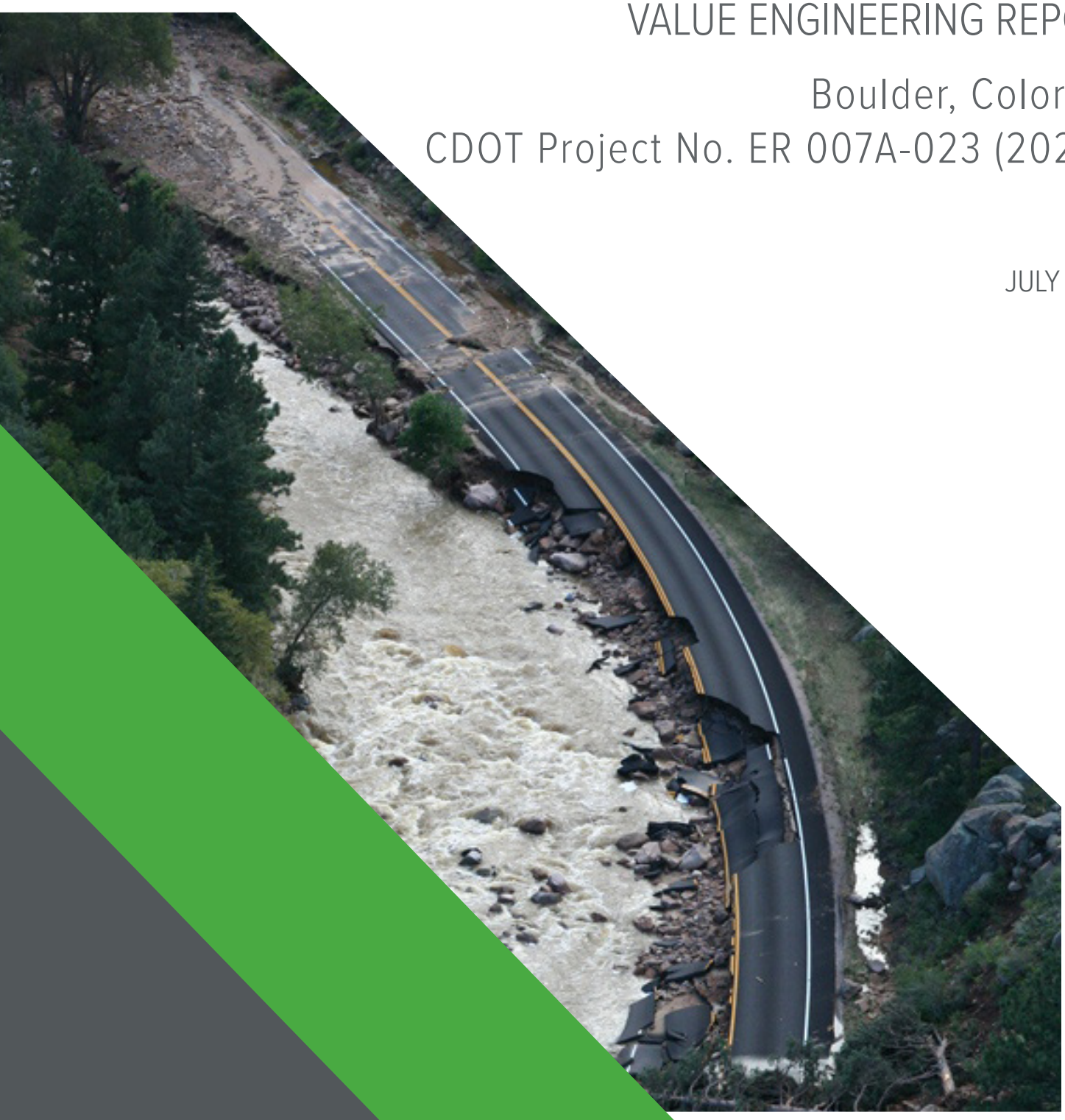
SH7 (LOWER) PERMANENT PAVEMENT REPAIR PROJECT

VALUE ENGINEERING REPORT

Boulder, Colorado
CDOT Project No. ER 007A-023 (20252)

JULY 2020



benesch

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EXECUTIVE SUMMARY

E.1 Project Description

A Value Engineering (VE) workshop was conducted on the SH 7 (Lower) Permanent Pavement Repair project from July 8 through July 10, 2020 in Firestone, Colorado. The project is 14 miles long and restores the two-lane highway to a more resilient infrastructure after repairs from damage caused by a flood in 2013. The project also includes improvements for cyclists and other recreational users within the corridor. Reconstruction of the Middle St. Vrain Creek which parallels the highway is included in the scope.

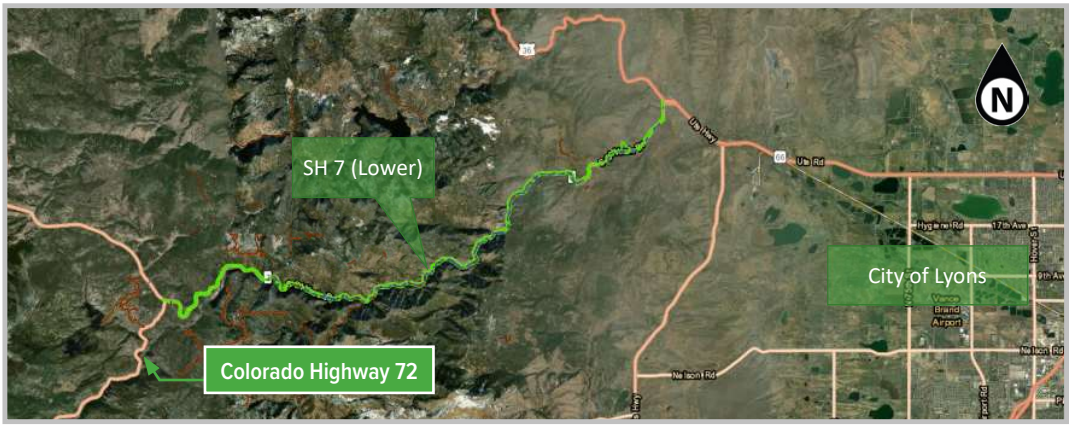


Exhibit E.1: SH 7 Lower Jct SH72 to Lyons

The project's construction estimate was $53.1 million after clarification was made on the limits of rockfall treatments within the corridor. A discussion of the project's estimate is in **Section 3** of the report and is included in **Appendix A.**

The six-phase job plan for Value Engineering was followed by the facilitation team from Alfred Benesch & Company (Benesch). The VE Team was composed of technical experts from Colorado Department of Transportation (CDOT), Rocksol, Kiewit, Federal Highway Administration (FHWA), Watershed Science & Design and Benesch. A kickoff meeting with the project team which included RS&H Incorporated as the design firm and Kiewit Infrastructure Group as the contractor was conducted on the first day. The project is being delivered as a Construction Manager/General Contractor (CMGC) form of alternative delivery. A summary of the information phase including stakeholders and their expectations are shown in **Section 2**.

In addition to the cost evaluation, function analysis and function cost analysis were performed. They are all shown in **Section 3** and include the Customer Function Model which shows the functions and their relationship to one another according to the understanding of the VE Team. The speculated ideas for project alternatives are documented in **Section 4**. One hundred thirty-

three ideas were generated and the screened for feasibility. Section 5 shows the screen listed and the ideas rejected along with their reason for removal. Concepts from the screened idea list were further evaluated for benefits to the project in the absence of cost before advancing to the proposal stage.

Section 6 lists detailed discussions of the proposals along with their advantages, limitations, and cost impacts.

PROPOSAL 1 discusses an alternative milling and overlay scheme where some of the existing asphalt is retained for benefit to the pavement section

PROPOSAL 2 evaluations substituting mill and overlay for the concrete sections of the highway.

PROPOSAL 3 discusses the use of recycled asphalt pavement in base.

PROPOSAL 4 compares two maintenance of traffic scenarios - one utilizing full closure windows with designated roadway opening windows and the other a full closure for the duration of the project.

PROPOSAL 5 develops an evaluation of the Cement Treated Soil (CTS) idea.

PROPOSALS 6 & 7 discuss different approaches to the stream reconstruction. Either one or the other or perhaps a partial combination of the two of these proposals is recommended.

PROPOSAL 8 discusses the benefits of partnering with locals for staging locations and minimizing haul lengths.

PROPOSALS 9 & 10 address ways to approach program costs for the benefit of the project's management and budget.

Exhibit E.2 summarizes the Proposals for the study. In addition, 22 design suggestions were developed for CDOT and the design team to consider.

An aggressive schedule expediting construction and utilizing full closures was evaluated along with a seasonally optimized schedule for both construction activities and traffic impacts to the canyon.

PROPOSAL SUMMARY

Pro. No.	Description	As Given	VE Proposal	Construction Cost Avoidance	Recommendation	Decision	Recommended Action
P1	Mill 1" and 2" Overlay	$3,470,000	$3,060,000	$410,000	Recommended	Consider Implementation	Review areas in floodplain where not possible; need to assess where roadway is not in floodplain overtopping and CLOMR/floodplain rise is not a risk
P2	Eliminate Concrete Sections	$5,380,000	$618,000	$4,762,000	Recommended	Consider Implementation	This will have to be explained/discussed with USFS - previous concern or point of interest was mitigation of cross-slope drainages. Initial conversations with this news have been delivered to USFS with field reviews, but is not closed.
P3	Incorporate Recycled Asphalt Pavement	$947,000	$947,000	$0	Recommended	Consider Implementation	Check with R4 materials on specification (Roadway team). Refer to Materials/Roadway team on feasibility/risk/benefit.
P4A	Full Closure Window for MOT	$4,620,000	$3,460,000	$1,160,000	Recommend P4B	Consider Implementation	Continue discussions with 4f stakeholders to make sure no impact. Need to begin public outreach plan and specific details if full closure selected.
P4B	Full Road Closure for MOT	$4,620,000	$2,890,000	$1,730,000			
P5	Utilize CTS and Eliminate Matrix Rip Rap	$13,937,000	$7,617,000	$6,320,000	Recommended	Consider Implementation	Defer to river rehab for feasibility/benefit/risk.
P6	Let it Grow: Vegetation-Centric Alternative Design	$8,160,000	$1,910,000	$6,250,000	Recommended	Consider Implementation	Meet with stakeholders at 50% plan review and discuss let it grow. Stakeholder input may drive some of the discussion.
P7	Lighter Touch: Reduce or Eliminate Structural Elements and Earthwork	$8,160,000	$2,940,000	$5,220,000	Recommended	Consider Implementation	Meet with stakeholders at 50% plan review and discuss lighter touch approach, need to minimize impact to river. Stakeholder input may drive some of the discussion.
P8A	Look for win-win opportunities with Boulder to justify using quarry for materials and staging area	$800,000	$0	$800,000	Recommended	Re-open Conversation	Suggest setting up meeting after review and digesting Boulder County Concerns to come up with benefit map, risk and concern mitigation based on Boulder County feedback.
P9	Appropriating work in specific phases to save on indirect/CE rates, schedule, efficiency	$3,270,000	$1,570,000	$1,700,000	Recommended	Needs Further Study	CDOT to look into how this would be done, given flood projects are already direct to project. Who would the money go to? How does CDOT hold control?
P10	Direct to project to reflect reduced project resources based on efficient oversight	$6,630,000	$4,770,000	$1,860,000	Recommended	Rejected	Suggest removing from VE. CE rate is already direct to project since flood.
	Maximum Potential Construction Cost Avoidance			**$23,832,000**			
	Maximum Potential Program Cost Avoidance			**$29,885000**			

Exhibit E.2: Summary of the proposals for Highway 7 (Lower)

Maximum Potential Construction Cost Avoidance is the sum of the recommended proposals except for Proposal 7. Either Proposal 6 or Proposal 7 or a combination of the two can be applied to the project. Proposal 6 is recommended between the two based on its maximum value.

The Maximum Potential Program Cost Avoidance is also determined by adding an additional 25.4 percent to the Maximum Construction Cost Avoidance. This number was determined based on the percent calculation of the program costs outside the construction cost less the lump sum items. The lump sum items are Design, Utilities, Right-of-way, Previous Expenditures, and Environmental Clearances. The values of these items are provided in the estimate in **Appendix A**.

Section 7 provides a summary and conclusion of the studies proposals along with an explanation of cost impacts to the project.

A virtual presentation was made to the owner and project team on July 20th. That presentation is included in **Section 8**.

Disclaimer

The cost differences developed are based on the design information provided to the VE Team and should not be considered absolute cost savings guarantees; but rather indicators of potential value magnitudes requiring further detailed engineering as the project develops.

1 INTRODUCTION

1.1 Project Description

In September of 2013, Storms on the Front Range of the Rocky Mountains in Colorado created major flood events in a number of canyons and waterways including the Middle St. Vrain Creek in Boulder County. State Highway (SH) 7 (Lower), located along the Middle St. Vrain Creek experienced significant damage during the flood event (Exhibit 1.1).

Exhibit 1.1: SH 7 (Lower) Middle St. Vrain Creek flood damage

The Colorado Department of Transportation (CDOT) made emergency repairs resulting in a serviceable highway for the short-term. Presently, CDOT Region 4 is designing a permanent repair project (Project No. ER 007A-023) for SH 7 (Lower). The project is being delivered as a Construction Manager/ General Contractor (CMGC) alternative delivery project. RS&H Incorporated is the design firm and Kiewit Infrastructure Group is the construction contractor partnering with CDOT to deliver the project.

As a part of the CMGC project development a Value Engineering (VE) study was commissioned with Alfred Benesch & Company (Benesch) serving as the facilitator. The workshop was conducted in the I-25 Construction Office in Firestone, Colorado from July 8 to July 10, 2020 with the final presentation made the morning of July 20th. The team consisted of independent subject matter experts from CDOT, Federal Highway Administration (FHWA), Rocksol, Kiewit, Benesch, and Watershed Science and Design. The workshop was unique in that the initial kickoff VE meeting was integrated into the CMGC kickoff meeting. Some members of the VE team also participated virtually with the final VE presentation made completely virtual.

The SH 7 (Lower) Permanent Pavement Repair project limits cover 14 miles of the highway from the community of Lyons, Colorado to the intersection of SH 7 with Colorado Highway 72. The scope of work includes reestablishment of two eleven-foot-wide lanes of the highway with shoulders where practicable. One intended benefit of the shoulder is to accommodate cyclists in the area. Cross-road piping is to be reconstructed or improved for drainage. Rock fall ditches, where feasible, and other mitigation measures are also planned to manage rock faces and protect the highway and its users. Resiliency elements of the project are planned to mitigate future flood events and to assist in providing egress for residents in the canyon and access for emergency responders. The Middle St. Vrain Creek is to be rehabilitated to promote or maintain a healthy ecosystem and recreational

opportunities. The construction cost originally provided to the VE team was $76.7 Million. During the workshop costs were updated due to a more refined scope for geo-hazard elements. The new construction cost and its associated line item costs used throughout the VE study was $53.1 Million.

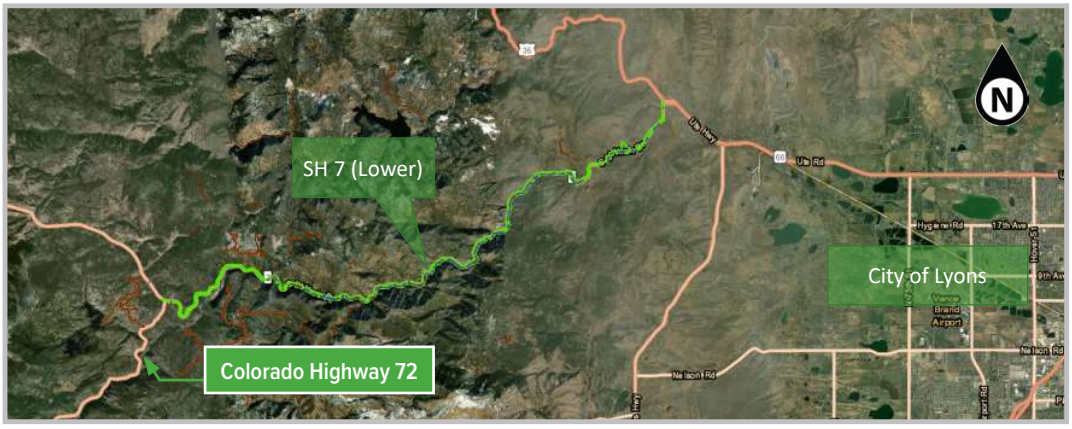


Exhibit 1.2: SH 7 Lower Jct SH72 to Lyons

1.2 Value Engineering Scope

The scope of the assignment was to perform a value engineering study following the SAVE International model. The Alternatives' potential cost savings, performance and stakeholder acceptance were compared with functions to assure that value was preserved or enhanced. This process was conducted over a three-day period with the presentation of the findings on July 20, 2020.

1.3 Value Engineering Process

The study was conducted utilizing value engineering techniques. Value engineering advocates a team-oriented, systematic approach. This systematic approach is embodied in the job plan (Exhibit 1.3). The job plan has several phases and imposes a set of rules that must be adhered to for each phase. The rules may appear to be simple, but they are vital to the success of the value planning process. This section describes the typical job plan and explains the rules of the job plan and the reasoning behind them.

The ultimate goal of a VE Study is to carefully transform the needs and desires for a project into functions. The VE Team then speculates about ideas for all functions and develops a solution that scores high on performance, with a reasonable acceptance and cost. At the end, VE efforts result in a solution that satisfies owners, users and stakeholders. The VE Team keeps the following three principles in mind when determining value:

1. Every action is required or desired by someone (Stakeholders)
2. Every action has a reason or purpose (Function)
3. The cost of each action must be justified within the limits of constraints (Function Cost)

INFORMATION PHASE

The purpose of the Information Phase is to gain an understanding of the project and the stakeholders who will be affected. The information phase can be summarized as follows:

- Review all relevant project information, including description and scope of work
- Identify owners, users and stakeholders
- Identify constraints, needs and desires of owners, users and stakeholders

FUNCTION ANALYSIS PHASE

- Using Stakeholder constraints, needs and desires, develop project related functions
- Determine the task, basic function(s) and supporting functions
- Estimate the cost of project elements and each critical function
- Analyze owner and Stakeholder attitudes toward each function

SPECULATION PHASE

The purpose of the Speculation Phase is to identify ideas that will perform the project functions or will enhance performance or acceptance at a reasonable cost.

EVALUATION PHASE

The purpose of the Evaluation Phase is to identify the most outstanding Alternatives for further development. This identification is accomplished through a series of screening processes that sort ideas by comparison and combination. Using these ideas, Alternatives are developed. These Alternatives are then rated for performance, acceptance and cost.

DEVELOPMENT PHASE

The purpose of the Development Phase is to add information that facilitates selection of a preferred Alternative. This is accomplished by comparing the remaining Alternatives. The following rules are considered during the Development Phase:

- Recognize ideas that may be unique
- Conduct research, as required, to provide additional information
- Analyze weaknesses of selected Alternatives and provide improvements

The VE Team was asked to review the As Given design and its cost estimates to determine if cost savings could be identified without compromising the main purpose (the Task) of the project.

VE Workshop Schedule	
Wednesday 07/08/20	Information Phase Function Analysis and Cost
Thursday 07/09/20	Speculation Phase Evaluation Phase Development Phase
Friday 07/10/20	Development Phase cont.
Monday 07/20/20	Presentation Phase

Exhibit 1.3 depicts the process from needs and desires of stakeholders to the project solution, using the VE Job Plan.

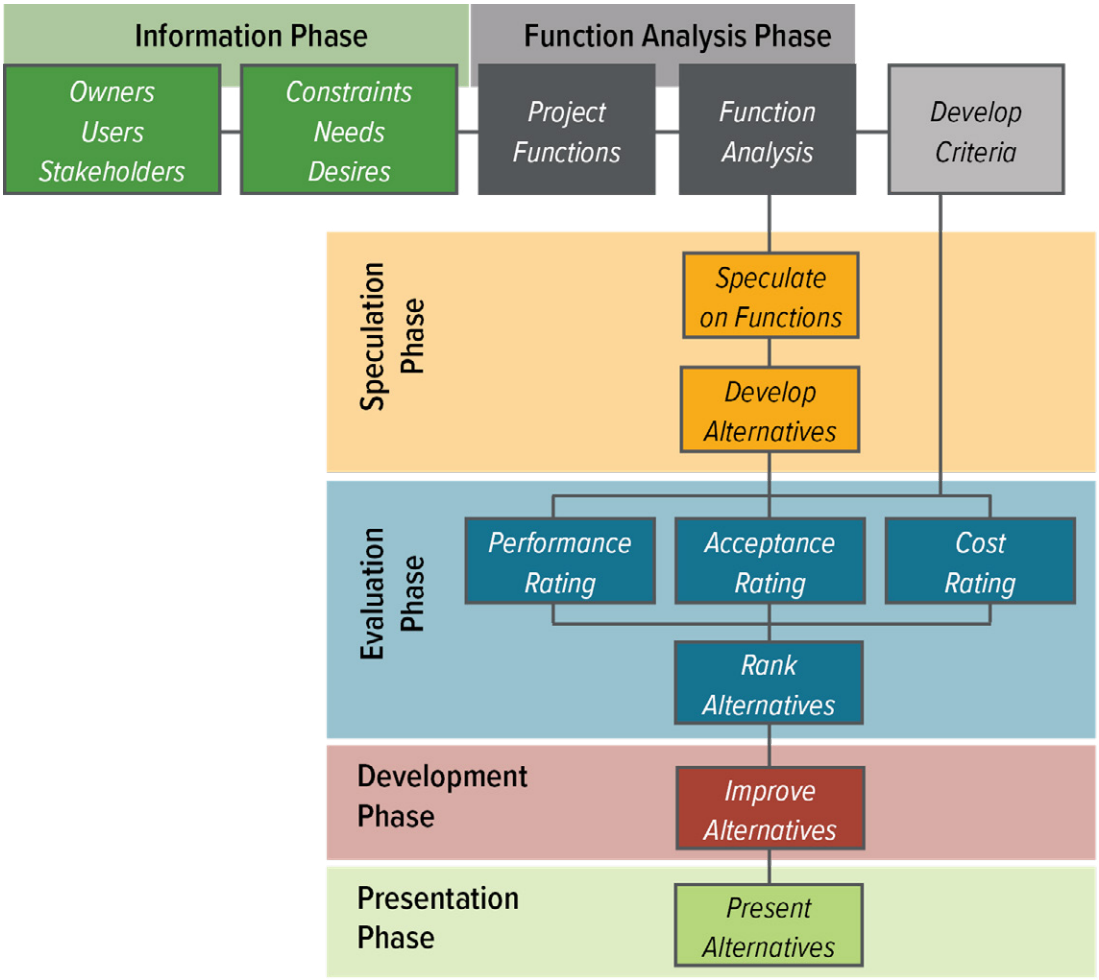


Exhibit 1.3 : Job Plan flow diagram

2 INFORMATION PHASE

2.1 Introduction

The first step in Value Engineering is to understand the Purpose and Need of the project:

What Is It?

The question can be answered in two steps:

1. Identify owners, users, and other stakeholders.
2. List their constraints, needs and desires.

Among the rules that govern the Information Phase are the following:

- Do not speculate
- Do not judge
- Understand the problem

Prior to the study, the VE Team was provided with design reports, preliminary cost estimates, roadway plans, and other documentation to familiarize themselves with the project. On the first day, the VE Team met with the Project Team. A presentation on the project was provided by the Design Team. An attendance sheet of those participating in the meeting is included in Appendix B.

The VE Team began the study by determining owners, users, and stakeholders for the project. Constraints, needs, and desires were also defined on day one of the study.

2.2 Description of Owners, Users and Stakeholders

In general, everyone involved in a project is a stakeholder. However, during this part of the Information Phase, they are grouped separately as owners, users and stakeholders, as defined below.

These groupings help the VE Team better understand what the project does and what it should do. In subsequent sections, the owners, users and stakeholders will be referred to only as stakeholders.

2.3 Owners, Users and Stakeholders

OWNERS
THOSE WHO:

1. Own the project
2. Fund the project
3. Share in the funding
4. Represent the owner's interests
5. Manage the project for the owner

USERS
THOSE WHO:

1. Use the project
2. Operate the project
3. Maintain the project

STAKEHOLDERS
THOSE WHO ARE:

1. Financially affected by the project
2. Environmentally concerned about the project
3. Disturbed by a required change in habits or recreation

2.4 List of Owners, Users and Stakeholders

The following is a list of owners, users and stakeholders identified by the VE Team.

OWNERS

1. Colorado DOT
2. FHWA

USERS

3. Eastbound Highway 7 Traffic
4. Westbound Highway 7 Traffic
5. Truck Traffic
6. Passenger Vehicle Traffic
7. Quarry Traffic
8. Cyclist
9. CDOT R4 Maintenance
10. River Users

STAKEHOLDERS

11. Community of Raymond
12. Town of Lyons
13. Colorado Parks and Wildlife
14. FEMA
15. USACE
16. US Forest Service
17. RS&H
18. Kiewit
19. Boulder County
20. Boulder Waterkeepers
21. Watershed Coalitions
22. Emergency Management
23. Community of Riverside
24. City of Longmont
25. Irrigation Companies
26. Town of Estes
27. Aggregate Industries
28. Boulder County
29. CDPHE
30. Estes Park and St Vrain Schools
31. US Post Office
32. Nelson Flanders Water Plant
33. Colorado Water Conservation Board

2.5 Constraints, Needs and Desires

Each stakeholder expects something from the project. Stakeholder expectations were then grouped into constraints, needs and desires, as defined in Section 2.6.

CONSTRAINTS:

1. Legal requirements
2. Standards of the owner
3. Physical site conditions
4. Stakeholder commitments

NEEDS

1. Expectations that must be fulfilled if constraints are not violated
2. Limitations or restrictions that are imposed by stakeholders but which can be violated (the degree of violations will be considered in the evaluation of Alternatives)

DESIRES

1. Expectations that should be fulfilled if cost is not a factor

There are several points to keep in mind in identifying the Stakeholder constraints, needs and desires. First, the majority of constraints are prescribed by law, applicable codes and standards. These constraints are too numerous to be listed for each VE Study. Constraints listed are those imposed by a Stakeholder or by a code or standard that applies strictly to this project. Secondly, design criteria are described as a constraint, need and desire. Lastly, needs and desires are generally not executable. They are generally visions of what the project should do.

2.6 List of Constraints, Needs and Desires:

CONSTRAINTS:

1. No imported topsoil
2. Avoid "no impact" areas
3. Provide 2 -11' lanes
4. Provide full time access for Emergency response during construction
5. Provide intermittent bus and local access during construction
6. 404 Permits
7. Accommodate seasonal river flows
8. Maintain acceptable levels of turbidity
9. No permanent encroachment into river
10. Comply with SB40 certification
11. Comply with USFS letter of consent
12. Do not exceed budget

NEEDS:

13. Limit rock falls
14. Provide recoverability
15. Improve the clear zone
16. Minimum 15' travel surface after flood event
17. Impacted area rock mitigation
18. 4' shoulder where easily accommodated
19. Replace undersized culverts
20. Avoid high risk cuts
21. Contextual aesthetic design
22. Avoid 4f areas
23. Everything needs to be maintainable by CDOT
24. All residences have egress after minor flood event
25. Do not degrade river / wildlife habitat

DESIRES:

26. Install rumble strips
27. Widen pavement section
28. 4' shoulder / uphill for cyclist
29. Preemptive rockfall mitigation
30. Provide 40-year design life
31. Provide multiple MOT options
32. Full closure w/ justified cost analysis
33. Expedited construction schedule
34. Eliminate CLOMR
35. Minimize ROW acquisitions
36. All residences have egress after major flood event
37. Improve river / wildlife habitat
38. Maximize available money

3 FUNCTION ANALYSIS PHASE

3.1 Introduction

The next step is to answer the questions:

What does it do?
What does it cost?

These are the key questions in the Function Analysis Phase and are developed by:

1. Using the constraints, needs and desires of the stakeholders.
2. Splitting each element into parts and assigning the reason for the part as functions.

Among the rules that govern the Function Analysis Phase are the following:

- Functions are expressed in two words; an active Verb and descriptive Noun
- Avoid the description or action of an element as functions

After the Information Phase the VE team worked together to define what the intent of the project is. This next phase is called the Function Analysis Phase. This is a collaborative process for the team as they consider what was heard earlier in the Information Phase and what was learned studying the project documents during the Pre-Workshop. The purpose of this phase is for the team to breakdown the project into components, called functions, that should describe what the project should do and not what the project is. This dissecting of the project into its functions fuels the teams understanding of what is important for the project to be successful, facilitates analysis and communication, and inspires alternative ideas that might fulfill the functions.

