Value Engineering Study

SURFACEWATER IMPROVEMENT PROJECT

Bend, OR

Final Report

March 2011

FUNCTION RSRI COST

FINAL VALUE ENGINEERING STUDY REPORT

For

SURFACEWATER IMPROVEMENT PROJECT

Bend, OR

March 2011

Prepared for:

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ACKNOWLEDGEMENTS

Robinson, Stafford, & Rude, Inc. and our associated firms would like to express our appreciation to the City of Bend staff members who assisted us in the review of this project. Particular thanks go to Heidi Lansdowne, Art Easton and Tom Hickman for providing valuable insights into project issues and to Connie Sweet for assisting with logistics during the workshop.

In addition, we would like to thank Bryan Black and the other members of the HDR, Inc. design team for sharing their knowledge about the project and for their responsiveness to our questions and requests throughout this value engineering study.

Cover photo(s) courtesy of HDR and Pat Van Duser of Black & Veatch.

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EXECUTIVE SUMMARY

Robinson, Stafford & Rude, Inc, assisted by technical specialists from Separation Processes, Inc., Brown & Caldwell, Black & Veatch, Lorden Engineering and VK Tech Services, Inc. conducted a 5-day value engineering workshop on the preliminary design of the Bend Surfacewater Improvement Project the week of January24, 2011.

The results of that evaluation consisted of four major conclusions and 31 detailed recommendations for improving the value of the project. The four major conclusions are summarized as follows:

- The City is following the proper course of action in continuing to obtain potable water from two different types of water sources, namely surface water and groundwater.
- The City is correct in including a strategy in the design of the filtration plant to deal with possible surface water quality impairment as a result of a future forest fire in the watershed.
- The use of membrane treatment as the primary treatment mode for the Bridge Creek supply is the appropriate choice of technology.
- The City should make future decisions about the surfacewater project and the water system in general considering the water system as a two-source, integrated system (surface water and groundwater).

The following detailed VE recommendations were accepted in whole or in part as improvements to the preliminary design:

- Reduce the size of the new transmission pipeline from 36-inch diameter to 30-in diameter
- Allow the construction contractor to use CDF (a lean concrete mix) as pipe bedding and pipe zone backfill
- Don't install a fish ladder at the water intake unless required by state regulatory agencies as a condition for installing hydropower
- Add the ability to temporarily connect portable propane heating tanks at the intake in the winter
- Conduct additional investigation of the dam and intake concrete condition and the dam stability
- Include a more detailed definition of the required demolition at the intake in the construction documents
- Validate the payback of hydropower with a sensitivity analysis before deciding on hydropower
- Re-task an existing generator at the Outback site rather than building a new treatment standby generator
- Don't construct the treatment building to accommodate more than 21 CFS capacity at this time
- Modify the SCADA system to provide a redundant PLC (programmable logic controller)
- Allow the membrane suppliers to propose on different individual unit sizes to achieve the total design flow.

Implementation of these changes will result in the following estimated cost savings:

• Final Accepted Capital Cost Savings	$3,410,000
• Final Accepted Present Worth of O&M Cost Savings	($498,000)
• Final Accepted total Life Cycle Cost Savings	$2,912,000

In addition, the City intends further designer evaluation of 12 additional VE team recommendations to determine their acceptability for inclusion in the design. If determined to be feasible, these VE recommendations have the potential to generate from $0.6 to $3 million in additional life cycle cost savings.

INTRODUCTION
SECTION 1

INTRODUCTION

This report presents the results of a VE study conducted by Robinson, Stafford & Rude, Inc. (RSRI) on the design of the Surfacewater Improvement Project in Bend, OR for the City of Bend (City). The project designer is HDR, Inc. (HDR) and associated firms. The project was reviewed at completion of Preliminary design. The 40-hour VE workshop was conducted in Bend, OR. The members of the VE Team are listed in Appendix D.

The Surfacewater Improvement Project consists of improvements to the existing water intake facility to add fish screens, a fish ladder and replace the existing building; construction of a new 10-mile long raw water transmission main; and construction of a hydropower facility and membrane filtration plant at the Outback pumping and water storage facility.

ORGANIZATION OF THIS REPORT

The report is organized to accomplish several purposes:

- Serve as a reference for final decision-makers to understand the implications of the various recommendations of the VE Team;
- Document the value engineering effort for the City of Bend, regulatory agencies, the public and/or other interested parties;
- Provide a reference document to track implementation of the accepted value engineering recommendations as the project design moves to completion.

This section, the **Introduction**, provides general information about the VE study that was conducted and suggestions about how to use this report and how to evaluate the VE Team recommendations.

The **Summary of Results** section provides an overview of the results of the VE study, including identification of those VE recommendations that were selected by the Owner and the Designer for incorporation into the project design. It is important to note that the VE Team does no design work and makes no design decisions on the project. All decisions regarding changes to the design resulting from the concepts advanced by the VE Team were made by the Owner and the Designer of record for the project.

The **Value Engineering Team Recommendations** section includes the details of all of the recommendations prepared by the VE Team. It is included to ensure a detailed understanding of the recommendations. Included in this section are comments about design validation, if appropriate, comprehensive recommendations packages, where appropriate, and the details of each individual VE Team recommendation.

The detailed VE Team recommendations are listed first by major project area or function (the letter portion of the recommendation number), and then by idea number within that project area or function, as follows:

- Raw Water Conduit (C)
- Emergency Discharge (E)
- Fiber Optic Link (F)
- Hydropower Plant (H)
- Intake (I)

- Miscellaneous (M)
- Treatment Plant (T)
- Waste Forcemain (W)

The **Appendices** provide additional technical detail about the project, additional detail about the value engineering process, an explanation of the basis for cost comparisons, and other details about the study which may be of interest to some report readers.

SCOPE OF THIS VALUE ENGINEERING STUDY

This study is the only study currently planned for this project. The scope of this VE study encompasses:

- Improvements at the existing water intake
- A new 36-inch diameter transmission main from the intake to a new filtration plant at the Outback site
- A Hydropower generating facility
- A new water filtration plant.

The focus of the VE study is to identify areas of high cost (both initial and annual) and to recommend alternatives for reducing or increasing these costs to maintain or improve the required functions, performance, safety, and quality. The value engineering work effort included the following work sessions:

- VE workshop – January 24 - 28, 2011
- Workshop site visit by the VE Team – January 24, 2011
- Post-workshop Implementation/Decision-making meeting – February 14, 2011.

Project Constraints

One of the other things that may define the scope of the value engineering study is VE study constraints. These are aspects of the project that the City does not want scrutinized by the team, because they represent project elements that, in the opinion of the City, cannot be changed. Constraints may result from a variety of political, technical, or environmental causes. Excessive constraints inhibit the team's ability to identify creative opportunities for project enhancement. Inadequately defined constraints can result in the VE effort being wasted in areas where there is no possibility of change.

The following project constraints were defined for this VE study:

- Water withdrawal location must not change
- Must have a surface water supply
- Must have membrane filtration.

UNDERSTANDING VE TEAM RECOMMENDATIONS

The VE Team comments fall into one of the following categories:

- Design Validation

- General Comments
- Individual detailed recommendations
- Other Benefits.

Additionally, there are often good ideas for project improvement or cost reduction that are identified by the VE Team but, because of the time limitations imposed by the VE workshop duration, cannot be developed by the VE Team as VE recommendations. For this reason, this report includes the entire list of creative ideas identified by the VE Team, in Appendix H. The City and HDR were provided the creative idea list to enable them to review all possible ideas that could improve the value of the project.

Design Validation

Design validation comments are VE Team commentaries on the portions of the design for which the VE Team would not recommend changes. These identify those areas of the project for which VE Team review has specifically confirmed represent excellent value, i.e. excellent functional accomplishment for the cost expended.

Comprehensive Recommendations

For this VE study, the VE team identified one comprehensive general recommendation that the VE team believes should be considered as a backdrop to implementation of all of the detailed VE recommendations. The comprehensive recommendations section describes this recommendation

Individual Detailed Recommendations

Individual detailed VE recommendations identify opportunities for improving the value of the design. These recommendations are projected to accomplish one of the following:

- Maintain or improve the accomplishment of needed design functions at a lower life cycle cost
- Improve the accomplishment of needed design functions at the same or similar life cycle cost
- Improve the accomplishment of needed design functions for an appropriate increase in life cycle cost.

Each VE recommendation includes:

- A summary of the currently proposed (original) design;
- A description of the change recommended by the VE Team;
- A summary of the advantages and disadvantages of the VE Team concept as compared with the original Designer's concept;
- A narrative comparing the original design and the recommended change and explaining the VE Team concept;
- Sketches, where appropriate, to further illustrate the VE Team recommendation;
- Calculations, where appropriate, to support the technical adequacy of the recommendation;
- A capital cost comparison;

- A life cycle cost analysis, if appropriate.

Both capital and life cycle costs are shown in year 2014 dollars. Capital costs were based on the VE-Team-validated, Designer's cost estimate. Life cycle costing was based on a net discount rate of 4% percent per year, and an economic analysis period of 20 years. Labor rates were based on information provided by the City, and other operations and maintenance costs were based on a combination of City information and the experience of the VE team.

The VE recommendations are presented as a "Shopping List" of value improvement opportunities for the City. Some recommendations are alternatives to one another, some are independent, and some overlap one another. For this reason, it is not possible to accept and implement all of the VE recommendations together. Nor, therefore, is it possible to add all of the individual savings together as initially presented. The final estimated savings accepted have been adjusted to correct any overlaps.

Each of the detailed VE recommendations is intended to convey a concept for change, not to propose a detailed design that can only be accomplished in accordance with the detailed assumptions contained in the VE recommendation. In order to calculate the cost impacts of these recommended changes, the VE Team had to make detailed assumptions about design issues to determine quantities, sizes, and costs.

Following the delivery of the preliminary VE report to the design team, the City and the designers reviewed the VE team recommendations to check the following:

- Validity of VE team assumptions
- Accuracy of VE team costing
- Practicality of the VE team recommendation for the Bend project

This is an important step in the VE process because the VE team recommendations, while creative, worthwhile and as accurate as can be developed by the VE team in the workshop timeframe; nonetheless, because of the short timeframe in which they are developed are subject to possible inaccuracies. Any potential concerns were identified by the designer and City review and additional information is provided in the designer responses (Appendix J). The final implementation (decision-making) meeting was then held to reconcile the information developed by both the VE team and the designers to provide the City with the most accurate combined information upon which to make decisions. For this reason, the cost estimates associated with the original VE team recommendations, the designer responses and the final accepted cost savings can vary.

SUMMARY OF RESULTS
SECTION 2

SUMMARY OF RESULTS

INTRODUCTION

This section of the report provides a summary of the results of the value engineering study. It lists all of the recommendations prepared by the VE Team and presented to the City and HDR for their consideration, as well as the decisions made by the City and HDR regarding acceptance of the recommendations of the VE Team.

Cost impacts shown in this section of the report reflect any revisions to the estimated cost impacts resulting from the City and HDR reviews of the VE recommendations.

Design Validation

Often, one of the significant benefits of a VE study is the review of particular design concepts, decisions or elements to confirm their appropriateness and/or viability. That was one of the results of this VE study. The following are design validation comments from the VE team:

- The VE team believes that the City is following the proper course of action in continuing to obtain potable water from two different types of water sources, namely surface water and groundwater. The City is fortunate to have these two types of water sources available. Some cities do not, and as a result, face greater risks of impairment of either raw water quality, water quantity or both. Both types of water supplies face risks of impairment to raw water quality and quantity. However, because the nature of the risk is different for the two types of sources, the likelihood of events making both supplies unavailable to meet water needs is much less likely than if only one type of source were available to the City. Accordingly, the availability of both types of supply provides the City of Bend with a substantially improved level of confidence in water availability.

- The VE team believes that the City is correct in including a strategy in the design of the filtration plant to deal with possible surface water quality impairment as a result of a future forest fire in the watershed. Information provided by the U.S. forest service suggests that, much like other natural events, a wildfire will occur in the watershed at some indefinite time in the future. Therefore, while the precise strategy for implementation and the specific technology to be used will benefit from the further study that is an outcome of this VE study, the implementation of a strategy to prepare for the consequences of w wildfire in the watershed is appropriate planning on the part of the City.

- Considering the high quality of the City's surface water supply under most conditions, the use of membrane treatment as the primary treatment mode for the Bridge Creek supply is the appropriate choice of technology.

Comprehensive Recommendations

The value engineering team identified one general recommendation that is not included in the individual detailed VE recommendations, as follows:

- The City should make future decisions about the surfacewater project and the water system in general considering it as a two-source, integrated system. That is, decisions about redundancy, standby power, water quality excursions in both supplies, etc., should be made using the resources of both types of supply in a complementary fashion, rather than viewing each supply as an independent system. This will result in a more robust, yet more cost-effective system, and one that provides staff with an optimized ability to successfully cope with the variables in supply and operation that affect any public water system and still deliver the desired quality and quantity of water.

Detailed VE Recommendations

The VE Team identified 31 VE recommendations for consideration by the City. A listing of these recommendations, the final agreed-upon estimated cost impacts, and the City decisions about which of these recommendations to include as the design proceeds are shown in Table 2-1.

TABLE 2-1
SUMMARY OF VE ACCEPTED RECOMMENDATIONS

Idea No.	Initial VE Team Design Concept	VE Team Estimated Capital Cost Savings	VE Team Estimated Present Worth of O&M Cost Savings	VE Team Estimated Life Cycle Cost Savings	Designer Estimated Capital Cost Savings	Designer Estimated Present Worth of O&M Cost Savings	Designer Estimated Life Cycle Cost Savings	Designer Recommendation	Final Owner/ Designer Decision	Accepted Capital Cost Savings	Accepted Present Worth of O&M Cost Savings	Accepted Total Life Cycle Cost Savings	Comments
Surfacewater Improvement Project													
	Raw Water Conduit (C)												
C-5/ C-6	Replace 1928 pipeline with new in existing alignment	$12,300,00	--	$12,300,000	$10,192,000	($18,811,000)	($8,619,000)	R	P	$2,750,000	($700,000)	$2,050,000	The City accepts the reduction of the pipeline size to 30", with a consequential small reduction in long term potential hydropower revenue. Because of access issues, concerns about adequate life of the 1950s pipeline, and more detailed cost analysis indicating no savings from the change in alignments will retain the originally proposed alignment of the new pipeline.
C-8	Span pipe without bridges	$358,000/	--	$358,000	$34,700	-	$34,700	R	F	TBD	TBD	TBD	The designer will further investigate the materials options and cost difference to provide the bridges, which are a community amenity, to determine whether the benefits are worth the additional cost, when optimized. Addition of snow load to VE team calculations will reduce VE team estimated savings.
C-9	Reuse on-site materials for backfill	$915,000/	--	$915,000	$0	-	$0	A	F	TBD	TBD	TBD	The existing design includes an intent to allow the contractor to use as much of the on-site materials for backfill as is suitable. The current estimate assumes significant imported material to be conservative. The Designer will further address the issue as more geotechnical information becomes available
C-17	Reduce minimum cover to 36"	$440,000	--	$440,000	$0	-	$0	A	F	TBD	TBD	TBD	The designer will review the proposed construction sequence for the road and the proposed pipe wall thickness further to confirm whether the pipe can accommodate the construction period stresses with the lesser cover.
C-20	Use steel pipe for bridge crossing	$60,000	--	$60,000	$0	-	$0	F	F	TBD	TBD	TBD	See C-8
C-21	Use narrow trench & CDF & only layback trench at joints	$380,000	--	$380,000	$100,000	-	$100,000	P	P	$100,000	-	$100,000	Based on input from the CM/GC team for the project, it is expected that the contractor will likely use a trench box for installation rather than simple open cut, reducing the potential savings from this option. The option will be included in the contract documents to permit the contractor to use this approach.
	Emergency Discharge (E)												
E-2	Do not restore watercourse	$668,000	--	$668,000		-		F	F	TBD	TBD	TBD	The existing watercourse will be used only in emergencies in the future, and thus only minimal work may be needed to maintain its functionality. The City will discuss with the property owner and DEQ the level of restoration that may be necessary to mitigate property owner and erosion concerns.
	Fiber Optic Link (F)												
F-2	Reduce conduit from 4" to 2"	$520,000	--	$520,000	$110,000		$110,000	F	R	-	-	-	Based on consultation with the CM/GC team at the post-workshop meeting, a 2" conduit is not large enough to accommodate a sheathed fiber optics cable
F-3	Use existing T1 & video accelerator	$1,370,000		$1,370,000	$691,000	($45,000)	$646,000	F	F	TBD	TBD	TBD	The designer will investigate options to a fiber optics link and provide a comparison of alternatives to the City for final decision.
	Hydropower Plant (H)												
H-17	Couple turbine to feed pump	$410,000	--	$410,000	$0	-	$0	R	R	-	-	-	Further investigation by the designer revealed that water turbine driven pumps are not available with the capacity and head requirements of the needed pumps.

A – ACCEPT; F – FURTHER STUDY; R – REJECT; P – PARTIALLY ACCEPT, TBD – TO BE DETERMINED

Idea No.	Initial VE Team Design Concept	VE Team Estimated Capital Cost Savings	VE Team Estimated Present Worth of O&M Cost Savings	VE Team Estimated Life Cycle Cost Savings	Designer Estimated Capital Cost Savings	Designer Estimated Present Worth of O&M Cost Savings	Designer Estimated Life Cycle Cost Savings	Designer Recommendation	Final Owner/ Designer Decision	Accepted Capital Cost Savings	Accepted Present Worth of O&M Cost Savings	Accepted Total Life Cycle Cost Savings	Comments
Surfacewater Improvement Project													
H-38	Rock anchor replaces thrust block	$46,000	--	$46,000	$0	-	$0	F	F	TBD	TBD	TBD	Further geotechnical investigation will determine which approach will be used.
	Intake (I)												
I-1	Eliminate fish ladder	$168,000	--	$168,000	$280,000	-	$280,000	F	R	TBD	TBD	TBD	The City, VE team and designer all question whether any measurable fisheries benefits would result from the expenditure of the funds for this project element. Accordingly the City will attempt to move forward through the ODFW waiver process to determine if the fish ladder can be eliminated in favor of a project more beneficial to fish. Development of baseline data and negotiations with ODFW will have associated professional services costs. No reduction in project budget has been assumed at this time.
I-2	Design screens to maintain pool water elevation			Design Suggestion				P	A	-	-	-	If screens are installed, the design will be revised to avoid raising the pool level behind the dam if at all possible.
I-6	Refurbish/upgrade spring diversion system	($61,000)	--	($61,000)				F	F	TBD	TBD	TBD	The City desires to improve the dependability of the supply from the spring, but further investigation is needed to determine the improvements to be made and the potential environmental and permitting implications of improvements.
I-10	Don't install screens or fish ladder	$880,000	$310,000	$1,190,000				F	R	-	-	-	Resolution of this recommendation will depend on the negotiations with ODFW described in I-1 above and the decision regarding hydropower implementation.
I-14	Add provision to connect small propane tanks in winter			Design Suggestion				A	A	-	-	-	This will be included in the final design.
I-18	Use construction process needs to expand parking			Design Suggestion				F	F	TBD	TBD	TBD	The City and designer support this concept, but additional discussions with the forest service will be needed to confirm its viability.
I-19	Specify extent of demo			Design Suggestion				A	A	-	-	-	If screens are included in the final project, details of proposed demolition will be shown on the drawings.
I-20	Verify concrete condition			Design Suggestion				A	A	-	-	-	As an early action in the next phase of work, concrete condition will be investigated, probably using non-destructive techniques to the extent possible
I-21	Assess dam condition			Design Suggestion				A	A	-	-	-	As an early action in the next phase of work, assessment of potential scour and undermining will be performed. Maintenance improvements, if indicated will be incorporated into the project.
	Miscellaneous (M)												
M-2	Validate hydropower payback			Design Suggestion				A	A	TBD	TBD	TBD	The designer will conduct a sensitivity evaluation of the hydropower option, considering both City implementation and privatization of hydropower to provide the City with the information needed to decide whether to include hydropower capability in the project.
	Treatment Plant (T)												
T-20	Eliminate standby power generation	$90,000	$290,000	$380,000	($120,000)		($120,000)	R	P	$85,000	$82,000	$167,000	Provided the potential for using existing standby generation capacity (550 kw diesel standby generator at wellhouse 6) at the Outback site to meet the new filtration plant standby power needs is confirmed, the new standby power generator will be eliminated and the existing large generator at Outback will be modified to also support the new filtration plant

Idea No.	Initial VE Team Design Concept	VE Team Estimated Capital Cost Savings	VE Team Estimated Present Worth of O&M Cost Savings	VE Team Estimated Life Cycle Cost Savings	Designer Estimated Capital Cost Savings	Designer Estimated Present Worth of O&M Cost Savings	Designer Estimated Life Cycle Cost Savings	Designer Recommendation	Final Owner/ Designer Decision	Accepted Capital Cost Savings	Accepted Present Worth of O&M Cost Savings	Accepted Total Life Cycle Cost Savings	Comments
Surfacewater Improvement Project													
T-24	Drop finish floor to rock elevation	$53,000	--	$53,000				R	R	-	-	-	The additional operational burden of going up and down steps for operation and maintenance access is not acceptable to the City
T-36	Limit design to 21 CFS (Reduce pipe from 36 to 30 inch diameter, *included in C-5/C-6 above*; reduce membrane building size; reduce sizing of electrical, piping, solids handling, pretreatment, chem. Storage)	$7,090,000	$120,000	$7,210,000	$1,755,000		$1,755,000	P	P	$475,000	$120,000	$595,000	The facility will be redesigned to allow future expansion of the process and building, but will not provide additional enclosed space for expansion at this time.
T-44	Use redundant PLC and remote I/O	$109,000	--	$109,000	$0		$0	A	A	$0	$0	$0	This was included as an option for the membrane supplier so there is no associated cost savings.
T-48	Use fewer treatment units	$865,000	--	$865,000	$0		$0	P	A	TBD	TBD	TBD	The specifications will be written to permit membrane supplies to provide a smaller number of larger units. However, recent communication with one supplier has indicated that the estimated savings may not be as large as estimated. Allowing this approach will permit the City to capture whatever savings are available. No credit for savings has been included in the VE study results for this recommendation.
T-50	Use DAF on backwash	$594,000	$1,436,000	$2,030,000	($86,000)	?	?	P/F	F	TBD	TBD	TBD	The designer will evaluate DAF and plate settlers as alternatives to secondary membranes with the goal of selection of whichever of these proves most effective and most cost-effective.
T-51	Use DAF for settling (Install now)	($56,000)	$1,045,000	$989,000				R	F	TBD	TBD	TBD	As an early action in the next phase of work, he Designer will perform an evaluation of the costs and benefits of pre-treatment so the City can decide if pre-treatment will be installed now or delayed until the future. The designer will research available data about the settling characteristics of solids resulting from forest fires at other locations to provide insight into the question of whether floating the solids or settling the solids will be more effective. Based on this information, the City will decide the best course of action.
T-53	Install pre-treatment equipment for now			Design Suggestion				F	F	TBD	TBD	TBD	The City will evaluate this question further as a part of the decision about the best choice for pre-treatment technology, considering procurement time, expected time available to implement treatment following a forest fire and available budget.
T-54	Eliminate daily chemical cleaning	($1,016,000)	$82,000	($934,000)				F	F	TBD	TBD	TBD	The designer will evaluate this further to determine the level of flexibility on this issue that should be included in the membrane purchase documents.
	Waste Forcemain (W)												
W-1	Use single lagoon for settling and for process waste settling and septic tank for sanitary waste	($189,000)	$1,271,000	$1,082,000	?	?	?	R	R	-	-	-	A pump station and forcemain will still be required to transfer cleaning wastes to the sanitary sewer, eliminating most benefits of the concept.
Final Estimated Savings										**$3,410,000**	**($498,000)**	**$2,912,000**	

A – ACCEPT; F – FURTHER STUDY; R – REJECT; P – PARTIALLY ACCEPT, TBD – TO BE DETERMINED

VALUE ENGINEERING TEAM RECOMMENDATIONS
SECTION 3

VALUE ENGINEERING TEAM RECOMMENDATIONS

ORGANIZATION OF RECOMMENDATIONS

All of the detailed recommendations developed by the value engineering team are included in this report section. The recommendations are organized first by project or functional area, and then numerically within each of those areas. The project/functional divisions are as follows:

— Raw Water Conduit (C)

— Emergency Discharge (E)

— Fiber Optic Link (F)

— Hydropower Plant (H)

— Intake (I)

— Miscellaneous (M)

— Treatment Plant (T)

— Waste Forcemain (W)

The individual VE recommendations follow.

RAW WATER CONDUIT (C)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	C-5, C-6	Idea Title	Replace 1928 Pipeline with New in Existing Alignment

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$26,590,000.00	--	$26,590,000.00
Proposed Concept	$14,290,000.00	--	$14,290,000.00
Estimated Savings	$12,300,000.00	--	$12,300,000.00

Description of Original Concept

The new pipeline is proposed to be 36" diameter and located (mostly) beneath the new shoulder/bike-path of Skyliners Road.

Description of Proposed Concept

This idea proposes to validate the integrity of the 1950s conduit, remove the 1928 conduit and replace it with a 18" diameter pipeline in the same alignment. The alignment will be cleared of existing trees which encroach. The total design flowrate of the proposed new plus 1950s conduits will be 36 cubic feet per second.

Advantages	Disadvantages
• Reduces new pipe/fittings cost • Reduces excavation cost • Two conduits provide operational flexibility and lower risk • Maintains easement rights • Validates condition of 1950s conduit • Improved alignment may be attractive to Forest Service for hiking and/or bike path rather than directly alongside traffic on Skyliners Road	• Some residential homeowners' lots will directly feel construction effects • Maintenance access is not as good as Skyliners Road alignment

Discussion

The existing, 1950s conduit is 14" diameter and provides a maximum flow of 9.4 cfs. The 1928 conduit ranges from 12" to 16" diameter and has reached the end of its service life. The new pipe is proposed to be 18" diameter steel with a maximum flowrate of 21.6 cfs (total of two conduits = 36 cfs). We have assumed the same number of isolation valves and blow-offs as the proposed 36" conduit. The new conduit connects to the proposed water treatment plant at the same point as the existing 1928 conduit.

The 1950s pipeline will be inspected to validate its continued serviceability using television and, where appropriate, direct visual methods. This proposal assumes for cost purposes that 5 deficient pipe zones each 10 feet long need replacement, as well as one blow-off.

Trees will be cleared from the existing alignment at an assumed rate of one tree each 50 feet. The timber is sold and nets revenue equal to 25% of the cost of clearing (which must be done carefully and not every tree is marketable). This and the continued pipeline operation maintains the City's claim(s) to easement rights along the alignment. It has been reported that in several instances residential out-buildings have

encroached into the alignment. Their disposition will need additional study and no cost is assigned herein.

Having two conduits provides operational flexibility. One may be shut down for inspection or repair if necessary. The maintenance work scope offered includes intake and discharge related elements fed by the temporarily shut-down conduit as well.

The cleared and re-graded alignment will, essentially, be a prepared alignment for some type of pathway – either pedestrian or bicycle, as desired. The Forest Service may wish to improve and maintain this alignment rather than utilizing Skyliners shoulder as currently proposed. The benefits include a more aesthetically pleasing pathway and greatly increased safety by removing hikers/bikers from high speed traffic.

Maintenance access will be somewhat less convenient than working in Skyliners ROW, but with the advantages of: (a) Personnel safety from greater separation between the pipes and traffic; (b) the pathway likely will not require expensive repaving and traffic control for work on the pipe.

VKTS
VK Tech Services

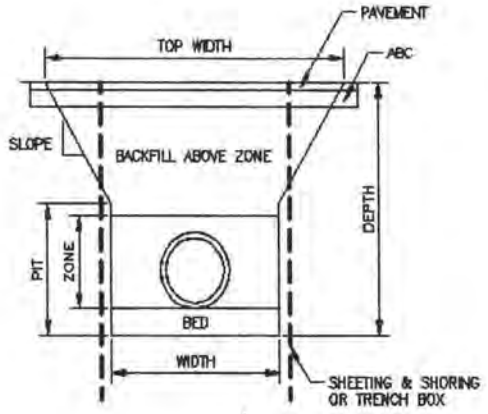
EXCAVATION CALCULATIONS Version 2.0

This Template calculates the excavation and backfill volumes for TYPE 1 and TYPE 2 trenches. The text and numbers in red can be changed to fit your project.
By changing the sideslope to 1 Vert. To 0 Horiz. you can calculate a sheeted & shored trench.

TYPE 1 TRENCHING

Proj No: **Bend Raw Water conduit**
Item: **36" Pipeline**
:
:

DESCRIPTION	INPUT	
Pipe Diameter(Nom.	**36**	inches
Average Depth	**7**	feet
Length	**50,000**	feet
Slope: 1 Vert. to	**1.50**	Horiz.
Pavement Thickness	**0.00**	inches
ABC Depth:	**0.00**	inches
No.of Pavement Cut	**0.00**	Each



Top Width = 15.0 ft

CALCULATED VOLUMES

Pavement Cutting	=	0 In ft
Pavement Removal	=	83,333 sq yd
Trench Excavation	=	76,852 cu yd
Bed + Zone fill	=	20,938 cu yd
Zone Only Fill	=	17,234 cu yd
Bed Only Fill	=	3,704 cu yd
Backfill Above Zone	=	42,824 cu yd
Waste if Import Bed, Zone	=	34,028 cu yd
Waste if Native Bed, Zone	=	13,090 cu yd
Surface Restoration Area	=	83,333 sq yd
Shoring Area (Optional)	=	NONE sq ft

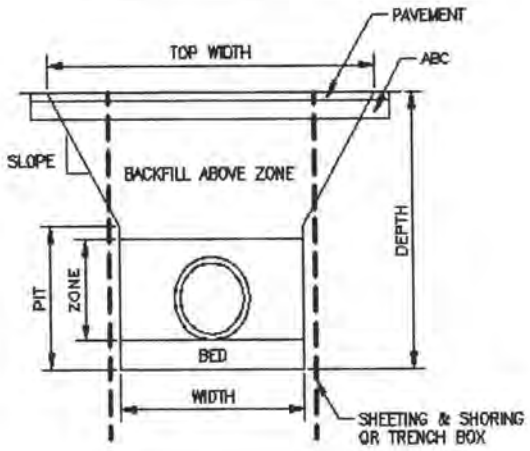
INPUT VARIABLES

Bed Depth =		**6**	in
Zone Depth =	D+	**12**	in
Min. Width =		**48**	in
Width	= D+	**12**	in
Pit Depth =		**4**	ft
<= Wid+/Side		**1**	ft

VKTS
VK Tech Services

EXCAVATION CALCULATIONS Version 2.0

This Template calculates the excavation and backfill volumes for TYPE 1 and TYPE 2 trenches. The text and numbers in red can be changed to fit your project.
By changing the sideslope to 1 Vert. To 0 Horiz. you can calculate a sheeted & shored trench.



TYPE 1 TRENCHING

Proj No: **Bend Raw Water conduit**
Item: **18" Pipeline**
:
:

DESCRIPTION	INPUT	
Pipe Diameter(Nom.	**18**	inches
Average Depth	**5.5**	feet
Length	**50,000**	feet
Slope: 1 Vert. to	**1.50**	Horiz.
Pavement Thickness	**0.00**	inches
ABC Depth:	**0.00**	inches
No.of Pavement Cut	**0.00**	Each

Top Width = 9.0 ft

CALCULATED VOLUMES

Pavement Cutting	=	0 In ft
Pavement Removal	=	0 sq yd
Trench Excavation	=	31,713 cu yd
Bed + Zone fill	=	10,616 cu yd
Zone Only Fill	=	8,302 cu yd
Bed Only Fill	=	2,315 cu yd
Backfill Above Zone	=	17,824 cu yd
Waste if Import Bed, Zone	=	13,889 cu yd
Waste if Native Bed, Zone	=	3,272 cu yd
Surface Restoration Area	=	50,000 sq yd
Shoring Area (Optional)	=	NONE sq ft

INPUT VARIABLES

Bed Depth =		**6**	in
Zone Depth = D+		**12**	in
Min. Width =		**30**	in
Width	= D+	**12**	in
Pit Depth =		**4**	ft
<= Wid+/Side		**1**	ft

1950s PIPE × 50,000 LF

16,666 LF 14" ϕ @ 4992 EL ↘ 4700 EL

33,333 LF 16" ϕ 4700 EL ↘ 4010 EL

Q_{14} = 9.4 CFS

Q_{16} = 14.9 CFS

NEED Q_{NEW} = 31 − 9.4 = 21.6 CFS

50^K LF @ 982 FT HEAD ⟶ USE 18" ϕ STEEL

V = 9.16 FT/SEC

RSRI

Construction Cost Estimate

Idea No: C-5 + C-6

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
				$ -		$ -
Fell/Remove Exst Trees	EA	$ 425.00	0	$ -	1,000	$ 425,000
General brush cleanup	ACRE	$ 382.50	0	$ -	23.0	$ 8,798
				$ -		$ -
TV Camera 1950s Conduit	LF	$ 3.00	0	$ -	50,000	$ 150,000
Replace 10ft lengths of 16" WSP	EA	$ 1,322.31	0	$ -	5	$ 6,612
Replace Blowoff	EA	$ 3,500.00	0	$ -	1	$ 3,500
				$ -		$ -
Remove 1928 conduit (12,14,16") WSP	LF	$ 30.00	0	$ -	50,000	$ 1,500,000
Remove old fittings	EA	$ 500.00	0	$ -	27	$ 13,500
				$ -		$ -
Excavate New Trench, 18"	CY	$ 4.22	0	$ -	31,713	$ 133,829
Spoil Excess Excavation, 18"	CY	$ 16.53	0	$ -	13,889	$ 229,585
Pipe Bed & Zone - CDF, 18"	CY	$ 90.00	0	$ -	10,616	$ 955,440
Backfill Above Zone, Native, 18"	CY	$ 3.08	0	$ -	17,824	$ 54,898
New 18" x .25 Wall WSP	LF	$ 107.80	0	$ -	25,000	$ 2,695,000
New 18" x .313 Wall WSP	LF	$ 134.97	0	$ -	25,000	$ 3,374,250
Regrade/finish surface	SY	$ 6.97			50,000	
Excavate New Trench, 36"	CY	$ 4.22	76,852	$ 324,315	0	$ -
Spoil Excess Excavation, 36"	CY	$ 16.53	34,028	$ 562,483	0	$ -
Pipe Bed & Zone - CDF, 36"	CY	$ 90.00	20,938	$ 1,884,420	0	$ -
Backfill Above Zone, Native, 36"	CY	$ 3.08	42,824	$ 131,898	0	$ -
36" HDPE, DR32.5	LF	$ 94.48	600	$ 56,688	0	$ -
New 1/4" x 36" steel pipe	LF	$ 184.93	30,000	$ 5,547,900	0	$ -
New 5/16" x 36" steel pipe	LF	$ 338.18	5,700	$ 1,927,626	0	$ -
New 3/8" x 36" steel pipe	LF	$ 491.43	13,700	$ 6,732,591	0	$ -
Regrade/finish surface	SY	$ 6.97	83,333	$ 580,831	0	$ -
Blowoffs, complete	EA	$ 1,938.00	10	$ 19,380	5	$ 9,690
Air-Vac Release	EA	$ 2,706.00	14	$ 37,884	7	$ 18,942
Isolation valves, complete	EA	$ 70,665.00	4	$ 282,660	2	$ 141,330
				$ -		$ -
				$ -		$ -
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				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
Subtotal				$ 18,088,676		$ 9,720,373
Markup		47%		$ 8,501,678		$ 4,568,575
TOTALS				$ 26,590,354		$ 14,288,948
NET SAVINGS						$ 12,301,406

Value Engineering Recommendation

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	C-8	Idea Title	Span Pipe Without Bridges

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$656,000.00	---	$656,000.00
Proposed Concept	$298,000.00	--	$298,000.00
Estimated Savings	$358,000.00	--	$358,000.00

Description of Original Concept

The original concept showed using weathered steel trusses to carry the water transmission pipe across two creek crossings that would also provide access for pedestrians/bicycles.

