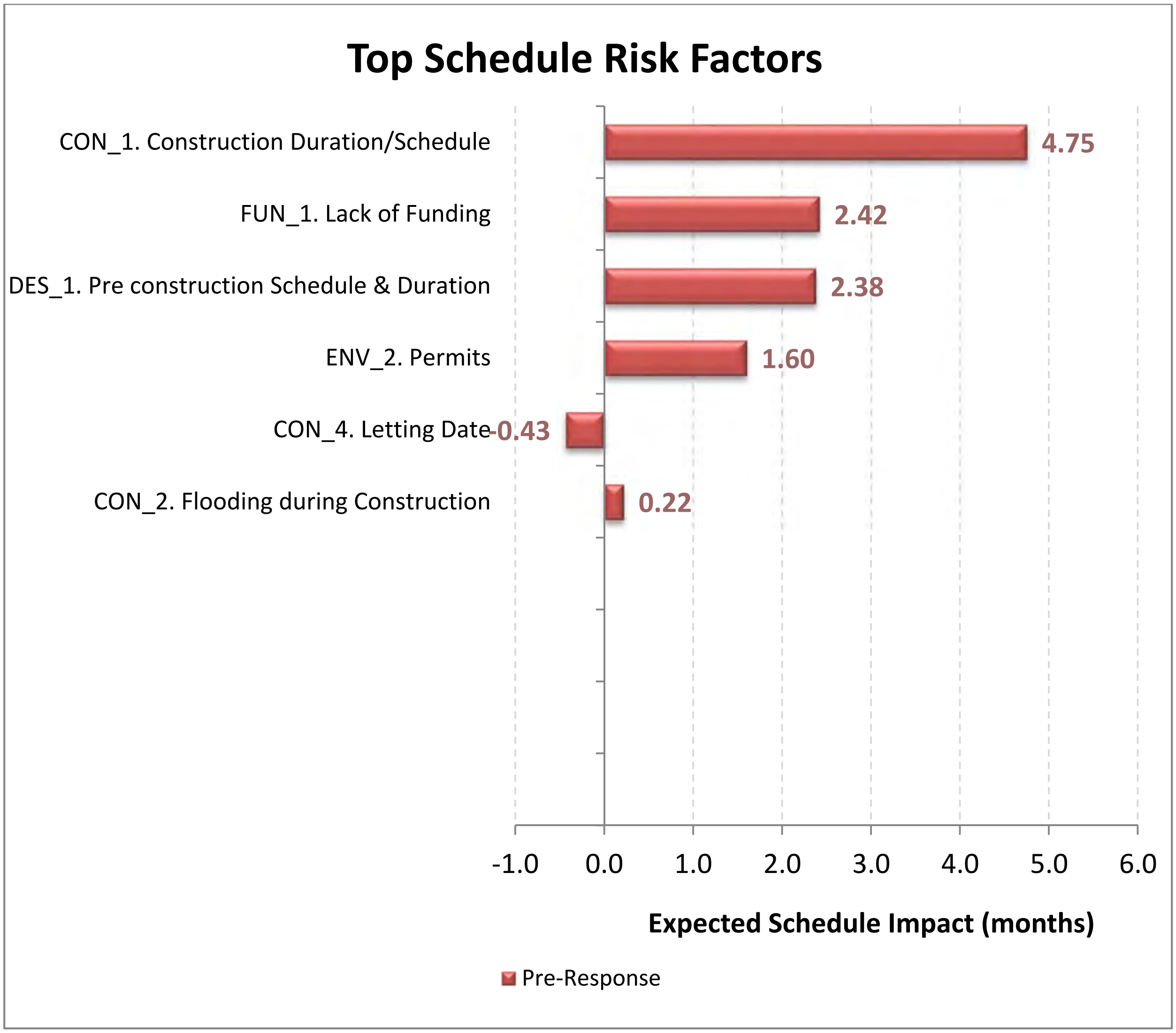
Reduce the Risk

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.



Top Cost Risk Tornado Diagram (Pre-Response)



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.

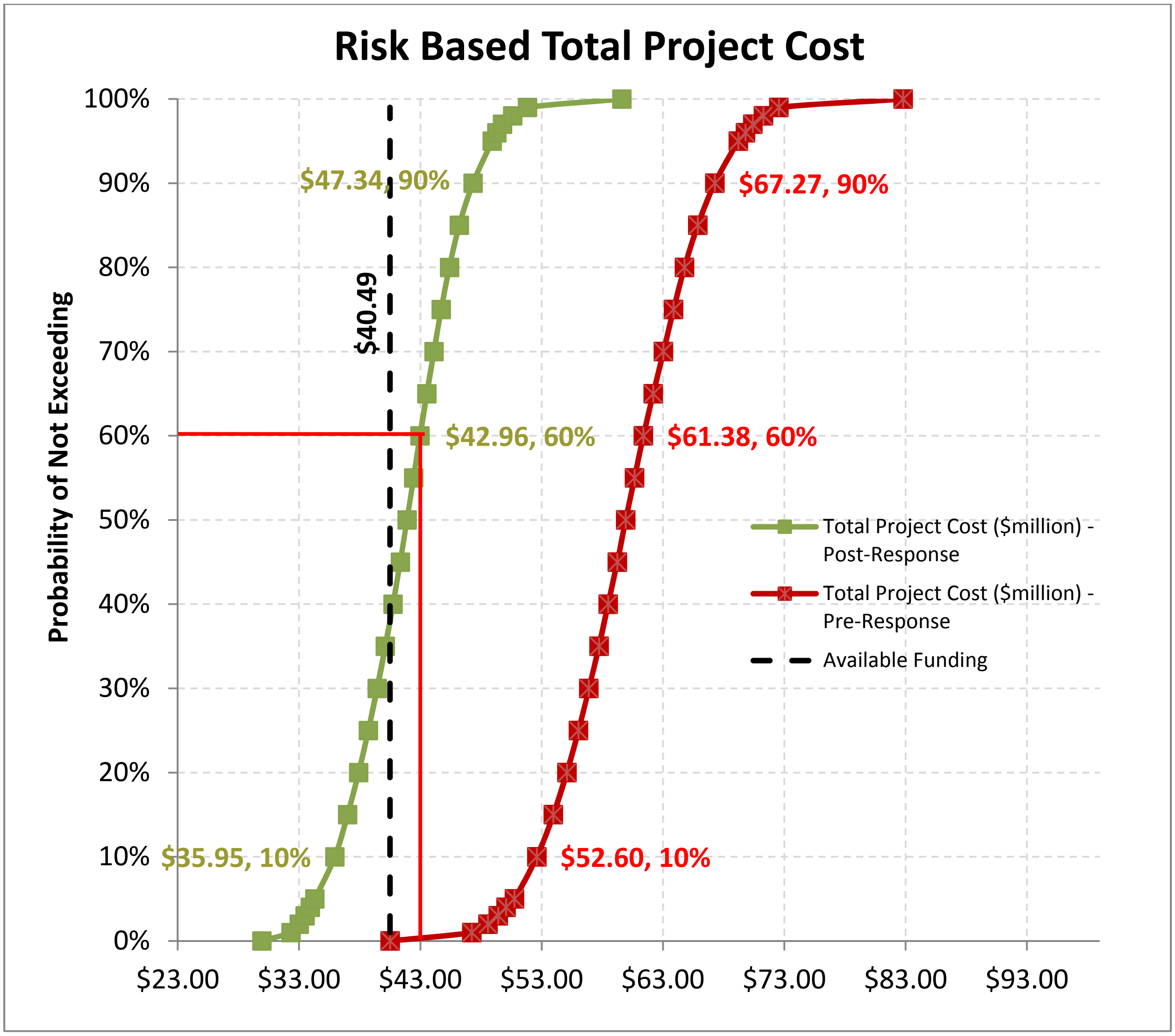
Avoiding a risk may cost more money up front, but may prevent more extensive impact later on. Accepting a risk means that there is not much that can be done to lessen the risk, except to know how to deal with it when it arises. The transferring of a risk allows for the risk owner to move the liability 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)