3.2 Function and Function Logic Diagram

Function

The VE Team developed a list of functions for the SH 7 (Lower) project based on the constraints, needs and desires of the stakeholders identified in the Information Phase of the workshop. Functions are carefully defined to express the team's understanding of what is driving the project and what is the purpose of each project element. They are expressed in two words (sometimes three) as an active verb and a descriptive noun. Word selection is thoroughly discussed and intentional so that agreement is clear on what is necessary for the project to be successful, and abstract enough so that creativity and innovation is maximized.

The goal of the Function Logic Phase of a VE Workshop is to develop an understanding of what the project must do.

It is important for the team to analyze from the Project's point of view. As a reconstruction/rehabilitation effort, this project addresses several issues related to restoration and preserving the stakeholder expectations for the Highway. Consequently, functions like *Reconstruct Pavement* and *Manage Runoff* were selected by the team. This contrasts with a new highway where functions like *Improve Route* or *Increase Capacity* might have been

more prominent. The project's functions, as selected by the VE team are shown graphically in Exhibit 3.1, the Customer Function Model. Definitions of the functions are provided in Exhibit 3.2.

Function Logic

The goal of the Function Analysis Phase is to categorize the functions developed by the team and assemble them in an orderly manner that facilitates analysis and communication. Categorization helps define what functions must be performed by the project in order to be successful and what functions would be nice for the project to fulfill if constraints are not violated and/or cost is not a factor. The analysis and subsequent diagramming help the team have perspective on how the functions related to each other. Applying costs to the functions in a future step, allows mismatches and opportunities for value to be observed and evaluated. It is important to note that from the stakeholders' perspective, all the functions are important and must be respected, however, some functions are basic to the project and some enhance the project, making it better and more appealing to stakeholders. Together, they make the project successful. Later in the VE process, the VE Team speculated on different ways to accomplish these functions.

The Customer Function Model in Exhibit 3.1 shows the Team's perspective on the functions and their relationships to each other. The model can be described in three main components: The Task, the Basic Functions, and the Enhancing Functions. The Task is the one function that represents the reason for the project. Basic Functions, however, represent the minimum or essential things the project must perform in order to fulfill the Task. The Basic Functions, however, operating alone, will not result in a successful project. The Enhancing Functions are also necessary to improve dependability, convenience, acceptance to stakeholders, and attractiveness to stakeholders.

Task

In classifying functions, the team expresses its logical reasoning for the function. The main driving force for the rehab work is to *Improve Mobility*. This is the Task of the project. This task was selected because the reliability of the roadway is important to resident motorists, visitors, tourists, recreational users, and bicyclists.

Basic Functions

As Basic Functions, *Reconstruct Pavement* and *Manage Runoff* were identified by the team as supporting the task and essential to delivering it. It should be noted that these two functions are not the only two important functions nor are they the priority functions. They will not deliver a successful project unless the functions below are integrated into the project.

DEPENDABLE

The highway can be considered dependable if the designed improvements *Increase Safety, Accommodate Cyclists, Protect Pavement,* or *Endure Storms*. Other supporting functions related to these are shown in the Customer Function Model, Exhibit 3.1. These supporting functions answer the question how the function will be fulfilled. For example, how is the function *Increase Safety* accomplished? It is accomplished by the functions *Mitigate Hazards, Mitigate Rockfalls, Establish Clear Zone* and *Protect Drivers*.

CONVENIENT

The next classification is how the project maintains and improves the convenience of the users of the highway. These users include but are not limited to traffic, maintenance crews, and construction contractors. *Accommodate Snow Removal* and *Convey Information* are convenience functions for the project.

IMPROVE ACCEPTANCE

While dependability and basic functions are typically quantifiable, improve acceptance functions are somewhat subjective. They are important because they capture what will make the project acceptable. Communications with the public before and during construction and complying with environmental regulations both manifest themselves with Improve Acceptance functions. As a result, *Reduce Fatigue, Satisfy Regulators, Accommodate Recreation, Preserve Property* and *Maintain Local Access* are important functions in this category. Additional supporting functions for *Reduce Fatigue* and *Accommodate Recreation* are shown in Exhibit 3.1.

ATTRACT STAKEHOLDERS

Attracting stakeholder functions appeal to the visual aspects of the project or exhibits a favorable image. It draws new stakeholders to the project. Because a significant element of the project is reconstruction of St. Vrain Creek, *Improve Habitat* and *Maintain Aesthetics* were placed in this category.

Value is defined as fulfilling the project functions that are needed to make the project work and sell. Basic and dependability functions make it work while Convenience, Improve Acceptance, and Attract Stakeholders help to sell or promote acceptance of the project.

Further explanation of the functions is covered as part of the explanation for allocating cost to each function.

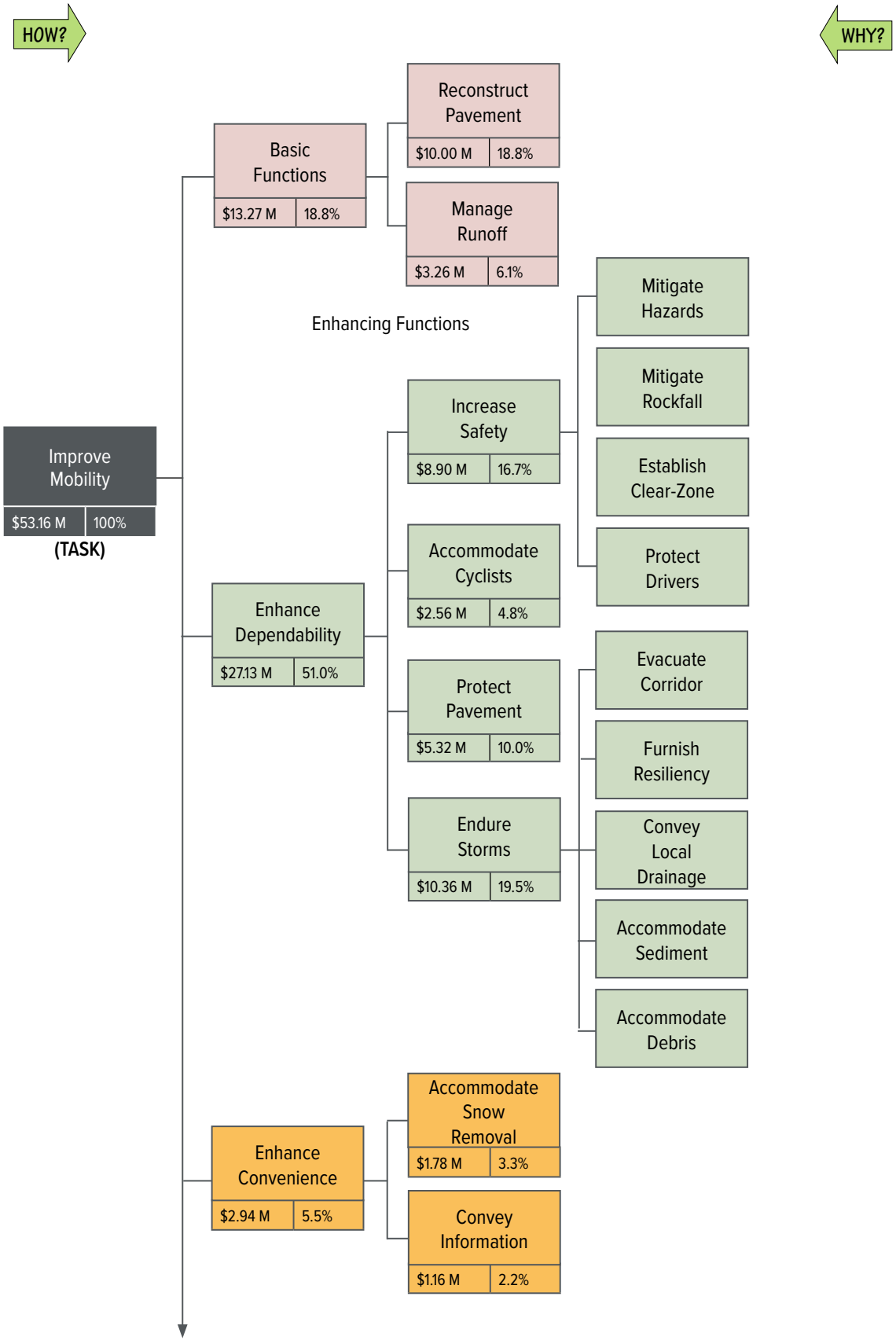


Exhibit 3.1: Function Logic Cost Diagram

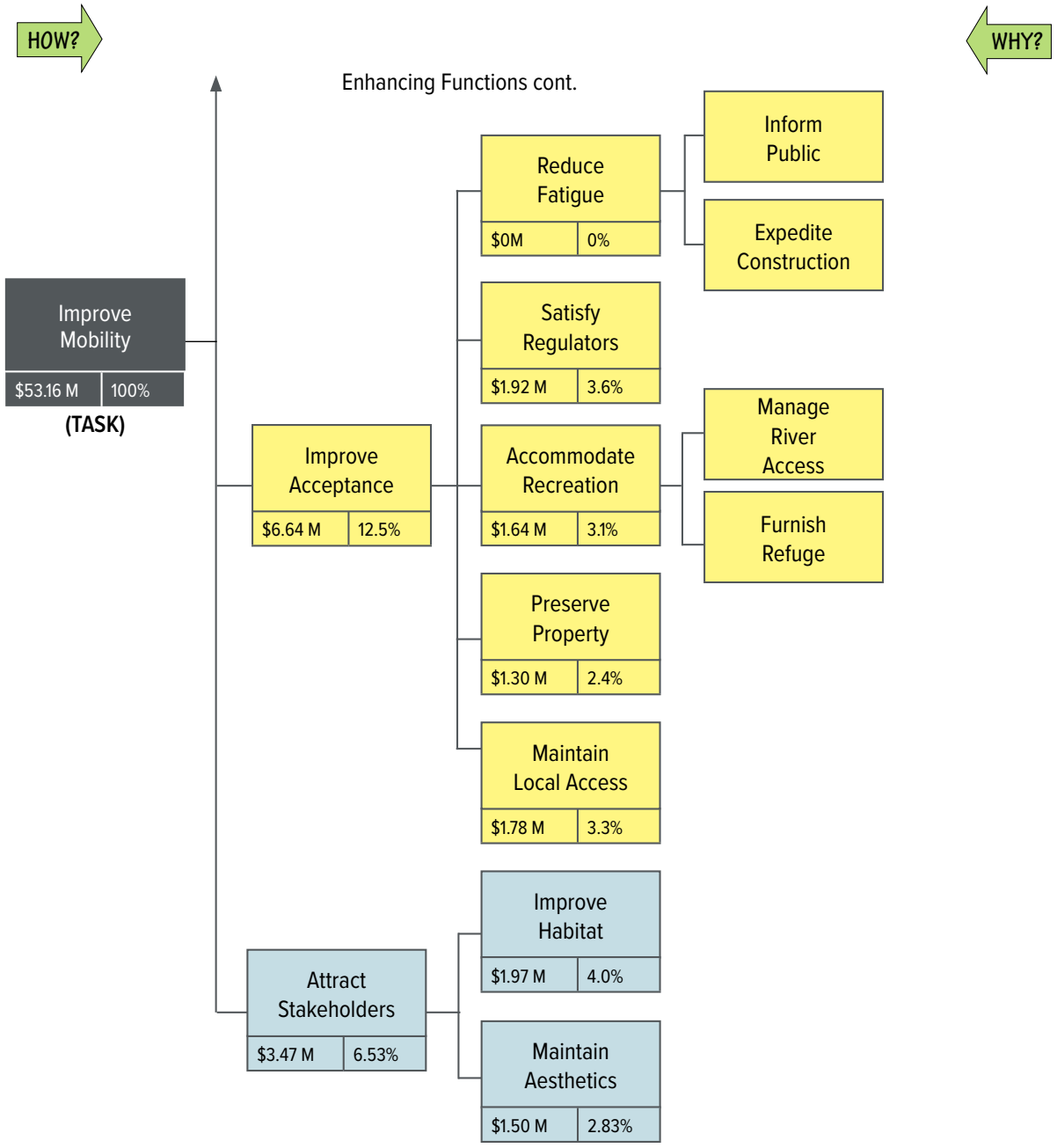


Exhibit 3.1: Function Logic Cost Diagram (cont.)

Task -Improve Mobility	Reconstruct the SH7 Corridor to preflood conditions, to provide a resilient travel way for all users of the corridor today and into the future, including after extreme flood events.
Basic Function - Reconstruct Pavement	Construct a resilient roadway pavement that carries traffic in two directions, accommodates bike traffic, and provides access to the local landowners and users of the canyon.
Basic Function - Manage Runoff	Deliver a project that adequately considers the effects of routine as well as extreme weather events. The project should accommodate routine events without damage and provide for safe evacuation of local residents and users of the corridor during extreme events.
Enhancing Functions – Enhance Dependability	
Increase Safety	The reconstructed corridor provides safety upgrades for corridor users.
Mitigate Hazards	Reconstruct the corridor to sensibly upgrade safety through improved alignment and consistent travel widths.
Mitigate Rockfall	Enhance protection for corridor users from high-risk rockfall locations throughout the canyon.
Establish Clear Zone	Provide an unobstructed, traversable area outside of the travel way where practical.
Protect Drivers	Measures and strategies that intuitively inform the main users of the highway and create a forgiving and navigable roadway.
Protect Pavement	Construct the roadway pavement using durable materials. Provide a roadway cross section designed to safely convey or withstand high water and debris flows during weather events.
Endure Storms	Create a corridor that better withstands the effects of routine and extreme weather events.
Evacuate Corridor	Evacuation of landowners and users of the canyon is accomplished during extreme weather events.
Furnish Resiliency	Elements of the corridor infrastructure withstand the demands and uncertainties of weather and natural events by utilizing robust, practical and cost efficient materials.
Convey Local Drainage	Cross roadway drainage features safely transports water away from the roadway.
Accommodate Sediment	The design of the drainage features includes strategies to defend against the effects of high sediment load during high water flows.
Accommodate Debris	The design of the roadway and areas adjacent to the roadway includes strategies to mitigate the effects of debris from high water flows.
Accommodate Cyclists	Managing the interface between bicyclist and motorized vehicle road users will help make the corridor more dependable.
Enhancing Functions – Enhance Convenience	
Accommodate Snow Removal	Providing areas for facilitating snow removal and/or storage.
Convey Information	Traffic control devices and signage that informs stakeholders on the use of the road.
Enhancing Functions – Enhance Acceptance	
Reduce Fatigue	Make decisions and advance the project with sensitivity to resident's endurance of project and pre-project inconveniences.
Inform Public	The public, local residents, canyon users, and the larger community in the area should be kept informed of the progress of the design and progress of construction once it begins.
Expedite Construction	Once construction begins, quick progress during construction will go a long way to augment approval of the eventually constructed corridor.
Satisfy Regulators	The project will be required to satisfy the standards of the affected and contributing agencies.
Accommodate Recreation	The canyon is utilized as a means of travel as well as represents an opportunity for recreation by cyclists, climbers, fishing and other river users and outdoor enthusiast.
Manage River Access	Provide an opportunity to safely and efficiently access the area for recreation purposes.
Furnish Refuge	Provide safety areas along the length of the project for disabled vehicles and parking areas for river users.

Preserve Property	Existing public and private landowner property should not be negatively affected by the reconstructed corridor as much as possible.
Maintain Local Access	Landowners within the corridor whose access during construction, after construction, as well as during and after weather events should be accommodated.
Enhancing Functions – Attract Stakeholders	
Improve Habitat	During construction the river habitat should not be degraded. After construction the river habitat should be improved from its current condition.
Maintain Aesthetics	The improved corridor should blend naturally in to the surroundings and not detract from the aesthetics of the canyon.

Exhibit 3.2: Function definitions

3.3 As Given Cost Analysis

The project's cost estimate was $53.1 million. The detailed cost estimated provided to the VE Team is included in Appendix A. Key to the VE process is a clear understanding of the project costs and why the dollars are being spent. This understanding also helps understand the functions of the project. They answer the question "Why are we spending these dollars?"

Determining where large dollars are being spent can also provide inspiration for speculation on alternatives. To facilitate this analysis the cost estimate was grouped and rolled into larger cost elements. For example, the three line items Hot Mix Asphalt Patching, Hot Mix Asphalt (Grading SX) (75) (PG 58-28) and Hot Mix Asphalt (Grading SX) (75) (PG 58-34) items were rolled into the element Pavement and Guardrail – HMA. Likewise, other items were rolled into the project elements listed in Exhibit 3.3 below.

ELEMENT	COST/$1,000
Utilities	$ 1.50
River Construction - Removals	$ 61.11
Signing/Striping (0.5%)	$ 200.22
Drainage - Riprap	$ 247.86
Drainage - Removals	$ 266.05
Drainage - Concrete	$ 456.00
Drainage - Enclosed System/Piping	$ 750.20
Drainage - CBC	$ 884.50
Pavement & Guardrail - Guardrail	$ 975.55
SWMP And Revegetation (3%)	$ 1,201.32
Pavement & Guardrail - Removals	$ 1,245.51
River Construction - Stream Restoration	$ 1,865.14
Pavement & Guardrail - Earthwork & Aggregate Base	$ 1,957.83
Traffic Control (8%)	$ 3,203.52
Pavement & Guardrail - Concrete Pavement	$ 3,557.80
River Construction - Earthwork	$ 3,706.91
F/A	$ 3,709.08
Pavement & Guardrail - HMA	$ 4,385.04

ELEMENT	COST/$1,000
Rock And Geology	$ 4,422.70
Allowance For Unlisted Items (12%)	$ 4,805.28
Miscellaneous Construction/Mobilization	$ 5,234.10
Matrix Riprap	$ 10,026.41
Construction Cost	$ 53,163.61

Exhibit 3.3: Project elements cost table

Pareto's Law states that 80% of the project cost will be consumed in 20% of the project items. In the case of the SH 7 (Lower) project, the highest cost items are shown at the bottom of the table and include matrix riprap, geo-hazard items, hot mix asphalt paving items, and contingency/ unknown items. The Pareto diagram in Exhibit 3.4 graphically shows the relationship between highest cost items to the lowest.

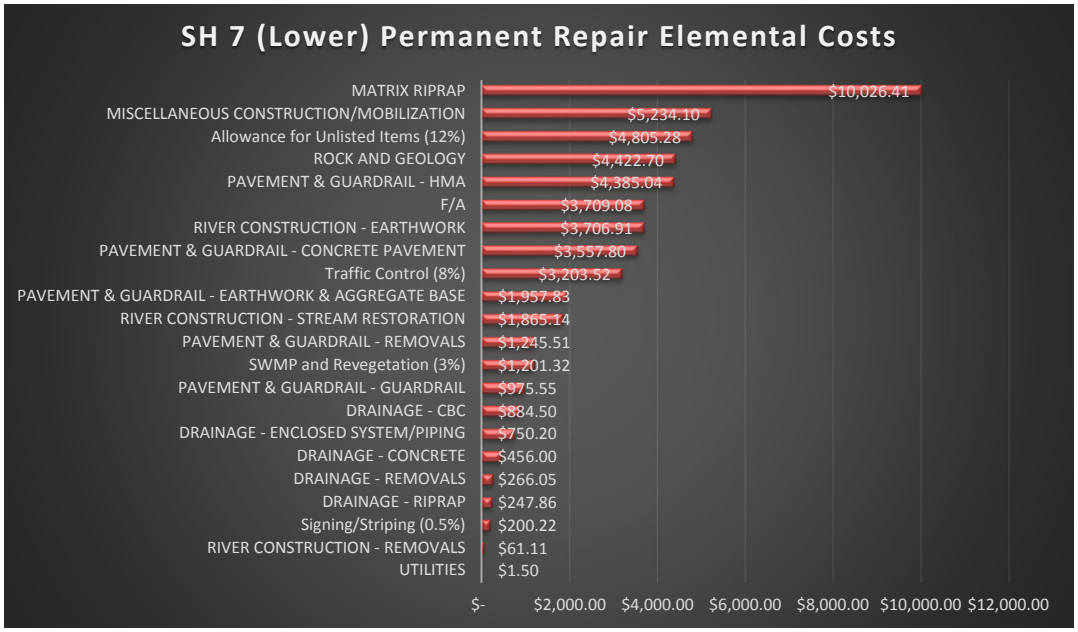


Exhibit 3.4: Pareto diagram showing the highest cost items to the lowest

3.3 Function Cost

Using the element costs, As Given dollars are then distributed among the project functions for further evaluation and identification of mismatches. One benefit of this analysis is to determine which functions are receiving a disproportionate amount of money. These functions and their associated project elements represent opportunities for improving value.

Over 25 percent of the project cost is being spent to fulfill the Basic functions of *Reconstruct Pavement* and *Manage Runoff*. Of those two functions, the majority is going to *Reconstruct Pavement*. Over fifty percent of the cost is dedicated to the Dependability functions. This is reinforced by the project's emphasis on resiliency and rockfall mitigation, represented by the functions *Endure Storm* and *Increase Safety*, respectively. Exhibit 3.5 provides a breakdown of the project element costs and their functions.

3.5 Function Analysis

Exhibit 3.6 shows a summary of the function classification distribution. Cost for the Basic Functions and Dependability Functions is around 76 percent which is high compared to the norm but can be explained by the rehabilitation nature of the project and the budgeting and design effort on resiliency and safety. The cost of the Convenience Functions is about 5.5 percent which is lower

Task: Improve Mobility			Basic Functions	
Elements	Cost	%	Reconstruct Pavement	Manage Runoff
UTILITIES	$ 1,500	0.00%	$ 1,500	$ -
RIVER CONSTRUCTION - REMOVALS	$ 61,110	0.11%	$ -	$ 15,278
DRAINAGE - RIPRAP	$ 247,860	0.47%	$ -	$ 123,930
DRAINAGE - REMOVALS	$ 266,050	0.50%	$ -	$ 66,513
Signing/Striping (0.5%)	$ 200,220	0.38%	$ -	$ -
DRAINAGE - CONCRETE	$ 456,000	0.86%	$ -	$ 228,000
DRAINAGE - ENCLOSED SYSTEM/PIPING	$ 750,200	1.41%	$ -	$ 187,550
DRAINAGE - CBC	$ 884,500	1.66%	$ -	$ 221,125
PAVEMENT & GUARDRAIL - GUARDRAIL	$ 975,550	1.83%	$ -	$ -
PAVEMENT & GUARDRAIL - REMOVALS	$ 1,245,507	2.34%	$ -	$ -
SWMP & REVEGETATION (3%)	$ 1,201,320	2.26%	$ -	$ -
PAVEMENT & GUARDRAIL - EARTHWORK & AGGREGATE BASE	$ 1,957,825	3.68%	$ 1,468,369	$ -
PAVEMENT & GUARDRAIL - CONCRETE PAVEMENT	$ 3,557,800	6.69%	$ 2,668,350	$ -
PAVEMENT & GUARDRAIL - HMA	$ 4,385,035	8.25%	$ 3,288,776	$ -
TRAFFIC CONTROL (8%)	$ 3,203,520	6.03%	$ 480,528	$ 480,528
MISCELLANEOUS CONSTRUCTION/MOBILIZATION	$ 5,234,100	9.85%	$ 418,728	$ 418,728
RIVER CONSTRUCTION - STREAM RESTORATION	$ 1,865,144	3.51%	$ -	$ 279,772
ALLOWANCE FOR UNLISTED ITEMS (12%)	$ 4,805,280	9.04%	$ 384,422	$ 384,422
RIVER CONSTRUCTION - EARTHWORK	$ 3,706,910	6.97%	$ -	$ 556,037
ROCK AND GEOLOGY	$ 4,422,700	8.32%	$ -	$ -
MATRIX RIPRAP	$ 10,026,406	18.86%	$ 1,002,641	$ -
FORCE ACCOUNT	$ 3,709,076	6.98%	$ 296,726	$ 296,726
Total	$ 53,163,613	100%	$ 10,010,040	$ 3,258,608
			18.8%	6.1%
			$13,270,000	
			25.0%	

Exhibit 3.5: Function cost (As Given).

Task: Improve Mobility			Enhance Dependability			
Elements	Cost	%	Increase Safety	Endure Storms	Protect Pavement	Accommodate Cyclists
UTILITIES	$ 1,500	0.00%	$ -	$ -	$ -	$ -
RIVER CONSTRUCTION - REMOVALS	$ 61,110	0.11%	$ -	$ 15,278	$ -	$ -
DRAINAGE - RIPRAP	$ 247,860	0.47%	$ -	$ -	$ 123,930	$ -
DRAINAGE - REMOVALS	$ 266,050	0.50%	$ -	$ 66,513	$ -	$ -
Signing/Striping (0.5%)	$ 200,220	0.38%	$ -	$ -	$ -	$ -
DRAINAGE - CONCRETE	$ 456,000	0.86%	$ -	$ 228,000	$ -	$ -
DRAINAGE - ENCLOSED SYSTEM/PIPING	$ 750,200	1.41%	$ 187,550	$ 187,550	$ 187,550	$ -
DRAINAGE - CBC	$ 884,500	1.66%	$ 221,125	$ 221,125	$ 221,125	$ -
PAVEMENT & GUARDRAIL - GUARDRAIL	$ 975,550	1.83%	$ 780,440	$ -	$ -	$ -
PAVEMENT & GUARDRAIL - REMOVALS	$ 1,245,507	2.34%	$ 996,405	$ -	$ -	$ -
SWMP & REVEGETATION (3%)	$ 1,201,320	2.26%	$ -	$ -	$ -	$ -
PAVEMENT & GUARDRAIL - EARTHWORK & AGGREGATE BASE	$ 1,957,825	3.68%	$ -	$ -	$ 97,891	$ 195,783
PAVEMENT & GUARDRAIL - CONCRETE PAVEMENT	$ 3,557,800	6.69%	$ -	$ -	$ 177,890	$ 355,780
PAVEMENT & GUARDRAIL - HMA	$ 4,385,035	8.25%	$ -	$ -	$ 219,252	$ 438,504
TRAFFIC CONTROL (8%)	$ 3,203,520	6.03%	$ 320,352	$ 320,352	$ 320,352	$ 461,882
MISCELLANEOUS CONSTRUCTION/MOBILIZATION	$ 5,234,100	9.85%	$ 366,387	$ 366,387	$ 366,387	$ 366,387
RIVER CONSTRUCTION - STREAM RESTORATION	$ 1,865,144	3.51%	$ -	$ 1,119,086	$ -	$ -
ALLOWANCE FOR UNLISTED ITEMS (12%)	$ 4,805,280	9.04%	$ 336,370	$ 336,370	$ 336,370	$ 484,977
RIVER CONSTRUCTION - EARTHWORK	$ 3,706,910	6.97%	$ -	$ 2,224,146	$ -	$ -
ROCK AND GEOLOGY	$ 4,422,700	8.32%	$ 4,422,700	$ -	$ -	$ -
MATRIX RIPRAP	$ 10,026,406	18.86%	$ 1,002,641	$ 5,013,203	$ 3,007,922	$ -
FORCE ACCOUNT	$ 3,709,076	6.98%	$ 259,635	$ 259,635	$ 259,635	$ 259,635
Total	$ 53,163,613	100%	$ 8,893,605	$ 10,357,644	$ 5,318,304	$ 2,562,947
			16.7%	19.5%	10.0%	4.8%
			$27,130,000			
			51.0%			

Task: Improve Mobility			Enhance Convenience	
Elements	Cost	%	Accommodate Snow Removal	Convey Information
UTILITIES	$ 1,500	0.00%	$ -	$ -
RIVER CONSTRUCTION - REMOVALS	$ 61,110	0.11%	$ -	$ -
DRAINAGE - RIPRAP	$ 247,860	0.47%	$ -	$ -
DRAINAGE - REMOVALS	$ 266,050	0.50%	$ -	$ -
Signing/Striping (0.5%)	$ 200,220	0.38%	$ -	$ 200,220
DRAINAGE - CONCRETE	$ 456,000	0.86%	$ -	$ -
DRAINAGE - ENCLOSED SYSTEM/PIPING	$ 750,200	1.41%	$ -	$ -
DRAINAGE - CBC	$ 884,500	1.66%	$ -	$ -
PAVEMENT & GUARDRAIL - GUARDRAIL	$ 975,550	1.83%	$ -	$ -
PAVEMENT & GUARDRAIL - REMOVALS	$ 1,245,507	2.34%	$ -	$ -
SWMP & REVEGETATION (3%)	$ 1,201,320	2.26%	$ -	$ -
PAVEMENT & GUARDRAIL - EARTHWORK & AGGREGATE BASE	$ 1,957,825	3.68%	$ 97,891	$ -
PAVEMENT & GUARDRAIL - CONCRETE PAVEMENT	$ 3,557,800	6.69%	$ 177,890	$ -
PAVEMENT & GUARDRAIL - HMA	$ 4,385,035	8.25%	$ 219,252	$ -
TRAFFIC CONTROL (8%)	$ 3,203,520	6.03%	$ 320,352	$ -
MISCELLANEOUS CONSTRUCTION/MOBILIZATION	$ 5,234,100	9.85%	$ 366,387	$ 366,387
RIVER CONSTRUCTION - STREAM RESTORATION	$ 1,865,144	3.51%	$ -	$ -
ALLOWANCE FOR UNLISTED ITEMS (12%)	$ 4,805,280	9.04%	$ 336,370	$ 336,370
RIVER CONSTRUCTION - EARTHWORK	$ 3,706,910	6.97%	$ -	$ -
ROCK AND GEOLOGY	$ 4,422,700	8.32%	$ -	$ -
MATRIX RIPRAP	$ 10,026,406	18.86%	$ -	$ -
FORCE ACCOUNT	$ 3,709,076	6.98%	$ 259,635	$ 259,635
Total	$ 53,163,613	100%	$ 1,777,777	$ 1,162,612
			3.3%	2.2%
			$2,940,000	
			5.5%	

Exhibit 3.5: Function cost (As Given) cont.