Description of Proposed Concept

This concept proposes that the pipe be used to span the creeks and that the pedestrians/bicycles use the existing roads.

Advantages	Disadvantages
• The creek crossings are simplified by using the pipe rather than a steel truss system • Construction costs are reduced • Long term maintenance is reduced	• Pedestrians and bicyclists would have to use the existing roadway/path • Additional permitting effort will be required

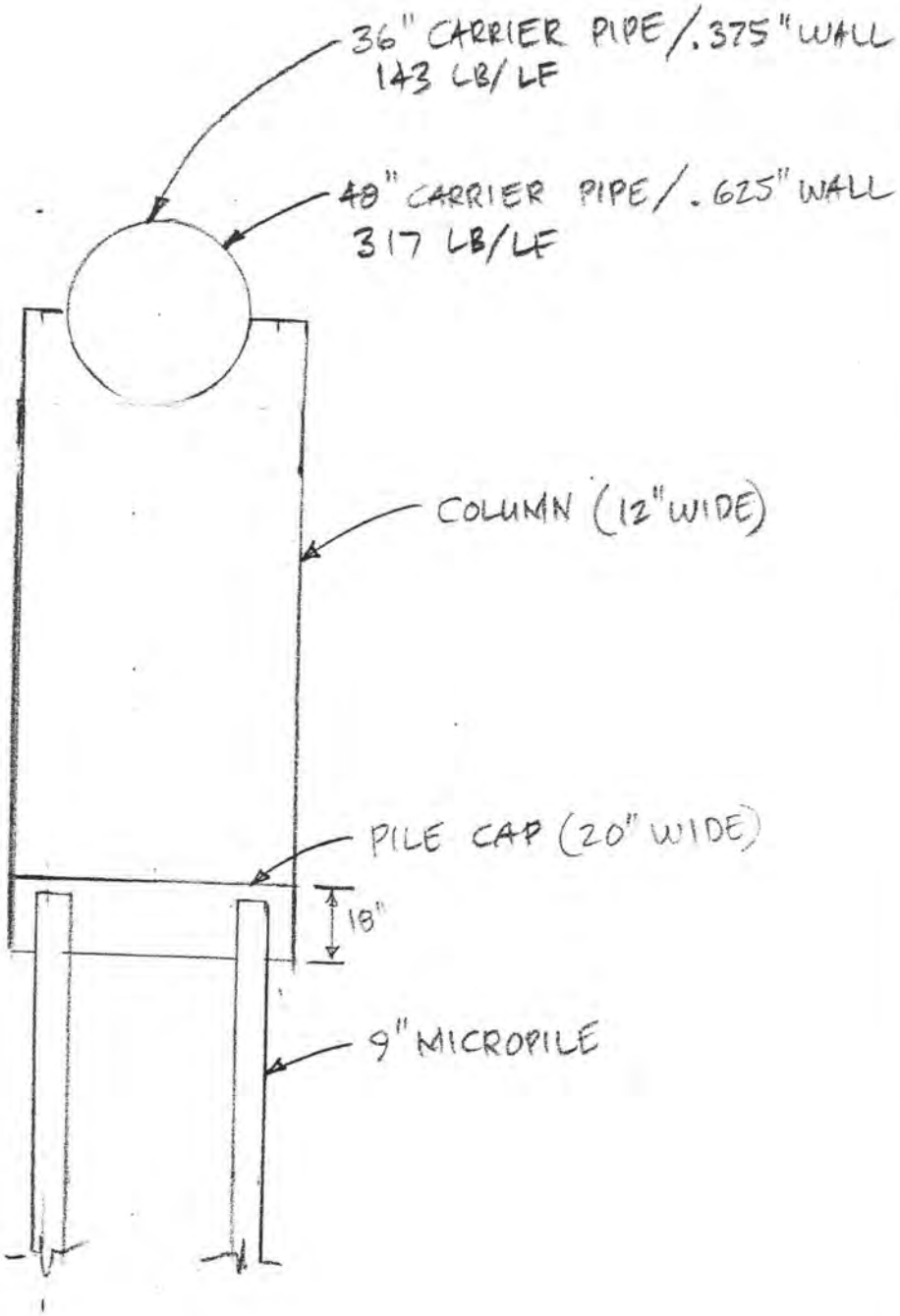
Discussion

At the Upper Creek Crossing, there is an existing vehicle bridge adjacent to the pipe crossing that is approximately 40 feet long. At the Lower Creek Crossing, there is an existing vehicle bridge adjacent to the pipe crossing that is approximately 70 feet long. Based on these existing conditions, reduce the length of the new pipe crossings to reduce the span length. Reduce the span of the Upper Creek Crossing from 100 feet to 70 feet. Reduce the length of the Lower Creek Crossing from 150 feet to 100 feet.

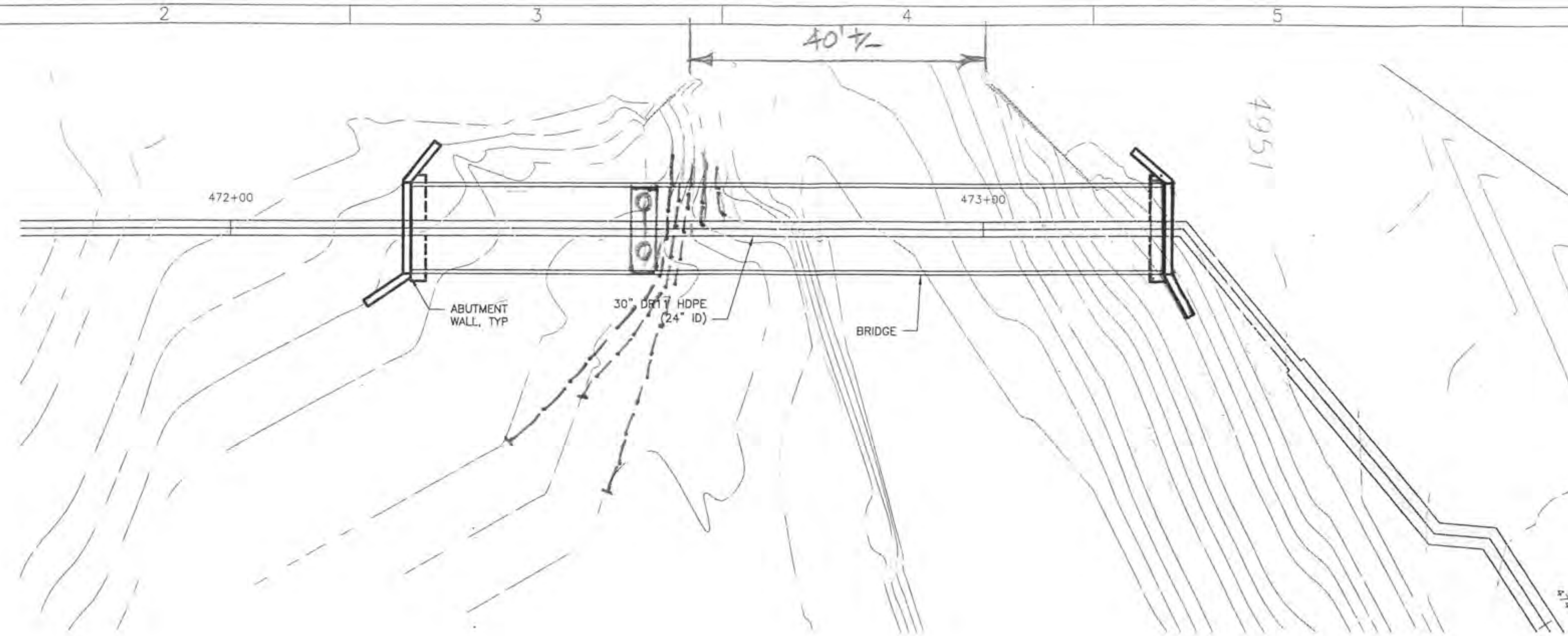
The carrier pipe would be analyzed as a structural beam and the wall thickness would be increased sufficiently to span the creek. For estimating purposes, it was calculated that the pipe diameter would need to be increased to 48 inch diameter to provide the structural rigidity to span the creek and limit deflection for the Lower Creek Crossing. For the Upper Creek Crossing the pipe would be 36 inches in diameter.

SKETCH

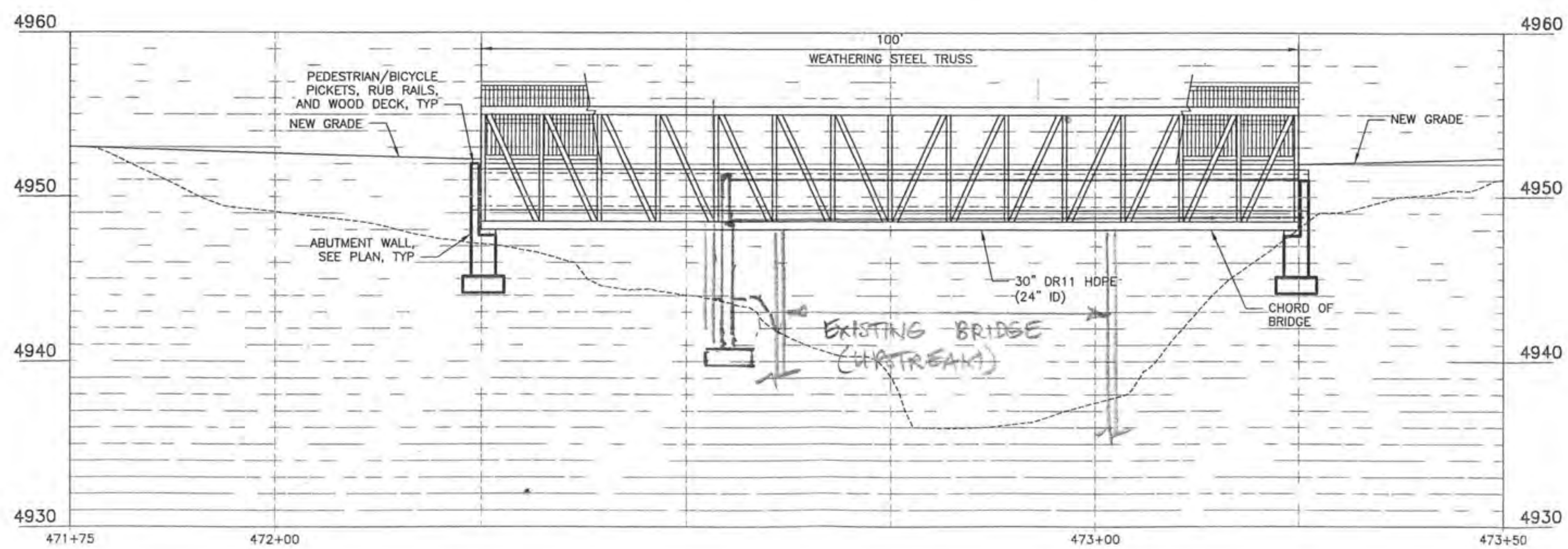
Idea No. C-8



RSRI

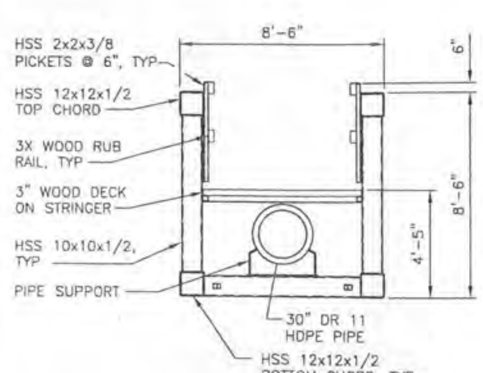


PLAN



PROFILE

SCALE: HOR 1" = 10'
VER 1" = 5'



OPTION 2
PEDESTRIAN/BICYCLE/CONDUIT BRIDGE

DWG: C:\Documents and Settings\rcorpent\Desktop\02D\03S-01.dwg USER: rcorpent
DATE: Jan 06, 2011 3:58pm XREFS: X_Border X_Contours X_Alignment X_Surface

PRE-DESIGN

DRAFT (Not For Construction)

SURFACE WATER IMPROVEMENT PROJECT
TRANSMISSION CONDUIT
UPPER CROSSING PLAN AND PROFILE
STA: 472+00 TO STA: 473+75
DESCHUTES COUNTY, OREGON

REVISIONS:
1.
2.
3.

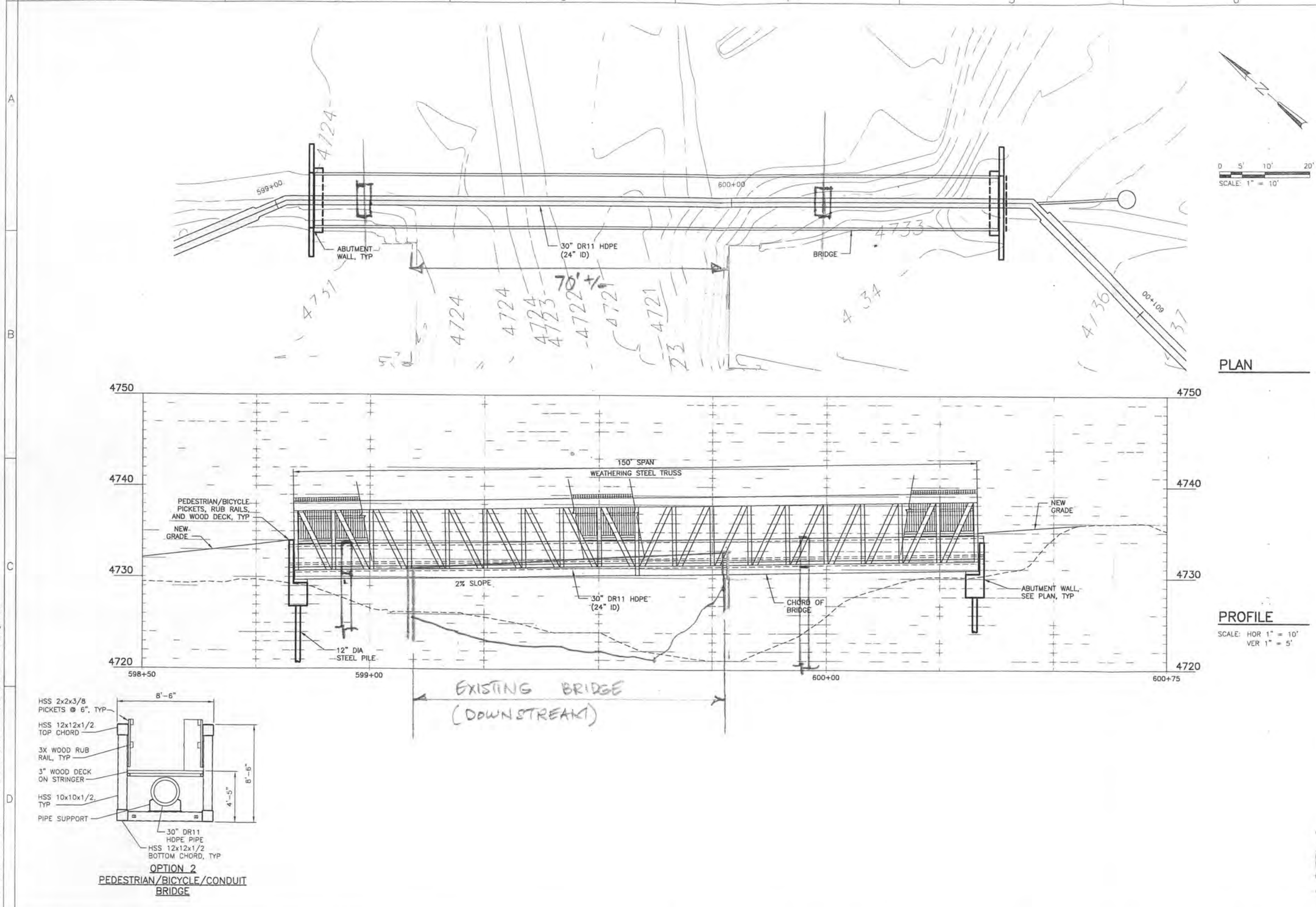
HDR

DESIGNED BY: N. MUCIBABIC
DRAWN BY: S. PAWLOWSKI
SCALE: AS NOTED
FILE:
DATE: JANUARY 2011

VERIFY SCALES
BAR EQUALS ONE INCH ON ORIGINAL DRAWING
0 1"

SHEET:
03S-01

COB #: WA0902



DRAFT (Not For Construction)

SURFACE WATER IMPROVEMENT PROJECT

TRANSMISSION CONDUIT

LOWER CROSSING PLAN AND PROFILE

STA: 599+00 TO STA: 601+00

DESCHUTES COUNTY, OREGON

REVISIONS: 1. 2. 3.

HDR

DESIGNED BY: N. MUCIBABIC
DRAWN BY: S. PAWLOWSKI
SCALE: AS NOTED
FILE:
DATE: JANUARY 2011

VERIFY SCALES
0 1"
BAR EQUALS ONE INCH ON ORIGINAL DRAWING

SHEET: **03S-02**

COB #: WA0902

DWG: C:\Documents and Settings\rcarpent\Desktop\02D\03S-02.dwg
DATE: Jan 06, 2011 3:58pm
USER: rcarpent
XREFS: X_Border X_Contours X_Alignment

C-8: SPAN PIPE OVER CROSSINGS

Gr50 Steel Pipe, F_y =	42	ksi		
Ω_b =	1.67			
Fall =	25.1	ksi		
Max Deflection =	L / 360			
Span, ft -->	100	ft	100	
Max allowable deflection, in		3.3		
Pipe OD, in	48		54	
Inner Pipe, OD x t	—		—	
Pipe wall t, in	0.625		0.50	
Outer Pipe weight, plf	317		286	= 490 x [π x (OD-t) x t] / 144
Inner Pipe weight, plf	0		0	
Water weight, plf	744		956	= 62.4 x π x $(OD-2t)^2$/4/144
Total load w, plf	1061		1242	
Flexural Moment M, in-k	15,915		18,630	= [w x L^2 / 8] x 12 / 1,000
Section Modulus, in^3	1,088		1,114	= π [OD^4 - $(OD-2t)^4$]/32OD
Moment of Inertia, in^4	26,101		30,070	= π [OD^4 - $(OD-2t)^4$]/64
F_b, ksi =	14.6		16.7	= M / S
Deflection, in =	3.15		3.2	= 5wL^4 / 384EI

C-8: SPAN PIPE OVER CROSSINGS

Gr50 Steel Pipe, F_y =	42	ksi	
Ω_b =	1.67		
Fall =	25.1	ksi	
Max Deflection =	L / 360		
Span, ft -->	70	70	
	ft		
Max allowable deflection, in	2.3		
Pipe OD, in	30	36	
Inner Pipe, OD x t	—	—	
Pipe wall t, in	0.375	0.375	
Outer Pipe weight, plf	119	143	= 490 x [π x (OD-t) x t] / 144
Inner Pipe weight, plf	0	0	
Water weight, plf	291	423	= 62.4 x π x (OD-2t)^2/4/144
Total load w, plf	410	566	
Flexural Moment M, in-k	3,014	4,160	= [w x L^2 / 8] x 12 / 1,000
Section Modulus, in^3	255	370	= π [OD^4 - (OD-2t)^4]/32OD
Moment of Inertia, in^4	3,829	6,659	= π [OD^4 - (OD-2t)^4]/64
F_b, ksi =	11.8	11.2	= M / S
Deflection, in =	1.99	1.58	= 5wL^4 / 384EI

CALCULATIONS

Idea No. C-8

LOWER CROSSING – FOUNDATION	X2 SUPPORTS
1. MICROPILES: 2EA × 20' = 40 LF	80 LF
2. PILE CAP: VOL = 6' LONG × 18" DEEP × 20" WIDE = 6' × 1.5' × 1.67' = 15 CF = 0.56 CY ≈ 0.6 CY	1.2 CY
3. COLUMN VOL = 6' LONG × 12" WIDE × 12' TALL = 6' × 1' × 12' = 72 CF = 2.67 CY ≈ 2.7 CY	5.4 CY
UPPER CROSSING – FOUNDATION	
1. MICROPILES: 2 EA × 15' = 30 LF	60 LF
2. PILE CAP: VOL = 5' LONG × 18" DEEP × 20" WIDE = 5' × 1.5' × 1.67' = 12.5 CF = 0.46 CY ≈ 0.5 CY	1.0 CY
3. COLUMN: VOL = 5' LONG × 12" WIDE × 8' TALL = 5' × 1' × 8' = 40 CF = 1.48 CY ≈ 1.5 CY	3.0 CY

RSRI

Construction Cost Estimate

Idea No: C-8

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Upper Creek Crossing - Pedestrian Bridge - 100 Feet Long	SF	$ 199.99	850	$ 169,992	0	$ -
				$ -		$ -
Lower Creek Crossing - Pedestrian Bridge - 150 Feet Long	SF	$ 213.99	1,275	$ 272,837	0	$ -
				$ -		$ -
Upper Creek Crossing - 36" diameter, 0.375" wall, 143 LB/LF	LF	$ 493.70	0	$ -	70	$ 34,559
				$ -		$ -
Lower Creek Crossing - 48" diameter, 0.625" wall, 317 LB/LF	LF	$ 956.91	0	$ -	150	$ 143,537
L						
Upper Creek Crossing Foundation - Pedestrian Bridge	CY	$ 225.00	7.50	$ 1,688		$ -
						$ -
Lower Creek Crossing Foundation - Pedestrian Bridge	CY	$ 225.00	7.50	$ 1,688		$ -
				$ -		$ -
				$ -		$ -
Upper Creek Crossing Foundation - Pipe Bridge						
				$ -		$ -
Micro Piles	LF	$ 70.25		$ -	80	$ 5,620
Pile Cap	CY	$ 970.25		$ -	1.20	$ 1,164
Column	CY	$ 1,500.00		$ -	5.40	$ 8,100
				$ -		$ -
				$ -		$ -
Lower Creek Crossing Foundatin - Pipe Bridge						
				$ -		$ -
Micro Piles	LF	$ 70.25		$ -	60	$ 4,215
Pile Cap	CY	$ 970.25		$ -	1.00	$ 970
Column	CY	$ 1,500.00		$ -	3.00	$ 4,500
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
Subtotal				$ 446,204		$ 202,665
Markup		47%		$ 209,716		$ 95,253
TOTALS				$ 655,920		$ 297,918
NET SAVINGS						$ 358,002

Value Engineering Recommendation

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	C-9	Idea Title	Reuse On-Site Material For Pipe Zone and Backfill Material

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$915,000.00	--	$915,000.00
Proposed Concept	$0.00	--	$0.00
Estimated Savings	$915,000.00	--	$915,000.00

Description of Original Concept

The pipe zone material is called for to be an approved classified granular material with 100 percent passing 3/8 mesh screen.

Description of Proposed Concept

Process trench excavated material for use as pipe zone material adding cement as necessary.

Advantages	Disadvantages
• Saves the cost of hauling excavated material off site • Saves the cost of hauling granular material to the site	• Requires additional equipment to screen and process the material • Requires additional planning and stockpiling of material

Discussion

The primary advantage of this proposed concept is that is reduces the volume of truck traffic necessary to haul material to and from the project site.

Boring logs indicate that existing material includes gravelly sand, silty sand, sandy silt. This material could be processed and used for pipe zone and backfill. Cement would be added to develop strength in the soil material.

Idea C-9R1 Bend – Reuse On-Site Material for Pipe Zone and Backfill Material

Assuming a pipe diameter of 36 inches, an average trench width of 6 feet in the pipe zone area, a 1 to 1.5 sideslope above the pipe zone and an average depth of cover of 4 feet over the pipe, the following volumes were calculated using Dennis' trench formula for a 50,000 foot length of pipeline.

Trench Excavation – 117,000 CY

Bedding and Pipe Zone - 37,000 CY

Backfill – 67,000 CY

Waste – 51,000 CY

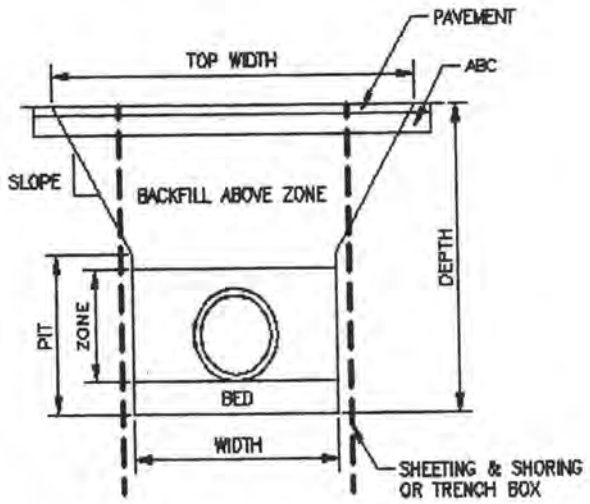
Restoration – 103,000 SY

VKTS
VK Tech Services

EXCAVATION CALCULATIONS

Version 2.0

This Template calculates the excavation and backfill volumes for TYPE 1 and TYPE 2 trenches.
The text and numbers in red can be changed to fit your project.
By changing the sideslope to 1 Vert. To 0 Horiz. you can calculate a sheeted & shored trench.



TYPE 1 TRENCHING

Proj No: Bend Raw Water Conduit
Item: C-9 36" Pipeline

DESCRIPTION	INPUT	
Pipe Diameter(Nom.)	36	inches
Average Depth	8	feet
Length	50,000	feet
Slope: 1 Vert. to	1.50	Horiz.
Pavement Thickness:	0.00	inches
ABC Depth:	0.00	inches
No.of Pavement Cuts	0.00	Each

Top Width = 18.5 ft

CALCULATED VOLUMES

Pavement Cutting	=	0 ln ft
Pavement Removal	=	102,778 sq yd
Trench Excavation	=	117,361 cu yd
Bed + Zone fill	=	37,604 cu yd
Zone Only Fill	=	32,049 cu yd
Bed Only Fill	=	5,556 cu yd
Backfill Above Zone	=	66,667 cu yd
Waste if Import Bed, Zone	=	50,694 cu yd
Waste if Native Bed, Zone	=	13,090 cu yd
Surface Restoration Area	=	102,778 sq yd
Shoring Area (Optional)	=	NONE sq ft

INPUT VARIABLES

Bed Depth =		6	in
Zone Depth =	D+	12	in
Min. Width =		72	in
Width =	D+	36	in
Pit Depth =		4	ft
<= Wid+/Side		1	ft

C-9

VKTS
VK Tech Services

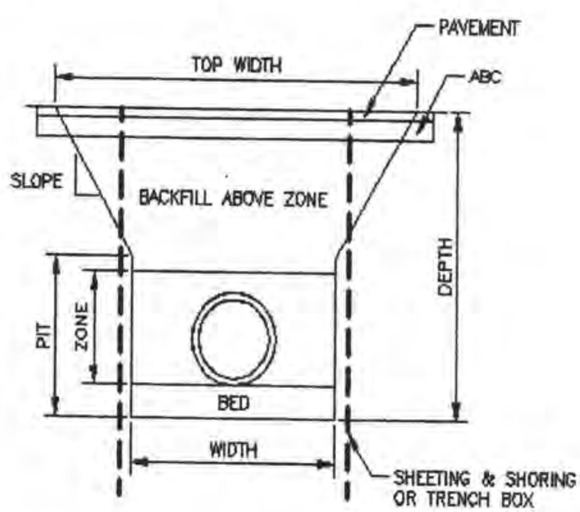
EXCAVATION CALCULATIONS

Version 2.0

This Template calculates the excavation and backfill volumes for TYPE 1 and TYPE 2 trenches.
The text and numbers in red can be changed to fit your project.
By changing the sideslope to 1 Vert. To 0 Horiz. you can calculate a sheeted & shored trench.

TYPE 1 TRENCHING

Proj No: Sand Raw Water Conduit
Item: C-9 36" Pipeline
:
:



DESCRIPTION	INPUT	
Pipe Diameter(Nom.)	36	inches
Average Depth	8	feet
Length	50,000	feet
Slope: 1 Vert. to	1.50	Horiz.
Pavement Thickness:	0.00	inches
ABC Depth:	0.00	inches
No.of Pavement Cuts	0.00	Each

Top Width = 18.5 ft

CALCULATED VOLUMES

Pavement Cutting	=	0	ln ft
Pavement Removal	=	102,778	sq yd
Trench Excavation	=	117,361	cu yd
Bed + Zone fill	=	37,604	cu yd
Zone Only Fill	=	32,049	cu yd
Bed Only Fill	=	5,556	cu yd
Backfill Above Zone	=	66,667	cu yd
Waste if Import Bed, Zone	=	50,694	cu yd
Waste if Native Bed, Zone	=	13,090	cu yd
Surface Restoration Area	=	102,778	sq yd
Shoring Area (Optional)	=	NONE	sq ft

INPUT VARIABLES

Bed Depth =			6	in
Zone Depth =		D+	12	in
Min. Width =			72	in
Width	=	D+	36	in
Pit Depth =			4	ft
<= Wid+/Side			1	ft

RSRI

Construction Cost Estimate

Idea No: C-9

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Bedding and Pipe Zone Material (Import)	CY	$ 42.04	37,000	$ 1,555,480		$ -
Bedding and Pipe Zone Material (On-Site Processed)	CY	$ 25.22		$ -	37,000	$ 933,140
				$ -		$ -
				$ -		$ -
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				$ -		$ -
Subtotal				$ 1,555,480		$ 933,140
Markup		47%		$ 731,076		$ 438,576
TOTALS				$ 2,286,556		$ 1,371,716
NET SAVINGS						$ 914,840

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	C-17 r1	Idea Title	Reduce Minimum Cover to 36 Inches

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$5,150,000.00	--	$5,150,000.00
Proposed Concept	$4,710,000.00	--	$4,710,000.00
Estimated Savings	$440,000.00	--	$440,000.00

Description of Original Concept

The original concept assumed a minimum cover over the pipe of 4 feet.

Description of Proposed Concept

The proposed concept reduces the minimum cover to 3 feet.

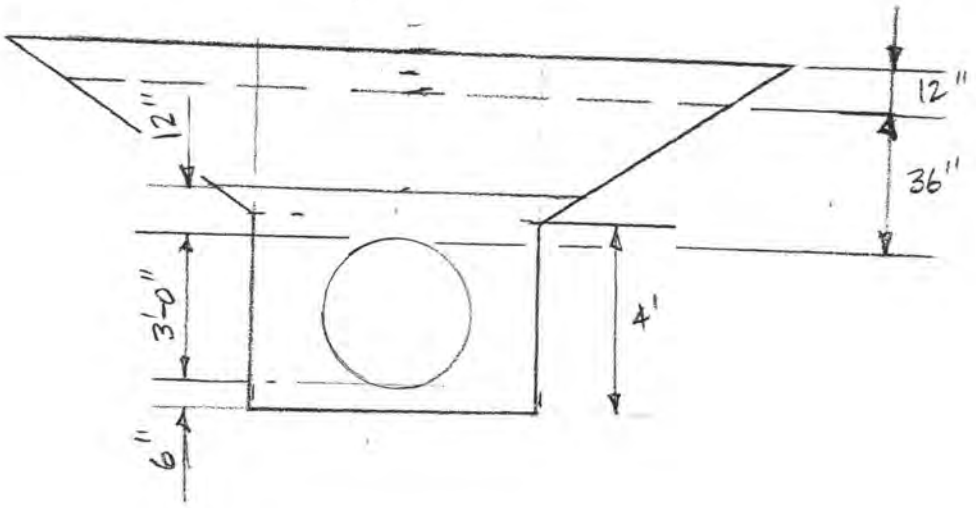
Advantages	Disadvantages
• Reducing the minimum cover to 3 feet would reduce the volume of material that needs to be excavated and the amount of material that would need to be backfilled	• With a shallower pipe there is a higher risk that someone could damage the pipe if they were digging around the pipe • If there is a major, long duration freeze with little snow cover and the pipeline is shut down for an extended period, water could freeze in the pipe

Discussion

The main advantage of this idea is that the volume of excavated trench material could be reduced by raising the pipe one foot along the alignment. Raising the pipe would also reduce the amount of surface restoration.

SKETCH

Idea No. C-17-1



TRENCH EXCAVATION

36" COVER

VOL/LF = 6'x4' + $\left(\frac{6+13.5}{2}\right)$(2.5) = 48.375 CF/LF = 1.79 CY/LF

VOL FOR 50,000 FT = 1.79 CY/LF x 50,000 LF = 89,583 CY

48" COVER

VOL = 6'x4' + $\left(\frac{6+16.5}{2}\right)$(3.5) = 63,375 CF/LF = 2.35 CY/LF

VOL FOR 50,000 FT = 2.35 x 50,000 = 117,361

Idea C-17R1 Bend – Reduce Cover to 36 inches

Assuming a pipe diameter of 36 inches, an average trench width of 6 feet in the pipe zone area, a 1 to 1.5 sideslopes above the pipe zone and an average depth of cover of 3 feet over the pipe, the following volumes were calculated using Dennis' trench formula for 50,000 feet of pipeline.

Trench Excavation – 103,000 CY

Bedding and Pipe Zone – 38,000 CY

Backfill – 52,000 CY

Waste – 51,000 CY

Restoration – 94,000 SY

VKTS
VK Tech Services

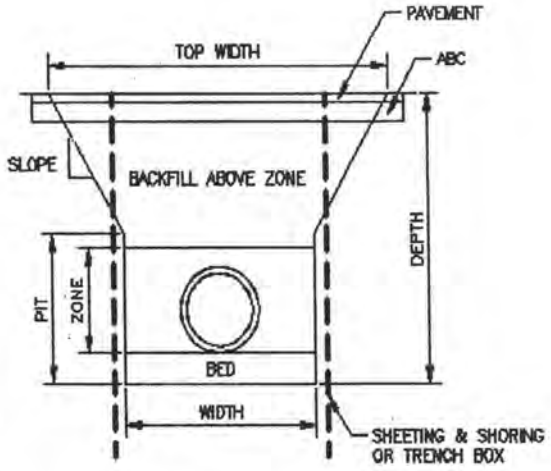
EXCAVATION CALCULATIONS Version 2.0

This Template calculates the excavation and backfill volumes for TYPE 1 and TYPE 2 trenches. The text and numbers in red can be changed to fit your project.
By changing the sideslope to 1 Vert. To 0 Horiz. you can calculate a sheeted & shored trench.