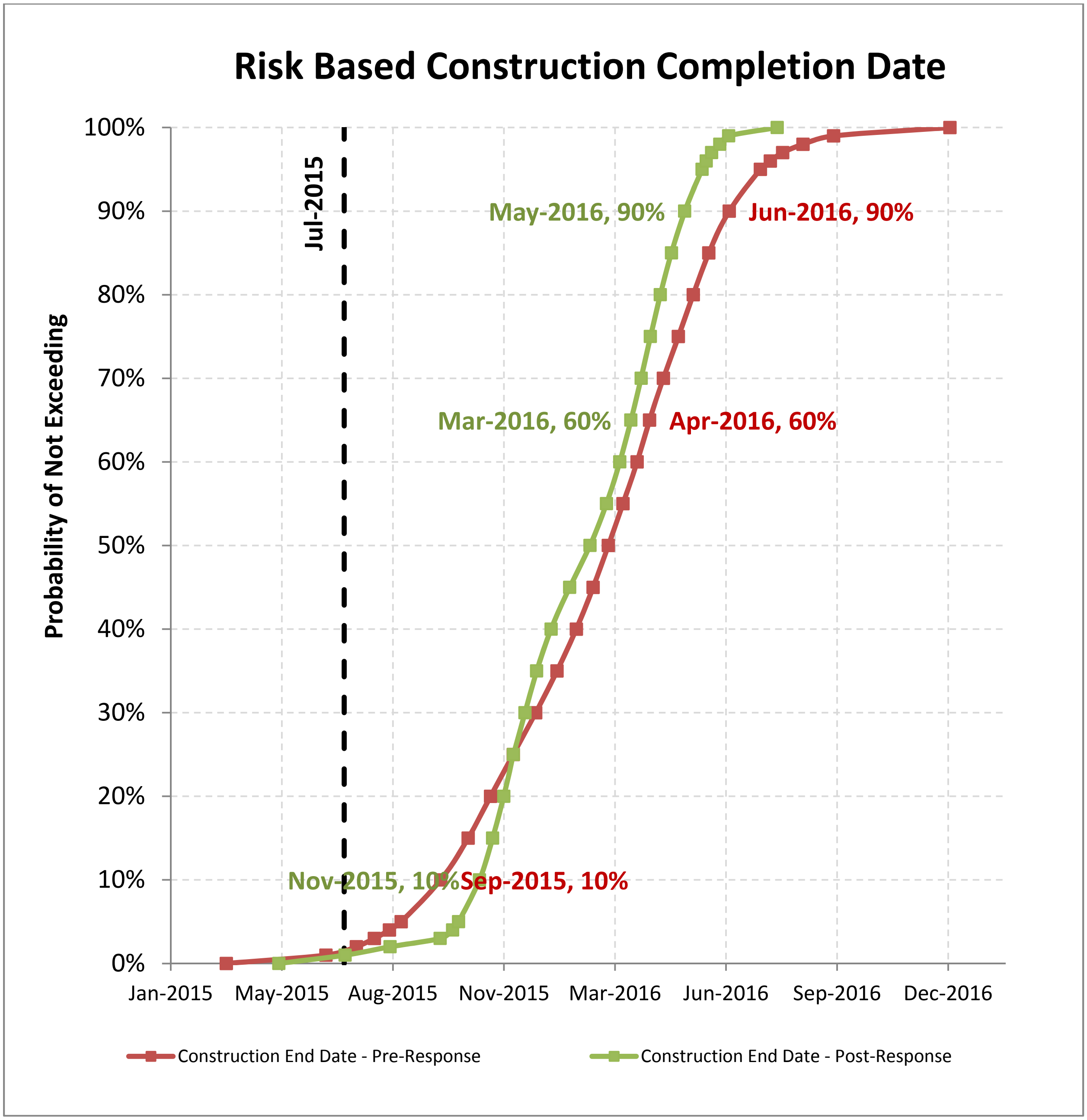
After identifying the appropriate risk response strategies for the highest risk areas, the project was again evaluated in a post-response manner. The CRAVE™ Team again discussed the risk response strategies for each risk and re-evaluated the probabilities and range of impacts for each risk element based 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.



Risk Based Total Project Cost - YOE (Post-Response)

The total estimated project cost in YOE dollars prior to response to the risk and implementation of the VE recommendations is $61.38 million at the 60% confidence level. After responding to the risks and implementing the value engineering recommendations the project has an estimated cost of $42.96 million at the 60% confidence level, or a reduction of $18.42 million in CY dollars.



Risk Based Construction Completion Date (Post-Response)