Task: Improve Mobility			Improve Acceptance				
Elements	Cost	%	Satisfy Regulators	Reduce Fatigue	Accommodate Recreation	Preserve Properties	Maintain Local Access
UTILITIES	$ 1,500	0.00%	$ -	$ -	$ -	$ -	$ -
RIVER CONSTRUCTION - REMOVALS	$ 61,110	0.11%	$ -	$ -	$ 15,278	$ -	$ -
DRAINAGE - RIPRAP	$ 247,860	0.47%	$ -	$ -	$ -	$ -	$ -
DRAINAGE - REMOVALS	$ 266,050	0.50%	$ -	$ -	$ 66,513	$ -	$ -
Signing/Striping (0.5%)	$ 200,220	0.38%	$ -	$ -	$ -	$ -	$ -
DRAINAGE - CONCRETE	$ 456,000	0.86%	$ -	$ -	$ -	$ -	$ -
DRAINAGE - ENCLOSED SYSTEM/PIPING	$ 750,200	1.41%	$ -	$ -	$ -	$ -	$ -
DRAINAGE - CBC	$ 884,500	1.66%	$ -	$ -	$ -	$ -	$ -
PAVEMENT & GUARDRAIL - GUARDRAIL	$ 975,550	1.83%	$ -	$ -	$ -	$ 146,333	$ -
PAVEMENT & GUARDRAIL - REMOVALS	$ 1,245,507	2.34%	$ -	$ -	$ -	$ 186,826	$ -
SWMP & REVEGETATION (3%)	$ 1,201,320	2.26%	$ 961,056	$ -	$ -	$ -	$ -
PAVEMENT & GUARDRAIL - EARTHWORK & AGGREGATE BASE	$ 1,957,825	3.68%	$ -	$ -	$ -	$ -	$ 97,891
PAVEMENT & GUARDRAIL - CONCRETE PAVEMENT	$ 3,557,800	6.69%	$ -	$ -	$ -	$ -	$ 177,890
PAVEMENT & GUARDRAIL - HMA	$ 4,385,035	8.25%	$ -	$ -	$ -	$ -	$ 219,252
TRAFFIC CONTROL (8%)	$ 3,203,520	6.03%	$ -	$ -	$ 320,352	$ -	$ 320,352
MISCELLANEOUS CONSTRUCTION/MOBILIZATION	$ 5,234,100	9.85%	$ 366,387	$ -	$ 366,387	$ 366,387	$ 366,387
RIVER CONSTRUCTION - STREAM RESTORATION	$ 1,865,144	3.51%	$ -	$ -	$ 93,257	$ -	$ -
ALLOWANCE FOR UNLISTED ITEMS (12%)	$ 4,805,280	9.04%	$ 336,370	$ -	$ 336,370	$ 336,370	$ 336,370
RIVER CONSTRUCTION - EARTHWORK	$ 3,706,910	6.97%	$ -	$ -	$ 185,346	$ -	$ -
ROCK AND GEOLOGY	$ 4,422,700	8.32%	$ -	$ -	$ -	$ -	$ -
MATRIX RIPRAP	$ 10,026,406	18.86%	$ -	$ -	$ -	$ -	$ -
FORCE ACCOUNT	$ 3,709,076	6.98%	$ 259,635	$ -	$ 259,635	$ 259,635	$ 259,635
Total	$ 53,163,613	100%	$ 1,923,448	$ -	$ 1,643,137	$ 1,295,550	$ 1,777,777
			3.6%	0.0%	3.1%	2.4%	3.3%
			$6,640,000				
			12.5%				

Task: Improve Mobility			Attract Stakeholders	
Elements	Cost	%	Improve Habitat	Maintain Aesthetics
UTILITIES	$ 1,500	0.00%	$ -	$ -
RIVER CONSTRUCTION - REMOVALS	$ 61,110	0.11%	$ 9,167	$ 6,111
DRAINAGE - RIPRAP	$ 247,860	0.47%	$ -	$ -
DRAINAGE - REMOVALS	$ 266,050	0.50%	$ 39,908	$ 26,605
Signing/Striping (0.5%)	$ 200,220	0.38%	$ -	$ -
DRAINAGE - CONCRETE	$ 456,000	0.86%	$ -	$ -
DRAINAGE - ENCLOSED SYSTEM/PIPING	$ 750,200	1.41%	$ -	$ -
DRAINAGE - CBC	$ 884,500	1.66%	$ -	$ -
PAVEMENT & GUARDRAIL - GUARDRAIL	$ 975,550	1.83%	$ -	$ 48,778
PAVEMENT & GUARDRAIL - REMOVALS	$ 1,245,507	2.34%	$ -	$ 62,275
SWMP & REVEGETATION (3%)	$ 1,201,320	2.26%	$ 120,132	$ 120,132
PAVEMENT & GUARDRAIL - EARTHWORK & AGGREGATE BASE	$ 1,957,825	3.68%	$ -	$ -
PAVEMENT & GUARDRAIL - CONCRETE PAVEMENT	$ 3,557,800	6.69%	$ -	$ -
PAVEMENT & GUARDRAIL - HMA	$ 4,385,035	8.25%	$ -	$ -
TRAFFIC CONTROL (8%)	$ 3,203,520	6.03%	$ -	$ -
MISCELLANEOUS CONSTRUCTION/MOBILIZATION	$ 5,234,100	9.85%	$ 366,387	$ 366,387
RIVER CONSTRUCTION - STREAM RESTORATION	$ 1,865,144	3.51%	$ 279,772	$ 93,257
ALLOWANCE FOR UNLISTED ITEMS (12%)	$ 4,805,280	9.04%	$ 336,370	$ 336,370
RIVER CONSTRUCTION - EARTHWORK	$ 3,706,910	6.97%	$ 556,037	$ 185,346
ROCK AND GEOLOGY	$ 4,422,700	8.32%	$ -	$ -
MATRIX RIPRAP	$ 10,026,406	18.86%	$ -	$ -
FORCE ACCOUNT	$ 3,709,076	6.98%	$ 259,635	$ 259,635
Total	$ 53,163,613	100%	$ 1,967,406	$ 1,504,895
			4%	2.83%
			$3,470,000	
			6.53%	

Exhibit 3.5: Function cost (As Given) cont.

than the norm of 25 percent. With most of the work restoring what is already in existence, little is planned to increase convenience given the functions the team selected. The Acceptance and Attract Stakeholders Functions at just around 19 percent with is a little low compared to the norm. However, with the emphasis on stream reconstruction the 12.5 percent for the Improve Acceptance Functions is the larger of the two categories.

Summary

FUNCTIONS	ALLOCATED COSTS	PERCENTAGE	NORM
Basic Functions	$13,270,000	25.0%	20%
Enhancing Functions			
Enhance Dependability	$27,130,000	51.0%	30%
Enhance Convenience	$2,940,000	5.5%	25%
Improve Acceptance	$6,640,000	12.5%	15%
Attract Stakeholders	$3,470,000	6.5%	10%

Exhibit 3.6: Function cost summary

4 SPECULATION PHASE

4.1 Introduction

Following the function and cost analysis, the next step is to answer the question:

What else will do the job?

This is the key question in the Speculation Phase and may be carried out in at least three ways:

1. Random
2. By function
3. By project element

Among the rules that govern the Speculation Phase of a VE Study are the following:

- Criticism is ruled out
- Quantity is wanted
- Combinations and improvements are sought

4.2 List of Ideas

Below is a list of the ideas generated by the VE Team during the Speculation Phase.

IDEAS			
1	Purchase residential properties	13	Install trash racks
2	Convert highway to bike facility	14	Debris berms
3	Separate bikeway	15	Debris flow fence
4	Build walls to provide bikeway	16	Grant to Forest Service for their work
5	PUR injections in place of scaling/drape	17	Grant to a nonprofit for river work
6	Bolting in place of drape	18	Reduce construction phase work
7	Pinned mesh in place of drape mesh	19	Move utility work to U phase
8	Chip seal	20	Move river work to the M phase
9	Overlay without milling	21	Redesign river work to include traditional riprap
10	Eliminate concrete sections	22	Include bio-treatments in river
11	All concrete pavement	23	River work should be net zero on material
12	White topping	24	Eliminate imported material for river work

25	Remove earthwork & structures from river work substitute vegetation
26	Contract out river work
27	Use quarry for staging in exchange for Boulder County desires
28	Use quarry for rock development in exchange for Boulder County desires
29	CTS in place of matrix riprap
30	Allow for strategic road loss
31	Narrow 15' evacuation surface
32	Provide alternate evacuation route to adjacent canyon
33	Provide ATV to residents for evacuation
34	Close roadway for accelerated construction
35	Turn roadway into nature access and local access facility
36	Monitor rockfall in place of mitigation
37	Harvest riprap from rockfall
38	Provide larger ditches in place of scaling, bolting etc.
39	Make permeable subgrade
40	Replace subdrains with permeable rock fill
41	Enclosed piping in place of ditch
42	Bridge over confluence in place of matrix riprap
43	Grade separated lanes to allow for bike lane
44	Install bike warning lights
45	Rumble strips closer to wheel path to warn bike lane
46	Rumble strips at centerline
47	Culvert lining rather than replacement
48	Use 7' post guard rail
49	Do nothing
50	Do nothing lower
51	Do nothing upper
52	Allow night work
53	Elevate the entire length of roadway
54	Do nothing between MP 23 & 25 & fix mini narrows
55	Gabion walls in conjunction with CTS
56	Use gabion walls in place of CTS
57	Install grout walls
58	Modified CFL rockery wall
59	Modified CFL rockery wall in place of CTS
60	Devolve SH 7 to Forest Service
61	Devolve SH 7 to Boulder County
62	Automated monitoring system to close road during hazard events
63	Provide low flow crossings in place of cross culverts
64	Provide low flow crossings of entire roadway
65	Combine local access locations
66	Gravel access for locals in place of hard surface
67	Work with CMGC contractor to reduce plan detail for resurfacing
68	Reference I-25 CMGC lessons learned
69	Incorporate QC activities with CMGC contractor
70	Separate roadside features from paving package
71	Reference US 34 lessons learned
72	Separate River features from paving package
73	Provide sheet pile walls in place of CTS
74	Eliminate toe wall on one side of resiliency sections
75	Larger cuts adjacent to matrix riprap to develop large rock
76	Have Boulder County handle CLOMR
77	Design modification to eliminate CLOMR
78	Remove grade control from river work
79	Evaluate 4f access
80	Install debris deflector on uphill side of pavement

* DC = During Construction

81	Setup on -site crusher and pugmill
82	Recycled asphalt pavement (RAP)
83	Hot place recycle
84	Reduce scope of work and build maintenance facility
85	Do all rock work in early package
86	Do all rock work with on-call contractors
87	Use single lane closures intermittently
88	Use pilot cars for single lane closures
89	Established closure times
90	Phase by work type
91	Phase by location
92	Only do high priority culverts
93	Pause river design work and monitor
94	Review design storm criteria
95	Lower speed limit
96	Review lane widths
97	Seasonal work (winter as opposed to summer)
98	Relocate residents during construction
99	Reuse topsoil with soil amendments
100	Avoid mine waste
101	Eliminate unnecessary overlay areas
102	Convert roadway to one way only
103	Convert roadway to alternating one way traffic (alternates AM / PM)
104	Convert Roadway to one way only with barrier separated bike lane
105	Develop one way pair with adjacent roadway
106	Convert roadway to alternating one way traffic (alternates by day of week)
107	One way during construction
108	Direct cyclist to Left Hand Canyon during construction
109	Alternate direction of cyclist during construction
110	Direct cyclist to Left Hand Canyon permanently
111	Minimize tree removals
112	Use vegetation to trigger and trap sediment and debris
113	Selectively provide pipe in place of roadside ditches
114	Manifold cross road culverts
115	Precast concrete box culvert (CBC)
116	Cast in place CBC
117	Metal plate arch in place of CBC
118	Provide multiple pipes in place of CBC
119	Conspan or precast arch
120	Provide form liner on wingwalls
121	Provide stacked stone wingwalls
122	Eliminate guardrail
123	Utilize weathering steel for guardrail
124	Install three-year irrigation system for plant establishment
125	Document preconstruction conditions (vegetation)
126	Strategic planting, only in areas with amended soil
127	CDOT take over vegetation maintenance period
128	Contract out vegetation maintenance program
129	Use cable rail for guardrail
130	Prioritize rockfall by maintenance needs
131	Maximize temp easement in place of permanent easements
132	Preserve existing riparian habitat
133	Minimize new assets that require maintenance

5 EVALUATION PHASE

5.1 Introduction

Evaluate the performance, acceptance and cost of the Alternatives:

Will it work?
Will it be acceptable?
Can we afford it?

Evaluation can be:

1. As simple as judging with advantages and limitations.
2. A detailed matrix rating for performance, acceptance and cost. In addition, measuring the sensitivity of the above ratings.

Among the rules that govern the Evaluation Phase are the following:

- Do not speculate
- Do not jump to conclusions
- Prepare to explain the conclusion

SCREENING JUSTIFICATION

R1	Violates Constraint
R2	Not Feasible
R3	Too Expensive
R4	Low Public Acceptance
R5	Low Benefit
R6	Duplicate Idea
R7	High Cost/Low Benefit
R8	Outside Scope/Beyond Study Area
R9	Low Agency Acceptance
R10	Lack of Detailed Information
R11	Environmental Complications
R12	High Risk Solution
R13	Adverse Schedule Impact
S	Selected for further consideration
AG	As Given

Exhibit 5.1: Codes for Justification of Screening Results

The objective of the Evaluation Phase is to identify the most outstanding Alternatives for further development. This is accomplished through a process of screening and ranking. Alternatives are developed using the ideas generated during the Speculation Phase and evaluated by comparison with the As Given Design.

5.2 Screening

Ideas generated during the Speculation Phase were not subject to criticism. This is done to promote free thinking. The next step is initial screening. At this time, each idea is reviewed and either selected for further consideration or rejected. In addition, ideas that violate project constraints are eliminated. Listed in Exhibit 5.1 are the justifications for the screening results. Below are the results of the screening process.

	IDEA	COMMENTS
~~1~~	~~Purchase residential properties~~	~~R4~~
~~2~~	~~Convert highway to bike facility~~	~~R4~~
~~3~~	~~Separate bikeway~~	~~R9~~

	IDEA	COMMENTS
~~4~~	~~Build walls to provide bikeway~~	~~R9~~
5	PUR injections in place of scaling/drape	S
6	Bolting in place of drape	S
7	Pinned mesh in place of drape mesh	S
8	Chip seal	S
9	Overlay without milling	S
10	Eliminate concrete sections	S
~~11~~	~~All concrete pavement~~	~~R3~~
~~12~~	~~White topping~~	~~R3~~
13	Install trash racks	S
14	Debris berms	S
15	Debris flow fence	S
~~16~~	~~Grant to Forest Service for their work~~	~~R9~~
17	Grant to a nonprofit for river work	S
18	Reduce construction phase work	S
19	Move utility work to U phase	S
20	Move river work to the M phase	S
~~21~~	~~Redesign river work to include traditional riprap~~	~~R2~~
22	Include bio treatments in river	S
23	River work should be net zero on material	S
24	Eliminate imported material for river work	S
25	Remove earthwork & structures from river work substitute vegetation	S
26	Contract out river work	S
27	Use quarry for staging in exchange for Boulder County desires	S
28	Use quarry for rock development in exchange for Boulder County desires	S
29	CTS in place of matrix riprap	S
30	Allow for strategic road loss	S
31	Narrow 15' evacuation surface	S
~~32~~	~~Provide alternate evacuation route to adjacent canyon~~	~~R8~~
~~33~~	~~Provide ATV to residents for evacuation~~	~~R8~~
34	Close roadway for accelerated construction	S
~~35~~	~~Turn roadway into nature access and local access facility~~	~~R8~~
~~36~~	~~Monitor rockfall in place of mitigation~~	~~R5~~

	IDEA	COMMENTS
37	Harvest riprap from rockfall	S
~~38~~	~~Provide larger ditches in place of scaling, bolting etc.~~	~~R5~~
~~39~~	~~Make permeable subgrade~~	~~R2~~
~~40~~	~~Replace subdrains with permeable rock fill~~	~~R2~~
~~41~~	~~Enclosed piping in place of ditch~~	~~R3~~
~~42~~	~~Bridge over confluence in place of matrix riprap~~	~~R3~~
~~43~~	~~Grade separated lanes to allow for bike lane~~	~~R3~~
44	Install bike warning lights	DS
~~45~~	~~Rumble strips closer to wheel path to warn bike lane~~	~~R12~~
46	Rumble strips at centerline	AG
~~47~~	~~Culvert lining rather than replacement~~	~~R5~~
~~48~~	~~Use 7' post guard rail~~	~~R7~~
~~49~~	~~Do nothing~~	~~R1~~
50	Do nothing lower	S
51	Do nothing upper	S
52	Allow night work	S
~~53~~	~~Elevate the entire length of roadway~~	~~R3~~
~~54~~	~~Do nothing between MP 23 & 25 & fix mini narrows~~	~~R3~~
~~55~~	~~Gabion walls in conjunction with CTS~~	~~R5~~
~~56~~	~~Use gabion walls in place of CTS~~	~~R5~~
~~57~~	~~Install grout walls~~	~~R2~~
~~58~~	~~Modified CFL rockery wall~~	~~R5~~
~~59~~	~~Modified CFL rockery wall in place of CTS~~	~~R5~~
~~60~~	~~Devolve SH 7 to Forest Service~~	~~R9~~
61	Devolve SH 7 to Boulder County	S
62	Automated monitoring system to close road during hazard events	DS
~~63~~	~~Provide low flow crossings in place of cross culverts~~	~~R2~~
~~64~~	~~Provide low flow crossings of entire roadway~~	~~R2~~
65	Combine local access locations	S
~~66~~	~~Gravel access for locals in place of hard surface~~	~~R5~~
67	Work with CMGC contractor to reduce plan detail for resurfacing	S
68	Reference I-25 CMGC lessons learned	DS
69	Incorporate QC activities with CMGC contractor	S
70	Separate roadside features from paving package	S

* DC = During Construction

	IDEA	COMMENTS
71	Reference US 34 lessons learned	DS
72	Separate River features from paving package	S
~~73~~	~~Provide sheet pile walls in place of CTS~~	~~R2~~
74	Eliminate toe wall on one side of resiliency sections	S
75	Larger cuts adjacent to matrix riprap to develop large rock	S
~~76~~	~~Have Boulder County handle CLOMR~~	~~R9~~
77	Design modification to eliminate CLOMR	S
78	Remove grade control from river work	S
79	Evaluate 4f access	DS
~~80~~	~~Install debris deflector on uphill side of pavement~~	~~R6~~
81	Setup on -site crusher and pugmill	S
82	Recycled asphalt pavement (RAP)	S
~~83~~	~~Hot place recycle~~	~~R2~~
~~84~~	~~Reduce scope of work and build maintenance facility~~	~~R8~~
85	Do all rock work in early package	S
86	Do all rock work with on-call contractors	S
87	Use single lane closures intermittently	AG
88	Use pilot cars for single lane closures	AG
89	Established closure times	S
90	Phase by work type	R6
91	Phase by location	AG
~~92~~	~~Only do high priority culverts~~	~~R5~~
93	Pause river design work and monitor	S
94	Review design storm criteria	S
~~95~~	~~Lower speed limit~~	~~R5~~
~~96~~	~~Review lane widths~~	~~R2~~
97	Seasonal work (winter as opposed to summer)	S
~~98~~	~~Relocate residents during construction~~	~~R4~~
99	Reuse topsoil with soil amendments	AG
100	Avoid mine waste	DS
101	Eliminate unnecessary overlay areas	S
~~102~~	~~Convert roadway to one way only~~	~~R4~~
~~103~~	~~Convert roadway to alternating one way traffic (alternates AM / PM)~~	~~R4~~
~~104~~	~~Convert Roadway to one way only with barrier separated bike lane~~	~~R4~~
~~105~~	~~Develop one way pair with adjacent roadway~~	~~R4~~

	IDEA	COMMENTS
~~106~~	~~Convert roadway to alternating one way traffic (alternates by day of week)~~	~~R4~~
~~107~~	~~One way during construction~~	~~R5~~
108	Direct cyclist to Left Hand Canyon during construction	S
109	Alternate direction of cyclist during construction	S
~~110~~	~~Direct cyclist to Left Hand Canyon permanently~~	~~R4~~
111	Minimize tree removals	S
112	Use vegetation to trigger and trap sediment and debris	S
~~113~~	~~Selectively provide pipe in place of roadside ditches~~	~~R6~~
114	Manifold cross road culverts	S
115	Precast concrete box culvert (CBC)	AG
~~116~~	~~Cast in place CBC~~	~~R3~~
~~117~~	~~Metal plate arch in place of CBC~~	~~R3~~
~~118~~	~~Provide multiple pipes in place of CBC~~	~~R2~~
~~119~~	~~Conspan or precast arch~~	~~R2~~
~~120~~	~~Provide form liner on wingwalls~~	~~R5~~
~~121~~	~~Provide stacked stone wingwalls~~	~~R5~~
~~122~~	~~Eliminate guardrail~~	~~R2~~
~~123~~	~~Utilize weathering steel for guardrail~~	~~R9~~
124	Install three-year irrigation system for plant establishment	S
125	Document preconstruction conditions (vegetation)	DS
126	Strategic planting, only in areas with amended soil	S
127	CDOT take over vegetation maintenance period	S
128	Contract out vegetation maintenance program	S
~~129~~	~~Use cable rail for guardrail~~	~~R2~~
130	Prioritize rockfall by maintenance needs	S
131	Maximize temp easement in place of permanent easements	DS
132	Preserve existing riparian habitat	S
133	Minimize new assets that require maintenance	DS

Once a short list of ideas is determined, they are grouped together into broad concepts and further investigated for potential as proposals. With the development of a list of potential proposals (in the case of the SH 7 (Lower), 10 were identified) the concepts were further evaluated with respect to the functions of the project and criteria selected by the team related to the functions. That evaluation is summarized in Exhibit 5.2 Proposals with positive total evaluation points were advanced to the Development Phase and assigned a proposal number. Those concepts with negative total points are typically not advanced and given an X instead of a proposal number. However, in some cases, if the VE Team still wants to discuss the concept it is recognized as cost cutting and not necessarily providing value. The discussion would be separate from the VE

study. Proposals with zero total evaluation points, a neutral impact to the project, are left to the discretion of the VE Team on advancement to the Development Phase. In case of the SH 7 (Lower) project all the concepts were considered neutral or beneficial to the project and advanced to the Development Phase. There were no concepts strictly driven by cost cutting.

Proposal Evaluation Rating	
Negative Impact	-1
Neutral	0
Positive Impact	1

PROPOSAL LIST EVALUATION

NO.*	PROPOSAL DESCRIPTION	PERFORMANCE CRITERIA				ACCEPTANCE CRITERIA				TOTAL EVALUATION POINTS
		Benefits to Safety	Improves Resiliency	Maintenance Impacts	Benefits to Drainage	Improves Aesthetic	Fosters Cooperation	Improves Public Perception	Benefits Recreation	
P1	Mill 1" and 2" Overlay	0	1	1	0	0	0	0	0	2
P2	Eliminate Concrete Sections	1	0	1	0	1	0	1	1	5
P3	Incorporate Recycled Asphalt Pavement	1	0	1	0	0	1	1	0	4
P4	Evaluate Closures	1	0	0	0	0	1	1	1	4
P5	Utilize CTS and Eliminate Matrix Riprap	-1	-1	-1	0	1	1	0	1	0
P6	Let it Grow: Vegetation-Centric Alternative Design	0	1	1	0	1	-1	1	1	4
P7	Lighter Touch: Reduce or Eliminate Structural Elements and Earthwork	0	1	1	0	1	1	1	1	6
P8	Look for win-win opportunities with Boulder to justify using quarry for materials and staging area	1	0	1	0	1	1	1	1	6
P9	Appropriating work in specific phases to save on indirect/ CE rates, schedule, efficiency	0	0	0	0	0	1	1	0	2
P10	Direct to project to reflect reduced project resources based on efficient oversight	0	0	0	0	0	0	0	0	0
	RELATED FUNCTION	Increase Safety	Furnish Resiliency	Protect Pavement	Manage Runoff	Maintain Aesthetics	Satisfy Regulators	Reduce Fatigue	Accommodate Recreation	

* Note: X indicates "Proposal Removed from Consideration"

Exhibit 5.2: Proposal List Evaluation

6 DEVELOPMENT PHASE

6.1 Introduction

The last step before implementation is to summarize the VE recommendations:

What are the VE recommendations? Why should the recommendations be accepted?

Proposals should be clearly presented:

1. Describe As Given with sketches.
2. Present VE Alternatives.
3. Compare advantages, limitations and cost.
4. Recommend a VE Alternative or validate As Given.

Among the rules that govern the Development Phase of a VE Study are the following:

- Improve ideas
- Combine ideas
- Verify features

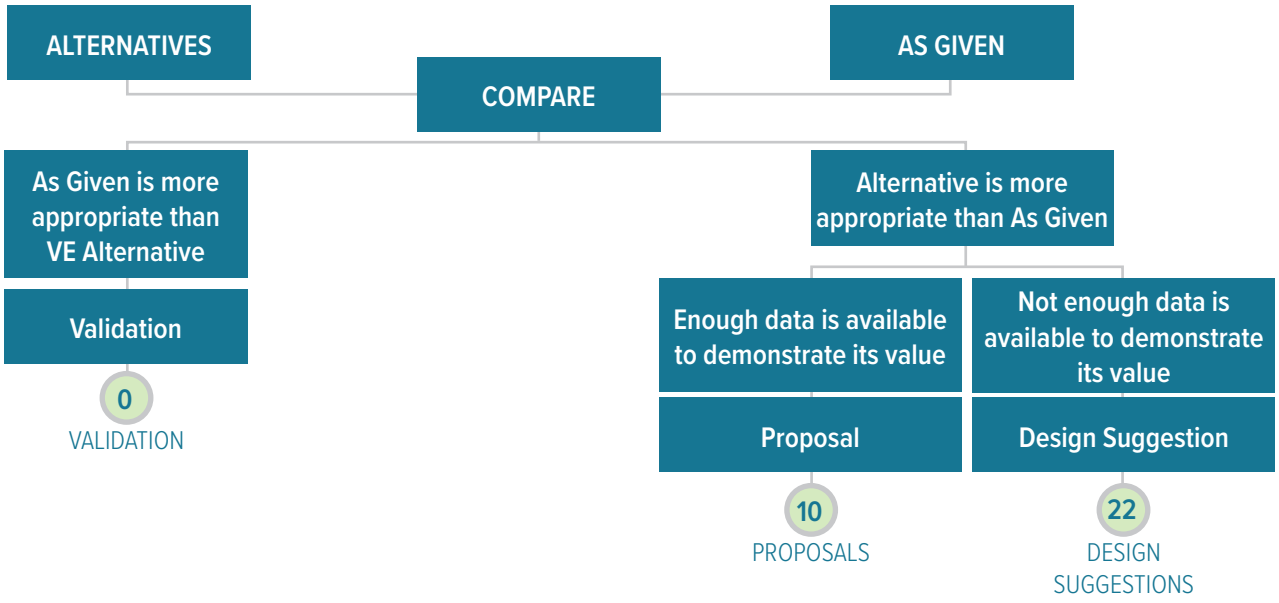


Exhibit 6. 1: Development Phase flow chart

As a result of the speculation and screening process, a number of Alternatives are developed for proposals.

