Taylor Creek Restoration Sediment Management Strategy

Final Value Study Report

Seattle Public Utilities

February 2024

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Document history

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Project	**Taylor Creek Restoration Sediment Management Strategy**
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1. Executive Brief

1.1. General

Faithful+Gould, on behalf of CM Solutions, conducted a Value Study (VS) for Seattle Public Utilities (SPU) for the Taylor Creek Restoration Project in Seattle. The VS was focused on the project's erosion control and sediment management strategy and held June 13–16, 2023, in compliance with the Value Methodology standards and procedures supported by SAVE International.

The project is comprised of two areas: upper Taylor Creek, designated by the Taylor Creek Ravine Stabilization and Sediment Management plan set; and lower Taylor Creek designated by the Taylor Creek Restoration plan set. The VS focused primarily on the Taylor Creek Ravine Stabilization and Sediment Management aspect of the project in Dead Horse Canyon including stabilization of the Canyon and the impact of escaping sediment on the lower Taylor Creek Restoration Project. Based on the design team's 90% design submission, the lower Taylor Creek Restoration Project, which includes the culvert replacement at Rainier Ave S, has a total construction cost estimated at $10.6 M while the Ravine Stabilization and Sediment Management portion ranges from $2.8 M for hand placement of logs to $4.4 M for machine placement (excluding costs for materials and equipment delivery). Pareto Cost Models of the total construction cost for both modes of log placement are provided in Appendix A. A Function Analysis Systems Technique (FAST) Diagram of the current project design for both projects is presented in Appendix C to capture the overall context of project interrelationships.

The VS team consisted of the personnel from Anchor QEA, Kleischmidt Group, Robin Kirschbaum, Inc. and Faithful+Gould as shown in the table below.

Name	Discipline	Organization
Scot McClintock, PE, CVS	Certified Value Specialist/VS Team Lead	Faithful+Gould
John Prosser, VMA, LEED AP	Assistant VS Team Leader	Faithful+Gould
Tayler Lynch, EIT, CQA	Construction Cost Estimator	Faithful+Gould
John Small, PLA	Arborist/Ecologist/Wetlands/Fed Permits	Anchor QEA
Brianna Blaud, CFB	Fisheries Biologist	Anchor QEA
Mike Roberts, PE, CCM	Construction Engineer	Anchor QEA
Paul Devries, Ph.D., PE	Geomorphologist / Civil Engineer	Kleischmidt Group
Robin Kirschbaum, PE,LEED AP	Stormwater/GSI engineer	Robin Kirschbaum, Inc.

1.2. Project Background

Taylor Creek is located in southeast Seattle, discharges into Lake Washington, has east and west forks totaling approximately 2.7 miles in length, and drains a total watershed consisting of roughly 640 acres of residential and forested land. Runoff from the basin flows to the creek, which passes through a steep ravine in Lakeridge Park (also known as Dead Horse Canyon) before discharging to the lake. The Taylor Creek Restoration Project is being led by SPU to improve fish passage, restore fish habitat, replace and upgrade aging drainage infrastructure and restore more natural ecological processes in Taylor Creek.

The Taylor Creek Restoration Project includes the lower Taylor Creek Restoration as well as the Ravine Stabilization and Sediment Management/Dead Horse Canyon. Replacement of the Rainier Ave. culvert is among SPU's highest priority culverts for replacement. It is in poor condition, undersized for current and future flows and is fish passage barrier. The Taylor Creek delta and channel are restoration priorities in the region's salmon recovery plans to improve habitat for federally listed Chinook salmon and other salmonids. The overall project will stabilize the stream channel and surrounding habitat, manage sediment and restore fish passage to areas that are currently inaccessible to fish, but have historically been accessible to fish passage. The project is designed to accomplish the following specific goals, as captured in the FAST Diagram presented in Appendix C:

- Improve fish passage by removing barriers.
- Improve the stream channel and surrounding habitat.

- Replace the culvert under Rainier Avenue S with a fish-passable culvert.
- Address storm-related flooding.
- Construct corridor safety, roadway, and pedestrian improvements in the ROW.
- Improve management of sediment originating from Lakeridge Park to reduce deposition on the Lake Washington Delta.
- Provide public access to the new natural area north of Rainier Avenue S.
- Stabilize the channel bed and banks in Dead Horse Canyon and create storage volume to capture and retain sediment.
- Arrest channel degradation in Dead Horse Canyon and associated bank and hillside erosion by restoring a rough, complex, channel to diffuse stream power during storm events and by tightlining two stormwater outfalls.

The final four goals listed above are primarily the scope of the Ravine Stabilization and Sediment Management/Dead Horse Canyon portion of work. A scope change at 60% design removed a proposed engineered sediment facility downstream of the ravine, with addressing the potential for in-channel storage of sediment in Dead Horse Canyon as a more sustainable and cost effective way to reduce sediment transport and aggradation through the system. Following additional work to characterize the erosion and sediment issues in the canyon, a design was developed to stabilize the channel and banks within the ravine and build a series of large log structures to capture and store sediment closer to its source and delay transport to the lower channel and delta. Three options were proposed by SPU:

- Option 1 – Machine-placed Large Woody Materials (included a full-length temporary access road)
- Option 2 – Hand-placed Large Woody Materials
- Option 3 – Hybrid Machine- and Hand-placed Large Woody Materials

After consultation with SPR, community groups and with feedback from the Rainier Beach community groups, Option 1 with a temporary access road was removed from consideration, and SPU added the following two goals:

- Prioritize the forest ecosystem and climate resilience as much as possible.
- Create and support Community Partnerships.

The community requested a third-party review of the project, as well as an evaluation of potential new alternatives to address the erosion and sediment issues in the canyon. To meet these needs and to determine if additional ideas and/or options to meet the project goals may be potential solutions, this value study was commissioned.

1.3. Objectives of the Value Study

The objectives of the Value Study for the Taylor Creek Restoration Sediment Management Strategy included:

- To review the 90% design submissions and related documents with respect to cost-effectiveness, risk, function, schedule and ability to meet all the above stated project goals, focusing primarily on the Dead Horse Canyon body of work.
- To generate and develop creative ideas that can be used by SPU to modify existing options or create new options that better meet all the above stated project goals.
- To provide recommended Value Alternatives and Design Suggestions to increase project value through improved functionality and/or capital and/or life cycle cost avoidance while maintaining a quality project that meets stakeholder needs and overall project goals.

1.4. Value Target Areas

The Value Team targeted areas of the project where value could be increased by better performance, sustainability, resilience, and community acceptance; reduced risk and environmental impact; constructability; regulatory and agency acceptability; and/or economic viability while maintaining necessary functions, goals, and budget. The result was 53 creative ideas for the project across five value target areas shown in the table on the right. The abbreviations shown are used in the numbering of the creative ideas as presented in Appendix D.

Value Target Area	Abbreviation
Control Erosion in Canyon	CE
Increase Resilience	IR
Minimize Construction Impact	MC
Materials Delivery Logistics	MD
Retain Sediment in Canyon	RS

1.5. Summary of Results

The Value Target Areas listed above were generated from the project presentation, the site visit, and various Value Study tools early in the workshop. Pareto Cost Models of the total construction cost for both machine and hand placement of logs (Appendix A) showed the distribution of costs for those elements. A Function Analysis Systems Technique (FAST) Diagram (Appendix C) of the current project design for both projects captured the overall context of functional interrelationships between the efforts and gave each discipline on the Value Team an increased understanding of the complexity of both bodies of work prior to the Creative Phase of the workshop. Finally, several ideas came as potential mitigations for project risks identified by the Value Team in the Qualitative Risk Register presented in Appendix B. Key potential risks as well as two potential opportunities include:

- Community does not accept any of the options.
- SPU being blamed for a landslide that happens during or after project completion.
- 500 year storm or some other cataclysmic event occurs that overwhelms the project.
- Project does not solve the sedimentation issues if caused by other factors.
- Creation of insufficient sediment storage.
- Landslides or slope instability lead to delays in construction and site safety issues.
- Opportunity: Provide ways for community to observe the project as it proceeds
- Opportunity: Address water quality issues harmful to the fish species we are attracting to improve environmental benefit.

As indicated above, the Creative Phase generated 53 ideas. After the Evaluation Phase, those 53 ideas resulted in 6 Quantitative Value Alternatives (avoid cost), 5 Qualitative Value Alternatives (added value for cost), and 11 Design Suggestions. The results of this Value Study are presented in Section 2 of this report, Value Alternatives and Design Suggestions.

First, Section 2 presents a Summary of Alternatives and Design Suggestions spreadsheet. This summary has the Alternative Number, Alternative Title, Alternative Type, and cost implications as First Costs (Capital), Present Worth (of future costs) and Life Cycle Costs for each Value Alternative. A detailed write-up of every individual Value Alternative and Design Suggestion developed during the workshop follows the summary list with text, sketches, capital cost estimates, and life cycle analyses as appropriate. Savings are presented as a positive number so any cost numbers in parentheses are additional costs. Highlights of key Value Alternatives are presented below.

CE-03: Add stormwater flow control and treatment to minimize erosion and pollutant loading

Add flow control and treatment facilities in roadways upstream of outfalls to the canyon to reduce peak flow rates into the canyon, reduce erosion and landslide potential within the canyon, and remove pollutants known to be harmful to fish. Treatment includes seven (7) 4'x6' Filterras, treating approximately 7 acres of roadway runoff. Flow control includes one (1) underground detention pipe designed for peak flow control for up to 10 acres in the East Fork Taylor Creek basin, where peak flow control is most needed. For an estimated additional capital cost of $4,872,200, this value-added alternative will improve the ultimate quality and longevity of the new lower Taylor Creek habitat.

IR-01: Develop pump station and force main to allow abandonment of sewer in canyon

Construct a sanitary sewer lift station near the junction of the existing ductile iron pipe with a 10-inch HDPE force main conveying flow to a point of connection to the west, replacing the function of the existing HDPE sewer that would be abandoned in place. This value-added alternative will eliminate the risk of sewer failure, whether from landslide or other cause, and resulting pollution and impacts of an emergency repair on the canyon. The estimated additional capital cost is $1,462,500.

MC-02: Access along channel from downstream and upstream directions as appropriate

Perform the work from a primary access from the Holyoke Way crossing, working along the channel moving upstream, and potentially creating another access point from upstream moving downstream, in lieu of constructing an access road and using the existing trail. Eliminates the environmental impact of constructing a 12-foot wide access road into the canyon, reduces impacts to the existing trail, and reduces the overall construction footprint within the canyon. The resulting capital cost avoidance is estimated at $3,086,400.

MC-06: Assemble mechanical equipment in the canyon for use and disassemble to remove

Coupled with other concepts to reduce the overall construction impact on the canyon, e.g., avoiding the 12-foot wide access road, bring in modular equipment to aid in moving and setting logs, boulders, and other elements to stabilize the creek and retain sediments. The existing trail will still be used for access although the equipment will be smaller and less impactful. While the savings of the access road is somewhat offset by increased labor and time, the resulting capital cost avoidance is still estimated at $3,562,700.

MD-02: Use helicopter delivery for materials

Use a helicopter to deliver logs to various areas of the project site along Taylor Creek in lieu of constructing an access road and using the existing trail. Logs would be delivered and stored in strategic locations along the creek during the winter, when the tree canopy has less foliage, using the recently renovated baseball field of Lakeridge Playfield as a staging area. While requiring some restoration to the baseball field and relocation of residents from up to 4 homes during the 3 flight days, the environmental impact and cost of constructing a 12-foot wide access road into the canyon can be eliminated and impacts to the existing trail can be reduced. The resulting capital cost avoidance is estimated at $3,708,300.

RS-06: Use smaller structures initially and return in future years to increase placements where required

Instead of the large log structures of the current design, install smaller accumulations of logs distributed at more locations, in conjunction with boulder placement (RS-07), for a lighter touch approach that can be constructed with or without the use of a specialized piece of excavation equipment such as a spider excavator. After monitoring indicates sufficient raising (1'-2') of grade has occurred, return in 5-10 years and place additional logs as required to continue sediment retention. The additional logs would be stored on upper banks during the first construction effort. The initial capital cost avoidance is estimated at $1,689,900 while the life cycle cost savings, based on a second effort in year 10, is estimated at

$861,900. In addition to the above Value Alternatives, 4 of the 11 Design Suggestions also deserve highlighting.

MC-10: Separate contractors for civil work and stream restoration work

Develop separate bid packages for 1) all stream restoration efforts, upstream and downstream, requiring related expertise and 2) infrastructure components requiring heavy civil expertise. More contractors will be able to bid on portions of the project they are best equipped to perform and have the specific expertise and experience.

MD-01: Use identified hazard trees on site as a source for logs and rootwads

An arborist qualified in Tree Risk Assessment by the ISA would assess local trees to determine the consequence of failure, value as habitat in-situ, and value for stream restoration efforts. Trees posing an imminent threat to park user safety with high value as stream habitat would be topped and remaining snag removed for hazard mitigation. Hazard trees very near the trail would likely be removed with their rootwads intact. Transportation costs and related greenhouse gas emissions will be reduced and trail user safety improved.

MD-12: Use winches and hoists to assist with material delivery

In conjunction with Value Alternative MC-02, use high capacity winches with cable to move logs, boulders, etc. upstream from Holyoke Way crossing to placement locations. Overhead tripods or four-legged hoists can move materials past local in-channel obstructions. Can be done in incremental sections of channel moving upstream.

MD-22: Use logs spanning channel, built as you go, to move materials up the streambed

Construct a skid road of logs up the creek to winch logs up the ravine. Logs would be placed with a spider excavator from the bottom of the ravine up, perpendicular to the channel. These skid logs would be set six to ten feet apart, high enough above the channel to clear existing obstacles. Winches would then drag additional logs over the skid logs. Other material such as slash and gravel would be hauled on simple sleds. Once materials have been winched up the stream, the crib logs would be removed and hauled up as needed from the bottom up.

The collective cost impact of the Value Team recommended Value Alternatives is not presented in this report since the Value Alternatives were compared to a variety of original options, as opposed to a single base case design. As the project planning moves forward, Value Alternatives will be applied to compatible options as those options are modified or created. SPU implementation decisions, following review of this report and community consultation, will determine the ultimate selected option and cost implications.

All the VE Alternatives, as developed during the VS Workshop, are included in Section 2 following the Summary of Alternatives and Design Suggestions spreadsheet. The VS Team also developed all 11 Design Suggestions for which cost implications could not be determined.

1.6. Alternatives Accepted by SPU

The ideas developed in the value study workshop addressed an element of each value target area identified for the project: Control Erosion in the Canyon, Increase Resilience, Minimize Construction Impact, Materials Delivery Logistics, and Retain Sediment in the Canyon.

Following the value study workshop, the project team's task was to seek feedback from stakeholder groups on the ideas that were generated, and to combine different ideas into three new Sediment Management Strategy Options.

These three new Sediment Management Strategy Options and two additional previously identified Sediment Management Strategy Options from an earlier effort in 2020–2021 (Taylor Creek Restoration: Sediment Management Options Evaluation Memo, 2022), for a total of five Sediment Strategy Options, have been identified for further engineering review and evaluation, to compare and decide which option would best address the project goals. (*Note – previously identified Sediment Management Strategy Options were Option 2, Hand Placed Large Woody Material and Option 3, Hybrid Hand and Machine-Placed Large Woody Material. These options have already undergone an engineering review*.)

Critical to the process of determining the ideas to be used to create the three new Sediment Management Strategy Options was stakeholder input from Seattle Parks and Recreation (SPR), Friends of Dead Horse Canyon (FODHC), and the wider community. SPU considered several options for sharing out value study workshop generated ideas to assist with Sediment Management Strategy Option development with these groups.

The project team created a summary table (Appendix F) of the ideas used to create the three new Sediment Management Strategy Options and solicited stakeholder review and input.

The table below summarizes the engagement with each stakeholder group:

Date	Stakeholder(s)	Event	Topic
7/20/2023	FODHC, SPR, VS Team	Post-Value Study meeting	Review and discuss idea details
8/15/2023	Community members	Ideas Evaluation community meeting	Share out ideas with the community
8/17/2023	Community members	Ideas Evaluation community meeting	Share out ideas with the community
8/18/23	FODHC	--	Scoring Received
9/7/2023	SPU	Ideas Evaluation meeting	Review and discuss idea details, provide scoring
9/11/23	SPR	--	Scoring Received
9/12/2023	SPU	Ideas Evaluation meeting	Review and discuss idea details, provide scoring
9/14/23	Community	--	Scoring tallied
9/19/2023	SPU Design Team	Alternatives Evaluation	Review and discuss draft option pairing
10/4/2023	SPR	Review of Alternative Options	Review and discuss draft option pairing

Information about each idea was presented to the stakeholder groups. Each group was then asked to provide feedback on each idea, stating whether it was an Excellent idea (value of 5), a Good/Neutral idea (value of 3), or a Poor idea (value of 1). The ideas which scored higher would then be a reflection of the stake holder group’s preferences for the work.

Several ideas were screened out by SPU prior to community and stakeholder input. One of these ideas, MC-05 was screened out because SPU decided to implement the idea of removing any structures planned for private properties in the east fork, and therefore wouldn’t require community input.

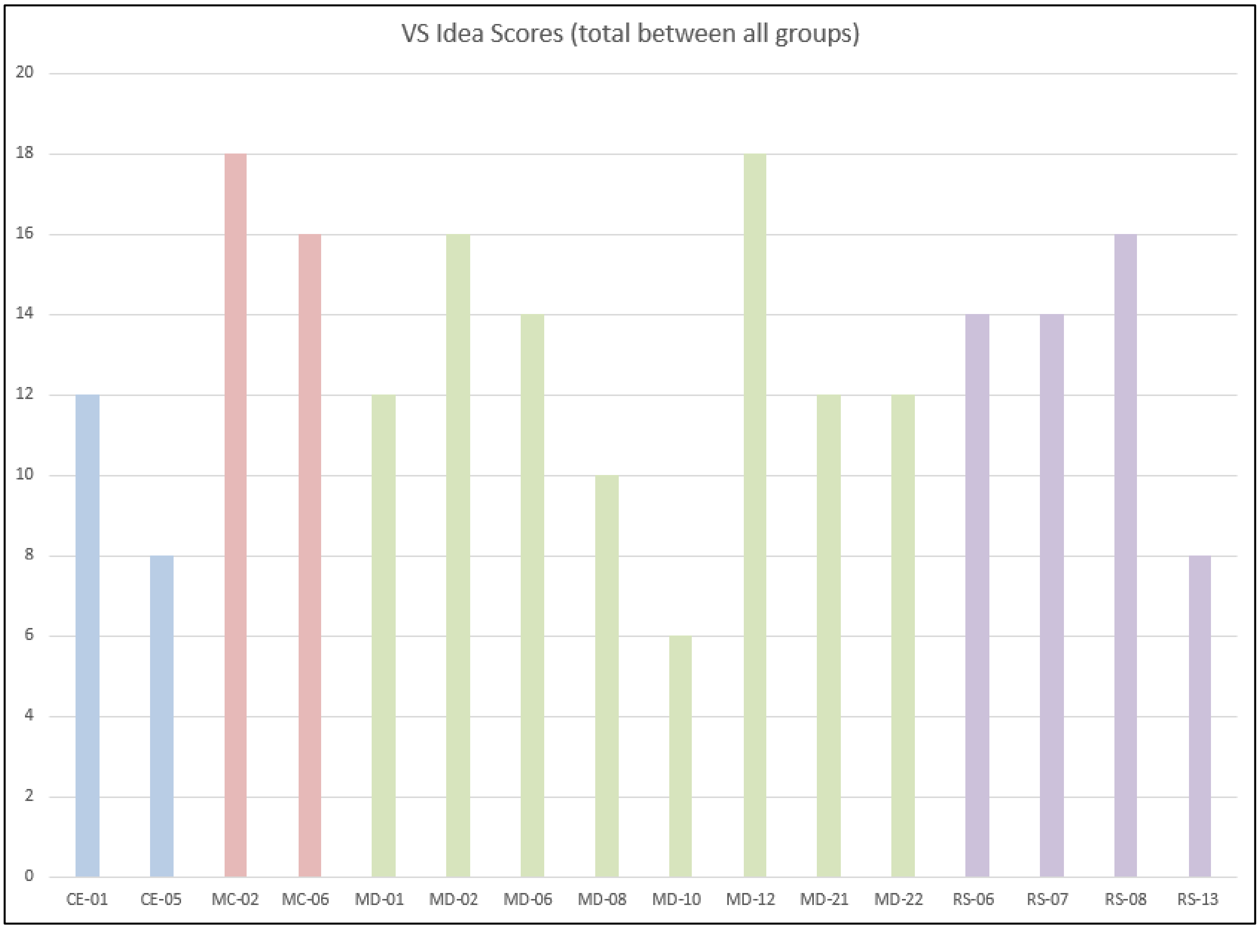
Number	Idea Name	Reason for Exclusion
CE-03	Add stormwater flow control and treatment to minimize erosion and pollutant loading	Value for treatment area is low. Could be done after the project, won't significantly help or resolve the issues in the canyon that the project is addressing. **Recommend evaluating whether to pursue after additional planning and analysis, in partnership with King County.**
CE-04	Work with King County to divert flow entering the canyon to treatment facility or controlled wetland	This is a longer-term planning effort with a large scope and a number of potential solutions; **recommend evaluating whether to pursue after additional planning and analysis, in partnership with King County.**
IR-01	Develop pump station and force main to allow abandonment of sewer in canyon	Outside scope of project; **elevate to SPU Management for longer term planning.** *(this was the only idea in the Increase Resilience category; therefore, no IR ideas are moving forward)*
MC-05	Don't do anything on private properties along East Fork	While the East Fork is the largest contributor of sediment, structures planned above and below the old WW treatment plant should mitigate eliminating two structures further up the canyon. **Support this recommendation because it eliminates the risk of not acquiring private property easements for those structures.**
MC-10	Separate contractors for civil work and stream restoration work.	Project team members discussed this benefit and risk with our Construction Management Group and **SPU will not pursue separate contractors for this work**, instead the team will incorporate controls into the bidding and contractor requirements to reduce risk.

Faithful+Gould provided SPU with a few different tools which could be used to evaluate the ideas. SPU's project manager selected an Excel Evaluation Matrix and made modifications to better suit the needs of the team in evaluating stakeholder preference. The main difference between this study and traditional Value Engineering studies is that cost savings is not a primary factor in decision making. With the unmodified excel tool, each criteria is assigning a weight and each idea is evaluated on how well it achieves that specific criteria giving a total value score for each idea. The idea's performance score is then obtained by dividing the value score by the cost. The ideas with the highest performance scores (higher value scores and lower costs) are implemented.

For this study, and because there were multiple ideas being grouped into each Sediment Management Strategy Option, the most important factors to evaluate were stakeholder support for the ideas and meeting project goals for minimizing physical disturbance in the project site. Cost was not a distinguishing factor for this portion of the study. Cost will be factored in decision making when the five Sediment Management Strategy Options are compared after an engineering evaluation is completed. The Evaluation Matrix (Appendix F) was modified to simply be a reflection of whether each stakeholder group thought the idea was Excellent (value of 5), Good (value of 3), or Poor (value of 1). An example of the scoring for idea MC-06 is below. This specific idea was to meet the target value area of Minimizing Construction Impact, so only that category was scored. Other ideas were scored in their respective categories.

	EVALUATION MATRIX					
HOW WELL DOES EACH IDEA SATISFY THE TARGET CATEGORY? INDICATE BY ENTERING E, G, OR P, UNDER THE CRITERIA RESPECTIVELY.	**STAKEHOLDER**	**Control Erosion in Canyon**	**Increase Resilience**	**Minimize Construction Impact**	**Materials Delivery Logistics**	**Retain Sediment in Canyon**
MC-06 Assemble mechanical equipment in the canyon for use and disassemble to remove	SPU			3		
	SPR			3		
	FODHC			5		
	COMMUNITY			5		
	SUBTOT.	0	0	16	0	0

Scores were received for each idea and they were tallied to determine those ideas that were preferred by the various stakeholder groups. The figure below is a summary of this data.



The ideas that scored higher than a 12, with the exception of MD-21 (which was exactly 12) were candidates for grouping. MD-21 was included because it was the only idea that provided an alternative location to enter the canyon for construction and SPU wanted to evaluate an alternative entry point. The table below shows the ideas that were candidates for synthesizing into options:

Number	Idea Name
CE-01	Place only timber frame structures strategically along banks of creek to help shore banks in areas without large wood structures
MC-02	Access only along channel from downstream and upstream directions as appropriate
MC-06	Assemble mechanical equipment in the canyon for use and disassemble to remove
MD-02	Use of helicopter delivery for materials
MD-06	Use small, tracked vehicle (ATV) to haul logs and other materials along existing trail
MD-12	Use winches and hoists to assist with material delivery
MD-21	Use existing easement to establish slide or highline to bring in material
RS-06	Use smaller structures initially and return in future years to increase placements where required
RS-07	Use boulders or boulder clusters to help retain sediment
RS-08	More strategic machine placement of log structures in fewer locations ("hot spots")
--	*Existing design for machine-placed structures*

The ideas were initially grouped so that at least one from each category was part of the new potential options. The design team provided additional thoughts on feasibility of the ideas and SPU determined that idea CE-01 was not appropriate to pursue alone due to the risk of failure of the structure without an adjacent bed-control (large wood) structure. Idea CE-01 was removed from the list, however, timber frames will still be reviewed as complimentary to and part of any large wood design. There are no ideas from the Control Erosion category moving forward. One additional idea was added to the list as an alternative large wood option, the existing design for machine-placed structures (Option Bb). The value study was centered on identifying less impactful ways to get materials and equipment into the canyon to build large wood structures, and alternative wood structures that are smaller and less impactful to construct, however, the existing design for large wood does meet the sediment management goals and could be installed using some of the newly identified materials delivery and equipment options. SPU decided to include it as an alternative to one of the new options for comparison in achieving the sediment management goals (Option Bb).

The following table summarizes the final scoring for the alternative grouping of ideas for the Sediment Management Strategy Options. There are three new options and one which has an alternative large wood design. The three new options resulting from this Value Study are identified as Option A, Option B and Option C. In addition to these three options, SPU has decided to include an alternative Option Bb which is the same as B but with the existing large wood design substituted for hot spots.