TYPE 1 TRENCHING

Proj No: **Bend Raw Water conduit**
Item: **C17 R2 36" Pipeline**
:
:

DESCRIPTION	INPUT	
Pipe Diameter(Nom.	**36**	inches
Average Depth	**6.5**	feet
Length	**50,000**	feet
Slope: 1 Vert. to	**1.50**	Horiz.
Pavement Thickness	**4.00**	inches
ABC Depth:	**8.00**	inches
No.of Pavement Cut	**2.00**	Each



Top Width = 15.5 ft

CALCULATED VOLUMES

Pavement Cutting	=	400,000	In ft
Pavement Removal	=	86,111	sq yd
Trench Excavation	=	89,583	cu yd
Bed + Zone fill	=	37,604	cu yd
Zone Only Fill	=	32,049	cu yd
Bed Only Fill	=	5,556	cu yd
Backfill Above Zone	=	38,889	cu yd
Waste if Import Bed, Zone	=	50,694	cu yd
Waste if Native Bed, Zone	=	13,090	cu yd
Surface Restoration Area	=	86,111	sq yd
Shoring Area (Optional)	=	NONE	sq ft

INPUT VARIABLES

Bed Depth =		**6**	in
Zone Depth = D+		**12**	in
Min. Width =		**72**	in
Width	=D+	**36**	in
Pit Depth =		**4**	ft
<= Wid+/Side		**1**	ft

RSRI

Construction Cost Estimate

Idea No: C17-R2

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Bedding and Pipe Zone Material (Import Granular)	CY	$ 33.65	37,000	$ 1,245,050	37,604	$ 1,265,375
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
Trench Excavation	CY	$ 4.22	117,000	$ 493,740	89,583	$ 378,040
				$ -		$ -
Backfill	CY	$ 3.08	67,000	$ 206,360	38,889	$ 119,778
				$ -		$ -
Waste	CY	$ 16.53	51,000	$ 843,030	50,694	$ 837,972
				$ -		$ -
Restoration (6" Gravel)	CY	$ 41.81	17,167	$ 717,752	14,352	$ 600,057
				$ -		$ -
				$ -		$ -
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				$ -		$ -
Subtotal				$ 3,505,932		$ 3,201,222
Markup		47%		$ 1,647,788		$ 1,504,574
TOTALS				$ 5,153,720		$ 4,705,796
NET SAVINGS						$ 447,924

RSRI

Construction Cost Estimate

Idea No: C17-R2

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Bedding and Pipe Zone Material (Import Granular)	CY	$ 33.65	37,000	$ 1,245,050	37,000	$ 1,245,050
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
Trench Excavation	CY	$ 4.22	117,000	$ 493,740	103,000	$ 434,660
				$ -		$ -
Backfill	CY	$ 3.08	67,000	$ 206,360	52,000	$ 160,160
				$ -		$ -
Waste	CY	$ 16.53	51,000	$ 843,030	51,000	$ 843,030
				$ -		$ -
Restoration (6" Gravel)	CY	$ 41.81	17,167	$ 717,752	15,667	$ 655,037
				$ -		$ -
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				$ -		$ -
Subtotal				$ 3,505,932		$ 3,337,937
Markup		47%		$ 1,647,788		$ 1,568,831
TOTALS				$ 5,153,720		$ 4,906,768
NET SAVINGS						$ 246,953

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	C-20	Idea Title	Use Steel Pipe For Bridge Crossing

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$96,000.00	--	$96,000.00
Proposed Concept	$36,000.00	--	$36,000.00
Estimated Savings	$60,000.00	--	$60,000.00

Description of Original Concept

The original concept is to use HDPE pipe for the Upper Crossing and the Lower Crossing.

Description of Proposed Concept

This concept proposes using steel pipe for the Upper Crossing and the Lower Crossing

Advantages	Disadvantages
• Simplifies construction by using one pipe material • Eliminates the need to deal with HDPE pipe expansion requirements	• Requires protecting pipe during freezing conditions under no flow conditions

Discussion

The original concept is to use the HDPE pipe for the bridge crossings to eliminate the risk of water freezing in the pipeline should the system shutdown. System shutdown has been a problem in the past when the turbidity in Bridge Creek has exceeded established limits and the intake has been shut down for several weeks in the spring time of the year or when major storm events have passed through the watershed.

For this analysis, we have assumed that when the new water treatment plant is operational, there will be no need to shut down the Bridge Creek intake because of turbidity. It is assumed that Bridge Creek will be kept in service as long as the City wants to use it as a water source.

One advantage of steel over HDPE is that the coefficient of expansion is much less for steel. This is a major issue for HDPE where the expansion of the HDPE pipe at the Lower Crossing could be as much as 6 inches for a 150 length of pipe over a 40 degree temperature change.

The energy loss for reducing the pipe ID from 36" to 24" is estimated to be approximately 1 foot for the Lower Crossing and slightly less for the Upper Crossing.

Idea C-20 Bend – Use Steel Pipe For Bridge Crossing

Maintaining the diameter of the transmission line across each creek crossing at 36 inches rather than reducing the inside diameter to 24 inches will save approximately 1 foot of head loss at each crossing.

Assuming that the design head is 908 feet (Page 4-1 Design Criteria Report), a 2 foot addition to the design head represents an increase of 0.0022 percent.

Referencing Table 7, in Appendix D, DRAFT Conduit Diameter Optimization, the Total 50-year Hydro Revenue for the 36-inch diameter pipe was estimated to be $20,308,139. If the available head is increased by 0.0022 percent, the additional revenue would increase by $44,678.

HEADLOSS FOR Q = 21 CFS WITH POWERHOUSE

Q = 21 CFS / 9,426 GPM

V = 6.69 FPS FOR 24"Ø

V = 2.97 FRS FOR 36"Ø

24"Ø = A = 3.14 SF

36"Ø = A = 7.07 SF

24" PIPE

H_L = PIPE FRICTION + REDUCER LOSSES (36"×24") - TWO

$= \left(150' \times .57'/100'\right) + \left(0.25\frac{V^2}{2g}\right) 2$

$= 0.86' + \frac{(.25)(6.7^2)}{2g} 2$

$= 0.86' + .35'$

$H_L = 1.20'$

36" PIPE

H_L = PIPE FRICTION

$= \left(150' \times 0.066'/100\right)$

$H_L = 0.10$

INCREASING THE PIPE I.D. FROM 24"Ø TO 36"Ø WILL SAVE APPROXIMATELY 1 FT HEADLOSS.

RSRI

Construction Cost Estimate

Idea No: C-20

36 Inch

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Upper Creek Crossing - 24 Inch HDPE - 100 Feet Long	LF	$ 261	100	$ 26,100		$ -
				$ -		$ -
Lower Creek Crossing -24 Inch HDPE - 150 Feet Long	SF	$ 261	150	$ 39,150		$ -
				$ -		$ -
Upper Creek Crossing - 36 Inch Steel - 100 Feet Long	LF	$ 278		$ -	100	$ 27,800
				$ -		$ -
Lower Creek Crossing - 36 Inch Steel - 150 Feet Long	LF	$ 278.00		$ -	150	$ 41,700
				$ -		$ -
Additional Hydro Revenue	LS			$ -	1	$ (44,678)
				$ -		$ -
				$ -		$ -
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Subtotal				$ 65,250		$ 24,822
Markup		47%		$ 30,668		$ 11,666
TOTALS				$ 95,918		$ 36,488
NET SAVINGS						$ 59,429

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	C-21	Idea Title	Use Narrow Trench and CDF and Only Lay Back Trench at Joints

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$380,000.00	--	$380,000.00
Proposed Concept	$0.00	--	$0.00
Estimated Savings	$380,000.00	--	$380,000.00

Description of Original Concept

The original concept assumed a trench width of 3 feet plus the outside diameter of the pipe.

Description of Proposed Concept

The proposed concept assumes a trench width of 1 foot plus the outside diameter of the pipe and that self settling CDF would be used for bedding and pipe zone material. It would not be necessary for laborers to enter the trench except to weld the joints.

Advantages	Disadvantages
• For 36-inch diameter pipe, the trench width would be reduced from 6 feet to 4 feet	• CDF may need to be transported to the site if it cannot be processed on site

Discussion

The main advantage of narrowing the trench is that the volume of excavated material would be reduced. Not only would the trench be narrower, but the sideslopes above the pipe zone could be reduced if no one has to enter the trench.

Idea C-21R1 Bend – Use Narrower Tench and CDF for Bedding and Pipe Zone

Assuming a pipe diameter of 36 inches, an average trench widthof 4 feet in the pipe zone area, a 1 to 1 sideslopes above the pipe zone and an average depth of cover of 4 feet over the pipe, the following volumes were calculated using Dennis' trench formula for 50,000 feet of pipeline.

Trench Excavation – 89,000 CY

Bedding and Pipe Zone – 21,000 CY

Backfill – 55,000 CY

Waste – 34,000 CY

Restoration – 78,000 SY

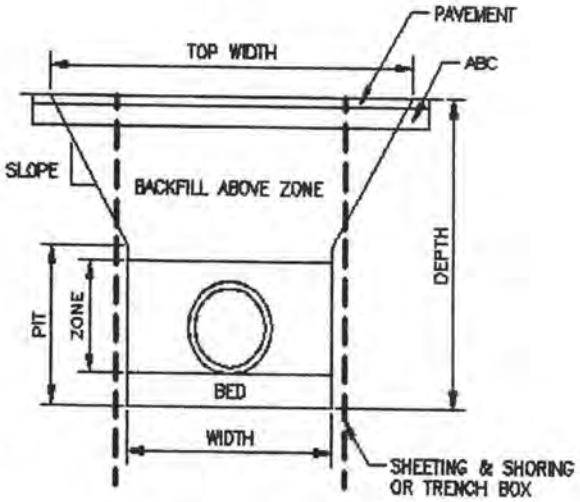
C-21

VKTS
VK Tech Services

EXCAVATION CALCULATIONS

Version 2.0

This Template calculates the excavation and backfill volumes for TYPE 1 and TYPE 2 trenches.
The text and numbers in red can be changed to fit your project.
By changing the sideslope to 1 Vert. To 0 Horiz. you can calculate a sheeted & shored trench.



TYPE 1 TRENCHING

Proj No: Bend Raw Water conduit
Item: C-21 36" Pipeline
: With CLSM Pipe Bed & Zone
:

DESCRIPTION	INPUT	
Pipe Diameter(Nom.)	36	inches
Average Depth	8	feet
Length	50,000	feet
Slope: 1 Vert. to	1.00	Horiz.
Pavement Thickness:	0.00	inches
ABC Depth:	0.00	inches
No.of Pavement Cuts	0.00	Each

Top Width = 14.0 ft

CALCULATED VOLUMES

Pavement Cutting	=	0 ln ft
Pavement Removal	=	77,778 sq yd
Trench Excavation	=	88,889 cu yd
Bed + Zone fill	=	20,706 cu yd
Zone Only Fill	=	17,003 cu yd
Bed Only Fill	=	3,704 cu yd
Backfill Above Zone	=	55,093 cu yd
Waste if Import Bed, Zone	=	33,796 cu yd
Waste if Native Bed, Zone	=	13,090 cu yd
Surface Restoration Area	=	77,778 sq yd
Shoring Area (Optional)	=	NONE sq ft

INPUT VARIABLES

Bed Depth =		6	in
Zone Depth =	D+	12	in
Min. Width =		48	in
Width =	D+	12	in
Pit Depth =		4	ft
<= Wid+/Side		1	ft

RSRI

Construction Cost Estimate

Idea No: C-21R1

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Bedding and Pipe Zone Material (Import Granular)	CY	$ 42.04	37,000	$ 1,555,480		$ -
				$ -		$ -
Bedding and Pipe Zone Material (CDF Import)	CY	$ 90.00		$ -	21,000	$ 1,890,000
				$ -		$ -
				$ -		$ -
Trench Excavation	CY	$ 4.22	117,000	$ 493,740	89,000	$ 375,580
				$ -		$ -
Backfill	CY	$ 1.51	67,000	$ 101,170	55,000	$ 83,050
				$ -		$ -
Waste	CY	$ 16.53	51,000	$ 843,030	34,000	$ 562,020
				$ -		$ -
Restoration (6" Gravel)	CY	$ 41.81	17,167	$ 717,752	13,000	$ 543,530
				$ -		$ -
				$ -		$ -
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Subtotal				$ 3,711,172		$ 3,454,180
Markup		47%		$ 1,744,251		$ 1,623,465
TOTALS				$ 5,455,423		$ 5,077,645
NET SAVINGS						$ 377,779

EMERGENCY DISCHARGE (E)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	E-2	Idea Title	Do Not Restore Watercourse

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$668,000.00	--	$668,000.00
Proposed Concept	$0.00	--	$0.00
Estimated Savings	$668,000.00	--	$668,000.00

Description of Original Concept

The original concept is to restore the watercourse.

Description of Proposed Concept

This concept proposes no action in the watercourse.

Advantages	Disadvantages
• Saves money for other uses	• Restoration is left to a more natural duration or time frame

Discussion

The existing pipeline flows at an unrestricted rate of approximately 11 mgd. During the winter the average usage is near 6 mgd. Consequently, during the winter the amount of water that flows down the emergency watercourse is approximately 5 mgd. During the rest of the year, the water flowing down the watercourse will decrease as water demand in the City increases. However, when the water demand exceeds total water rights for Tumalo Creek, the City is required to reduce its water extraction at the Outback Site and allow more water to overflow via the emergency watercourse to Tumalo Creek.

When the new water treatment plant is put into operation, the flow in the pipeline will be reduced to match the demand of the treatment plant which will be set to match the demand of the City. Consequently, the flow in the emergency watercourse will be reduced to zero. This will be a dramatic change in the volume of water that will be flowing down the watercourse.

Because the volume and rate of water flowing down the creek will undergo such a radical change, delay performing any restoration work in the watercourse. Allow native vegetation to return to the watercourse.

RSRI

Construction Cost Estimate

Idea No: E-2

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
			1			$ -
Restoration	LS	$ 400,000	1	$ 400,000	0	$ -
				$ -		$ -
				$ -		$ -
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Subtotal				$ -		$ -
				$ 400,000		$ -
Markup		67%		$ 268,000		$ -
TOTALS				$ 668,000		$ -
NET SAVINGS						$ 668,000

FIBER OPTIC LINK (F)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	F-2	Idea Title	Reduce Conduit from 4-Inch to 2-Inch

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$594,000.00	--	$594,000.00
Proposed Concept	$74,000.00	--	$74,000.00
Estimated Savings	$520,000.00	--	$520,000.00

Description of Original Concept

The original concept appears to be based on installing the 4-inch fiber optic conduit in a separate trench.

Description of Proposed Concept

This concept proposes that the diameter of the fiber optic conduit be reduced from 4-inch to 2-inch diameter.

Advantages	Disadvantages
	• May be more difficult to pull fiber optic cable

Discussion

Rather than digging a separate trench for the PVC conduit that will carry the fiber optic line, install the PVC conduit when the trench is backfilled. Install the conduit on top of the pipe zone material and before the trench backfill is placed. Reduce the size of the conduit from 4 inch diameter to 2-inch diameter.

RSRI

Construction Cost Estimate

Idea No: F-2

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
				$ -		$ -
4-inch PVC Fiber Optic Conduit - Separate Trench	LF	$ 8	50,500	$ 404,000		$ -
				$ -		$ -
2-inch PVC Fiber Optic Conduit in Pipe Trench	LF	$ 1		$ -	50,500	$ 50,500
				$ -		$ -
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Subtotal				$ 404,000		$ 50,500
Markup		47%		$ 189,880		$ 23,735
TOTALS				$ 593,880		$ 74,235
NET SAVINGS						$ 519,645

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	F-3	Idea Title	Use Existing T-1 and Video Accelerator

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$1,150,000.00	--	$1,150,000.00
Proposed Concept	$140,000.00	--	$140,000.00
Estimated Savings	$1,370,000.00	--	$1,370,000.00

Description of Original Concept

The proposed design includes a fiber optic communications enclosed in a 4 inch conduit for the length of approximately 50,300 feet.

Description of Proposed Concept

The alternative is to use the existing T-1 communication for monitoring and control. Video communication can be enhanced through the use of a video accelerator which reduces the information sent to changes in the video screen, instead of resending the entire content of the video display.

Advantages	Disadvantages
• Eliminates Fiber Optic Conduit and Installation	• Non- Dedicated Communication

Discussion

Fiber optic cable in contained in 4 inch conduit, which is oversized for a single 12 strand communication cable.

The fiber optic installation has not considered any requirement for repeaters or other equipment and appurtenances required transmission of this distance. There could be a need to provide as many as 8 repeaters to maintain communication unless a specialized transmitter/receiver was included as part of the project.

The use of a video acceleration technology will allow for increased communication. Technology such as motion active cameras, and video compression which transmits only the changes in a static image reduces the bandwidth necessary to provide communication between remote and operational facilities.

The proposed alternative includes a provisional 2 inch conduit for a future fiber cable.

RSRI

Construction Cost Estimate

Idea No: F-3

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Fiber Optic Cable	LF	$ 26.800	50,300	$ 1,028,000		$ -
2 inch conduit	LF	$ 1.67		$ -	50,300	$ 84,001
Video Accelerator	ea	$ 5,000		$ -	2	$ 10,000
				$ -		$ -
				$ -		$ -
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Subtotal				$ -		$ -
				$ 1,028,000		$ 94,001
Markup		47%		$ 483,160		$ 44,180
TOTALS				$ 1,511,160		$ 138,181
NET SAVINGS						$ 1,372,979

HYDROPOWER PLANT (H)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	H-17	Idea Title	Couple Turbine to Membrane Feed Pump.

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$3,720,000.00	--	$3,720,000.00
Proposed Concept	$3,310,000.00	--	$3,310,000.00
Estimated Savings	$410,000.00	--	$410,000.00

Description of Original Concept

The Membrane system includes 4 feed pumps to supply the membrane filtration system with raw water at a nominal 30 to 40 psi of pressure at a minimum flow of 13.6 mgd (21 cfs). 4 pumps are currently sized at 150 HP at a nominal flow of 4500 gpm. The design of the pump is as a vertical turbine pump in a can style.

Description of Proposed Concept

The concept offered is to incorporate an energy recovery (pelton) turbine into the membrane feed pump, sometimes called a turbo booster to operate the feed pump. Raw water at an available pressure of approximately 400 psi can be used to operate the feed pump. The flow through the turbo section would nominally require a 10 percent of the flow that is being discharged as feed to the membrane system. A throttling valve will be used to control flow and pressure through the pump. Typical of this design would be an Afton Model PRT or Pump Engineering LPT. A second alternative, such as an isobaric device such as the ERI Pressure Exchanger (not evaluated) as deemed inappropriate for raw water.

Advantages	Disadvantages
• Reduces stand by generation size by 50 percent • Reduces or Eliminates pump VFD and 150 HP Pump Motor and VFD • Saves energy required for pump operation • Reduces Generator Sizing by 1/3rd	• Pump section will have to incorporate an energy recovery section and control valve • System may require a hydropneumatic tank to stabilize feed pressure and flow to the membrane treatment units

Discussion

In this alternative it would be more advantageous to locate the membrane feed pump in the afterbay effluent chamber to minimize the distance of high pressure piping. Discharge from the turbo boost section would be become feed water to the membrane system.

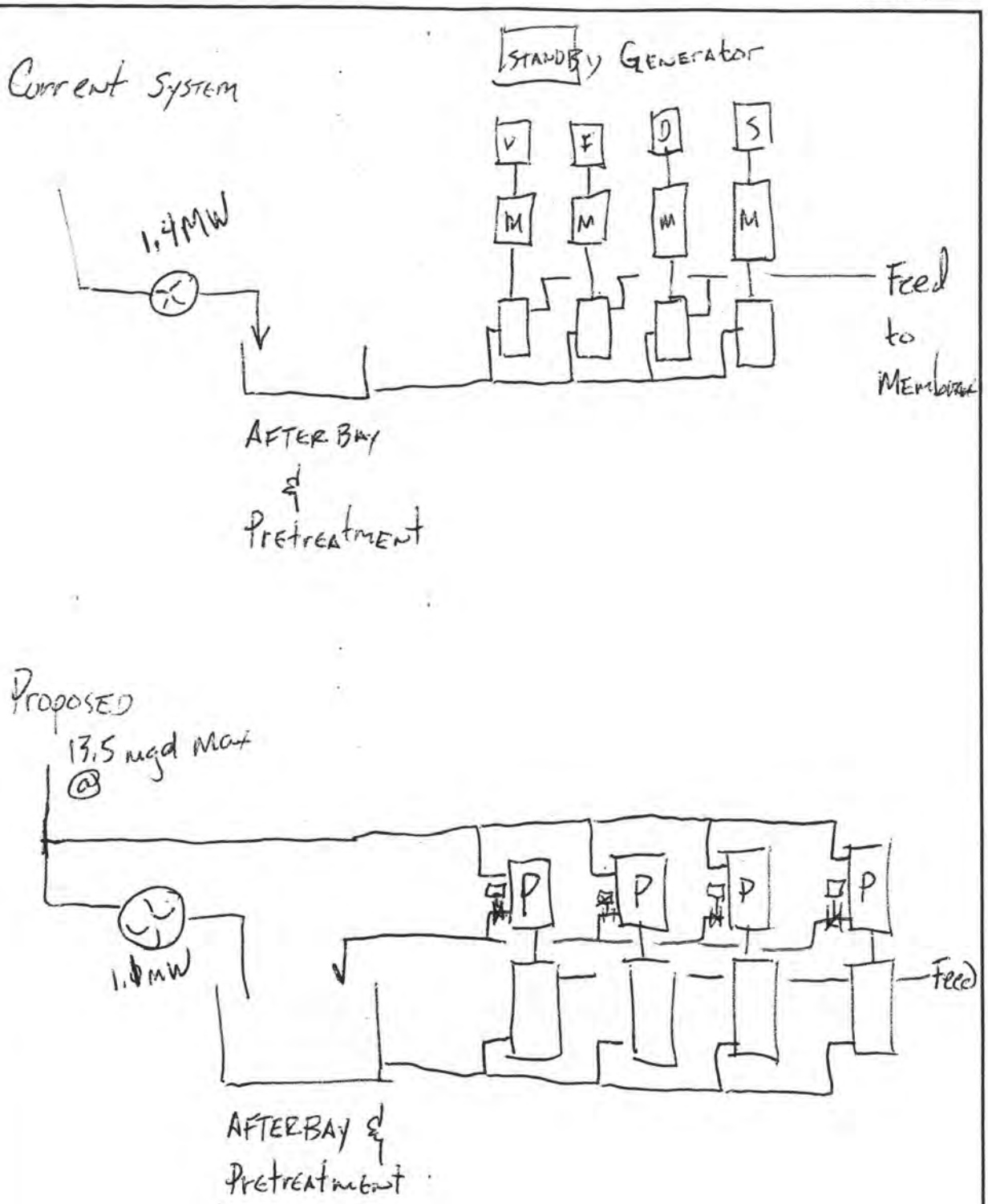
The current design generates electricity from a turbine which is transformed to a higher voltage. Electricity is then purchased for the operation of the membrane feed pumps. The design eliminates the need for the mechanical electrical-electrical mechanical conversion by coupling a similar pelton wheel turbine to the shaft of the membrane feed pump. Not only does this alternative eliminate the need for a VFD drive and motor for the membrane feed pump, it also reduces the size of the standby electrical generator that would be required in the event of a power generation failure, as the membrane feed pumps are not powered by electrical energy.

The turbine can be reduced in size, because a portion of the power is used by the membrane feed pumps.

Each feed pump would be controlled by a valve that would serve to throttle the volume of water and act in a manner similar to a VFD to obtain a similar method of control.

For the purpose of this discussion, the price of electricity for sale or purchase is assumed to be equivalent. In addition, power losses through the transformers to increase and decrease voltage has not been incorporated into any preliminary estimates.

The proposed arrangement is conceptual in nature, as the specifics for range-ability, control and hydraulic response were not evaluated. One potential solution to further minimize pressure and flow variations to the membrane feed system is to use a hydro-pneumatic tank to further dampen pressure and flow changes.


Current System
STANDBY GENERATOR
V
F
D
S
M
M
M
M
1.4MW
Feed to Membrane
AFTER BAY & Pretreatment
Proposed
13.5 mgd Max @
P
P
P
P
1.0MW
Feed
AFTERBAY & Pretreatment
* may need hydro tank to stabilize flow/pressure

Cost Savings - None

11.25 mgd
80 ft Head (average)
= 82,400 lb/hr

$0.06 /kWh
75% pump, motor, VFD efficiency

Power Generation ≅ Power Consumed By Membrane Feed Pump

RSRI

Construction Cost Estimate

Idea No: H-17

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
150 HP VFD	ea	$ -	4	$ -	0	$ -
150 HP Vertical Turbine Pump	ea	$ 73,088	4	$ 292,353	0	$ -
150 HP Pelton Turbine Pump	ea	$ 87,706		$ -	4	$ 350,824
3 inch Globe Control Valve	ea	$ 20,000		$ -	4	$ 80,000
1.4 MW Turbine	ea	$ 1,375,000	1	$ 1,375,000		$ -
1.1 MW Turbine	ea	$ 1,080,357		$ -	1	$ 1,080,357
Powerhouse	LS	$ 673,000	1	$ 673,000	0.85	$ 572,050
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Subtotal				$ 2,340,353		$ 2,083,231
Markup		59%		$ 1,380,808		$ 1,229,106
TOTALS				$ 3,721,161		$ 3,312,337
NET SAVINGS						$ 408,825

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	H-38	Idea Title	Rock Anchor Replaces Thrust Block

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$73,000.00	--	$73,000.00
Proposed Concept	$27,000.00	--	$27,000.00
Estimated Savings	$46,000.00	--	$46,000.00

Description of Original Concept

The conduit's pressure/thrust is resisted by a mass of concrete just ahead of the hydro power plant.

Description of Proposed Concept

This idea places a concrete collar and rock anchors ahead of the conduit bypass split to resist thrust.

Advantages	Disadvantages
• Less excavation • Smaller open hole to work around • Less concrete	• Specialty contractor for anchors • Work excavation is still noticeably large unless other steps taken to reduce footing size

Discussion

With competent rock near the surface significant capacity exists to tie the pipeline into rock and reduce the large excavation and mass concrete placement. Williams 1 1/4" dia rock anchors are grouted 10 feet into rock and slope up to a concrete collar/footing at the pipe. A steel collar engages the pipe to the concrete, same as the original concept.

PIPE THRUST: 36" DIA PIPE x 1000 FT HEAD

$F_H = 7.06 \times 434 \times 144/1000 = 441$ KIPS

ORIGINAL THRUST BLOCK DEPTH:

SAY F.S. = 1.5 @ ALLOWABLE

$\mu = 0.5$

$P_{passive} = 250(H-1)$] S&W pls

BEARING WIDTH = 16.92'

MASS CONC = 145 PCF

$1.5F_H = .5 \times 16.92 \times .25(H-1) \times H + .145 \times .5 \times 249.65 \times (H-1)$

KIPS

$661.5 + 18.1 = 2.12H^2 - 2.12H + 18.1H$

$679.60 = 2.12H^2 + 15.98H$

$0 = H^2 + 7.53H - 320.6$

$H = 14.53$ FT CONC ~13.5' THICK

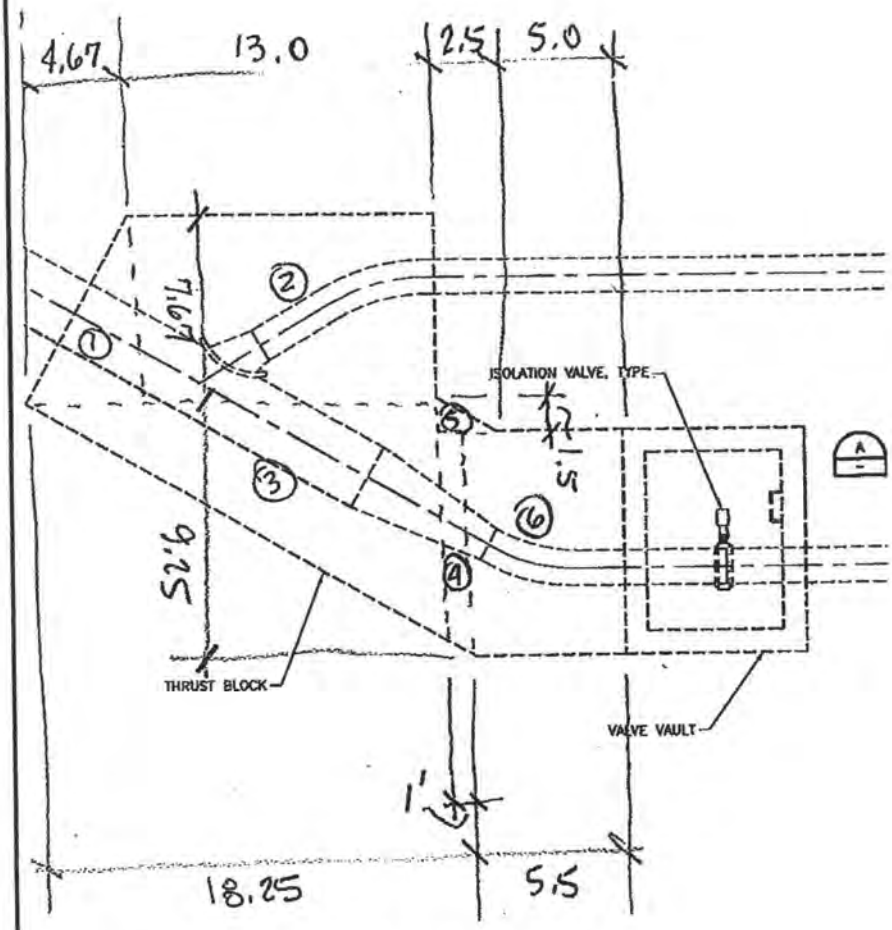
CHECK

$16.92 \times 13.5 \times 1.69 + 244.9 \overset{?}{<} 661.5$

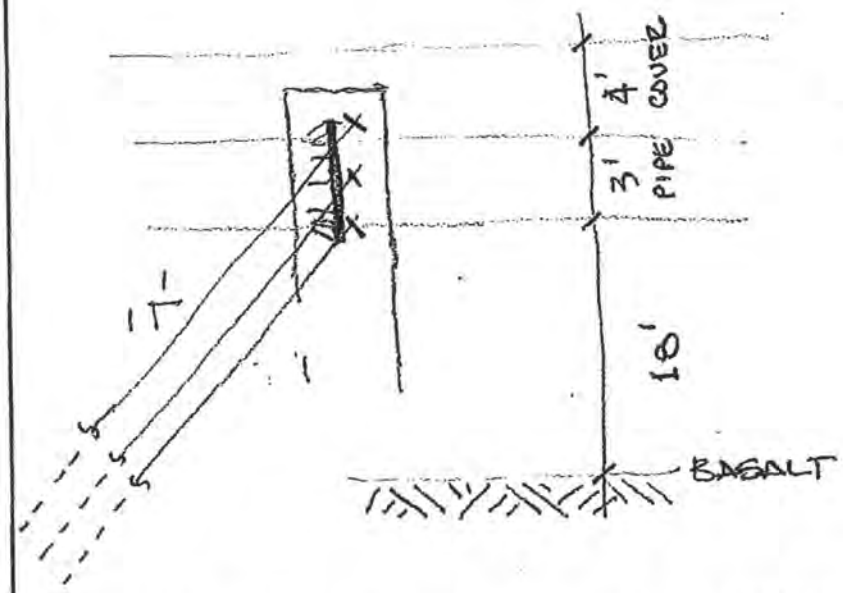
386

630.9 CLOSE ENOUGH

p1



ZONE	AREA	VOLUME
1	17.90	
2	99.71	
3	79.78	
4	~ 7.75	
5	1.88	
6	42.63	
	249.65 FT²	3370 FT³
		125 CY



N = # ANCHORS

USE ALLOWABLE STRESSES, ∴

$F_H = 441^K$

$T_{TOT} = 441/\cos 45 = 624^K$

WILLIAMS GROUT BONDED ROCK ANCHOR

GRANITE/BASALT 250 - 450 PSI BOND

2.5" ϕ HOLE @ 300 PSI

$t_\ell = 45^K/FT$ ULTIMATE BOND

$= 22.5^K/FT$ ALLOW "

GR75 $f_{all} = 37.5^{KSI}$ $A_{tot} = 624/37.5 = 16.64\ IN^2$

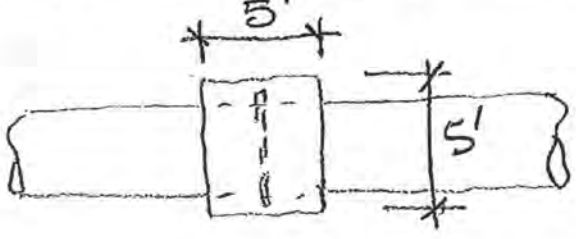
GR150 $= 75^{KSI}$ $8.32\ IN^2$

(8) - 1 1/4" ϕ GR150 ANCHORS ($T_{ult} = 184^K$/ANCHOR)

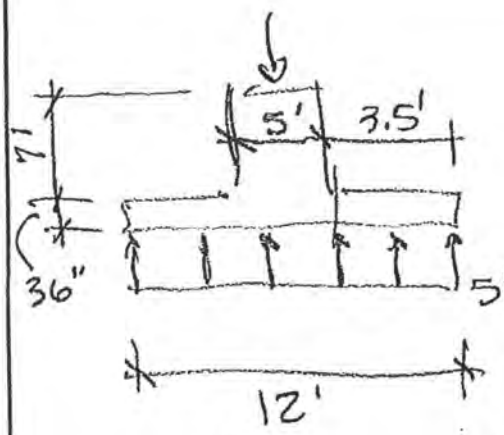
EMBED 10' INTO ROCK

$L_{TOT} = 19.5/\cos 45 + 10' = \underline{38'}$ EACH

BEARING 624^K @ 5,000 PSF $= 125^{\square'} = 12'$ SQ



p3



$M_u = 9 \times 3.5^2/2$
$= 55.1$ FT-K/FT
$= 662$ IN-K/FT
$V_u = 3.5 \times 9 = 31.5$ K/FT

$f'_c = 3$ KSI $b = 12"$ $d = 36 - 4 = 32"$

$\phi V_n = .75 b d (2\sqrt{f'_c}) \geq 31.5$ K/FT ✓

$K_u = .05$ $J_n \geq .85$ $A_s = .4$ IN^2

$A_{s,min} \sim .38$ IN^2 T&B

USE #6@12" EW T&B

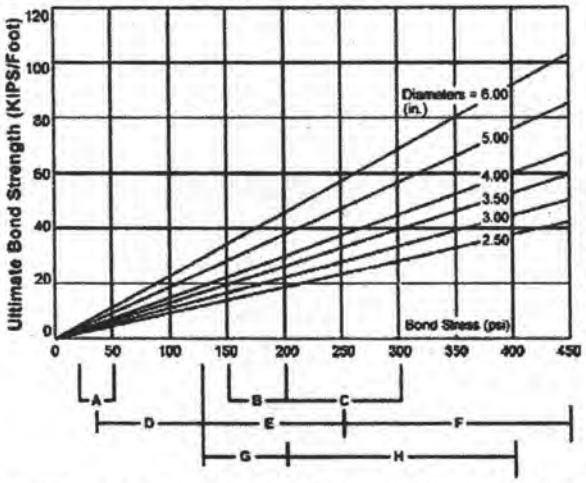
p4

All-Thread Bar Structural Properties

Bar Type	Yield Stress	Ultimate Stress	Typical Elongation	Reduction of Area
150 KSI All-Thead-Bar	128 KSI (881 Mpa)	150 KSI (1034 Mpa)	4% over 20 bar diameters	20%
Grade 75 All-Thread Rebar	75 KSI (517 Mpa)	100 KSI (698 Mpa)	7% - 9% in 8" bar	---

Ultimate Bond Strength

Per Linear Foot of Cement Grout by Diameter of Drill Hole



Rock Type

A. Coral
B. Soft Limestone
C. Dolomitic Limestone
D. Soft Shale
E. Sandstone
F. Granite & Basalt
G. Hard Shale & Slate
H. Concrete

Notes: If overall length is over 50' (or 40' for 1-3/4" and 2-1/2" diameters), anchor coupling should be located in bond zone with field-applied barrier, such as heat shrink tube installed across splice joint. At minimum drill hole size, centralizers will only fit around anchor in the bond zone.