These alternatives are compared with the As Given. It should be noted that alternatives can be macro in scale and address the design concept or micro in scale and address individual design elements. If the As Given is considered better than the alternative then the As Given design is validated. However, if the alternative can provide value without compromising functions, then the alternative is developed into a proposal or design suggestion. A proposal is an alternative that can be supported by cost, design features and a clear advantage over the As Given design. If enough data is not available to demonstrate an alternative's value, then it is considered a design suggestion.

Description: One Inch Mill with Two Inch Overlay

PROPOSAL NO. P1

As Given:

Mill 2" of existing pavement and overlay with 2" of HMA.

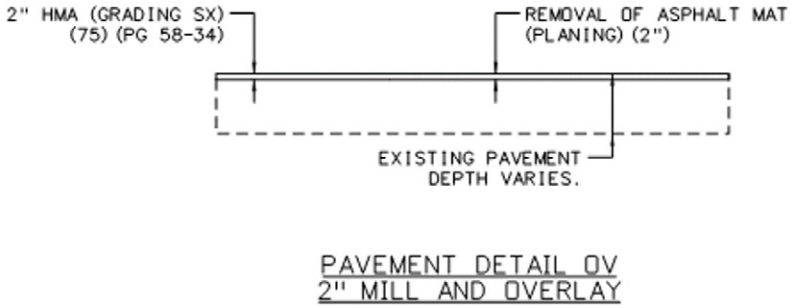


Exhibit P1.1: As Given

As Given Cost:

ITEM	UNIT	QUANTITY	PRICE	COST
Two-Inch Mill	SY	141,709	$3.15	$ 446,385
Removal of Asphalt Mat*	SY	2,834	$10	$ 28,340
Uncl. Ex (CIP)**	CY	944	$30	$ 28,320
ABC (Cl. 6) (Patching)**	CY	472	$55	$ 25,960
HMA Patching**	TON	623	$160.00	$ 99,680
Two-Inch Overlay	TON	15,588	$120.00	$ 1,870,560
			Line Item Subtotal	$ 2,499,245
			Contingency & Unknowns at 39%	$974,705
			Construction Subtotal	$ 3,473,950

* Assumes 10% of mill and overlay area could have thinner sections which may require full depth repair. For calculated costs, 20% of this potential area was carried as a risk amount for the as-given design.

** Assumes 12 inches of subgrade removed, six-inch moisture treated recompacted, six-inch of ABC

Exhibit P1.2 As Given Cost

VE Proposal P1: One Inch Mill with Two Inch Overlay

Mill one inch of existing pavement and overlay with two inches of HMA.

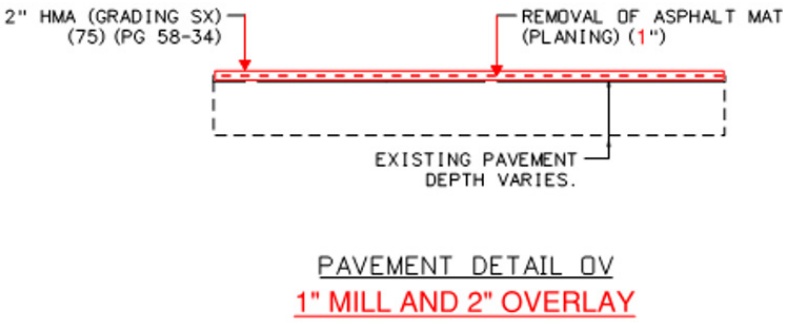


Exhibit P1.3: As Given

VE Alternative P1 Cost:

ITEM	UNIT	QUANTITY	PRICE	EXTENSION
One-Inch (25% unit price savings)	SY	141,709	$2.35	$333,016
Two-Inch Overlay	TON	15,588	$120.00	$ 1,870,560
			Line Item Subtotal	$ 2,203,576
			Contingency & Unknowns at 39%	$859,394
			Construction Subtotal	$ 3,062,970

Exhibit P1.4: Costs for Proposal P1

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Maintains the same roadway profile for roadside tie-ins (driveways/shoulders) • Generates more RAP for incorporation into project	• Slightly longer activity duration • Increased trucking and cost related to milling • Higher risk for full depth repairs in thinner pavement sections • Higher risk for delaminating in locations with chip seal in place (2.5" approx. combined wearing surface) • Requires additional funds to be carried in Risk Register which limits ability to add scope back in • Would require tapered edge if traffic placed on partially milled roadway

ALTERNATIVE	ADVANTAGES	LIMITATIONS
VE Alternative P1	• Still facilitates meeting smoothness requirements • Slight decrease in overall duration of milling activity • Decreases required trucking for milling • Would allow traffic to be placed on a partially milled portion of road without tapered edge • Removes chip seal in areas where it is still in place while partially removing underlying wearing surface • Reduces risk of full depth repairs or reconstruction in thinner existing pavement sections that will not hold up to construction equipment/activities • Reduces risk of thicker wearing surfaces or chip seals not being fully removed but too thin to bond and delaminates after milling prior to paving resulting in additional milling/prep work • Reduces amount needed to be carried in the Risk Register to address full depth repairs or delamination which can then be allocated to project scope items • Increases overall pavement thickness (structural number) which should slightly benefit the related Life Cycle	• Only conducive in locations where guardrail and shoulders are being re-done • Increases shouldering fill required to match higher grade • Does not remove entire wearing surface or deeper ruts (if present)

Exhibit P1.5: VE Alternative Proposal Evaluation

Recommendation

The VE Team recommends changing the overlay pavement section to a one inch mill and two inch overlay in all locations that will have shoulders and/or guardrail replaced.

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal P1: One Inch Mill with Two Inch Overlay	$3,470,000	$3,060,000	$410,000

Accepted: ☐ Rejected: ☐ Needs to be Resolved: ☒ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
		✓	✓	

PROPOSAL NO. P2

Description: Eliminate Concrete Sections

This proposal requires that all concrete paving/resiliency sections be replaced with the typical 2" mill and 2" fill of HMA paving section with consideration for some local hardening of the ditches and drainages at documented debris over topping locations.

Existing:

The existing conditions include HMA pavement with minimal shoulders and drainage structures.

As Given:

The plans include 10 locations of concrete pavement meant to function as resiliency areas to primarily resist damage from upslope drainage crossing the roadway. These paving sections are 28 feet wide and vary in length from 300 LF to 600 LF. Dimensions for the toe-walls were not provided but are assumed to be about 8 feet deep and 6 inches thick based on scaling in the detail..

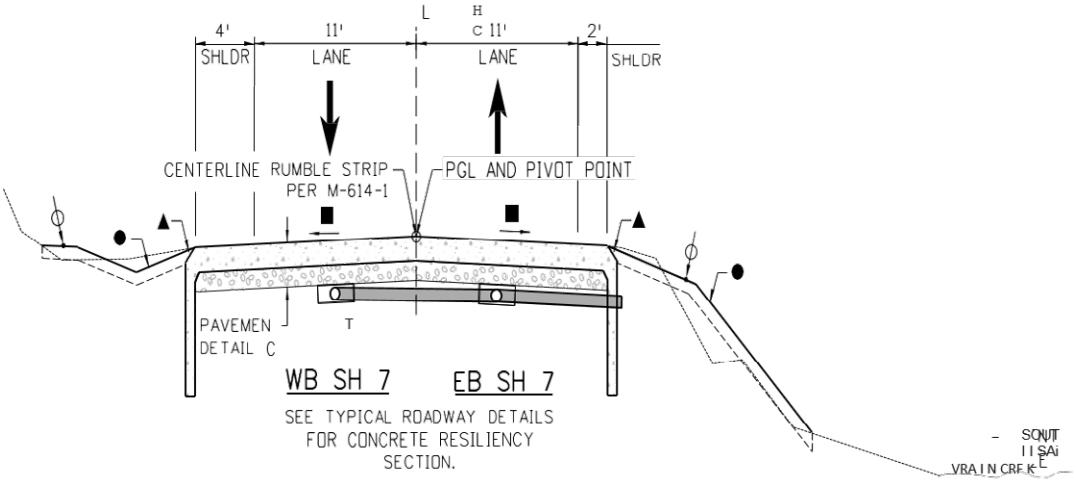


Exhibit P2.1: As Given - Resiliency Paving Section

As Given Cost:

ITEM	UNIT	QUANTITY	PRICE	EXTENSION
PCCP	SY	17,789	$200	$3,557,800
ABC CL6	CY	2,281	$55	$125,455
Rem Asphalt MAT	SY	11,733	$10	$117,330
Excavation	CY	2,281	$30	$68,430
			Line Item Subtotal	$3,869,015
			Contingency & Unknowns at 39%	$1,508,916
			Construction Subtotal	$5,377,931

Exhibit P2.2: Costs for As Given

VE Proposal P2: Eliminate Concrete Sections

The proposed paving section matches the shoulder widening and mill and overlay sections of other sections of the project.

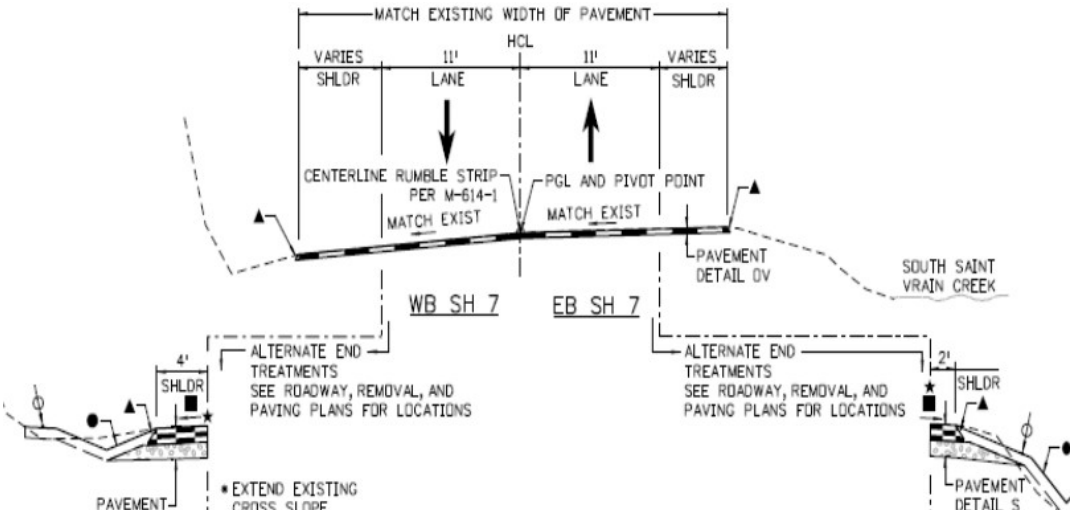


Exhibit P2.3: VE Proposal P2 - Mill and Overlay

VE Alternative P2 Cost:

ITEM	UNIT	QUANTITY	PRICE	EXTENSION
HMA	Ton	1,519	$120.00	$182,280
HMA Patching	Ton	651	$160.00	$104,160
ABC CL6	CY	488	$55.00	$26,840
Rem Asphalt Mat (Planing)	SY	11,733	$3.15	$36,959
Excavation	CY	488	$30.00	$14,640
Slope and ditch Paving	CY	200	$400.00	$80,000
			Line Item Subtotal	$444,879
			Contingency & Unknowns at 39%	$173,503
			Construction Subtotal	$618,382

Exhibit P2.4: Costs for Proposal P2

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Larger work zone for deliveries and work vehicles, Potentially more resilient to river damage	• Much more difficult to construct • Much more difficult to maintain • More difficult to plow • Poor smoothness. Multiple joints could create dynamic loading of pavement. • Multiple section changes result in a poor public perception.
VE Alternative P2	• Easier and faster to construct • Easier to maintain • Better smoothness • Easier to plow • Equal cross drainage protection at significant costs savings	• Potentially less resilient to river damage

Exhibit P2.5: VE Alternative Proposal Evaluation

Recommendation

VE Team recommends the Mill and Overlay be adopted and for the elimination of Concrete Paving Sections. The proposal offers better value with comparable performance

1. Cost avoidance is $4.8 million

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal P2 Eliminate Concrete Sections	$5,380,000	$618,000	$4,762,000

Accepted: ☐ Rejected: ☐ Needs to be Resolved: ☒ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
	✓		✓	

PROPOSAL NO. P3

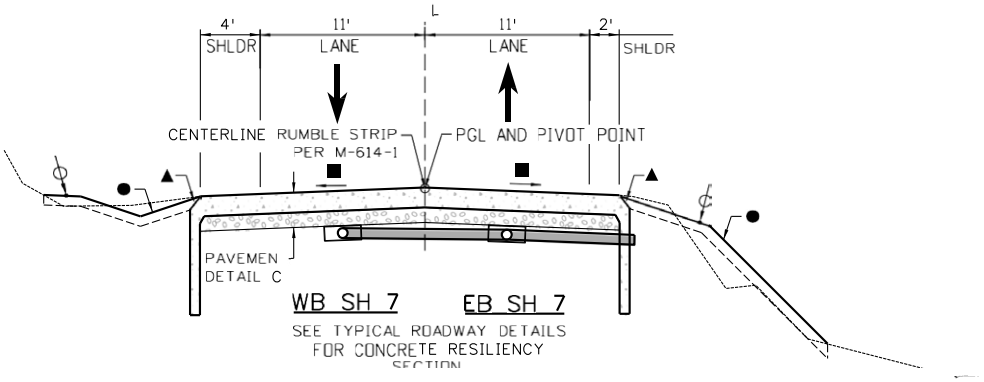
Description: Incorporate Recycled Asphalt Pavement (RAP)

Existing:

Emergency repairs were conducted in fall 2013 to remove debris from the road and complete temporary repairs in order to re-open the road for essential traffic. The existing conditions include HMA pavement with minimal shoulders and drainage structures.

As Given:

The plans require ABC Class 6 under all reconstruction sections including locations with shoulder widening. It was not noted in the plans where RAP was allowed in the ABC Class 6 although it is typical that Region 4 is reluctant to allow its use. Removal of HMA (Planing) is currently planned at approximately 7,872 CY of millings. In addition, removal of HMA is currently planned at approximately 7,889 CY. This results in a total of 15,761 potential cubic yards of RAP available for use in ABC CL 6. See example typical sections below:



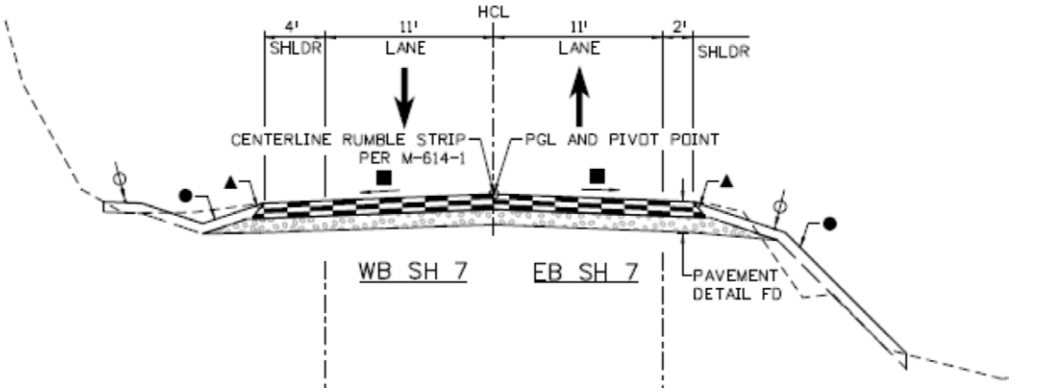


Exhibit P3.1: As Given -

As Given Cost:

ITEM	UNIT	QUANTITY	PRICE	EXTENSION
ABC CL6	CY	12,391	$55	$681,505
			Line Item Subtotal	$681,505
			Contingency & Unknowns at 39%	$265,787
			Construction Subtotal	$947,292

Exhibit P3.2: As Given Cost

VE Proposal P3: Incorporate Recycled Asphalt Pavement (RAP)

RAP would be used in the ABC CL 6. This eliminates the need to haul the material off the project and protects the environment. It is anticipated that the material would either be hauled to the quarry and mixed with appropriate proportions of virgin aggregate or would be processed at one of several locations within the project limits at smaller staging areas. It is anticipated that savings would be generated based on reduced hauling of the millings, however, it is not possible to quantify those savings due to variables in potential haul destinations. There would be additional benefits to locals with reduced trucks on the road.

VE Alternative P3 Cost:

ITEM	UNIT	QUANTITY	PRICE	EXTENSION
ABC CL6 (Special) (RAP)	CY	12,391	$55	$681,505
			Line Item Subtotal	$681,505
			Contingency & Unknowns at 39%	$265,787
			Construction Subtotal	$947,292

Exhibit P3.3: Costs for Proposal P3

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• None	• Requires hauling in of material • More truck traffic outside of project • No environmental benefit
VE Alternative P3	• Less truck traffic outside of the project limits • Environmental benefit • Potential cost avoidance	• None

Exhibit P3.4: VE Alternative Proposal Evaluation

Recommendation

VE Team recommends that Proposal P3 - RAP be adopted. The proposal offers equal value, equal performance and environmental benefits.

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Alternative P3: Incorporate Recycled Asphalt Pavement (RAP)	$947,292	$947,292	$0

Accepted: ☐ Rejected: ☐ Needs to be Resolved: ☒ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
		✓	✓	

PROPOSAL NO. P4

Description: Maintenance of Traffic Sequencing Changes

Existing:

Single lane closures in line with CDOT Region 4 Lane Closure Strategy Guidelines.

As Given:

Proposed MOT involves using single lane closures of varying lengths with a cumulative maximum 20-minute delay permitted through the project.

- Fall/Winter – Nov., Dec., Jan., Feb., Mar.
- Spring/Summer – Apr., May., June, July, Aug., Sept., Oct.
- One mile daytime closures are allowed in the spring/summer with up to three miles in the fall/winter.
- Base strategy is working within one mile lane closures.

As Given Cost:

ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
Region 4 Lane Closure Policy	LS	1	8%	$4,620,000
			TOTAL	$4,620,000

Exhibit P4.1: Costs for As Given

VE Proposal P4A: Full Closure Windows

- Similar to US 36 Construction
- Known closure periods to balance construction work and use of the canyon by the public
- Open - 6:00 AM to 9:00 AM & 4:00 PM to 7:00 PM
- Closed - 9:00 AM to 4:00 PM & 7:00 PM to 6:00 AM

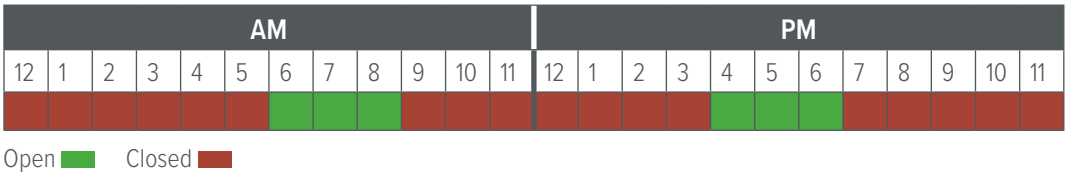


Exhibit P4.2: Full closure windows

VE Alternative P4A Cost:

ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
Full Closure Windows (Alt 1)	LS	1	6%	$3,464,117
			TOTAL	$3,464,117

Exhibit P4.3: Costs for Proposal P4A

VE Proposal P4B: Full Closure with Local Access

- Full Closure of SH 7 for Construction Season (March to October)
- Only allow local traffic and EMS through work zone

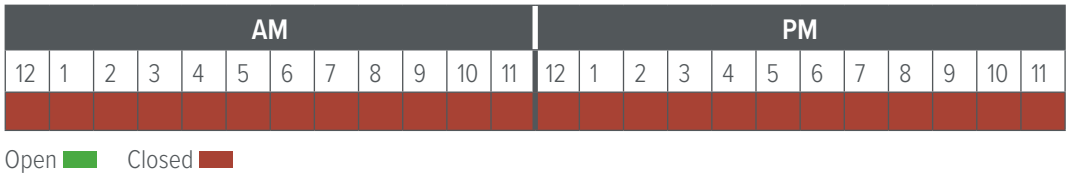


Exhibit P4.4: Full Road Closure Schedule

VE Alternative P4B Cost:

ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
Full Closure with Local /Emergency Access only	LS	1	4%	$2,886,764
			TOTAL	$2,886,764

Exhibit P4.5: Costs for Proposal P4B

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Familiarity to CDOT Staff • Familiarity to Travelling Public	• Longest construction duration • Increased public fatigue • Highest cost • Allows for more potential conflicts between users and the construction
VE Alternative P4A: Closure Window	• Allows for expedited work • Reduces Project Cost • Known Closure times to Residents and SH 7 User	• Impacts to commuting and travel in the area • Requires extra PI / Communication • Requires coordination with EMS services • Inconsistent work flow (for contractor and users) • User (vehicles and cyclist) may be caught prior to a closure period
VE Alternative P4B: Full Closure	• Allows for expedited work • Reduces Project Cost • Safest MOT – Significantly eliminates conflicts between users and Construction	• Impacts to travelling public • Peak Construction season coincides with peak RMNP Visits • Disruption to EMS services, requiring close coordination

Exhibit P4.6: VE Alternative Proposal Evaluation

Recommendation

VE Team recommends Alternative P4B full closure of the highway

The proposal offers better value through Performance (P), Acceptance (A) and Cost (C):

1. Increased quality (P)
2. Shorter construction (A)
3. Cost avoidance is $1.7 million (C)

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Alternative P4A: Closure Window	$4,620,000	$3,460,000	$1,160,000
VE Alternative P4B: Full Closure	$4,620,000	$2,890,000	$1,730,000

Accepted: ☒ 4B Rejected: ☐ Needs to be Resolved: ☐ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
			✓	

PROPOSAL NO. P5

Description: Utilize CTS and Eliminate Matrix Riprap

Existing:

The existing condition includes riprap that was placed immediately after the 2013 flood event to protect the roadway from runoff events until permanent protection measures could be designed and installed. These locations include: MP 23.3-23.4, MP 23.5-23.7 and MP 23.8-23.9.

The material that was placed immediately after the flood event was not an engineered solution and is not anticipated to be able to withstand a future 100 year flood event.

The three locations in question are all located on outside bends of the river where the hydraulic model shows increased shear stresses and velocities that are greater than what a traditional loose rip rap section could stand up against, given the available riprap sizes available along the front range.

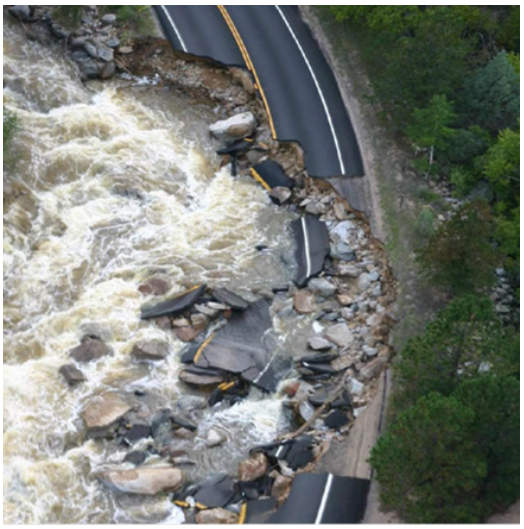


Exhibit P5.1: Full roadway washout at MP 23.8

Exhibit P5.2: Existing Aerial (September 2019 Google Earth)

As Given:

The As Given design includes 12-18” Matrix Rip at the locations reference above in the existing condition description.

This design consists of utilizing d50 of 12-18” riprap and then partially grouting the riprap together. The section spans vertically from the modeled scour depth or top of bedrock to two feet above the 100-year water surface elevation.

Matrix riprap is a tested and proven slope armament treatment, however, it is very difficult to construct in confined canyon environments, especially if during the wintertime. There are extensive quality assurance/control requirements to ensure that it is installed correctly.

Installation of matrix riprap at the proposed locations will likely require to temporally divert or pipe the river, which will cause a great disturbance to the riparian habitat at these locations. Dewatering and monitoring of water quality is very challenging as well.

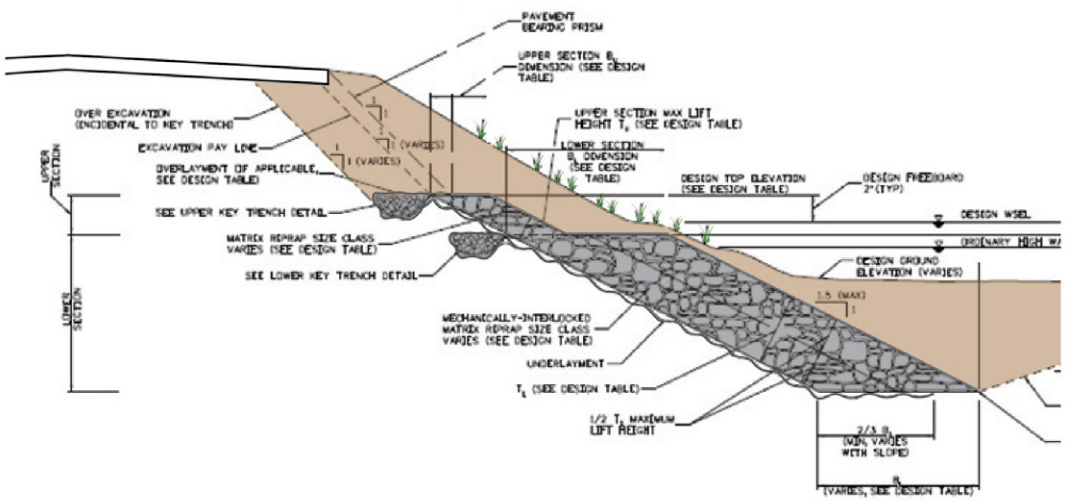


Exhibit P5.3: As Given

As Given Cost:

ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
Unclassified Excavation	CY	50,814	$85	$4,319,000
Dewatering	LS	1	$1,000,000	$1,000,000
Matrix Riprap (12in)	CY	1,802	$243	$438,000
Matrix Riprap (18in)	CY	13,594	$245	$3,331,000
Topsoil	SY	3,486	$50	$174,000
Temporary Diversion	LF	2,780	$275.	$765,000
			Line Item Subtotal	$ 10,027,000
			Contingency & Unknowns at 39%	$3,910,000
			Construction Subtotal	$13,937,000

Exhibit P5.4: Costs for As Given

VE Proposal P5: Utilize CTS and Eliminate Matrix Riprap

This VE proposal further explores the Cement Treated Subgrade (CTS) option that the CM/GC design team has proposed and is currently exploring. As stated from the design team during the kickoff meeting, below are some of the key features CTS option:

- This option consists of beginning on the mountain side of the corridor and excavating down at a 1.5:1 slope until the excavation reaches the scour depth or bedrock.
- The CTS section is then built up in lifts by using a pug mill to mix in cement and water to create a hardened section.
- In addition to the CTS section, at the three proposed locations, there would be room to construct a one-way bypass, which would allow flow of construction, emergency and local traffic.

- In a flood event, it is anticipated that the roadway section would be washed away, leaving the CTS section, with a 15' traversable surface. The traversable surface would allow emergency ingress/egress for through traffic, locals, emergency responders. It would also allow for rapid mobilization of construction crews in the case of the next flood event.

There is a chance that a one-way bypass road could be built to allow traffic by in most locations of the construction, shown in the x-section in Exhibit P5.5.