EVALUATION MATRIX						
HOW WELL DOES EACH METHOD SATISFY THE TARGET CATEGORY? INDICATE BY ENTERING 5, 3, OR 1, UNDER THE CRITERIA RESPECTIVELY.	**Control Erosion in Canyon**	**Increase Resilience**	**Minimize Construction**	**Materials Delivery Logistics**	**Retain Sediment in Canyon**	**TOTAL SCORE**
Option A						
MC-02 Access along channel			19			
MD-06 ATV				14		
MD-12 Winches & Hoists				17		
RS-06 Smaller Log Structures					15	
RS-07 Boulder Clusters					14	
	0	0	19	31	29	**79**
Option B						
MC-02 Access along channel			19			
MC-06 Assemble Equipment			16			
MD-02 Helicopter				17		
RS-08 Hot Spots					15	
	0	0	35	17	15	**67**
Option C						
MD-06 ATV				14		
MD-12 Winches & Hoists				17		
MD-21 Easements				11		
RS-06 Smaller Log Structures					15	
	0	0	0	42	15	**57**

After the draft options were prepared, they were shared out with the stakeholder groups via the project website, listserv emails and personal communications. Following an engineering evaluation on each new option, SPU will compare all options (Option A, Option B, Option C, Option 2, Option 3, and the alternative Option Bb) and make a decision on the sediment management strategy via our Multi- Objective Decision Analysis process. This will occur in early 2024. The following table shows all options that will be compared for a final decision on the Sediment Management Strategy:

Option A

- Access only along channel from downstream and upstream directions as appropriate (Idea MC-02)
- Use small-tracked vehicle (ATV) to haul logs and other materials along existing trail(Idea MD-06)
- Use winches and hoists to assist with material delivery (Idea MD-12)
- Use smaller structures initially and return in future years to increase placements where required (Idea RS-06)
- Use boulders or boulder clusters to help retain sediment (Idea RS-07)

Option B

- Access only along channel from downstream and upstream directions as appropriate (Idea MC-02)
- Assemble mechanical equipment in the canyon for use and disassemble to remove(Idea MC-06)
- Use helicopter delivery for materials (Idea MD-02)
- More strategic machine placement of log structures in fewer locations ("hot spots")(Idea RS-08)

Option Bb

- Access only along channel from downstream and upstream directions as appropriate(Idea MC-02)
- Assemble mechanical equipment in the canyon for use and disassemble to remove(Idea MC- 06)
- Use helicopter delivery for materials (Idea MD-02)
- *Alternative to RS-08: Log structures throughout canyon rather than just in hot spots*

Option C

- Use small-tracked vehicle (ATV) to haul logs and other materials along existing trail(Idea MD- 06)
- Use winches and hoists to assist with material delivery (Idea MD-12)
- Use existing easements to establish slide or highline to bring in material(Idea MD-21)
- Use smaller structures initially and return in future years to increase placements where required (Idea RS-06)

Option 2

- Hand-placed large woody material, small structures
- No equipment or machinery required; all materials hand carried in

Option 3

- Hybrid machine- and hand-placed large woody material
- Combination of large structures and small structures
- A temporary access road would be constructed in the lower half of the canyon to accommodate placement of large wood structures in the lower half of the canyon
- Small structures would be constructed in the upper half of the canyon with all materials hand carried in beyond the extent of the temporary access road

1.7. Acknowledgments

CM Solutions and Faithful+Gould thank the SPU personnel and the design team for their cooperation and support in preparation for this Value Study, and especially for their attendance and participation during the Value Study presentation and site visit workshop. In addition, we thank the personnel of SPU for their expertise and active consultation throughout the Value Study workshop. Finally, we thank the personnel from Anchor QEA, Kleischmidt Group, Robin Kirschbaum, Inc., and Faithful+Gould for serving as the Value Study team.

2. Value Alternatives and Design Suggestions

The “Summary of Alternatives and Design Suggestions” spreadsheet on the subsequent pages summarizes the results of the Value Study workshop, identifying the Alternative Number, Descriptive Alternative Title, Alternative Category, and Potential Impact on First (Capital) Costs (expressed as construction cost avoidance); Present Worth of Future Costs; and the resulting Life Cycle Cost over a 30-year service life, for each Alternative.

The 6 Quantitative Value Alternatives that avoid cost, 5 Qualitative Value Alternatives that add value (at an additional cost), and 11 Design Suggestions developed during the Value Study Workshop are presented in their entirety on the pages following the “Summary of Alternatives and Design Suggestions” spreadsheet, in order of their appearance in the spreadsheet.

Summary of Alternatives and Design Suggestions

ID No.	Alternative Title	Alter. Cat.	Potential Costs ($) Initial	O&M (PW)	Life Cycle
CE-00	**Control Erosion in Canyon**				
CE-01	Place only timber frame structures strategically along banks of creek to help shore banks in areas without large wood structures	DS	Design	Suggestion	$-
CE-03	Add stormwater flow control and treatment to minimize erosion and pollutant loading	Qlt(-)	$(4,872,200)	$ -	$(4,872,200)
CE-04	Work with King County to divert flow entering the canyon to treatment facility or controlled wetland	DS	Design	Suggestion	$-
CE-05	Create constructed storage wetland at location of the historic wastewater treatment facility in the East Fork	DS	Design	Suggestion	$-
IR-00	**Increase Resilience**				
IR-01	Develop pump station and force main to allow abandonment of sewer in canyon	Qlt(-)	$(1,462,500)	$-	$(1,462,500)
MC-00	**Minimize Construction Impact**				
MC-02	Access only along channel from downstream and upstream directions as appropriate	Qnt(+)	$3,086,400	$-	$3,086,400
MC-05	Don't do anything on private properties along East Fork	DS	Design	Suggestion	$-
MC-06	Assemble mechanical equipment in the canyon for use and disassemble to remove	Qnt(+)	$3,562,700	$-	$3,562,700
MC-10	Separate contractors for civil work and stream restoration work	DS	Design	Suggestion	$-
MD-00	**Materials Delivery Logistics**				
MD-01	Use identified hazard trees on site as a source for logs and rootwads	DS	Design	Suggestion	$-
MD-02	Use helicopter delivery for materials	Qnt(+)	$3,708,300	$-	$3,708,300
MD-06	Use small tracked vehicle (ATV) to haul logs and other materials along existing trail	Qnt(+)	$143,000	$-	$143,000
MD-08	Buy a property in the right location and install slide or highline for material delivery	Qlt(-)	$(1,143,800)	$-	$(1,143,800)
MD-10	Use pack animal delivery for materials	DS	Design	Suggestion	$-
MD-12	Use winches & hoists to assist with material delivery	DS	Design	Suggestion	$-

ID No.	Alternative Title	Alter. Cat.	Potential Costs ($) Initial	O&M (PW)	Life Cycle
MD-21	Use existing easement to establish slide or highline to bring in material	DS	Design	Suggestion	$-
MD-22	Use logs spanning channel, built as you go, to move materials up the streambed	DS	Design	Suggestion	$-
RS-00	**Retain Sediment in Canyon**				
RS-06	Use smaller structures initially and return in future years to increase placements where required	Qnt(+)	$1,689,900	$(828,000)	$861,900
RS-07	Use boulders or boulder clusters to help retain sediment	Qlt(-)	$(630,000)	$-	$(630,000)
RS-08	More strategic machine placement of log structures in fewer locations ("hot spots")	DS	Design	Suggestion	$-
RS-13	Place dredged material from the delta	Qlt(-)	$(48,800)	$-	$(48,800)

Alternative Category

Qnt(+) - Quantitative

Qlt(-) - Qualitative

DS - Design Suggestion

CE-01 Design Suggestion

Control Erosion in Canyon

Place only timber frame structures strategically along banks of creek to help shore banks in areas without large wood structures.

Original Concept

The original concept proposed two to four timber frames associated with the large wood structures for the purpose of stabilizing the banks while the large wood structures collected sediment to increase the height of the streambed. The structures were planned for throughout the canyon, approximately 17 (hand placed) to 23 (machine-placed) bed control structures, and between 78 and 102 timber frames accordingly.

Alternative Concept

Install timber frames independent of large wood structures to stabilize banks throughout channel where there is existing erosion or potential for slope failure. The design team will need to conduct further field study to identify where there are areas needing bank stabilization in between the various large wood structures. The value team was not able to determine an appropriate number.

Advantages

- Increase amount of slope protected by timber frame.
- Increase protection along slope for establishment of riparian vegetation.

Disadvantages

- Would rely on anchors embedded into slope for stability and not be integrated into a bed control structure for increased stability at the channel.
- Anchors and channel embedment would require mechanical installation (machine placement).
- Without a bed control structure to slow flows at each location, vegetation could be washed out in high flow events.

Discussion / Justification

The purpose of the timber frame structure is to stabilize the bank and provide a framework for the reestablishment of riparian plant communities. Each structure would be constructed with six 20-foot- long, 12-inch-diameter logs that are anchored to the bank and embedded in the streambed channel. The ground anchors are necessary for structural stability. Structural stability calculations for the timber frame structures would be included if incorporated later in design. The logs create and support pockets of soil. Each of the soil pockets would be protected with a layer of coir fabric to reduce the potential for new soil to be eroded before the plantings are able to establish a mature root network. The timber frames will provide immediate relief to the banks and greatly reduce the current rate of sediment transport from the hillside to the channel. As the vegetation becomes more established, it will provide long-term stabilization of the banks.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$ Design**	**Suggestion**	$

CE-01 Design Suggestion

Discussion / Justification (Continued)

The planting design for the timber frames would include soil and mulch bags to provide a stable and high-quality planting medium in poor soils along steep banks. Containing the soil and mulch in bags

will protect against erosion and loss of material during storm events. Additionally, the soil and mulch

bags would be located outside of the ordinary high water mark (OHWM) and would not be subject to streamflow.

Successful plant establishment in the timber frames is critical to long term creek and forest restoration as a way to introduce sources of large wood (conifer trees near bank) that will drop debris into the creek long after the timber frames are gone. Falling trees and limbs are part of the natural wood loading cycle and critical to long term sediment storage as an acceptable aspect of long-term damage to and decay of timber frame logs. The timber frames would be densely planted with three conifer species and a variety of shrub species totaling approximately 50 to 55 plants per structure. Plant community composition is based on site observations, Washington Department of Natural Resources plant community types (Chappell 2004), and Dead Horse Canyon VMP plot data (SUNP 2005). Plant material type and size will optimize survival, growth, and successful establishment, and would require a specialized contractor and crew that has documented experience working in this type of setting, with bioengineering techniques, and an understanding of acquiring and handling local seed zone provenance bareroot plant material.

Previous conceptual design only incorporated timber frames associated with large wood structures for sediment storage to raise the elevation of the streambed. Incorporating more timber frames along vulnerable, eroding banks would provide additional, necessary protection to reduce the amount of sediment entering the system.

CE-03 Qualitative Value Alternative

Exhibits

Example of a timber frame structure independent of a large log structure — post construction.

CE-03 Qualitative Value Alternative

Exhibits

Example of a slope that could be supported by timber frames to reduce bank erosion. A timber frame was planned for this location in Option 1.

CE-03 Qualitative Value Alternative

Exhibits

Another Example of a slope that could be supported by timber frames to reduce bank erosion. A timber frame was also planned for this location in Option 1.

CE-03 Qualitative Value Alternative

Exhibits

Existing eroding bank downstream of historical wastewater facility.

CE-03 Qualitative Value Alternative

Exhibits

Existing eroding banks with downstream channel-spanning logs.

CE-03 Qualitative Value Alternative

Exhibits

Existing eroding banks beneath Taylor Creek footbridge protecting sewer line. Timber frames could likely only be installed by hand in this location.

CE-03 Qualitative Value Alternative

Control Erosion in Canyon

Add stormwater flow control and treatment to minimize erosion and pollutant loading.

Original Concept

Install new tightline with diffuser tees and outfall protection for the existing outfalls at Rustic Road South and Crestwood Drive South. No flow control or treatment included.

Alternative Concept

In addition to the Original Concept above, add flow control and treatment facilities in roadway upstream of outfalls to canyon. Treatment assumes use of seven (7) 4'x6' Filterras, treating approximately 7 acres of roadway runoff which currently drains untreated to the creek. Flow control assumes one (1) underground detention pipe designed for peak flow control for up to 10 acres in the East Fork Taylor Creek basin, where peak flow control is most needed. These Best Management Practices (BMPs) are simple proxies for treatment and flow control. Alternative approaches, such as non-infiltrating Green Stormwater Infrastructure BMPs, could be evaluated if desired.

Advantages

- Reduce peak flow rates into canyon, thereby reducing erosion within the canyon
- Treat roadway runoff to remove pollutants known to be harmful to fish
- Reduce potential for landslides within the canyon
- Improve the ultimate quality and longevity of the new habitat being built in lower Taylor Creek
- Highly scalable solution

Disadvantages

- Adds construction cost
- Adds Operation and Maintenance cost
- Adds roadway construction impact to neighbors

Discussion / Justification

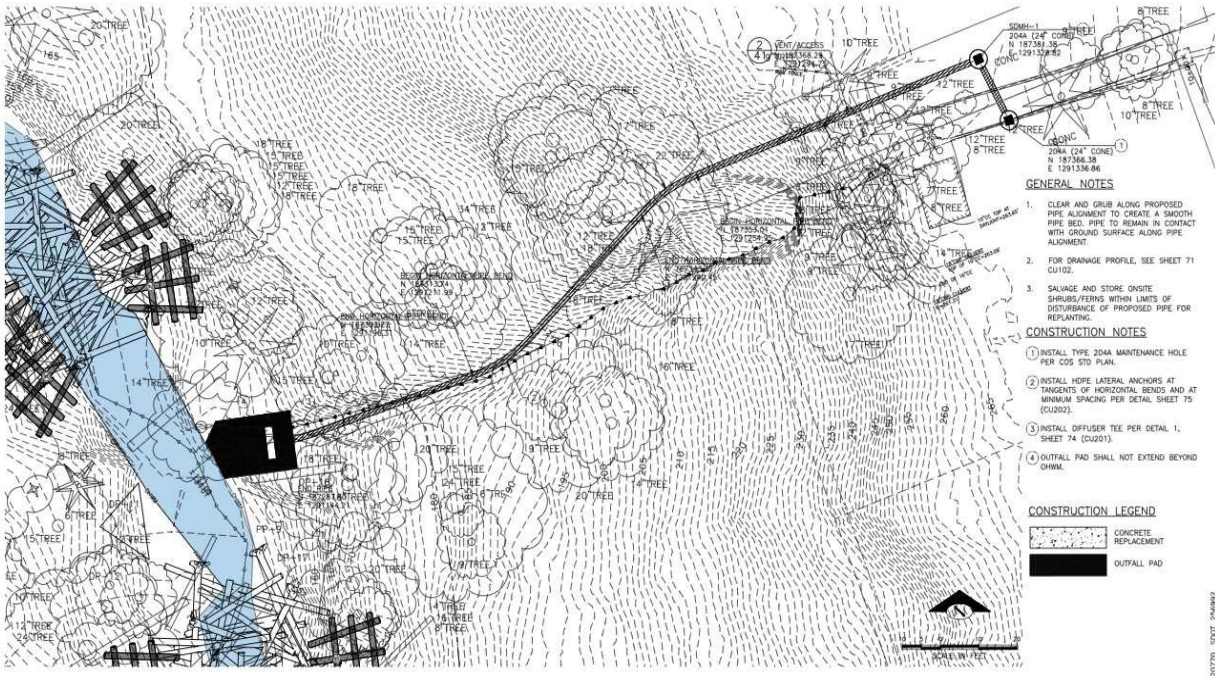
Stormwater runoff currently flows untreated and uncontrolled to Taylor Creek, contributing to excessive peak flow rates and erosion within the canyon, increased potential for landslides, and elevated loadings of pollutants that are toxic to fish and other aquatic species. By adding stormwater treatment and flow control in the upland neighborhoods surrounding the canyon, peak flows and pollutant loading rates can be significantly reduced, helping to stabilize the canyon, protect private properties, and protect fish and other aquatic species in the creek and Lake Washington.

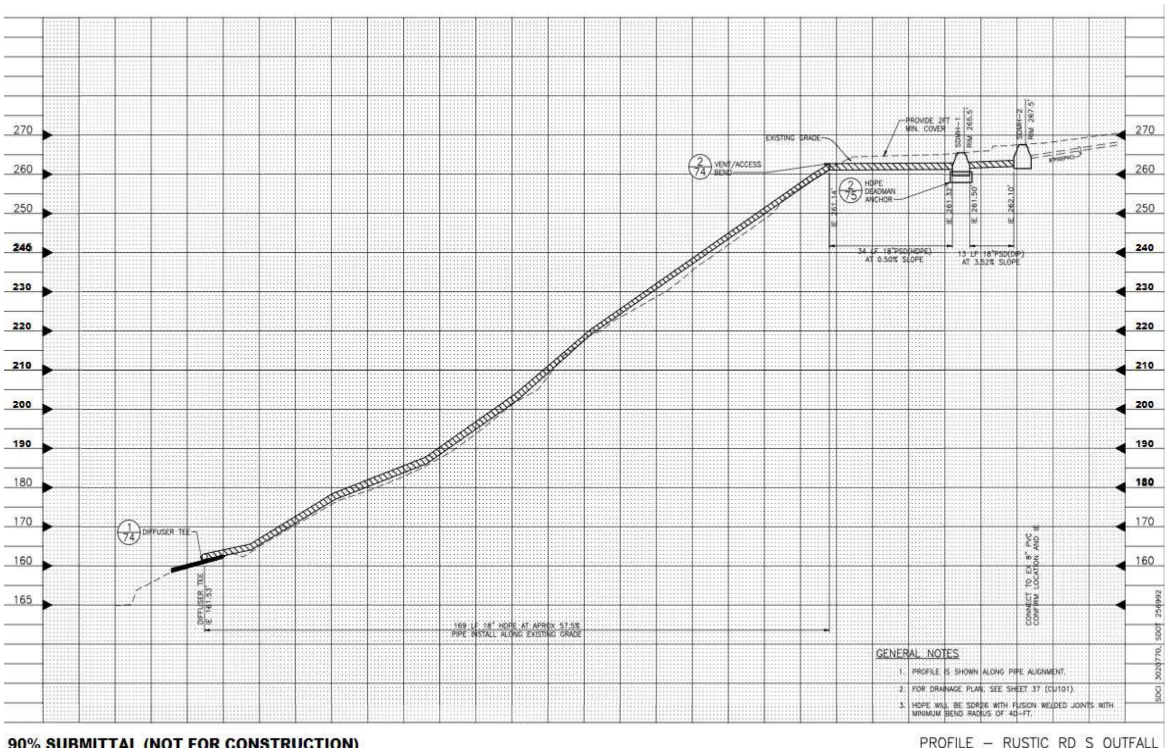
Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$707,200	$	$707,200
Alternative Concept	$5,579,400	$	$5,579,400
Difference	**$(4,872,200)**	**$**	**$(4,872,200)**

CE-03 Qualitative Value Alternative

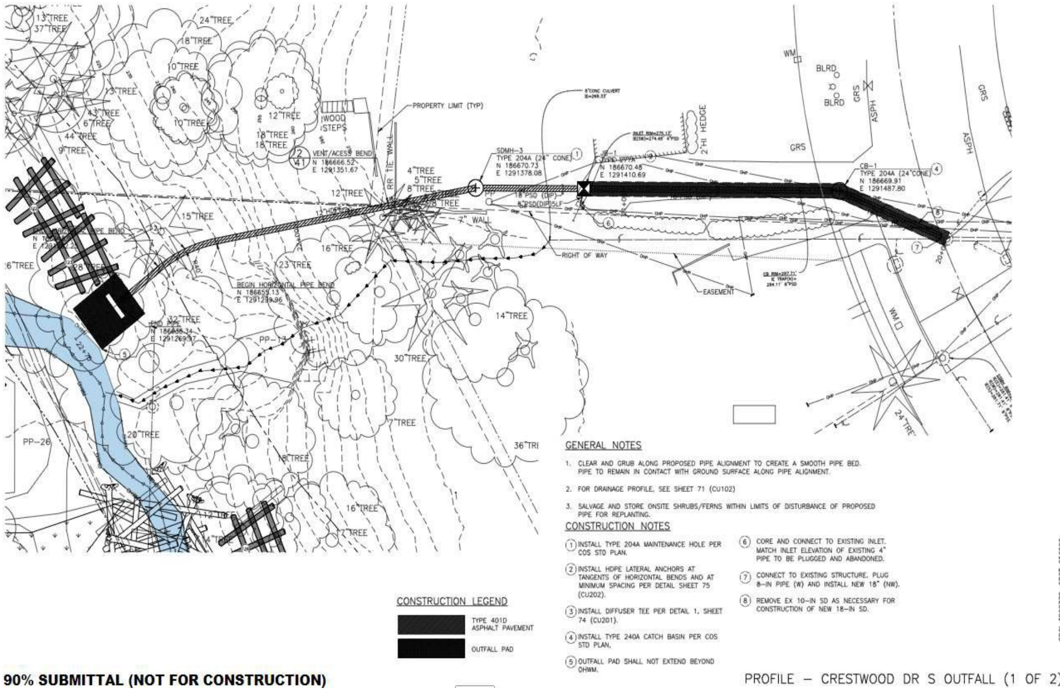
Exhibits – Original Concept

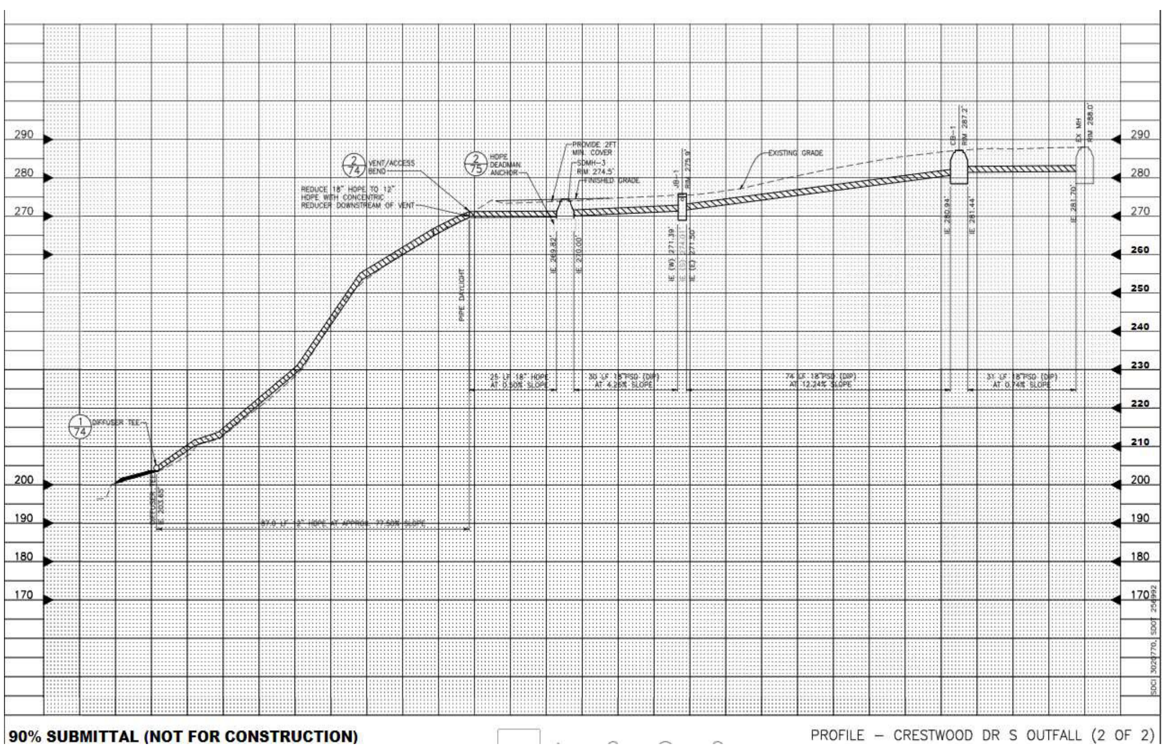




CE-03 Qualitative Value Alternative

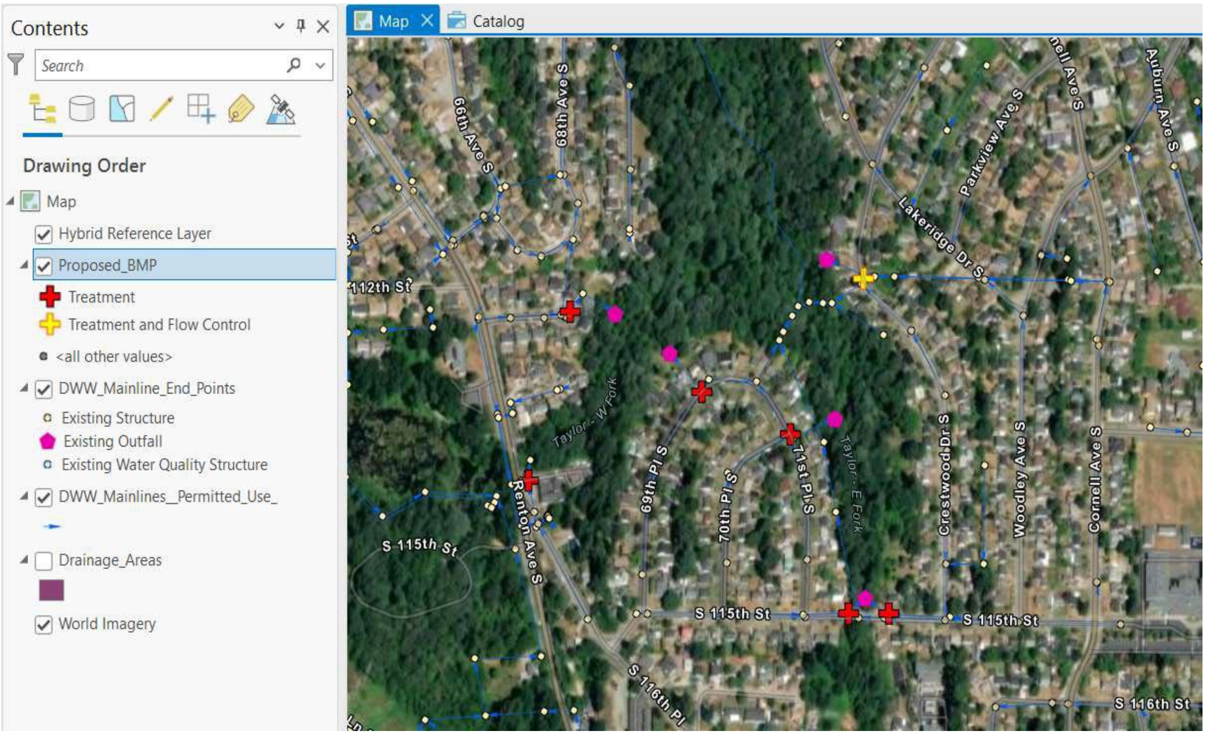
Exhibits – Original Concept





CE-03 Qualitative Value Alternative

Exhibits – Alternative Concept



CE-03 Qualitative Value Alternative

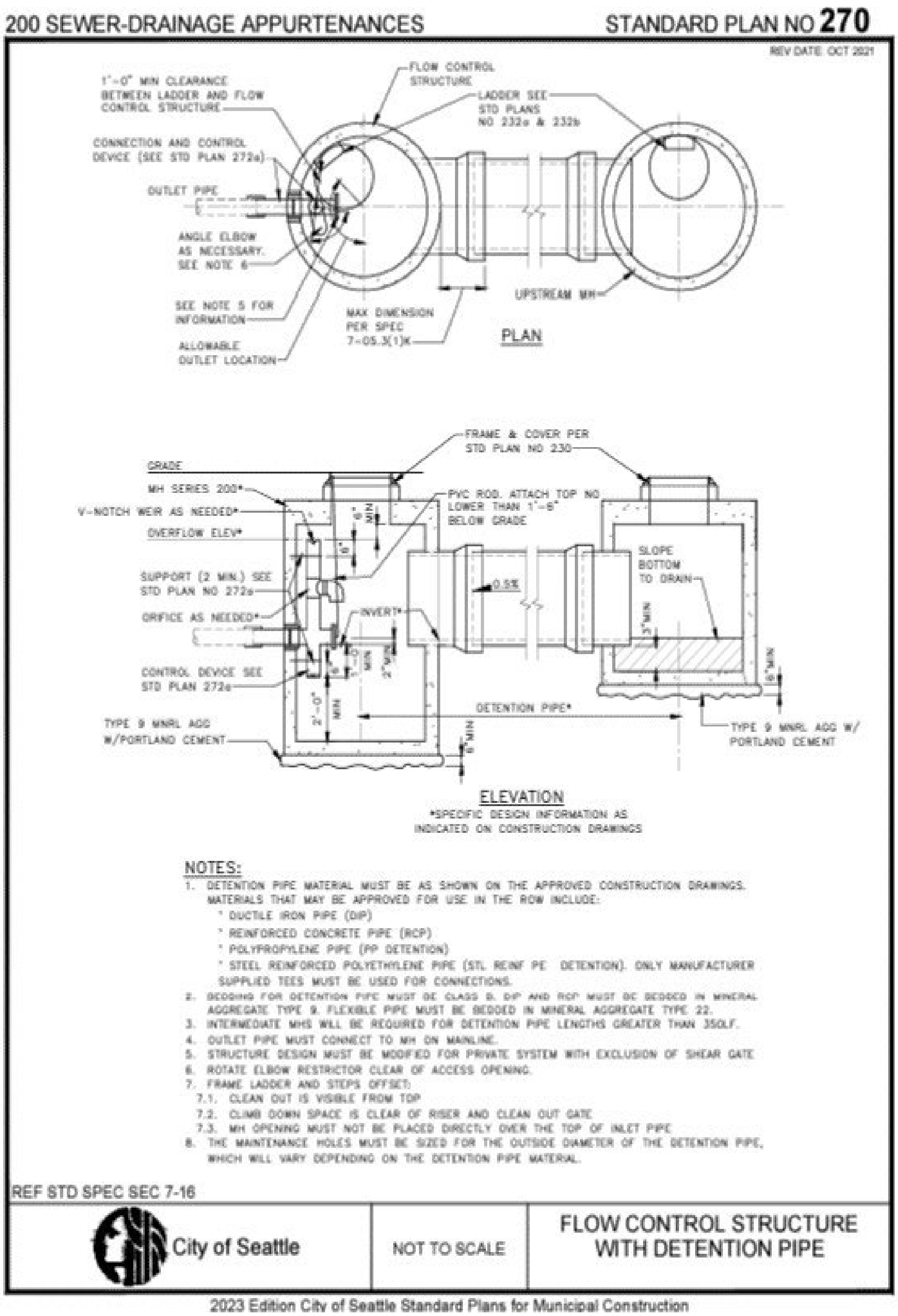
Exhibits – Alternative Concept

Possible Treatment BMP — Filterra

CE-03 Qualitative Value Alternative

Exhibits – Alternative Concept

Possible Flow Control BMP — Detention Pipe



CE-03 Qualitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Lumped 2 new outfalls with diffuser tees	1	1	707,203	707,203

Subtotal:	**$707,203**
Markup:	$
Total Cost (Rounded):	**$707,200**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Lumped 2 new outfalls with diffuser tees	EA	1	707,203	707,203
Filterra, 4'x6'	EA	7	28,939	202,573
Detention Tank, Peak Control, Approx. 10 acres	EA	1	3,695,154	3,695,154

		Subtotal:	**$4,604,930**
Only applied to last 2 items	25%	**Markup:**	$974,432
		Total Cost (Rounded):	**$5,579,400**
		Cost Difference:	**$(4,872,200)**

CE-04 Design Suggestion

Control Erosion in Canyon

Work with King County to divert flow entering the canyon to treatment facility or controlled wetland

Original Concept

The original concept does not include regional coordination of stormwater management in the basin with King County nor any other entity.