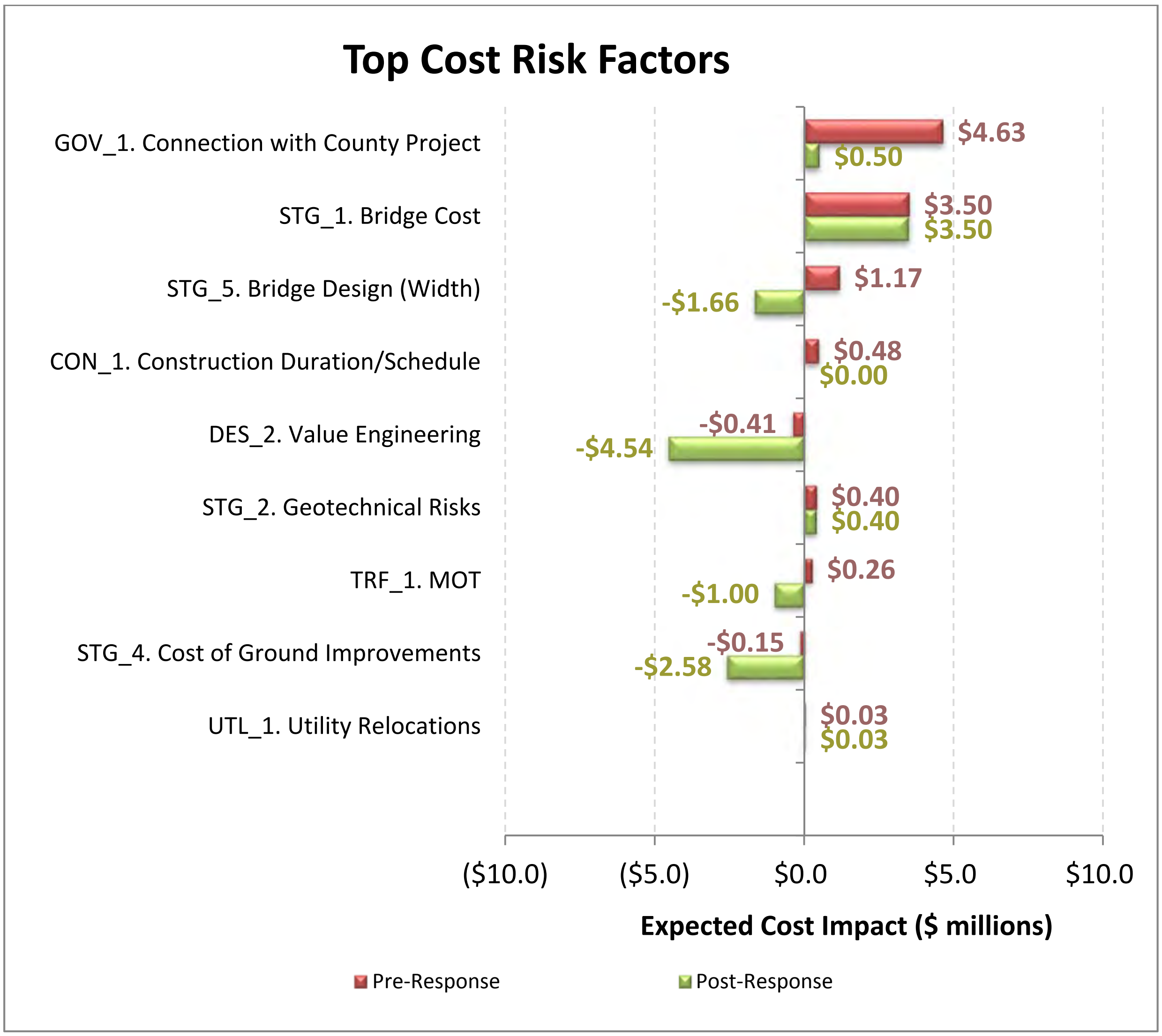
The project completion date prior to response to the risk and implementation of the VE recommendations is March 2016 at the 60% confidence level. After responding to the risks and implementing the value engineering recommendations the project completion date showed only a slight improvement and remains March 2016.

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

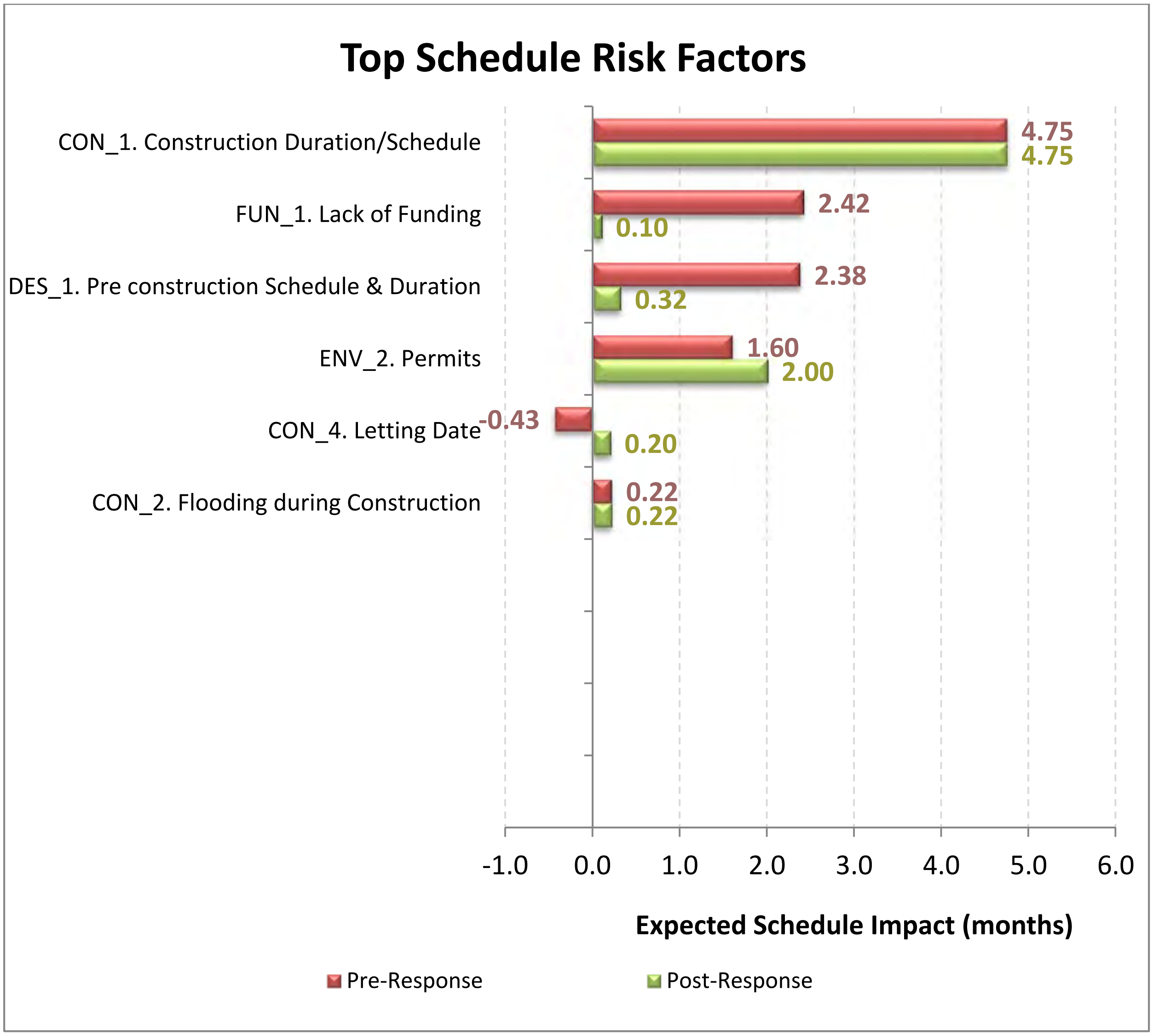
Risk Process Summary

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).



Top Cost Risk Tornado Diagram (Post-Response)



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.

This page intentionally left blank

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.