150 KSI All-Thread-Bar

Threaded Bar Types | 150 KSI Information | 150 KSI Accessories | Case Histories | Corrosion Protection

Structural Properties	
Yield Stress	Ultimate Stress
127.7 KSI (880.5 MPa)	150 KSI (1034.3 MPa)
Elongation in 20 bar diameters	Reduction of Area
4%	20%

Unique Thread Form

R71 150 KSI All-Thread-Bar - ASTM A722

Nominal Bar Diameter	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Dia.	Part Number
1" (25 mm)	0.85 in^2 (549 mm^2)	128 kips (567 kN)	102 kips (454 kN)	3.09 lbs./ft. (4.6 Kg/M)	1-1/8" (28.6 mm)	R71-08
1-1/4" (32 mm)	1.25 in^2 (807 mm^2)	188 kips (834 kN)	150 kips (667 kN)	4.51 lbs./ft. (6.71 Kg/M)	1-7/16" (36.5 mm)	R71-10
1-3/8" (36 mm)	1.58 in^2 (1019 mm^2)	237 kips (1054 kN)	190 kips (843 kN)	5.71 lbs./ft. (8.50 Kg/M)	1-9/16" (39.7 mm)	R71-11
1-3/4" (45 mm)	2.60 in^2 (1664 mm^2)	400 kips (1779 kN)	320 kips (1423 kN)	9.06 lbs./ft. (13.5 Kg/M)	2" (50.8 mm)	R71-14
2-1/4" (57 mm)	4.08 in^2 (2632 mm^2)	613 kips (2727 kN)	490 kips (2181 kN)	14.1 lbs./ft. (20.8 Kg/M)	2-1/2" (64 mm)	R71-18
2-1/2" (65 mm)	5.19 in^2 (3350 mm^2)	778 kips (3467 kN)	622 kips (2766 kN)	18.2 lbs./ft. (27.1 Kg/M)	2-3/4" (69.9 mm)	R71-20
3" (75 mm)	6.46 in^2 (4169 mm^2)	969 kips (4311 kN)	775 kips (3448 kN)	22.3 lbs./ft. (32.7 Kg/M)	3-3/64" (78.2 mm)	R71-24

Effective cross sectional areas shown are as required by ASTM A 722-98. Actual areas may exceed these values.
ACI 355.1R section 3.2.5.1 indicates an ultimate strength in shear has a range of .6 to .7 of the ultimate tensile strength.
Designers should provide adequate safety factors for safe shear strengths based on the condition of use.
Per PTI Recommendations for Prestressed Rock and Soil Anchors section 6.6, anchors should be designed so that:
- The design load is not more than 60% of the specified minimum tensile strength of the prestressing steel.

RSRI

Construction Cost Estimate

Idea No: H-38

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
				$ -		$ -
Excavation, soil	CY	$ 25.00	850	$ 21,250	300	$ 7,500
Mass concrete	CY	$ 400.00	125	$ 50,000	0	$ -
Backfill, native	CY	$ 2.12	725	$ 1,537	278	$ 588
Spoil on site (spread)	CY	$ 1.00	125	$ 125	23	$ 23
				$ -		$ -
Rock anchors	EA	$ 620.00	0	$ -	8	$ 4,960
Struct conc footing	CY	$ 600.00	0	$ -	16	$ 9,600
Struct Conc Pedestral	CY	$ 600.00	0	$ -	7	$ 3,900
				$ -		$ -
Struct steel collar on pipe			Same		Same	
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Subtotal				$ 72,912		$ 26,571
Markup		59%		$ -		$ -
TOTALS				$ 72,912		$ 26,571
NET SAVINGS						$ 46,341

INTAKE (I)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-1	Idea Title	Eliminate Fish Ladder

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$179,000.00	--	$179,000.00
Proposed Concept	$11,000.00	--	$11,000.00
Estimated Savings	$168,000.00	--	$168,000.00

Description of Original Concept

The 30% design includes upstream fish passage via a concrete fish ladder. The new hydrogeneration facility and FERC Conduit Exemption hydro-license open the possibility that fish passage will be required by ODFW.

Description of Proposed Concept

The proposed concept is to eliminate the fish ladder from the project. With reference to the hydrogeneration facility, this can be accomplished in two ways:

1. If the hydrogeneration facility is NOT constructed, there is no FERC application for agencies to seek modifications to the existing diversion;
2. If the hydrogeneration facility IS constructed, seek a waiver from ODFW for fish passage requirement or challenge the requirement on lack of Federal nexus for comment.

Advantages	Disadvantages
• Reduces project elements and cost • Little impact to existing present species present at the diversion	• May require additional negotiation with ODFW, fish agencies • May require additional permitting consultation costs • May impact future migratory species

Discussion

There are two potential approaches envisioned for avoiding the construction of an upstream passage fish ladder:

1. Seek a waiver from ODFW for the fish ladder on the grounds that there are no ESA-listed species in the Diversion Pool or in Bridge Creek below the Diversion Dam, that additional opened habitat is minimal due to the presence of a natural barrier to passage nearby upstream, and the City of Bend is seeking to construct this project on a minimum-cost basis.
2. Recommend that City investigate possibility of no jurisdiction for ODFW in this as there are no ESA-listed species and ODFW lacks regulation to make the requirement. As ODFW would be a commenter on a FERC-license application, negotiation may be required between FERC, ODFW and the City. VE Team is not aware of the results of NOAA Fisheries consultation, which would inform this recommendation..

CALCULATIONS Idea No. I-1

I-1 TAKE-OFFS

Slab on grade - (1')(11.5' x 62' + 16' x 6.67') = 820 CF = 30 CY

Excavation (11.5 + 2' + 1') x (62' + 2' x 2') x 5' deep = 4785 CF = 177 CY (NOT KNOWN FOR SURE)

Backfill = Excav. - [(11.5' x 62') + (16' x 5.67')] x 5' deep = 1,076 CF = 40 CY

Walls = (7'2")(10")[(16')(2) + (62')(3) + (9')(1)] = 1355 SF / 27 = 50.2 C

Steplogs = (3'-6") x 20 = 315 SF 15.75 x 20 SETS

Handrail = 16' + 63' + 62' + 10' = 151 LF

RSRI

Construction Cost Estimate

Idea No: I-1

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Excavation	CY	$ 25.00	177	$ 4,425	0	$ -
Backfill	CY	$ 18.43	40	$ 737	0	$ -
Concrete - 12" Slab on grade	CY	$ 793.53	30	$ 23,806	0	$ -
Concrete - 10" Walls	CY	$ 715.39	50	$ 35,770	0	$ -
Stoplogs, 4'-6"Wx3'-6"H (15.75 SF); Timber , Multiple 3" x 12"	SF	$ 143.00	16	$ 2,288	0	$ -
Weir gate, 4'Wx7'H	SF	$ 1,187.97	1	$ 1,188	0	$ -
Handrail	LF	$ 47.07	151	$ 7,108	0	$ -
Cofferdam (20'W x 10'H)	LF	$ 353.00	85	$ 30,005	20	$ 7,060
Dewatering	Weeks	$ 2,189.00	3	$ 6,567	0	$ -
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Subtotal				$ 111,893		$ 7,060
Markup		60%		$ 67,136		$ 4,236
TOTALS				$ 179,029		$ 11,296
NET SAVINGS						$ 167,733

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-2	Idea Title	Design screens to maintain pool water elevation

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			DESIGN SUGGESTION

Description of Original Concept

The current design will raise the pool elevation at the Intake pool by approximately six inches to provide desired water level with relationship to the new screens.

Description of Proposed Concept

Redesign the screen system so that the pool elevation is not raised.

Advantages	Disadvantages
• Avoids possible challenges and potential delays	• May increase the cost of screen installation

Discussion

The VE team believes that raising the pool elevation at the intake may trigger either regulator or public response because the City is changing the parameters of the impoundment. Additionally, if the water level is raised, the dam stability and strength should probably be confirmed. While resolution of such issues may not be insurmountable, the VE team believes that the screen design can be acceptably revised to avoid generating potential dam design, regulator or public responses and issues. This may require use of three smaller diameter screens.

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-6	Idea Title	Refurbish/Upgrade Spring Diversion System

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$0.00	--	$0.00
Proposed Concept	$61,000.00	--	$61,000.00
Estimated Savings	($61,000.00)	--	($61,000.00)

Description of Original Concept

The original concept includes no work at the spring diversion facility.

Description of Proposed Concept

Adequate post-earthquake system reliability is a primary project function. Idea I-6 will strengthen the intake penstocks, reinforces the vertical stemwall, and increase the diversion dam's anchorage to resist anticipated seismic motions/forces.

Advantages	Disadvantages
• Eliminates a weak spot in the raw water collection and transmission system	• Increases resource needs of the project without offset

Discussion

The following elements' seismic performance have been estimated:

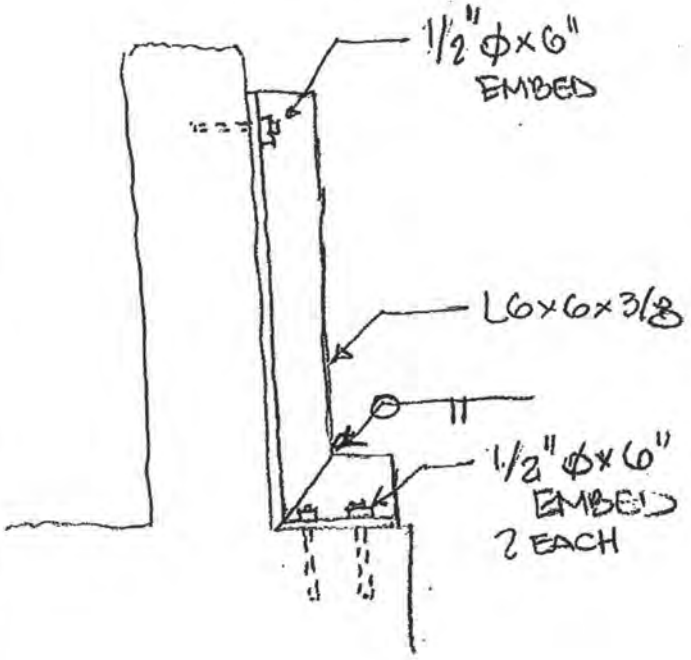
1. Impoundment Dam Wall – Wall is significantly below minimum reinforcing per ACI Code and vertical bars are not detailed with hooks, thus being only 46% developed. Under normal hydrostatic loading the wall appears to have ultimate flexural capacity greater than the relatively small demand, but not sufficient for expected seismic pressures. In addition, the failure mode is expected to be brittle and complete, not just a minor/repairable crack due to bar yielding.
   Upgrade Estimated: Stainless steel pilasters attached to back side of wall with adhesive anchors and spaced approximately 36" on center.

2. Impoundment Dam Overturning – Resultant moves out of middle third under hydro-dynamic loading. Rock anchor upstream footing at 4'-0" centers to resist overturning.

3. Impoundment Dam Sliding (and Key Bearing) – No analysis, but the rock anchors will also increase sliding resistance should a detailed analysis indicate such a need.

4. Penstock Span Lateral Capacity – Detailed analysis (by others) may indicate acceptable strength, but preliminary calculations show pipes flowing full with a potential for buckling the thin-wall corrugated metal pipe. Brace each pipe laterally with an HSS6x6x/14 and (3) tie-straps.

DAM WALL PILASTERS :



$P_{eq} = 1.25 \times .72 \times 62.4 \times 15'$

$= 700$ PSF

$M_{eq} = 1.75 P_{eq}$

$= 1.23$ FT-K/FT

@ 4' SPCG

$M_{EQ} = 60$ IN-K/EACH

Z (33 KSI, STAINLESS $\phi = 0.9$)

$= 60 / .9 \times 33$

$= 2.02$

USE

L6x6x3/8

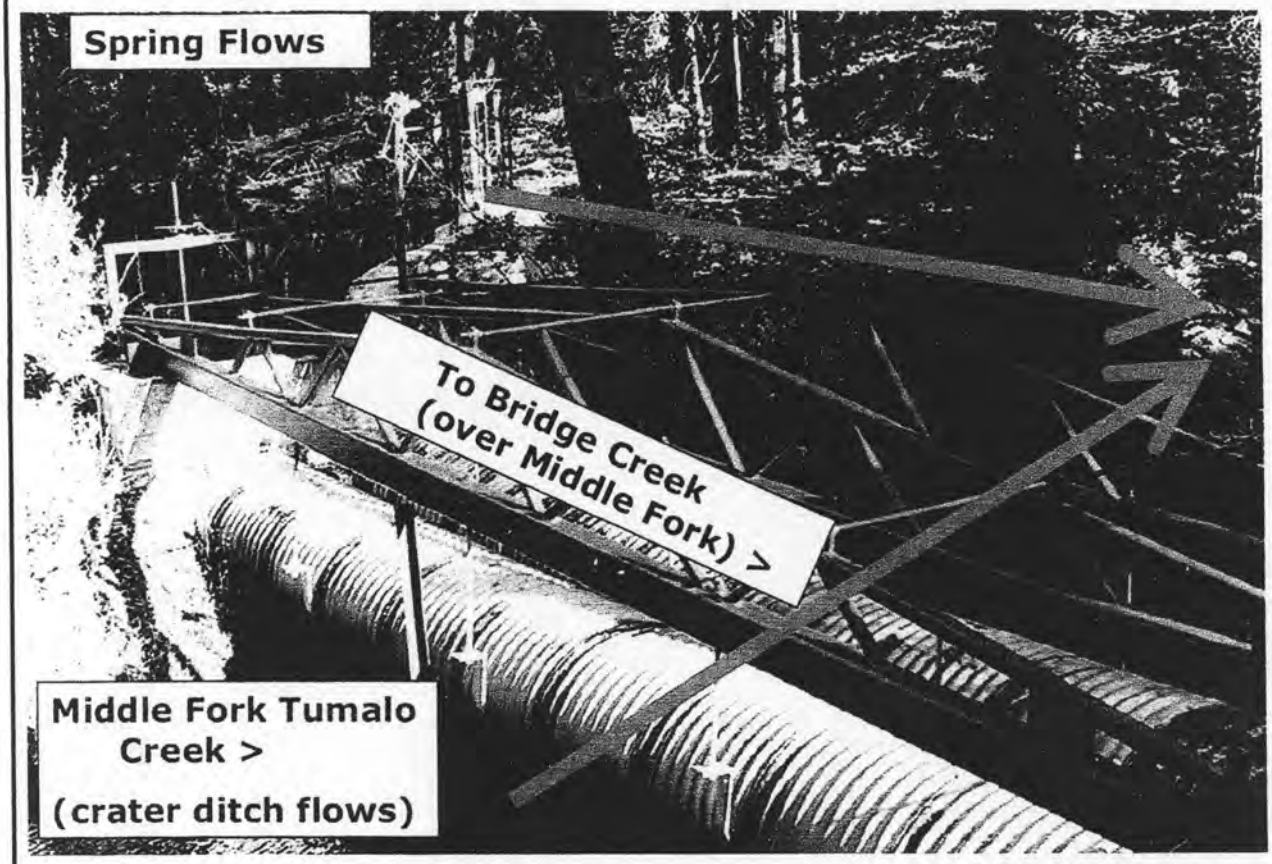
$V_w = 700 \times 4 \times 3.5$

$= 9.8^K$ ULT

USE 3/4" ϕ ADHESIVE x 9" EMBED

REDUCE SPACING TO 3 FT O.C.

Penstock general arrangement:

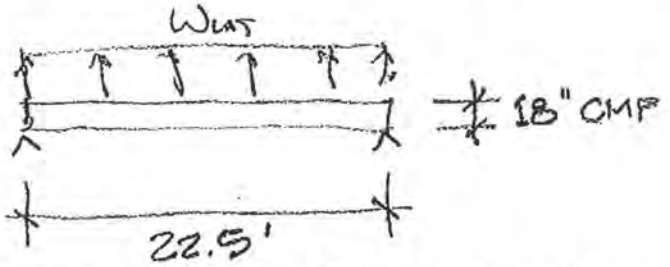


No lateral bracing. Evaluate CMP ability to resist seismic when flowing full (normal condition).

p1

CMP TO RESIST LATERAL

$S_{DS} = 0.72$
$I = 1.25$



ASSUME 0.10" WALL @ 18" ϕ
$F_Y = 30^{KSI}$
$F_{ALL} = 30/1.67 = 18^{KSI}$
NEGLECT BUCKLING (NOT CONSERVATIVE)

$I = 225\ IN^4$
$S = 25\ IN^3$
$A = 1.77\ FT^2$
@ 2x A WITH 15.9 cfs
$V = 4.5\ FT/SEC$
~5.5% SLOPE
PIPES ARE FULL

STEEL WATER
$W_G = 20 + 110 = 130\ PLF$

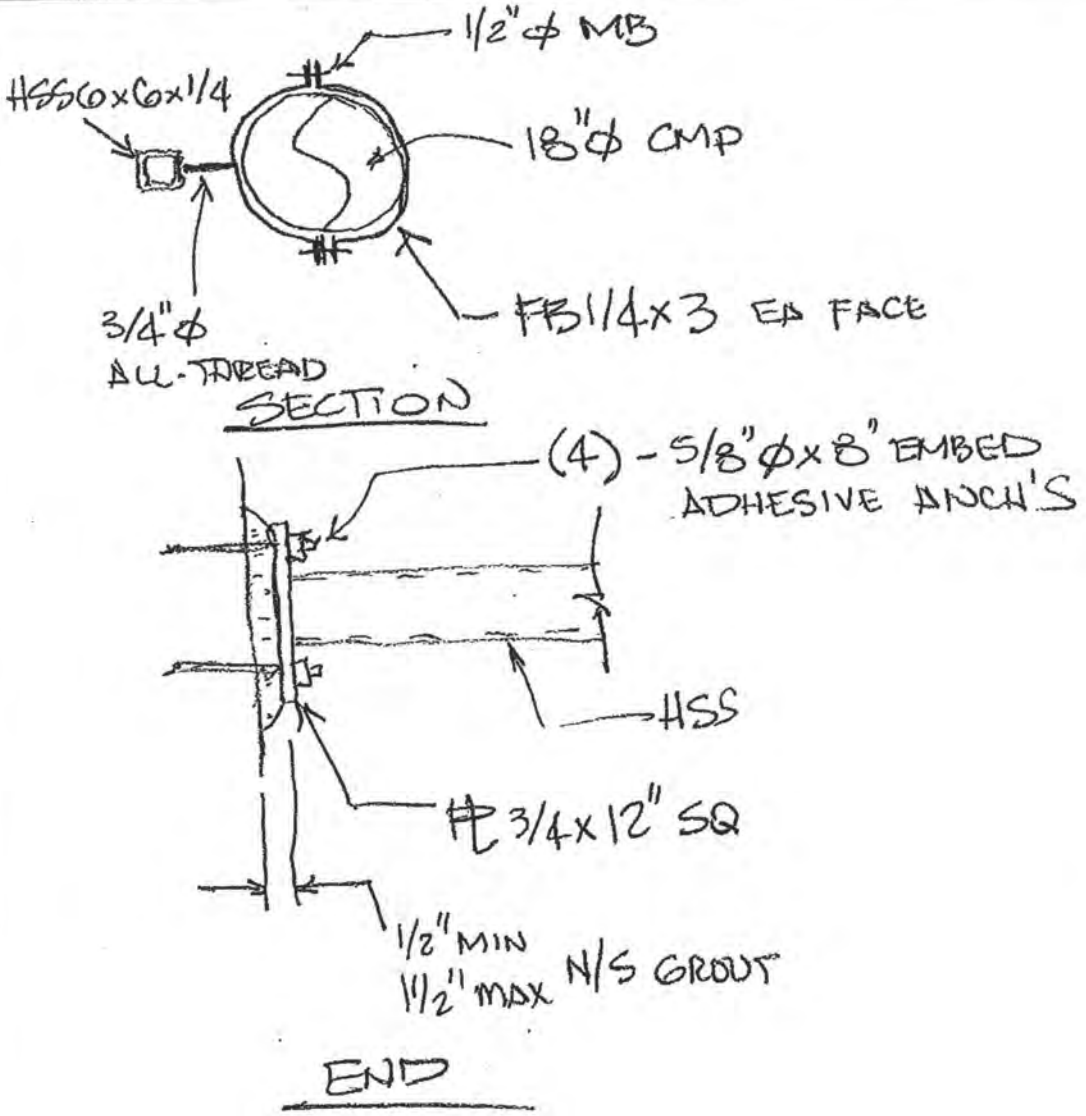
$W_{LAT} = 1.25 \times .72 \times .13 = 0.12\ KLF$

$M = 7.4\ FT\text{-}K$
$= 88.8\ IN\text{-}K$

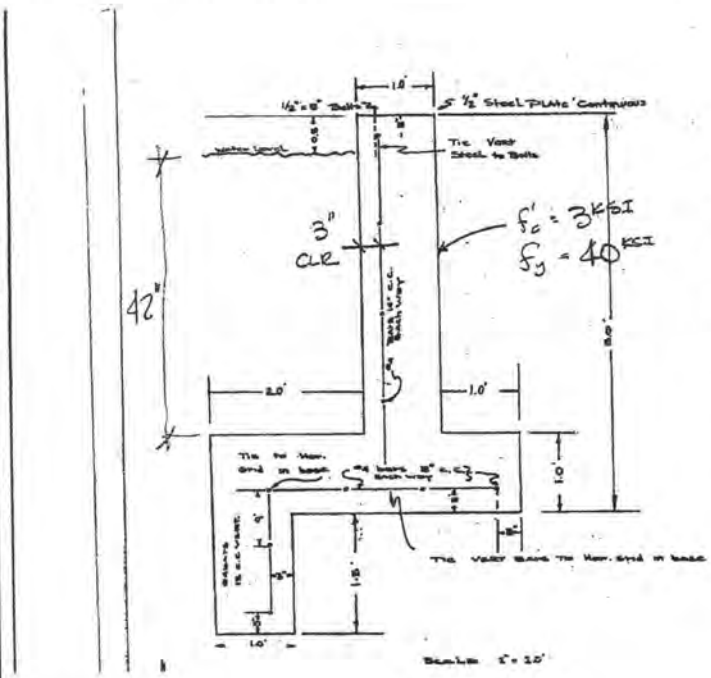
$f_b = 88.8/25 \cong 4^{KSI}$ ← STRESS ALONE IS LOW, BUT I NEED BETTER I,S NUMBERS.

FOR THIS ESTIMATE SPAN A HSS6x6x1/4 ALONG EACH PIPE AND COLLAR AT 1/4 PTS.

p2


1/2" ϕ MB
HSS6x6x1/4
18" ϕ CMP
3/4" ϕ ALL-THREAD
FB1/4x3 EA FACE
SECTION
(4) - 5/8" ϕ x 8" EMBED ADHESIVE ANCH'S
HSS
PL 3/4x12" SQ
1/2" MIN 1 1/2" MAX N/S GROUT
END

Vertical stemwall strength.



$b = 12"$

$d = 12 - 3.25 = 8.75"$

$A_s = .2\ IN^2/16" = .15\ IN^2/FT$

$\rho_b = .037$

$\rho = .15/bd = .0014$

$\rho_{min} = .002bd = 0.21\ IN^2/FT$

UNDER REINFORCED

VERT BARS LIKELY NOT DEVELOPED, ~ 7" EMBED

⇒ 15" MIN ACI 12.2.2 350

~ 46% DEVELOPED

$M_u \sim \frac{1}{8} \times (.46 \times 40) \times 8.75 \times .15 = 21.1\ IN\cdot K/FT$

Proposed City of Bend Diversion Dam - 8-15-00

Wall demand under seismic:

SEISMIC - USE WATER MASS EXTENDING 5x DEPTH AWAY FROM FACE

$H = 1.25 \times 0.72 \times [17.5 \times 62.4]$

$= 983\ PSF$

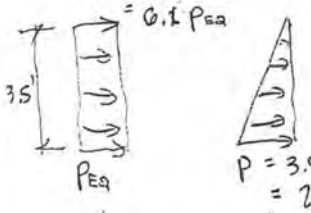
BY INSPECTION ⇒ OVERLOAD

S ≤ W

$S_{MS} = 0.48g$ | $S_{DS} = 1.5 \times .48 = .72$

$S_{M1} = 0.27g$ | $I = 1.25$

$M_{EQ} = P_{EQ} \times 3.5/2 \times 3.5 = 6.1\ P_{EQ}$



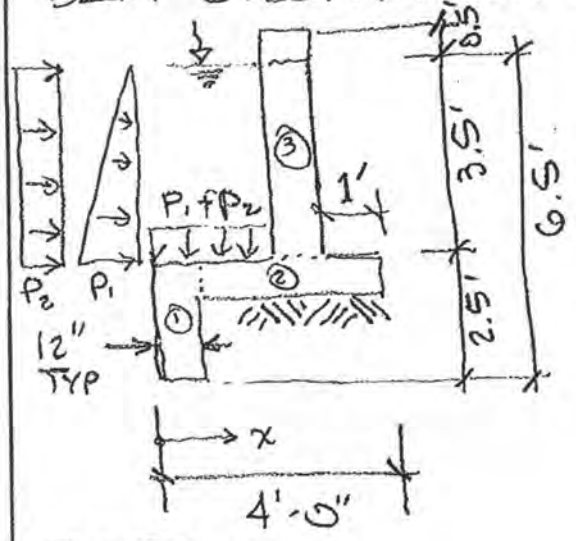
$M_{EQ,ALL} \leq 21.1 - 10.7 = 10.4\ IN\text{-}K/FT = 0.87\ FT\text{-}K/FT = 6.1\ P_{EQ}$

$P_{EQ} = 142\ PSF$ $\quad l = \frac{142}{1.25 \times .72 \times 62.4} = 2.5\ FT$ TOO LOW

$M_{BASE} = .219 \times 3.5^2 \times 1/3 = 10.7\ IN\text{-}K/FT$ $\quad LF = 1.0$

Required ultimate moment exceeds capacity assuming only 2.5 ft of water mass is effective…much below what an more accurate analysis would indicate. Wall is overstressed – even if bars are fully developed (which about doubles the Mu available).

DAM OVERTURNING -



	WT	x	x·WT
W1	375	.5	188
W2	450	2.5	1125
W3	600	2.5	1500
	1425 LB/FT		2813

$\bar{x}_3 = \frac{2813}{1425} = 1.97'$

SAY 2.0'

W4 = 2P1	437	1.0	437
	1862		3250

$\bar{x}_4 = 1.75'$ MIDDLE 1/3 ✓

$P_1 = 218$ PSF

EVALUATE 2 CASES:

(A) $l_{WATER} = 5$ FT, $1.25 \underset{.72}{S_{DS}} = 0.90g$ $P_{2A} = 0.9 \times 5 \times 62.4 = 281$ PSF

(B) $l_{WATER} = 10$ FT, $1.25 \underset{0.13}{PGA} = .1625g$ $P_{2B} = 0.1625 \times 10 \times 62.4 = 102$ PSF

$M_{OT} = P_1 \times 3.5^2/3 + P_2 \times 3.5^2/2 = 4.1 P_1 + 6.1 P_2$

$R = 1862 + 2P_2$

(A) $R = 2424$ $M_{OT} = 1848$ FT-LB/FT $e_A = \frac{M}{R} = 0.76'$

(B) $R = 2066$ $M_{OT} = 1516$ $e_B = \quad = 0.73'$

$e_{max} = 0.67$ TO BE IN MIDDLE 1/3. SLIGHT UPLIFT & ROCKING.

CONSERVATIVE COSTING: INSTALL WILLIAMS ROCK ANCHORS (SMALL) AT 4'-0", UPSTREAM FACE.

Install 1/2" dia spin lock rock anchors at 4'-0" (15 total) through footing upstream side. Use 5 ft length each.

Concrete Forming Hardware Systems

CONCRETE ACCESSORIES DIVISION

R1J Structural Properties

Yield Stress	Ultimate Stress	Elongation in 8" (203 mm)
60 KSI (413 MPa)	90 KSI (621 MPa)	7-9%

R1J Solid Rebar Spin-Lock Rock Anchor - ASTM A-615

Dia. & Threads Per in.	Recomm. Design Load at 2:1 Safety Factor	Maximum Working Load to Yield	Ultimate Strength (5)	Rock Type	Drill Hole Diameter (1)	Type Head Ass'y	Torque ft.-lbs. To Expand Shell (2)	Torque ft.-lbs. On Nut for Tension	Part Number
1/2 - 13 (12 mm)	6,350 lbs. (28.2 kN)	8,500 lbs. (37.7 kN)	12,700 lbs. (56.5 kN)	Hard & Medium	1-1/4"-(32mm)	A 10	50 ft.-lbs. (70")	60	R1J04A10
				Hard & Medium	1-5/8"-(41mm)	A 13			R1J04A13
5/8" - 11 (16 mm)	10,150 lbs. (45.2 kN)	13,500 lbs. (60.1 kN)	20,300 lbs. (90.3 kN)	Hard & Medium	1-1/4"-(32mm)	A 10	100 ft.-lbs. (100")	110	R1J05A10
				Hard & Medium	1-5/8"-(41mm)	A 13			R1J05A13
3/4" - 10 (20 mm)	15,000 lbs. (66.7 kN)	20,000 lbs. (88.9 kN)	30,000 lbs. (133.5 kN)	Hard & Medium	1-5/8"-(41mm)	A 13	165 ft.-lbs. (165")	175	R1J06A13
				Medium & Weak	1-3/4"-(44mm)	B 14			R1J06B14
				Weak Rock & Concrete	1-3/4"-(44mm)	C 14			R1J06C14
7/8" - 9 (22 mm)	20,700 lbs. (92.1 kN)	27,000 lbs. (120.0 kN)	41,500 lbs. (184.6 kN)	Hard & Medium	1-5/8"-(41mm)	A 13	265 ft.-lbs. (265")	290	R1J07A13
				Medium & Weak	1-3/4"-(44mm)	B 14			R1J07B14
				Weak Rock & Concrete	1-3/4"-(44mm)	C 14			R1J07C14
1" - 8 (25 mm)	27,000 lbs. (120.1 kN)	36,000 lbs. (160.1 kN)	54,000 lbs. (240.2 kN)	Hard & Medium	1-5/8"-(41mm)	A 13	400 ft.-lbs. (400")	420	R1J08A13
				Medium & Weak	1-3/4"-(44mm)	B 14			R1J08B14
				Weak Rock & Concrete	1-3/4"-(44mm)	C 14			R1J08C14
1-1/8" - 7 (30mm)	34,000 lbs. (151.2 kN)	45,000 lbs. (200.2 kN)	68,000 lbs. (302.5 kN)	Hard & Medium	2"-(51mm)	B 16	750 ft.-lbs. (750")	810	R1J09B16
				Rock & Concrete	2-1/4"-(57mm)	C 18			R1J09C18
1-1/4" - 7 (32 mm)	43,500 lbs. (193.5 kN)	58,000 lbs. (258.0 kN)	87,000 lbs. (387.0 kN)	Rock & Concrete	2-1/4"-(57mm)	C 18	750 ft.-lbs. (750")	810	R1J10C18

p7

RSRI

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Construction Cost Estimate

Idea No: I-6

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
HSS6x6x1/4 w/ end plates	LB	$ 10.00	0	$ -	855	$ 8,550
Adhesive anchors 1/2 x 6	EA	$ 50	0	$ -	16	$ 800
N-S grout ends	EA	$ 100	0	$ -	4	$ 400
Protective coating (high quality)	LS	$ 500	0	$ -	1	$ 500
Pipe straps - material	EA	$ 200	0	$ -	6	$ 1,200
Pipe straps - install	EA	$ 400.00	0	$ -	6	$ 2,400
				$ -		$ -
SST L-pilasters material	LB	$ 6.50	0	$ -	1,345	$ 8,743
Pilaster - SST 1/2x6 Adh Anchors	EA	$ 50.00	0	$ -	60	$ 3,000
Install pilasters	LB	$ 1.50	0	$ -	20	$ 30
				$ -		$ -
1/2" dia x 5ft rock anchors, SST	EA	$ 620.00	0	$ -	15	$ 9,300
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
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				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
Subtotal				$ -		$ 34,923
Markup		75%		$ -		$ 26,192
TOTALS				$ -		$ 61,114
NET SAVINGS						$ (61,114)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-10 r1	Idea Title	Do Not Install Intake Screens or Fish Ladder

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$880,000.00	$310,000.00	$1,190,000.00
Proposed Concept	$0.00	--	$0.00
Estimated Savings	$880,000.00	$310,000.00	$1,190,000.00

Description of Original Concept

The 30% design includes upstream fish passage via a concrete fish ladder and exclusionary NMFS-criteria screens on the intake inlet. The new hydrogeneration facility and FERC Conduit Exemption hydro-license open the possibility that fish passage and screen protection will be required by ODFW.

Description of Proposed Concept

The proposed concept is to eliminate the fish mitigation (the ladder and the new screens) from the project. With reference to the hydrogeneration facility, this can be accomplished in two ways:

1. If the hydrogeneration facility is NOT constructed, there is no FERC application for agencies to seek modifications to the existing diversion;
2. If the hydrogeneration facility IS constructed, seek a waiver from ODFW for these fish mitigation requirements or challenge the requirements on lack of Federal nexus for comment.

Advantages	Disadvantages
• Reduces project elements and cost • Little impact to existing species present at the diversion	• May require additional time and negotiation with ODFW, fish agencies • May require additional permitting consultation costs • May impact future migratory species

Discussion

There are two potential approaches envisioned for avoiding the construction of an upstream passage fish ladder:

1. Seek a waiver from ODFW for the fish ladder and fish screens on the grounds that there are no ESA-listed species in the Diversion Pool or in Bridge Creek below the Diversion Dam, that additional opened habitat is minimal due to the presence of a natural barrier to passage nearby upstream, that screen protection has not been present for the 90-years of the project and that the fish in the pool have not been significantly impacted by the existing inlet screens and the City of Bend is seeking to construct this project on a minimum-cost basis.
2. Investigate the possibility that there is no jurisdiction for ODFW in this situation as there are no ESA-listed species present and ODFW lacks regulation to make the requirement. As ODFW would be a commenter on a FERC-license application, negotiation may be required between FERC, ODFW and the City. VE Team is not aware of the results of NOAA Fisheries consultation, which would inform this recommendation. The result of the negotiation

for the new FERC license could result in a Habitat Conservation Plan or similar agreement involving concerned agencies and entities (including ODFW). In these negotiations, the City could conceivably offer less expensive fish mitigation (i.e. downstream habitat restoration) instead of the fish screens and fish ladder included in the original concept.