Alternative Concept

Initiate coordination process to work collaboratively with King County to implement a long-term regional approach to managing stormwater for the entire basin area contributing flows and toxic pollutants to the canyon.

Advantages

- Greatly reduce peak flow rates to the creek
- Greatly reduce pollutant loadings to the creek and Lake Washington
- Reduce landslide potential in the canyon
- Protect private properties
- Enhance the long-term function and quality of the lower Taylor Creek habitat improvements

Disadvantages

- Coordination with King County is difficult and could prove to be costly or unproductive

Discussion / Justification

A regional approach to stormwater management can significantly reduce peak flow rates and pollutant loadings to the creek and Lake Washington, bringing a host of safety and environmental benefits while directly protecting future habitat improvements in lower Taylor Creek. Without significant levels of stormwater management offered via a regional approach, the water quality in the creek may be toxic for fish.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

CE-05 Design Suggestion

Control Erosion in Canyon

Create constructed storage wetland at location of the historic wastewater treatment facility in the East Fork

Original Concept

Building up the channel bed directly downstream of the concrete wall associated with the historic wastewater facility will reduce, or disperse, the hydraulic energy at that location and work to minimize the drop over time, burying the wall in the channel.

Alternative Concept

Initiate coordination process to work collaboratively with King County to implement a long-term regional approach to managing stormwater for the entire basin area contributing flows and toxic pollutants to the canyon.

Advantages

- Treat stormwater runoff to improve downstream water quality.
- Provide additional substrate storage.
- Removed unnatural structure from channel.
- Potential to improve benthic invertebrate community.

Disadvantages

- May require periodic maintenance.
- Failure of wetland may lead to large flush of substrate downstream.
- Complex permitting requirements

Discussion / Justification

A wetland is a complex assemblage of water, substrate, plants (vascular and algae), organic debris, invertebrates, and an array of microorganisms. The mechanisms that are available to improve water quality a numerous and interrelated and include the settling of fine sediment, filtration and chemical precipitation, chemical transformation, adsorption and ion exchange, breakdown and transformation of pollutants, uptake and transformation of pollutants and nutrients, and predation and natural die-off of pathogens.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

CE-05 Design Suggestion

Discussion / Justification (Continued)

Constructed wetlands are a cost-effective and technically feasible approach to treating stormwater runoff. Constructed wetlands can be less expensive to build than other treatment options; operation and maintenance expenses (energy and supplies) are low; operation and maintenance require only periodic, rather than continuous, on-site labor; wetlands are able to tolerate fluctuations in flow; and they facilitate water reuse and recycling. In addition, they provide habitat for many wetland organisms; they can be built to fit harmoniously into the landscape; they provide numerous benefits in addition to water quality improvement, such as wildlife, habitat, and the aesthetic enhancement of open spaces; and they are environmentally sensitive approach to water treatment.

Given the location of the proposed constructed wetland within the stream channel, the design would be based on a surface flow wetland. A surface flow wetland consists of a shallow basin, soil or other medium to support the roots of vegetation, and a water control structure that maintains a shallow depth of water. The water surface is above the substrate. Surface flow wetlands look much like natural marshes and can provide wildlife habitat and aesthetic benefits as well as water treatment. In surface flow wetlands, the near-surface layer is aerobic while the deeper waters and substrate are usually anaerobic. The capital and operating costs of surface water wetlands are low, and their construction, operation, and maintenance are straightforward. The main disadvantage of surface water wetlands is that they generally require large areas than other systems; however, the large area in the footprint of the historic wastewater facility is available.

Despite a large amount of research and published information, the optimal design of constructed wetlands for various applications has not yet been determined. Among the systems that have been monitored, performance has varied and the influences of the diverse factors that affect performance, such as location, type of stormwater runoff, wetland design, climate, weather, disturbance, and daily or seasonal variability, have been difficult to quantify.

In general, wetland designs attempt to mimic natural wetlands in overall structure while fostering those wetland processes that are thought to contribute the most to the improvement of water quality. The following guidelines outline a successful path to constructed wetlands (Mitsch 1992): keep the design simple as complex technological approaches often fail; design for minimal maintenance; design the system to use natural energies, such as gravity flow; design for the extreme of weather and climate, not the average, where storms, floods, and droughts are expected and planned for; design the wetland with the landscape and integrate the design with the natural topography of the site; avoid over- engineering the design with rectangular basins, rigid structures and channels, and regular morphology to mimic natural systems; design the system with the expectation that it will take time, possibly years, before the constructed wetland becomes functional; and design the system for function, not form.

CE-05 Design Suggestion

Discussion / Justification (Continued)

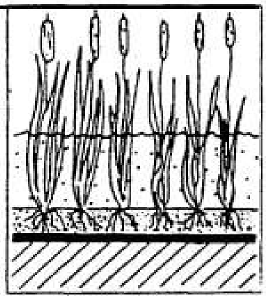
There are several wetlands immediately adjacent to the channel, including along the left bank by the historic wastewater treatment facility.

The appropriate agencies must be contacted to determine the regulatory requirements for a proposed constructed wetland and its discharge. As the facility would be within Taylor Creek and discharge to Taylor Creek, permits for work in the waterway and discharge to natural waters would be required. Any stormwater plan must meet local and state stormwater regulations.

To address the existing load of substrate currently supported by the concrete wall, a natural replacement structure would be required to maintain the same or greater level of storage. Plant community composition would be based on site observations, Washington Department of Natural Resources plant community types (Chappell 2004), Dead Horse Canyon VMP plot data (SUNP 2005), and the National Wetland Plant List (88 FR 3729).

CE-05 Design Suggestion

Exhibits – Alternative Concept

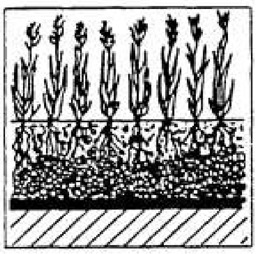


Water level is above the ground surface; vegetation is rooted and emerges above the water surface: waterflow is primarily above ground

WETLAND PLANTS AND WATER

SOIL
LINER
NATIVE SOIL

Surface Flow Wetland



Water level is below ground; water flow is through a sand or gravel bed; roots penetrate to the bottom of the bed

WETLAND PLANTS

SOIL. SAND. AND GRAVEL
LINER
NATIVE SOIL

Subsurface Flow Wetland

Figure 1. Surface flow and subsurface flow constructed wetlands (from Water Pollution Control Federation 1990).

Surface flow and subsurface flow constructed wetlands (from Water Pollution Control Federation 1990).

CE-05 Design Suggestion

Exhibits – Alternative Concept

Existing historic wastewater facility concrete wall.

IR-01 Qualitative Value Alternative

Increase Resilience

Develop pump station and force main to allow abandonment of sewer in canyon

Original Concept

Protect the existing 10-inch HDPE sanitary sewer line that runs the length of the Dead Horse Canyon, approximately 2,300 linear feet. The sewer line is buried for most of its length and suspended below one pedestrian bridge in the canyon.

Alternative Concept

Construct a sanitary sewer lift station near the junction of the existing ductile iron pipe with a 10-inch HDPE force main conveying flow to a point of connection to the west, as shown on the attached sketch. The existing HDPE line in the canyon would be abandoned in place.

Advantages

Would reduce risk of sewer line failure and leak into canyon resulting from a land slide

Provides improved maintenance access

Eliminates need for emergency access, which would be impactful to the canyon.

Disadvantages

Localized impact to construct lift station at the bottom of the canyon, requiring construction of a permanent access roadway and developing an access easement.

Cost of constructing sewer lift station and needed force main pipe installation and power.

On site backup generator may be required, needing regular testing resulting in noise and diesel smoke.

Discussion / Justification

Considering future liability if there were a break in the existing HDPE sanitary sewer line that runs the length of the canyon, installing a sewer lift station would reduce the potential for damage resulting from a sewage spill and the resulting cleanup effort, which would most like involve the construction of a temporary access roadway that would have a significant impact on the canyon's landscape.

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$5,937,500	$	$5,937,500
Alternative Concept	$7,400,000	$	$7,400,000
Difference	**$(1,462,500)**	**$**	**$(1,462,500)**

IR-01 Qualitative Value Alternative

Discussion / Justification

A conceptual layout (shown on page 3) would require a temporary access road and development of a permanent access. This could require the need to acquire an existing parcel to provide the needed access. This access could provide an additional access point that could be used for future trail access as well as delivering material and equipment to the canyon floor to permit the construction of the proposed features in the creek to aid in managing river sediment and erosion. The alignment shown is purely schematic.

The construction would be impactful to the affected community, as a new sewer line would need to be installed in the existing roadway to a point where the force main would be tied into the existing sanitary sewer system. Design of the system and flows would be needed to determine if there is adequate capacity in the existing system, or if the existing gravity system would need to be upgraded. As this is a force main pipe, the depth of burry would be assumed to be four-feet, rather than the deeper gravity sewers.

The original concept being considered would be the emergency repair and associated cleanup related to a sanitary sewage discharge. This concept would initially include the temporary bypass of 244 separate residences that are served by the existing 10-inch HDPE sewer line. At the same time, a Contractor would need to construct a road to the point of failure. This would require the construction of a temporary roadway, cutting of existing trees, construction of temporary fill to gain access to the work area. Temporary and/or permanent slope stabilization efforts may be needed depending on the nature of a potential slope failure and scour created by the raw sewage running down the west side of the canyon and into Taylor Creek.

The sewer line can be repaired using electrofusion couplings and providing a new section of HDPE after the limits of the damage are identified. This would put the sewer back into service and end the need for bypassing the sewer to the 244 residences.

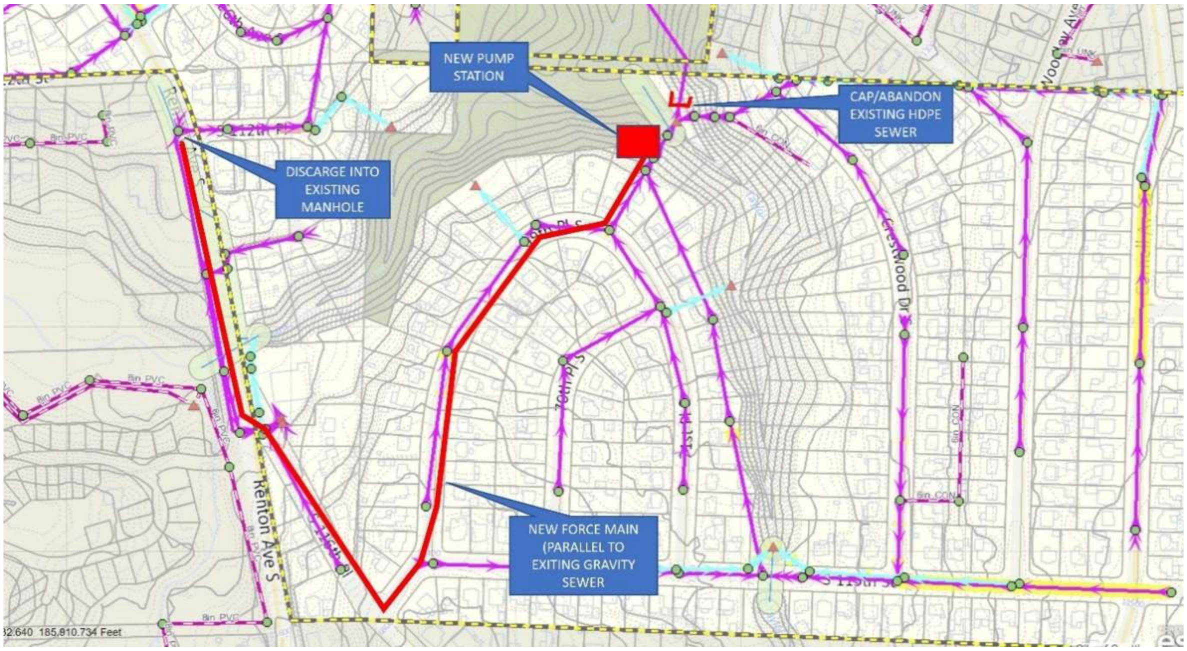
Cleanup of the affected areas would require some level of sampling and testing to determine the limits of impact; excavation and disposal of impacted soils; and subsequent restoration of the site. The farther up the canyon a failure occurs would increase overall cost and time impacts. The impacted area would require multiple years to recover before the area of impact is restored.

The costs of the lift station are estimated to be $2 Million, including cost or a backup power system. To provide construction and maintenance access, a road will need to be established and most likely an existing residence will need to be purchased to provide adequate room. This could be used as a future park and trail access following construction. Based on Zillow, the average pricing for homes along the canyon is roughly $600,000.

IR-01 Qualitative Value Alternative

Exhibits

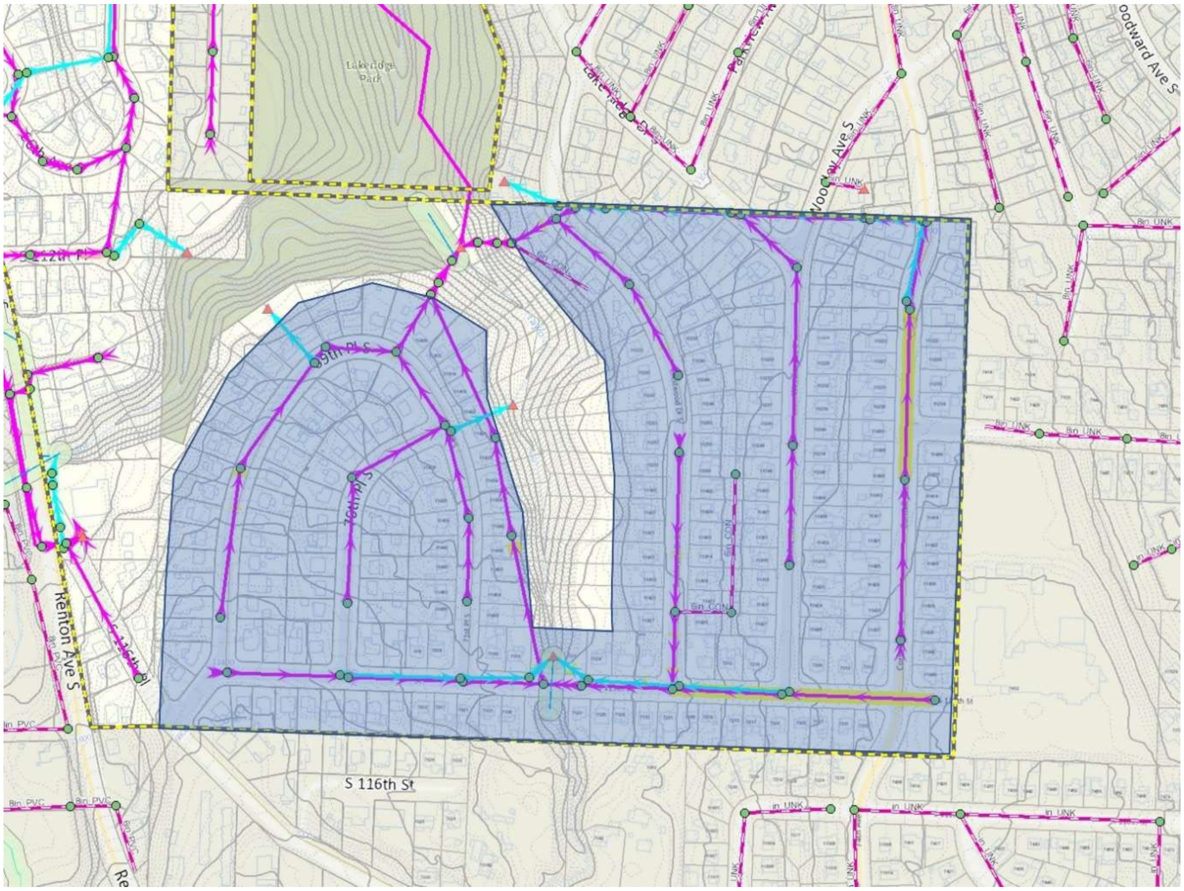
Conceptual layout of sanitary sewer lift station and piping.



IR-01 Qualitative Value Alternative

Exhibits

244 homes being served by existing 10-inch HDPE sewer and would be served by proposed lift station.



IR-01 Qualitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Emergency Repair and Cleanup				
Temporary bypass of sewer	EST	1	500,000.00	500,000
Access roadway for repair	EST	1	750,000.00	750,000
Repair impacted sewer line	EST	1	500,000.00	500,000
Soil stabilization	EST	1	750,000.00	750,000
Disposal of impacted soils	EST	1	750,000.00	750,000
Removal of temporary access	EST	1	500,000.00	500,000
Restoration of impacted areas.	EST	1	1,000,000.00	1,000,000

	Subtotal:	**$4,750,000**
25%	Markup:	$1,187,500
	Total Cost (Rounded):	**$5,937,500**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Design of new lift station and piping	LS	1	500,000.00	500,000
Access roadway, including power	LS	1	750,000.00	750,000
Right of way / house for access	LS	1	600,000.00	600,000
Lift station construction	LS	1	2,000,000.00	2,000,000
8-inch force main (including road restoration)	LF	2200	600.00	1,320,000
Permanent enhancements to trail entry and trail/access	Ls	1	750,000.00	750,000

	Subtotal:	**$5,920,000**
25%	**Markup:**	$1,480,000
	Total Cost (Rounded):	**$7,400,000**
	Cost Difference:	**$(1,462,500)**

MC-02 Qualitative Value Alternative

Minimize Construction Impact

Original Concept

Construct a 12' wide roadway up through the canyon to provide access for heavy equipment. The road would be constructed with a mechanically stabilized earth (MSE) wall system, or "pillow wall" to establish a roadway profile that could be used by heavy equipment. Following construction, the roadway would be cut down and in width and height and the trail re-established and landscaping restored. The existing trail will also be used for equipment and log delivery.

Alternative Concept

Primary access from Holyoke Way crossing, working along channel moving upstream, and potentially another access point from upstream moving downstream. Needs mapping of potential obstruction locations for a spider excavator if used, there are at least two within ~500 feet of Holyoke Way, a large fallen Cedar and a large boulder constriction.

Can be implemented in conjunction with MD-12 and MD-15. Cost estimate includes set-up of these, but not cost of moving material or adding second access point from above.

Advantages

- Lower cost
- No/limited impact to trail
- Works for both original and alternative concept construction
- Can use spider excavator with lighter disturbance impacts to slopes

Disadvantages

- Requires clearing of brush in channel, although if original concept is implemented, that would occur anyway
- Large Cedar & boulder constructions cannot/should not be moved, would need to be bypassed or additional access points established upstream from upper canyon (e.g., winch down equipment from S Bangor St)

Discussion / Justification

If original concept is implemented involving machinery placement, construction of each structure will effectively disturb streambed and side slopes throughout project reach anyway, so no real difference in terms of impacts to channel if alternative concept is implemented. Same goes for running materials up the channel via MD-12, where MD-15 can be used to negotiate over/around/through constrictions.

Large Cedar lies up western, less steep slope compared with east side. It can be cut upslope leaving enough weight to keep rootwad in place, and 2-3 sections cut and used in the project; spider excavator may be able to circumnavigate around cut end, and around boulder constriction.

Cost Summary

Description	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$3,181,700	$	$3,181,700
Alternative Concept	$95,300	$	$95,300
Difference	**$3,086,400**	**$**	**$3,086,400**

MC-02 Qualitative Value Alternative

Exhibits – Alternative Concept

Photos of large cedar & boulder constriction

MC-02 Qualitative Value Alternative

Exhibits – Original Concept

Summary Costs Estimated by SPU Design Team

Construction Line Item Pricing	$2,748,443.60
Allowance for Indeterminates	5.00%
Construction Bid Amount	$2,885,865.78
Sales Tax %	10.25%
Construction Contract Amount	$3,181,667.02

MC-02 Qualitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
C399315_Dead Horse_ AccessRd_2022_90pct	LS	1	3,181,667.00	3,181,667

	Subtotal:	**$3,181,667**
Price includes indeterminants	Markup:	$
	Total Cost (Rounded):	**$3,181,700**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Construction access to stream channel from Holyoke Way; rock base	CY	44	50.00	2,200
Clearing brush	LF	2,800	5.00	14,000
Setting up winch / cable yarding	LS	1	10,000.00	10,000
Setting up tripod hoists	EA	5	10,000.00	50,000

	Subtotal:	**$76,200**
25%	Markup:	$19,050
	Total Cost (Rounded):	**$95,300**
	Cost Difference:	**$3,086,400**

SNC·LAVALIN FAITHFUL+GOULD Member of the SNC-Lavalin Group

MC-05 Design Suggestion

Minimize Construction Impact

Don't do anything on private properties along East Fork

Original Concept

The original approach was to install LWM in the East fork of Taylor Creek where significant erosion has been observed. Since this portion of the East Fork is on several private properties that extend down to the creek on either side of the ravine, temporary access will be required to get to these properties to install LWM and timber frame structures.

Alternative Concept

Do not perform any mitigation measures along the Taylor Creek East fork where it is owned by private properties, but leave them as they are.

Advantages

- The approach of taking no action will result in no budget expenditure
- No impact to residents at this location and therefore no community impact
- No disruption of the forest in this vicinity
- Avoidance of time delays of gaining easements or access to these properties

Disadvantages

- Taking no action at this location could make the overall solution more difficult and perhaps more expensive to achieve
- To do nothing on the East Fork would create a potential need to take more measures on the West Fork and other locations to achieve the projects goals
- East Fork has issues such as landslides that perhaps can be addressed most effectively through taking action at the properties along 71st Place South. The East Fork contributes substantially more sediment than the West Fork
- By disregarding doing anything at the properties along the East Fork the project maybe missing out on an access opportunity to the Creek

Discussion / Justification

If no measures are considered and instigated along the private properties at East Fork the solution elsewhere could be less cost effective than incorporating measures at this location as part of an holistic approach.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

MC-06 Quantitative Value Alternative

Minimize Construction Impact

Assemble mechanical equipment in the canyon for use and disassemble to remove

Original Concept

Construct a temporary access road up through the canyon to provide access for heavy equipment. The road would be constructed with a mechanically stabilized earth (MSE) wall system, or "pillow wall" to establish a roadway profile that could be used by heavy equipment. Following construction, the roadway materials would be removed and the trail re-established and landscaping restored.

Alternative Concept

Coupled with other concepts to reduce the overall construction impact on the canyon, bring in modular equipment to aid in moving and setting logs, boulders, and other elements to stabilize the creek and to retain sediments.

Advantages

Reduces overall impact on the canyon.

Reduces overall project cost

Disadvantages

Significantly reduces the size of the structures and facilities that can be constructed

Increases overall duration of the work, as production will be lower.

Potential to increase injuries by using hand equipment on uneven terrain.

Discussion / Justification

This approach would be used in a variety of the discussed hybrid approaches to constructing features along Taylor Creek and in Dead Horse Canyon. With a focus to reduce the overall impact, concepts would be implemented to construct elements on the project site that could be accomplished in some areas with equipment that is transported to the site and assembled for use at each location.

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$6,761,100	$	$6,761,100
Alternative Concept	$3,198,400	$	$3,198,400
Difference	**$3,562,700**	**$**	**$3,562,700**

MC-06 Quantitative Value Alternative

Discussion / Justification (Continued)

Various elements can be carried and assembled on site, coupled with small tools to construct some of the project elements and to supplement work that could be done with a spider excavator, or in areas where there is no possible access by equipment.

Frames and gantry use: Using on site materials, construct frames to lift project elements such as logs and rocks. However, a gantry would provide more flexibility. The various pieces of a gantry could be brought into the site using ATVs, pack animals, helicopter, or other means. The gantry and/or frames would be set up at each location to facilitate the construction of each element in Taylor Creek.

Using jack hammers/drivers, steel posts could be driven into the bank to support or retain log structures in the creek. The use of Diamond Piers (see exhibits) could be used to provide foundations for project elements, and also demonstrates ability to drive 2" diameter posts into the ground using hand equipment.

The use of hand equipment would limit the size of the structures in the creek and could result in ongoing evaluation and modification of the structures over time.

Use of gantries and frames to move and set wood and supporting/retaining elements introduces more hand work in a very uneven and challenging work zone. This increases overall risk and the Contractor's health and safety plan would need to clearly identify how to best manage these risks.