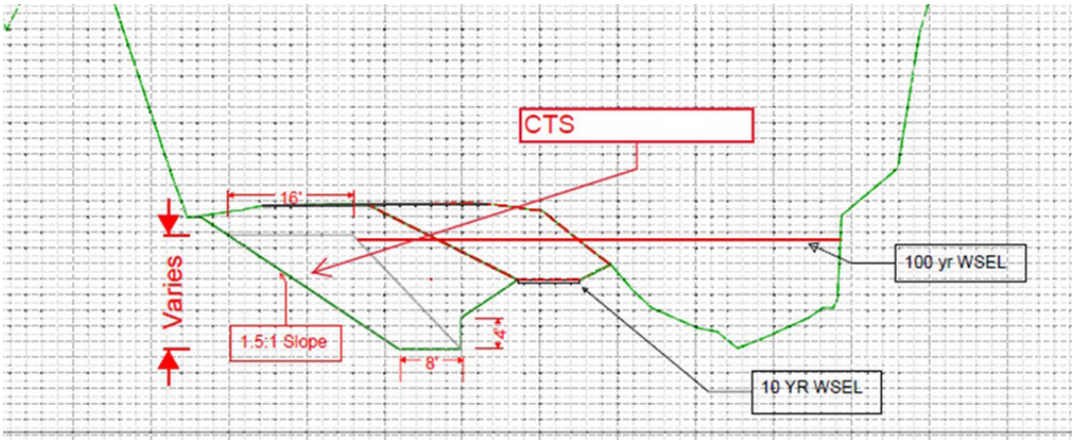


Exhibit P5.5: CTS Typical Section

VE Alternative P5 Cost:

ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
4" Mill WB	CY	66,370	$23.00	$1,526,000
4" Mill EB	LS	1	$700,000	$700,000
4" Overlay WB	SY	29,165	$26.00	$758,000
4" Overlay EB	CY	44,284	$22.90	$1,014,000
Permanent Materials	CY	29,165	$45.26	$1,320,000
HMA	TN	1,242	$90.00	$112,000
Misc. Items				$47,000
			Line Item Subtotal	$5,477,000
			Contingency & Unknowns at 39%	$2,140,000
			Construction Subtotal	$7,617,000

Exhibit P5.6: Construction Costs for Proposal P5

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Protect entire roadway in case of 100yr event • Restore roadway faster after 100yr flood • Tested and established slope protection treatment	• Limits revegetation options planted within matrix prism • Additional impact to the river and riparian habitat that is beginning to recovery well on its own after the flood • Difficult/tedious construction process • Added dewatering/ filtering/ monitoring efforts during construction • Long haul for riprap
VE Alternative P5	• Limits disturbance in riparian areas • Less dewatering / filtering / monitoring required • Allows for emergency ingress/egress in case of flood even • Could run live traffic over cement section within an hour • Allows room for construction bypass • Faster production rates • Readily available material • More conducive for winter construction than As Given	• Entire roadway not protected and would still need to be rebuilt after 100-year flood • Large excavation • Quantity uncertainty

Exhibit P5.7: VE Alternative Proposal Evaluation

Recommendation

VE Team recommends replacing matrix riprap sections with the current CTS alternative. The proposal offers better value through Performance (P), Acceptance (A) and Cost (C):

1. Less Riparian/River Disturbance(A/C)
2. Provides Emergency ingress/egress(A)
3. Shorter construction time (P)
4. Cost avoidance is $6.32 million (C)

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal 5: Utilize CTS and Eliminate Matrix Riprap	$13,937,000	$7,617,000	$6,320,000

Accepted: ☒ Rejected: ☐ Needs to be Resolved: ☐ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
✓			✓	

PROPOSAL NO. P6

Description: Let it Grow: Vegetation-Centric Alternative Stream Design

Existing:

There does not seem to be a systemic assessment on the current condition of the stream corridor. There is a Design Suggestion that encourages the design work to pause while this information is gathered.

Exhibit P6.1: Existing MP 29.8

Exhibit P6.2: Existing MP 29.2

As Given:

As proposed the work includes major grading throughout the corridor, the removal of mature trees, and removal of established and existing riparian vegetation. The work, as proposed, will be a full reconstruction of the creek bed, banks, and floodplain. Secondary channels will be filled. There are no major changes to main channel geometry or slope.

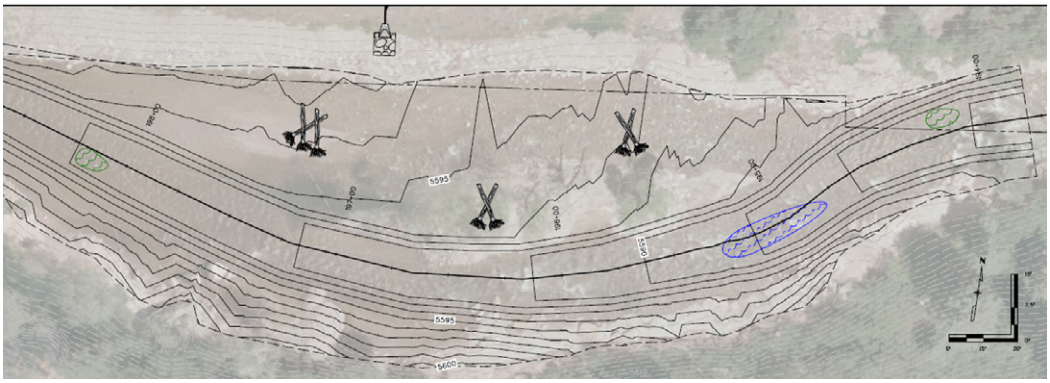


Exhibit P6.3: As Given MP 29.8

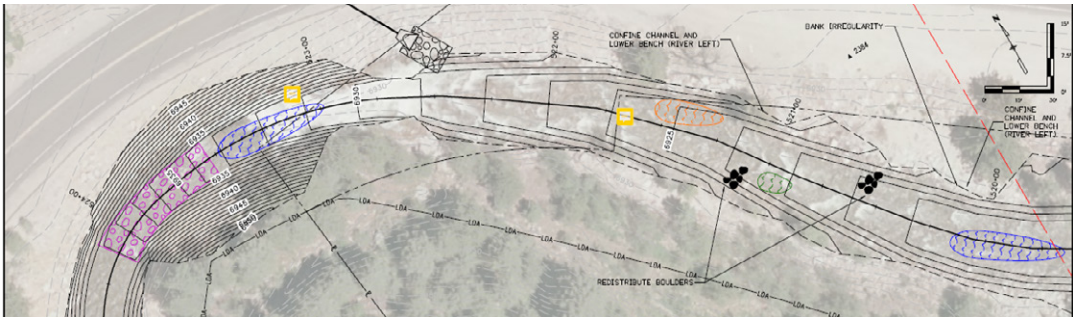


Exhibit P6.4: As Given MP 24.7

As Given Cost:

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL
Unclassified Excavation (Channel Grading)	CY	16,061	$100	$1,606,100
Unclassified Excavation (Channel Features)	CY	2,210	$100	$221,000
Unclassified Excavation (Floodplain Excavation)	CY	20,416	$85	$1,735,360
In-Channel Boulder Feature: Riffles	EA	54	$13,160	$710,640
In-Channel Boulder Feature: Steps	EA	37	$4,000	$148,000
In-Channel Boulder Feature: Cascade	EA	16	$15,000*	$240,000
In-Channel Boulder Feature: Habitat Boulder Field	EA	21	$9,160	$192,360
Rock Excavation	CY	1,926	$75	$144,450
Void Filled Riprap	CY	1,007	$195	$196,365
Removal of Tree	EA	126	$485	$61,110
Large Woody Material (subject to on-site availability)	EA	129	$1,665	$214,785
RipRap for Nuisance Protection**	CY	3,002	$133	$399,266
			Line Item Subtotal	$5,869,436
			Contingency & Unknowns at 39%	$2,289,080
			Construction Subtotal	$8,158,516

Exhibit P6.5 As Given Cost

*Possibly a typo in the original estimate. Unit price assumed at $15,000 each.

VE Proposal P6: Let it Grow: Vegetation-Centric Alternative Stream Design

This approach takes advantage of on-going, beneficial stream processes to maximize long-term benefit while reducing heavy civil construction, civil construction costs, and maintenance considerations. This proposal is to replace the majority of, or all of, the proposed streamwork with an intensive revegetation plan. This is not a recommendation for a standard revegetation or general landscape planting plan. This is a recommendation for the foundation of the stream design to shift toward using vegetation to drive geomorphic responses that will naturally build the channel, floodplain, in-stream habitat, and induce vegetation succession. This proposal also includes a recommendation for bioengineering for bank stability, where necessary.

There are FHWA documents such as HEC 15 that can provide the benefits of using vegetation for bank stability which will provide stability to the roadway embankments, reduce shear stresses, and provide resilience. Benefits of intensive vegetation installation range from directly providing food to aquatic species, to supporting pollinators, to providing shade and cover to fish, to cycling and storing carbon.

This proposal can be taken alone, or it can be applied selectively to portions of the corridor.

Background

Stream form and function is the result of the interactions between the water in the channel, the sediment in the system, and biotic factors, such as vegetation. Unlike the Big Thompson, Boulder Creek, and North St. Vrain, this stream does not have a major water storage facility in its upper reaches; the hydrology of this system is much closer to a natural regime. This stream also has mobile sediment and sediment inputs from the hillslopes, flood deposits, and debris flows. The combination of these two factors may be why this stream has recovered so well. There is evidence to suggest that the channel bed is

mobilizing sediment and building in-channel complexity. Moving forward with Design Suggestion 19, the Design Pause could verify the extent and degree of these observations.

MESSY STREAMS ARE HEALTHY STREAMS

The interplay between a stream's hydrology, sediment, and biology create, maintain, and shift features such as riffles, pools, bars, banks, wetlands, and floodplains, and influences riparian vegetation succession and the recruitment and distribution of large wood. Streams that have this functional interplay often look messy. That is, there may be obstructions from large wood; floodplain wetlands formed from channel migration and scour processes; secondary channels; sediment deposits on the channel bed and banks, and varying non-uniformity along the channel bed and banks (Wohl, 2016).

Exhibit P6.6: South St. Vrain Creek, July 10, 2020.

VE Alternative P6 Cost:

ITEM	UNIT	QUANTITY	PRICE	EXTENSION
Container Plantings (multiple sizes)	EA	25,000	$10	$250,000
Willow Cuttings (48")	EA	12,000	$8	$96,000
Cottonwood Cuttings (60")	EA	1,000	$15	$15,000
Soil Conditioning	AC	20	$9,500	$190,000
Irrigation of Containers	EA	25,000	$15.00	$375,000
Seeding (riparian and transitional)	AC	15	$2,500	$37,500
Mulching	AC	15	$2,500	437,500
Bioengineering	LF	5000	$75	$375,000
			Line Item Subtotal	$1,376,000
			Contingency & Unknowns at 39%	$536,640
			Construction Subtotal	$1,912,640

Exhibit P6.7: Costs for Proposal P6

This is a rough example of this type of approach from a different project--on the left the over-widened channel was intensely planted with wetland species and it is catching fine sediment which in turn narrows up the low-flow channel. In the higher bank locations woody species were planted to provide stability and sediment trapping during larger flows. In this specific location, the approach was blended with some earthwork and wood installation as the initial condition of this creek was quite impaired.

Exhibit P6.8: Over planting example

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Contractor and owner are familiar with past designs that look similar and are similar to construct	• Complex permitting • Disturbs or destroys existing in stream habitat. • Relies on an uncertain rock supply • Necessitates a specific construction season
VE Alternative P6	• Reduced permitting requirements (no CLOMR, no 404 wetland impacts) • More contextually sensitive given the current state of the stream • Does not negatively impact the habitat and stream function that already exists • Restores function to the stream corridor which will support resilience in the form of the channel (that is if the channel blows out, the stream has the tools to repair itself)	• More difficult for contractors, owners, designers and stakeholders to understand • Relies on an uncertain plant supply • Necessitates a specific construction season

Exhibit P6.9: VE Alternative Proposal Evaluation

Recommendation

VE Team recommends implementing a vegetative centric stream design to the greatest extent practicable, especially in locations where construction disturbance will negatively impact existing, quality habitat.

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal 6: Let it Grow	$8,160,000	$1,910,000	$6,250,000

Accepted: ☒ Rejected: ☐ Needs to be Resolved: ☐ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
		✓		

PROPOSAL NO. P7

Description: Light Touch: Reduce or Eliminate Structural Elements and Earthwork

Existing:

There does not seem to be a systemic assessment on the current condition of the stream corridor There is a Design Suggestion that encourages the design work to pause while this information is gathered.

Exhibit P7.1: Existing MP 29.8

Exhibit P7.2: Existing MP 29.2

As Given:

As proposed the work includes major grading throughout the corridor, the removal of mature trees, and removal of established and existing riparian vegetation. The work, as proposed, will be a full reconstruction of the creek bed, banks, and floodplain. Secondary channels will be filled. There are no major changes to main channel geometry or slope.

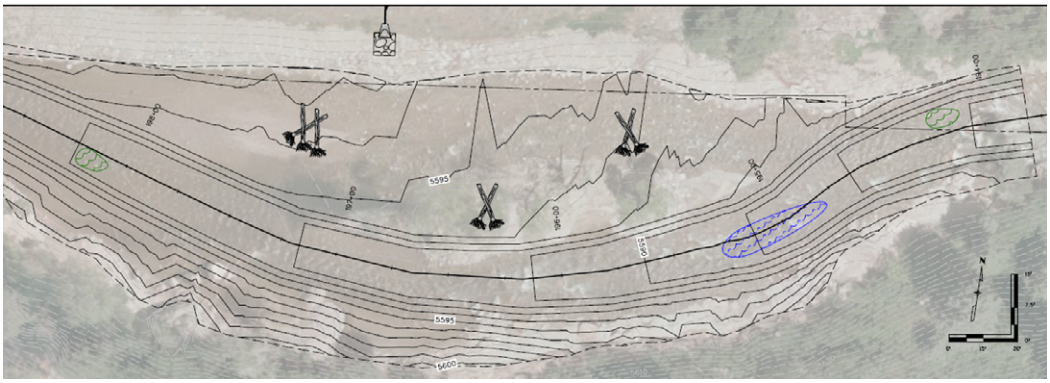


Exhibit P7.3: As Given MP 29.8

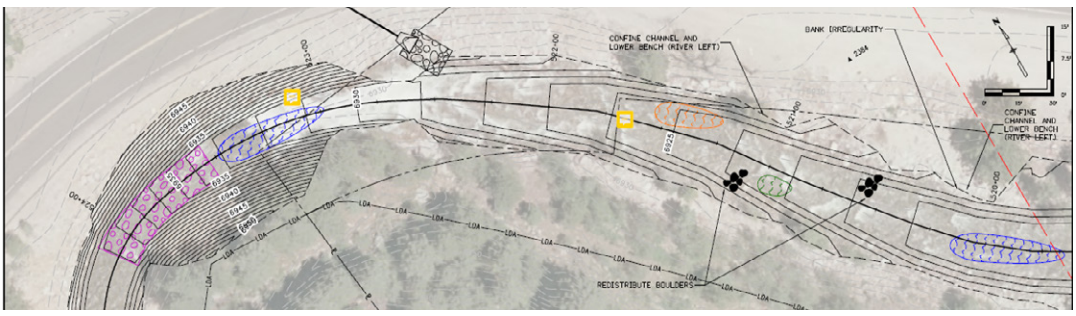


Exhibit P7.4: As Given MP 24.7

As Given Cost:

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL
Unclassified Excavation (Channel Grading)	CY	16,061	$100	$1,606,100
Unclassified Excavation (Channel Features)	CY	2,210	$100	$221,000
Unclassified Excavation (Floodplain Excavation)	CY	20,416	$85	$1,735,360
In-Channel Boulder Feature: Riffles	EA	54	$13,160	$710,640
In-Channel Boulder Feature: Steps	EA	37	$4,000	$148,000
In-Channel Boulder Feature: Cascade	EA	16	$15,000*	$240,000
In-Channel Boulder Feature: Habitat Boulder Field	EA	21	$9,160	$192,360
Rock Excavation	CY	1,926	$75	$144,450
Void Filled Riprap	CY	1,007	$195	$196,365
Removal of Tree	EA	126	$485	$61,110
Large Woody Material (subject to on-site availability)	EA	129	$1,665	$214,785
RipRap for Nuisance Protection**	CY	3,002	$133	$399,266
			Line Item Subtotal	$5,869,436
			Contingency & Unknowns at 39%	$2,289,080
			Construction Subtotal	$8,158,516

Exhibit P7.5 As Given Cost

*Possibly a typo in the original estimate. Unit price assumed at $15,000 each.

VE Proposal P7: Light Touch

This alternative is to eliminate approximately 70% of the proposed stream work and to conduct the rest with surgical precision. This task eliminates the current proposal to fully rebuild the creek channel, bed, and banks, and proposes to alter only small segments of each, as needs are identified by a Current Conditions Assessment. Structural habitat features would be built as specific and targeted interventions, grading would be highly specific and variable by reach, and bank protection would be focused on bioengineering techniques.

This proposal also would eliminate the majority of the tree removal and the vegetation removal that is currently shown on the plan set. It also removes all boulder cascades and structural riprap and greatly reduces the number of drops.

This proposal can be done alone or in conjunction with Proposal 6: Let it Grow.

Exhibit P7.6: Example of tree and vegetation removal.

The intention of this proposal is to avoid intensive construction that disturbs the entirety of the creek corridor.

VE Alternative P7 Cost:

ITEM	UNIT	QUANTITY	PRICE	EXTENSION
Unclassified Excavation (Channel Grading)	CY	5,000	$100	$500,000
Unclassified Excavation (Channel Features)	CY	2,210	$100	$221,000
Unclassified Excavation (Floodplain Excavation)	CY	500	$85	$42,500
In-Channel Boulder Feature: Riffles	EA	12	$13,160	$157,920
In-Channel Boulder Feature: Steps	EA	10	$4,000	$40,000
In-Channel Boulder Feature: Cascade	EA	0	$18,000	$0
In-Channel Boulder Feature: Habitat Boulder Field	EA	21	$9,160	$192,360
Rock Excavation	CY	1,926	$75	$144,450
Void Filled Riprap	CY	0	$195	$0
Removal of Tree	EA	5	$485	$2,425
Large Woody Material (subject to on-site availability)	EA	40	$1,665	$66,600
Bioengineering	LF	10,000	$75	$750,000
			Line Item Subtotal	$ 2,117,255
			Contingency & Unknowns at 39%	$825,729
			Construction Subtotal	$2,942,984

Exhibit P7.7: Costs for Proposal P7

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Contractor and owner are familiar with past designs that look similar and are similar to construct	• Relies on an uncertain rock supply • Necessitates a specific construction season.
VE Alternative P7	• Potentially reduced permitting requirements (no CLOMR, no 404 wetland impacts) • More contextually sensitive given the current state of the stream • Does not negatively impact the habitat and stream function that already exists	• Necessitates a specific construction season • Relies on an uncertain rock supply

Exhibit P7.8: VE Alternative Proposal Evaluation

Recommendation

VE Team recommends reducing or eliminating structural elements in all the locations that require physical interventions (based on the results of the Current Conditions Assessment), and where Proposal 6 is not applicable.

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal 7: Light Touch	$8,160,000	$2,940,000	$5,220,000

Accepted: ☒ Rejected: ☐ Needs to be Resolved: ☐ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
		✓		

PROPOSAL NO. P8

Description: Look for win-win opportunities with Boulder County to justify using quarry for materials and staging area

Existing:

Boulder County owns an old Aggregate Industries mine located approximately two miles west of Lyons. Because of its ideal location within the project limits, this site would serve as a key staging area for contractor operations. Utilizing this site could dramatically improve efficiency in operations and lessen the impacts and risks associated with trucking materials through Lyons. Although Kiewit requested use of the site, an allowance has not been given.

As Given:

Discussions are underway to identify opportunities to use the mine for a staging area. Currently, Kiewit plans on crushing and hauling outside of the project limits.

Garnering approval for the contractor to use the quarry is a big advantage because of more effective contract operations and effects of less truck traffic, as well as associated safety and traffic operations advantages.

As Given Cost:

Currently unknown. Kiewit has reached out to private property owners for staging opportunities but has not heard back. Realized cost avoidance would be the amount Kiewit would have had to pay for alternative staging areas.

VE Proposal P8: Look for win-win opportunities with Boulder to justify using quarry for materials and staging area

Garnering approval for the contractor to use the quarry is a big advantage because of more effective contractor operations and effects of less truck traffic, as well as associated safety and traffic operations advantages.

Continue pursuing an agreement to allow temporary use as a staging area for the project whether through the contractor or by CDOT. Continue discussions with Boulder County to donate the land for staging use while shifting conversations to identify “win-win” solutions, which could be:

- Reconstruct an access road to staging area consistent with the future plans for the site
- Invest staging cost avoidance to build more scope that Boulder County desires, such as four-foot uphill shoulders
- Set up staging area with the future Boulder County Parks and Open Space in mind. For example, construction staging parking lot areas can be placed in areas that can easily be used in the future Open Space configuration
- Work with Boulder County Parks and Open Space about using recycled asphalt from the project on their trail system or trailhead parking spots.

Identify the constraints of using rock material for road base or riprap from the quarry. If reclamation is mandated as a condition of mining material, reclamation costs need to be determined to understand the cost/benefit of reclaiming the quarry and how much useful material can be mined. During this process, maintain close collaboration with FHWA regarding eligible costs when developing an agreement with the County.

VE Alternative P8 Cost:

Cost avoidance for the proposed recommendations can be leveraged in three ways:

1. Operational savings in productivity and hauling by using the county quarry site instead of hauling in from outside of Lyons (that location is currently unknown). Per the Kiewit preconstruction group, an estimated $800K in value could be realized should the contractor be able to stage at the County quarry site.
2. Cost avoidance by Boulder County donating the quarry site for staging, can be calculated using what DOT's pay for Temporary Easement (20-25%) of the land value and this cost avoided savings has not been added to this recommendation.
3. Mining Material from the quarry if the reclamation costs are cheaper than base and/or riprap costs.

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• No IGA's needed with Boulder County	• Relies on an uncertain rock supply • Necessitates a specific construction season
VE Alternative P8	• Less truck traffic through Lyons and work site • More efficient and effective operations • Put money into scope instead of staging area	• Permitting regulations • Land use stipulations • Mine reclamation efforts

Exhibit P8.1: VE Alternative Proposal Evaluation

Recommendation

The VE Team recommends the project team pursues "win-win" conversations with Boulder County on using the quarry area for staging and/or material.

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal 8: "Win-Win"	$800,000	0	$800,000

Accepted: ☐ Rejected: ☐ Needs to be Resolved: ☒ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
			✓	

PROPOSAL NO. P9

Description: Appropriating work in specific phases to save on indirect/CE rates, schedule, efficiency

Existing:

Construction Phase CE and Indirect rates is as follows (for total of 26%):

RATE CHANGED EFFECTIVE OCTOBER 1, 2019

Indirect Rate:
Project Indirect Rate 12.00%
(Participating 9.93%; Non-Participating 2.07% against All Costs).

Construction Engineering (CE) Pool Rate:
CE Pool Rate 12.50%.

CE and Indirect Rate on Project Financial Statements:
The calculations used for CE and Bid Item Indirect Costs for Project Financial Statements beginning 10/01/19 are:

CE	12.50%
Participating Indirects on CE	1.24%
Participating Indirects on Bid Items	9.93%
Total Participating CE & Indirect	23.68%
Nonpart Indirect on CE	0.26%
Nonpart Indirects on Bid Items	2.07%
Total Non Participating CE & Indirect	2.32%
Total all CE and Indirects	**26.00%**

Miscellaneous phase includes a 12% indirect markup.

As Given:

River work and rockfall work is shown in the Construction (C) Phase so 26% CE/Indirect is applied to all items and will be incorporated in packages with other scope elements.

As Given River Work Cost

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL
Unclassified Excavation (Channel Grading)	CY	16,061	$100	$1,606,100
Unclassified Excavation (Channel Features)	CY	2,210	$100	$221,000
Unclassified Excavation (Floodplain Excavation)	CY	20,416	$85	$1,735,360
In-Channel Boulder Feature: Riffles	EA	54	$13,160	$710,640
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Removal of Tree	EA	126	$485	$61,110
Large Woody Material (subject to on-site availability)	EA	129	$1,665	$214,785
RipRap for Nuisance Protection**	CY	3,002	$133	$399,266
			Line Item Subtotal	$5,869,436
			Contingency & Unknowns at 39%	$2,289,080
			Construction Subtotal	$8,158,516

Exhibit P9.1 As Given River Work Cost

*Possibly a typo in the original estimate. Unit price assumed at $15,000 each.

River work has a construction cost of $8.2M, so using a 26% CE/Indirect rate in the construction phase, adds $2.13M to the project cost.

Geohazard work in the $106M package accounted for $29,221,885 in costs, so using a 26% CE/indirect rate in the construction phase, adds $7.6M to the project cost.

Re-baseline As-Given Cost ($55M-$70M Program Cost):

River work is same as above cost.

Geohazard was re-base lined from $29.2M to $4.4M construction costs, so using a 26% CE/indirect rate in the construction phase, adds $1.15M to the project cost.

As Given Construction Engineering Cost

ITEM	ROCKFALL (ORIGINAL ESTIMATE)	CE/INDIRECT (ORIGINAL ESTIMATE)	ROCKFALL (RE-BASELINE ESTIMATE)	CE/INDIRECT (RE-BASELINE ESTIMATE)
Geohazard As Given (C Phase 26% CE/Indirect)	$29,221,885	$7,597,690	$4,422,700	$1,149,902
River Work As Given (C Phase 26% CE/Indirect)			$8,160,000	$2,121,600
			Subtotal	$3,271,502

Exhibit P9.2 As Given CE Cost

VE Proposal P9: Appropriating work in specific phases to save on indirect/CE rates, schedule, efficiency

Shift specific river work and rock scaling scope elements into the miscellaneous phase that will have a lower indirect percentage of 12%.

Select river and geohazard work items can be migrated to a separate contract that can be performed through the M phase. An IGA can be created between CDOT and an appropriate water district or geohazard unit. These districts/agencies have more experience managing this type of work than a roadway general contractor. This approach is also useful for long-term monitoring and closing out the construction phase while still leaving appropriate work open.

VE Alternative P9 Construction Engineering Cost

ITEM	ROCKFALL (ORIGINAL ESTIMATE)	CE/INDIRECT (ORIGINAL ESTIMATE)	ROCKFALL (RE-BASELINE ESTIMATE)	CE/INDIRECT (RE-BASELINE ESTIMATE)
Geohazard VE Proposal (M Phase 12%)	$29,221,885	$3,652,736	$4,422,700	$552,838
River Work VE Proposal (M Phase 12%)			$8,160,000	$1,020,000
			Subtotal	$1,572,838

Exhibit P9.3 VE Alternative P9 CE Cost

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• One contract to manage	• Monitoring work could hold up closing out construction project
VE Alternative P9A	• Keep similar work elements under one contract • Set up long-term monitoring under more appropriate contracting method	• Multiple contracts and IGAs to manage • Multiple contractors working in one canyon

Exhibit P9.4: VE Alternative Proposal Evaluation

Recommendation

The VE Team recommends shifting the river work and geohazard work out of the C Phase and into the M Phase.

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal 9: Appropriating work in specific phases to save on indirect/CE rates, schedule, efficiency	$3,270,000	$1,570,000	$1,700,000

Accepted: ☐ Rejected: ☐ Needs to be Resolved: ☐ Needs Further Study: ☒

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
			✓	

PROPOSAL NO. P10

Description: Direct to project to reflect reduced project resources based on efficient oversight

Existing:

Traditionally, Construction Engineering pool rate is 12.5% that is applied to the construction contract and change orders.

As Given:

The SH 7 project is using the traditional construction engineering contracting methods that includes paying the 12.5% on construction contracts.

As Given Cost ($106M Program Cost):

The program summary sheet references a 12.5% CE number of $9.58M based on a $76.6M construction contract.

Re-baseline As-Given Cost ($55M -$70M Program Cost):

The re-baselined program summary sheet references a 12.5% CE number of $6.62M on a $53M construction contract.

VE Proposal P10: Direct to project to reflect reduced project resources based on efficient oversight

Track direct to project costs for owner support including construction engineering, project management, inspection, testing, etc. If extended road closures are implemented, more opportunities exist to save resources on owner traffic inspection due to minimized traffic control inspection throughout the construction areas.

For the US 34 canyon project, when comparing bid items to CE, the percentage was 10.8%. If the project were to have gone direct to project using a rate of 11%, instead of the CE pool rate of 12.5%, it would have equated to a $1.1M Savings

VE Alternative P10 Cost:

If assumed 9% direct to project rate on original construction cost of $76.6M then construction engineering cost becomes $6.8M. Likewise 9% direct to project rate on re-baselined construction cost of $53 M yields a construction engineering cost of $4.77 M. See Exhibit P10.1.

	CONSTRUCTION COST	CE RATE 12.50%	DIRECT TO PROJECT 9% (ASSUMED RATE)	COST AVOIDANCE
As Given	$76,600,000	$9,580,000	$6,890,000	$ 2,680,000
Re-baselined As Given	$53,000,000	$6,625,000	$4,770,000	$ 1,855,000

Exhibit P10.1: Costs for Alternative P10

VE Alternative Proposal Evaluation

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Contracting methods in place	• Using flood money to fund CDOT overhead, more appropriate to use emergency funds towards recovery project
VE Alternative P10	• Forces accountability of using tax payer money efficiently	• Approval needed by Chief Engineer

Exhibit P10.2: VE Alternative Proposal Evaluation

Recommendation

The VE Team recommends adoption the proposal of using direct to project rates.