TAKE-OFFS.

. FISH LADDER SEE IDEA NO. I-1

. FISH SCREENS

PROPOSED - NO CHANGES

EXISTING. TAKE-OFFS PER CONST. COST EST. SHT. OTHERS:

24" ϕ HDPE – 56 LF (SCALE)

36" ϕ HDPE → 8 LF (SCALE)

CONCRETE DEMO: (OIS TO V/S)

2'x3'x1.5' x 2 = 12 CF

6'x3.5'x1' x 2 = 42 CF

2'x3'x1.5' x 2 = 12 CF

2.5'x21'x 6" x 1 = 26 CF

21'x8'x1.5' x 1 = 252 CF

4'x1.5'x21' = 126 CF - chipping

470 CF = 17.4 CY

BAR RACK

5' x 5'.

½" TH x 2" DEEP BARS SPACED 3" O.C.

(5')(12") x (0.5) x (2") = 60 cu. in / bar

5/3" = 20 BARS. + 3 FOR FRAME = 23 bars + bar equivalent

60 cu. in x 23 = 1380 cu. in

Density steel = 0.283 lbs/cu. in → 390 lbs.

EPOXY PAINT

RSRI

Construction Cost Estimate

Idea No: I-10

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Excavation	CY	$ 25.00	177	$ 4,425	0	$ -
Backfill	CY	$ 18.43	40	$ 737	0	$ -
Concrete - Slab on grade	CY	$ 793.53	30	$ 23,806	0	$ -
Concrete - Walls	CY	$ 715.39	50	$ 35,770	0	$ -
Stoplogs, 4'-6"Wx3'-6"H (15.75 SF); Timber 3" x 6"	Sets	$ 143.00	20	$ 2,860	0	$ -
Weir gate, 4'Wx7'H	Unit	$ 1,187.97	1	$ 1,188	0	$ -
Handrail	LF	$ 47.07	151	$ 7,108	0	$ -
Cofferdam (20'W x 10'H)	LF	$ 353.00	43	$ 15,179	0	$ -
Dewatering	Weeks	$ 2,189.00	3	$ 6,567	0	$ -
				$ -		$ -
ISI Intake Drum Screens, 42" diam, 54"L retractable, operator, controls	EA	$ 173,575.50	2	$ 347,151	0	$ -
Slide Gate, 48"x48", 8' stem riser, yoke, guides	LS	$ 33,736.00	1	$ 33,736	0	$ -
Bar rack (5'x5'), steel, epoxy coated	Lbs	$ 5.00	390	$ 1,950	0	$ -
Concrete wall demo	CY	$ 282.45	17	$ 4,802	0	$ -
24-inch pipe - HDPE	LF	$ 182.78	51	$ 9,322	0	$ -
Paddle meter	EA	$ 2,000.00	2	$ 4,000	0	$ -
36-inch pipe - HDPE	LF	$ 337.51	8	$ 2,700	0	$ -
HDPE - Fittings	LS	$ 18,910.00	1	$ 18,910	0	$ -
Handrail	LF	$ 47.07	45	$ 2,118	0	$ -
Ductile Iron Thrust Fittings - (2) 24-inch wall fittings, (1) 36-inch wall fitting	LS	$ 3,981.39	1	$ 3,981	0	$ -
Cofferdam (20'W x 15'H)	LF	$ 353.00	42	$ 14,826	0	$ -
Dewatering	Weeks	$ 2,189.00	4	$ 8,756	0	$ -
				$ -		$ -
				$ -		$ -
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				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
Subtotal				$ 549,891		$ -
Markup		60%		$ 329,935		$ -
TOTALS				$ 879,826		$ -
NET SAVINGS						$ 879,826

Value Engineering Recommendation

O&M Cost Estimate Idea No. I-70

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
ANNUAL COSTS						
Operations						
Labor						
screen maint @ 4%/yr of capital		.04	555442	22,218		—
Materials & Equipment						
Fuel for waterheater	gal.	$2.50	200	500		
~~Screen~~						
Maintenance						
Labor						
Materials & Equipment						
Energy						
Gas						
Power						
Oil						
TOTAL ANNUAL COSTS			A =	22,718	B =	—

	PWF	A x PWF	B x PWF
PRESENT WORTH (Annual O&M)	13.59	308,738	—

REPLACEMENT COSTS	Year	Amount	Amount

RSRI

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-14	Idea Title	Add provisions to connect small propane tanks in winter

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			DESIGN SUGGESTION

Description of Original Concept

The Original design includes a water heater at the intake structure to provide warmed water to dissipate frazil ice that may form on the new intake screens under certain conditions. The VE team understanding is that the water will be heated with propane.

Description of Proposed Concept

The VE team recommends adding inlet/tee/fitting that will permit connection of small propane tanks for emergency use that could be transported to the Intake site via snow-cat or snowmobile.

Advantages	Disadvantages
• Provides additional insurance against frazil ice in unusual climatic conditions	• None identified

Discussion

The VE team understanding is that the current plan is to fuel the water heater to address frazil ice with propane. While information has not been provided to define the size of the propone storage tank, it is expected that the tank would be sized to provide sufficient propane for an entire winter season, because of the difficulty of access for a propane tank truck to the site during the winter. The VE team recommends adding a connection to the propane system to permit connection of one or more portable tanks in the event a particularly cold winter should exhaust the propane supply in the fixed tank before the road is accessible for a propane tank truck. The portable tanks would be of a size to be able to be brought to the site on a snowmobile or snow-cat, which the City has available for access in the winter. The cost of the connection would likely be negligible. A check would need to be made to ensure that the vaporization rate for portable-sized tanks would be sufficient at the temperatures at which they would be used to operate the water heater.

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-18	Idea Title	Use construction process needs to expand parking

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			DESIGN SUGGESTION

Description of Original Concept

The existing plan does not include any expansion of parking facilities near the intake.

Description of Proposed Concept

Designate a contractor staging area or areas near the intake. Have the contractor(s) pave the area(s) for parking lot use when complete.

Advantages	Disadvantages
• Reduces contractor impacts on National Forest users during construction • Provide measurable additional needed parking for the Tumalo Falls site in the National Forest	• Small additional cost for additional compaction, paving and striping

Discussion

Anecdotal information provided to the VE team suggests that parking is very limited for people desiring to visit Tumalo Falls and to hike in the area surrounding it. The contractors working on the intake improvements (if implemented) and on the upper end of the new pipeline will need flat areas for storage of materials, parking of equipment and vehicles and for operational needs in the vicinity of the intake. The VE team suggests identifying, in coordination with the Forest Service, areas suitable for clearing and grading to produce the level areas needed for contractor operations during construction to minimize contractor intrusion on the already limited public access and public parking areas, and when construction is completed, require parking and striping of the contractor staging area(s) to convert them to additional parking for use by the public. The extra cost will likely be limited to some extra compaction of the areas (if required) and asphalt paving and striping.

This will permit double use of the disturbed areas and ultimate conversion to an appropriate and needed National Forest use of the disturbed areas.

If additional runoff from paved parking areas is a concern, the parking could be graveled instead. The attached aerial photo shows the general area in which the contractor staging area(s) might be located.


CONTRACTOR WORK AREA Location.
Image State of Oregon
©2010 Google
Imagery Date: Jun 29, 2005
44°01'53.28" N 121°34'02.57" W elev 5003 ft
Eye alt 7066 ft

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-19	Idea Title	Specify Extent of Demolition

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			

Description of Original Concept

The 30% design drawing 02D-01 includes descriptions of work that are not measureable.

Description of Proposed Concept

The VE Team concept recommends that the following call-outs be removed and replaced with dimensions.

- "Cut beam and wall as close to adjacent walls as possible"
- "Replace if required"

Advantages	Disadvantages
• Define the work for the purposes of creating a common basis for producing a GMP and a Engineer's Opinion of Probable Constructed Cost	• None noted

Discussion

The work of the project would be biddable.

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-20	Idea Title	Verify Concrete Condition

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			DESIGN SUGGESTION

Description of Original Concept

There is no effort planned to evaluate the condition of the existing intake system beyond the visual observations made to date.

Description of Proposed Concept

The intake elements are essential facilities for the operation of the City's surface water system. This idea proposes to validate their expected performance with a more complete range of testing and stability evaluation.

Advantages	Disadvantages
• Validates these elements perform as well as the conduit(s) and treatment facility	• May identify necessary upgrade work, consuming resources

Discussion

The intake facility consists primarily of a dam to impound watershed collected water, and an intake system which transfers impounded water into the conduit(s). Screening is also accomplished in the intake. Visual observations have been made to date and not indicated mission-critical deficiencies.

This idea suggests a more thorough evaluation be made (see I-21 for the dam element). This will require better knowledge of the immediate area's geotechnical setting, concrete jointing and, if present, reinforcing steel quantities/placement. It is understood that limited, destructive testing such as boring, coring or chipping may be required.

The intake concrete and metalwork should be studied under the same performance criteria used for the dam and conduit(s). It is assumed the existing wood structure will be removed (and possibly replaced) and so no study is recommended for it.

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	I-21	Idea Title	Assess Dam Condition

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			DESIGN SUGGESTION

Description of Original Concept

There is no effort planned to evaluate the condition of the existing dam beyond the visual observations made to date.

Description of Proposed Concept

The dam is an essential facility for the operation of the City's surface water system and presents a (limited) potential hazard for downstream residents and structures. This idea proposes to validate its expected performance with a more complete range of testing and stability evaluation.

Advantages	Disadvantages
• Validates the dam performs as well as the conduit(s) and treatment facility	• May identify necessary upgrade work, consuming resources

Discussion

This idea suggests a more thorough evaluation be made, especially the dam structure. Of particular interest are: (a) dam stability versus seismic demand; (b) dam structural capacity versus seismic demand. This will require a better knowledge of the geotechnical setting, concrete jointing and, if present, reinforcing steel quantities/placement. It is understood that limited, destructive testing such as boring, coring or chipping will be required.

MISCELLANEOUS (M)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	M-2	Idea Title	Validate Hydropower Payback

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			DESIGN SUGGESTION

Description of Original Concept

The Analysis conducted by the design team suggested that the break-even point for hydropower installation would occur about 45 years after installation and start-up, and because it would generate long term revenue benefits as well as other social benefits, that the hydropower facility should be installed

Description of Proposed Concept

The VE team recommends review of that analysis to confirm whether designing for hydropower is the appropriate decision for the City.

Advantages	Disadvantages
• Provides a more complete picture of possible outcomes • Improves confidence in decision	• None noted

Discussion

The VE team is concerned that possible differences between the assumed values and the ultimate actual values for a number of parameters used to analyze the cost-effectiveness of either installing hydropower facilities now or designing other components to make provisions to add hydropower facilities later could result in a decision that might not be in the ultimate best interests of the City. Accordingly, the VE team worked in with the design team during the VE workshop to re-run the designers hydropower analysis model with different assumptions than used previously by the designer. At the VE team's request, the designer re-ran the model with the following revised assumptions to assess the sensitivity of the analysis to discount rate and differential escalation between purchased and sold power.

Parameter	Original	Revised
Energy Purchase Escalation Rate	1% per year	2% per year
Energy Sales Escalation Rate	2% per year	2% per year
Net Discount Rate	3.2% per year	4% per year

That revised analysis resulted in an approximate 5-year shift into the future of the breakeven point between installing and not installing hydropower if the project is done by the City. Subsequent discussions suggest that reductions in the pipeline diameter that could be possible if the new pipeline is not designed to accommodate future pipeline construction could extend the breakeven point a significant additional time into the future beyond that shown in the current analysis.

As a result, the VE team is recommending that the City direct their designers to conduct a sensitivity

analysis on the hydropower issue to provide the City with a better sense of the potential variability of the cost-effectiveness of hydropower within the potential range of variation that may be experienced from the various parameters that could affect the decision. The minimum parameters that the VE team recommends be considered in the sensitivity analysis are as follows:

- Net discount rate for general cost elements - Suggested evaluation range - 2-6 %
- Escalation rate for energy sale - Suggested evaluation range – 1-3%
- Escalation rate for energy purchase - Suggested evaluation range – 1-3%
- Differential in escalation rate between energy sale and energy purchase – Suggested evaluation range – 0-2%
- Change in pipeline diameter and associated cost as a result of not planning for hydropower (include consideration of only designing pipeline for 21 cfs capacity)

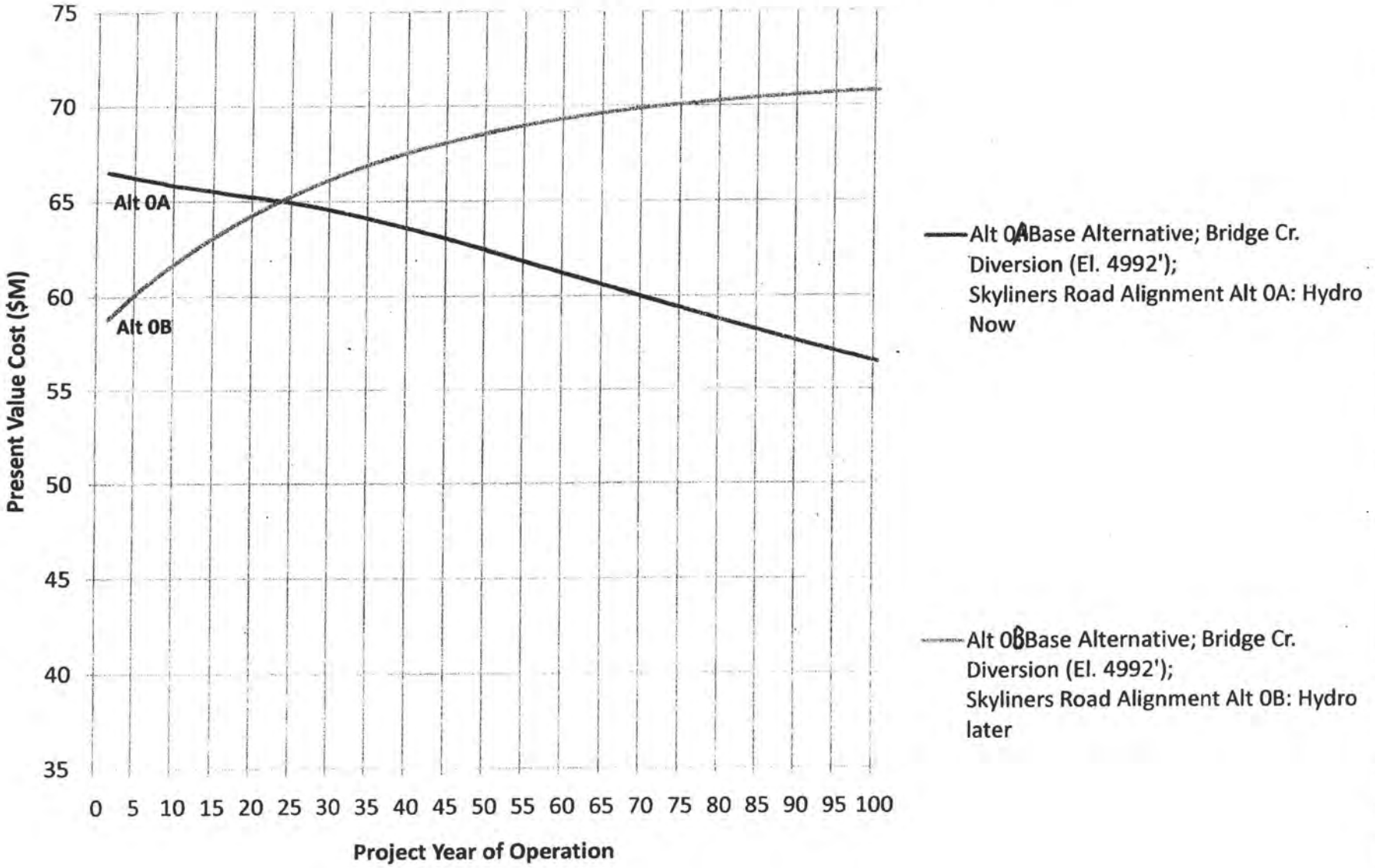
There may be other parameters that the designer or the City may wish to consider, as well.

The VE team also recommends that a similar sensitivity analysis be conducted for a case in which the hydropower is implemented by a private concessionaire under contract to the City, in which the concessionaire may be able to obtain government incentives not available to the City.

These sensitivity analyses will provide the City with a better picture of the range of possible financial outcomes to weigh against the other non-monetary advantages and disadvantages of implementing hydropower, to better inform the City as the decision is made about hydropower implementation.

ORIGINAL ANALYSIS

Cumulative Life Cycle Costs (Present Value Year 2011)
Bend Surface Water Supply Alternatives



14-2

ORIGINAL ANALYSIS

Cost Assumptions

2.3%	Inflation (escalation of non-electrical O&M)
1%	Escalation for energy purchase
2%	Escalation for energy sale
0.065	Energy purchase cost ($/kWh, 2011)
5.5%	Discount rate
55.25	Powerhouse O&M Cost ($K/yr, 2011)
2%	Annual O&M cost for pump sta (% of construction)

Notes:

Energy sale cost from PP&L Schedule 37 blended rate value
PV: Present Value (Year 2011)
FV: Future Value
First year of operation assumed to be 2014

REVISED ANALYSIS

Cost Assumptions

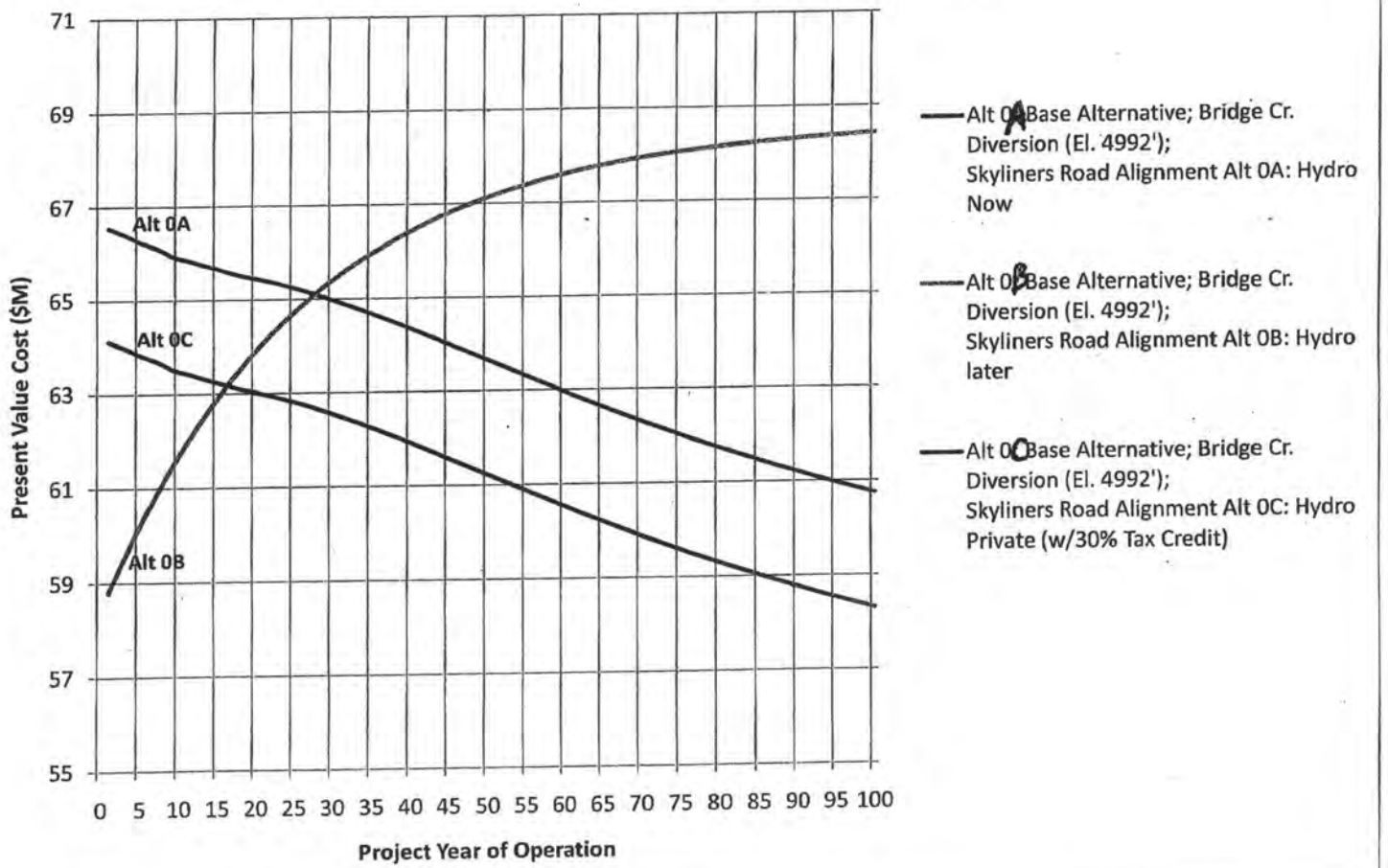
2.3%	Inflation (escalation of non-electrical O&M)
2%	Escalation for energy purchase
2%	Escalation for energy sale
0.065	Energy purchase cost ($/kWh, 2011)
4%	Net discount rate
6.3%	Discount rate
55.25	Powerhouse O&M Cost ($K/yr, 2011)
2%	Annual O&M cost for pump sta (% of construction)

Notes:

Energy sale cost from PP&L Schedule 37 blended rate value
PV: Present Value (Year 2011)
FV: Future Value
First year of operation assumed to be 2014

Revised Analysis

Cumulative Life Cycle Costs (Present Value Year 2011)
Bend Surface Water Supply Alternatives



H-2

TREATMENT PLANT (T)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-20	Idea Title	Eliminate Stand-by Power Generation

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$625,000.00	$340,000.00	$965,000.00
Proposed Concept	$535,000.00	$50,000.00	$585,000.00
Estimated Savings	$90,000.00	$290,000.00	$380,000.00

Description of Original Concept

The 30% design includes a 550 kW back-up generator. This generator is sized to provide back-up power to the new treatment plant at half-capacity, or 6.75 MGD.

Description of Proposed Concept

The VE Team concept eliminates the stand-by generator from the project. The new filtration plant would rely primarily upon the PacifiCorp transmission feed; in the event of an extended line power failure, the hydrogeneration facility would power the filtration plant.

Advantages	Disadvantages
• Eliminate the stand-by generator • Eliminate the use of diesel fuel for back-up power and associated safety measures and greenhouse gases • If no water to generate power; no power is needed to treat water	• Additional electrical equipment from the hydrogeneration transformer to the treatment plant required • Matching generator output to treatment plant load must be done sequentially • Slight risk of loss of grid power during powerhouse outage

Discussion

The back-up generator would not be provided and capital, fuel and maintenance costs saved.

There are two conceived durations of loss of transmission grid power to the treatment plant: shorter durations and longer durations. Shorter duration outages are those where system demand can be met by the capacity of the storage tanks in the system; these might extend up to 6 to 12 hours. Longer duration outages would be due to a significant storm event that would prevent repair of transmission grid power to the site. During shorter duration outages, the City would rely upon storage to meet system demand. During longer outages, the hydrogeneration facility would be configured to meet treatment plant electrical loads without the electrical grid.

The 30% design proposes two station service transformers, sized each at 75 kVA and 50 kVA. The VE Team approach would be to upsize one of these to meet treatment plant loads at half-capacity of 6.75 MGD, or 550 kW. The VE Team does not have specialized expertise in electrical power distribution, however, we view the following as issues to address in pursuing the proposed concept:

1. At a given flow, the hydrogeneration unit will generate more power than the treatment plant will need. Without an active connection to the transmission grid, this excess capacity will result in a trip of the hydrogeneration unit – flow will be diverted into the afterbay through the bypass valve.

The load of the plant will need to be balanced with the generation of the hydrogeneration unit after a subsequent "black start"; mechanically this could be achieved by diverting treatment plant flow greater than needed generation flow through the bypass valve.

2. The treatment plant would need to be re-started, one load at a time. To effect this "black start" of the hydropower plant, another power supply would be needed to start auxiliaries of this unit to allow it to start, operate under speed control and match the running generators voltage, frequency, and phasing before they synchronize together. This is typically done with a back-up generator, but can be accomplished by increasing the capacity of the station batteries, utilizing DC voltage auxiliaries and a generation unit designed for "black start-up".
3. An automatic transfer switch may not be needed as short-duration outages would not require the treatment plant to be on-line. However, manual transfer switch would be utilized to accomplish using the hydrogeneration facility without using the PacifiCorp grid.

RSRI

Construction Cost Estimate

Idea No: T-20

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
Stand-by Generator - 550kW	Unit	$ 350,000	1	$ 350,000	0	$ -
Diesel fuel storage tank - 1,100 gallons	Unit	$ 12,000	1	$ 12,000	0	
Automatic Transfer Switch and Gear (sized for 550 kW, 480/270 3 phase)	Unit	$ 12,000	1	$ 12,000	0	
Station Service Transformer - 75 kVA, 5kV to 480/270V 3 phase	Unit	$ 19,000	1	$ 19,000	0	$ -
Station Service Transformer - 500 kVA, 5 kV to 480/270V 3 phase	Unit	$ 31,000	0	$ -	1	$ 31,000
Manual transfer switch and gear (480/270 V)	Unit	$ 7,500	0	$ -	1	$ 7,500
Incremental cost of additional DC station batteries	Unit	$ 5,000.00	0	$ -	1	$ 5,000
"Black start" capability on hydrogenerator auxiliaries	Unit	$ 13,125.00	0	$ -	1	$ 13,125
				$ -		$ -
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Subtotal				$ 393,000		$ 56,625
Markup		59%		$ 231,870		$ 33,409
TOTALS				$ 624,870		$ 90,034
NET SAVINGS						$ 534,836

Value Engineering Recommendation

O&M Cost Estimate Idea No. T-20

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
ANNUAL COSTS						
Operations						
Labor						
Equipment Maint. @4% /yr of capital		.04	624870	24994	90034	3601
Materials & Equipment						
Maintenance						
Labor						
Materials & Equipment						
Energy						
Gas						
Power						
Oil						
TOTAL ANNUAL COSTS			A =	24994	B =	3601

	PWF	A x PWF	B x PWF
PRESENT WORTH (Annual O&M)	13.59	339,668	48,938

REPLACEMENT COSTS	Year	Amount	Amount

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-24	Idea Title	Drop Finished Floor to Rock Elevation

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$2,788,000.00	--	$2,788,000.00
Proposed Concept	$2,735,000.00	--	$2,735,000.00
Estimated Savings	$53,000.00	--	$53,000.00

Description of Original Concept

The membrane building is constructed conventionally, founded at grade. It utilizes concrete block, insulated metal wall and roof panels and steel framing.

Description of Proposed Concept

The idea is to drive steel sheetpiling forming a 124'x128' perimeter matching the original building footprint, excavate the soil and construct the building therein. The sheetpiling remains in place providing permanent walls. The roof system is steel framed, clear span. Two walk-in, above grade access buildings and one elevator are included.

Advantages	Disadvantages
• Lower construction cost • Lower heating cost • Improved security	• Slightly more access effort (despite elevator)

Discussion

The geotechnical report indicates fractured basalt approximately 18 feet below grade with dense but not cemented granular (to 20" cobbles) material above. Groundwater is more than 450 feet below grade. This indicates the ability to drive adequately designed piling to provide shoring and permanent walls. The sheetpiling may be restrained at top during construction with tieback/deadmen. To ensure installation the cost estimate includes percussion drilling the perimeter to break up cobbles and boulders which may be present.

Placing the structure below grade eliminates the need for expensive, architectural wall systems and insulation. Heating needs are reduced and ventilation remains unchanged. The excavated material is bermed up two feet around the building but the roof is set another 2.5 feet above grade to prevent vehicle/equipment access. It is a typical roof.

Access is provided by two above-grade penthouses leading to stairways. A passenger elevator is also included to serve various needs. Equipment install/removal can be accomplished through two, 6'x6' roof hatches.

The current design includes indoor space for chemical tanks as does this idea. These might better be placed outdoors (weather insulated/heat-traced) on slabs to reduce the size of this building and ease access for filling.

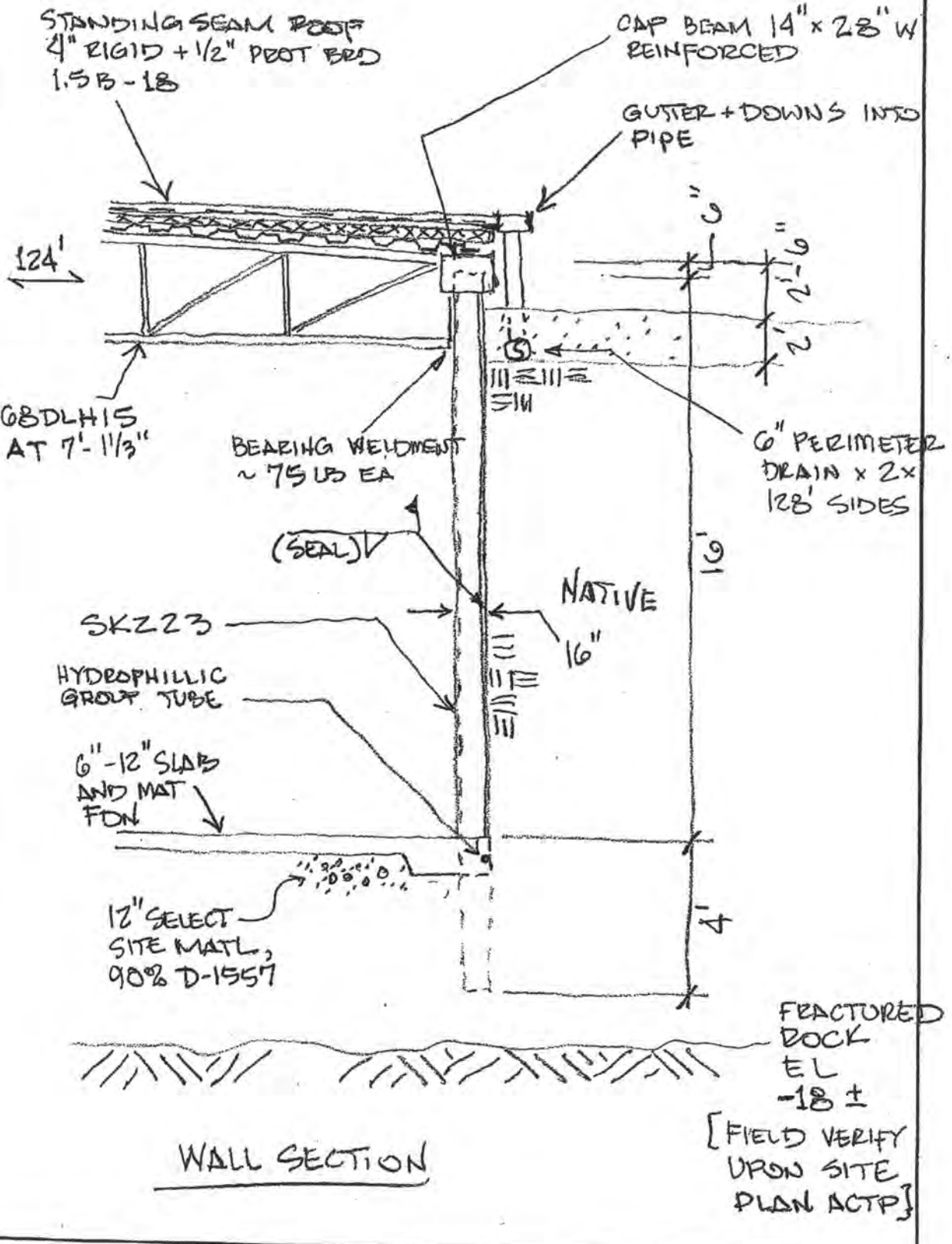
NOTE: This type construction has been used in many instances, including the Pacific NW. The Blaine,

WA WWTP utilizes permanent sheetpile walls (see below). A 22-story condominium with underground parking also successfully utilized this technique. See:

http://www.skylinesteel.com/case_studies/TheJ3ohnRoss_CS.pdf

SKETCH

Idea No. T-24

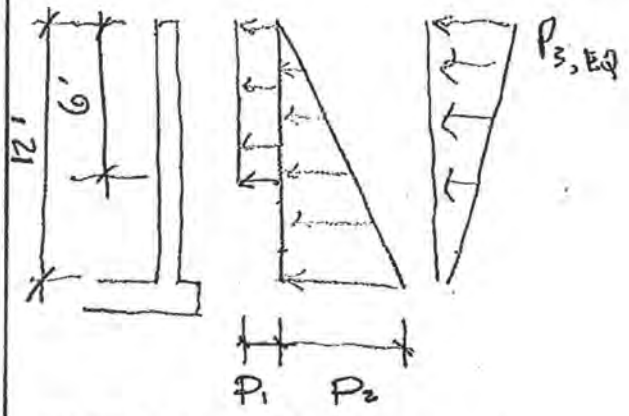


WALL SECTION

RSRI

CURRENT BUILDING FOOTPRINT = 124'x128' = 15,872 SF
" " HEIGHT = 24' ↘ 16'

GE → ROCK: HYDRO DWG 14'
GEOTECH 18' S+W p8
- MODERATELY FRACTURED BASALT
- NO GROUNDWATER



$P_1 = 500 \times 0.4 = 200$ PSF

$P_2 = 50 \times 12 = 600$ PSF

$P_3 = 7 \times 12 = 84$ PSF

12' $M_{ASD} = [6 \times 200 \times 9 + \frac{1}{2} \times 600 \times 12^2/3 + \frac{1}{2} \times 84 \times 12^2 \times 2/3] / 1000$
$= 29.3$ FT-K/FT $= 351$ IN-K/FT

16' $M_{ASD} = [6 \times 200 \times 13 + \frac{1}{2} \times 800 \times 16^2/3 + \frac{1}{2} \times 112 \times 16^2/1.5] / 1000$
$= 59.3$ FT-K/FT $= 711$ IN-K/FT

SKYLINE STEEL SKZ23 $S = 35.6$ IN^3/FT
depth = 16" WT = 22.8 PSF WALL
joints = 28.5" t = 0.354"

USE 12' ↓, 4' A.Gr w/ BERM 2' & 2" EXP, 4' TOE

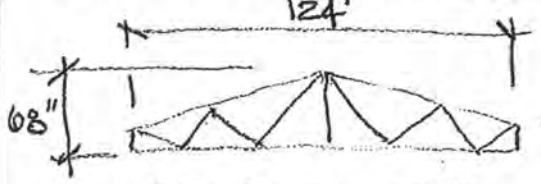
20' STICKS x 504 LF
= 115 TONS

p1

ROOF - USE TO BRACE WALL TOPS
1.5B - 18 DECK x 7.11' SPAN

DL = 8 MEP + 2 SPRINKLERS + 10 STRUCT = 20
LL = SNOW = 30
50 PSF

W = 50 x 7.11 = 356 PLF D+L



USE SLOPED TOP
CHORD @ 5% δ = 38"

VULCRAFT
68DLH15 42 PLF
124' CLEAR SPAN
7.11' SPCG ⇒ 17 PCS

JOIST WEIGHT = 44.3 TON
DECK = 15872 SF x 18 GA

FLOOR ASSUME: 50% 6" S.O.G
50% 12" MATS FOR EQ

6" ⇒ 7936 x .5 / 27 = 147 CY
12" ⇒ 294 CY

P2

124 ft span with 356plf D+L. 68DLH15.