Additional time would be needed to construct project elements using material that is brought in and assembled on site. With the short fish window affecting work in the creek, much (if not all) of the equipment and site materials could be brought in prior to the fish window opening to make best use of the limited construction window in the creek.

The cost impact of this concept is somewhat skewed, as using equipment that is assembled on site would greatly change the nature of the work and overall project outcome. The original concept is based on the construction estimate to construct the 12-foot wide roadway compared with localized improvements to the existing trail that would have minimal impact, as well as evaluating the costs of heavy equipment. The construction cost estimate, dated 7/15/22, was used as a starting point to compare the cost of constructing a temporary road with lesser improvements to the trail plus adding 2 seasons of equipment and labor use for constructing the project elements with smaller equipment. Costs for materials are excluded from this comparison of estimates.

MC-06 Quantitative Value Alternative

Exhibits – Alternative Concept

Crude frame assembled for lifting logs

MC-06 Quantitative Value Alternative

Exhibits – Alternative Concept

DiamondPier

Quick Installation Overview

IMPORTANT: Read Full *Diamond Pier Installation Manual* and View the *Installation Video* at: www.DiamondPiers.com

Before You Purchase

Page references refer to the Full Installation Manual

1. **Know Your Soils** See "Normal Soil Conditions" (page 5) – 1500 psf min supporting soils.
2. **Check Your Loads** "Residential Diamond Pier Load Chart" (page 6) shows Equivalency to Traditional Concrete Footings.
3. **Get Building Permit from Local Municipality** Provide Diamond Pier model size and code compliance documentation. See "Use and Applications" (page 7).
4. **Locate Buried Utilities** Determine safety zones and adequate clearances (page 8).

Documents to Submit with a Permit Application

- ESR-1895 Code Compliance Document
- Wisconsin UDC Approval Evaluation
- Detail Drawings and Load Chart
- See "Use and Applications" (page 7)

To Get Started You will Need...

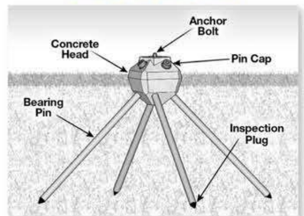
- **The Proper Sized Diamond Pier**
  Includes:
  1 - Concrete Head
  4 - Pins
  4 - Plugs
  4 - Caps

- **Driving Bit** 1-1/8" hex shaft

- **Demo/ Breaker Hammer** 35 lb.+

Ask dealer about rental

Diamond Pier® Detail



Other Common Tools Required...

- Square-Edge Shovel
- Sledgehammer
- Torpedo Level
- Tape Measure
- Pipe Wrench
- Proper Safety Goggles
- Ear Protection
- Insulated Gloves & Protective Clothing

Install in Minutes

A minimum two-person crew is recommended. See Full Installation Instructions pages (11-14).

1. Install plugs in pins to prevent soil from entering as they are driven into the ground. Inspectors can then use a tape measure to verify pin length after installation.
2. Lay out string approx. 12–14" above the ground on center location of post/pier to allow for quick reference point.
3. Remove soil the same size as bottom half of concrete head, approx. 6" depth. Note: Pier can be buried for aesthetic reasons, but access to top of pier needs to be maintained. Concrete slabs, patios, and other products installed MUST NOT interfere with the Diamond Pier system and the attached post/beam assembly. Expansion joints are commonly used to protect the system. Proper drainage must also be maintained.
4. Set concrete head in hole and, keeping the pin centered in the driving hole, carefully set each pin 6–12" into soil tapping with a short grip on sledgehammer until pier is locked into a level position. Note: The edges on the flat top of the concrete head do not have to align exactly with the sides of the post or post bracket as long as the bracket is fully supported by the concrete for proper weight distribution. Piers can be nested next to each other to provide more loading, but if closer than 3' on-center, a 13% load reduction should be applied to each pier.
5. With driving bit attached to the automatic hammer, drive pins in evenly from side to side in equal increments, approx.1–2' each until pin is approx. 6" out. Then double check pier position before final driving of the pins to ¾" out for cap attachment. Note: One person should hold pin to limit vibration to pier while pin is driven.
6. Be sure the pin length is inspected per permit requirements before caps are applied.

Removal/Repositioning if Obstruction Encountered

If a pin stops moving when being driven in, STOP driving the pin. Put pencil mark on pin by head to indicate if pin is moving. With other pins part way in, use the automatic hammer for approx. 10–20 seconds, or give the pin one or two firm square hits with the sledgehammer. If it still will not move, then remove and reposition the pier. To remove, spin and pry a pin simultaneously using a pipe wrench and pry bar. If the obstruction is close to the surface, it may be dug up and removed. Then recompact the soils with the sledgehammer, and reset the pier. See Installation Manual (page 13) and Removal Video available at www.DiamondPiers.com.

Register Your Product Warranty

See information at www.DiamondPiers.com

WARNING: Do not install Diamond Pier foundations before all underground utilities have been located, marked, and de-energized. See "Locate Buried Utilities" in the full Installation Manual at www.DiamondPiers.com

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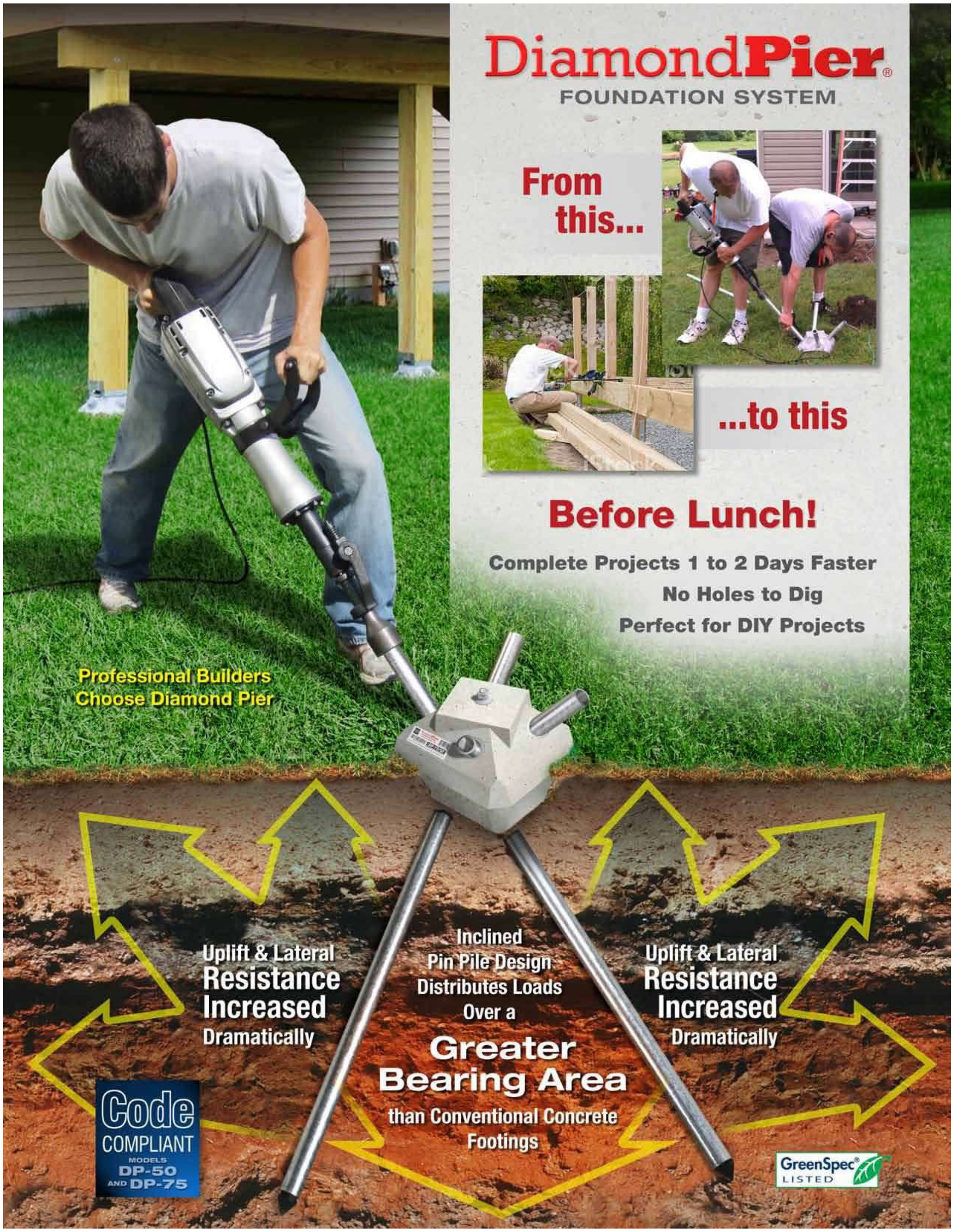
DiamondPier®

MC-06 Quantitative Value Alternative

Exhibits – Alternative Concept



MC-06 Quantitative Value Alternative

Exhibits – Alternative Concept

Vestil Gantry Crane — 4,000-Lb. Capacity, 10ft. X 15ft., Model# FHS-4-15

Item# 103161 (0) Write a Review Ask a Question Top Seller On Sale

Click or Tap image to Zoom

How can we improve these images?

$2529.99

Reg $2729.99 | Save $200.00

Order today to get this price.

Quantity

Qty: 1 **Add to Cart**

Save to List

Shipping:
Factory shipped

See Shipping Options

Store Pickup:
Not available - online only

- Industrial steel gantry cranes are designed for transporting and positioning materials
- Solid steel construction will provide years of service
- Large 8in. dia. locking phenolic casters with roller bearings facilitate easy mobility from one area to another when unloaded
- More economical and flexible than permanent cranes
- Quick setup design

See full description

MC-06 Quantitative Value Alternative

Exhibits – Alternative Concept

Example of a Spider or Walking Excavator at work. The literature for the pictured Menzi Muck says: "Fixed tilting edges on Menzi Muck excavators can be adjusted depending on the task ahead thanks to the adjustable wheel and claw supports. As a result, it produces lifting and ripping forces beyond those of conventional excavators. A Menzi Muck weighing 9.5 tons produces an output similar to that of a 20 ton tracked excavator."

MC-06 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Civil – CSEC and Site Preparation	EST	1	648,556.00	648,556
Civil – Access road construction	EST	1	1,131,615.60	1,131,616
Civil – Access Road and demo/trail restoration	EST	1	968,272.00	968,272
Contingencies and tax	EST	1	433,233.42	433,233
Equipment to construct features	EST	1	729,600.00	729,600
General Labor	EST	1	768,000.00	768,000
Operators	EST	1	729,600.00	729,600

	Subtotal:	**$5,408,877**
25%	Markup:	$1,352,219
	Total Cost (Rounded):	**$6,761,100**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Civil – CSEC and Site Preparation	EST	1	162,139.00	162,139
Trail Modifications	EST	1	282,903.90	282,904
Trail Restoration	EST	1	242,068.00	242,068
Contingencies and tax	EST	1	108,308.36	108,308
Equipment to construct features	EST	1	323,328.00	323,328
General Labor	EST	1	1,075,200.00	1,075,200
Operators	EST	1	364,800.00	364,800

	Subtotal:	**$2,558,747**
25%	**Markup:**	$639,687
	Total Cost (Rounded):	**$3,198,400**
	Cost Difference:	**$3,562,700**

MC-10 Design Suggestion

Minimize Construction Impact

Separate contractors for civil work and stream restoration work

Original Concept

Develop one bid package for the entire project, including stream restoration, culvert replacement, sewer, and drainage components.

Alternative Concept

Develop separate bid packages for 1) all stream restoration efforts, upstream and downstream, requiring related expertise and 2) infrastructure components requiring heavy civil expertise.

Advantages

- More contractors able to bid on portions of the project they are best equipped to perform
- Contractors will have the specific expertise and experience for their scope of work
- City saves costs by allowing most cost-effective contractor for each portion of the project

Disadvantages

- Additional construction administration required to manage a larger team
- Construction permitting not streamlined under one general contractor
- Additional crew meetings and coordination needed to keep crews informed and working efficiently around each other

Discussion / Justification

This arrangement worked well on Illabot Creek, which was a partnership between Skagit County Public Works and the Skagit River System Cooperative (SRSC). One appropriately experienced contractor constructed two bridges and a second appropriately experienced contractor constructed new stream channels and habitat structures. Permitting was combined. Skagit County supervised the bridge construction, and SRSC's engineer consultant inspected the stream work. The two contractors coordinated project timing, staging, and access successfully. The project won an APWA award. Summary details can be found at:
https://skagitcountywa.gov/PublicWorks/Documents/2018%20Public%20Works%20Annual%20Report.pdf.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

MD-01 Design Suggestion

Materials Delivery Logistics

Use identified hazard trees on site as a source for logs and rootwads

Original Concept

Import logs and rootwads from off site

Alternative Concept

An arborist qualified in Tree Risk Assessment by the ISA would determine which trees are very likely, likely or somewhat likely to impact the trail. These trees would then be further assessed to determine the consequence of failure, value as habitat in-situ, and value in stream restoration efforts. Trees that pose an imminent threat to park user safety and have high value as stream habitat would be topped. The height of the remaining snag would be determined based on mitigating the hazard. Hazard trees very near the trail would likely be removed with their rootwads intact.

Advantages

- Reduced transportation costs and related greenhouse gas emissions
- Increased safety for trail users
- Reduced cost
- Reduced impacts and time related to transport up the ravine
- Great source of slash

Disadvantages

- Would include more deciduous species that degrade more quickly in streams than conifers
- Disturbance of vegetation from felling, hauling trees
- Trees removed from natural area
- Opening of canopy can increase threat of invasive species
- Only a few trees would warrant being used
- Would need to identify all hazard trees on the Park's property since only trees along the proposed temporary access road have been surveyed

Discussion / Justification

The VE team noted trees above the trail that appeared to be at risk of falling over the trail. Some were in poor health and others were precariously situated at the top of erosion scarps. The team felt that consideration should be given to using part or all of these trees on a case by case basis. This would not preclude leaving some of the tree in situ as a habitat snag unless the hazard could not be mitigated without a full removal.

MD-03: Use down wood near the channel or spanning the channel.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

MD-01 Design Suggestion

Exhibits – Alternative Concept

The chart above from the Arborists report (Bartlett) identifies trees greater than 6" DBH and near the trail by species and health. This indicates that there are at least a few candidates for additional study. Note that this survey was only performed along the temporary access road, which mostly coincides with the trail location.

MD-01 Design Suggestion

Exhibits – Alternative Concept

MD-03: Use down wood near the channel or spanning the channel

The design team noted about a dozen "spanner logs" which are trees that have fallen across the channel, but are perched above the water. Using winches or other equipment these logs could be dropped into the channel and used in combination with other logs and boulders to create structures that capture and store sediment

MD-18: Source logs from post-forest fire cleanup

Logs and trees salvaged after wildfire could be used in addition to other source. The limiting factor would likely be transportation cost, but several salvage operations are occurring now. Trees would be slated for removal anyway, either for timber value or due to hazards (trees falling across roadways after a fire is a common hazard that prompts the felling of many burned trees). Using trees from public lands would help ensure that salvage operations have limited ecological impact.

MD-19: Consider use of native deciduous tree species for log sources

The original concept calls for the exclusive use of conifers for log structures. Conifer logs have been shown to greatly outlast deciduous logs in this application, but the VE team believes that the use of deciduous logs in limited, not structural locations will provide the same function in terms of capturing and storing sediment while also providing other ecosystem benefits. This alternative concept would provide cost savings and reduce the overall impact of the project by allowing the use of much more locally sourced material.

MD-20: Obtain logs from tree removal in other parts of the city

Seattle Parks and Recreation, Seattle Department of Transportation and Seattle City Light all remove trees regularly. This suggestion is to work with the City's Office of Sustainability to identify suitable trees that are scheduled for removal and that would be appropriate for use on this project. SPU would pay any additional cost to have the trees salvaged for reuse on this project and could use the acquired properties for temporary storage.

MD-02 Quantitative Value Alternative

Materials Delivery Logistics

Use helicopter delivery for materials

Original Concept

Construct a temporary access road into Dead Horse Canyon to permit he delivery of logs, materials and equipment to the project site.

Alternative Concept

Use a helicopter to deliver logs to various areas of the project site, along Taylor Creek. This would involve staging the logs during the winter, where there would less foliage in the tree canopy. Logs would be staged in the baseball field that was recently renovated on Rainier Ave. S.

Advantages

- Minimize impacts from building a temporary access road into the canyon
- Ability to deliver large logs at nearly all areas of Taylor Creek
- Reduced time to deliver all planned logs and possibly other materials such as slash and/or boulders

Disadvantages

- Cost of helicopter
- Definite need to vacate 3 to 4 homes and roadway during flights
- Noise and blowdown impacts to trees and other vegetation from use of the helicopter
- Impact to the newly renovated Lakeridge Playfield from using it as a staging area for logs and materials before being moved into the canyon
- Potential difficulty in getting permits for helicopter operations and Lakeridge Playfield use

Discussion / Justification

The use of a helicopter, if permitted, would negate the need to construct an access roadway up through Dead Horse Canyon. Smaller equipment could be walked up the creek alignment to areas where trees and logs have been staged by the helicopter. This would also negate the need to either skid logs or haul up using trailers on the back of ATV or other small equipment.

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$3,977,100	$	$3,977,100
Alternative Concept	$268,800	$	$268,800
Difference	**$3,708,300**	**$**	**$3,708,300**

MD-02 Quantitative Value Alternative

Discussion / Justification (Continued)

Viability of a helicopter

The typical length of cable on helicopter is 100-feet. The tree canopy is approximately 80 to 100 feet in height. In discussion with Fair Lifts (www.fairlifts.com), they can provide a 150 or 200 foot cable on the bottom of the helicopter, which would work with the current height of the tree canopy.

According to discussions with Fair Lifts, the City of Seattle does not permit the use of the Huey helicopter and the work will be limited to a smaller helicopter with a reduced lifting capacity. The proposed helicopter would be able to haul 2 to 3 logs per trip, with an estimated weight per log of 1,000 pounds.

In order to be used as a staging area, the existing Lakeridge Playfield would need to be protected with hog fuel or temporary surfacing to provide protection to the field from the movement of equipment for the delivery and staging of logs to be lifted. Following the flight of the logs up the canyon, the playfield would need to be restored. Additionally, the playfield would need to be closed for roughly 1 to 2 months to permit this operation. Log delivery in early winter should make this feasible.

For safety reasons, the helicopter needs 150 feet of clearance on each side of the flight path. There is a native / forested pathway from the playfield to Dead Horse Canyon. There are two houses that have approximately 245 feet between them. To provide a safe corridor for the helicopter, approximately 3 to 4 homes would need to be vacated during the flights. This would require the City to provide temporary housing for the impacted properties for approximately 2 to 3 days, depending on the total number of logs to be delivered. Holyoke Way South through the project and down to Rainier Avenue South would also need to be closed to traffic during this operation.

Production rate and cost

Fair Lifts is providing a written cost estimate that is approximately $120,000 for the work. This cost estimate will be provided when it comes in. Their production is based on 9 picks per hour and the ability to haul 2 to 3 logs per pick. Working 8 hours per day would result in 72 picks per day. Depending on the total number of logs needed (between 500 and 700 logs), it would take between 2.5 and 5 days of flight time. The total number of logs is showing a range as the size and scope of the log features along Taylor Creek could be changed from the current design.

The overall cost would need to include the site preparation and restoration of the Lakeridge Playfield.

A key component of this Alternative is to deliver the majority of needed materials in the winter and store them along the stream for use in construction during the fish window when those materials get placed. Having the needed materials nearby will expedite placement and maximize the work that can be completed within the fish window.

MD-02 Quantitative Value Alternative

Exhibits – Alternative Concept

Proposed flight path of helicopter

MD-02 Quantitative Value Alternative

Exhibits – Alternative Concept

MD-02 Quantitative Value Alternative

Exhibits – Alternative Concept

MD-02 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Construction of temporary access road	EST	1	3,181,677.00	3,181,677
* per City estimate of temporary roadway				

	Subtotal:	**$3,181,677**
25%	Markup:	$795,419
	Total Cost (Rounded):	**$3,977,100**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Staging and site prep	EST	1	20,000.00	20,000
Restoration of playfield	EST	1	50,000.00	50,000
Helicopter flight for 3 days	EST	1	120,000.00	120,000
Labor to support helicopter	EST	1	20,000.00	20,000
Temporary housing for impacted properties	EST	1	5,000.00	5,000

	Subtotal:	**$215,000**
25%	**Markup:**	$53,750
	Total Cost (Rounded):	**$268,800**
	Cost Difference:	**$3,708,300**

MD-06 Quantitative Value Alternative

Materials Delivery Logistics

Use small tracked vehicle (ATV) to haul logs and other materials along existing trail

Original Concept

The current construction approach considered the use of Compact Skidders and Log Loaders which are typically towed by a tractor or similar vehicle that would require roadway improvement to get up the trail. Widening of the existing trail would require the removal of trees and compaction of the root zone of remaining trees due to the ground pressure and depth of roadway fill.

Alternative Concept

Use four wheel drive All Terrain Vehicles (ATVs) or very small tracked equipment to haul logs up the existing trail without widening it. This would require installation of tree protection at key locations and driven posts on the down slope side of the trail to prevent equipment from sliding off the trail. This would also require periodic maintenance of the trail during construction and trail rehabilitation after construction. This method would likely be supplemented by the use of winches on steeper sections of trail.

Advantages

- Allow the transport of logs with minimal long term impacts to the forest and trail
- Can accommodate transport of large logs (up to 1 ton each) if used in conjunction with winching
- Works well with other methods (Spider excavator, tripod hoists, winches)
- Poles could be used for a split rail fence after construction to improve trail safety and discourage trampling of vegetation
- Logs could be hauled to confluence foot bridge and dropped into high incision reach

Disadvantages

- Requires trail closure during construction
- Minimizes but does not eliminate the risk to existing trees
- Requires an alternate method to get logs down to the channel
- Risk of fuel spill or equipment slipping off the trail and rolling down the ravine
- Uphill and downhill transport cannot happen at the same time, which could limit productivity

Discussion / Justification

The VE team understands that widening the existing trail would have unacceptable impacts to the surrounding forest, but we did feel that the existing trail offered an excellent opportunity to transport even large logs to the upper ravine. The surfacing of the trail would need some improvement, which could be a long term benefit for accessibility. The risk of equipment sliding off the trail would be minimized with the installation of poles into the soil along the downslope side of the trail. These poles could be utilized for a future fence or railing that would improve accessibility and protect vegetation.

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$1,172,500	$	$1,172,500
Alternative Concept	$1,029,500	$	$1,029,500
Difference	**$143,000**	**$**	**$143,000**

MD-06 Quantitative Value Alternative

Exhibits – Original Concept

MD-06 Quantitative Value Alternative

Exhibits – Original Concept

MD-06 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Haul Logs Machine Option	LS	1	488,000.00	488,000
Highline Setup/Operation	LS	1	450,000.00	450,000

	Subtotal:	**$938,000**
25%	Markup:	$234,500
	Total Cost (Rounded):	**$1,172,500**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
ATV and Operator (run 2 at a time)	hour	1382	150.00	207,300
Loader and Operator	hour	691	190.00	131,290
Unloader and Operator	hour	691	190.00	131,290
Highline (limited travel)	LS	1	225,000.00	225,000
Split Rail Fence	FT	2250	35.00	78,750
Trail Restoration	LS	1	50,000.00	50,000

	Subtotal:	**$823,630**
25%	**Markup:**	$205,908
	Total Cost (Rounded):	**$1,029,500**
	Cost Difference:	**$143,000**

MD-08 Quantitative Value Alternative

Materials Delivery Logistics

Buy a property in the right location and install slide or highline for material delivery

Original Concept

No purchase of a property, using existing access from the lower end of the project, off of Holyoke.

Alternative Concept

Acquire a property at a strategic point along the canyon to provide construction access to install a high line and/or provide a pathway to deliver materials down slope to Taylor Creek. The installation of materials could be accomplished with a high line or by placing plastic sheeting on the bank and sliding down materials to the bottom of the canyon. While this Alternative on its own cannot replace a temporary access road, it would lead to less use of that access road. However, in combination with other Value Alternatives, such as MC-06, it could eliminate the need for a temporary access road.

Advantages

- Reduced reliance on an access road being needed up the canyon
- Potential future access point for the trail, depending on location and grade of slope
- Ability to bring larger materials up the canyon than using small equipment (ATVs or pack animals)
- In combination with other Value Alternatives, could help eliminate the need for a temporary access road

Disadvantages

- Cost of purchasing property and possibly demolishing the residence
- Time to acquire a property through traditional property purchase by a willing seller
- Time for permitting and completing deconstruction of a residence
- Will require SPR/SPU future use determination for the property after construction
- Requires a willing seller

Discussion / Justification

The purchase of a property could provide added benefit of another access point that could deliver materials to the confluence of the creek and possibly up the west and east forks of Taylor Creek. There is also the ability to slide materials down the slope. This would have a localized impact to the vegetation directly in this pathway.

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$125,000	$	$125,000
Alternative Concept	$1,268,800	$	$1,268,800
Difference	**$(1,143,800)**	**$**	**$(1,143,800)**

MD-08 Quantitative Value Alternative

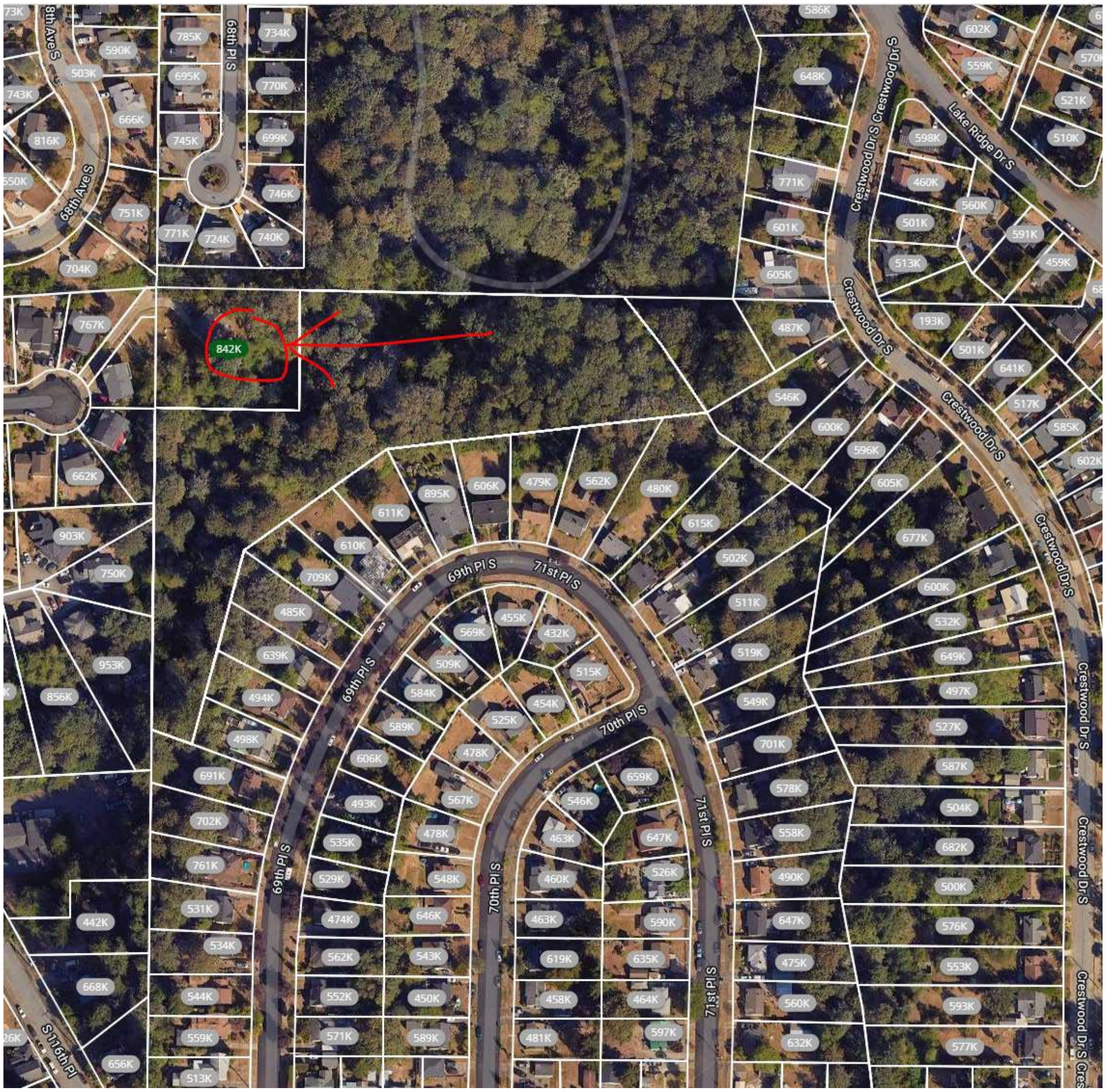
Discussion / Justification (Continued)

Properties in the area range from roughly $500,000 to $1,000,000. Once the property is acquired, the residence would need to be demolished and the lot prepared for use for construction. It is assumed that some level of asbestos and lead paint abatement would be needed. Following the construction, the property could be converted into park property and possibly could lead to a new access point to the trail.