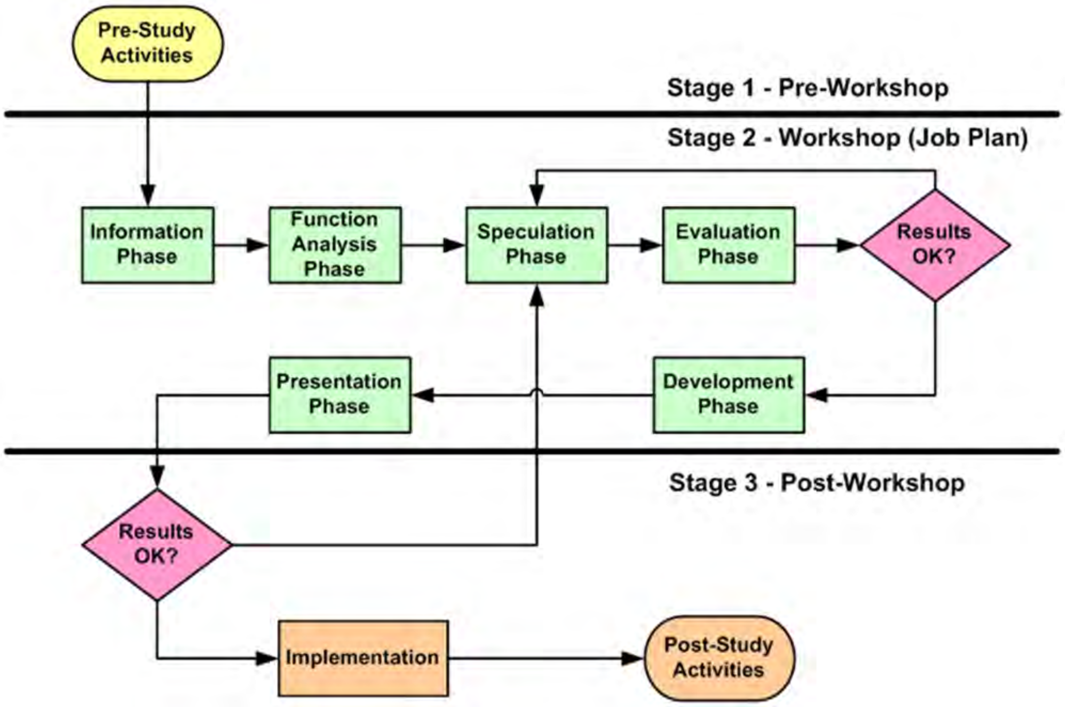
Pre-CRAVE™ Workshop

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. This process is known as Value Metrics. 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.

This page is left intentionally blank

Appendix B

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

This page is left intentionally blank

Value Engineering Recommendation Approval Form

Project: TH 101 Floodplain Bridge SP 1009-24

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	Test Pile Program	Accept for further review	Likely will complete this, need to determine timing within project delivery schedule.				1	1	$ 670,000	
2	Procurement	Reject	Due to funding constraints, need to let project in May 2014				1	1	$ -	
3	TH 101 Staged Construction	Accept for further review	Accepted, but not on the same alignment, shifted bridge alignment to the west of existing to build "offline". There will be some additional cost due to shoulder work needed on TH 101 to keep it open to traffic (estimated at $1M). Also, the $2.25M allocated to the TH 169 restriping will still be used to restripe on TH 169. However, the $2.25M will not come out of the $34M budgeted for the project (will be a separate project). The bridge cost was estimated to be the same cost if moved to the westernly alignment as the base case. No cost savings anticipated with staged construction.				1	1	$ -	$ 1,000,000
4a	Reduce Width of Trail	Accept	Accepted by all parties, reasonable request that meets LRFD requirements.			1			$ 620,000	
4b	Bridge Typical Section	Accept	Accepted by most parties, some concern about possible future head-on crashes with no barrier, but the larger outside shoulder was a safety improvement (for storage or pull-off), and helps with drainage.		1	1		1	$ 1,170,000	
5	Construct One-Way Wye	Reject	Not accepted by municipal partners, would not receive municipal consent on the project.		1	1	1		$ 3,710,000	
6	Extend Bridge	Accept	Increased length of the bridge to 4100-ft to "bridge over" the extremely bad soils. Plan also to realign Bluff Creek to go under the 2nd span from the north. Will have some added cost for stream realignment (and additional permit/discussion work with the natural resource regulatory agencies).			1	1		$ 2,720,000	
7	Pedestrian Railing	Reject	Not accepted by municipal partners, minimal cost savings, want to keep options open for aesthetic purposes.						$ 450,000	
			Total for 8 recommendations	0	2	4	5	4	$ 9,340,000	$ 1,000,000
			Total for 5 accepted recommendations	0	1	3	3	3	$ 5,180,000	$ 1,000,000

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

Value Engineering Recommendation Approval Form

Project: TH 101 Floodplain Bridge SP 1009-24
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

[signature]
Signature Project manager

12/26/12
Date

Nicole Danielson-Bartelt
Name (please print)

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.

ONE COMPANY | *Many solutions*

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);

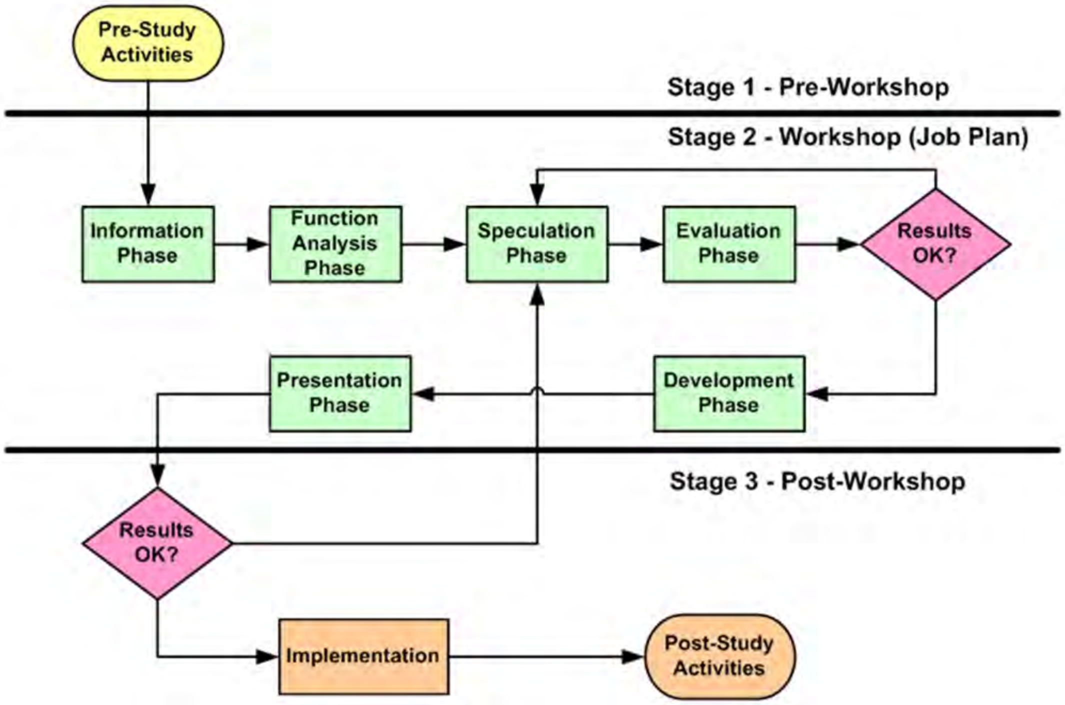
Tuesday thru Friday: Arden Hills Training Center; 1900 West County Road I; Shoreview, MN 55126, Room 10.