Joist Type	Loads (PLF) Total	Live	Weight (lbs./ft.)
64DLH12	255	146	29
60DLH13	301	154	34
64DLH13	310	176	34
60DLH14	332	165	37
64DLH14	354	189	37
68DLH15	391	228	39
60DLH15	392	194	43
64DLH15	407	223	43
60DLH16	428	217	46
68DLH16	463	268	46
60DLH17	493	247	52
72DLH17	505	302	50
64DLH17	527	283	52
60DLH18	568	279	59
64DLH18	608	320	59
68DLH19	696	391	66
60DLH12	244	124	29
64DLH12	251	142	29
60DLH13	296	161	34
64DLH13	305	171	34
60DLH14	327	161	37
64DLH14	349	184	37
72DLH15	395	222	38
68DLH15	387	224	41
64DLH15	400	217	43
60DLH16	421	211	46
64DLH16	450	242	46
68DLH16	459	263	46
60DLH17	484	241	52
72DLH17	501	297	50
64DLH17	518	275	52
60DLH18	559	272	59
64DLH18	598	311	59

Joist Type	Loads (PLF) Total	Live	Weight (lbs./ft.)
64DLH15	387	206	43
60DLH16	407	201	46
72DLH16	437	252	45
68DLH16	452	254	46
72DLH17	492	287	49
64DLH17	501	262	52
68DLH17	609	289	53
60DLH18	540	259	59
64DLH18	578	296	59
68DLH18	589	327	60
72DLH19	676	368	67
68DLH19	678	371	67
60DLH12	232	115	29
64DLH12	238	132	29
60DLH13	282	139	34
64DLH13	291	159	34
60DLH14	310	149	37
64DLH14	332	171	37
68DLH14	337	190	38
72DLH15	375	211	38
68DLH15	378	213	40
64DLH15	381	201	43
60DLH16	400	196	46
72DLH16	434	248	45
68DLH16	448	250	46
72DLH17	488	282	49
64DLH17	497	258	52
68DLH17	505	284	53
60DLH18	631	252	59
64DLH18	569	286	59
68DLH18	594	321	60
68DLH19	673	365	67

Joist Type	Loads (PLF) Total	Live	Weight (lbs./ft.)
64DLH13	277	146	34
68DLH13	284	168	35
64DLH14	316	158	37
68DLH14	327	179	38
68DLH15	365	201	42
72DLH15	368	200	41
72DLH16	423	236	45
68DLH16	433	236	46
64DLH17	468	237	52
68DLH17	489	268	53
64DLH18	540	257	59
68DLH18	566	304	60
72DLH19	654	344	67
64DLH12	224	119	29
64DLH13	273	144	34
68DLH13	279	164	35
64DLH14	311	154	37
68DLH14	322	175	38
68DLH15	360	196	42
72DLH15	363	197	41
64DLH16	401	203	46
72DLH16	420	232	47
68DLH16	427	230	46
64DLH17	461	231	52
68DLH17	481	252	53
64DLH18	532	261	59
68DLH18	557	297	60
72DLH19	649	339	68
64DLH12	221	216	29

Joist Type	Loads (PLF) Total	Live	Weight (lbs./ft.)
72DLH15	354	188	41
64DLH16	382	189	46
72DLH16	410	221	47
64DLH17	439	215	52
72DLH17	461	252	53
64DLH18	507	243	59
68DLH18	532	276	60
72DLH18	540	284	59
72DLH19	633	323	67
64DLH12	211	109	29
64DLH13	257	131	34
64DLH14	292	140	37
68DLH14	303	159	38
72DLH14	307	166	37
68DLH15	337	178	41
72DLH15	352	185	41
64DLH16	376	186	46
72DLH16	407	218	47
64DLH17	432	210	52
68DLH17	453	238	53
72DLH17	457	248	53
64DLH18	498	237	59
68DLH18	524	269	60
72DLH18	536	280	59
68DLH19	601	305	67
72DLH19	628	318	67
68DLH13	259	145	35
68DLH14	299	155	38
72DLH14	305	163	38

Sheetpile 711 in-k/ft, A36 steel. Assume cantilever but in reality brace top with roof structure. SKZ23.

SECTION	Width (w) in (mm)	Height (h) in (mm)	Thickness (t) in (mm)	Cross Sectional Area in²/ft (cm²/m)	WEIGHT Pile lb/ft (kg/m)	WEIGHT Wall lb/ft² (kg/m²)	SECTION MODULUS Elastic in³/ft (cm³/m)	SECTION MODULUS Plastic in³/ft (cm³/m)	Moment of Inertia in⁴/ft (cm⁴/m)	COATING AREA Both Sides ft²/ft (m²/m)	COATING AREA Coating Area ft²/ft² (m²/m²)
SKZ 20	28.50 723.9	16.00 406.4	0.315 8.0	6.00 136.20	48.24 71.79	20.31 99.17	31.69 1704	36.66 1970.97	253.51 34619	7.60 2.32	1.60 1.60
SKZ 22	28.50 723.9	16.00 406.4	0.335 8.5	6.30 145.40	51.30 76.34	21.60 105.46	33.43 1797	38.94 2093.55	267.40 36515	7.60 2.32	1.60 1.60
SKZ 23	28.50 723.9	16.00 406.4	0.354 9.0	6.70 162.50	54.20 80.66	22.82 111.42	35.61 1915	41.12 2210.75	284.90 38909	7.60 2.32	1.60 1.60
SKZ 24	28.50 723.9	16.00 406.4	0.375 9.5	7.10 179.50	57.43 85.47	24.18 118.06	37.73 2028	43.52 2339.78	301.80 41212	7.60 2.32	1.60 1.60
SKZ 25	28.50 723.9	16.00 406.4	0.399 10.1	7.60 188.00	61.10 90.93	25.73 125.61	40.14 2159	46.24 2486.02	321.12 43851	7.60 2.32	1.60 1.60
SCZ 14	28.50 723.9	10.00 254.0	0.250 6.4	4.18 88.48	33.81 50.31	14.23 69.50	14.36 772	16.32 877.4	71.82 9809	6.10 1.86	1.28 1.28
SCZ 16	28.50 723.9	10.00 254.0	0.276 7.0	4.62 97.79	37.37 55.61	15.73 76.82	15.75 847	17.97 965.9	78.73 10751	6.10 1.86	1.28 1.28
SCZ 17	29.95 760.8	10.13 257.3	0.315 8.0	5.16 109.22	43.86 65.27	17.57 85.79	16.86 906	19.57 1051.9	88.77 12122	6.32 1.93	1.27 1.27
SCZ 18	29.95 760.8	10.13 257.3	0.335 8.5	5.49 116.21	46.67 69.45	18.70 91.28	17.86 960	20.85 1121.0	90.48 12356	6.32 1.93	1.27 1.27
SCZ 19	29.95 760.8	10.13 257.3	0.354 9.0	5.80 122.77	49.30 73.37	19.75 96.43	18.74 1008	22.06 1186.0	94.92 12962	6.32 1.93	1.27 1.27

p3

RSRI

RSRI

Construction Cost Estimate

Idea No: T-24

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Drill perimeter	EA	$ 16.00	0	$ -	1,137	$ 18,192
Sheetpile, in place	SF	$ 25.00	0	$ -	10,080	$ 252,000
Deadman tiebacks	EA	$ 1,068.75	0	$ -	32	$ 34,200
Construction Waler	LB	$ 2.50	0	$ -	26,712	$ 66,780
Seal weld all joints	LF	$ 6.00	0	$ -	3,820	$ 22,920
Finish coating, good quality	SF	$ 1.00	0	$ -	12,900	$ 12,900
				$ -		$ -
Excavate inside walls	CY	$ 1.59	0	$ -	7,050	$ 11,210
Place Spoils	CY	$ 1.59	0	$ -	7,050	$ 11,210
Light compact + levelling	SF	$ 0.49	0	$ -	95,175	$ 46,636
12" Select fill plc/cmpct	CY	$ 2.94	590	$ 1,735	590	$ 1,735
				$ -		$ -
Grout tube, perimeter	LF	$ 12.00	0	$ -	670	$ 8,040
Concrete 6" Slab	CY	$ 415.62	0	$ -	150	$ 62,343
Concrete 12" finished matts	CY	$ 415.62	0	$ -	290	$ 120,530
Conc cap beam atop piling	CY	$ 500.00	0	$ -	50	$ 25,000
Conc Slab+Foundations	LS	$ 315,042.00	1	$ 315,042	0	$ -
CMU Wall System	LS	$ 428,070.00	1	$ 428,070	0	$ -
Ins Panel Wall System	LS	$ 9.00	3,000	$ 27,000	0	$ -
CMU Insulation + Finish	LS	$ 6.36	5,040	$ 32,054	0	$ -
Windows + Doors	LS	$ 112,405.00	1	$ 112,405	0	$ -
				$ -		$ -
Standing seam roof	LS	$ 10.62	0	$ -	15,872	$ 168,587
Gutters w/ downspouts	LF	$ 24.00	0	$ -	504	$ 12,096
Closure allowance at top	LF	$ 20.00	0	$ -	504	$ 10,080
Perimeter 6" drain	LF	$ 4.96	0	$ -	256	$ 1,270
				$ -		$ -
4" Rigid w/ 1/2" Prot Board	SF	$ 7.55	0	$ -	15,872	$ 119,834
1.5B-18 Deck	SF	$ 4.03	0	$ -	15,872	$ 63,964
68DLH15 x 124ft	EA	$ 3,720.00	0	$ -	17	$ 63,240
End weldments for joists	LB	$ 25.00	0	$ -	2,550	$ 63,750
Structural steel framing	LS	$ 379,918.00	1	$ 379,918	0	$ -
Steel deck/roof	LS	$ 47,306.00	1	$ 47,306	0	$ -
						$ -
				$ -		$ -
Stairwell, conc metal pan	EA	$ 11,400.00	0	$ -	2	$ 22,800
Elevator, 1 stop	EA	$ 40,000.00	0	$ -	1	$ 40,000
				$ -		$ -
Entrance Structure, 24 x 24	SF	$ 300.00	0	$ -	576	$ 172,800
Equipment Hatches, 6ft sq	EA	$ 7,500.00	0	$ -	2	$ 15,000
				$ -		$ -
Heating	LS	$ 268,095.00	1	$ 268,095	0.5	$ 134,048
				$ -		$ -
				$ -		$ -
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				$ -		$ -
				$ -		$ -
				$ -		$ -
Subtotal				$ 1,611,625		$ 1,581,162
Markup		73%		$ 1,176,486		$ 1,154,248
TOTALS				$ 2,788,111		$ 2,735,410
NET SAVINGS						$ 52,701

Value Engineering Recommendation

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-36	Idea Title	Limit Design to 21 cfs

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$35,680,000.00	$360,000.00	$36,040,000.00
Proposed Concept	$28,590,000.00	$240,000.00	$28,830,000.00
Estimated Savings	$7,090,000.00	$120,000.00	$7,210,000.00

Description of Original Concept

The Membrane System is designed for future expansion from 21 to 36 cfs.

Description of Proposed Concept

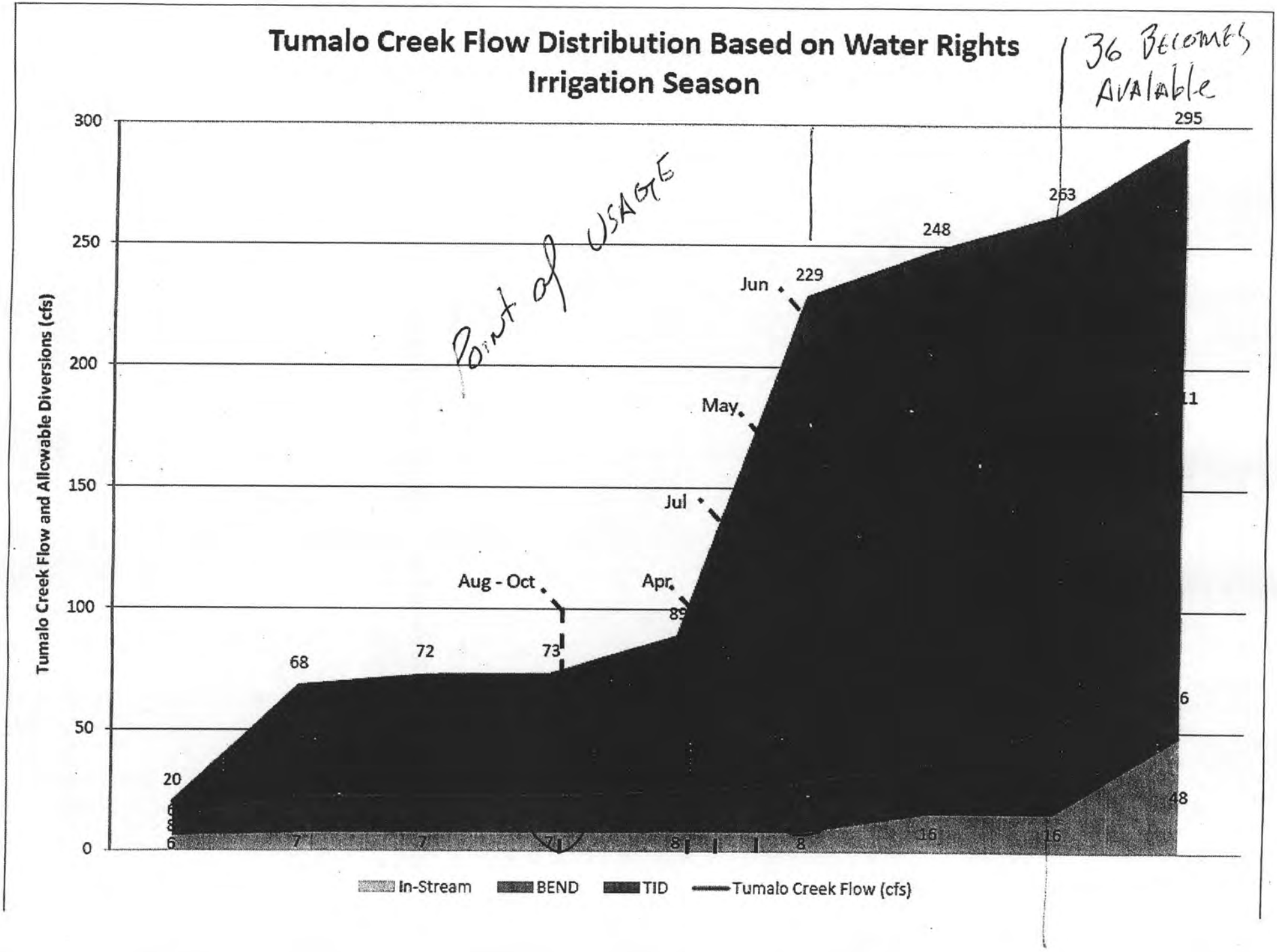
Limit the design of the facility to 21 cfs. A review of the flow distribution of water indicates that availability of raw water to the City of Bend only occurs when the Tumulo Creek flow is above 263 cfs. This condition does not occur during the course of a normal year.

Advantages	Disadvantages
• Reduces Membrane Building footprint (allowance for expansion by 25 percent) • Reduces infrastructure requirements for planned expansion by 40 percent (electrical, piping after bay, solids handing. Pretreatment equalization chemical storage etc) • Reduces Pipeline area by 40 percent under equivalent conditions of flow	• Expansion would be more costly if additional water rights were obtained

Discussion

It does not seem appropriate to design a facility for capacity that may only be available a small fraction of the year, if at all.

- ✓ Savings (Order of Magnitude Estimates)
- ✓ Building area 25 percent
- ✓ Switchgear Transformer and Main Bus (40 percent)
- ✓ Piping – 10 percent
- ✓ Chemical Storage (Sodium Hypochlorite) 40 percent.
- ✓ Pretreatment – None Sized for 13.5 mgd
- ✓ HVAC and Fire (25 percent)
- ✓ Transmission Line Reduction from 36 inch to 30 inch


Tumalo Creek Flow Distribution Based on Water Rights
Irrigation Season
36 Becomes Available
Point of USAGE
Tumalo Creek Flow and Allowable Diversions (cfs)
300
250
200
150
100
50
0
Jun
May
Jul
Aug - Oct
Apr
229
248
263
295
68
72
73
89
20
6
7
7
7
8
8
16
16
48
6
11
In-Stream
BEND
TID
Tumalo Creek Flow (cfs)

RSRI

Construction Cost Estimate

Idea No: T-36

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
36 inch supply pipe	LF	$ 301.56	50,000	$ 15,078,000	0	$ -
30 inch supply pipe	LF	$ 251.30		$ -	50,000	$ 12,565,000
Ppeline Multiplier		47%		$ 7,086,660		$ 5,905,550
Reduce Building Area	SF	$ 282.99	17,550	$ 4,966,486	12,000	$ 3,395,888
Reduce Electrical	LS	$ 2,142,623	1	$ 2,142,623	0.9	$ 1,928,361
Membrane Building Piping	SF	$ 96.74	6,882	$ 665,765	5,162	$ 499,324
Chemical Storage	Gal	$ 3.00	12,000	$ 36,000	8,000	$ 24,000
WTP Multiplier		73%		$ 5,701,937		$ 4,268,727
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TOTALS				$ 35,677,471		$ 28,586,849
NET SAVINGS						$ 7,090,622

O&M Cost Estimate

Idea No. T-36

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
ANNUAL COSTS						
Operations						
Labor						
Bldg O&M	SF	1.50	17,550	26,325	12,000	18,000
Materials & Equipment						
Maintenance						
Labor						
Materials & Equipment						
Energy						
Gas						
Power						
Oil						
TOTAL ANNUAL COSTS			A =	26,325	B =	18,000

	PWF	A x PWF	B x PWF
PRESENT WORTH (Annual O&M)	13.59	357,757	244,620

REPLACEMENT COSTS	Year	Amount	Amount

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-44	Idea Title	Use Redundant PLC's and RIO

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$152,000.00	--	$152,000.00
Proposed Concept	$43,000.00	--	$43,000.00
Estimated Savings	$109,000.00	--	$109,000.00

Description of Original Concept

The PLC Architecture shows individual unit and systems Programmable Logic Controllers (PLC's). (IE-02)

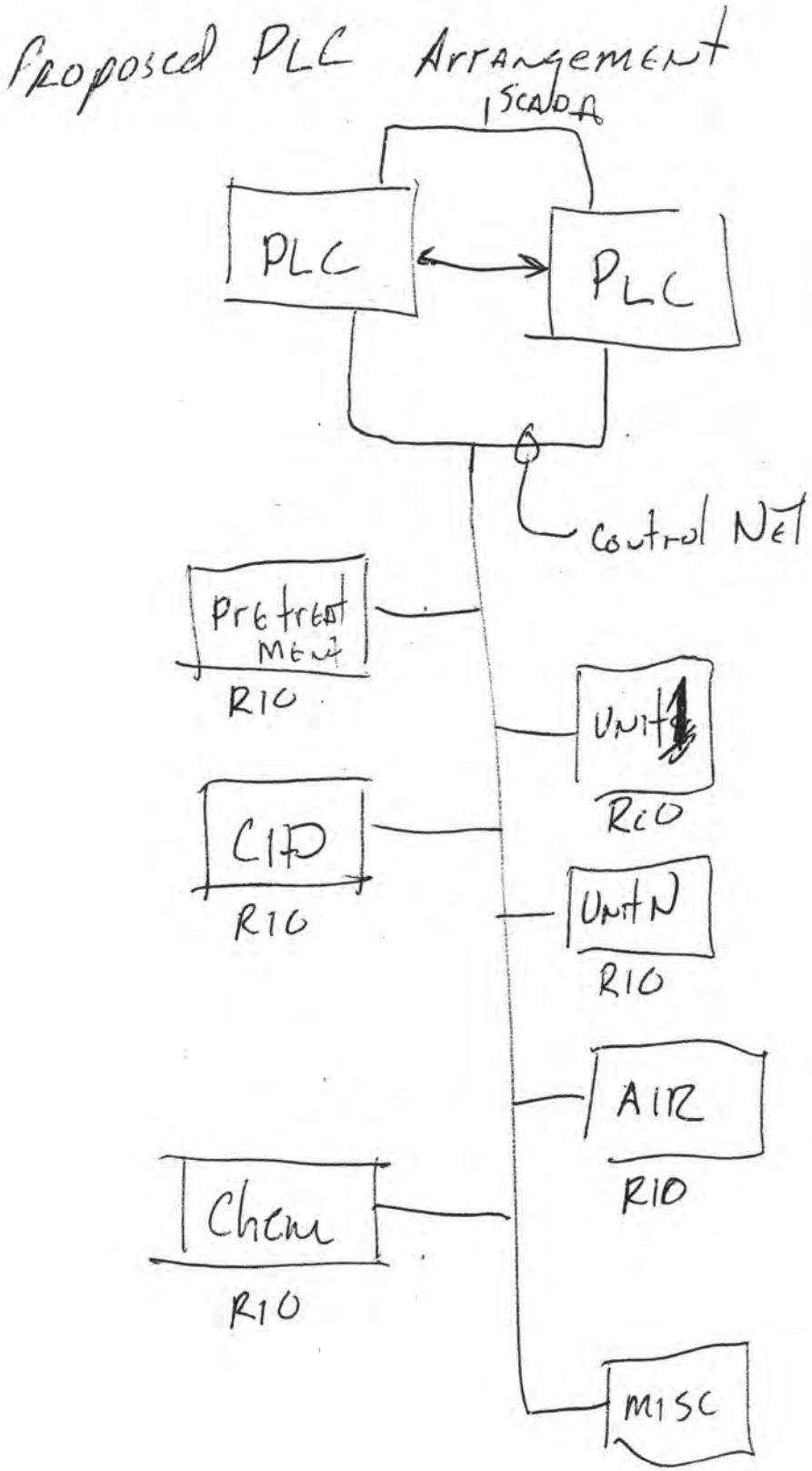
Description of Proposed Concept

Use a single redundant PLC with Remote Input / Output Modules to control the system.

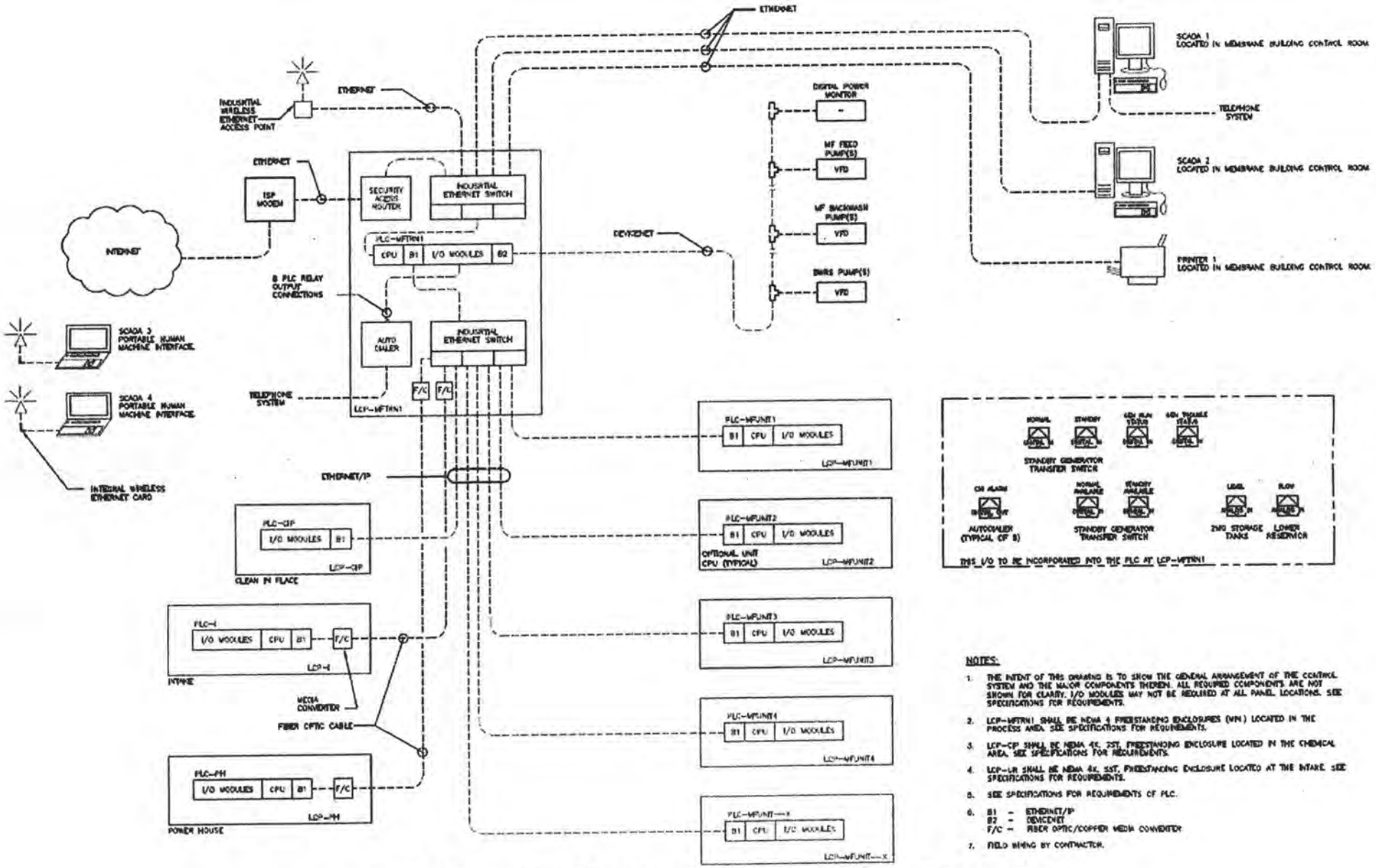
Advantages	Disadvantages
• Eliminates multiple field based PLC's • Simplifies Programming • Improves reliability	• None

Discussion

This eliminates the 10 to 15 local process based PLC's. A single redundant PLC will be simpler to program and coordinate and is more typical of system design.


Proposed PLC Arrangement
SCADA
PLC
PLC
Control Net
Pretreatment
RIO
Unit
RIO
CTD
RIO
Unit N
RIO
AIR
RIO
Chem
RIO
MISC

1E-02: PLC System Overview



NOTES:

1. THE INTENT OF THIS DRAWING IS TO SHOW THE GENERAL ARRANGEMENT OF THE CONTROL SYSTEM AND THE MAJOR COMPONENTS THEREIN. ALL REQUIRED COMPONENTS ARE NOT SHOWN FOR CLARITY. I/O MODULES MAY NOT BE REQUIRED AT ALL PANEL LOCATIONS. SEE SPECIFICATIONS FOR REQUIREMENTS.
2. LCP-MFTRN1 SHALL BE NEMA 4 FREESTANDING ENCLOSURES (MN) LOCATED IN THE PROCESS AREA. SEE SPECIFICATIONS FOR REQUIREMENTS.
3. LCP-CIP SHALL BE NEMA 4X, 2ST, FREESTANDING ENCLOSURE LOCATED IN THE CHEMICAL AREA. SEE SPECIFICATIONS FOR REQUIREMENTS.
4. LCP-LR SHALL BE NEMA 4X, SST, FREESTANDING ENCLOSURE LOCATED AT THE INTAKE. SEE SPECIFICATIONS FOR REQUIREMENTS.
5. SEE SPECIFICATIONS FOR REQUIREMENTS OF PLC.
6. B1 – ETHERNET/IP
   B2 – DEVICENET
   F/C – FIBER OPTIC/COPPER MEDIA CONVERTER
7. FIELD WIRING BY CONTRACTOR.

~~[illegible]~~ USE REDUNDENT PLC WITH FIELD RIO

RSRI

Construction Cost Estimate

Idea No: T-44

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
PLC Control Modules	ea	$ 5,000	12	$ 60,000	2	$ 10,000
PLC RIO Modules	ea	$ 1,500	2	$ 3,000	10	$ 15,000
PLC Programming Coordination	lot	$ 25,000	1	$ 25,000	0	$ -
				$ -		$ -
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Subtotal				$ 88,000		$ 25,000
Markup		73%		$ 64,240		$ 18,250
TOTALS				$ 152,240		$ 43,250
NET SAVINGS						$ 108,990

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-48	Idea Title	Use Fewer Treatment Units

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$865,000.00	--	$865,000.00
Proposed Concept	$0.00	--	$0.00
Estimated Savings	$865,000.00	--	$865,000.00

Description of Original Concept

The Design describes nominally 9 treatment units or nominally 1.7 mgd treatment units to obtain the facility capacity.

Description of Proposed Concept

Use larger treatment unit for primary treatment and smaller units for secondary treatment. Most manufacturers can provide treatment unit of 2.5 to 3 mgd in size. This would reduce that total number of treatment units to 4 or 5 for primary treatment and 2 smaller units for backwash recovery.

Advantages	Disadvantages
• Reduces Membrane Unit Cost • Simplifies Installation and Operation • Simplifies controls	• Larger Backwash Pump and CIP Tanks

Discussion

The interconnected backwash recovery unit may be overly complex being the same size as the primary treatment system. It will be difficult to send filtered water out as treated water under LT2 guidelines due to the increased concentration that will occur in the backwash membrane system (subject to State of Oregon DPH acceptance). Standard package treatment units may be more appropriate for backwash recovery.

There is a 9.9 Million allowance for Membrane System and Installation. Since the details of the system are not available, it will be assumed that this configuration change has a total savings of about 5 percent or $500,000 dollars.

RSRI

Construction Cost Estimate

Idea No: T-48

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Membrane System	LS	$ 6,182,227		$ 9,900,000	0.9	$ 9,400,000
				$ -		$ -
				$ -		$ -
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Subtotal				$ 9,900,000		$ 9,400,000
Markup		73%		$ 7,227,000		$ 6,862,000
TOTALS				$ 17,127,000		$ 16,262,000
NET SAVINGS						$ 865,000

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-50	Idea Title	Use DAF on Backwash Water

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$12,190,000.00	$1,617,000.00	$13,807,000.00
Proposed Concept	$11,596,000.00	$181,000.00	$11,777,000.00
Estimated Savings	$594,000.00	$1,436,000.00	$2,030,000.00

Description of Original Concept

The design describes a nominal 13.5 mgd treatment facility with a primary membrane backwash unit and an interconnected primary/backwash unit. Operating at 11.25 mgd, backwash flow from the primary membrane system is estimated at 540,000 gallons/day. The secondary backwash system operated at a recovery of 80 percent meaning that 108,000 gallons of backwash will be discharged to the sewer per day.

Description of Proposed Concept

Use an alternative high rate clarification treatment process for backwash treatment. The DAF is suggested to keep the profile low and within the membrane building working area.

Advantages	Disadvantages
• Reduces Membrane System Cost and Complexity • Reduces Volume Discharged to Sewer • Simplifies permitting of Membrane system	• Potential Impact on Membrane flux from DAF effluent

Discussion

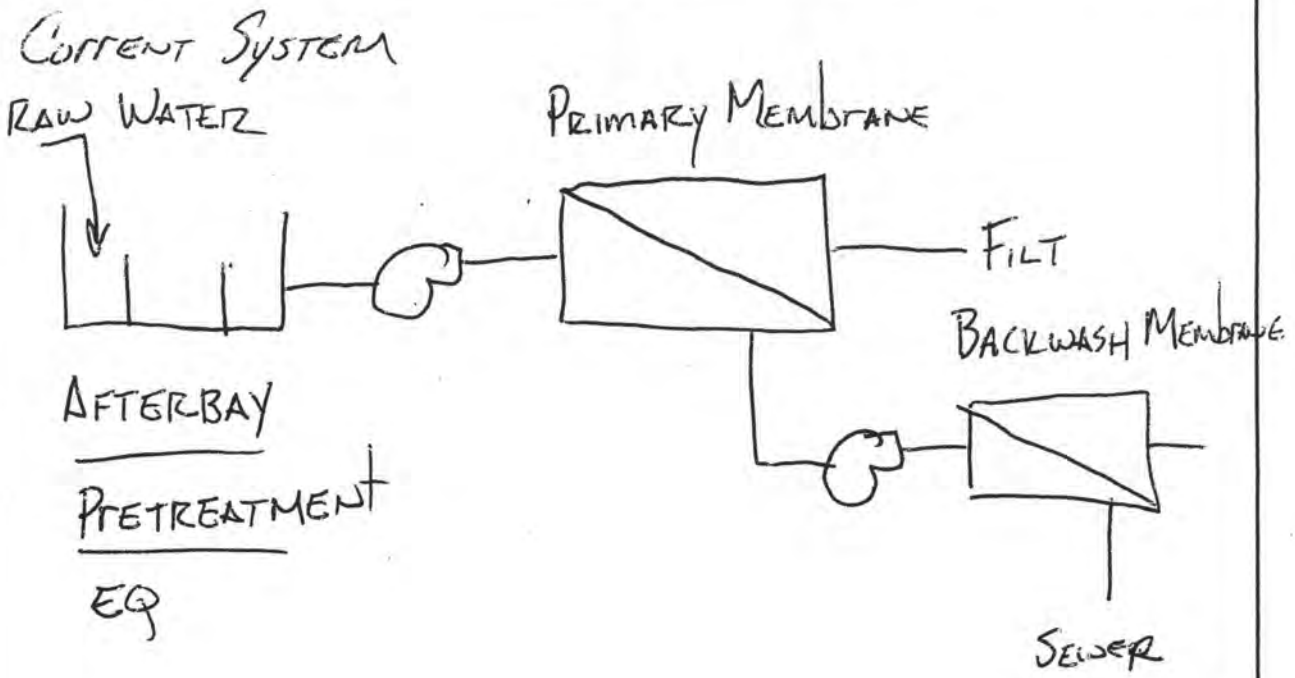
The total amount of solids that can be delivered to the facility is estimated at approximately 47 lbs/day based on a TSS of 0.5 mg/L at 11.25 mgd average flow, typical for the turbidity levels offered in the basis of design report. Coagulant (ACH or PaCL) will be added to the backwash water to enhance settling. It can be assumed that the amount of coagulant will be equal to the amount of solids, resulting in a solids load of 94 lbs/day. Although DAF processes can produce up to 2 or 3 percent solids, a more liquefied stream of 0.5 percent solids can be assumed to maintain liquefied form of the waste suitable for disposal in a sanitary sewer. Using these assumptions, the amount of backwash discharged to the sewer is approximately 2,500 gallons per day.