The installation of a high line on this property would permit the delivery of materials (logs) to multiple points, depending on the ability to snake a cable through the trees to a desired spot. This would permit the delivery of larger material than could be skidded or towed up the canyon with small equipment (ATV or skid steer tractor). This could also allow the delivery of material to the east fork of Taylor Creek.

MD-08 Quantitative Value Alternative

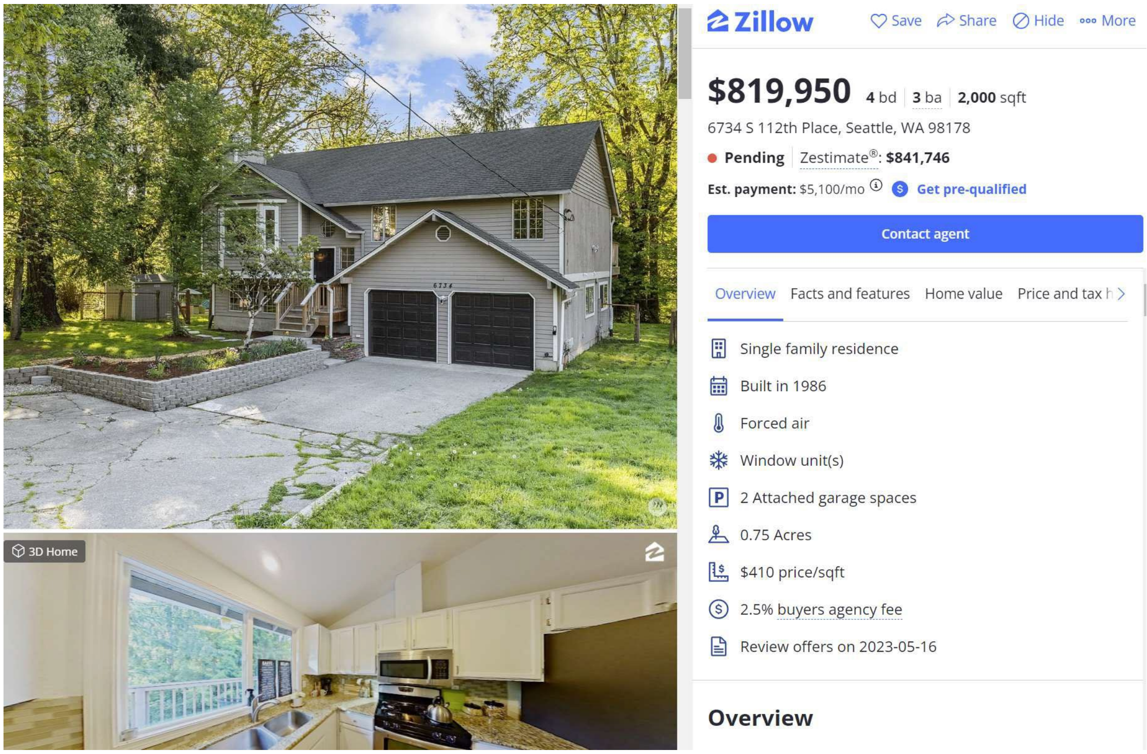
Exhibits – Alternative Concept



Costs of homes in area, per Zillow.com Note one property for sale

MD-08 Quantitative Value Alternative

Exhibits – Alternative Concept



Property for sale

MD-08 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Use of small equipment to deliver wood and materials up the canyon	EST	1	100,000.00	100,000

	Subtotal:	**$100,000**
25%	Markup:	$25,000
	Total Cost (Rounded):	**$125,000**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Purchase of property	EST	1	900,000.00	900,000
Demolition of property and site prep	EST	1	75,000.00	75,000
Restoration of property	EST	1	40,000.00	40,000

	Subtotal:	**$1,015,000**
25%	**Markup:**	$253,750
	Total Cost (Rounded):	**$1,268,800**
	Cost Difference:	**$(1,143,800)**

SNC·LAVALIN FAITHFUL GOULD Member of the SNC-Lavalin Group

MD-10 Quantitative Value Alternative

Materials Delivery Logistics

Use pack animal delivery for materials

Original Concept

The original concept was based on several variables that explored potential hand-delivery, machine delivery, or a hybrid of the two methods.

Alternative Concept

Use pack animals to deliver material throughout canyon along the existing trail.

Advantages

- Can function on uneven and narrow terrain
- Little to no trees would require removal to provide access for pack animals
- Reduced carbon footprint associated with greenhouse gases that would be generated by machinery

Disadvantages

- Limitations in log size for stability/maneuverability during delivery
- Greater risk of injury (human and animal) associated with navigation along narrow trail
- Trail modifications required for animal and human safety
- Damage to trail and slopes associated with pack animal use and dragging large wood

Discussion / Justification

For the purposes of this analysis, we are not comparing the use of pack animals to another proposed delivery technique, but rather assessing the logistics, feasibility, and cost associated with this methodology. While the possibility of using pack animals within the stream channel was discussed, it was dismissed due to a very uneven terrain and obstacles to their passage.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

MD-10 Quantitative Value Alternative

Discussion / Justification (Continued)

Pack animals are still widely used in underdeveloped areas to aid in construction techniques; however, their use in the United States was phased out after the development of the combustion engines. With growing awareness and concern over the impact of greenhouse gases generated by combustion fuels as well as the large footprint required for larger equipment and machinery, the use of pack animals is being explored as an option for delivering logs throughout the canyon to construct the proposed structures. Specifically within Dead Horse Canyon, the potential use is limited by the size of the trail, the proposed size of the logs to construct the structures, and the terrain.

The existing trail is approximately 0.4 mile long with an overall elevation gain of 127 feet. The trail width varies in width from 3 to 8 feet between steep slopes. The width of the trail is further restricted by the presence of large trees and bridges. The trail through Dead Horse Canyon was not designed for equestrian use and would require modifications for safety and navigability such as removing stairs, eliminating muddy areas, and reducing trail slope for safe navigability. To provide slope stability and improve conditions for safety, the downslope side would require posts. To allow crossings further up the trail, the boardwalk and bridge would need to be replaced. Additional considerations would be required for pulling a long log along portions of the trail where there are bends or turns that further restrict or hinder mobility.

Due to the narrow trail size and limitations to expanding the trail width without compromising the existing unstable slopes and removing large trees, the passage would be limited to one pack animal. The weight that a pack animal could pull varies by species and size. Below are some estimates:

- Draft horse: 8,000 lb
- Horse (not draft horse): 1,800 to 2,400 lb
- Mule: 1,200 lb
- Donkey: 2,200 lb

The size of the logs proposed in the original concepts were mainly 18-inch-diameter, 30-foot-long logs, which weight approximately 2,200 lb. To prevent injury of pulling through rough terrain, this limits the suitability of pack animals so only draft horse would be a consideration. By pulling the logs behind a pack animal, the maneuverability is limited so the log could only be safely transported in the direction the animal is moving. In areas where there are tight turns along the narrow trail, this could reduce mobility so the transport uphill along the narrow trail without the ability to backup or make tight turns is not feasible.

Draft horses weigh between 1,400 to 2,000 pounds. This weight, spread over four hooves, would damage the soft soil of the trail, decompacting and causing erosion or further instability. Additionally, the log would be pulled in a manner that the end is dragging behind the draft horse, further disturbing the trail soil and creating sources of erosion and instability.

MD-12 Design Suggestion

Materials Delivery Logistics

Use winches & hoists to assist with material delivery

Original Concept

Deliver log materials over constructed trail, from upper rim of canyon at selected locations, and/or helicopter

Alternative Concept

In conjunction with MC-02, use high capacity winches with cable to move logs, boulders, etc. upstream from Holyoke Way crossing to placement locations. Use overhead tripod or four-legged hoists to move materials past local in-channel obstructions. Can be done in incremental sections of channel moving upstream.

Advantages

- Avoids need for trail and slope delivery method construction/impacts
- Allows for manual placement using mechanical advantage at placement site
- Portable winch with 3000 lb+ pulling capacity single line weighs ~50 lb

Disadvantages

- Heavier winches (up to 500 lb) could require up to 6 workers to move in unstable/irregular terrain using specialized transport method = safety risk
- Reliance on manual labor vs. machinery = time consuming
- Better suited for light touch design ((RS-06, RS-07) than original concept based on number of logs required

Discussion / Justification

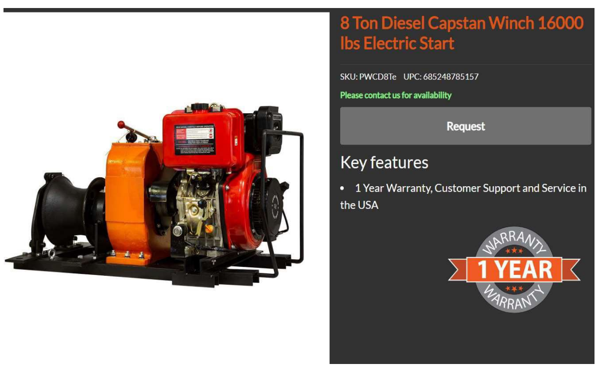
Feasible approach in conjunction with either original concept or alternate design approaches (RS-06, RS-07).

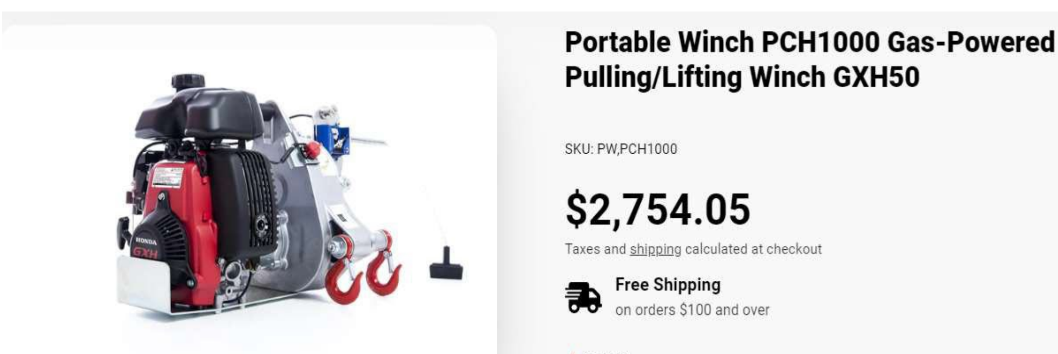
Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

MD-12 Design Suggestion

Exhibits – Alternative Concept





Representative photos of winch and hoist/gantry crane

MD-21 Design Suggestion

Materials Delivery Logistics

Use existing easement to establish slide or highline to bring in material

Original Concept

Use a combination of smaller equipment on new roadway to construct highlines into target reaches at three locations along the roadway. Each highline will have the ability to pivot to three locations along the stream channel.

Alternative Concept

Utilize existing utility easements to mobilize specialized equipment into place that can be used to highline material into the ravine. Narrow easements would necessitate the use of very small equipment to transfer logs from staging area to highline. Additionally ground improvements would be needed at crane pads to ensure stability. Tree trimming would likely be required due to lower cable height and lower system capacity.

Advantages

- Provides additional locations for bringing materials down to the creek
- Does not require acquisition costs or delays

Disadvantages

- Need to use streets as staging areas will be disruptive to neighborhoods
- Larger cranes would be needed to deliver materials into the canyon from a higher, farther away locations at the top of the rim
- Ground and canopy disturbance
- Materials could only be delivered to less than ideal locations
- Requires double handling of all material
- Limited capacity and specialized equipment requirements

Discussion / Justification

It is possible that this suggestion could have a place if it was determined to be the best way to deliver specific materials to specific locations. Mobilization would likely be a major cost driver and could make the limited use cases cost prohibitive.

Discussion / Justification

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

MD-21 Design Suggestion

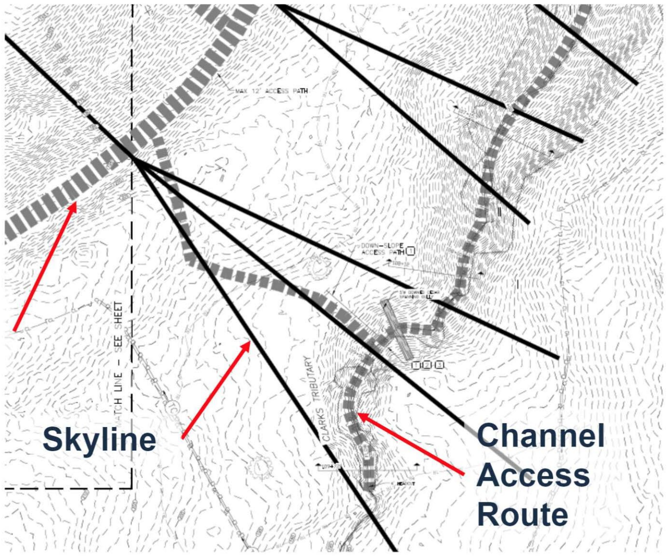
Exhibits – Original Concept

Construction Methods

Challenges:

1. Steep, unstable slopes, loose soils
2. Large material quantities
3. Short timeline, and narrow difficult install sites

Upland Access Route

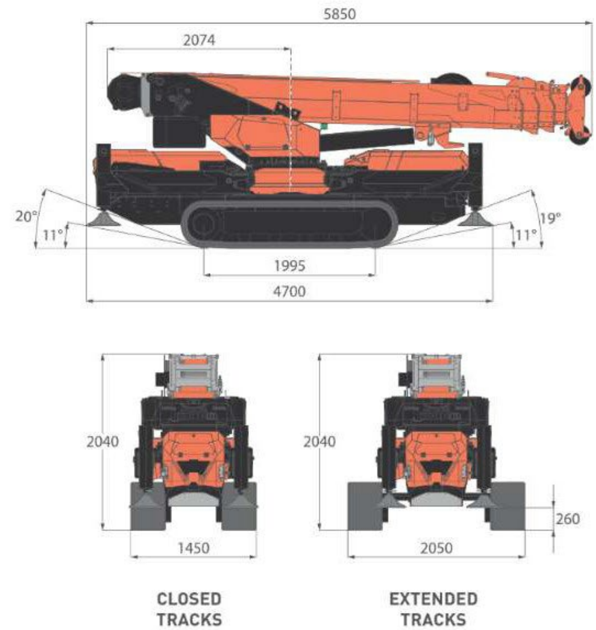


Solutions:

1. Upland access routes and staging
2. Skyline material delivery
3. Machine install (size limits) and hand install in channel

MD-21 Design Suggestion

Exhibits – Alternative Concept



MD-21 Design Suggestion

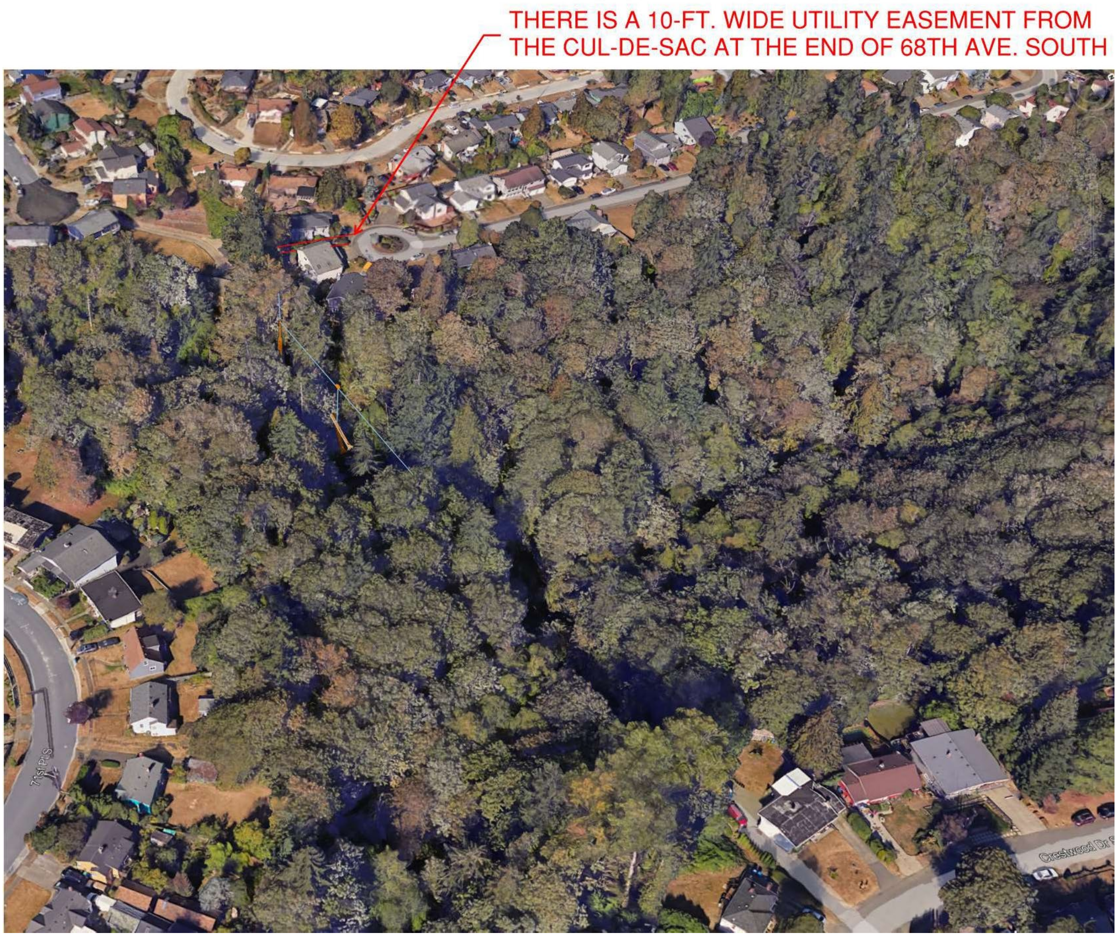
Exhibits – Alternative Concept

MD-21 Design Suggestion

Exhibits – Alternative Concept

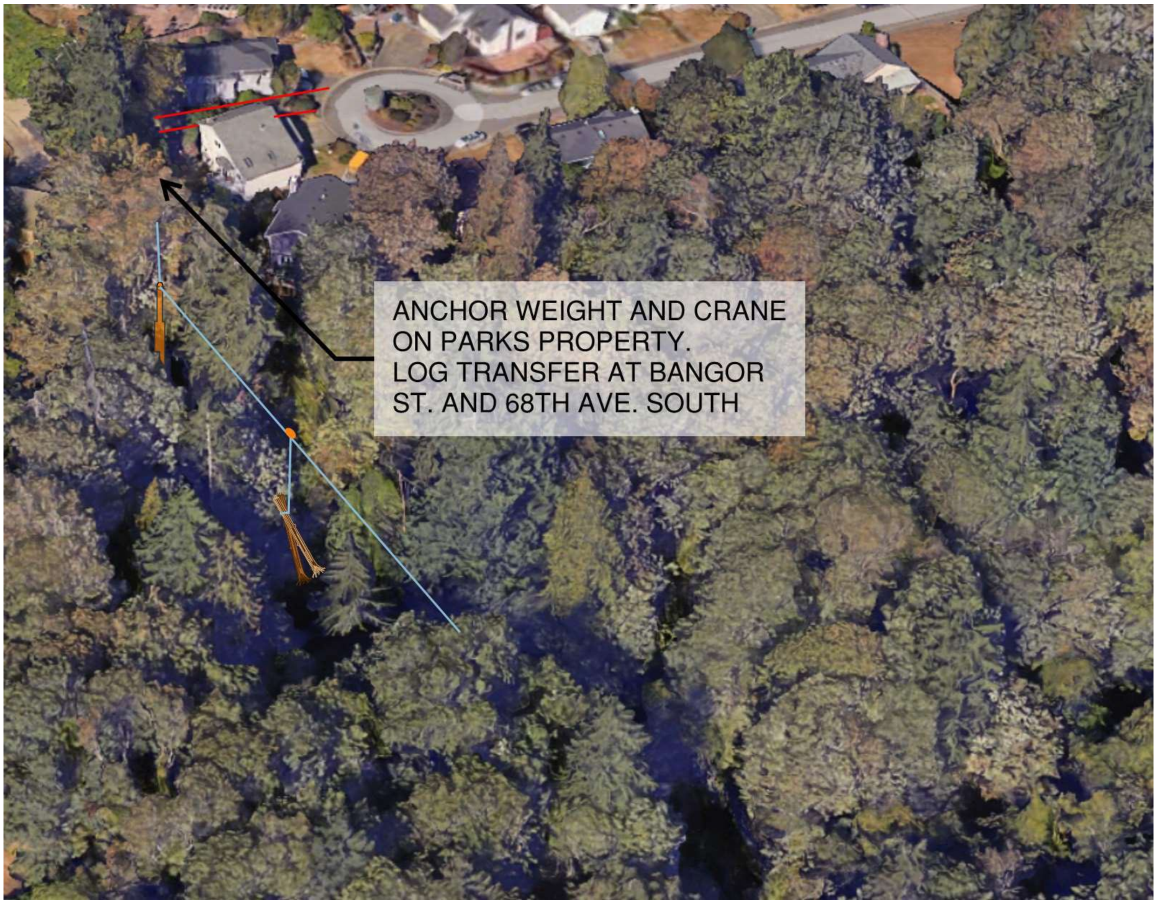
MD-21 Design Suggestion

Exhibits – Alternative Concept



MD-21 Design Suggestion

Exhibits – Alternative Concept



MD-22 Design Suggestion

Materials Delivery Logistics

Use logs spanning channel, built as you go, to move materials up the streambed

Original Concept

The original concept was to bring logs in by one of three methods:

1. Build a road along existing trail which is infeasible to construct without excessive impact.
2. Construct highlines into target reaches at three locations along the roadway. Each highline will have the ability to pivot to three locations along the stream channel.
3. Bring material up the channel by hand which limits the size of material, greatly increases cost and could be unsafe for workers.

Alternative Concept

Construct a skid road of logs up the creek to winch logs up the ravine. Logs would be placed with a spider excavator from the bottom of the ravine up and perpendicular to the channel. These skid logs would be set high enough above the channel to clear existing obstacles and six to ten feet apart. Winches would then drag additional logs over the skid logs. Other material such as slash and gravel would be hauled on simple sleds. Once materials have been winched up the stream the crib logs would be removed and hauled up as needed from the bottom up.

Advantages

- Relatively low impact
- Trail could remain open
- Does not disrupt neighborhoods above the canyon
- Less labor intensive than hand carrying
- Has capacity for large logs

Disadvantages

- Labor intensive relative to other mechanical techniques
- Requires additional restoration where skid logs are placed on the banks
- Difficult to construct and execute during existing work window (would require an exemption)
- Requires an experienced and/or creative contractor

Discussion / Justification

In concept, logs would be brought in via a staging area at the Holyoke Way South hairpin. Skid logs would be placed such that they span the channel and are supported by the banks. Dunnage or other ground improvements would be used to roughly level the skid logs. Additional logs would be pulled up over the skid logs and used initially as skids. Other materials such as slash, manila, plants and gravel would be transported in long narrow sleds capable of being hauled up over the skids. Winches would be placed on the banks to haul logs up in relatively short segments due to the bends in the creek. Additional skids may be required at these bends. Existing, fallen trees that span the channel could be used in situ or with some modification.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

MD-22 Design Suggestion

Exhibits – Alternative Concept

A typical skid road. In this application, longer logs would be used to span the creek.

MD-22 Design Suggestion

Exhibits – Alternative Concept

4HS56M Power Winches

Capacity: 48,000 - 56,000 lbs.

Line Speed: 20 - 35 fpm.

Travel Dist.: 720 - 1,630 ft.

HP: 30 - 50

Examples of electric and gas/diesel powered winches that would be anchored in place on the banks of stream.

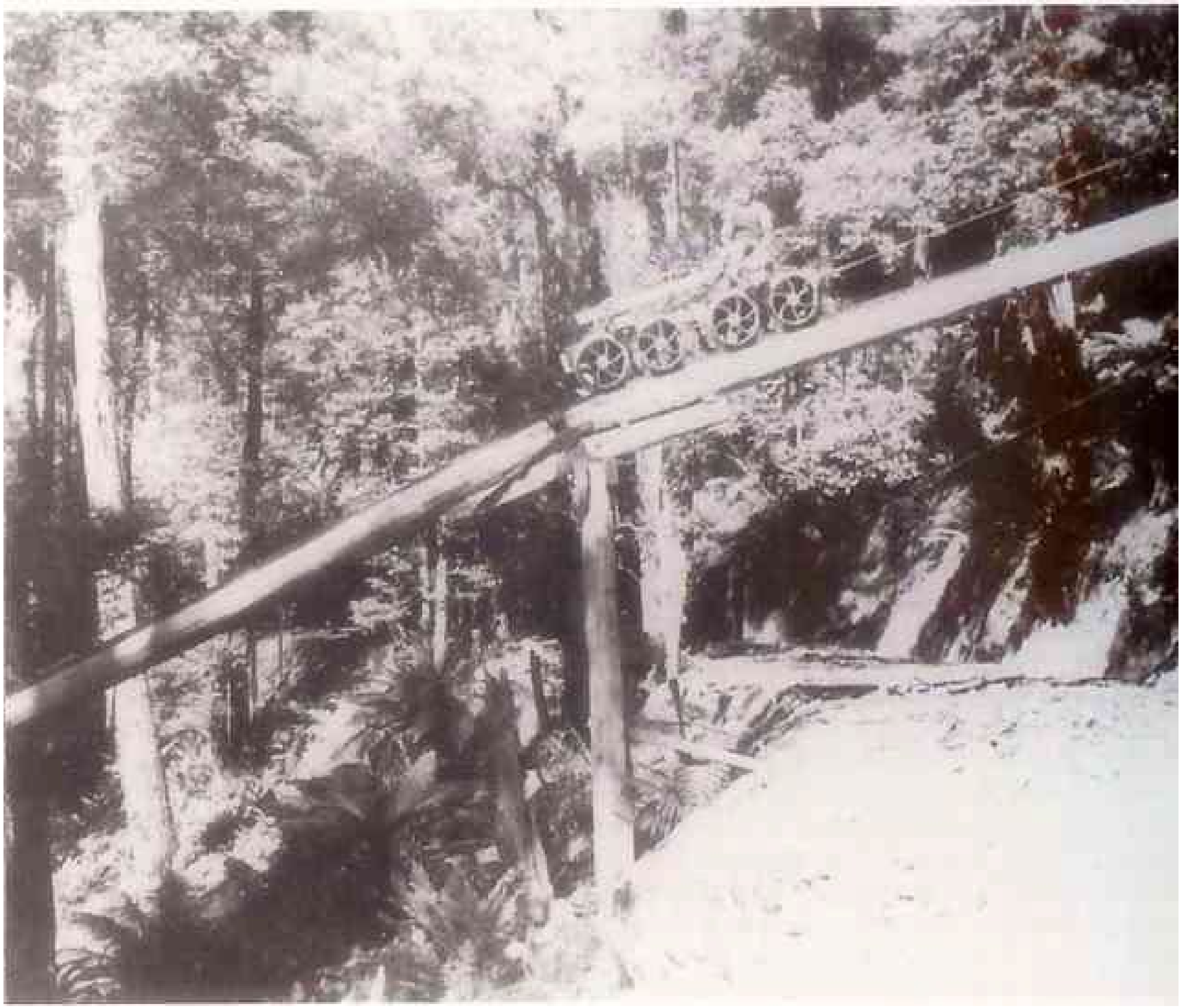
MD-22 Design Suggestion

Exhibits – Alternative Concept

A variation on the skid road that is an example of how logs could be used to build cribbing to elevate the skid road over obstacles.