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



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

Minnesota Department of Transportation

CRAVE™ Study Attendees

TH 101 – Minnesota River Floodplain Bridge

HDR

2012 November 5	6	7	8	9	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE Office	TELEPHONE Cell / 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 – Minnesota River Floodplain Bridge

2012 November					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE Office / E-MAIL	TELEPHONE Cell
5	6	7	8	9					
✓					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 Blane.Long@hdrinc.com	(360) 742-7682
✓					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	

Minnesota Department of Transportation

CRAVE™ Study Attendees

TH 101 – Minnesota River Floodplain Bridge

HDR

2012 November 5	6	7	8	9	NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE Office	TELEPHONE Cell	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

Minnesota Department of Transportation

CRAVE™ Study Attendees

TH 101 – Minnesota River Floodplain Bridge

HDR

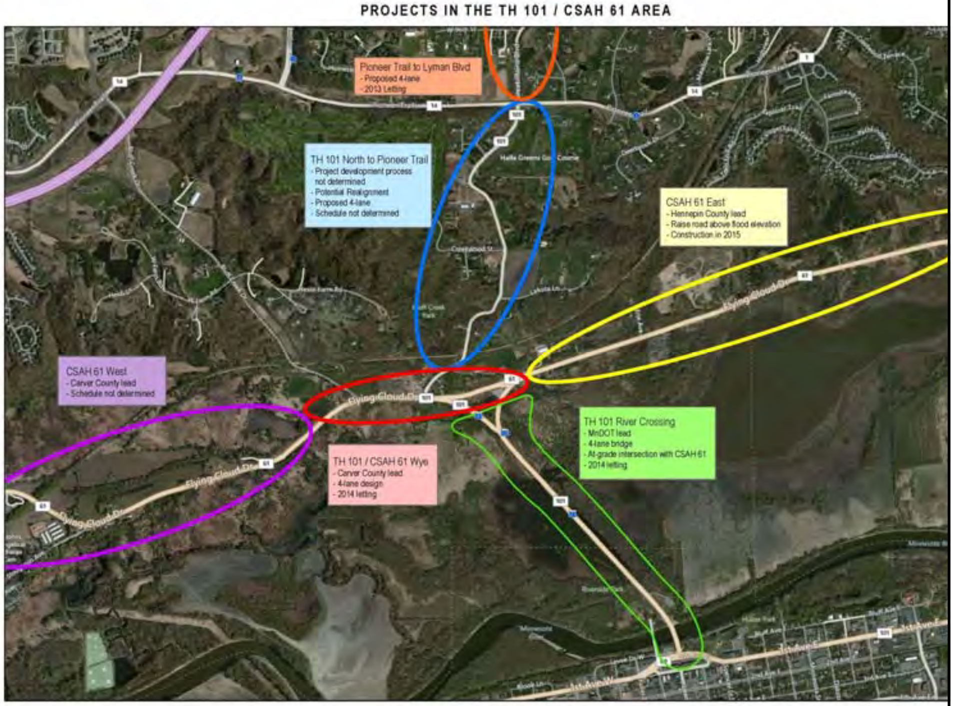
2012 November					NAME	ORGANIZATION	POSITION/DISCIPLINE	TELEPHONE		
5	6	7	8	9				Office	Cell	E-MAIL
✓	✓	✓	✓	✓	Ken L. Smith	HDR	Team Leader/Facilitation	(360) 570-4415	(360) 451-2527	Ken.L.Smith@hdrinc.com
✓	✓	✓	✓	✓	Brian Wifler	MnDOT	Pre-design	(651) 234-7668		brian.wifler@state.mn.us
✓					Lee Williams	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