Proposal Comparison Cost Table

The table below summarizes As Given, Alternative Cost and the Cost Difference between the As Given and the Alternatives.

Item	First Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Given	VE Proposal	
VE Proposal 10: Direct to project to reflect reduced project resources based on efficient oversight	$6,630,000	$4,770,000	$1,860,000

Accepted: ☐ Rejected: ☒ Needs to be Resolved: ☐ Needs Further Study: ☐

FHWA Functional Benefit

Safety	Operations	Environment	Construction	Right of Way
			✓	

6.3 Design Suggestions

In addition to the 10 proposals, the VE team provided the 22 design suggestions below. Design suggestions are ideas that the VE Team felt would benefit the project but did not have adequate data to evaluate and demonstrate value as a proposal.

DS1 Utilization Of Native Material For Riprap Sourced From Rock Scaling Or Adjacent Low Risk Cut

There are currently 2,380 hours of rock scaling in the estimate, which has the potential to generate material suitable for riprap. It is suggested that scaling work be done prior to the placement of riprap to utilize these materials and decrease the amount of material needing to be hauled.

In addition, it was noted that some pull-offs were desired by stakeholders. In cases where pullouts are located in areas where low risk rock cuts are possible, it is suggested that small cuts could be utilized to source riprap material.

DS2 Drainage Criteria for the Project

Background: The 30% Preliminary Drainage Report (January 2019, Muller Engineering) indicates that survey information, including inverts of existing pipes and the topography in the areas of proposed pipe locations, was not available at the time of preliminary drainage design. Thus, conservative and broad assumptions are made within the Report, and by extension the 50% VE Plan Set – these assumptions may be leading to oversizing of proposed cross-culverts to meet the 4% (25-year) annual recurrence storm.

Further, the broad assumptions used to calculate proposed culvert performance via CulvertMaster in the Report have the potential to lead to over- or under-design of the outlet protection, which is being designed to the 1% (100-year) annual recurrence storm per project criteria as stated in the Report.

Finally, the 1% (100-year) annual recurrence design standard for the culvert outlet protection is coming from Boulder County criteria, as stated in the Report. CDOT specifies that the design storm frequency should be used for outlet protection, or a 10% (10-year) annual recurrence storm event may be used under certain conditions (CDOT Drainage Design Manual, 2019).

Design Suggestions:

A. The drainage design should be advanced to the appropriate standard of design for a 50% overall plan set. This would include a re-analysis of the proposed pipe crossings utilizing topographic information surveyed at the site, including the invert elevations of the existing/proposed pipes. This will reveal any instances of oversizing of the culverts, and the plan set, quantities, and cost estimate may be modified accordingly.

B. The outlet protection (though see DS #3 below) may then be re-evaluated using the results from DS1 (above) to ensure that right-sizing of the outlet protection is taking into account the best information available from the hydraulic analysis.

C. The CDOT criteria gives significant flexibility in selecting the design standard for culvert outlet protection. Though typical process is to select the more stringent criteria when selecting between multiple jurisdictional requirements, a design suggestion is to analyze the cost avoidance in pulling back the culvert outlet protection from a 100-year standard to a lesser standard. As CDOT would only be requiring a 25-year riprap design at the most, it may not be financially prudent to defer to Boulder County's much higher standard in some, or most, instances for this project.\

DS3 Appropriating Work in Specific Packages to Save on Schedule, Efficiency, Cost Competitiveness

Efficient packaging of work by type, timing, availability, etc is a hallmark of CM/GC project delivery. It is the opinion of the VE team that the project PM team consider the following packaging for optimal delivery.

Packaging

- Increase cost competitiveness
- Schedule
- Efficiency
- Geographic versus Scope

Advantages

- Allows for Project Team familiarity
  - Price negotiations
  - Migrates specific work that GC may not want to perform, allowing for an amicable separation of earlier packages from larger work (i.e. rock mitigation or river work).
- Learn pain points
- Allows for work that is “in the way” to be completed so that work which requires full closures can be done in a condensed window
- Allow for longer river self-healing
- Decouples river work from majority of packages during USFS plan approval
- Culvert work more conducive to phased construction and more accommodating MOT reducing full closure duration
- Majority of culverts not impacted by CLOMR may be able to be completed in low flow seasons
- Understanding budget versus scope in biggest package and allows for scope flexibility
- Expediting CP1 prior to CLOMR/ROW/Permit being in place could reduce associated cost escalation over for that work

Notes

- Culverts in resiliency sections should be completed at the time of the resiliency work
- Kiewit needs to verify if after CP1, they would be able to complete the CP2 work in nine months
- Need to verify durations for weather sensitive items
- Culverts in CTS (if change is made), would be in CP2

Limitations

- Risk related to CLOMR timing is increased
- Risk of gap in work is increased (ROW, agency approval/ permitting, etc.)
- CLOMR September 2021
- Preferable to do rock mitigation work after winter
- River work after peak flow (i.e. Q1/Q2)
- Rockfall may be able to be subbed to existing “on-call” contractor(s)
- Roadway work will have “no work” areas
- Culverts will have “no work” areas

See schedules in Exhibits DS3.1 and DS3.2.

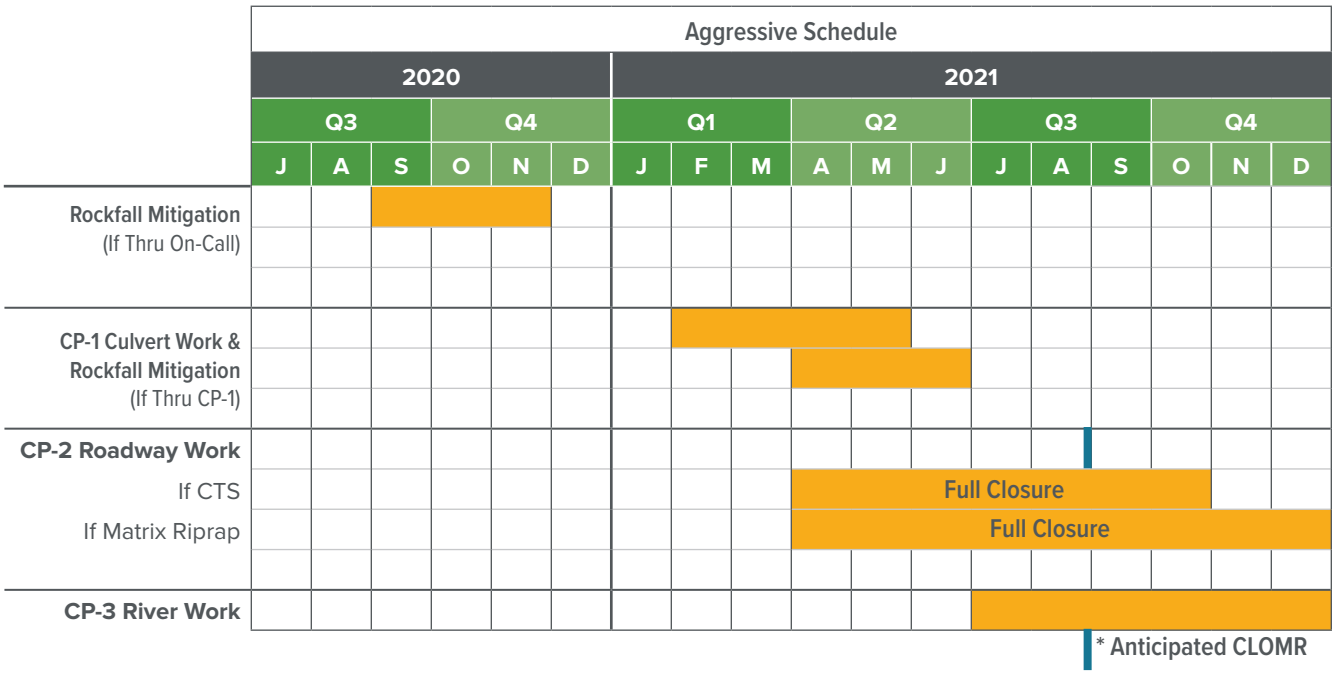

Exhibit DS3.1: Aggressive Schedule

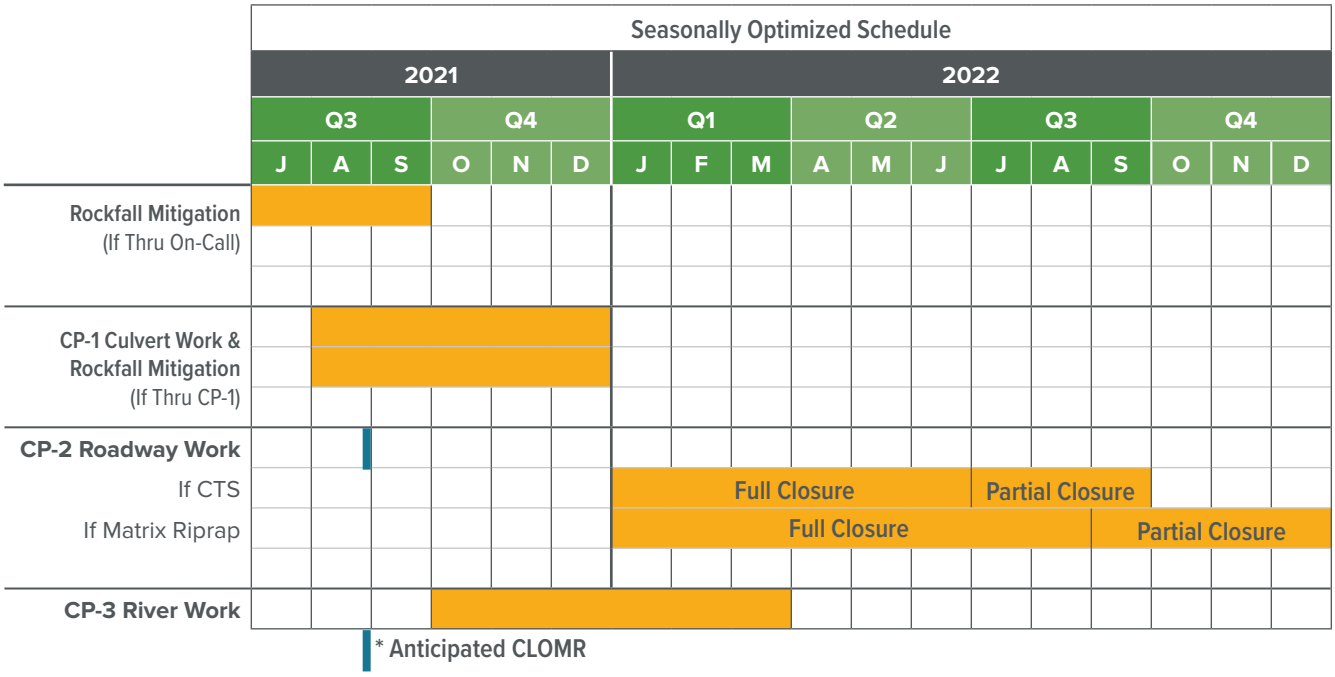

Exhibit DS3.2: Seasonally Optimized Schedule

DS4 Work with CMGC Contractor to Reduce Plan Detail for Resurfacing

Because the CMGC approach maximizes communication and collaboration with the contractor and the design team, opportunities exist for streamlining the pavement plans. The design team and CMGC should work together and provide just enough information for construction to occur.

DS5 Prioritization of Rockfall Mitigation by Maintenance Needs

It's recommended that rockfall mitigation sites be prioritized by maintenance needs. They can provide valuable information on common occurrences, and in areas where debris commonly accumulates after storms. See Exhibit DS5.1.

Exhibit DS5.1: Photo of current slope conditions from a maintenance request after a rockfall that occurred in April on SH7 near MM 23.4

DS6 Eliminate Toe Wall on One Side of Resiliency Sections

The resiliency sections of the highway include toes walls on both sides to control undermining of the road. In addition, a drainage system is included for allowing water to vacate the section between the walls. Consideration could be given to providing the wall on the more likely side to receive undermining.

DS7 Combine Local Access Locations

To control access points on the highway multiple drives, where possible, could utilize frontage roads with one access point, combined into shared drives, or rerouted to side roads.

DS8 Direct Cyclist to Left Hand Canyon During Construction

At this time, cyclists are allowed on any road open to traffic, except for interstate highways (with specific exceptions). The existing conditions are that cyclists should be allowed to travel with traffic through the canyon during any periods when the highway is open to traffic, e.g. morning/evening rush hours. This suggestion envisions that during construction, lanes will be narrow, barriers will be set within two-feet of the lanes to protect work zones, and there will be stretches where the driving/riding surface will not be paved and uneven. More than likely, cyclists will not be able to safely traverse the closure as quickly as cars, and will therefore impede traffic. The project team should work with the cycling community to encourage cyclists to use US 36 to get to Estes Park (net 14-miles shorter), and Left-Hand Canyon to get to Ward (net 0.8-miles shorter). The SH 7 work zone should be signed to not allow cyclists to proceed past Boulder County Road 84.

DS9 Install Debris Trash Racks in Drainages in Forest

The current plans envision a roadway surface that is durable enough where heavy equipment could be used to remove any debris, that may flow from the surrounding forests onto the highway. This suggestion envisions that it is easier and safer to keep the debris in the forests where it belongs. The design team should investigate if a variant of trash racks like irrigation ditch trash racks could be constructed in the forest, in order to intercept the debris before it ever reaches CDOT ROW. These racks could be checked after heavy storms in the area to see if they need to be cleaned. Materials cleaned from the racks could be dragged into the forest and left to decompose. This will eliminate the need for a durable section of highway, that may still be damaged from removal operations. This will also minimize the safety concern of debris flows onto the roadway where it could be struck by traffic.

DS10 Install Debris Berms in Drainages in Forest

The current plans envision a roadway surface that is durable enough where heavy equipment could be used to remove any debris, that may flow from the surrounding forests onto the highway. This suggestion envisions that it is easier and safer to keep the debris in the forests where it belongs. The design team should investigate if berms like waterlogs constructed on trails could be constructed in the forest, in order intercept the debris before it ever reaches CDOT ROW. If constructed correctly, these berms would direct debris laden runoff into the woods where existing vegetation could intercept the debris, and water would then be able to continue along the drainage. These berms could be checked after heavy storms in the area to see if they need to be cleaned. Materials cleaned from the racks could be dragged into the forest and left to decompose. This will eliminate the need for a durable section of highway, that may still be damaged from removal operations. This will also minimize the safety concern of debris flows onto the roadway where it could be struck by traffic.

DS11 Install Debris Flow Fence in Drainages in Forest

The current plans envision a roadway surface that is durable enough where heavy equipment could be used to remove any debris, that may flow from the surrounding forests onto the road. This suggestion envisions that it is easier and safer to keep the debris in the forests where it belongs. The design team should investigate if a variant of debris cable fences like rock draping systems could be constructed in the forest, in order intercept the debris before it ever reaches CDOT ROW. These fences could be checked after heavy storms in the area to see if they need to be cleaned. Materials cleaned from the fences could be dragged into the forest and left to decompose. This will eliminate the need for a durable section of highway, that may still be damaged from removal operations. This will also minimize the safety concern of debris flows onto the roadway where it could be struck by traffic.

DS12 Devolve SH 7 to Boulder County

With lower traffic counts, alternative routes and limited residents along the highway, consider negotiating with Boulder County to convert SH 7 (Lower) to a local road.

DS13 Install Bike Warning Lights

The current plan envisions a four-foot uphill shoulder and a two-foot downhill shoulder to accommodate cyclists. In some areas where rock outcroppings encroach on the highway, this could be a costly proposition, because of ROW limitations and the pure cost of removing the outcroppings. In areas where a four-foot uphill shoulder is overly costly, the design team should consider if it may be less costly to install a warning system that would be triggered by a cyclist crossing an in-pavement sensor, triggering a light. If hard wiring to an existing system is impractical, solar power may be an alternative.

DS14 Automated Monitoring System To Close Road During Hazard Events

Automatic gates with sensors tied to stream gauging stations could be installed to restrict access to the highway during potential flood events. Other hazard events like wildfires could also be accommodated.

DS15 Use Lessons Learned and Best Practices from I-25 CM/GC Project

The CM/GC delivery method is a fast-paced delivery method with many moving parts. Delivering a project with this format requires strong project management skills, teamwork, communication, and experience. The I-25 team has created various tools that track costs, scope, project management, communication, and budget from a micro level (project level) to a macro level (programmatic level), the following tools will be highly beneficial for the SH 7 team to implement on their project:

- Program Summary Spreadsheet – shows complete project funding, including design, ROW, utility, project delivery, and construction costs with appropriate percentages applied based on phase. As construction packages are released the spreadsheet adjusts to show contractual numbers versus packages still under design yet to be negotiated.
- Program Funding and Cost Tracker – tracks the progression of the project costs through various pricing exercises based on design progression. The tracker also shows additional funding the project may receive. The tracker compares the project funding to the project costs in a graph format.
- Scope and Priority Tracker - separates "base" project from priority scope elements that can be deleted or added into the project based on variable funding the project may receive at any given time.
- EMT Presentations – portrays best practices of how to communicate and "manage up" by showing appropriate information and level of detail for discussions, recommendations, and decisions
- OPCC/CAP Negotiation Spreadsheet – documents the progression of 30%, 60%, and 90% OPCC, as well as CAP negotiations. Details item numbers, quantities, prices from ICE and CM, and relevant percentages to be applied to formulate contract price. Best management tool to use during active negotiations to document discussions and track assumptions and decisions.
- Best Practices and Lessons Learned Tracker – as part of the FHWA monthly construction updates, the project team is logging best practices and lessons learned throughout the CM/GC construction phase, these can be shared with the SH 7 team. The project team has also compiled a running list of best practices and lessons learned while in the preconstruction phase of the project.

A google drive has been created with these tools and has been shared with the SH 7 team. The I-25 team will continue to work closely with the SH 7 team to pass on experience and knowledge as both projects progress, as well as update the drive with pertinent information that may be useful for the delivery of SH 7.

DS16 Reference US 34 Lessons Learned

There are several similarities between the US 34 reconstruction and the one planned form SH 7 (Lower). Reviewing the successes and challenges overcome in delivering US 34 could prove beneficial to the SH 7 (Lower) project team.

DS17 Evaluate 4f Access

It is the VE team's understanding that any properties with multiple accesses, individual accesses can be closed, because the property is still accessible from other points. All 4f properties within the project limits should be evaluated for intermittent closures to facilitate the work.

DS18 Avoid Mine Waste

There appears to be mine waste near the stream in at least one location (Photo: approximately STA 535). Grading plans show reworking and tie-into the toes of these slopes. It is recommended that these areas be avoided by the project.

DS19 Pause Design and Document Preconstruction Conditions (Vegetation)

A purposeful pause in the design effort will allow owners and stakeholders to focus on establishing desired outcomes and develop a process and plan for the design of the stream corridor features. This design pause will facilitate partnerships, achieve long-term outcomes and result in a cost-effective project as design iterations can be reduced. The potential for change orders during construction may also be reduced.

It is suggested that direction from CDOT should be function and outcome-based and based on the current condition of the stream corridor.

- A goals and outcomes workshop focused on the stream work can provide benefit to the design. A site visit for the workshop team can provide benefit and opportunity for documenting existing stream conditions and identifying healthy habitat that may not require work. Once the stream assessment is completed a design charette could be scheduled to collaboratively develop a design for stream restoration strategies.

- Adaptive management, particularly as it relates to weed control, is a key component of stream restoration work. During the design pause, a plan for long-term weed management/control in areas that are disturbed by the stream work as well as an adaptive management and maintenance plan for other elements of the river rehabilitation work can be developed.

DS20 Maximize Temporary Easements in Place of Permanent Easements

In an effort to foster cooperation with local property owners, land could be “borrowed” with temporary easements during construction and returned after improvement. This allows property owners to retain their land and benefits local jurisdictions but not removing it from the tax rolls.

DS21 Construction of New Assets That Require Maintenance

It is suggested that newly constructed assets be evaluated and minimized where possible because of the required future cost associated with their maintenance. Specifically, in regards to newly installed drainage assets, and rockfall mitigation devices, it is recommended that a maintenance plan be created to inform all parties of who is taking ownership of the maintenance of the new assets.

DS22 Alternative Rockfall Mitigation to Minimize Ditch Widths Requirements

The 50% plan set describes extensive rockfall mitigation achieved by draped cable net. After discussions with the design team, it was understood that the estimate assumed all slopes in the plan set would be altered by the proposed highway alignment and would therefore need rockfall mitigation. Further discussions with the project manager indicated that the planned alignment currently does not require modification to the adjacent slopes, and therefore rockfall mitigation needs were going to be significantly decreased.

Exhibit DS22.1: Anchored mesh installed on US 24 Ute Pass.

Due to roadway alignment constraints, and the desire to maximize the shoulder, it is suggested that alternative rockfall mitigation be considered at some sites. In many locations along SH 7, ditch catchment isn't adequate for the deflection and catchment of material released by a rockfall drapery system. In some proposed locations there is a risk that fallen material could be directed onto the shoulder which could pose a safety hazard to the traveling public, and specifically to bicycle traffic encouraged to utilize the shoulder. Proposed locations should be evaluated for the effectiveness of drapery with specific attention to ditch constraints.

Anchored mesh systems consist of a combination of a wire mesh or cable net and rock anchors that cover a section of slope to prevent rockfall. This system is meant to reinforce the slope and prevent the mobilization of rocks from the face which allows ditch width to be minimized without compromising mitigation effectiveness. Anchored mesh systems are also aesthetically pleasing in that the mesh lays closer to the slope because it is anchored, rather than laying on the top. See Exhibit DS22.1.

Exhibit DS22.2: Rock spot bolting and PUR injection on SH14 Poudre Canyon

Rock spot bolting combined with polyurethane resin injection PUR) is an alternative rockfall mitigation that should be considered in areas where ditch width is minimal, and aesthetically pleasing results are desired. Spot bolting provides stabilization for individual blocks or outcrops, and the PUR effectively "glues" the mass together to further stabilize the mass with limited aesthetic consequences. See Exhibit DS22.2

7 CONCLUSION

7.1 Conclusion

Ten proposals were developed for the SH 7 (Lower) Permanent Pavement Repair Project. They are summarized in Exhibit 7.1 along with their cost impacts. Each of the As Given and VE alternative costs in each proposal were calculated based on the line items in the estimate provided to the VE team. After review of the estimate the VE team determined that 39% should be applied to the calculated costs to represent contingency and unknowns called out in the estimate with the exceptions of Proposals 4, 8, 9 and 10. Because Proposal 4 is related to maintenance of traffic, a cost within the 39% contingency, it would have been redundant to apply again. Proposals 8, 9, and 10 are related to program costs outside construction cost and thus did not received the additional 39% .

Maximum Potential Construction Cost Avoidance is the sum of the recommended proposals except for Proposal 7. Either Proposal 6 or Proposal 7 or a combination of the two can be applied to the project. Proposal 6 is recommended between the two based on its maximum value.

The Maximum Potential Program Cost Avoidance is also determined by adding an additional 25.4 percent to the Maximum Construction Cost Avoidance. This number was determined based on the percent calculation of the program costs outside the construction cost less the lump sum items. The lump sum items are Design, Utilities, Right-of-way, Previous Expenditures, and Environmental Clearances. The values of these items are provided in the estimate in Appendix A.

Disclaimer

The cost differences developed are based on the design information provided to the VE Team and should not be considered absolute cost savings guarantees; but rather indicators of potential value magnitudes requiring further detailed engineering as the project develops.

PROPOSAL SUMMARY

Pro. No.	Description	As Given	VE Proposal	Construction Cost Avoidance	Recommendation	Decision	Recommended Action
P1	Mill 1" and 2" Overlay	$3,470,000	$3,060,000	$410,000	Recommended	Consider Implementation	Review areas in floodplain where not possible; need to assess where roadway is not in floodplain overtopping and CLOMR/floodplain rise is not a risk
P2	Eliminate Concrete Sections	$5,380,000	$618,000	$4,762,000	Recommended	Consider Implementation	This will have to be explained/discussed with USFS - previous concern or point of interest was mitigation of cross-slope drainages. Initial conversations with this news have been delivered to USFS with field reviews, but is not closed.
P3	Incorporate Recycled Asphalt Pavement	$947,000	$947,000	$0	Recommended	Consider Implementation	Check with R4 materials on specification (Roadway team). Refer to Materials/Roadway team on feasibility/risk/benefit.
P4A	Full Closure Window for MOT	$4,620,000	$3,460,000	$1,160,000	Recommend P4B	Consider Implementation	Continue discussions with 4f stakeholders to make sure no impact. Need to begin public outreach plan and specific details if full closure selected.
P4B	Full Road Closure for MOT	$4,620,000	$2,890,000	$1,730,000			
P5	Utilize CTS and Eliminate Matrix Rip Rap	$13,937,000	$7,617,000	$6,320,000	Recommended	Consider Implementation	Defer to river rehab for feasibility/benefit/risk.
P6	Let it Grow: Vegetation-Centric Alternative Design	$8,160,000	$1,910,000	$6,250,000	Recommended	Consider Implementation	Meet with stakeholders at 50% plan review and discuss let it grow. Stakeholder input may drive some of the discussion.
P7	Lighter Touch: Reduce or Eliminate Structural Elements and Earthwork	$8,160,000	$2,940,000	$5,220,000	Recommended	Consider Implementation	Meet with stakeholders at 50% plan review and discuss lighter touch approach, need to minimize impact to river. Stakeholder input may drive some of the discussion.
P8A	Look for win-win opportunities with Boulder to justify using quarry for materials and staging area	$800,000	$0	$800,000	Recommended	Re-open Conversation	Suggest setting up meeting after review and digesting Boulder County Concerns to come up with benefit map, risk and concern mitigation based on Boulder County feedback.
P9	Appropriating work in specific phases to save on indirect/CE rates, schedule, efficiency	$3,270,000	$1,570,000	$1,700,000	Recommended	Needs Further Study	CDOT to look into how this would be done, given flood projects are already direct to project. Who would the money go to? How does CDOT hold control?
P10	Direct to project to reflect reduced project resources based on efficient oversight	$6,630,000	$4,770,000	$1,860,000	Recommended	Rejected	Suggest removing from VE. CE rate is already direct to project since flood.
	Maximum Potential Construction Cost Avoidance			**$23,832,000**			
	Maximum Potential Program Cost Avoidance			**$29,885000**			

Exhibit 7.1: Summary of the proposals for Highway 7 (Lower)

8 PRESENTATION PHASE

8. 1 Introduction

Prepare to convince decision makers to accept the study results:

How do we present our recommendations? What are the road blocks?

Presentation is client driven:

1. Common practice is an informal report on the last day of the workshop
2. A Power Point presentation improves the understanding of the VE Proposals

Among the rules that govern the Presentation Phase are the following:

- Do not assume that ideas are good
- Demonstrate their worth

8. 2 Presentation

The following presentation was made to the Project Team and other stakeholders on Monday, July 20, 2020 virtually. Those attending are listed in Appendix B.