MD-22 Design Suggestion

Exhibits – Alternative Concept



A long tram is a similar concept that is more complex to build but uses fewer logs.

RS-06 Quantitative Value Alternative

Retain Sediment in Canyon

Use smaller structures initially and return in future years to increase placements where required

Original Concept

Build 23 structures (18 between forks and Holyoke Way; 4 in lower East Fork, 1 in lower West Fork); each structure composed of 46 logs mostly 18" diameter (11 x 30 ft w/ rootwads, 31 x 30 ft w/o, and 4 x 20 ft w/o), placed to form channel-blocking porous log jam approx. 60 ft long upstream-downstream, 5 ft high, Selected logs are bolted together throughout structure in 4 layers. Intent is to store future (mostly coarse) sediment and build grade up to 5 feet thick.

Alternative Concept

Install smaller accumulations of wood distributed at more locations, in conjunction with boulder placement (RS-07). Return after monitoring indicates sufficient raising (1'-2') of grade has occurred and repeat. As part of this, place additional wood on upper banks during first year of construction for use in second effort (anticipated to occur within 5-10 years).

Several options considered for type of placement:

1. 1-2 x 30 ft logs with or without rootwads between 12"-16" diameter placed diagonal across channel, one log wedged on stream bottom between banks sloping in downstream direction, a second may be placed raised across channel upstream of or crossing first log, also wedged between banks.
2. 1-2 x 30 ft logs with rootwads on channel bottom at each bank toe, and leaning upslope; boulders placed as irregular array downstream of contraction between (i) rootwads or (ii) rootwad and opposing bank with boulders.
3. Shorter log(s) pinned against posts inserted/drilled into underlying substrate/highly compacted clay material, respectively.
4. Beaver dam analogs with smaller diameter posts and slash.

Advantages

- Requires purchase and delivery of fewer logs for in-channel and timber frame structures (material cost savings)
- Lighter touch approach that can be constructed with or without use of spider excavator; no bolt hardware required
- Options without posts do not require excavation
- More compatible with adaptive management process
- Lower risk of upstream fish passage difficulty in event of major landslide input
- Resembles natural template in channel (see photo exhibit)

Disadvantages

- Options with posts require excavation/augering
- Smaller diameter logs have shorter lifespan, although wood decay model in NSD report indicates 12"-16" Douglas Fir logs should still remain intact > 30-50 years when placed in channel
- May retain less sediment than 5 feet grade raise (although see caveat in discussion)

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$3,057,000	$	$3,057,000
Alternative Concept	$1,367,100	$828,000	$2,195,100
Difference	**$1,689,900**	**$(828,000)**	**$861,900**

RS-06 Quantitative Value Alternative

Discussion / Justification

Basis for raising grade by up to 5 feet was justified in original concept by assumed depth of incision, and on principle that supporting the toe of an unstable slope can stop or slow down mass wasting associated with toe erosion. On the other hand, field observations walking up the channel indicates that (i) there are also locations where incision appears to have been less, for example around 2 feet or thereabouts a short distance upstream from the Holyoke Way crossing, and (ii) there are various locations, particularly along the east bank, where the adjacent hillside is composed of exposed highly compacted clay material that is more resistant to erosion, undermining, and collapse.

Note furthermore that gravel transported to delta could well have been sourced originally from primarily channel incision, and that with installation of measures to stop further incision that will no longer be a dominant source of gravel downstream. Which then implies that the material needed to fill the structures to 5 feet throughout the project reach will need to come almost exclusively from sidewall and upslope mass wasting failures. Some of the material on the western upper slope appears to be glacial outwash with abundant gravel (e.g., seen along trail), but most exposed slopes and banks were observed to be composed of either highly compacted clay material or a gravel-silt-sand conglomerate where the gravel composition was eyeballed to be around 10%-30% by volume (see exhibit photos 1 and 2, respectively). Hence, a significant fraction of mass wasting material delivered to the channel may end up effectively as washload, and the time to fill behind the original concept structures and raise the grade by 5 feet along the entire length of the channel could be long (20 years+? - spit-balling here). In the meantime, some structures could fill completely after a local mass wasting event, resulting in a fish passage blockage until the rest of the channel grade is raised.

A lighter touch, completed in two iterative lifts (stages), would cost less, more scale-consistent/closely resemble the natural template seen in the channel (i.e., better aesthetics; exhibit photo 3), allow greater flexibility on the part of SPU to manage sediment in the basin in the event delivery is slower or faster than estimated, minimize potential for fish passage blockage, and along with RS-07 could be implemented in concert with other alternatives such as MC-02, MD-01, MD-04 with an A-Star or equivalent helicopter, MD-06, MD-10, MD-12, MD-15, and MD-22.

This option would require a commitment from SPU to return to the site in 5-10 years. However, if logs are already staged onsite along the channel upslope, would not necessarily need machine access then.

Laying out cross-channel logs on the channel profiles in the 90% plan set (cf. sheets 59-62; see exhibit schematics 4, 5, 6), where the spacing between logs is determined by a one feet rise above a 1 feet burial depth at each log placement location once the channel achieves grade, with minor slope of deposited material surface between placements, results in needing approximately 340 logs (if doubled at each location), and achieves maximum fill along the length of the project reach on the order of approximately 1,800-2,200 CY after the first lift, and potentially a similar amount after the second lift is filled. All schematics created by the author on top of design team plans.

Exhibit schematics 7 and 8 depict an alternative opposing rootwads placement layout. Placement relying on posts may be more difficult to construct and require gas-powered equipment to get posts in.

RS-06 Quantitative Value Alternative

Exhibits

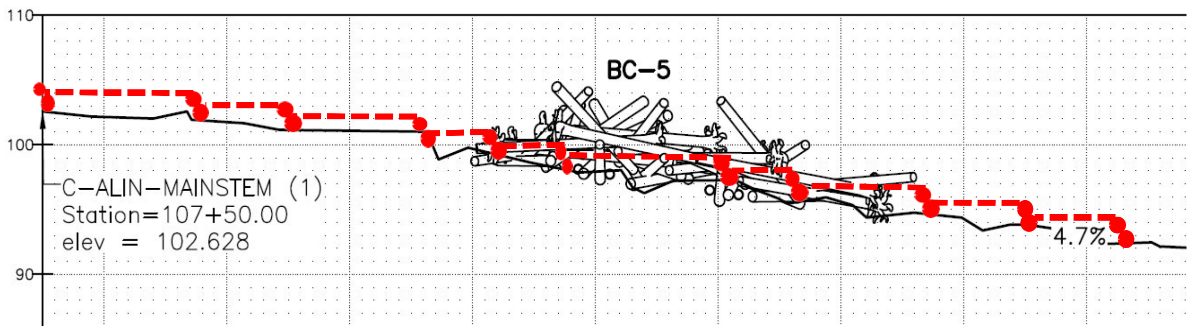
Photo 1: Highly compacted clay material sidewall and grade control

Photo 2: Finer grained sand and gravel at eroded bank

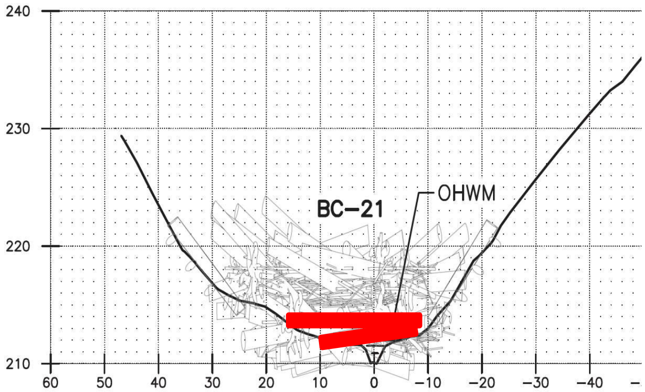
Photo 3: ~12”–14” diameter log across channel with 1–2 ft of sediment retention

RS-06 Quantitative Value Alternative

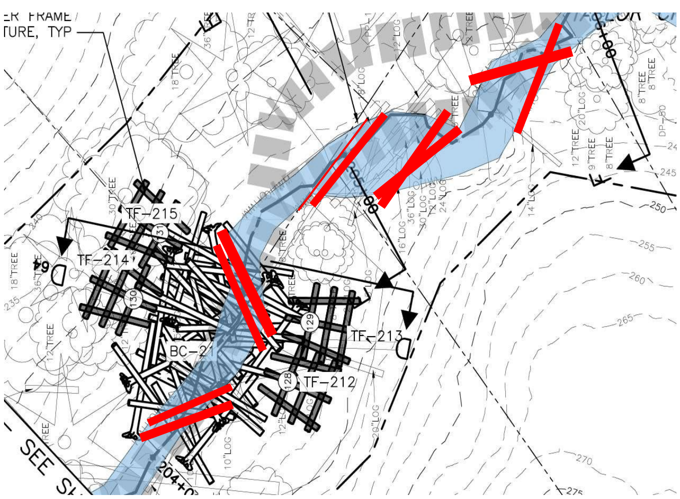
Exhibits



Schematic 4: Alternative cross-log placement along profile view; fill projection for first lift

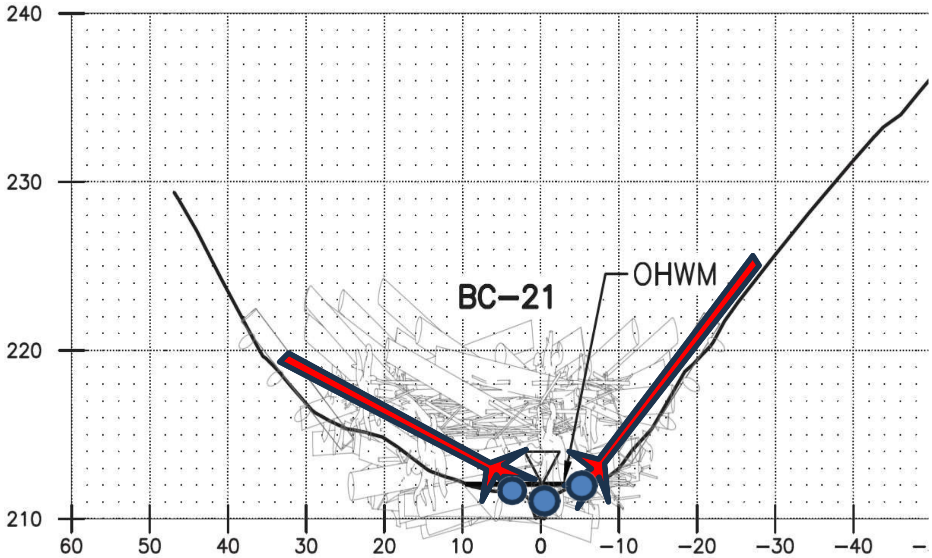


Schematic 6: Alternative

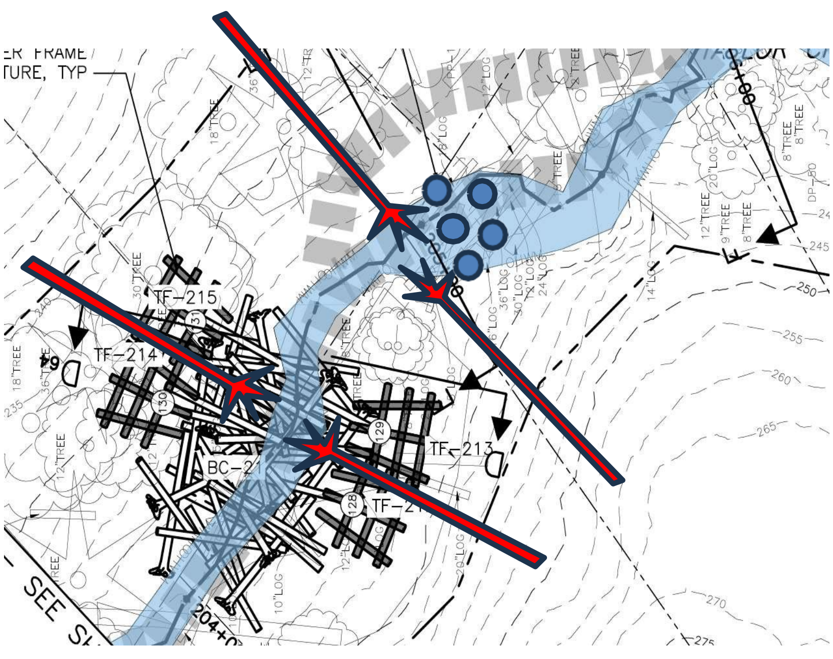


RS-06 Quantitative Value Alternative

Exhibits – Alternative Concept



Schematic 7: Alternative rootwad in channel, log on slope alternative, with boulders — section view



Schematic 8: Alternative rootwad in channel, log on slope alternative, with boulders — plan view

RS-06 Quantitative Value Alternative

Exhibits – Alternative Concept

RAVINE - HAND CONSTRUCTION						
		Mobilization				$ 101,432
		bypass/fish bypass				$ 125,000
1	204005	COMMON Excavation {QTY 50- 200}	73	CY	$ 17	$ 1,592
2		MATERIAL DELIVERY - BY HAND	1	LS	$ 608,000	$ 779,846
3		BED CONTROL STRUCTURE - HAND INSTALL	23	EA	$ 12,800	$ 294,400
4		TIMBER FRAME STRUCTURE - HAND INSTALL	102	EA	$ 4,800	$ 489,600
5		LOG D14 L20	828	EA	$ 375	$ 310,500
6		LOG D12 L20	474	EA	$ 260	$ 123,240
7		SLASH	90	CY	$ 39	$ 4,502
8		GROUND ANCHOR	158	EA	$ 683	$ 138,314
9		MANILA LASHINGS	144	EA	$ 250	$ 46,175
10		BOLTED CONNECTIONS	504	EA	$ 130	$ 84,039
11		LOG PINS	711	EA	$ 10	$ 9,120
12		COIR	5,609	SY	$ 10	$ 72,420
13		PLANTING - TIMBER FRAMES	1	LS	$ 45,000	$ 58,101
14		RESTORATION	1	LS	$ 55,000	$ 71,013
					Construction Line Item Pricing	**$ 2,482,861**
					Compounded Adjustment Rate	0.00%
					Adjusted Construction Line Item Pricing	**$2,482,861**
					Allowance for Indeterminates	25.00%
					Construction Bid Amount	**$3,103,577**
					Sales Tax 0 %	0.00%
					Construction Contract Amount	**$3,103,577**

Cost estimate for original concept upscaled to machine placed numbers of structures

RAVINE - HAND CONSTRUCTION						
		Mobilization				$ 101,432
		bypass/fish bypass				$ 125,000
1	204005	COMMON Excavation {QTY 50- 200}	0	CY	$ 17	$ -
2		MATERIAL DELIVERY - BY HAND	1	LS	$ 158,771	$ 158,771
3		IN CHANNEL LOGS - HAND INSTALL	170	EA	$ 3,000	$ 510,000
4		TIMBER FRAME STRUCTURE - HAND INSTALL	0	EA		$ -
5		LOG D14 L20	340	EA	$ 375	$ 127,500
6		LOG D12 L20	0	EA	$ 260	
7		SLASH	0	CY	$ 39	$ -
8		GROUND ANCHOR	0	EA	$ 683	$ -
9		MANILA LASHINGS	0	EA	$ 250	$ -
10		BOLTED CONNECTIONS	0	EA	$ 130	$ -
11		LOG PINS	0	EA	$ 10	$ -
12		COIR	0	SY	$ 10	$ -
13		PLANTING - TIMBER FRAMES	0	LS	$ 45,000	$ -
14		RESTORATION	1	LS	$ 71,013	$ 71,013
					Construction Line Item Pricing	**$ 867,284**
					Compounded Adjustment Rate	0.00%
					Adjusted Construction Line Item Pricing	**$867,284**
					Allowance for Indeterminates	25.00%
					Construction Bid Amount	**$1,084,105**
					Sales Tax 0 %	0.00%
					Construction Contract Amount	**$1,084,105**

Cost estimate for Alternative, first lift

RS-06 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Mobilization				101,432
bypass/ fish bypass				125,000
HAND PLACED OPTION, SCALED UP TO SAME NUMBER OF STRUCTURES AS MACHINE OPTION				
Common Excavation (QTY 50-200)	CY	73	17.00	1,241
Material Delivery – By Hand	LS	1	608,000.00	608,000
Bed control Structure – Hand Install	EA	23	12,800.00	294,400
Timber Frame Structure – Hand Install	EA	102	4,800.00	489,600
Log D14 L20	EA	828	375.00	310,500
Log D12 L20	EA	474	260.00	123,240
Slash	CY	90	39.00	3,510
Ground Anchor	EA	158	683.00	107,914
Manilla Lashings	EA	144	250.00	36,000
Bolted Connections	EA	504	130.00	65,520
Log Pins	EA	711	10.00	7,110
Coir	SY	5609	10.00	56,090
Planting – Timber Frames	LS	1	45,000.00	45,000
Restoration	LS	1	71,013.00	71,013

	Subtotal:	**$2,445,570**
25%	Markup:	$611,393
	Total Cost (Rounded):	**$3,057,000**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
Mobilization				101,432
bypass/ fish bypass				125,000
FIRST LIFT				
Material Delivery - By Hand	LS	1	158,771.00	158,771
In Channel Logs - Hand Install	EA	170	3,000.00	510,000
Log D14 L20	EA	340	375.00	127,500
Restoration	LS	1	71,013.00	71,013

Note: A second lift in 10 years is included in the life cycle cost analysis. Cost = above items, minus material delivery and Log D14L20, x 1.25 or $1,009,306.

	Subtotal:	**$1,093,716**
25%	**Markup:**	$273,429
	Total Cost (Rounded):	**$1,367,100**
	Cost Difference:	**$1,689,900**

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RS-06 Quantitative Value Alternative

Life Cycle Cost Estimate

Life Cycle Study Period (Years): 30 **Discount Rate:** 2.00% Net

Original Concept

Initial Costs	Total Cost / Event	Present Worth (PW)
Original Concept (from Initial Costs Worksheet)	3,057,000	3,057,000

Total First (Initial) Cost: **$3,057,000**

Annual Costs	Year Start	Year Stop	Inflat. Rate	Total Cost / Event	PW Factor

Total Annual Costs (Present Worth): **$**

Replace / Residual Costs	Occurrence Year-or-Cycle		Inflat. Rate	Total Cost / Event	PW Factor

Total Replacement / Salvage Costs: **$**

Alternative Concept

Initial Costs	Total Cost / Event	Present Worth (PW)
Original Concept (from Initial Costs Worksheet)	1,367,100	1,367,100

Total First (Initial) Cost: **$1,367,100**

Annual Costs	Year Start	Year Stop	Inflat. Rate	Total Cost / Event	PW Factor

Total Annual Costs (Present Worth): **$**

Replace / Residual Costs	Occurrence Year-or-Cycle		Inflat. Rate	Total Cost / Event	PW Factor
Second lift, no mat'l delivery	10		0.820	1,009,306	827,982
(Assumes inflation rate for this					
Effort matches general rate)					

Total Replacement / Salvage Costs: **$828,000**

RS-06 Quantitative Value Alternative

Life Cycle Cost Estimate

Life Cycle Cost Summary

	Original	Alternative	Difference
Total First (Initial) Costs	3,057,000	1,367,100	**1,689,900**
Total Annual Costs + Replace/Residual Costs		828,000	**(828,000)**
Total Life Cycle Costs (Present Worth)	**3,057,000**	**2,195,100**	**861,900**
Total Life Cycle Costs (Annualized)	**(136,494.81)**	**(98,011.04)**	

RS-07 Quantitative Value Alternative

Retain Sediment in Canyon

Use boulders or boulder clusters to help retain sediment

Original Concept

Boulders not included in design

Alternative Concept

Place large boulders (~1000-3000 lb dry weight) in arrays to form steps that coarse sediments deposit upstream of. Arrays can consist of 7-10 boulders per step; Assume 1.5 ft/step, elevation drop in project reach = 168 ft, total number of boulders if no logs = 10*168/1.5 = 1,120 boulders maximum if no logs. Fewer if blended with RS-06 opposing logs, say 5 boulders/log pair, say 840 boulders?

Advantages

- Consistent with/emulates natural template
- Small disturbance footprint
- Better upstream fish passage conditions than logs
- Relatively inexpensive material cost

Disadvantages

- Boulders harder than logs to deliver/place without machinery, require drilling holes for cabling/winching
- May need repeat application in future

Discussion / Justification

Field observations indicate that boulders work well in building up sediment deposits; see exhibit photos. Stream channel has lots of glacial erratics in place, so adding more would not adversely affect aesthetics. Boulders are also appropriate for 3-5% gradients in terms of stability during floods. Fish swimming upstream can negotiate between boulders during freshets. Size of boulders onsite = 1000-3000 lb.

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$	$	$
Alternative Concept	$630,000	$	$630,000
Difference	**$630,000**	**$**	**$(630,000)**

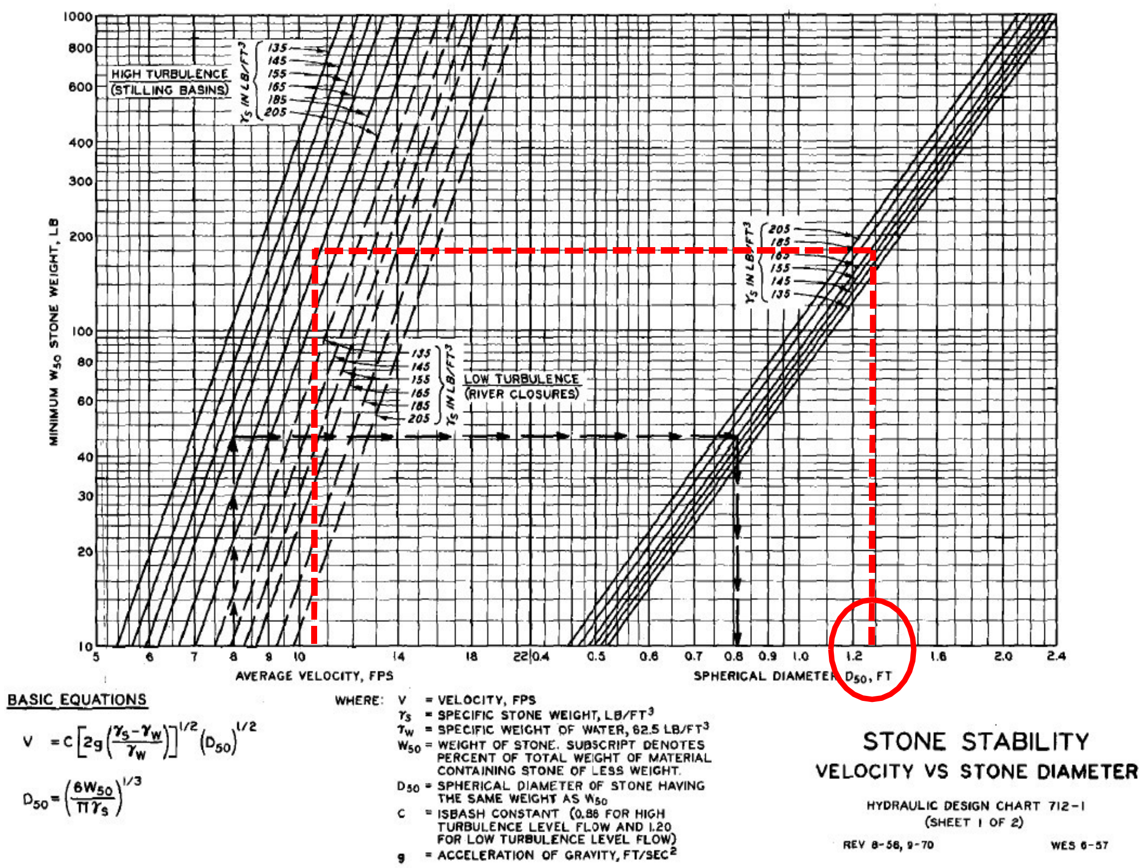
RS-07 Quantitative Value Alternative

Exhibits – Alternative Concept

Photos showing 2-3 ft boulder arrays/steps, some with sediment buildup (1-2 ft head drop) upstream

RS-07 Quantitative Value Alternative

Exhibits – Alternative Concept



Isbash chart showing stable sizes of boulders for likely peak velocity in channel during extreme flood

RS-07 Quantitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total

	Subtotal:	**$**
25%	Markup:	$
	Total Cost (Rounded):	**$**

Alternative Concept

Description	Unit	Quantity	Unit Cost	Total
1000-3000 lb Boulders Delivered; WSDOT spec 9-03.11(3)	EA	1,120	250.00	280,000
Haul, Placement	EA	1,120	200.00	224,000

	Subtotal:	**$504,000**
25%	**Markup:**	$126,000
	Total Cost (Rounded):	**$630,000**
	Cost Difference:	**$(630,000)**

RS-08 Design Suggestion

Retain Sediment in Canyon

More strategic machine placement of log structures in fewer locations ("hot spots")

Original Concept

The original design team recommendation was to install 23 instream structures targeting 3,200 CY of storage at a cost $8.8 M. This cost includes temporary access road and machine placed large wood structures.

Alternative Concept

The alternative concept is to build fewer large instream structures placed in two specific locations. These would be complemented with smaller structures (RS-03, RS-04, RS-05, RS-06 and/or RS-07) in other areas. The two areas for machine placed structures would be at the bottom of the ravine using the Holyoke Way S. hairpin for access and staging and just below the fork using a highline from the Crestwood Drive S. utility easement.