PROJECTS IN THE TH 101 / CSAH 61 AREA



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

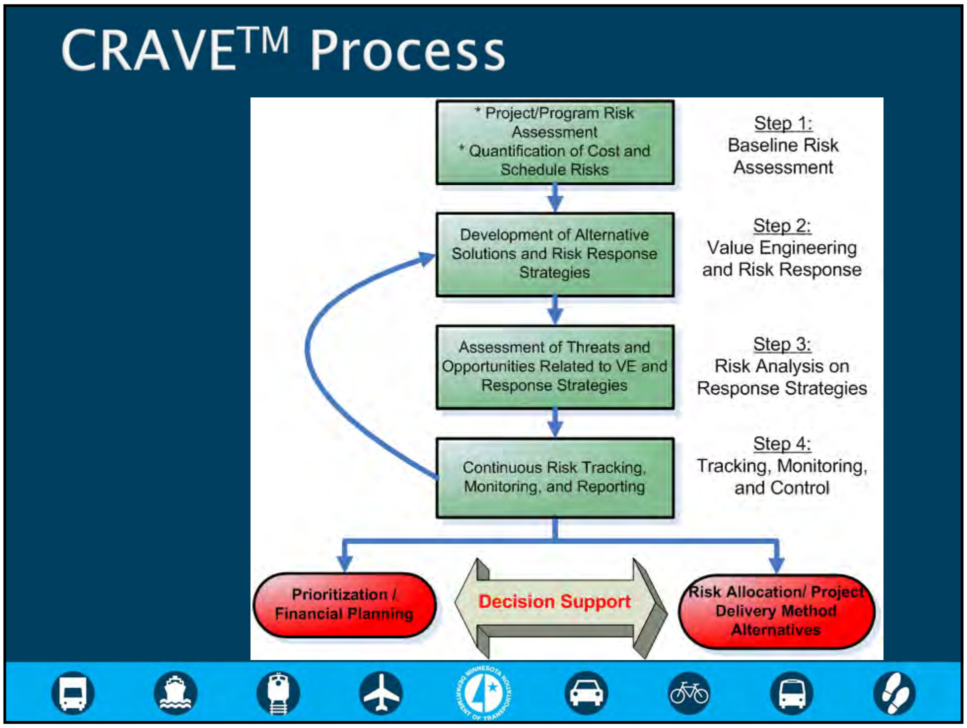
Addressing Cost and Schedule Concerns

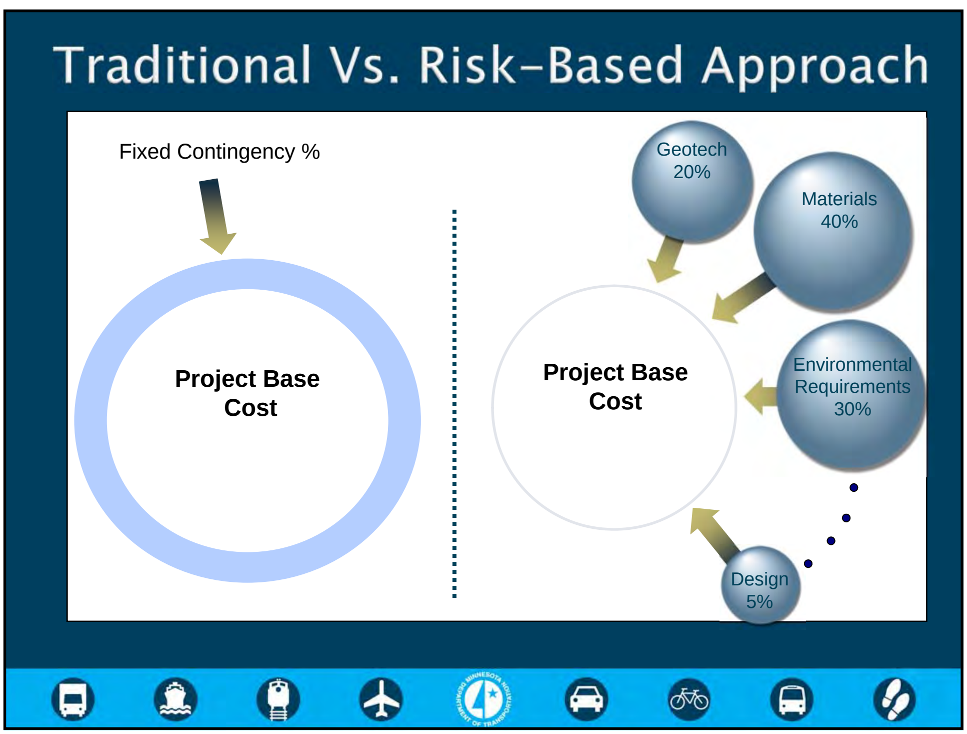
Usual Questions

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

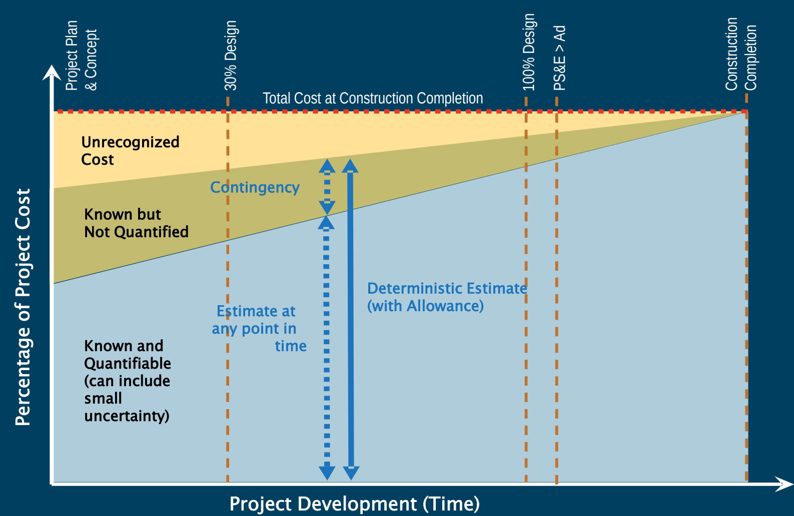
Analysis Needs

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


CRAVE™ Process
* Project/Program Risk Assessment
* Quantification of Cost and Schedule Risks
Step 1:
Baseline Risk Assessment
Development of Alternative Solutions and Risk Response Strategies
Step 2:
Value Engineering and Risk Response
Assessment of Threats and Opportunities Related to VE and Response Strategies
Step 3:
Risk Analysis on Response Strategies
Continuous Risk Tracking, Monitoring, and Reporting
Step 4:
Tracking, Monitoring, and Control
Prioritization / Financial Planning
Decision Support
Risk Allocation/ Project Delivery Method Alternatives


Traditional Vs. Risk-Based Approach
Fixed Contingency %
Project Base Cost
Geotech 20%
Materials 40%
Project Base Cost
Environmental Requirements 30%
Design 5%

Assessment of Baseline Cost



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

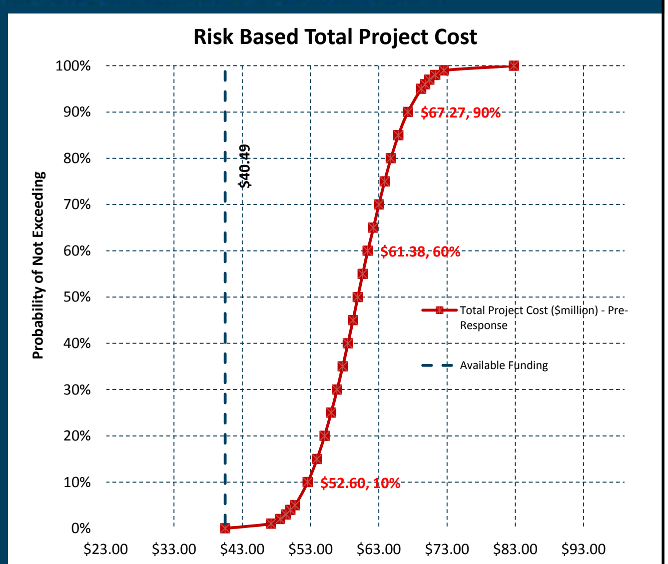
- All State Funds
  - $20M Flood Mitigation bonding
  - $9M Local Road Improvement Program (LRIP)
  - $5M Local match (Carver and Scott Counties)
  - $3.84M Preliminary Engineering Costs (MnDOT)
  - $2.65M Construction Engineering Cost (MnDOT)
- **$40.49M total**
  - Cash flow considerations
- Current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

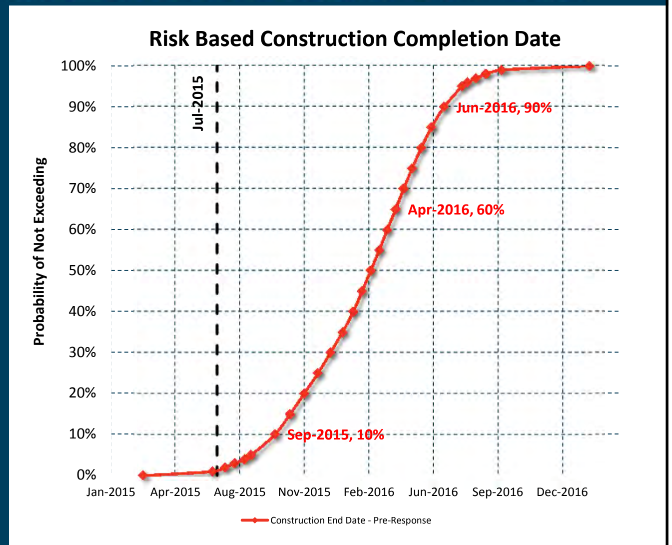
Pre-Response Risk TH 101

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

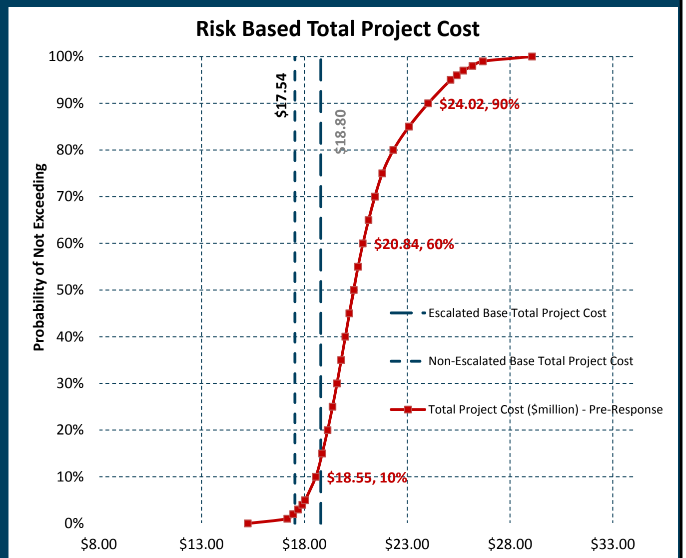
Canaidates fo Schedule Mitigation TH 101