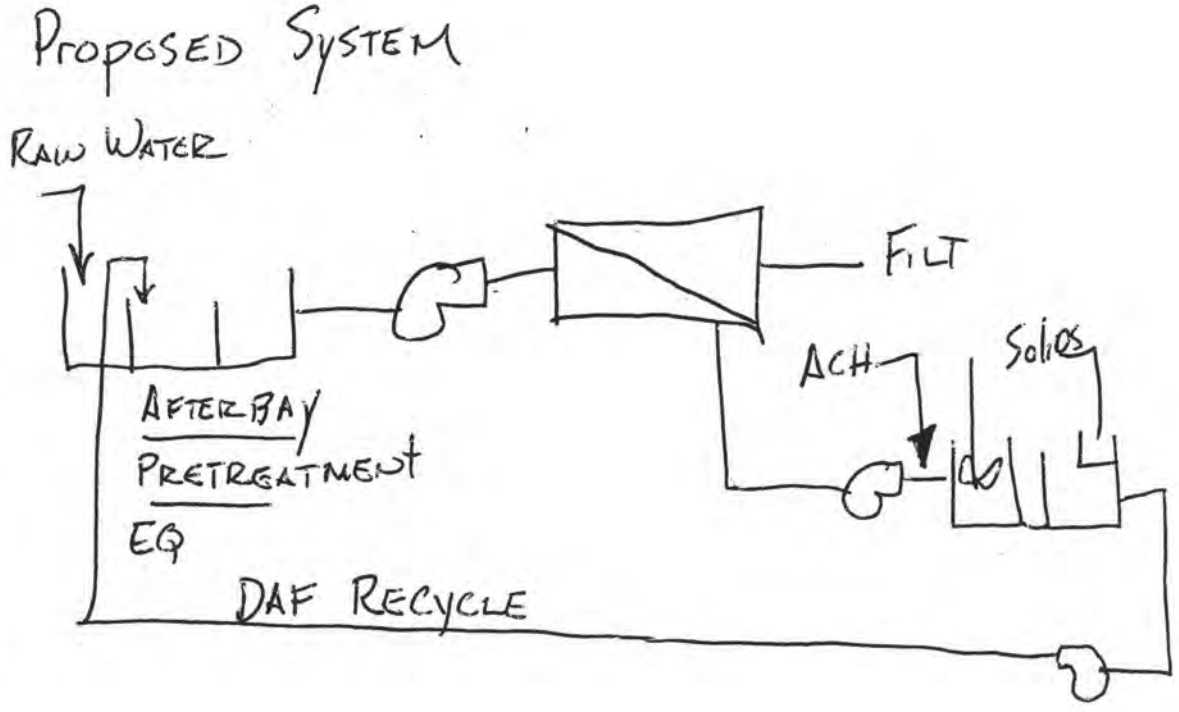
Estimated Cost for a 0.54 mgd (2 x 100 percent) DAF system is $300,000 for the equipment. Installed cost is about 400,000 dollars. Information was estimated using a Westech DAF design similar in size to the Yucaipa, CA system designed by HDR.

Operational costs are include a reduction in total membrane modules required for backwash treatment (54 modules), and an energy difference of about 50 feet of head. The DAF also requires a Recycle pump (10 percent of flow) at 85 psi and a nominal air supply. Coagulant cost is estimated at about 8,000 dollars per year.

SKETCH

Idea No. T-50





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Operational Cost Comparison

Membrane Backwash Pumps

375 gpm · 80 ft

= $4000 /yr

Other $ item

DAF = 375 gpm @ 30 feet TDH

= 1500 /yr

Coagulant = (0.48)(47)(365)

= 8000 /yr

DAF Recycle

40 gpm · 85 psi

= 1000 dollars

Membrane Modules 10 gpm/module = 54 modules

54 × $3000 /modules

10 yrs = 16200 /yr

Membrane $ 20,200 yr

DAF = $ 10,500 yr

Sewer Cost

Δ 105,000 gal/day

× 2.50 • K gal

= ≈ 96,000 #/yr

Solids Content of DAF Float

K — ACH + solids

$$\frac{94 \text{ lbs}}{0.005} = \frac{18\,800 \text{ lbs}}{7.48} = 2513 \text{ gal}$$

Say 2500 gal

RSRI

Construction Cost Estimate

Idea No: T-50

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Membrane System	LS	$ 6,182,227	1	$ 6,182,227	0.90	$ 5,564,004
DAF System	LS	$ 300,000		$ -	1	$ 300,000
6 inch Sewer Line (12340 ft)	LF	$ 70	12,340	$ 863,800		$ -
3 inch sewer line	LF	$ 68		$ -	12,340	$ 839,120
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Subtotal				$ 7,046,027		$ 6,703,124
Markup		73%		$ 5,143,600		$ 4,893,281
TOTALS				$ 12,189,627		$ 11,596,405
NET SAVINGS						$ 593,222

O&M Cost Estimate Idea No. T-50

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
ANNUAL COSTS						
Operations						
Labor						
Materials & Equipment						
ACH	#/lb	0.48				8000
SEWER	Kgal	2.50	108	98000	7.5	2300
Maintenance						
Labor						
Modules	EA	3000	54	16,200		
Materials & Equipment						
Energy						
Gas						
Power	Kwh	0.06		4000		2500
Oil						
TOTAL ANNUAL COSTS			A =		B =	

	PWF	A x PWF	B x PWF
PRESENT WORTH (Annual O&M)	13.59	1,552,800	140 000
	16.35	65,000	41,000

REPLACEMENT COSTS	Year	Amount	Amount

1,617,000 181,000

(1,436,000)

RSRI

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-51	Idea Title	Use DAF for Settling (Install now)

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$12,189,000.00	$1,518,000.00	$13,707,000.00
Proposed Concept	$12,245,000.00	$473,000.00	$12,718,000.00
Estimated Savings	($56,000.00)	$1,045,000.00	$989,000.00

Description of Original Concept

The Design describes a nominal 13.5 mgd treatment facility with a primary membrane backwash unit and an interconnected primary/backwash unit. The settling equipment is currently uninstalled. The secondary backwash system operated at a recovery of 80 percent meaning that 108,000 gallons of backwash will be discharged per day.

Description of Proposed Concept

There this concept is a variant of the recommendation T-53 (Install settling equipment now). The alternative is to use a high rate clarification process such as DAF for clarification and eliminate the backwash recovery treatment units. Process solids would be recycled to the DAF treatment process and would exit the system via the DAF float.

Advantages	Disadvantages
• Eliminates Secondary Membrane System • Reduces Volume Discharged to Sewer • Simplifies permitting of Membrane system • System is better able to respond to variation in water turbidity • May respond better to ash solids from a fire	• Potential Impact on Membrane Flux from DAF effluent

Discussion

Total amount of solids that can be delivered to the facility is estimated at approximately 47 lbs/day based on a TSS of 0.5 mg/L at 11.25 mgd average flow, typical for the turbidity levels offered in the basis of design report. These solids are discharged to the sewer in a volume of 108,000 gallons per day.

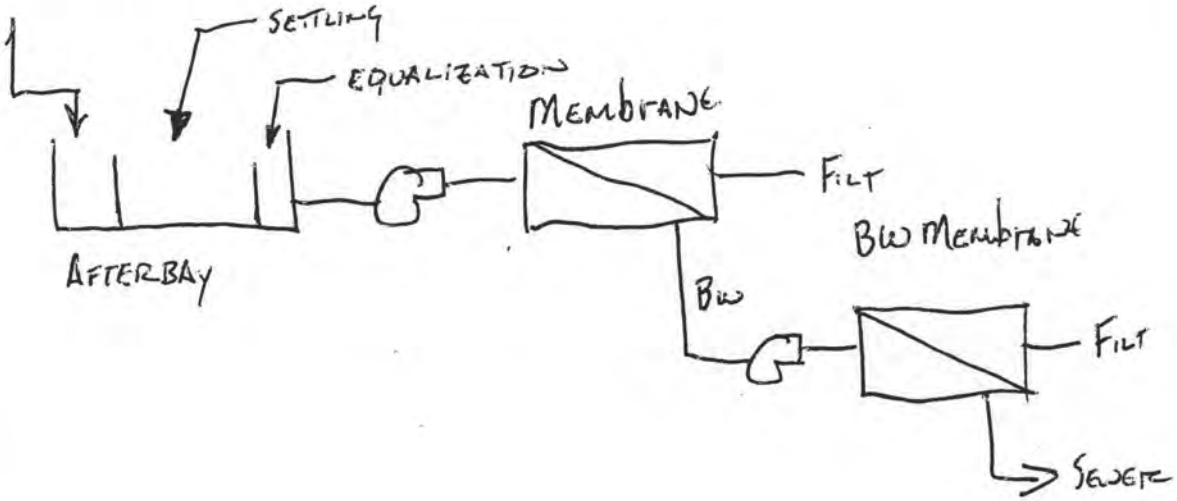
Coagulant (ACH or PaCL) will be added to the feedwater to enhance settling. It can be assumed that the amount of coagulant will be equal to the amount of solids, resulting in a solids load of 94 lbs/day. Although DAF can produce up to 2 or 3 percent solids, a more liquefied stream of 0.5 percent solids can be assumed to maintain liquefied form of the waste suitable for disposal in a sanitary sewer. Using these assumptions, the amount of liquid backwash discharged to the sewer would be approximately 2,500 gallons per day.

This approach would eliminate the need for a backwash treatment membrane system, and interconnected unit. Since exact membrane system pricing has not been established a reduction of 10 percent of the system cost has been used for a basis of design. This value accounts for the fact that the backwash membrane system would be operated at a lower membrane flux than the primary membrane system.

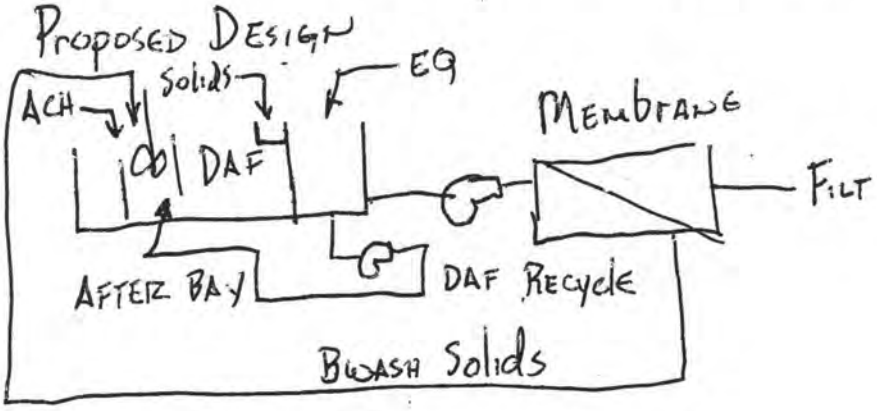
Estimated Cost for a 13.5 mgd of pretreatment equipment DAF system is 675,000 for the equipment. Equipment of this type is described as high-rate DAF (Aqua-DAF or Clari-DAF) which would be installed in the same location as the plate settling equipment with similar construction needs, although a significantly smaller settling area would be required as the rise rate in the DAF flocculation zone is in the range of 12 gpm/ft2 versus 4 gpm/ft2 for plate settlers. This would be offset by a larger equalization basin necessary to maintain a stable flow through the DAF system, and to account for membrane system backwashing cycling. Thus, for the purpose of this discussion, no change in concrete is envisioned.

Operational costs are include a reduction in total membrane modules required for backwash treatment (54 modules) and membrane feed pump energy, The DAF also requires a recycle pump (10 percent of flow) at 85 psi and a nominal air supply. Coagulant cost is estimated at about 8,000 dollars per year.

Current Design



Proposed Design



Calculate Volume of DAF Float

ACH + solids

$$\text{? gal water} = \frac{94\ \text{lb}}{0.005} = \frac{18{,}800}{7.48} = 2513\ \text{gal}$$

0.5 percent

Say

2500 gal

RSRI

Construction Cost Estimate

Idea No: T-51

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
Membrane System	LS	$ 6,182,000	1	$ 6,182,000	0.90	$ 5,563,800
DAF System	LS	$ 675,000		$ -	1	$ 675,000
6 inch Sewer Line (12340 ft)	LF	$ 70	12,340	$ 863,800		$ -
3 inch sewer line	LF	$ 68		$ -	12,340	$ 839,120
				$ -		$ -
				$ -		$ -
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				$ -		$ -
				$ -		$ -
Subtotal				$ 7,045,800		$ 7,077,920
Markup		73%		$ 5,143,434		$ 5,166,882
TOTALS				$ 12,189,234		$ 12,244,802
NET SAVINGS						$ (55,568)

O&M Cost Estimate Idea No. T-51

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
ANNUAL COSTS						
Operations						
Labor						
Materials & Equipment						
Sewer Charges	Kgal	2.5	108	98500	2.5	2300
ACH	lbs	0.48			47	8200
Maintenance						
Labor						
Membranes	ea	3000	54	10,000		
Materials & Equipment						
Energy						
Gas						
Power	kwh	0.06		2600		20,200
Oil						
TOTAL ANNUAL COSTS			A =		B =	

	PWF	A x PWF	B x PWF
PRESENT WORTH (Annual O&M)	13.59 / 16.35	1,475,000 / 43 000	149,000 / 330,800

REPLACEMENT COSTS	Year	Amount	Amount

1,518,000 473,000

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VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-53	Idea Title	Install pre-treatment equipment now

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept			
Proposed Concept			
Estimated Savings			DESIGN SUGGESTION

Description of Original Concept

The Current design will install the tankage for the pre-treatment facilities at this time, but defer the installation of the equipment until needed.

Description of Proposed Concept

The VE team suggests at lease purchasing and perhaps installing all or part of the pre-treatment equipment at this time.

Advantages	Disadvantages
• Speeds response in the event of a forest fire	• Requires maintenance on unused equipment to ensure operability when needed, if equipment is installed • May result in the warranty not being valid

Discussion

The purpose of the pre-treatment facilities is primarily to deal with the degraded water quality that may occur in the event of a major forest fire in the Bridge Creek watershed. City discussions with the U.S. Forest Service have indicated that the likelihood of the occurrence of a forest fire in the watershed is high, but that the timing of the occurrence and the degree of impact to the watershed is not predictable. Information provided to the VE team from Phoenix, AZ and Durango, CO, where major fires have occurred in watersheds suggest that a substantial increase in turbidity may occur immediately and last for up to 18 months following the fire, and that beginning 1-2 years following the fire and extending for up to 10 or more years thereafter there may be a significant increase in total organic carbon (TOC) in the water. The provided information did not indicate whether the TOC at those locations was in a particulate, colloidal or dissolved form.

The City has elected to install the concrete tankage at this time, but to defer the installation of the mechanical equipment until a fire occurs, to avoid the need to maintain the equipment for an unforeseeable period until needed. The proposed pre-treatment facilities are effective at removal of particulate and colloidal material from the water, but may not remove measurable quantities of dissolved materials. Accordingly the designer has included capability to add activated carbon in the future, if needed, to address the potential for dissolved TOC.

The process of purchasing, manufacture, delivery and installation of the mixers, pumps and settling equipment that would be installed in the pre-treatment tankage could easily take several weeks to several months.

Because the need for particulate removal could begin either during or immediately following a forest fire, the VE team has concerns that the equipment might not be in-place and operational in a timely fashion. Accordingly if the City should elect to continue with the plan to install pre-treatment facilities, the VE team recommends that the City consider purchasing the pre-treatment equipment and either storing it onsite in a suitable fashion or installing all or part of it now. There would likely be enough time to acquire and install the activated carbon equipment should it be needed.

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	T-54	Idea Title	Eliminate Daily Chemical Cleaning

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$12,190,000.00	$340,000.00	$12,530,000.00
Proposed Concept	$13,206,000.00	$258,000.00	$13,464,000.00
Estimated Savings	($1,016,000.00)	$82,000.00	($934,000.00)

Description of Original Concept

The Design is assumed to include daily sodium hypochlorite process necessary to maximize membrane flux and extend the interval between chemical cleaning. Waste from the chemical cleaning process includes a portion of the cleaning solution and the flushing water necessary to rinse the membrane unit prior to returning to service.

Description of Proposed Concept

Use lower membrane flux to minimize the need for daily chemical cleaning. It is suggested that membrane system size may increase by 10 percent to accommodate the lack of a daily cleaning process.

Advantages	Disadvantages
• Reduces Chemical Waste Discharges • Reduces Volume Discharged to Sewer	• Increases Membrane System Size

Discussion

The total estimated amount of cleaning waste discharged per day is in the range of 27,000 gallons. (9 units, 3000 gallons to rinse) It is estimated that the total annual cost for cleaning waste disposal is in the range of 25,000 dollars per year.

Chemical Cost of sodium hypochlorite make up is about 3000 gallons at 200 mg/L. Approximately 5 lb/day of hypochlorite solution is required per day of operation Using 12.5 percent solution (0.9 lb/gal) and a cost of 1.35 /gallon, annual cost of hypochlorite is about 2800 dollars per year.

This option appears more viable when the backwash as well as daily cleaning waste is removed from the system. Under the alternative arrangement only CIP waste (generated monthly) not daily is discharged to the sewer system.

In this case a significantly smaller sewer line (perhaps a 2 or 3 inch) force main would be needed to transport waste 2.5 miles to the local sewer connection. This would be a reduction in size of from the 6 inch line contained in the original cost estimate.

Sewer Cost Disposal

Chemical Washing

$$\frac{27\ Kgal}{dy} \times 365 \times \$2.50/Kgal = 25{,}000/yr$$

Chemical Cost Saving

$$\frac{3000}{1{,}000{,}000}(8.33)(200) = 5\ lbs/dy$$

$$SHC = 0.9\ lb/gal = 5.56\ gal/dy$$

$$5.56 \times \$1.35/gal \times 365 = \$2800/yr$$

Membrane Replacement

$$10\% = 54\ modules \times 3000/module = 16200/yr$$

10 yr life

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Construction Cost Estimate

Idea No: T-54

			Original Concept		Proposed Concept	
Item	**Unit of Meas.**	**Unit Cost**	**Quantity**	**Total**	**Quantity**	**Total**
Membrane System	LS	$ 6,182,227	1	$ 6,182,227	1.1	$ 6,800,450
6 inch sewer line (12,340 ft)	LF	$ 70.00	12,340	$ 863,800		$ -
3 inch sewer line	LF	$ 67.50		$ -	12,340	$ 832,950
				$ -		$ -
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				$ -		$ -
Subtotal				$ 7,046,027		$ 7,633,400
Markup		73%		$ 5,143,600		$ 5,572,382
TOTALS				$ 12,189,627		$ 13,205,781
NET SAVINGS						$ (1,016,155)

O&M Cost Estimate Idea No. T-54

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
ANNUAL COSTS						
Operations						
Labor						
Materials & Equipment						
Add Sodium Hypo	gal	1.35			5.56/dy	2800
Sewer	Kgal	2.50	27	25,000		
Maintenance						
Labor						
Materials & Equipment						
Membranes					54	16,200
Energy						
Gas						
Power						
Oil						
TOTAL ANNUAL COSTS			A =		B =	

	PWF	A x PWF	B x PWF
PRESENT WORTH (Annual O&M)	13.59	339,750	258,210

REPLACEMENT COSTS	Year	Amount	Amount

-(89,500)

RSRI

WASTE FORCEMAIN (W)

VALUE ENGINEERING RECOMMENDATION

SURFACEWATER IMPROVEMENT PROJECT — BEND, OREGON

Idea No.	W-1	Idea Title	Use Single Lagoon for Settling and for Process Waste Settling plus Septic Tank for Sanitary Waste

ESTIMATED COST IMPACTS

	Capital Cost	Present Worth of O&M Cost	Total Present Worth Cost
Original Concept	$1,204,000.00	$1,339,000.00	$2,543,000.00
Proposed Concept	$1,393,000.00	$68,000.00	$1,461,000.00
Estimated Savings	($189,000.00)	$1,271,000.00	$1,082,000.00

Description of Original Concept

The 30% design includes a 6-inch diameter waste forcemain to the sanitary sewer manhole at the elementary school down Skyliners Road. The waste forcemain is intended to carry filter backwash flow, membrane cleaning waste stream and sanitary sewage.

Description of Proposed Concept

The VE Team concept would significantly reduce the flow to the waste forcemain by:

1. Directing the filter backwash flow to settling ponds on-site and then return the settled water to the head of the treatment process, and
2. Collecting site sanitary waste in an on-site septic tank

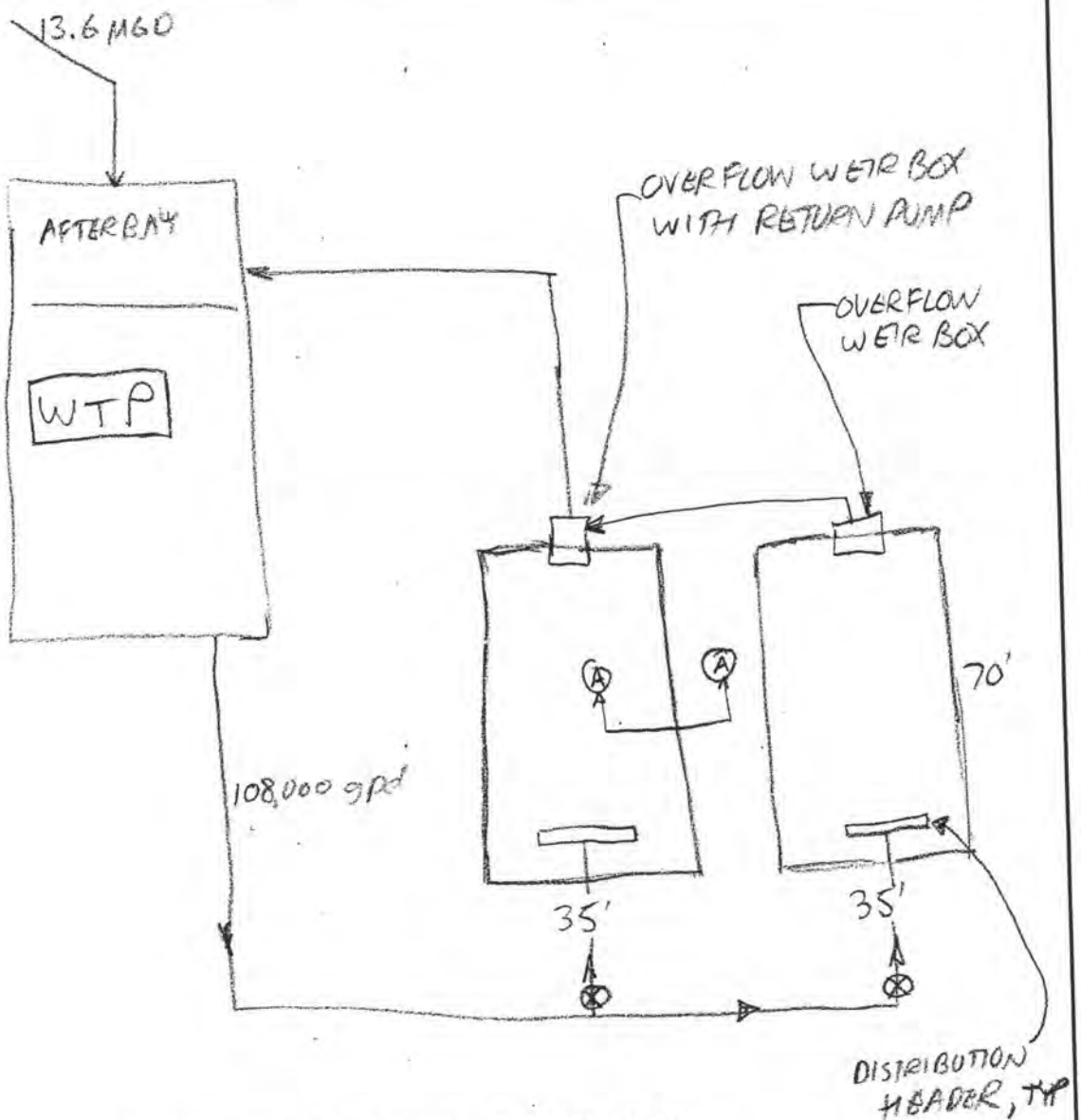
Advantages	Disadvantages
• Reduce discharge to the sewer by 108,200 gpd and save associated charges • Reduce the size of the waste forcemain and pump required to carry the remaining flow	• Periodic cleaning of solids from the settling ponds and septic tank • Land required for settling ponds

Discussion

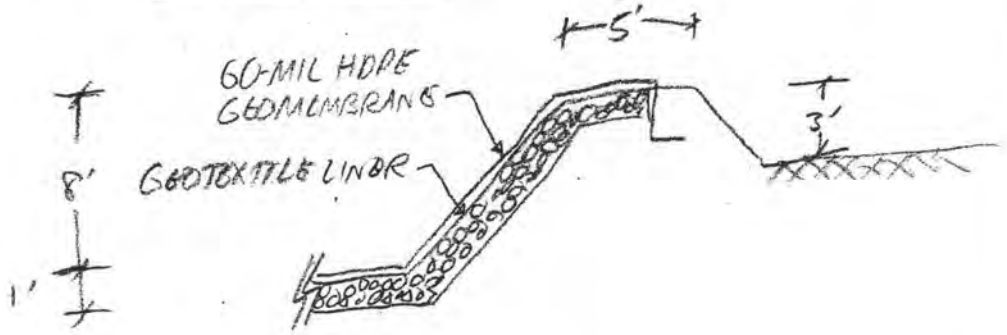
The proposed concept would construct two earthen ponds on the Outback site to receive the filter backwash flow from the membrane treatment plant. The ponds will be sized to each handle the plants full design capacity of filter backwash so that one can be taken off-line, drained, and the solids removed on an annual basis. Pond detention time would be 24 hours. The settling ponds will be 35' x 70' and 5 feet deep excavation with a 3-feet tall berm above finished grade, lined with a 60-mil HDPE geomembrane liner. Backwash decant would be conveyed to the ponds with a buried 3-inch main. Each pond will have a single access ramp, 8-inch distribution header and a 2-foot wide by 7-foot tall overflow weir gate outlet box. A pump would be used to return the settled backwash water to the afterbay at the head of the treatment plant with a 3-inch buried pipeline.

Estimated wastewater loading for this facility is 75 gpd. A septic tank and system would be installed to reduce loading on the waste forcemain by this amount. Another alternative not presented here would be compost toilets and a grey water distribution system.

Remaining flow in the waste forcemain would be due to periodic membrane cleaning operations with a peak of 30,000 gpd.

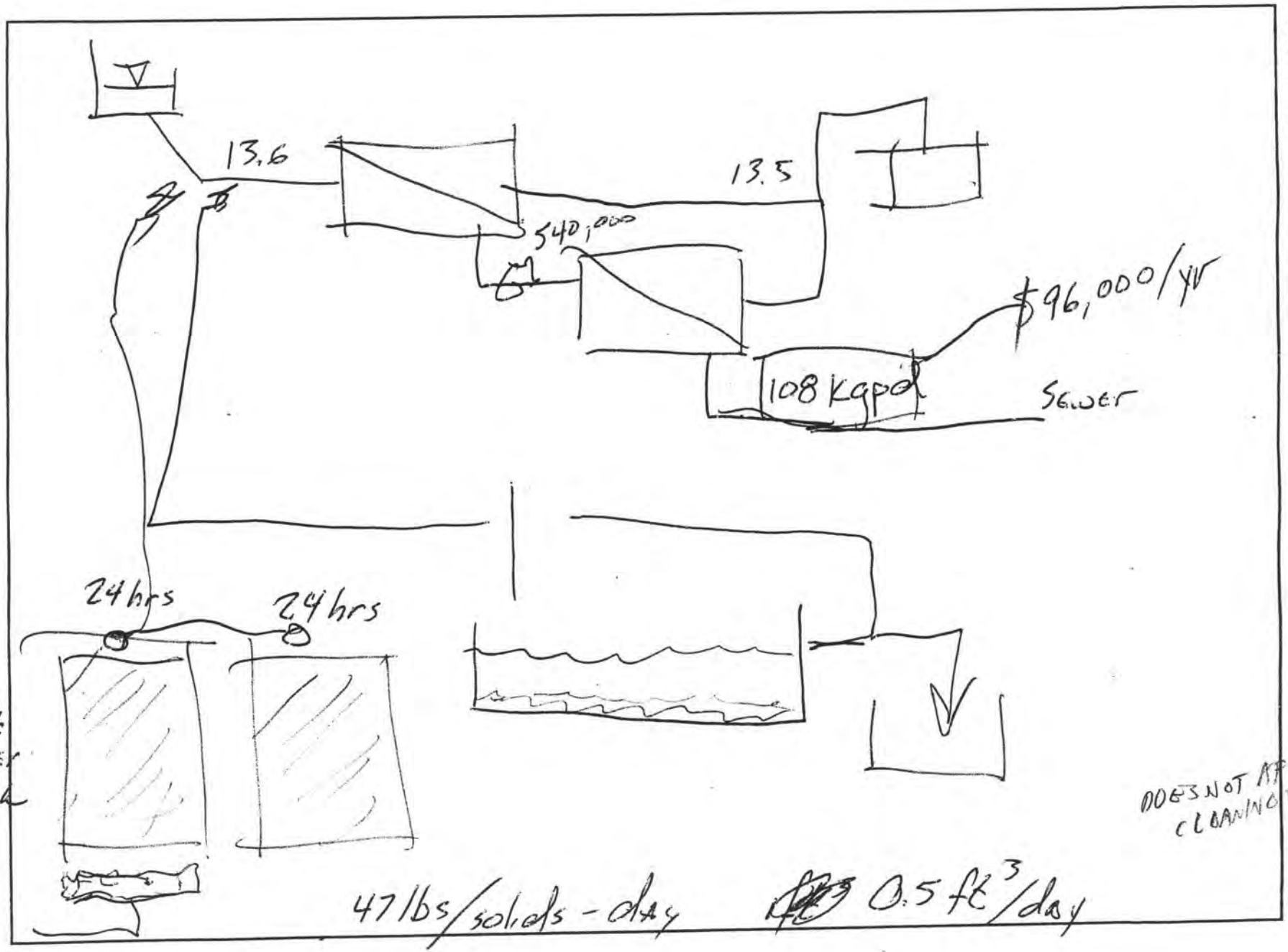


SCHEMATIC PLAN - BACKWASH SETTLING POND



SECTION - A-A

SKETCH



RSRI

Idea No. W-1

W-1

Bend WSP
VE Study
27-Jan-11

Flow			Detention Time		Required Volume		Desired Depth	Resulting a	Avg Width	Avg Length	Resulting A/R	
gpd	mgd	cfs	hours	second	cf	gallon	ft					
108000	0.108	0.1674	24	86400	14463.36	120624.4	6	2410.56	100	24.1056	0.241056	
108000	0.108	0.1674	24	86400	14463.36	120624.4	6	2410.56	24	100.44	4.185	
108000	0.108	0.1674	24	86400	14463.36	120624.4	6	2410.56	34	70.89882	2.08526	
108000	0.108	0.1674	24	86400	14463.36	120624.4	6	2410.56	34.5	69.8713	2.025255	
108000	0.108	0.1674	24	86400	14463.36	120624.4	6	2410.56	40	60.264	1.5066	
108000	0.108	0.1674	24	86400	14463.36	120624.4	6	2410.56	35	68.87314	1.967804	<-- choose
108000	0.108	0.1674	24	86400	14463.36	120624.4	6	2410.56	36	66.96	1.86	

Volume of excavation
area35 x 70 x depth less 2:1 slope under perimeter = 210 LF

Area (SF)	Depth	base volum	angled slop	net (cf)
2450	2	4900	-840	4060
2450	3	7350	-1890	5460
2450	4	9800	-3360	6440
2450	4.5	11025	-4252.5	6772.5
2450	5	12250	-5250	7000

Volume of Berm
cross-sectional area x rough perimeter length=210 LF

height	perimeter l	volume berm (cf)
2	210	3780
3	210	6930
2.5	210	5250
2	210	3780
2	210	3780

cf	CY
6930	257
7000	259
3675	136
3116	115

Over-excavation for select fill
3675 cf
Imported select fill
3116

Area of geomembrane
3854 sf
7708 x2 ponds
volume of concrete in weir box.
192 cf
7.111111 CY

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Construction Cost Estimate

Idea No: W-1

Item	Unit of Meas.	Unit Cost	Original Concept Quantity	Original Concept Total	Proposed Concept Quantity	Proposed Concept Total
6-inch PVC wastewater forcemain	LF	$ 70.00	10,300	$ 721,000		$ -
4-inch PVC wastewater forcemain	LF	$ 68.00		$ -	10,300	$ 700,400
3-inch PVC backwash and settled decant	LF	$ 66.00		$ -	500	$ 33,000
1-hp backwash and decant submersible pumps	Unit	$ 5,500.00		$ -	2	$ 11,000
8-inch PVC distribution header	LF	$ 50.00		$ -	40	$ 2,000
PVC fittings	LS	$ 400.00		$ -	1	$ 400
Pond excavation, Fill & Compact	CY	$ 7.79		$ -	800	$ 6,232
Select fill	CY	$ 33.00		$ -	230	$ 7,590
60-mil HDPE geomembrane liner	SF	$ 1.30		$ -	7,700	$ 10,010
Geotextile liner	SF	$ 0.50		$ -	7,700	$ 3,850
Overflow weir gate, 3' wide, 7' tall	Unit	$ 25,000.00		$ -	2	$ 50,000
Overflow weir box, concrete vault, 9'x4'x6', 12-inch thick walls	CY	$ 600.00		$ -	16	$ 9,600
				$ -		$ -
				$ -		$ -
Annual sewage fee	1,000 gal	$ 912.50	108	$ 98,550		$ -
				$ -		$ -
Annual pond cleaning, bobcat	man-hour			$ -	40	$ -
				$ -		$ -
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				$ -		$ -
Subtotal				$ 721,000		$ 834,082
Markup		67%		$ 483,070		$ 558,835
TOTALS				$ 1,204,070		$ 1,392,917
NET SAVINGS						$ (188,847)

O&M Cost Estimate Idea No. W-1

Item	Unit of Meas.	Unit Cost	Original Concept		Proposed Concept	
			Quantity	Total	Quantity	Total
ANNUAL COSTS						
Operations						
Labor						
Sewer Fees				98,550		-0-
Materials & Equipment						
Pond Cleaning	M-h	$125	-	-	40	5,000
Maintenance						
Labor						
Materials & Equipment						
Energy						
Gas						
Power						
Oil						
TOTAL ANNUAL COSTS			A =	98,550	B =	5,000

	PWF	A x PWF	B x PWF
PRESENT WORTH (Annual O&M)	13.59	1,339,295	67,950

REPLACEMENT COSTS	Year	Amount	Amount

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APPENDICES

PROJECT DESCRIPTION
APPENDIX A

PROJECT DESCRIPTION

The City of Bend currently operates a dual-source potable water system with both surface water and groundwater sources. Surface water is extracted from Bridge Creek in the National Forest at a location approximately 10 miles west of the Outback site. A major wellfield, chlorination facilities and significant system storage are currently located at the Outback site. The Bridge Creek water is piped to the Outback site through two existing pipelines, one of which was installed in the 1920s and the other in the 1950s. Both the surface and groundwater sources are currently chlorinated for disinfection, but receive no further treatment. Because surface water is currently less expensive to deliver due to lower energy consumption, surface water is generally used preferentially throughout the year. Surface water is used to meet base flows, and groundwater is generally used to meet peak shorter-term summer demands. The City's winter demands are currently in the range of 5 to 6 mgd and are currently projected to increase to 8.4 mgd by 2018. Maximum Day Demands (MDD, Summer) are currently in the range of 29.2 mgd and are anticipated to reach 47.3 mgd by 2018.