Advantages

- Lower cost
- Targets areas which are a high priority for capture and storage of materials
- Does not require work in E. Fork that would be on private property
- Does not require road up the ravine (spider excavator would need to walk up the channel)

Disadvantages

- Requires widening and other modifications of the easement
- Disruptive to neighborhood/ Lack of staging areas
- Potential impact to canopy
- Would require installation of additional smaller structures over time to meet the storage capacity of original concept

Discussion / Justification

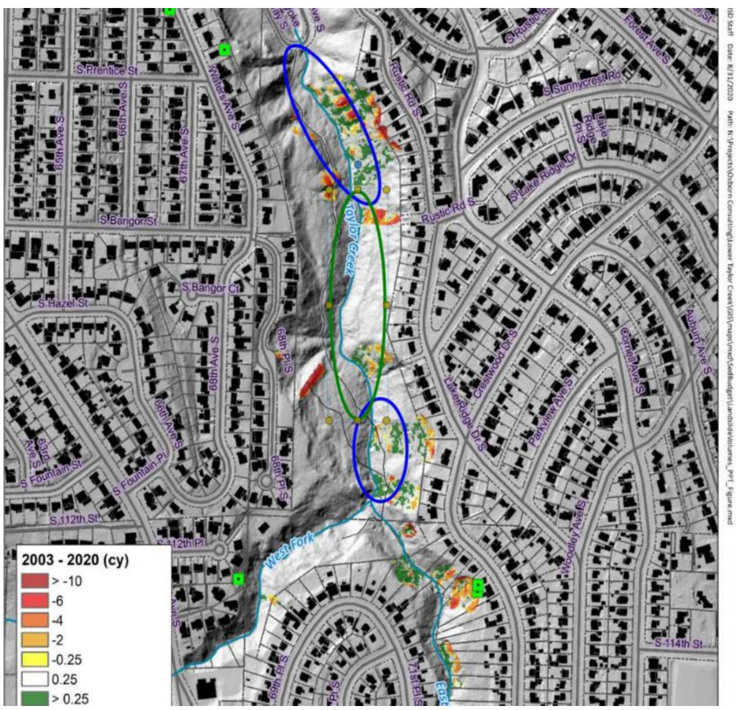
This concept hybrid approach has several advantages. Machine construction of larger structures below and just downstream of identified erosion areas have capacity to capture material from landslides without being overwhelmed. The use of smaller structures like those described in RS-03, RS-04, RS-05, RS-06, and RS-07 would allow for low impact construction in the middle ravine. The major drawback remains identifying a suitable location for a highline to the upper mainstem. The identified location has several drawback and not better option has been identified to date.

Design Suggestion

Original Concept	$	$	$
Alternative Concept	$	$	$
Difference	**$Design**	**Suggestion**	**$**

RS-08 Design Suggestion

Exhibits – Alternative Concept



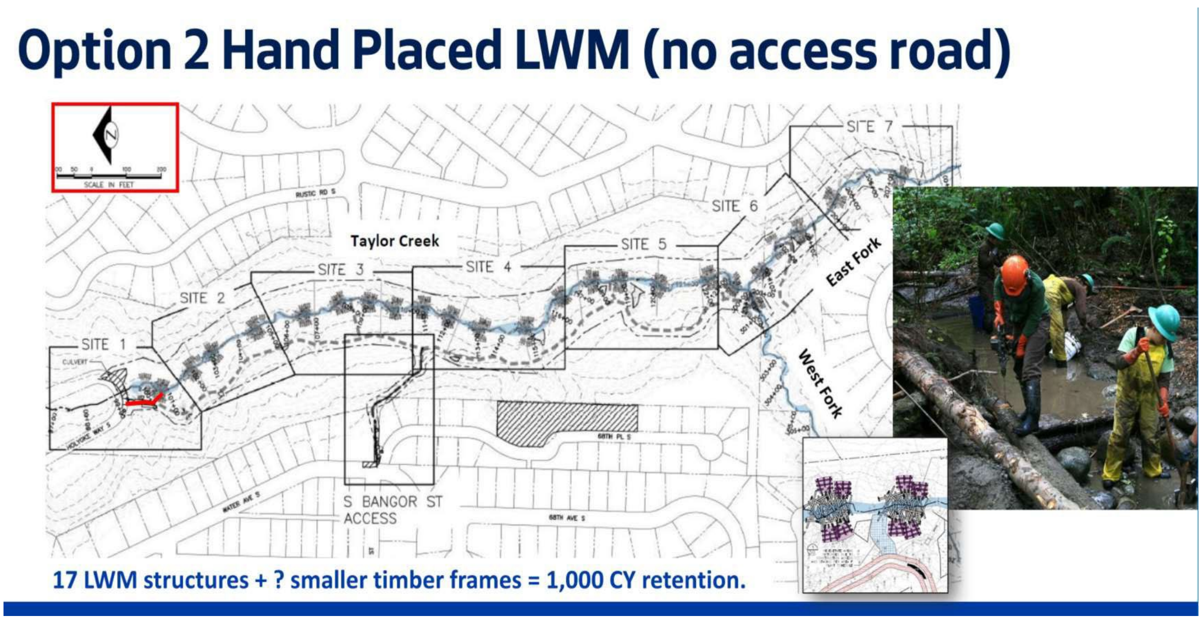
DEM Differencing 2003 to 2016/2020

LARGER MACHINE PLACED STRUCTURES TO PROVIDE INITIAL CAPACITY AT 'HOT SPOTS'

USE SMALLER STRUCTURES INSTALLED OVER SEVERAL YEARS TO GRADUALLY BUILD CAPACITY

RS-08 Design Suggestion

Exhibits – Original Concept



RS-13 Qualitative Value Alternative

Retain Sediment in Canyon

Place dredged material from the delta

Original Concept

Not considered. However, this alternative has implications to deciding which way to go, either original concept or Value Alternatives RS-06/RS-07.

Alternative Concept

Salvage dredged gravels from delta and place in stream channel, pile against streambank in vicinity of forks. Location(s) would be as far upstream as possible wherever (I) access for a dump truck to near the edge of the canyon and (II) a slide can be installed to deliver to the channel are feasible. The stream is expected to rework the deposited material and gradually transport it downstream to provide fill behind measures implemented to store sediments and raise the overall grade.

Advantages

- Restores native material exhumed through incision back upstream instead of using imported material
- Offsite hauling and disposal avoided
- Improves upstream passage access for fish to Taylor Creek from the lake
- Grain size data in Perkins (2007) indicates subsurface gravel is relatively clean with minor impacts to water quality expected

Disadvantages

- Could reduce sockeye spawning habitat availability around delta
- Must take care to avoid using materials with toxic/invasive weeds at shoreline

Discussion / Justification

Re-using material lost to the lake would help pre-charge storage structures within the project reach. Placing gravel in a pile that the stream gradually entrains has been implemented in other streams for purposes of enhancing spawning habitat. The farther upstream the material is placed, and if the material is placed in a way facilitating gradual erosion (as opposed to rapid entrainment), the more likely it is that the material will remain within the grade restoration reach and not re-accumulate in the habitat reach downstream of Rainier Ave S.

Cost Summary

	Initial Cost	O&M Cost	Life Cycle Cost
Original Concept	$138,100	$	$138,100
Alternative Concept	$186,900	$	$186,900
Difference	**$(48,800)**	**$**	**$(48,800)**

RS-13 Qualitative Value Alternative

Discussion / Justification (Continued)

A grab sample indicated that the material comprising the delta underneath a coarse gravel armor layer was a mix of gravel and sand, with median diameter of 13 mm (1/2 inch; grain size distribution provided in Appendix A of the Perkins report). The gravel component (taken here as particle sizes > 8 mm) accounted for approximately 65 percent of the sample weight, which (very) roughly converts to more than 90 percent of the sampled volume. This implies the prevailing delta material underneath the surface armor layer is also composed of a packed gravel framework with fines present mostly within the void spaces.

Consequently, each 1 feet of incision in the project reach between the forks and Holyoke Way crossing corresponds to roughly 1,000-1,300 CY of gravel material. Perkins (2007) estimated one-time dredging volume of approximately 1,000 CY, and estimated delta deposition rates in the range of 160- 330 CY/year. It appears from the report text, data, and photos that the source of delta material is a mix of landslide inputs and incision. Based on this, it could be inferred that the amount of incision was not 5 feet and may have been closer to 1-2 feet, which would be consistent with implementing lighter touch RS-06 and RS-07 alternative measures rather than the original concept?

In the Original Concept, dredging of the delta was proposed to ensure the delta meets the elevation of the new channel in the lower creek. The estimated quantity of dredging was 1700 CY at a unit cost of$65/CY.

RS-13 Qualitative Value Alternative

Initial Cost Estimate

Original Concept

Description	Unit	Quantity	Unit Cost	Total
Dredging of delta to meet level of Lower Taylor Creek channel	CY	1700	65.00	110,500

	Subtotal:	**$110,500**
25%	Markup:	$27,625
	Total Cost (Rounded):	**$138,100**

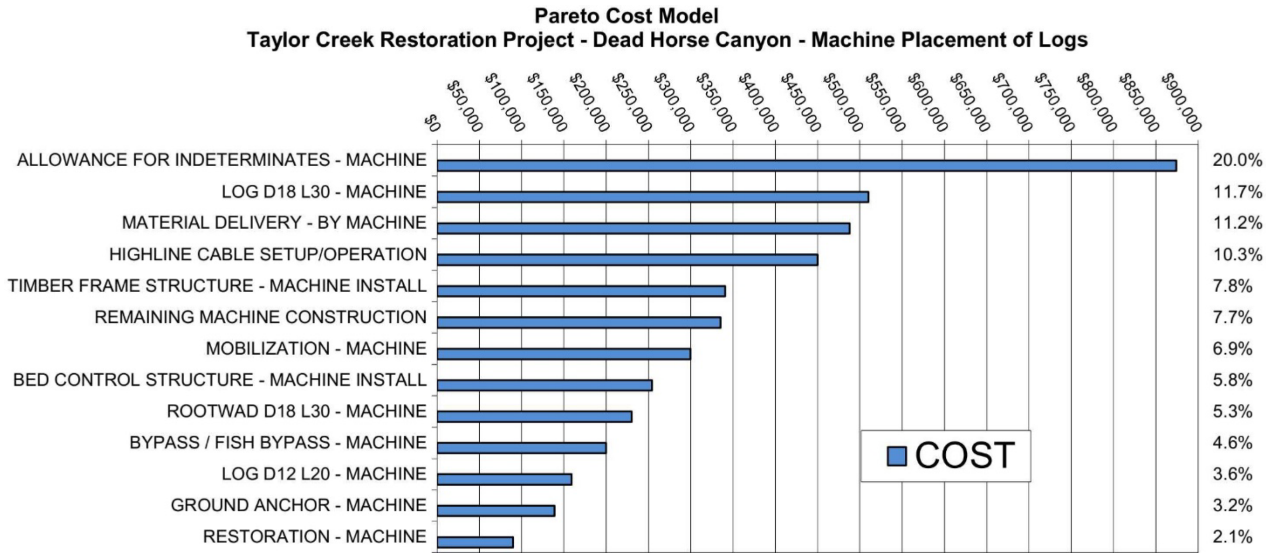
Alternative Concept

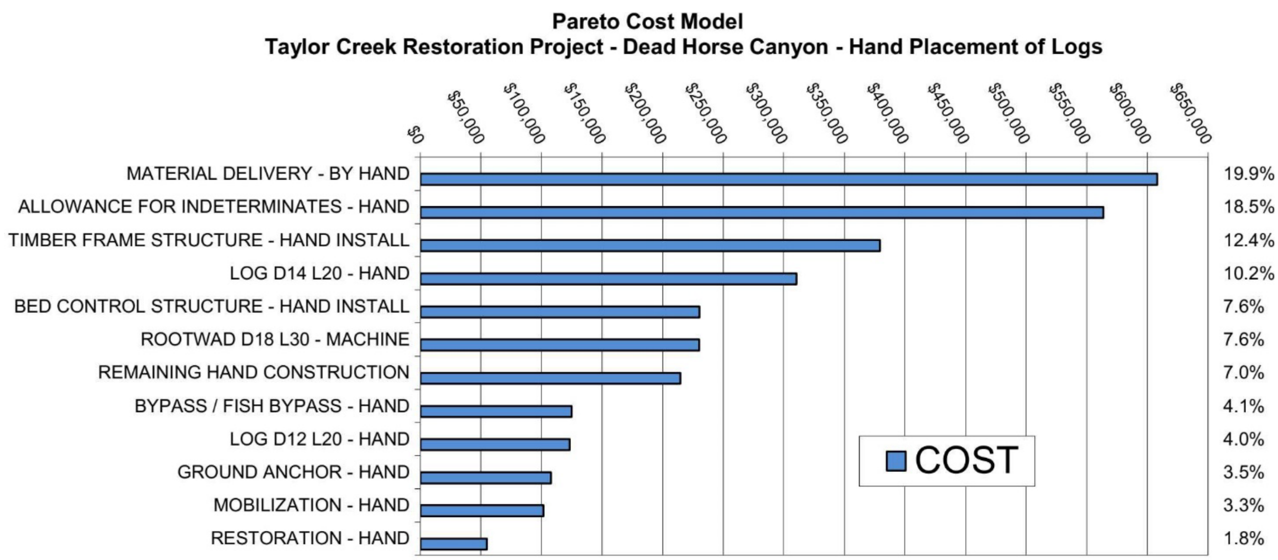
Description	Unit	Quantity	Unit Cost	Total
Silt Curtain (Material)	EST	1	1,000.00	1,000
Silt Curtain (Install)	EST	1	2,000.00	2,000
Dredge Delta	CY	1000	65.00	65,000
Haul and drop into creek at one spot	CY	1000	36.00	36,000
Additional dredging of delta to meet level of Lower Taylor Creek channel	CY	700	65.00	45,500

	Subtotal:	**$149,500**
25%	**Markup:**	$37,375
Total Cost (Rounded):		**$186,900**
Cost Difference:		**$(48,800)**

Appendices

Appendix A. Pareto Cost Models





Appendix B. Project Risk Register

Taylor Creek Restoration Sediment Management Strategy and Ravine Stabilization and Sediment Management - Dead Horse Canyon — **June 13-16, 2023**

Risk No.	Risk To	Type (Threat or Opportunity)	Description	Risk Object	Risk Management: Threat: Accept, Avoid, Mitigate, Transfer Opportunity: Enhance, Exploit, Share	Likelihood (L, M, H)	Impact (L, M, H)	Overall (L, M, H)
1	2 - Construction	Threat	Community does not accept any of the options	2 - Schedule	Mitigate: Communicate with community and adjust options accordingly while letting them know you are listening	M	H	H
2	4 - Organization	Threat	SPU being blamed for a landslide that happens during or after the SPU project	6 - Operations	Monitor ground movement throughout construction; avoid tree removal; insurance	H	H	H
3	4 - Organization	Threat	500 year storm or some other cataclysmic event occurs that overwhelms the project	6 - Operations	Clarify in basis of design the storm level you are designing; Resilient design; Complete work in reasonable sized phases	L	H	M
4	2 - Construction	Threat	Exacerbate sedimentation issues during construction due to phasing	3 - Quality	Phase appropriately; Finish one section before moving to next	L	L	L
5	3 - Environment	Threat	Introduction of invasive species as a function of construction	3 - Quality	Manage through appropriate BMPs	L	L	L
6	4 - Organization	Threat	Project does not solve the sedimentation issues if caused by other factors	6 - Operations	Identify and mitigate other factors; Control other outfalls quantity and quality; Manage expectations	M	M	M
7	4 - Organization	Threat	Creation of insufficient sediment storage	6 - Operations	Identify and mitigate other factors; Control other outfalls quantity and quality; Manage expectations	M	M	M
8	3 - Environment	Threat	Coarse sediment starvation in lower reaches after project completion	3 - Quality	As planned, lower channel will have required coarse sediment placed	M	L	L
9	2 - Construction	Threat	Parks does not accept any of the	2 - Schedule	Seek compromise win-win solution	L	L	L
10	4 - Organization	Threat	Revegetation plans fail due to lack of water or other factors	6 - Operations	Keep temporary access road until revegetation is established; Plant at optimal times; Install temporary water tank	M	L	L
11	3 - Environment	Threat	Environmental damage caused by the construction pumping such as fuel leaks or spills during fueling	3 - Quality	Transfer risk to contractors	L	L	L
12	2 - Construction	Threat	Construction delays caused by need to stay within work windows	2 - Schedule	Liquidated damages; Plan well to stay within windows; Good CM; Good communication with DFW to perhaps extend windows; Alternate delivery methods	M	M	M
13	2 - Construction	Threat	Public safety during construction	6 - Operations	Community outreach; Transfer management of site to contractor	L	H	M
14	4 - Organization	Opportunity	Provide ways for community to observe the project as it proceeds	6 - Operations	Increase partnership with Parks; Planned tours of work sites; Document construction progress to SPU website with drones, cameras, time lapse videos, etc.; Meet the contractor events; Signage; Create project model placed at overlook	E	E	E
15	2 - Construction	Threat	Damage to the existing sewer line under the access road by moving logs	5 - Cost & Schedule	Use steel plates or temporary fill to protect sewer; Transfer to	L	M	L
16	2 - Construction	Threat	Landslides or slope instability lead to delays in construction and site safety issues	5 - Cost & Schedule	Monitor ground movement throughout construction; avoid tree removal; Erosion control in roadway and at construction site; Do not allow cuts	M	M	M
17	2 - Construction	Threat	Construction worker safety on steep slopes	5 - Cost & Schedule	Transfer risk to contractors; Use fencing to keep non-workers out of the site	L	L	L
18	3 - Environment	Threat	Unintentional damage to adjacent trees and vegetation	6 - Operations	Good on-site construction supervision; Protect especially significant plants	H	L	M
19	3 - Environment	Threat	Unintentional loss of wildlife species due to the project even if public perception	6 - Operations	Seek guidance from regulatory agencies early to identify any specific concerns and share with community steps being taken to avoid	L	L	L
20	6 - Project Management	Threat	Risk of contractor taking shortcuts that backfire onto SPU	6 - Operations	Pre-qualify contractors; Alternate delivery; Good CM; Independent inspector	H	M	M
21	4 - Organization	Threat	Failure to stay within the fish windows	5 - Cost & Schedule	Transfer risk to contractors; Make clear not allowed in contractual language	H	M	M
22	3 - Environment	Opportunity	Address water quality issues harmful to the fish species we are attracting to improve environmental benefit	4 - Scope	Treat roadway drainage before discharge; Identify potential sources and how to mitigate; Effectiveness monitoring	E	E	E
23	4 - Organization	Threat	MIT changing mind about amount of wood being placed by the project	2 - Schedule	Early outreach and coordination	L	L	L
24	4 - Organization	Threat	Sewer failure leads to undoing all the good of the project	3 - Quality	Consider increased stability protection along sewer as required: Replace with pump station and force main	L	H	L
25	2 - Construction	Threat	Failure to get permits from any regulatory agency	5 - Cost & Schedule	Get permits early as possible; Good communication as early as possible; Present feasible solutions that they can have confidence in.	L	H	M

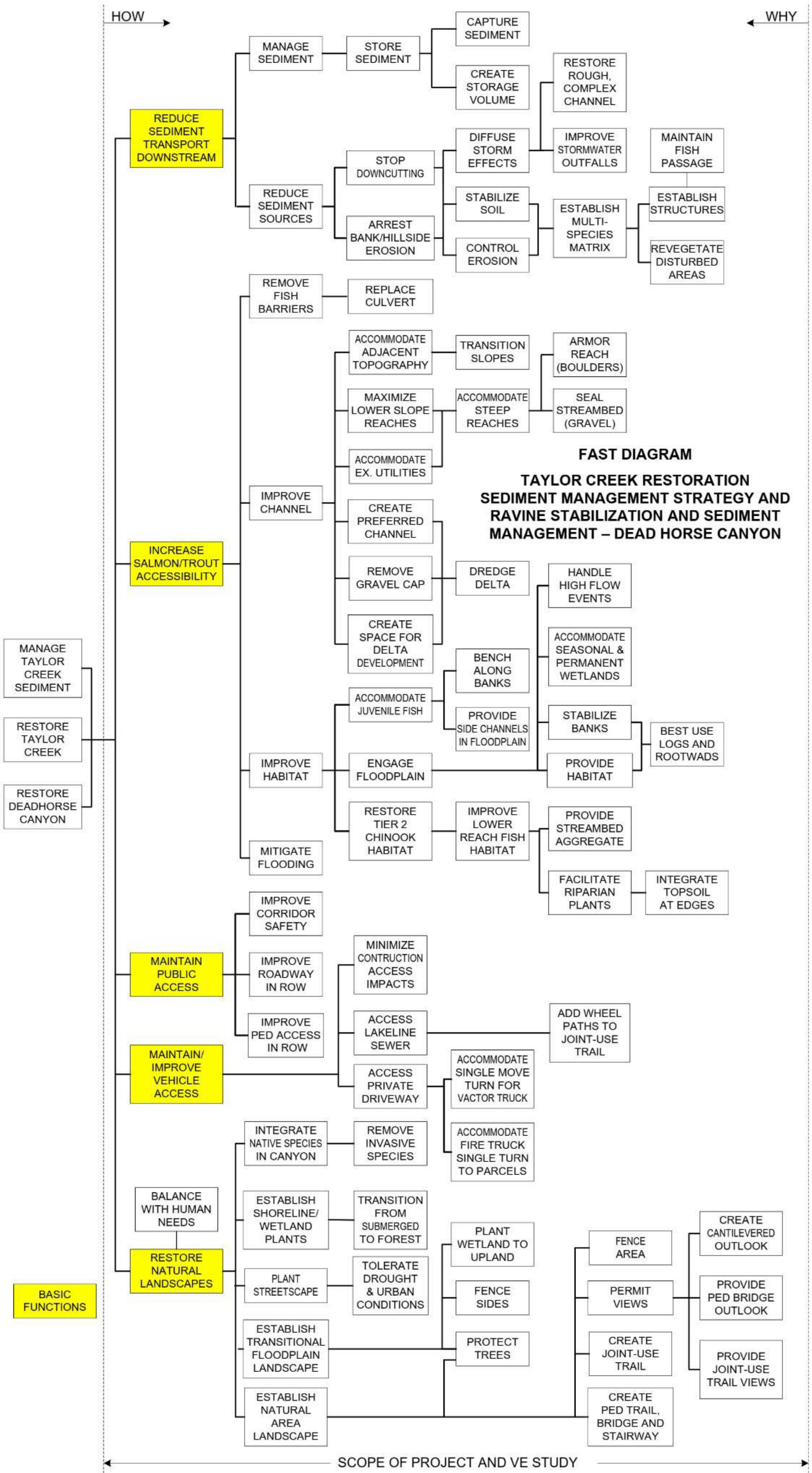
Appendix C. Function Analysis System Technique (FAST) Diagram

The Function Analysis Systems Technique (FAST) Diagram that follows documents the results of the function analysis performed for the Taylor Creek Restoration Sediment Management Strategy and Ravine Stabilization and Sediment Management – Dead Horse Canyon projects. Function analysis helps the VS Team clearly understand the relationships of the functions to one another, and how they work together to satisfy the requirements of the project. A FAST diagram graphically illustrates the interrelationships of the project functions and is often invaluable in accomplishing this understanding.

Guidelines for arranging functions logically into a FAST diagram are included below to assist the reader in understanding the FAST diagram, which follows.

1. Two vertical dashed lines, known as Scope Lines, define the scope of the project and the VS Study. The scope lines are usually near the left and right margins.
2. The FAST diagram has a "critical path of functions" going from left to right across the scope lines. A bold line represents the critical path.
3. The critical path contains only the basic function(s) (immediately to right of left scope line) and required secondary functions. Higher order functions (related goals beyond the scope of the Value Study) are sometimes included on the critical path, left of the basic function(s). The critical path can have parallel branches.
4. Required secondary functions are to the right of the basic function.
5. All other secondary functions, which can be supporting functions, aesthetic functions or unwanted functions, are either above or below the critical path.
6. Functions that "happen at the same time" and/or "are caused by" a function on the critical path are placed below the related critical path function.
7. Functions which happen "all the time", such as an aesthetic function, are placed above the critical path function to the extreme right of the diagram.
8. Specific "design objectives" are placed above the basic function to the extreme left.
9. Proper arrangement and relationships of the functions in the FAST diagram can be confirmed with the how-why logic test as follows:
    a. Ask the question of any function, "How do I verb-noun?" The answer should be the function to the immediate right.
    b. Ask the question "Why do I verb-noun?" The answer should be the function to the immediate left (i.e., "So that I can verb-noun.")
    c. A function that does not pass the how-why test is either described improperly or is in the wrong place. The answer must make sense.
10. Our prime concern when constructing a FAST diagram is the essential functions. All functions on the critical path must occur to accomplish the basic function. All other functions on the FAST diagram are subordinate to the critical path function and may or may not have to take place to accomplish the basic functions. These functions are often the source for Value targets and resulting savings.

The FAST diagram for the Taylor Creek Restoration Sediment Management Strategy and Ravine Stabilization and Sediment Management – Dead Horse Canyon projects is presented on the following page.