Pre-Response Risk CSAH 61

Risk Reserve @ 60%
$2.45M or 7.4%

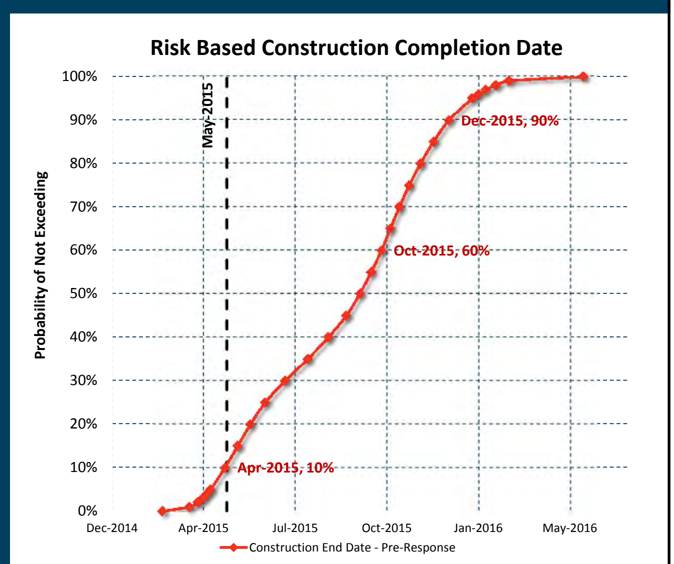
Pre-Response Risk CSAH 61

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

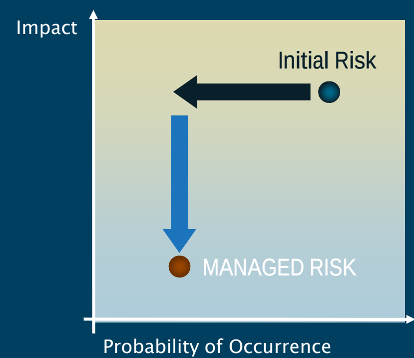
"What gets measured, gets managed"

19

Candidates for Schedule Mitigation CSHA 61

Goal of Risk Management

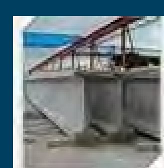
- Risk Assessment's aim is to assess potential impact of various scope, event, and budget risks on the project's cost and schedule.
- Risk Management's aim is to identify opportunities and mitigation strategies to reduce both the likelihood of an event occurrence and the potential effect if it occurs.



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

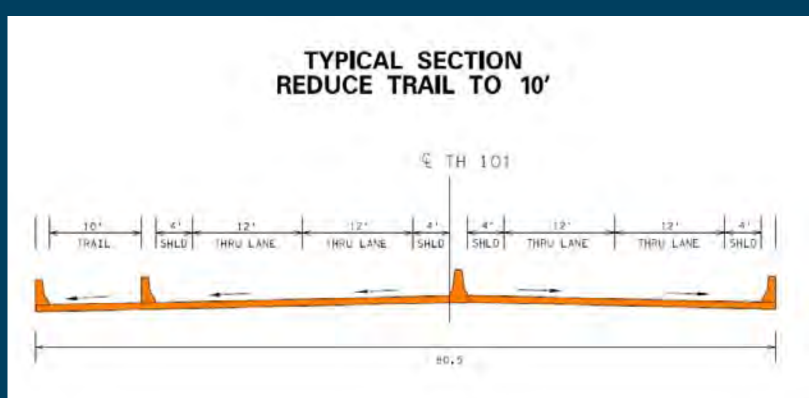
TH-101 # 2 Procurement Schedule



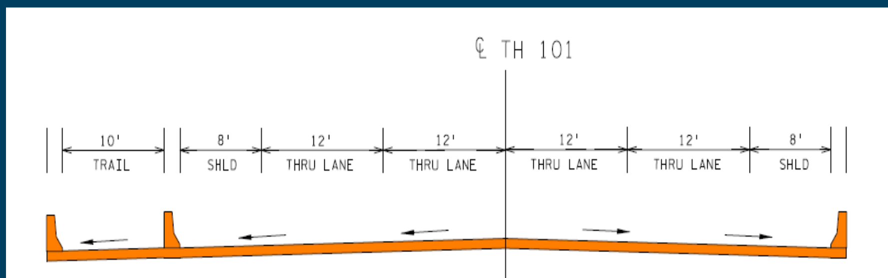
By advertising and letting the contract in the fall it will be possible for a contractor to procure piling and girders in the fall.