1

RECOGNITION

- We express our thanks to all project partners.
  - James Zufall — CDOT
  - Brian Varrella — CDOT
  - Nate Mares — Kiewit
  - Harry Koenigs — Kiewit
  - Robin Stoneman — RS&H
  - Caroline Draper — RS&H

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2

VALUE ENGINEERING TEAM

Team Member	Company	Expertise
Chuck Bartlett	Benesch	Facilitator
Michael Cates	Kiewit	Design
Brian Dobling	FHWA	Area representative
Bill Epp	Benesch	Co-facilitator
Pete Garcia	FHWA	VE Coordinator
Abra Geissler	CDOT	I-25 Project Director
Steven Griffin	CDOT	Hydrology and hydraulics
Jess Hastings	Benesch	Construction
Katie Jagt	Watershed Science and Design	Stream Design
Nicole Oester	CDOT	Geo-hazard
Scott Rees	Rocksol	Construction
James Usher	CDOT	North Program Engineer
William White	Kiewit	Construction
Jim Zufall	Rocksol	Construction

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3

PRESENTATION OBJECTIVES

- Report VE Findings
- Provide details of the VE process and explain the reasoning behind our recommendations
- Improve the quality of our final report by collecting your initial impressions of the proposals
- No decisions have to be made today

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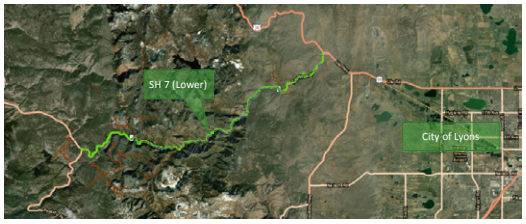
4

PROJECT OVERVIEW MAP



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5

VE WORKSHOP SCHEDULE

Wednesday (7/8)	Information Phase Function Analysis and Cost
Thursday (7/9)	Speculation Phase Evaluation Phase – Screening Development Phase
Friday (7/10)	Development Phase
Monday (7/20)	Presentation Phase

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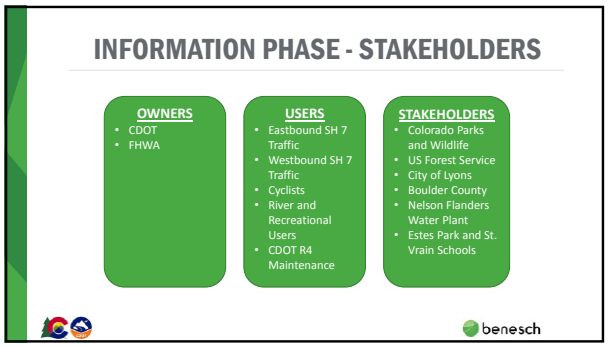
INFORMATION PHASE - STAKEHOLDERS
OWNERS
CDOT
FHWA
USERS
Eastbound SH 7 Traffic
Westbound SH 7 Traffic
Cyclists
River and Recreational Users
CDOT R4 Maintenance
STAKEHOLDERS
Colorado Parks and Wildlife
US Forest Service
City of Lyons
Boulder County
Nelson Flanders Water Plant
Estes Park and St. Vrain Schools
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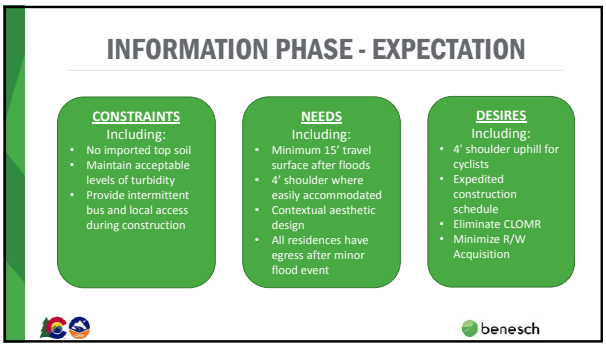
INFORMATION PHASE - EXPECTATION
CONSTRAINTS
Including:
No imported top soil
Maintain acceptable levels of turbidity
Provide intermittent bus and local access during construction
NEEDS
Including:
Minimum 15' travel surface after floods
4' shoulder where easily accommodated
Contextual aesthetic design
All residences have egress after minor flood event
DESIRES
Including:
4' shoulder uphill for cyclists
Expedited construction schedule
Eliminate CLOMR
Minimize R/W Acquisition
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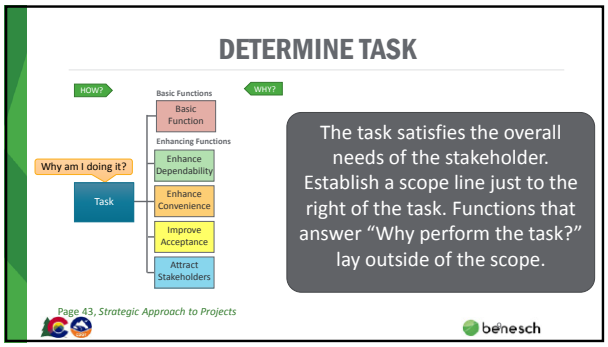
DETERMINE TASK
HOW?
WHY?
Basic Functions
Basic Function
Enhancing Functions
Enhance Dependability
Enhance Convenience
Improve Acceptance
Attract Stakeholders
Why am I doing it?
Task
The task satisfies the overall needs of the stakeholder. Establish a scope line just to the right of the task. Functions that answer "Why perform the task?" lay outside of the scope.
Page 43, Strategic Approach to Projects
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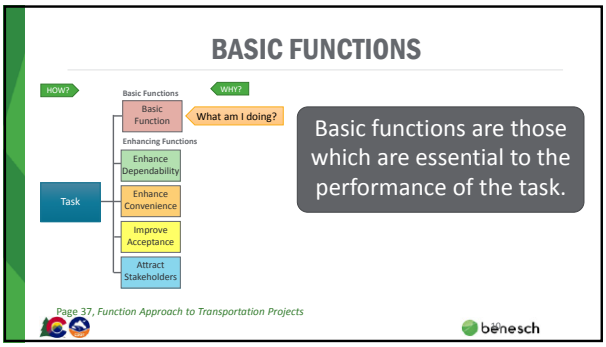
BASIC FUNCTIONS
HOW?
WHY?
Basic Functions
Basic Function
What am I doing?
Enhancing Functions
Enhance Dependability
Enhance Convenience
Improve Acceptance
Attract Stakeholders
Task
Basic functions are those which are essential to the performance of the task.
Page 37, Function Approach to Transportation Projects
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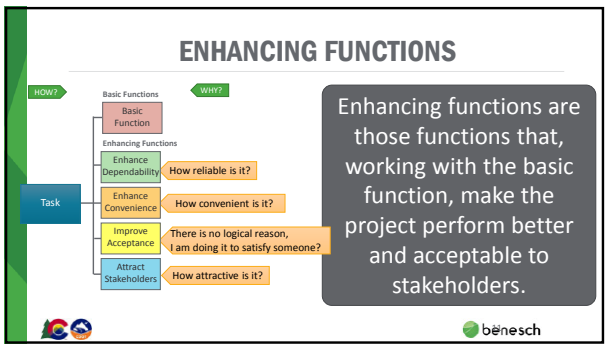
ENHANCING FUNCTIONS
HOW?
WHY?
Basic Functions
Basic Function
Enhancing Functions
Enhance Dependability
How reliable is it?
Enhance Convenience
How convenient is it?
Improve Acceptance
There is no logical reason, I am doing it to satisfy someone?
Attract Stakeholders
How attractive is it?
Task
Enhancing functions are those functions that, working with the basic function, make the project perform better and acceptable to stakeholders.
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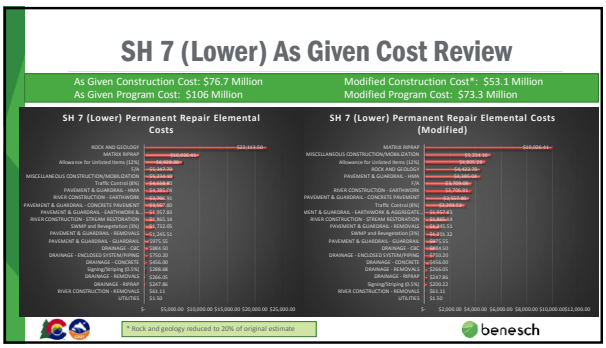
SH 7 (Lower) As Given Cost Review
As Given Construction Cost: $76.7 Million
As Given Program Cost: $106 Million
Modified Construction Cost*: $53.1 Million
Modified Program Cost: $73.3 Million
SH 7 (Lower) Permanent Repair Elemental Costs
SH 7 (Lower) Permanent Repair Elemental Costs (Modified)
* Rock and geology reduced to 20% of original estimate
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FUNCTION ANALYSIS

As Given Construction Cost:	$53.1 Million	Task: Improve Mobility
Classification	Allocated Costs	Percent of Project Cost
Basic Function (Reconstruct Pavement, Manage Runoff)	$13.3 Million	25.0%
Enhancing Functions		
Enhance Dependability (Increase Safety, Endure Storms)	$27.1 Million	51.0%
Enhance Convenience (Accommodate Snow, Convey Info)	$2.94 Million	5.5%
Improve Acceptance (Satisfy Regulators, Accommodate Rec)	$6.64 Million	12.5%
Attract Stakeholders (Improve Habitat, Maintain Aesthetics)	$3.47 Million	6.5%

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SPECULATION

133 IDEAS

Overlay without milling
Pinned mesh in place of drape mesh
Debris berms
Move river work to M phase
Close roadway for accelerated construction
Convert highway to a bicycle facility
Others....

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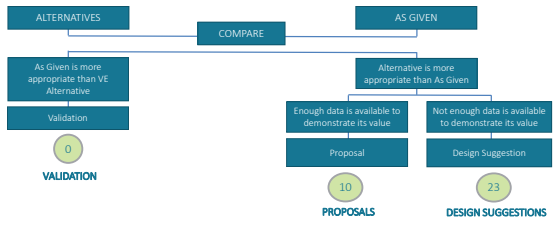
PROPOSAL DEVELOPMENT



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PROPOSAL P1

Mill 1" and 2" HMA Overlay

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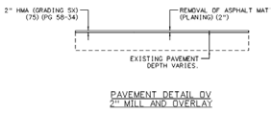
PROPOSAL P1 – EXISTING



PAVEMENT DETAIL OV 2" MILL AND OVERLAY

Current plans propose to mill 2" of the existing pavement and overlay with 2" of HMA in areas that are not being reconstructed full depth.

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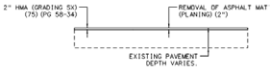
PROPOSAL P1 – AS GIVEN

Current plans propose to mill 2" of the existing pavement and overlay with 2" of HMA in areas that are not being reconstructed full depth.



PAVEMENT DETAIL OV 2" MILL AND OVERLAY

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PROPOSAL P1 AS GIVEN COSTS

Item	Quantity	Unit	Unit Cost	Total Cost
2" Mill	141,709	SY	$3.15	$446,385
Removal of Asphalt Mat [1]	2,834	SY	$10	$28,340
Uncl. Ex (CIP) [2]	944	CY	$30	$28,320
ABC (Cl. 6) (Patching) [2]	472	CY	$55	$25,960
HMA Patching [2]	623	TON	$160.00	$99,680
2" Overlay	15,588	TON	$120.00	$1,870,560
Line Item Subtotal				$2,499,245

[1] Assumes 10% of mill and overlay area could have thinner sections which may require full depth repair. For calculated associated costs, 20% of this potential area was carried as a risk amount for the as-given design.

[2] Assumes 12" of subgrade removed, 6" moisture treated recompacted, 6" of ABC

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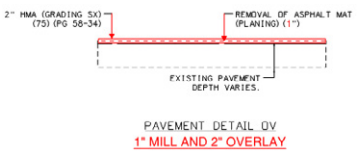
VE ALTERNATIVE P1 – MILL AND OVERLAY

Mill 1" of existing pavement and overlay with 2" of HMA.



PAVEMENT DETAIL OV
1" MILL AND 2" OVERLAY

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VE ALTERNATIVE P1 COST

Item	Quantity	Unit	Unit Cost	Total Cost
1" Mill [1]	141,709	SY	$3.15	$333,016
Removal of Asphalt Mat	2,834	SY	$10	$1,870,560
Line Item Subtotal				$2,203,576

[1] Assumes 25% unit price reduction due to decreased depth of milling and trucking

Note: Cost associated with increased risk of full-depth pavement reconstruction in potential thinner pavement sections has been removed

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PROPOSAL P1 COST EVALUATION

As Given Cost	$2,500,000
Proposal Cost	$2,200,000
Line Item Cost Avoidance	$300,000
Contingency and Unknowns (39%)	$117,000
Construction Cost Avoidance	$417,000

Note: Potential future cost reduction for increased pavement thickness (structural number) and associated maintenance was not included due to low ESAL's resulting in negligible impact

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PROPOSAL P1 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Maintains existing roadway profile for roadside tie-in (driveways/shoulders/etc.) • Generates more RAP for incorporation into project	• Slightly longer activity duration • Increased trucking/cost for milling • Higher risk for full depth repairs in thinner pavement sections • Higher risk for delaminating in locations with existing chip seal or thicker wearing surface (approx. 2.5") • Requires additional funds to be carried in Risk Register • Requires tapered edge if traffic placed on 2" milled roadway at centerline

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PROPOSAL P1 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
VE Alternative	• Facilitates meeting smoothness • Slight decrease of milling duration and related trucking/cost • Eliminates need for tapered edge to place traffic on partially milled road • Reduces risk of full depth repairs in thinner existing pavement sections • Reduced risk of delamination after milling prior to paving • Reduces amount carried in Risk Register for full depth repairs or delamination • Slight decrease in Life Cycle cost due to increased overall pavement thickness	• Only conducive in locations where guardrail and shoulders are being re-done • Increases shouldering fill required to match higher grade • Does not remove entire wearing surface or deeper ruts (if present)

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RECOMMENDATION

VE Team recommends the 1" Mill and 2" Overlay be adopted in lieu of the proposed 2" Mill and Overlay.

The proposal offers better value through Performance (P), Acceptance (A) and Cost (C):

1. Reduces risk during construction (C)
2. Allows for traffic without tapered edge (A)
3. Shorter construction duration (A)
4. Increased Life Cycle (P)
5. Cost Reduction is $417,000 (C)

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PROPOSAL P2

Eliminate Concrete Sections

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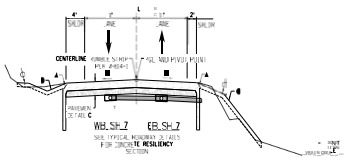
PROPOSAL P2 – AS GIVEN

Roadway:
- 8" PCCP
- 6" ABC Class 6



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PROPOSAL P2 – AS GIVEN COST

Item	Quantity	Unit	Unit Cost	Total Cost
PCCP	17,789	SY	$200.00	$3,557,800
ABC CL6	2,281	CY	$55.00	$125,455
Rem Asphalt MAT	11733	SY	$10.00	$117,330
Excavation	2281	CY	$30.00	$68,430
Line Item Subtotal				$3,869,015

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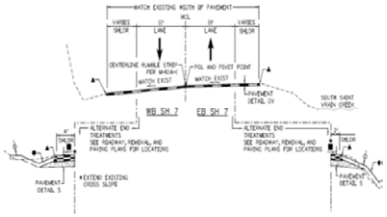
VE ALTERNATIVE P2 – MILL AND OVERLAY

Roadway:
- 2" Mill and Overlay
- Shoulder Widening



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VE ALTERNATIVE P2 COSTS

Item	Quantity	Unit	Unit Cost	Total Cost
HMA	1,519	Ton	$120.00	$182,280
HMA Patching	651	Ton	$160.00	$104,160
ABC CL6	488	CY	$55.00	$26,840
Rem Asphalt Mat (Planing)	11,733	SY	$3.15	$36,959
Excavation	488	CY	$30.00	$14,640
Slope and ditch Paving	200	CY	$400.00	$80,000
Line Item Subtotal				$444,879

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PROPOSAL P2 COST EVALUATION

As Given Cost	$3,870,000
Proposal Cost	$445,000
Line Item Cost Avoidance	$3,425,000
Contingency & Unknowns (39%)	$1,340,000
Construction Cost Avoidance	$4,765,000

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PROPOSAL P2 EVALUATION

Alternatives	Advantages	Limitations
As Given	• Potentially more resilient to river damage	• Much more difficult to construct • Much more difficult to maintain • More difficult to plow • Poor smoothness. Multiple joints could create dynamic loading of pavement. • Multiple section changes result in a poor public perception.
VE Alternative	• Easier and faster to construct • Easier to maintain • Better smoothness • Easier to plow • Equal cross drainage protection at significant costs savings	• Potentially less resilient to river damage

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P2 RECOMMENDATION

VE Team recommends the Mill and Overlay be adopted and for the elimination of Concrete Paving Sections. The proposal offers better value with comparable performance

1. Cost Reduction is $4.8 million

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PROPOSAL P3

Incorporate Recycled Asphalt Pavement

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PROPOSAL P3 – AS GIVEN

The plans require ABC Class 6 under all reconstruction sections including locations with shoulder widening. It was not noted in the plans where RAP was allowed in the ABC Class 6 although it is typical that Region 4 is reluctant to allow its use. Removal of HMA (Planing) is currently planned at approximately 7,872 CY of millings. In addition, Removal of HMA is currently planned at approximately 7,889 CY. This results in a total of 15,761 potential cubic yards of RAP available for use in ABC CL 6.

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VE ALTERNATIVE P3 – RAP in ABC CL 6

The proposal requires that RAP would be used in the ABC CL 6. This eliminates the need to haul the material off the project and results in environmental benefits as well. It is anticipated that the material would either be hauled to the quarry and mixed with appropriate proportions of virgin aggregate or would be processed at one of several locations within the project limits at smaller staging areas. It is anticipated that savings would be generated based on reduced hauling of the millings, however, it is not possible to quantify those savings due to variables in potential haul destinations. There would be additional benefits to locals as well with reduced trucks on the road.

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PROPOSAL P3 COSTS

Item	Unit	Quantity	Price	Subtotal
ABC CL6	CY	12391	$ 55.00	$ 681,505.00
ABC CL6 (Special) (RAP)	CY	12391	$ 55.00	$ 681,505.00
			Total	$ -

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PROPOSAL P3 COST EVALUATION

As Given Cost (With 39% Cont.)	$948,000
Proposal Cost (With 39% Cont.)	$948,000
Line Item Cost Avoidance	$0
Construction Cost Avoidance	$0

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PROPOSAL P3 EVALUATION

Alternatives	Advantages	Limitations
As Given	• None	• Requires hauling in of material • More truck traffic outside of project • No environmental benefit
VE Alternative	• Less truck traffic outside of the project limits • Environmental benefit • Potential cost savings	• None

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P3 RECOMMENDATION

VE Team recommends the RAP proposal be adopted. The proposal offers equal value, equal performance and environmental benefits.

Cost Reduction is $0.

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PROPOSAL P4

MOT Sequencing Changes

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PROPOSAL P4 – AS Given

Use CDOT Region 4 Lane Closure Strategy

- Fall/Winter – Nov., Dec., Jan., Feb., Mar
- Spring/Summer – Apr., May., June, July, Aug., Sept., Oct.
- 1 mile daytime closures are allowed in the Spring/Summer with up to 3 miles in the Fall/Winter.
- Base strategy is working within 1-mile lane closures for both.

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PROPOSAL P4 – AS GIVEN Schedule & Cost

Traffic Control
- 13 Miles
- 2 Years Construction
- $4.6 Million
- CO 7 – ADT 2020

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VE Alternative P4A – Use of Full Closure Windows

- Similar to US 36 Construction
- Known closure periods to balance construction work and use of the canyon by the public
- Open - 6:00 AM to 9:00 AM & 4:00 PM to 7:00 PM
- Closed - 9:00 AM to 4:00 PM & 7:00 PM to 6:00 AM

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VE ALTERNATIVE P4A - Cost

Option	MOT Phasing	Cost
4A	Full Closure Windows	$ 3,464,117

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VE Alternative P4B –Full Closure with Local Access

- Similar to US 34 Construction
- Full Closure of CO 7 for Construction Season (March to October)
- Only allow local traffic and EMS through work zone

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VE ALTERNATIVE P4B - Cost

Option	MOT Phasing	Cost
4B	Full Road Closure	$ 2,886,764

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PROPOSAL P4 COST EVALUATION

As Given Cost	$4,620,000
Proposal P4A Cost	$3,460,000
Line Item Cost Avoidance	$1,160,000

As Given Cost	$4,620,000
Proposal P4B Cost	$2,890,000
Line Item Cost Avoidance	$1,730,000

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PROPOSAL P4 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Familiarity to CDOT Staff • Familiarity to Traveling Public	• Longest construction duration • Increased public fatigue • Highest Cost • Allows for more potential conflicts between users and the construction
VE Alternative P4A	• Allows for expedited work • Reduces Project Cost • Known Closure times to Residents and CO 7 Users	• Impacts to commuting and travel in the area • Requires extra PI / Communication • Requires passable surface throughout construction and related costs • Requires coordination with EMS services • Inconsistent Work Flow (for Contractor and Users) • User (Vehicles and Cyclist) may be caught just before a closure period
VE Alternative P4B	• Allows for expedited work • Reduces Project Cost • Safest MOT – Significantly eliminates conflicts between users and Construction	• Impacts to travelling public • Peak Construction season coincides with peak RMNP Visits • Disruption to EMS services, requiring close coordination

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RECOMMENDATION

VE Team recommends the Alternative P4B full closure of the Highway

The proposal offers better value through Performance (P), Acceptance (A) and Cost (C):

1. High sustainability and increased quality (P)
2. Shorter construction (A)
3. Cost Reduction is $1.7 million (C)

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PROPOSAL P5

Utilize CTS and Eliminate Matrix Rip Rap

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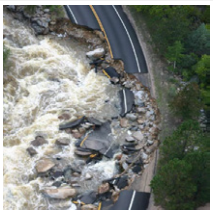
PROPOSAL P5 – EXISTING



Full Roadway Washout at MP 23.8

Existing Aerial (September 2019 Google Earth)

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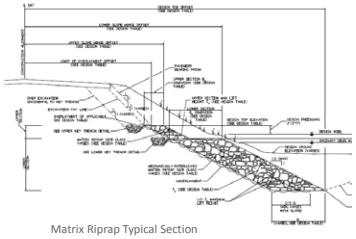
PROPOSAL P5 – AS GIVEN



Matrix Riprap Typical Section

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PROPOSAL P5 AS GIVEN COSTS

Item	Quantity	Unit	Unit Cost	Total Cost
Unclassified Excavation	50,814	CY	$85.00	$4,319,000
Dewatering	1	LS	$1,000,000.00	$1,000,000
Matrix Riprap (12in)	1,802	CY	$243.00	$438,000
Matrix Riprap (18in)	13,594	CY	$245.00	$3,331,000
Topsoil	3,486	SY	$50.00	$174,000
Temporary Diversion	2,780	LF	$275.00	$765,000
Line Item Subtotal				$10,027,000

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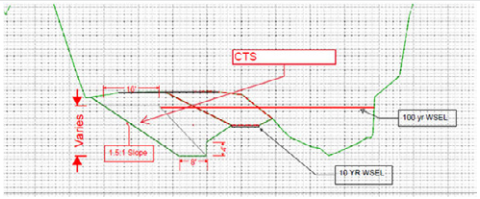
VE ALTERNATIVE P5 – CTS



CTS Typical Section

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VE ALTERNATIVE P5 COST

Item	Quantity	Unit	Unit Cost	Total Cost
Unclassified Excavation	66,370	CY	$23.00	$1,526,000
Dewatering	1	LS	$700,000	$700,000
Place CTB (10% waste)	29,165	SY	$26.00	$758,000
Embank Roadway	44,284	CY	$22.90	$1,014,000
Permanent Materials	29,165	CY	$45.26	$1,320,000
HMA	1,242	TN	$90.00	$112,000
Misc. Items				$47,000
Construction Subtotal				**$5,477,000**

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PROPOSAL P5 COST EVALUATION

As Given Cost	$10,000,000
Proposal Cost	$5,480,000
Line Item Cost Avoidance	$4,520,000
Contingency & Unknown (39%)	$1,760,000
Construction Cost Avoidance	$6,280,000

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PROPOSAL P5 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Protect entire roadway in case of 100yr event • Restore roadway faster after 100yr flood • Tested and established slope protection treatment	• Limits revegetation options planted within matrix prism • Additional impact to the river and riparian habitat that is beginning to recovery well on its own after the flood • Difficult/tedious construction process • Added dewatering/ filtering/ monitoring efforts during construction • Long haul for riprap

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PROPOSAL P5 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
VE Alternative	• Limits disturbance in riparian areas • Less dewatering / filtering / monitoring required • Allows for emergency ingress/egress • Could run live traffic over cement section within an hour • Allows room for construction bypass • Faster production rates • Readily available material • More conducive for winter construction than as-given	• Entire roadway not protected and would still need to be rebuilt after 100yr flood • Large excavation • Quantity uncertainty

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RECOMMENDATION

VE Team recommends replacing matrix riprap sections with the current CTS alternative that the CM/GC team is analyzing . The proposal offers better value through Acceptance (A) and Cost (C):

1. Less Riparian/River Disturbance(A/C)
2. Provides Emergency ingress/egress(A)
3. Shorter construction (C)
4. Cost Reduction is $6.28 million (C)

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PROPOSAL P6

Let it Grow: Vegetation-Centric Alternative Stream Design

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PROPOSAL P6 – EXISTING

MP 29.8

MP 29.2

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PROPOSAL P6 – AS GIVEN

- Major grading throughout the corridor
- Removal of mature trees, and
- Removal of established and existing riparian vegetation
- Full channel and streambank grading

MP 29.8

MP 24.7

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PROPOSAL P6 AS GIVEN COSTS

Item	Quantity	Unit	Unit Cost	Total Cost
Unclassified Ex. (Channel Grading)	16,061	CY	$100.00	$1,606,100
Unclassified Ex. (Channel Features)	2210	CY	$100.00	$221,000
Unclassified Ex. (Floodplain Ex.)	20,416	CY	$85.00	$1,735,360
In-Channel Boulder Feature (Riffles)	54	Ea	$13,160.00	$710,640
In-Channel Boulder Feature (Steps)	37	Ea	$4,000.00	$148,000
In-Channel Boulder Feature (Cascade)	16	Ea	$233.00	$3,728
In-Channel Boulder Feature (Habitat)	21	Ea	$9,160.00	$192,360
Rock Ex.	1926	CY	$75.00	$144,450
Void Filled Riprap	1,007	CY	$195.00	$196,365
Removal of Tree	126	Ea	$485.00	$61,110
Large Woody Material	129	Ea	$1,665.00	$214,785
Riprap for Nuisance Protection	3002	CY	$133.00	$399,266
Line Item Subtotal				$5,633,164

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VE ALTERNATIVE P6 – Vegetation Centric Design

This is a recommendation for the foundation of the stream design to shift toward using vegetation to drive geomorphic responses that will naturally build the channel, floodplain, in-stream habitat, and induce vegetation succession. This proposal is also includes a recommendation for bioengineering for bank stability, where necessary.

- Strategic installation of vegetation (container plants and live stakes)
- Minimal or very specific earthwork only
- Preservation of established and existing riparian vegetation

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VE ALTERNATIVE P6 COST

Item	Quantity	Unit	Unit Cost	Total Cost
Container Plantings	25,000	Ea	$10.00	$250,000
Willow Cuttings (48")	12,000	Ea	$8.00	$96,000
Cottonwood Cuttings (60')	1,000	Ea	$15.00	$15,000
Soil Conditioning	20	AC	$9,500.00	$190,000
Irrigation of Containers	25,000	Ea	$15.00	$375,000
Seeding (Riparian & Transitional	15	AC	$2,500.00	$37,500
Mulching	15	AC	$2,500.00	$37,500
Bioengineering	5,000	LF	$75.00	$375,000
Line Item Subtotal				$1,376,000

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PROPOSAL P6 COST EVALUATION

As Given Cost	$5,630,000
Proposal Cost	$1,380,000
Line Item Cost Avoidance	$4,250,000
Contingency & Unknown (39%)	$1,660,000
Construction Cost Avoidance	$5,910,000

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PROPOSAL P6 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Contractor and owner are familiar with past designs that look similar and are similar to construct.	• Complex permitting. • Disturbs or destroys existing in stream habitat. • Relies on an uncertain rock supply. • Necessitates a specific construction season.
VE Alternative	• Reduced permitting requirements (no CLOMR, no 404 wetland impacts). • More contextually sensitive given the current state of the stream. • Does not negatively impact the habitat and stream function that already exists. • Restores function to the stream corridor which will support resilience in the form of the channel (that is if the channel blows out, the stream has the tools to repair itself).	• More difficult for contractors, owners, designers and stakeholders to understand. • Relies on an uncertain plant supply. • Necessitates a specific construction season.

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RECOMMENDATION

Implement this approach to the greatest extent practicable, especially in locations where construction disturbance will negatively impact existing, quality habitat.

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PROPOSAL P7

Light Touch: Reduce or Eliminate Structural Elements and Earthwork

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PROPOSAL P7 – EXISTING

MP 29.8

MP 29.2

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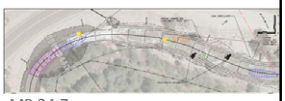
PROPOSAL P7 – AS GIVEN

- Major grading throughout the corridor
- Removal of mature trees, and
- Removal of established and existing riparian vegetation
- Full channel and streambank grading

MP 29.8



MP 24.7

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PROPOSAL P7 AS GIVEN COSTS

Item	Quantity	Unit	Unit Cost	Total Cost
Unclassified Ex. (Channel Grading)	16061	CY	$100.00	$1,606,100
Unclassified Ex. (Channel Features)	2210	CY	$100.00	$221,000
Unclassified Ex. (Floodplain Ex.)	20416	CY	$85.00	$1,735,360
In-Channel Boulder Feature (Riffles)	54	Ea	$13,160.00	$710,640
In-Channel Boulder Feature (Steps)	37	Ea	$4,000.00	$148,000
In-Channel Boulder Feature (Cascade)	16	Ea	$233.00	$3,728
In-Channel Boulder Feature (Habitat)	21	Ea	$9,160.00	$192,360
Rock Ex.	1926	CY	$75.00	$144,450
Void Filled Riprap	1007	CY	$195.00	$196,365
Removal of Tree	126	Ea	$485.00	$61,110
Large Woody Material	129	Ea	$1,665.00	$214,785
Riprap for Nuisance Protection	3002	CY	$133.00	$399,266
Line Item Subtotal				$5,633,164

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VE ALTERNATIVE P7 – Light Touch

The intention of this proposal is to avoid intensive construction that disturbs the entirety of the creek corridor and to focus efforts in locations where work will result in uplift rather than degradation.