HOW
WHY
FAST DIAGRAM
TAYLOR CREEK RESTORATION
SEDIMENT MANAGEMENT STRATEGY AND
RAVINE STABILIZATION AND SEDIMENT
MANAGEMENT – DEAD HORSE CANYON
MANAGE TAYLOR CREEK SEDIMENT
RESTORE TAYLOR CREEK
RESTORE DEADHORSE CANYON
BASIC FUNCTIONS
REDUCE SEDIMENT TRANSPORT DOWNSTREAM
INCREASE SALMON/TROUT ACCESSIBILITY
MAINTAIN PUBLIC ACCESS
MAINTAIN/ IMPROVE VEHICLE ACCESS
BALANCE WITH HUMAN NEEDS
RESTORE NATURAL LANDSCAPES
MANAGE SEDIMENT
STORE SEDIMENT
CAPTURE SEDIMENT
CREATE STORAGE VOLUME
RESTORE ROUGH, COMPLEX CHANNEL
REDUCE SEDIMENT SOURCES
STOP DOWNCUTTING
ARREST BANK/HILLSIDE EROSION
DIFFUSE STORM EFFECTS
IMPROVE STORMWATER OUTFALLS
STABILIZE SOIL
CONTROL EROSION
ESTABLISH MULTI-SPECIES MATRIX
MAINTAIN FISH PASSAGE
ESTABLISH STRUCTURES
REVEGETATE DISTURBED AREAS
REMOVE FISH BARRIERS
REPLACE CULVERT
ACCOMMODATE ADJACENT TOPOGRAPHY
TRANSITION SLOPES
ARMOR REACH (BOULDERS)
MAXIMIZE LOWER SLOPE REACHES
ACCOMMODATE STEEP REACHES
SEAL STREAMBED (GRAVEL)
ACCOMMODATE EX. UTILITIES
IMPROVE CHANNEL
CREATE PREFERRED CHANNEL
REMOVE GRAVEL CAP
DREDGE DELTA
CREATE SPACE FOR DELTA DEVELOPMENT
HANDLE HIGH FLOW EVENTS
ACCOMMODATE SEASONAL & PERMANENT WETLANDS
BENCH ALONG BANKS
ACCOMMODATE JUVENILE FISH
PROVIDE SIDE CHANNELS IN FLOODPLAIN
STABILIZE BANKS
BEST USE LOGS AND ROOTWADS
IMPROVE HABITAT
ENGAGE FLOODPLAIN
PROVIDE HABITAT
RESTORE TIER 2 CHINOOK HABITAT
IMPROVE LOWER REACH FISH HABITAT
PROVIDE STREAMBED AGGREGATE
MITIGATE FLOODING
FACILITATE RIPARIAN PLANTS
INTEGRATE TOPSOIL AT EDGES
IMPROVE CORRIDOR SAFETY
IMPROVE ROADWAY IN ROW
MINIMIZE CONTRUCTION ACCESS IMPACTS
IMPROVE PED ACCESS IN ROW
ACCESS LAKELINE SEWER
ADD WHEEL PATHS TO JOINT-USE TRAIL
ACCESS PRIVATE DRIVEWAY
ACCOMMODATE SINGLE MOVE TURN FOR VACTOR TRUCK
ACCOMMODATE FIRE TRUCK SINGLE TURN TO PARCELS
INTEGRATE NATIVE SPECIES IN CANYON
REMOVE INVASIVE SPECIES
ESTABLISH SHORELINE/ WETLAND PLANTS
TRANSITION FROM SUBMERGED TO FOREST
PLANT WETLAND TO UPLAND
FENCE AREA
CREATE CANTILEVERED OUTLOOK
PLANT STREETSCAPE
TOLERATE DROUGHT & URBAN CONDITIONS
FENCE SIDES
PERMIT VIEWS
PROVIDE PED BRIDGE OUTLOOK
ESTABLISH TRANSITIONAL FLOODPLAIN LANDSCAPE
PROTECT TREES
CREATE JOINT-USE TRAIL
PROVIDE JOINT-USE TRAIL VIEWS
ESTABLISH NATURAL AREA LANDSCAPE
CREATE PED TRAIL, BRIDGE AND STAIRWAY
SCOPE OF PROJECT AND VE STUDY

Appendix D. Creative Idea List

ID No.	Creative Idea Description	Score	Action	Grouped With	Comments / Notes
CE-00	**Control Erosion in Canyon**				
CE-01	Place timber frame structures strategically along banks of creek to help shore banks	7	DS		Requires excavation or anchoring
CE-02	Strategic planting plan with more conifers for soil stabilization and future wood source	9	ABD		Above and beyond current design intent
CE-03	Add stormwater flow control and treatment to minimize erosion	8	A		
CE-04	Work with King County to divert flow entering the canyon to treatment facility or controlled wetland	9	DS		Will require broader watershed coordination
CE-05	Create constructed storage wetland at location of the historic wastewater treatment facility in the East Fork	8	DS		
CE-06	Use Underground Injection Control (UIC) where appropriate to reduce stormwater discharge into creek	5	X		
CE-07	Collect stormwater and relocate outside of canyon	3	X		
IR-00	**Increase Resilience**				
IR-01	Develop pump station and forcemain to allow abandonment of sewer in canyon	8	A		Measure versus cost of emergency repair of sewer and related impact
MC-00	**Minimize Construction Impact**				
MC-01	Use east slope piles as a base for an access road	4	X		
MC-02	Access along channel from downstream and upstream directions as appropriate	9	A		Spider excavator and winch compatible
MC-03	Place mobile wood in the stream and let it move into place naturally	4	X		
MC-04	Pursue a permanent easement from properties along East Fork	3	X		32 properties involved
MC-05	Don't do anything on private properties along East Fork	10	DS		
MC-06	Assemble mechanical equipment in the canyon for use and disassemble to remove	8	A		
MC-07	Sequence work in Canyon and on Lower Taylor Creek project to minimize time of construction	9	ABD		Alternate delivery? Monetary incentives for early completion
MC-08	Complete all canyon work before beginning in stream work in Lower Taylor Creek	8	G	MC-07	Community acceptance? Issues with permitting?
MC-09	Totally complete upper canyon work before working in the mid and lower canyon	4	X		
MC-10	Separate contractors for civil work and stream restoration work	10	DS		
MD-00	**Materials Delivery Logistics**				
MD-01	Use identified hazard trees on site as a source for logs and rootwads	9	DS		
MD-02	Use helicopter delivery for materials	9	A		
MD-03	Use down wood near the channel or spanning the channel	10	G	MD-01	
MD-04	Use helicopter delivery in winter for materials when trees are bare and store until use	9	G	MD-02	
MD-05	Use highlines for material delivery in lieu of movement by hand or animal	9	ABD		
MD-06	Use small tracked vehicle (ATV) to haul logs and other materials along existing trail	10	A		
MD-07	Buy derelict property and install slide for material delivery	5	G	MD-14	
MD-08	Buy a property in the right location and install slide or highline for material delivery	8	DS		
MD-09	Release a colony of beavers in the canyon	1	X		
MD-10	Use pack animal delivery for materials	8	DS		

ID No.	Creative Idea Description	Score	Action	Grouped With	Comments / Notes
MD-11	Drag materials up and down channel from a limited number of access points	9	ABD		
MD-12	Use winches to assist with material delivery	9	DS		
MD-13	Use temporary bridges to span obstacles in the channel, e.g. the fallen cedar tree	3	X		
MD-14	Create new access point on the south side for delivery of materials	8	G	MD-08	
MD-15	Use tripod hoists in the channel to assist with moving materials	9	G	MD-12	
MD-16	Use hybrid of mechanical placement and hand placement depending on access	8	G	MD-14	
MD-17	Create bundles of materials that can be dumped in the channel by helicopter	8	G	MD-02	
MD-18	Source logs from post-forest fire cleanup	7	G	MD-01	
MD-19	Consider use of native deciduous tree species for log sources	9	G	MD-01	
MD-20	Obtain logs from tree removal in other parts of the city	9	G	MD-01	
MD-21	Use existing easement to establish slide or highline to bring in material	8	DS		
MD-22	Use logs spanning channel, built as you go, to move materials up the streambed	8	DS		
RS-00	**Retain Sediment in Canyon**				
RS-01	Reduce peak flow rates within canyon by creating more wetland areas for storage	9	G	CE-05	
RS-02	Reduce peak flow rates in the canyon by controlling roadway drainage	8	G	CE-03	
RS-03	Install pole-assisted logjams (PAL) initially and every couple of years as they allow the stream channel to aggrade.	7	G	RS-06	
RS-04	Install beaver dam analogs (BDA) initially and every couple of years as they allow the stream channel to aggrade.	8	G	RS-06	
RS-05	Place channel spanning logs on channel bottom and over channel	10	G	RS-06	
RS-06	Use smaller structures initially and return in future years to increase placements where required	8	A		
RS-07	Use boulders or boulder clusters to help retain sediment	10	A		
RS-08	More strategic machine placement of log structures in fewer locations ("hot spots")	10	DS		Addresses erosion more than sedimentation
RS-09	Use single log structures placed much more frequently to reduce total number of logs needed	8	G	RS-04	
RS-10	Purchase hard to develop properties on the East Fork to create storage wetlands	9	G	CE-05	Karch properties located in King County
RS-11	Use smaller rocks to create riffles in the	3	X		
RS-12	Import sediment to create the channel contour that we want	8	G	RS-13	
RS-13	Place dredged material from the delta to prime channel contour that we want	8	A		Focus on lower reach, use inwater material

40	**Action**
10	A - Alternative
12	DS - Design Suggestion
0	EC - Estimate Correction
19	G - Group with Other Alternative
2	ABD - Already Being Done
9	X - Dropped during Development

Appendix E. VS Workshop Agenda

Hybrid In-Person/Virtual VS Workshop Agenda

(Times are PDT; Flexible except start and adjourn; Breaks mid-AM & PM)

Tuesday, June 13, 2023 (In-Person)

8:00–8:30	**Arrival and Introductions** (Location details on page 3)	ALL
8:30–11:30	**Presentation of Project** • Project Overview • Sediment Management and Erosion Control Evaluation and Recommendation • Design Progression • Recommended Option and Stakeholder Review • Community Sentiment and Incorporation of Community Priorities • Value Study Goals and Objectives • Next Steps for Sediment Management & Erosion Control Strategy Decision Making	SPU / Design Team
11:30–12:00	**Discussions and Questions**	
12:00–1:00	**Lunch Break**	
1:00–4:30	**Site Visit** (Details on page 3)	SPU / Design Team / VS Team

Wednesday, June 14, 2023 (Virtual)

8:00–8:15	**VS Workshop Overview & Instructions** • Overview of the VS Process and Agenda / Workshop Goals	Scot McClintock, VSTL
8:15–9:15	**Information Phase** (continued) • Project and Site Visit Observations, Questions, and Answers • Key Project Issues • Project Data Familiarization	VS Team
9:15–10:30	**Qualitative Risk Register** • Define Project Risks (threats and opportunities) • Identify Risk Management Strategies • Complete Draft Project Risk Register	VS Team
10:30–12:00	**Function Analysis Phase** • Overview of Intent/Rules of Function Analysis • Review Draft Project FAST Diagram • Finalize FAST Diagram by Team Consensus • Select Value Target Functions by Consensus	VS Team
12:00–1:00	**Lunch Break**	
1:00–4:30	**Creative Phase** • Rules for Creativity • Generate ideas according to Value Target Functions	
4:30	**Adjourn**	

Thursday, June 15, 2023 (Virtual)

8:00–9:00	**Creative Phase** (continued) • Generate ideas according to Value Target Functions	VS Team
9:00–10:30	**Evaluation Phase** • Explain Method for Consensus Evaluation of Creative Ideas • Score Ideas and Select Best Ideas for Development • Identify Selected Ideas as Value Alternative, Design Suggestion, or Grouped • Assign Value Alternatives and Design Suggestions for Development	VS Team
10:30–12:00	**Development Phase** • Team Discussion – Forms • Prepare Value Alternatives and Design Suggestions - Narratives; Sketches; Calculations; Advantages, Disadvantages, Cost Estimates	VS Team
12:00–1:00	**Lunch Break**	
1:00–4:30	**Development Phase** (continued) • Prepare Value Alternatives & Design Suggestions - Narratives; Sketches; Calculations; Advantages, Disadvantages, Cost Estimates	VS Team
4:30	**Adjourn**	

Friday, June 16, 2023 (Virtual)

8:00–12:30	**Development Phase** (continued) • Prepare Value Alternatives & Design Suggestions - Narratives; Sketches; Calculations; Cost Estimates • Finalize Write-Ups • QC Review / VS Team Concurrence • Prepare for Presentation	
12:30–1:00	**Lunch Break**	
1:00–4:00	**Presentation Phase** (separate Teams meeting) • Introductions and Logistics • Executive Summary • Review of Recommendations • Q & A Session • Recap / Next Steps	VS Team / SPU & Design Teams
4:00	**VS Workshop Adjourns**	

Appendix F. Evaluation Matrix

	EVALUATION MATRIX					
How well does each idea satisfy the target category? Indicate by entering E, G, or P under the criteria, respectively.	**Stakeholder**	**Control Erosion in Canyon**	**Increase Resilience**	**Minimize Construction Impact**	**Materials Delivery Logistics**	**Retain Sediment in Canyon**
CE-01 – Place only timber frame structures strategically along banks of creek to help shore banks in areas without large wood structures	SPU	3				
	SPR	3				
	FODHC	3				
	COMMUNITY	3				
	SUBTOT.	12	0	0	0	0
CE-05 – Create constructed storage wetland at location of the historic wastewater treatment facility in the East Fork	SPU	1				
	SPR	1				
	FODHC	3				
	COMMUNITY	3				
	SUBTOT.	8	0	0	0	0
MC-02 – Access only along channel from downstream and upstream directions as appropriate	SPU			3		
	SPR			5		
	FODHC			5		
	COMMUNITY			5		
	SUBTOT.	0	0	18	0	0
MC-06 – Assemble mechanical equipment in the canyon for use and disassemble to remove	SPU			3		
	SPR			3		
	FODHC			5		
	COMMUNITY			5		
	SUBTOT.	0	0	16	0	0
MD-01 – Use identified hazard trees on site as a source for logs and rootwads	SPU				3	
	SPR				3	
	FODHC				1	
	COMMUNITY				5	
	SUBTOT.	0	0	0	12	0
MD-02 – Use helicopter delivery for materials	SPU				3	
	SPR				3	
	FODHC				5	
	COMMUNITY				5	
	SUBTOT.	0	0	0	16	0
MD-06 – Use small tracked vehicle (ATV) to haul logs and other materials along existing trail	SPU				5	
	SPR				3	
	FODHC				3	
	COMMUNITY				3	
	SUBTOT.	0	0	0	14	0

	EVALUATION MATRIX					
How well does each idea satisfy the target category? Indicate by entering E, G, or P under the criteria, respectively.	**Stakeholder**	**Control Erosion in Canyon**	**Increase Resilience**	**Minimize Construction Impact**	**Materials Delivery Logistics**	**Retain Sediment in Canyon**
MD-08 – Buy a property in the right location and install slide or highline for material delivery	SPU				3	
	SPR				3	
	FODHC				3	
	COMMUNITY				1	
	SUBTOT.	0	0	0	10	0
MD-10 – Use pack animal delivery for materials	SPU				1	
	SPR				1	
	FODHC				3	
	COMMUNITY				1	
	SUBTOT.	0	0	0	6	0
MD-12 – Use winches and hoists to assist with material delivery	SPU				5	
	SPR				5	
	FODHC				5	
	COMMUNITY				3	
	SUBTOT.	0	0	0	18	0
MD-21 – Use existing easements to establish slide or highline to bring in material	SPU				3	
	SPR				5	
	FODHC				3	
	COMMUNITY				1	
	SUBTOT.	0	0	0	12	0
MD-22 – Use logs spanning channel, built as you go, to move materials up the streambed	SPU				1	
	SPR				3	
	FODHC				3	
	COMMUNITY				5	
	SUBTOT.	0	0	0	12	0
RS-06 – Use smaller structures initially and return in future years to increase placements where required	SPU					3
	SPR					3
	FODHC					5
	COMMUNITY					3
	SUBTOT.	0	0	0	0	14
RS-07 – Use boulders or boulder clusters to help retain sediment	SPU					3
	SPR					3
	FODHC					5
	COMMUNITY					3
	SUBTOT.	0	0	0	0	14
RS-08 – More strategic machine placement of log structures in fewer locations ("hot spots")	SPU					5
	SPR					3
	FODHC					5
	COMMUNITY					3
	SUBTOT.	0	0	0	0	16

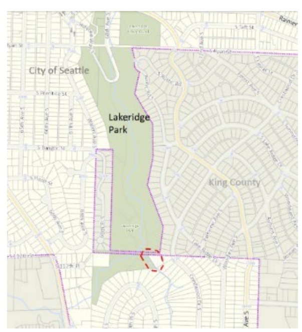
	EVALUATION MATRIX					
How well does each idea satisfy the target category? Indicate by entering E, G, or P under the criteria, respectively.	**Stakeholder**	**Control Erosion in Canyon**	**Increase Resilience**	**Minimize Construction Impact**	**Materials Delivery Logistics**	**Retain Sediment in Canyon**
RS-13 – Place dredged material from the delta	SPU					1
	SPR					1
	FODHC					3
	COMMUNITY					3
	SUBTOT.	0	0	0	0	8

Value Study Ideas

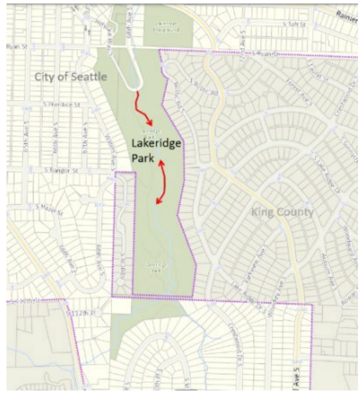
The Taylor Creek Value Study took place over the course of one week in mid-June. The Value Study team consisted of an expert panel recommended by the Value Study consultant firm and reviewed by SPU, SPR, and Friends of Dead Horse Canyon.

The Value Study expert panel focused their recommendations on accomplishing the project goals. These included community promoted goals of reducing impact to trees and vegetation as much as possible as well as SPU's goals of capturing as much sediment as possible in the creek to raise the creek bed, reducing erosion and landslide risk along the steep canyon walls, and restoring habitat for fish and other wildlife. The ideas from the value study are sorted into four categories: Control Erosion in Canyon, Minimize Construction Impact, Materials Delivery Logistics, and Retain Sediment in Canyon.

Control Erosion in Canyon

	**Idea CE-01: Place only timber frame structures strategically along banks of creek to help shore banks in areas without large wood structures.** *This idea proposes to install timber frame structures along areas of the bank that are eroded regardless of whether there is a proposed large wood structure planned in the channel adjacent to the timber frame. The timber frame acts as a wall of sorts providing support to the bank and new vegetation. Without a corresponding wood structure in the channel, there is risk that high flows could undermine the timber frame and wash out vegetation.*
 	**Idea CE-05: Create constructed storage wetland at location of the historic wastewater treatment facility in the East Fork** *This idea is intended to create some of the benefits of having a headwater wetland, similar to the one that is located upstream in the west fork of Taylor Creek. A wetland has many benefits such as treating stormwater, providing storage of both water and sediment, slowing flows and providing unique wetland habitat. A constructed wetland would also require periodic maintenance, complex permitting requirements and concerns regarding slope stability from surrounding neighbors.*

Minimize Construction Impact



Idea MC-02: Access only along channel from downstream and upstream directions as appropriate

This idea eliminates any need for a temporary road into the canyon by using the channel itself as the “road” by bringing materials and equipment directly up the channel. Currently, there is only one location to access the channel, near the trailhead at Holyoke Way S. so everything would come in and out from this point.

Idea MC-06: Assemble mechanical equipment in the canyon for use and disassemble to remove

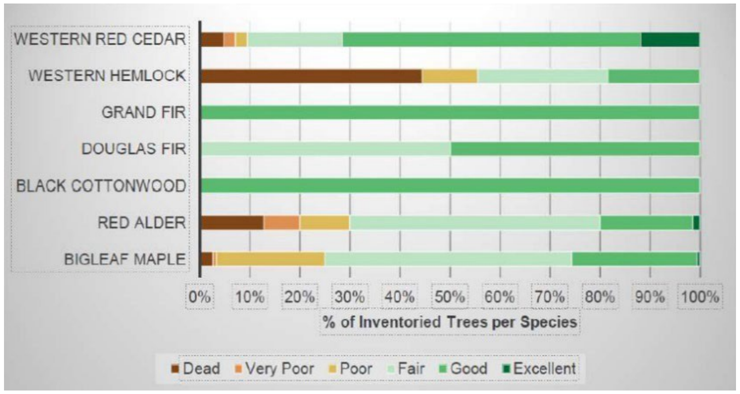
This idea focuses on utilizing smaller equipment that can be hand carried up the channel, then assembled in place to assist with bringing in and placing materials (such as wood structures or boulders). This method would have less impact to surrounding vegetation than utilizing larger machines but be time consuming and significantly increase the duration of the work.

LEARN MORE

We are committed to keeping you informed. If you would like more information about the project or have questions, please use one of the following resources

Learn more on the project webpage: **seattle.gov/utilities/taylorcreek**
Email the project manager at **Cody.Nelson@seattle.gov**

Materials Delivery Logistics



Idea MD-01: Use identified hazard trees on site as a source for logs and rootwads

This idea proposes to cut down trees that are viewed as hazards to users of the trail into the canyon, and to use those trees in (or as part of) the wood structures in the creek. Doing so would reduce risk to people on the trail and could be a cost savings (and convenience) by using onsite materials. This would result in removing a portion of the tree canopy and there could be additional vegetation disturbance.

Idea MD-02: Use helicopter delivery for materials

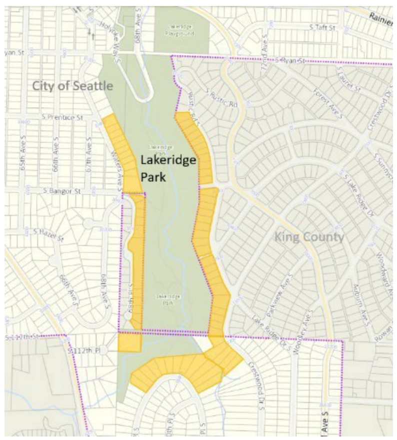
Description: This idea proposes using a helicopter to get the large wood and other materials into the canyon during the winter. The helicopter would need to utilize the newly renovated Lakeridge Playfield for log staging and then fly the materials into the canyon where they would be stockpiled in several locations for later use. While the actual helicopter use is expected to be around one week, preparing and restoring the playfield could take up to 3 months.

Idea MD-06: Use small tracked vehicle (ATV) to haul logs and other materials along existing trail

Description: This idea proposes to use ATVs and carts to transport materials into the canyon on the existing trail. This could take advantage of the existing trail with minimal to no modifications but may present challenges with getting the materials from the trail to the creek, or taking longer to deliver because there would only be enough room for one way travel.

Seattle Public Utilities

Taylor Creek Restoration Project



Idea MD-08: Buy a property in the right location and install slide or highline for material delivery

Description: This idea involves purchasing a property along the rim of the canyon, tearing down any buildings, and using a slide or a highline to get materials from the top of the canyon to the channel. Property acquisition, permitting and demolition would take a minimum of 3 years.

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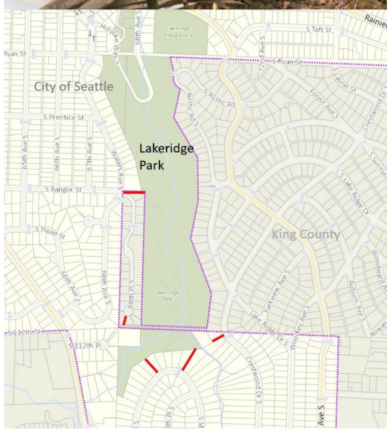
Taylor Creek Restoration Project

	**Idea MD-10: Use pack animal delivery for materials** *Description: This idea proposes to use pack animals or draft horses to transport materials into the canyon on the existing trail. This could take advantage of the existing trail (with modifications) and may present challenges with getting the materials from the trail to the creek, or taking longer to deliver because there would only be enough room for one way travel. Extensive trail restoration would be required.*
  Wallace 6-Ton H3-12141 Steel Adjustable Height	**Idea MD-12: Use winches and hoists to assist with material delivery** *Description: This idea proposes to use winches and cables to move materials up the creek channel from Holyoke Way S. and then aid manual placement. This method may be suited to move smaller wood or logs into the channel and may increase the construction duration.*

Seattle Public Utilities

Taylor Creek Restoration Project



Idea MD-21: Use existing easements to establish slide or highline to bring in material

Description: This idea involves using existing utility easements along the rim of the canyon and using a slide or a highline to get materials from the top of the canyon to the channel. While this idea does not require lengthy property acquisition, the location of the existing easements presents a challenge to getting materials throughout the canyon. The width of the easements presents another challenge for large equipment that would need to be situated at the top of the steep slope.

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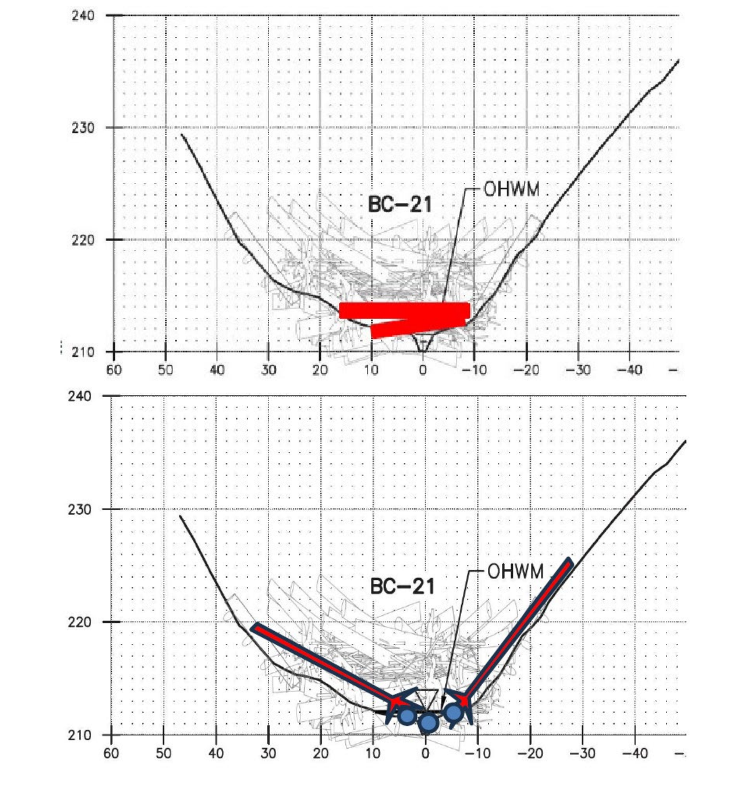
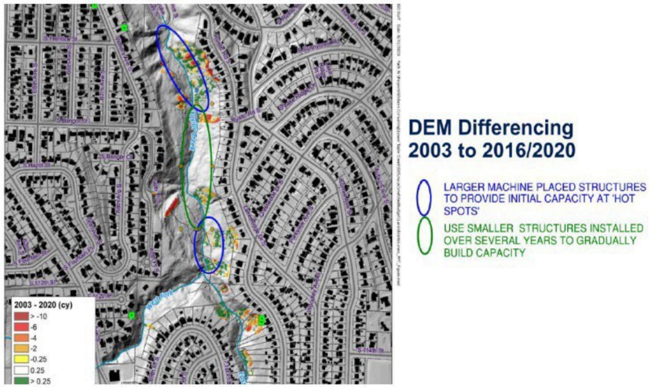
	**Idea MD-22: Use logs spanning channel, built as you go, to move materials up the streambed** *Description: This idea proposes constructing a skid road of logs up the channel, and spanning the channel, to act as a road to bring in materials with winches and a spider excavator would place the materials into the channel.* *This may be less labor intensive than hand carrying and could accommodate larger logs; the skid road would be difficult to construct and use within the 2-month required work window.*

Retain Sediment in Canyon



Idea RS-06: Use smaller structures initially and return in future years to increase placements where required

Description: This idea proposes to install smaller accumulations of wood at more locations throughout the channel. Additional wood would need to be stockpiled on the channel banks for future installation after a period of monitoring. Several different wood configurations are possible, two are shown below. This idea would require ongoing monitoring and future construction efforts in the canyon within a few years.

	**Idea RS-07: Use boulders or boulder clusters to help retain sediment** *Description: This idea is to use large boulders as the sediment retaining structures in the channel. The boulders could be installed to form steps which may be better for upstream fish passage but could be difficult to deliver and install (each boulder between 1,000-3,000 pounds).*
	**Idea RS-08: More strategic machine placement of log structures in fewer locations ("hot spots")** *Description: This concept is to install wood structures only in the locations that appear to be experiencing the worst erosion (lower and mid-ravine). This would target the worst areas of erosion and provide support to the banks and channel for vegetation establishment and may require additional smaller structures to be installed over time to ensure that a lot of sediment isn't continuing to be deposited downstream.*

	**Idea RS-13: Place dredged material from the delta back into the channel upstream** *Description: This idea simply puts the excavated gravel from the delta (planned work) back in the channel in the canyon as far upstream as possible. This would improve fish passage into the lower channel from the lake but may be difficult to permit and reintroduces loose gravels to the channel upstream that could be easily eroded and transported downstream.*

Notes

Materials Delivery Logistics	**Idea MD-06**
	Idea MD-12
	Idea MD-08
	Idea MD-21
	Idea MD-01
	Idea MD-02
	Idea MD-10
	Idea MD-22

Notes

Retain Sediment in Canyon	**Idea RS-06**
	Idea RS-07
	Idea RS-08
	Idea RS-13
Control Erosion in Canyon	**Idea CE-01**
	Idea CE-05
Minimize Construction Impacts	**Idea MC-02**
	Idea MC-06

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