TH-101 # 3 Staging

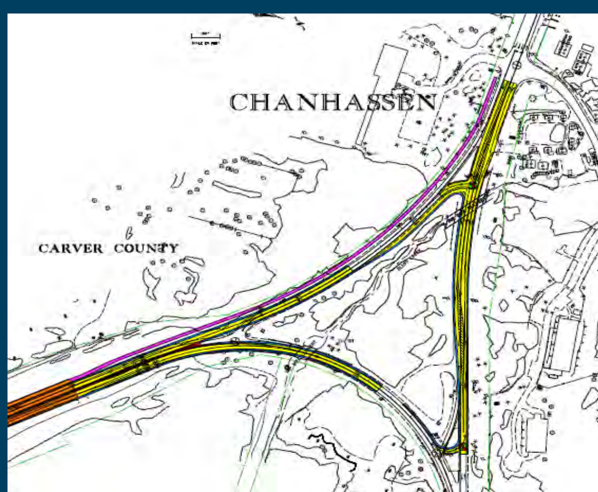
TH-101 #4a Trail on Bridge



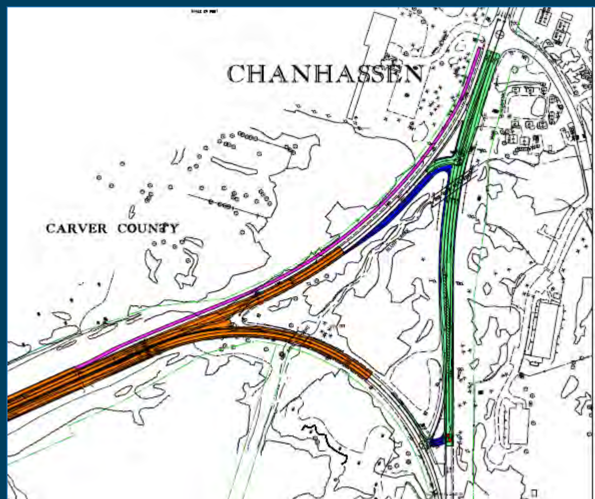
TH-101 # 4b Median Width



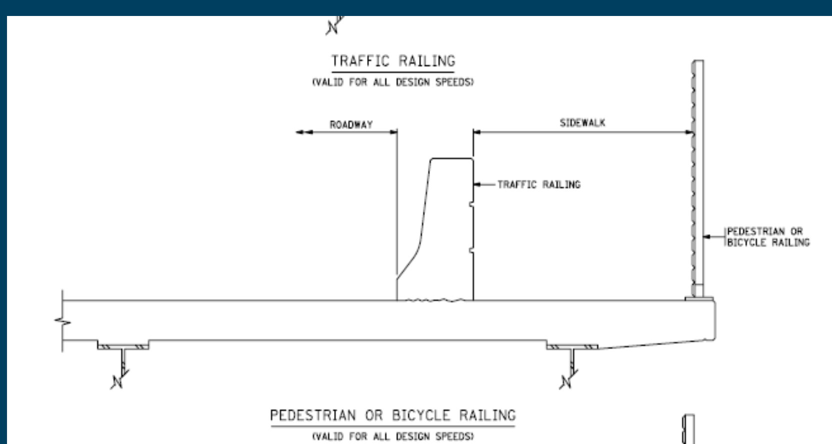
TH-101 # 5 One Way Wye



TH-101 # 6 Extend Bridge



TH-101 # Pedestrian Railing



TH-101 Recommendation Summary

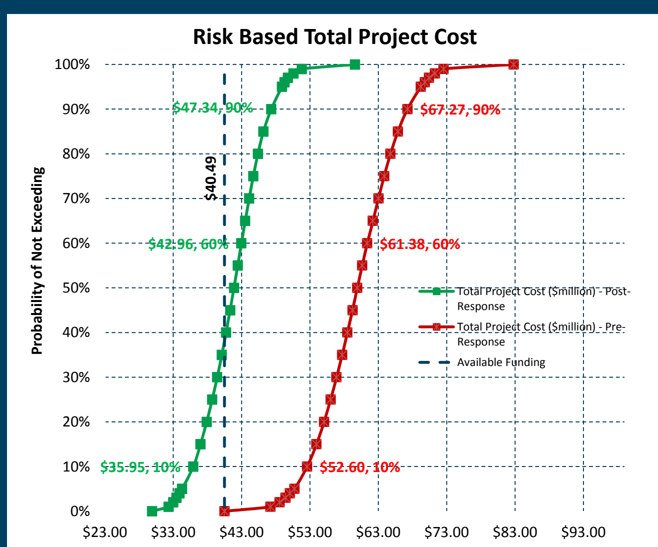
Minnesota Department of Transportation — HDR

Summary of Recommendations

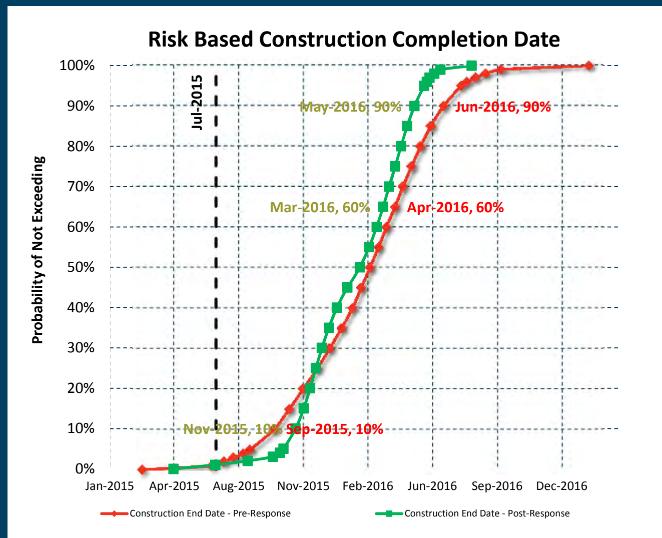
TH 101 Floodplain Bridge

#	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



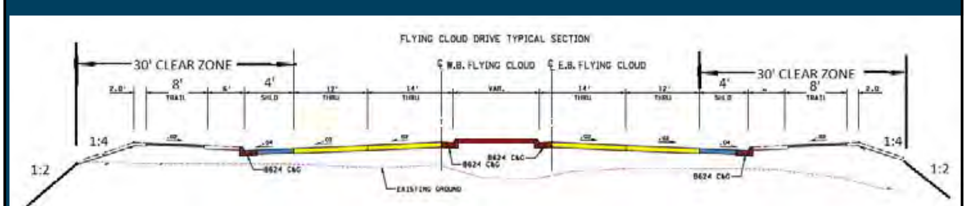
TH-101 # Mitigated Cost

TH-101 # Mitigated Schedule

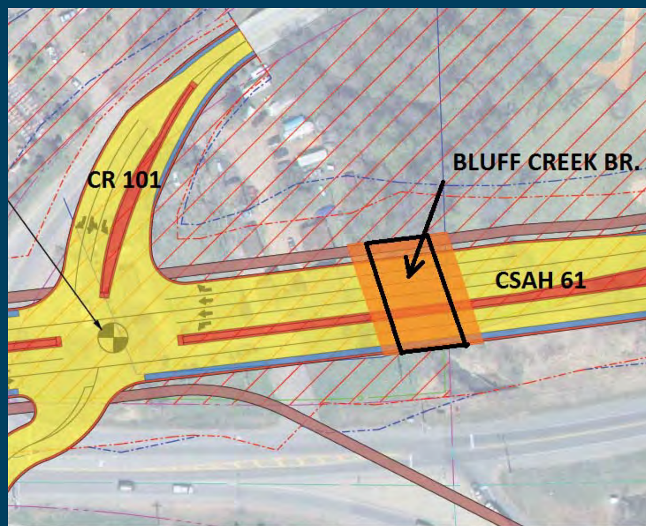
CSAH 61 Base Case

CSAH 61 #1Reduce Right of Way Acquisition

CSAH 61 #2 Roadway Section



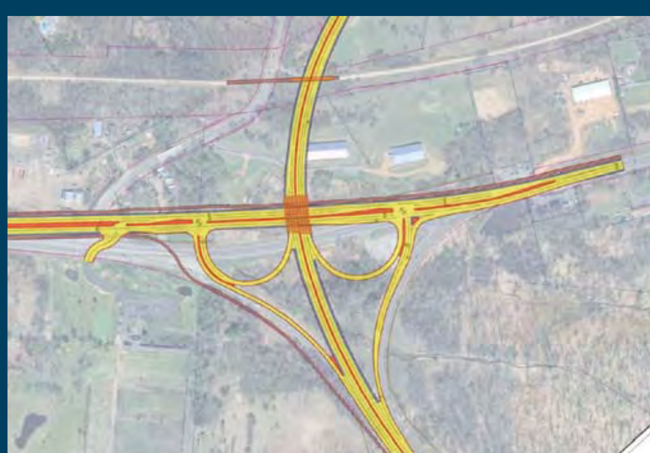
CSAH 61 #3 Bluff Creek Bridge



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



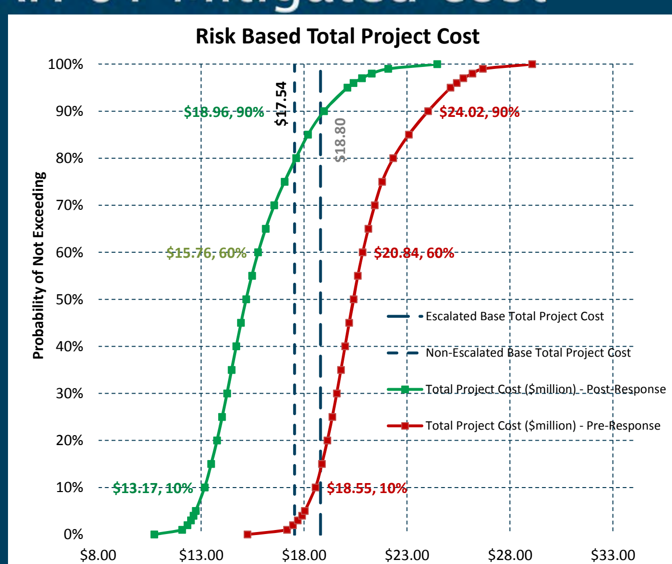
CSAH 61 Recommendation Summary

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