- Strategic earthwork and in-stream structures
- Preservation of established and existing riparian vegetation.
- Preservation of existing habitat
- Surgical habitat enhancements rather than blanket regrading and shaping

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VE ALTERNATIVE P7 COST

Item	Quantity	Unit	Unit Cost	Total Cost
Unclassified Ex. (Channel Grading)	5000	CY	$100.00	$500,000
Unclassified Ex. (Channel Features)	2210	CY	$100.00	$221,000
Unclassified Ex. (Floodplain Ex.)	500	CY	$85.00	$42,500
In-Channel Boulder Feature (Riffles)	12	Ea	$13,160.00	$157,920
In-Channel Boulder Feature (Steps)	10	Ea	$4,000.00	$40,000
In-Channel Boulder Feature (Cascade)	0	Ea	$233.00	$0
In-Channel Boulder Feature (Habitat)	21	Ea	$9,160.00	$192,360
Rock Ex.	1926	CY	$75.00	$144,450
Void Filled Riprap	0	CY	$195.00	$0
Removal of Tree	5	Ea	$485.00	$2,425
Large Woody Material	40	Ea	$1,665.00	$66,600
Bioengineering	10000	LF	$75.00	$750,000
Line Item Subtotal				$2,117,255

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PROPOSAL P7 COST EVALUATION

As Given Cost	$5,630,000
Proposal Cost	$2,120,000
Line Item Cost Avoidance	$3,510,000
Contingency & Unknowns (39%)	$1,370,000
Construction Cost Avoidance	$4,880,000

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PROPOSAL P7 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Contractor and owner are familiar with past designs that look similar and are similar to construct.	• Relies on an uncertain rock supply. • Necessitates a specific construction season
VE Alternative	• Potentially reduced permitting requirements (no CLOMR, no 404 wetland impacts) • More contextually sensitive given the current state of the stream • Does not negatively impact the habitat and stream function that already exists	• Necessitates a specific construction season • Relies on an uncertain rock supply

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RECOMMENDATION

Implement this approach in all the locations that require physical interventions (based on the results of the Current Conditions Assessment), and where Proposal 6 is not applicable.

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PROPOSAL P8

Look for win-win opportunities with Boulder to justify using quarry for materials and staging area

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PROPOSAL P8 – Existing and As Given

- **Existing Condition:**
  - Boulder County owns an old Aggregate Industries mine
  - Located two-miles west of Lyons and within project limits
  - Ideal for staging area
- **As Given:**
  - Discussions underway to use mine or private property have not proven successful
  - Crushing and hauling outside project limits and through Lyons

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VE Alternative P8

Use Quarry as Staging Area - Continue discussions with Boulder County to donate the land for staging use while shifting conversations to identify "win-win" solutions, which could be:

- More effective contractor operations and strong benefits of having less construction traffic through Lyons
- Invest staging cost savings to build more scope that Boulder County desires, such as 4' uphill shoulders
- Set up staging area with the future Boulder County Parks and Open Space in mind. For example, construction staging parking lots areas can be placed in areas that can easily be used in the future Open Space configuration and access road to staging area could be consistent with the future plans for the site
- Work with Boulder County Parks and Open Space about using recycled asphalt from the project on their trail system or trailhead parking spots

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VE Alternative P8

Mining Material

- Identify the constraints of using rock material for road base or rip rap from the quarry
- If reclamation is mandated as a condition of mining material, reclamation costs need to be determined to understand the cost/benefit of reclaiming the quarry and how much useful material can be mined
- During this process, maintain close collaboration with FHWA regarding eligible costs when developing an agreement with the County

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PROPOSAL P8 – COST SAVINGS

Cost savings for the proposed recommendations can be leveraged in two ways:

1. Operational savings in productivity and hauling by using the county quarry site instead of hauling in from outside of Lyons (that location is currently unknown). The Kiewit team has estimated ~$500,000 in value that could be realized should the contractor be able to crush and haul at the quarry site.
2. Cost savings by Boulder County donating the quarry site for staging, which is shown below:

Temp Easement/month	Acres	Months	Acres	Cost Savings
$0.045/ sq ft	43560 sq ft/ acre	14	5	$ 137,214.00
$0.045/ sq ft	43560 sq ft/ acre	20	5	$ 196,020.00

Boulder County would most likely require land restoration on the five acres of land once the project is complete, we've estimated about $25,000 cost for that activity to be deducted from the savings.

Item	First Cost		Maintenance & Operation Cost		VE Savings or Cost Avoidance (+) or Cost Added (-)
	As Designed	VE Proposal	As Designed	VE Proposal	
1	$500,000	$0	NA	NA	$500,000
2	$110,000-$175,000	$0	NA	NA	$110,000-$175,000

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VE P8 – Evaluation

Alternatives	Advantages	Limitations
As Given	• No IGA's needed with Boulder County	
VE Alternative	• Less truck traffic through Lyons and worksite • More efficient and effective operations • Put money into scope instead of staging area	• Permitting regulations • Land use stipulations • Mine reclamation efforts

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P8 RECOMMENDATION

VE Team recommends pursuing an agreement to allow temporary use of the quarry as a staging area and possible material mining. Conversations with Boulder County should shift by showing additional project scope that can be built with donation.

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PROPOSAL P9

Appropriating work in specific phases to save on indirect/CE rates, schedule, efficiency

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PROPOSAL P9 – EXISTING

- Construction Phase CE and Indirect rates is as follows (for total of 26%):

RATE CHANGES EFFECTIVE OCTOBER 01, 2019

INDIRECT RATE:

Project Indirect Rate 12.00%
(Participating 9.93%, Non-Participating 2.07% against All Costs).

CONSTRUCTION ENGINEERING (CE) POOL RATE:

CE Pool Rate 12.50%.

CE AND INDIRECT RATE ON PROJECT FINANCIAL STATEMENTS:

The calculations used for CE and Bid Item Indirect Costs for Project Financial Statements beginning 10/01/19 is:

CE	12.50%
PARTICIPATING INDIRECTS ON CE	1.24%
PARTICIPATING INDIRECTS ON BID ITEMS	9.93%
TOTAL PARTICIPATING CE & INDIRECT	23.68%
NONPART INDIRECT ON CE	0.28%
NONPART INDIRECTS ON BID ITEMS	2.07%
TOTAL NON PARTICIPATING CE & INDIRECT	2.32%
TOTAL ALL CE AND INDIRECTS	26.00%

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PROPOSAL P9 – AS GIVEN

As Given Cost ($106M Program Cost):

- River work has a construction cost of $8.9M, so using a 26% CE/Indirect rate in the construction phase, adds $2.31M to the project cost
- Geo-hazard work in the $106M package accounted for $29,221,885 in costs, so using a 26% CE/indirect rate in the construction phase, adds $7.6M to the project cost

Re-baseline As-Given Cost ($55-70M Program Cost):

- River work is same as above cost
- Geo-hazard was re-baselined from $29.2M to $4.4M construction costs, so using a 26% CE/indirect rate in the construction phase, adds $1.15M to the project cost

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VE P9 – Proposal

Shift specific river work and rock scaling scope elements into the miscellaneous phase that will have a lower indirect percentage of 12%.

An IGA can be created between CDOT and an appropriate water district or geo-hazard unit, benefits include:

- Districts/agencies have more experience managing this type of work than a roadway general contractor
- Useful for long-term monitoring and closing out the construction phase while still leaving appropriate work open

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PROPOSAL P9 COSTS

GEOHAZARD	Rockfall ($76.6M)	CE/Indirect ($76.6M)	Rockfall ($53M)	CE/Indirect ($53M)
As Given (C Phase 26% CE Indirect)	$ 29,221,885	$ 7,597,690	$ 4,422,700	$ 1,149,902
VE Proposal (M Phase 12%)	$ 29,221,885	$ 3,506,626	$ 4,422,700	$ 530,724
Savings Difference		$ 4,091,064		$ 619,178

RIVER WORK	River Work	CE/Indirect
As Given (C Phase 26% CE Indirect)	$ 8,896,000	$ 2,312,960
VE Proposal (M Phase 12%)	$ 8,896,000	$ 1,067,520
Savings Difference		$ 1,245,440

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PROPOSAL P9 EVALUATION

Alternatives	Advantages	Limitations
As Given	• One contract to manage	• Monitoring work could hold up closing out construction project
VE Alternative	• Keep similar work elements under one contract • Set up long-term monitoring under more appropriate contracting method	• Multiple contracts and IGAs to manage • Multiple contractors working in one canyon

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P9 RECOMMENDATION

The VE Team recommends shifting the river work and geo-hazard work out of the C phase and into the M phase.

1. Cost Reduction is ~$1.87 million

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PROPOSAL P10

Direct to project to reflect reduced project resources based on efficient oversight

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PROPOSAL P10 – EXISTING

Traditionally, Construction Engineering pool rate is 12.5% that is applied to the construction contract and change orders.

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PROPOSAL P10 – AS GIVEN

- The SH 7 project is using the traditional construction engineering contracting methods that includes paying the 12.5% on construction contracts

As Given Cost ($106M Program Cost):

- The program summary sheet references a 12.5% CE number of $9.58M based on a $76.6M construction contract

Re-baseline As-Given Cost ($55-70M Program Cost):

- The re-baselined program summary sheet references a 12.5% CE number of $6.62M on a $53M construction contract

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VE P10 – Proposal

- Track direct to project costs for owner support including:
  - Construction engineering
  - Project management
  - Inspection
  - Testing
- Extended road closures are likely, could save resources on owner traffic inspection due to minimized traffic control inspection throughout the construction areas

***Note: US 34 canyon project – CE percentage was 10.8%
If the project were to have gone direct to project using a rate of 11%, instead of the CE pool rate of 12.5%, it would have equated to a $1.1M Savings

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PROPOSAL P10 COSTS

	Construction Cost	Construction Engineering Rate	Direct to Project	Savings
		12.50%	9% (Assumed Rate)	
As Given	$76,600,000	$9,580,000	$6,890,000	$ 2,680,000
Re-baselined As Given	$53,000,000	$6,625,000	$4,770,000	$ 1,855,000

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PROPOSAL P10 EVALUATION

ALTERNATIVE	ADVANTAGES	LIMITATIONS
As Given	• Contracting methods in place	• Using flood money to fund CDOT overhead, more appropriate to use emergency funds towards recovery project
VE Alternative	• Forces accountability of using tax payer money efficiently	• Approval needed by Chief Engineer

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P10 RECOMMENDATION

VE Team recommends using direct-to-project contracting method.

1. Cost Reduction is ~$1.86 million

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Achieving higher performance with a broad acceptance at a reasonable cost.

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Summary of Proposals

No.	Proposal	As Given	VE Proposal	Line Item Cost Avoidance	Construction Cost Avoidance	Recommendation
P1	Mill 1" and 2" Overlay	$2,500,000	$2,200,000	$300,000	$417,000	Recommended
P2	Eliminate Concrete Sections	$3,870,000	$445,000	$3,425,000	$4,760,750	Recommended
P3	Incorporate Recycled Asphalt Pavement	$948,000	$948,000	$0	$0	Recommended
P4A	Full Closure Window for MOT	$4,620,000	$3,460,000	$1,160,000	$1,612,400	Recommend P4B
P4B	Full Road Closure for MOT	$4,620,000	$2,890,000	$1,730,000	$2,404,700	
P5	Utilize CTS and Eliminate Matrix Rip Rap	$10,000,000	$5,480,000	$4,520,000	$6,282,800	Recommended
P6	Let it Grow: Vegetation-Centric Alternative Design	$5,630,000	$1,380,000	$4,250,000	$5,907,500	Recommended
P7	Lighter Touch: Reduce or Eliminate Structural Elements and Earthwork	$5,630,000	$2,120,000	$3,510,000	$4,878,900	Recommended
P8A	Look for win-win opportunities with Boulder to justify using quarry for materials and staging area	NA	NA	NA	$675,000	Recommended
P9	Appropriating work in specific phases to save on indirect/CE rates, schedule, efficiency	NA	NA	NA	1,245,000	Recommended
P10	Direct to project to reflect reduced project resources based on efficient oversight	NA	NA	NA	$1,855,000	Recommended
Maximum Cost Avoidance					**$23,542,000**	
Maximum Program Cost Avoidance*					**$29,500,000**	

* Does not include Design, Utilities, R/W, Previous Expenditures and Environmental Clearances

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PROPOSAL DECISION

Once the report has been submitted Proposals will be subject to:

- Accepted
- Rejected
- Needs Further Study
- Needs to be Resolved

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APPENDIX A

PRIMARY CONSTRUCTION ITEMS							
CODE	CONTRACT ITEM NO.	CONTRACT ITEM	UNIT	PROJECT TOTALS	UNIT PRICE	TOTAL COST	COMMENTS
MISC	201-00000	CLEARING AND GRUBBING	LS	1	$ 150,000.00	$ 150,000.00	
HYD	202-00001	REMOVAL OF STRUCTURE	EACH	2	$ 1,500.00	$ 3,000.00	
RIV	202-00010	REMOVAL OF TREE	EACH	126	$ 485.00	$ 61,110.00	Preliminary estimate, subject to change
HYD	202-00015	REMOVAL OF HEADWALL	EACH	53	$ 1,500.00	$ 79,500.00	
HYD	202-00035	REMOVAL OF PIPE	LF	7,310	$ 25.00	$ 182,750.00	
HYD	202-00037	REMOVAL OF END SECTION	EACH	4	$ 200.00	$ 800.00	
RDWY	202-00220	REMOVAL OF ASPHALT MAT	SY	71,005	$ 10.00	$ 710,050.00	
RDWY	202-00240	REMOVAL OF ASPHALT MAT (PLANING)	SY	141,709	$ 3.15	$ 446,383.35	
RDWY	202-01130	REMOVAL OF GUARDRAIL TYPE 3	LF	11,443	$ 4.50	$ 51,493.50	
RDWY	202-01170	REMOVAL OF GUARDRAIL TYPE 7	LF	856	$ 30.00	$ 25,680.00	
RDWY	202-01300	REMOVAL OF END ANCHORAGE	EACH	34	$ 350.00	$ 11,900.00	
RIV	203-00000	UNCLASSIFIED EXCAVATION	CY	20,416	$ 85.00	$ 1,735,360.00	Floodplain Excavation. Includes excavation
RIV	203-00000	UNCLASSIFIED EXCAVATION	CY	50,814	$ 85.00	$ 4,319,190.00	For Matrix Riprap
RDWY	203-00010	UNCLASSIFIED EXCAVATION (COMPLETE IN PLACE)	CY	37,807	$ 30.00	$ 1,134,210.00	for roadway
RIV	203-00015	UNCLASSIFIED EXCAVATION (CHANNEL GRADING)	CY	16,061	$ 100.00	$ 1,606,100.00	Channel Grading
RIV	203-00015	UNCLASSIFIED EXCAVATION (CHANNEL GRADING)	CY	2,210	$ 100.00	$ 221,000.00	In-Channel Feature Grading
RIV	203-00060	EMBANKMENT MATERIAL (COMPLETE IN PLACE)	CY	20,029		-	For Information Only - Floodplain Benching
RIV	203-00060	EMBANKMENT MATERIAL (COMPLETE IN PLACE)	CY	6,768		-	For Information Only - In-Channel Fill
RIV	203-00060	EMBANKMENT MATERIAL (COMPLETE IN PLACE)	CY	35,419		-	For Information Only - For Matrix Riprap
RDWY	203-00060	EMBANKMENT MATERIAL (COMPLETE IN PLACE)	CY	4,977		-	For Information Only - for roadway
RIV	203-00400	ROCK EXCAVATION	CY	1,926	$ 75.00	$ 144,450.00	Habitat Rock Harvesting. Subject to on-site
MISC	203-01100	PROOF ROLLING	HOUR	80	$ 110.00	$ 8,800.00	
MISC	203-01510	BACKHOE	HOUR	1,000	$ 225.00	$ 225,000.00	
MISC	203-01582	TRUCK (DUMP)	HOUR	1,000	$ 150.00	$ 150,000.00	
MISC	203-01594	COMBINATION LOADER	HOUR	2,000	$ 120.00	$ 240,000.00	
MISC	203-01597	POTHOLING	HOUR	80	$ 225.00	$ 18,000.00	
GEO	203-02300	ROCK SCALER	HOUR	2,380	$ 200.00	$ 476,000.00	
GEO	203-02315	MECHANIZED SCALING	HOUR	40	$ 150.00	$ 6,000.00	
MISC	203-02330	LABORER	HOUR	2,000	$ 70.00	$ 140,000.00	
HYD	206-00510	FILTER MATERIAL (CLASS A)	CY	432	$ 80.00	$ 34,560.00	
RDWY	207-00205	TOPSOIL	CY	9,474	$ 15.00	$ 142,110.00	
RIV	207-00205	TOPSOIL	CY	3,486	$ 50.00	$ 174,300.00	For Matrix Riprap
MISC	208-00020	SILT FENCE	LF	650	$ 2.00	$ 1,300.00	
RIV	208-00301	TEMPORARY DIVERSION	LF	2,780	$ 275.00	$ 764,500.00	For Matrix Riprap
GEO	211-01115	ROCK REINFORCEMENT (NUMBER 10)	LF	2,750	$ 100.00	$ 275,000.00	
RIV	211-03005	DEWATERING	LS	1	$ 1,000,000.00	$ 1,000,000.00	For Matrix Riprap
RIV	214-01032	LARGE WOODY MATERIAL	EACH	129	$ 1,665.00	$ 214,785.00	Subject to on-site availability
MISC	240-00000	WILDLIFE BIOLOGIST	HOUR	200	$ 80.00	$ 16,000.00	
MISC	250-00110	HEALTH AND SAFETY OFFICER	HOUR	500	$ 100.00	$ 50,000.00	
MISC	250-00120	MATERIAL SAMPLING AND DELIVERY	EACH	400	$ 150.00	$ 60,000.00	
RDWY	304-06007	AGGREGATE BASE COURSE (CLASS 6) (in the shoulder)	CY	3,765	$ 55.00	$ 207,075.00	
RDWY	304-06007	AGGREGATE BASE COURSE (CLASS 6) (in the patching)	CY	2,890	$ 55.00	$ 158,950.00	
RDWY	304-06007	AGGREGATE BASE COURSE (CLASS 6) (in the full depth)	CY	5,243	$ 55.00	$ 288,365.00	
RDWY	304-06007	AGGREGATE BASE COURSE (CLASS 6) (in the driveways)	CY	493	$ 55.00	$ 27,115.00	
RDWY	403-00720	HOT MIX ASPHALT (PATCHING) (ASPHALT)	TON	6,009	$ 160.00	$ 961,440.00	
RDWY	403-34721	HOT MIX ASPHALT (GRADING SX) (75) (PG 58-28)	TON	8,381	$ 95.00	$ 796,195.00	
RDWY	403-34731	HOT MIX ASPHALT (GRADING SX) (75) (PG 58-34)	TON	21,895	$ 120.00	$ 2,627,400.00	
RDWY	412-00801	CONCRETE PAVEMENT (8 INCH) (SPECIAL)	SY	17,789	$ 200.00	$ 3,557,800.00	
HYD	506-00212	RIPRAP (12 INCH)	CY	2,133	$ 100.00	$ 213,300.00	
RIV	506-00212	RIPRAP (12 INCH)	CY	3,002	$ 133.00	$ 399,266.00	Nuisance Protection
RIV	506-00600	IN-CHANNEL BOULDER FEATURE (RIFFLE)	EACH	54	$ 13,160.00	$ 710,640.00	
RIV	506-00601	IN-CHANNEL BOULDER FEATURE (STEP)	EACH	37	$ 4,000.00	$ 148,000.00	
RIV	506-00602	IN-CHANNEL BOULDER FEATURE (BOULDER CASCADE)	EACH	16	$ 233.00	$ 3,728.00	
RIV	506-00603	IN-CHANNEL BOULDER FEATURE (HABITAT BOULDER FIELD)	EACH	21	$ 9,160.00	$ 192,360.00	
RIV	506-00612	MATRIX RIPRAP (12 INCH)	CY	1,802	$ 243.00	$ 437,886.00	
RIV	506-00618	MATRIX RIPRAP (18 INCH)	CY	13,594	$ 245.00	$ 3,330,530.00	
RIV	506-00700	VOID-FILLED RIPRAP	CY	1,007	$ 195.00	$ 196,365.00	
HYD	601-01000	CONCRETE CLASS B	CY	304	$ 1,500.00	$ 456,000.00	
HYD	603-70603	6X3 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	90	$ 550.00	$ 49,500.00	
HYD	603-70604	6X4 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	60	$ 600.00	$ 36,000.00	
HYD	603-70606	6X6 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	80	$ 650.00	$ 52,000.00	
HYD	603-70703	7X3 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	80	$ 600.00	$ 48,000.00	
HYD	603-70704	7X4 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	60	$ 650.00	$ 39,000.00	
HYD	603-71204	12X4 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	240	$ 2,000.00	$ 480,000.00	
HYD	603-71210	12X10 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	60	$ 3,000.00	$ 180,000.00	
HYD	604-00505	INLET TYPE D (5 FOOT)	EACH	2	$ 7,800.00	$ 15,600.00	
UTIL	604-50200	MANHOLE RING AND COVER	EACH	3	$ 500.00	$ 1,500.00	Sanitary Rim for adjustments with
RDWY	606-00301	GUARDRAIL TYPE 3 (6-3 POST SPACING) (MGS)	LF	16,627	$ 50.00	$ 831,350.00	
RDWY	606-02003	END ANCHORAGE (NONFLARED)	EACH	28	$ 5,150.00	$ 144,200.00	
GEO	607-55050	MESH ANCHOR (SPECIAL)	EACH	143	$ 1,500.00	$ 214,500.00	
GEO	607-55102	CABLE NET (5/16 INCH)	SF	211,420	$ 100.00	$ 21,142,000.00	
MISC	620-00002	FIELD OFFICE (CLASS 2)	EACH	1	$ 50,000.00	$ 50,000.00	
MISC	620-00012	FIELD LABORATORY (CLASS 2)	EACH	1	$ 50,000.00	$ 50,000.00	
MISC	620-00020	SANITARY FACILITY	EACH	1	$ 25,000.00	$ 25,000.00	
HYD	624-29025	24 INCH DRAINAGE PIPE (CLASS 9) (COMPLETE IN PLACE)	LF	800	$ 180.00	$ 144,000.00	
HYD	624-29031	30 INCH DRAINAGE PIPE (CLASS 9) (COMPLETE IN PLACE)	LF	710	$ 200.00	$ 142,000.00	
HYD	624-29037	36 INCH DRAINAGE PIPE (CLASS 9) (COMPLETE IN PLACE)	LF	300	$ 150.00	$ 45,000.00	
HYD	624-29043	42 INCH DRAINAGE PIPE (CLASS 9) (COMPLETE IN PLACE)	LF	240	$ 350.00	$ 84,000.00	
HYD	624-29049	48 INCH DRAINAGE PIPE (CLASS 9) (COMPLETE IN PLACE)	LF	120	$ 380.00	$ 45,600.00	
HYD	624-29061	60 INCH DRAINAGE PIPE (CLASS 9) (COMPLETE IN PLACE)	LF	60	$ 420.00	$ 25,200.00	
HYD	624-49037	36 INCH EQUIVALENT DRAINAGE PIPE ELLIPTICAL (CLASS 9) (COMPLETE IN PLACE)	LF	180	$ 400.00	$ 72,000.00	
HYD	624-49043	42 INCH EQUIVALENT DRAINAGE PIPE ELLIPTICAL (CLASS 9) (COMPLETE IN PLACE)	LF	240	$ 420.00	$ 100,800.00	
HYD	624-49049	48 INCH EQUIVALENT DRAINAGE PIPE ELLIPTICAL (CLASS 9) (COMPLETE IN PLACE)	LF	80	$ 450.00	$ 36,000.00	
HYD	624-49055	54 INCH EQUIVALENT DRAINAGE PIPE ELLIPTICAL (CLASS 9) (COMPLETE IN PLACE)	LF	80	$ 500.00	$ 40,000.00	
MISC	625-00000	CONSTRUCTION SURVEYING	LS	1	$ 300,000.00	$ 300,000.00	
MISC	626-00000	MOBILIZATION	LS	1	$ 3,750,000.00	$ 3,750,000.00	5% of construction cost
				SUBTOTA		$ 57,735,000.00	

CONTINGENCY				
ITEM NO.	ITEM	PERCENTAGE	COST	COMMENTS
	Allowance for Unlisted Items (12%)	12.00%	$ 6,928,236.00	
	Traffic Control (8%)	8.00%	$ 4,618,824.00	
	Signing/Striping (0.5%)	0.50%	$ 288,676.00	
	SWMP and Revegetation (3%)	3.00%	$ 1,732,059.00	
	SUBTOTAL CONTINGENCY ITEMS (B)		**$ 13,567,795.00**	
	SUBTOTAL CONSTRUCTION COST (A+B)		**$ 71,302,795.00**	

FORCE ACCOUNT				
ITEM NO.	ITEM	PERCENT	COST	COMMENTS
	F/A	7.50%	$ 5,347,709.63	
		SUBTOTA	**$ 5,347,709.63**	
		TOTAL	**$ 76,650,504.63**	

PROJECT					
ITEM NO.	ITEM	UNIT	QUANTITY	COST	COMMENTS
D PHASE	PROFESSIONAL CIVIL ENGINEERING - DESIGN	6,155,000	1.00	$ 6,155,000.00	
D PHASE	CDOT INDIRECTS (11% D PHASE)		11.00%	$ 677,050.00	
D PHASE	PREVIOUS EXPENDITURES			$ 2,900,000.00	
		DESIGN		**$ 9,732,050.00**	
U PHASE	UTILITIES	100,000	1.00	$ 100,000.00	
R PHASE	RIGHT OF WAY	100,000	1.00	$ 100,000.00	
U/R	CDOT INDIRECTS (ROW AND UTILITIES)		12.00%	$ 24,000.00	
		ROW		**$ 224,000.00**	
C PHASE	CONSTRUCTION ENGINEERING (12.5% of (A+B+C))		12.50%	$ 9,581,353.00	
C PHASE	CONSTRUCTION INDIRECTS (12% of (A+B+C))		12.00%	$ 9,198,099.00	
MISC	ENVIRONMENTAL CLEARANCES (ROD 2 & RE-EVALUATION)			$ 800,000.00	
		SUBTOTA		**$ 29,535,502.00**	
		TOTAL		**$106,186,325.00**	

APPENDIX B

ATTENDANCE LIST

The following is list of personnel who attended the SH 7 (Lower) kickoff meeting to the VE Team on July 8, 2020.

Heather Paddock
Keith Sheaffer
Brian Varrella
James Zufall
Monte Malik
Robin Stoneman
Anthony Alvarado
Kenneth Atkins
John Cater
Christopher Krumwiede
William DeRosset
Corey Engen
Brian Dobling
Caroline Draper
Ed Jones
Evan Phelps
Pete Garcia
Harry Koenigs
Heather Conrad
Jess Hastings
Jesse Barton
Jason Hagerty
Mark Gosselin
Laura Meyer
Nathan Mares
Philip Drazek
Jeff Simmons
Steve Griffin
Steven Humphrey
Mark Talvitie
David Unkefer
Abra Geissler
Chuck Bartlett
Brian Dobling
James Usher
Jim Zufall
Katie Jagt
Michael Cates
William White
Nicole Oester
William Epp
Hunter Sydnor
Steve Bignall
Scott Rees

The following is list of personnel who attended the final presentation on July 20, 2020.

Tess Ellender
Steve Bignall
Bill Epp
Chuck Bartlett
Will DeRosset
Devin Bunnell
Mark Gosselin
Heather Conrad
James Usher
Katie Jagt
Laura Meyer
Maisie Wingerter
Michael Cates
Monte Malik
Mark Talvitie
Nathan Mares
Pete Garcia
Philip Drazek
Scott Rees
Jeff Wulliman
Jess Hastings
James Zufall
Caroline Draper
Corey Engen
Anthony Alvarado
Brian Varrella
Robin Stoneman
Abra Geissler
Hunter Sydnor
Jesse Barton
Kaitlyn Fleming
Steve Griffin
Steven Humphrey
Jim Zufall
John Cater

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