In 2009, Brown and Caldwell conducted a water supply alternatives study and recommended installation of a replacement pipeline, hydropower facility and a water filtration plant at the Outback site. Subsequently, HDR Engineering Inc. developed a design criteria report defining a preliminary design for these proposed facilities.

As defined in that design criteria report, the City of Bend will construct a new membrane filtration treatment plant at the Outback site to treat water from the existing Bridge Creek water Intake. The raw water will be transported to the new treatment plant through a new steel pipeline approximately 9.5 miles long, dropping 1,012 ft. in elevation. The pipeline will be sized for an ultimate capacity of 36 cfs (23.3 mgd). Also included is a conceptual design for an optional hydroelectric power plant at the Outback site. Fish screens and fish passage facilities at the existing Bridge Creek Intake have been assumed necessary if the hydropower facility is constructed. The Intake building has been assumed to be replaced with a building that meets current code requirements. The maximum flow during the first 10 years of operation is expected to be 21 cfs (13.6 mgd). The initial capacities of the WTP and the powerhouse are set at 13.6 mgd. The City's maximum instantaneous water right is 36 cfs (23.3 mgd). The design hydraulic capacities of the intake, pipeline, powerhouse and WTP, are set at 23.3 mgd.

INTAKE

If the City decides to install a hydropower facility, initial discussions with the Oregon Department of Fish and Wildlife (ODFW) have indicated that ODFW will require the addition of fish screens on the intake and fish passage provisions at the dam. Accordingly, HDR has proposed drum screens with both brush and water jet cleaning systems, conduit gates, and a concrete fish ladder. However, there are currently no indications of fish movement over the existing dam, nor any indications of the presence of endangered or threatened fish species at the dam/intake location. Also, a new Intake building is planned to house the additional support facilities for the screens and to comply with existing building codes.

PIPELINE

The proposed pipeline will be a 36 inch diameter, welded steel pipeline with interior and exterior epoxy coating.. The planned alignment is initially along U.S. Forest Service Road 4603 and then along Skyliners Road to the Outback site. Flow control is planned to occur downstream at the Outback site for maximum conservation of potential energy to drive the power plant turbine. The pipeline will be designed to service a single hydroelectric turbine and an energy-dissipating bypass valve. The pipeline will be designed to withstand the full static head of approximately 1000 feet.

HYDROPOWER FACILITY

The City has not yet made a final decision regarding the installation of power generation facilities at the Outback site, but has directed HDR to include a hydropower facility in the preliminary project design. The City will shortly decide whether to include the capability to install hydropower as a part of the project, to provide the capability for later hydropower installation, or to forego the hydropower option. The hydropower facility is designed to pass 21 cfs at a maximum gross head of 1,008 ft. and will use a single Pelton turbine for power generation. The plant is expected to generate approximately 1.4 megawatts (MW) of power, and will normally operate at approximately 908 ft of net head.

WATER FILTRATION PLANT

The new WTP will be designed to treat 13.6 mgd. A pretreatment system consisting of rapid mix basins with mixers, flocculation tanks and plate settler clarifiers will be installed to handle the significant changes in raw water quality from Bridge Creek in the event of a watershed wildfire. The pretreatment system will also support operation of the surface water supply during Bridge Creek turbidity events that now require shutdown of the supply. The concrete pretreatment basins will be constructed, but the flocculation mixers and sedimentation plates will not be installed until a wildfire occurs.

The two concrete rapid mix basins will be designed for a combined hydraulic retention time (HRT) of 30 seconds at 13.5 mgd. They will each be equipped with a 30 Hp mixer.

Flocculation will be accomplished in two 3-flocculation tank trains. Each train will have a HRT of 40 minutes at 7 mgd. The three stages in each train will be equipped with 3 Hp, 2 Hp, and 1 Hp horizontal paddle flocculators respectively.

Two plate-settler type concrete settling tanks will be constructed, each designed for 7 mgd at a design overflow rate of 0.29 gpm/sf.

The City has prequalified membrane suppliers and identified the following as acceptable membranes:

Kruger	Kruger Ceramic Membrane (KCM)	0.1 micron
Pall Corporation	Pall Aria AP-Series, Ashi membranes	0.1 micron
GE/Zenon	Model 500d	0.04 micron

The Kruger and Pall systems are pressure membranes. The GE/Zenon membranes are submerged membranes.

The membrane system support facilities and building have been initially designed to be capable of supporting any of the three membrane suppliers. The City will shortly solicit bids from the three suppliers, select one and then finalize the design based on a single membrane supplier.

Following the membrane system, space will be provided for the later addition of a granular activated carbon filtration system to deal with elevated total organic carbon (TOC) concentrations that may be present in the raw water following a wildfire in the watershed; however, no equipment will be installed at this time.

Liquid sodium hypochlorite will be used for disinfection. The existing water storage tanks at the Outback site will be used for contact time.

A liquid wastes pump station and 6-inch PVC pipeline will be constructed to transport process wastes and site sanitary wastes to the nearest city sewer, about two and a half miles away.

VE Process Description
Appendix B

VALUE ENGINEERING PROCESS DESCRIPTION

The value engineering (VE) study was conducted to review and evaluate the proposed project to identify areas of high initial and annual costs, and to suggest opportunities to reduce these costs while maintaining or improving performance. Alternatives are recommended to achieve these goals without jeopardizing the performance of the required project functions or the project's reliability.

PARTICIPANTS

The value engineering process included participation by many people from the Owner, the Designer(s), members of the VE Team, and others. The participants in the process are shown in Appendix C.

VE STUDY PROCESS

The VE study was organized into three major parts:

1. Pre-Workshop
2. Workshop
3. Post-Workshop

Part 2, the workshop, was further divided into a six-step process called the "job plan". This six-step job plan is consistent with the standards of SAVE International, which is the international value engineering professional organization; the ASTM standards for value engineering: and U.S federal government standards for value engineering.

PRE-WORKSHOP

Pre-workshop activities include scheduling, collecting background information on the project, and developing cost models. Most of the background information was generated by the Designer and reviewed by the VE Team prior to the study. Coordination with the Owner and Designer prior to the workshop enhanced the workshop's effectiveness by allowing members of the value engineering team to review available information on design concepts, cost data, design criteria, reports, and scheduling before the workshop began.

WORKSHOP

The VE workshop was an intensive multi-day session during which the project design was analyzed for optimization of capital costs and operation and maintenance (O&M) costs. The six-step VE job plan provides an organized and highly systematized approach during this portion of the study for identifying high cost areas of the project and confirming or improving the ability of the project to accomplish its functional objectives.

The functional requirements for the project were critically analyzed to assure performance. Portions of the project that were not functionally required or that contained major portions of project costs were targeted for value improvements.

The six phases of the job plan are:

- Information Phase

- Function Analysis Phase
- Creative Phase
- Judgment Phase
- Development Phase
- Presentation Phase.

A copy of the workshop agenda is included at the end of this appendix.

Information Phase

At the beginning of the workshop, it was important to understand the background against which the design was developed. This background was provided in an oral overview by the Owner and the project Designer team. The overview and subsequent efforts provided information on the following topics:

- Project constraints on the VE Team
- Economic data for life cycle cost analysis
- Project cost
- Functional requirements.

These presentations provided the VE Team with a description of the project, issues, and concerns from their perspective. The Owner's and the Designer's discussions provided the VE Team with an overview of the goals, issues, and expectations from their respective points of view. As a part of the Information Phase, modeling was done to help the VE Team focus on those parts of the project that generate the largest targets of opportunity for value improvement. These models are shown in Appendix F in this report.

Function Analysis Phase

During the Function Analysis Phase, the VE Team used function analysis tools to analyze the project. This analysis helped the team confirm its understanding of the overall project objectives and analyzed the functions of key project elements. The VE Team leader led the team through an in-depth discussion of the possible functions of the key project elements to clearly and precisely identify the purposes of each.

In addition to identifying the essential project functions, this phase of the workshop was also used for achieving two other goals:

- The unification of the individual VE Team members into a synergistic, cohesive team, and
- The stimulation of creative ideas prior to beginning the subsequent creative phase.

A detailed description of the function analysis process used for this VE study is shown in Appendix G of this report.

Creative Phase

This step in the VE process involved generating ideas using creativity techniques. The team recorded all ideas regardless of their feasibility. Judgment of the ideas was not allowed during the Creative Phase. The team looked for a large quantity of ideas. These ideas were later screened in the Judgment Phase of the workshop. The ideas generated in the workshop are included in Appendix H of this report. The list should be reviewed carefully for

ideas not developed during the workshop that could be further evaluated or modified by the design team for use in the project.

Judgment Phase

In this phase of the workshop, the team selected the ideas with the most merit for further development. After an initial vote, the ideas were discussed to reassess whether all those selected by the vote should be developed, and whether any not selected for development should be reconsidered. The following criteria were used for selection:

- Is it a good idea in the opinion of the VE Team?
- How much value improvement does it offer?
- Is it likely to be accepted?

Ideas were selected for development as VE recommendations based on all three criteria. Other ideas were selected for development as design suggestions primarily on the basis of the first two criteria rather than for cost savings. Some design suggestions may save costs, others may increase costs, and the cost impact of some could not be predicted adequately with information and time available to the team. Not all ideas were developed. Generally, those ideas with a greater number of votes were developed first.

Mid-Workshop Review

Following the Judgment Phase, key Owner and Designer representatives reviewed the list of ideas selected for development to identify any selected ideas that either:

- had fatal flaws, and thus are not viable;
- were not selected for development by the VE Team, but the Owner or Designer would like for them to be developed into VE recommendations.

Adjustments were then made to the list of ideas to be developed by the VE Team to reflect these changes.

Development Phase

During the Development Phase of the workshop, each selected idea was analyzed by one or more VE Team members to determine whether the recommendation was viable. Concepts were dropped from consideration when they were found to be either infeasible or not cost effective. The remaining ideas were each expanded into workable alternatives to the original design concepts. Development consisted of preparing a description of the VE recommendation, determining life cycle cost, and evaluating advantages and disadvantages. Some concepts were combined with other ideas when they will be most useful if considered together. The basis for estimating the cost impacts of the VE recommendations are shown in Appendix E.

Each recommendation includes a brief narrative comparing the original design and the proposed change. Sketches and design calculations were developed if needed to clarify and support the recommendation. The VE Team leader, other team members and Owner personnel reviewed each recommendation to ensure completeness and accuracy. The VE recommendations developed during the workshop are presented in Section 2 of this report.

Presentation Phase

The last phase of this workshop was the presentation of recommendations. The presentation was made on the last day of the VE workshop to representatives of the Owner and the project design consultants. The VE Team described the recommendations and the rationale that went into the development. The acceptability of the recommendations was not debated at this time.

POST-WORKSHOP

The Post-Workshop Phase of this VE study consisted of preparing the Value Engineering Study Reports and coordinating with the Owner and the project Designers to help make decisions regarding the acceptance of the VE recommendations.

Bend Surfacewater Improvement Project
VE Workshop Agenda
January 24-28, 2011

Monday

7:00 – 7:30	Introduction
	Participant Introduction
	Review of Agenda
	Workshop Guidelines
7:30 – 8:00	Owner/Client Presentation
	Project Goals & Purpose
	Key Project Issues For VE Team
	Constraints on VE Team Recommendations
8:00 – 12:00	Designer Presentation
	Overview
	Basis of Design
	Rationale for Design Choices
	Description of Project Elements
12:00 – 1:00	Lunch Break
1:00 – 3:00	Site Visit
3:00 – 4:00	Team Review of Documents
4:00 – 5:00	Project Analysis/Function Analysis

Tuesday

7:00 – 9:30	Project Analysis/Function Analysis (Cont.)
9:30 – 12:00	Creative Idea Generation
12:00 – 1:00	Lunch Break
1:00 – 4:00	Creative Idea Generation (Cont.)
4:00 – 5:00	Evaluation of Ideas

Wednesday

7:00 – 8:00	Evaluation of Ideas (Cont.)
8:00 – 11:00	Begin VE Recommendation Development
11:00 – 12:00	Owner/Client/Designer Review of Ideas Selected for Development With Team Leader
12:00 – 1:00	Lunch Break
1:00 – 5:00	VE Recommendation Development (Cont.)

Thursday

7:00 – 11:00	VE Recommendation Development (Cont.)
11:00 – 12:00	Lunch Break
12:00 – 5:00	VE Recommendation Development (Cont.)

Friday

8:00 – 9:00	Prepare for VE Team Presentation
9:00 – 12:00	VE Team Presentation of VE Recommendations

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City of Bend
Surface Water Improvement Project

VE Presentation
January 24, 2011
AGENDA

DATE/TIME HELD: **January 24, 2011, 7:00 a.m. – noon**

LOCATION: **City of Bend Boyd Acres Training Room**
Live Meet

VE Consultant: **RSRI (Robinson, Stafford and Rude, Inc.)**

TIME	AGENDA ITEM	LEAD
7:00 – 7:30	**Introduction** • Participant Introduction • Review of Agenda • Workshop Guidelines	RSRI
7:30 – 8:00	**Owner/Client Presentation** • Project goals & Purpose • Key Project Issues for VE Team • Constraints on VE Team Recommendations	Heidi Lansdowne
8:00 – 8:20	**Designer Presentation** • Overview • Basis of Design • Rationale for Design Choices • Description of Project Elements (Power Point Presentation follows)	Bryan Black
8:20 – 8:40	**Environmental** • Presentation • Comments / questions / answers	Susan Haupt
8:40 – 9:10	**Intake / Fish Screens / Fishway** • Presentation • Comments / questions / answers	John Nelson
9:10 – 9:40	**Water Transmission Conduit** • Presentation • Comments / questions / answers	Ben Jacob
9:40 – 9:50	**Break**	
9:50 – 10:10	**Outback Site Plan** • Presentation • Comments / questions / answers	Shawn Kuhns
10:10 – 10:40	**Powerhouse** • Presentation • Comments / questions / answers	Leanne Greisen

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City of Bend
Surface Water Improvement Project

VE Presentation
January 24, 2011
AGENDA

10:40 – 11:10	**Water Filtration Facility** • Presentation • Comments / questions / answers	Karen Bill
11:10 – 11:40	**Electrical, Instrumentation & Controls** • Presentation • Comments / questions / answers	Don Best
11:40 – 12:00	Additional question and answer opportunity.	

PARTICIPANTS
APPENDIX C

ATTENDEES

Project Surfacewater Improvement Project Bend OR

Date 24TH Jan-11

INITIALS	NAME/TITLE	ORGANIZATION	MAILING ADDRESS	PHONE/FAX NO.	EMAIL ADDRESS
TD	Deas, Tabi Assistant VE Team Leader	Robinson, Stafford & Rude, Inc	5021 Tangerine Ave S Gulfport, FL 33707	727-328-2921 727-328-2914	tabi@rsri.net
	Oeth, Larry Structural	Lorden Engineering	2600 FinFeather Road Bryan, TX 77801	503-522-8941 Fax	loeth@lordeng.net
	Roppo, Phil Pipeline Specialist	Brown & Caldwell	6500 SW Macadam Ave Suite 200 Portland, OR 97239	503-244-7005 Fax	proppo@brwncald.com
DRS	Stafford, Don VE Team Leader	Robinson, Stafford & Rude, Inc	5021 Tangerine Ave S Gulfport, FL 33707	727-328-2921 727-328-2914	don@rsri.net
PVD	Van Duser, Pat Hydropower Specialist	Black & Veatch	5885 Meadows Road Suite 700 Lake Oswego, OR 97035	503-443-4417 Fax	vanduserpm@bv.com
	Van Kirk, Dennis Cost Estimating	VK Tech Services	10013 NE Hazel Dell Ave # 197 Vancouver, WA 98685-5203	360-574-0736 Fax	dvk@vktechservices.com
	Vickers, Jim WTP Specialist	Separation Processes Inc.	3156 Lionshead Ave Suite 2 Carlsbad, CA 92010	760-400-3660 760-400-3661	jvickers@spi-engineering.com
BB	Bryan Black PM	~~Brg~~ HDR	920 NW Bond St Bend OR 97701	503 490-2041	bryan.black@hdrinc.com
DCP	DAVID PAUL ASSISTANT TO P.M.	CIVILWORKS ENGINEERING GROUP, LLC	20380 N.W. HALFWAY RD. BEND, OR 97701	541 728-7092	dcpaul@bendcable.com
AE	ART EASTON WATER OPERATIONS	City of Bend	62975 NE Boyd Acres Rd. Bend Oregon 97701	541-693-2190	aeaston@ci.bend.or.us
HL	Heidi Lansdowne Project Manager	City of Bend	Same as AE Same as AE	541-388-5538 541-280-4590(c)	hlansdowne@ci.bend.or.u
RCO	RYAN OSTER CITY UTILITY ENGINEER	City of Bend	Same as above	541-693-2134	roster@ci.bend.or.us

ATTENDEES

Project Surfacewater Improvement Project Bend OR

Date 24-Jan-11

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	Susan Haupt	HDR	920 NW BOND ST. BEND, OR 97701	541-633-8021 541-323-2331	Susan.Haupt@hdrinc.com

ATTENDEES

Project Surfacewater Improvement Project Bend OR

Date Wednesday, January 26, 2011

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TD	Deas, Tabi Assistant VE Team Leader	Robinson, Stafford & Rude, Inc	5021 Tangerine Ave S Gulfport, FL 33707	727-328-2921 727-328-2914	tabi@rsri.net
	Oeth, Larry Structural	Lorden Engineering	2600 FinFeather Road Bryan, TX 77801	503-522-8941 Fax	loeth@lordeng.net
	Roppo, Phil Pipeline Specialist	Brown & Caldwell	6500 SW Macadam Ave Suite 200 Portland, OR 97239	503-244-7005 Fax	proppo@brwncald.com
	Stafford, Don VE Team Leader	Robinson, Stafford & Rude, Inc	5021 Tangerine Ave S Gulfport, FL 33707	727-328-2921 727-328-2914	don@rsri.net
PVD	Van Duser, Pat Hydropower Specialist	Black & Veatch	5885 Meadows Road Suite 700 Lake Oswego, OR 97035	503-443-4417 Fax	vanduserpm@bv.com
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JCV	Vickers, Jim WTP Specialist	Separation Processes Inc.	3156 Lionshead Ave Suite 2 Carlsbad, CA 92010	760-400-3660 760-400-3661	jvickers@spi-engineering.com
HL	Lansdowne, Heidi Project Manager	City of Bend	62975 NE Boyd Acres Road Bend, OR 97701	541-388-5538 541-280-4590 cell	hlansdowne@ci.bend.or.us
AE	Easton, Art Water Operations	City of Bend	62975 NE Boyd Acres Road Bend, OR 97701	541-693-2180	aeaston@ci.bend.or.us
BB	Black, Bryan Project Manager	HDR	920 NW Bond St Bend, OR 97701	503-490-2041	bryan.black@hdrinc.com
	Haupt, Susan	HDR	920 NW Bond St Bend, OR 97701	541-633-8021 541-323-2331	susan.haupt@hdrinc.com
	Jacob, Ben Water Project Manager	HDR	1001 SW 5th Ave, Suite 1800 Portland, OR 97204	503-423-3871 503-804-3456 cell	ben.jacob@hdrinc.com
	Prull, David Asst. to Project Manager	Clearwater Engineering Group, Inc.	20380 NW Halfway Road Bend, OR 97701	541-728-7092	dcprull@gmail.com
RCO	Oster, Ryan City Utility Engineer	City of Bend	62975 NE Boyd Acres Road Bend, OR 97701	541-693-2134	roster@ci.bend.or.us
✓ Mid Week Review	Hickmann, Tom Asst. Director, City Engineer	City of Bend		541-317-3029	thickmann@ci.bend.or.us

ATTENDEES

Project Surfacewater Improvement Project Bend OR

Date Friday, January 28, 2011

INITIALS	NAME/TITLE	ORGANIZATION	MAILING ADDRESS	PHONE/FAX NO.	EMAIL ADDRESS
	Deas, Tabi Assistant VE Team Leader	Robinson, Stafford & Rude, Inc	5021 Tangerine Ave S Gulfport, FL 33707	727-328-2921 727-328-2914	tabi@rsri.net
	Oeth, Larry Structural	Lorden Engineering	2600 FinFeather Road Bryan, TX 77801	503-522-8941 Fax	loeth@lordeng.net
	Roppo, Phil Pipeline Specialist	Brown & Caldwell	6500 SW Macadam Ave Suite 200 Portland, OR 97239	503-244-7005 Fax	proppo@brwncald.com
	Stafford, Don VE Team Leader	Robinson, Stafford & Rude, Inc	5021 Tangerine Ave S Gulfport, FL 33707	727-328-2921 727-328-2914	don@rsri.net
	Van Duser, Pat Hydropower Specialist	Black & Veatch	5885 Meadows Road Suite 700 Lake Oswego, OR 97035	503-443-4417 Fax	vanduserpm@bv.com
	Van Kirk, Dennis Cost Estimating	VK Tech Services	10013 NE Hazel Dell Ave # 197 Vancouver, WA 98685-5203	360-574-0736 Fax	dvk@vktechservices.com
	Vickers, Jim WTP Specialist	Separation Processes Inc.	3156 Lionshead Ave Suite 2 Carlsbad, CA 92010	760-400-3660 760-400-3661	jvickers@spi-engineering.com
	Lansdowne, Heidi Project Manager	City of Bend	62975 NE Boyd Acres Road Bend, OR 97701	541-388-5538 541-280-4590 cell	hlansdowne@ci.bend.or.us
	Easton, Art Water Operations	City of Bend	62975 NE Boyd Acres Road Bend, OR 97701	541-693-2180	aeaston@ci.bend.or.us
	Black, Bryan Project Manager	HDR	920 NW Bond St Bend, OR 97701	503-490-2041	bryan.black@hdrinc.com
	Haupt, Susan	HDR	920 NW Bond St Bend, OR 97701	541-633-8021 541-323-2331	susan.haupt@hdrinc.com
	Jacob, Ben Water Project Manager	HDR	1001 SW 5th Ave, Suite 1800 Portland, OR 97204	503-423-3871 503-804-3456 cell	ben.jacob@hdrinc.com
	Prull, David Asst. to Project Manager	Clearwater Engineering Group, Inc.	20380 NW Halfway Road Bend, OR 97701	541-728-7092	dcprull@gmail.com
RCO	Oster, Ryan City Utility Engineer	City of Bend	62975 NE Boyd Acres Road Bend, OR 97701	541-693-2134	roster@ci.bend.or.us
	Hickmann, Tom Asst. Director / City Engineer	City of Bend	Bend, OR 97701	541-371-3029	thickmann@ci.bend.or.us
	Rick Mingus Water OPS	City of Bend	Bend OR 97701	(541)410-2366	
S.G.	Scott Gardner Water OPS	City of Bend	Bend, OR 97701	(541)280-0942	

ATTENDEES

Project Surfacewater Improvement Project Bend OR

Date Friday, January 28, 2011

INITIALS	NAME/TITLE	ORGANIZATION	MAILING ADDRESS	PHONE/FAX NO.	EMAIL ADDRESS
PG	PATRICK GRIFFITHS	City of Bend			pgriffiths@ci.bend.or.us
MCB	Chris Brady	City of Bend			
PR	Paul Rheault	city of Bend			

VE TEAM MEMBER INFORMATION
APPENDIX D

VE Team Member Information

City of Bend Surfacewater Improvement Project

1/24/2011-1/28/2011

Deas, Tabi Robinson, Stafford & Rude, Inc. 5021 Tangerine Ave. So. Gulfport, FL 33707	Assistant VE Team Leader	727-328-2921	727-328-2914	tabi@rsri.net
Oeth, Larry Lorden Engineering 2600 Finfeather Road Bryan, TX 77801	Structural	503-522-8941		loeth@lordeng.net
Roppo, Phil Brown and Caldwell 6500 SW Macadam Ave, Ste 200 Portland, OR 97239	Pipeline Specialist	503-244-7005		proppo@brwncald.com
Stafford, Don Robinson, Stafford & Rude, Inc. 5021 Tangerine Avenue South Gulfport, Florida 33707	VE Team Leader	727-328-2921	727-328-2914	don@rsri.net
Van Duser, Pat Black & Veatch 5885 Meadows Rd., Ste. 700 Lake Oswego, OR 97035	Hydropower Specialist	503-443-4417		vanduserpm@bv.com
Van Kirk , Dennis VK Tech Services 10013 NE Hazel Dell Ave. #197 Vancouver, WA 98685-5203	Cost Estimating	360-574-0736		dvk@vktechservices.com
Vickers, Jim Separation Processes Inc. 3156 Lionshead Ave., Suite 2 Carlsbad, CA 92010	WTP Specialist	760-400-3660	760-400-3661	jvickers@spi-engineering.com

BASIS OF COSTING
APPENDIX E

BASIS OF COSTING

The VE team leader and cost estimator reviewed the capital cost estimate provided to the VE Team to determine the reasonableness of the project budget, and to ensure a common basis for cost comparisons of VE recommendations with the original design.

Review of the costs included comparison of unit prices to recently received prices for similar projects and to published unit price indices. Unit prices for unique project elements were compared to prices based on applicable crew compositions and production rates, where appropriate. Vendor quotations were obtained for unique and/or major equipment and compared to those in the design cost estimate. Adjustments were made to the estimate provided to the VE Team, where appropriate, to bring unit prices and quantities into conformance with the design documents and presentation information provided to the VE Team. The VE Team then used this "validated" estimate as the basis for all capital cost comparisons in the VE recommendations.

The VE Team comments based on this review are as follows:

QUANTITIES AND UNIT PRICES:

For purposes of estimating this complex project, it was broken into seven elements. The Raw Water Conduit; Treatment Plant; Hydropower Plant; Fiber Optic Link; Intake; Waste Force Main; and Emergency Discharge. In general, the estimate supports the level of detail shown in the drawings and specifications. Development and extension of unit costs in line items is complete and accurate within the context of the accuracy ranges shown in the Basis of Estimate dated November 2, 2010.

MARKUPS:

These are generally percentage items that are applied to the total Direct Cost (Materials, Labor, Equipment and subcontractor costs in order to complete the estimate. In this project estimate, they are identified as Contractor's Field Overhead and Mobilization; Sales tax (Not applicable in Oregon); Contractor's Bonds and Insurance; Undefined SOW (Contingency); Contractor's Fee (Profit), Escalation, and CMGC Fee. In this estimate, some of the above markups have been consistently applied to all seven elements, while others are variable, and yet others were left out. While this is acceptable practice, this reviewer differs in opinion as to the percentages applied to some of the elements, based on experience with similar projects.

- **Contractor Field Overhead and Mobilization:** Commonly referred to as General Conditions, , i.e. Divisions 00 and 01 of the specifications, including Contractor General Supervision, Field Overheads, Testing, Start-up and Commissioning and any constraints the client may require of the contractor. The percentage applied ranges from 5% to 10%. This item was omitted from the Waste Force Main; and Emergency Discharge. On smaller projects, the impact tends to be higher, so this reviewer recommends 10% be applied to those that were omitted.

- **Contractor's Bonds and Insurance:** The 1.5% used in the estimate is accurate for a project this size, however, it was not included in the estimates for the Hydro Power Plant, Waste Force Main, and Emergency Discharge.

- **Undefined SOW (Contingency):** Intended to cover the cost of unknown items within the scope of the design and risk associated with the overall project, the contingency percentage generally ranges from 15% to 30%. In this estimate, it ranges from 10% to 30%. At this level of design, given the high potential for unknowns, this reviewer is of the opinion that 15% should be the minimum, with a maximum of 30%,

recognizing that as the design matures and most unknown issues will be resolved, the contingencies will shrink to around 5% by the end of design.

- **Contractor's Fee (Profit):** In the estimate, the Contractor's Fee ranges from 6% to 10%. It has been omitted from the Hydro Power Plant, Waste Force Main, and Emergency Discharge. 6% is recommended for those missing items.

- **Escalation:** The percentage used for escalation varies from 4.7% to 5.62%. Escalation was not included in the estimates for the Hydro Power Plant, Waste Force Main, or Emergency Discharge. Since no durations were given in the estimate and no mid-points of construction identified, it is not possible to differ with the percentages applied. Once the mid-point is established for each element, we recommend that 1.5% compounded annually from the date of the estimate to mid-point of construction be used to calculate the escalation percentage. This is in keeping with current market conditions, and with other current projects.

- **CMGC Fee:** Intended to compensate the Contractor for his overall Construction Management role during design, advertising, bidding and executing the project, this fee can range from 3 or 4% to over 20% depending upon the specific arrangements negotiated with the owner. Since these negotiations were not complete at the time of the estimate, 7% was applied to The Raw Water Conduit, Fiber Optic Link; and Intake. This fee was omitted from all other elements of the project. Since the entire project will be within the purview of the CMGC, this percentage should be uniformly applied to all elements until negotiations are complete.

SPECIFIC ADJUSTMENTS MADE FOR VE COMPARISONS:

No changes are recommended to the unit prices for either the project budget or the VE recommendation comparisons.

Changes are recommended to the markups, however. These recommendations are shown in table E-1.

Life cycle cost comparisons were prepared for all of the VE recommendations that are expected to affect either annual costs of operation and maintenance or which have equipment replacement cycles that would require equipment replacement for either the existing design concept of the VE concept within the economic analysis period selected for the project. The basis for the life cycle costing analysis is shown in Table E-2. All costs are presented in year 2014 dollars.

Table E-1
Markup Summary

HDR ESTIMATE: INDIRECT COST MODEL

	Raw Water Conduit		Treatment Plant		Hydropower Plant		Fiberoptic Link		Intake		Waste Forcemain		Emergency Discharge		TOTAL
	COST	%	COST	%	COST	%	COST	%	COST	%	COST	%	COST	%	
DIRECT COST	$ 16,880,327		$ 13,525,166		$ 4,193,000		$ 1,028,000		$ 936,357		$ 785,276		$ 727,770		$ 38,075,896
FIELD OHD & MOB	$ 1,012,820	6.0%	$ 1,352,517	10.0%	$ 209,650	5.0%	$ 61,680	6.0%	$ 56,181	6.0%	$ 78,528	10.0%	$ 72,777	10.0%	
SUBTOTAL	$ 17,893,147		$ 14,877,683		$ 4,402,650		$ 1,089,680		$ 992,538		$ 863,804		$ 800,547		
CONTRACTOR'S FEE	$ 1,073,589	6.0%	$ 1,487,768	10.0%	$ -	0.0%	$ 65,381	6.0%	$ 59,552	6.0%	$ -	0.0%	$ -	0.0%	
SUBTOTAL	$ 18,966,735		$ 16,365,451		$ 4,402,650		$ 1,155,061		$ 1,052,091		$ 863,804		$ 800,547		
BONDS/INS	$ 284,501	1.5%	$ 245,482	1.5%	$ -	0.0%	$ 17,326	1.5%	$ 21,042	2.0%	$ -	0.0%	$ -	0.0%	
SUBTOTAL	$ 19,251,236		$ 16,610,933		$ 4,402,650		$ 1,172,387		$ 1,073,133		$ 863,804		$ 800,547		
CONTINGENCY	$ 1,925,124	10.0%	$ 4,152,733	25.0%	$ 1,320,795	30.0%	$ 175,858	15.0%	$ 268,283	25.0%	$ 259,141	30.0%	$ 240,164	30.0%	
SUBTOTAL	$ 21,176,360		$ 20,763,666		$ 5,723,445		$ 1,348,245		$ 1,341,416		$ 1,122,945		$ 1,040,711		
ESCALATION	$ 995,289	4.7%	$ 1,166,918	5.62%	$ -	0.0%	$ 63,368	4.7%	$ 63,047	4.7%	$ -	0.0%	$ -	0.0%	
SUBTOTAL	$ 22,171,649		$ 21,930,584		$ 5,723,445		$ 1,411,612		$ 1,404,462		$ 1,122,945		$ 1,040,711		
CMGC FEE	$ 1,552,015	7.0%	$ -	0.0%	$ -	0.0%	$ 98,813	7.0%	$ 98,312	7.0%	$ -	0.0%	$ -	0.0%	
TOTAL OPCC EST	$ 23,723,664		$ 21,930,584		$ 5,723,445		$ 1,510,425		$ 1,502,775		$ 1,122,945		$ 1,040,711		$ 56,554,549
MULTIPLIER	**1.41**		**1.62**		**1.37**		**1.47**		**1.60**		**1.43**		**1.43**		**1.49**

VE TEAM INDIRECT COST MODEL

	Raw Water Conduit		Treatment Plant		Hydropower Plant		Fiberoptic Link		Intake		Waste Forcemain		Emergency Discharge		TOTAL
	COST	%	COST	%	COST	%	COST	%	COST	%	COST	%	COST	%	
DIRECT COST	$ 16,880,327		$ 13,525,166		$ 4,193,000		$ 1,028,000		$ 936,357		$ 785,276		$ 727,770		$ 38,075,896
FIELD OHD & MOB	$ 1,012,820	6.0%	$ 1,352,517	10.0%	$ 209,650	5.0%	$ 61,680	6.0%	$ 56,181	6.0%	$ 78,528	10.0%	$ 72,777	10.0%	
SUBTOTAL	$ 17,893,147		$ 14,877,683		$ 4,402,650		$ 1,089,680		$ 992,538		$ 863,804		$ 800,547		
CONTRACTOR'S FEE	$ 1,073,589	6.0%	$ 1,487,768	10.0%	$ 264,159	6.0%	$ 65,381	6.0%	$ 59,552	6.0%	$ 51,828	6.0%	$ 48,033	6.0%	
SUBTOTAL	$ 18,966,735		$ 16,365,451		$ 4,666,809		$ 1,155,061		$ 1,052,091		$ 915,632		$ 848,580		
BONDS/INS	$ 284,501	1.5%	$ 245,482	1.5%	$ 70,002	1.5%	$ 17,326	1.5%	$ 21,042	2.0%	$ 13,734	1.5%	$ 12,729	1.5%	
SUBTOTAL	$ 19,251,236		$ 16,610,933		$ 4,736,811		$ 1,172,387		$ 1,073,133		$ 929,366		$ 861,309		
CONTINGENCY	$ 2,887,685	15.0%	$ 4,152,733	25.0%	$ 1,421,043	30.0%	$ 175,858	15.0%	$ 268,283	25.0%	$ 278,810	30.0%	$ 258,393	30.0%	
SUBTOTAL	$ 22,138,922		$ 20,763,666		$ 6,157,854		$ 1,348,245		$ 1,341,416		$ 1,208,176		$ 1,119,701		
ESCALATION	$ 1,040,529	4.7%	$ 1,166,918	5.62%	$ 92,368	1.5%	$ 63,368	4.7%	$ 63,047	4.7%	$ 18,123	1.5%	$ 16,796	1.5%	
SUBTOTAL	$ 23,179,451		$ 21,930,584		$ 6,250,222		$ 1,411,612		$ 1,404,462		$ 1,226,299		$ 1,136,497		
CMGC FEE	$ 1,622,562	7.0%	$ 1,535,141	7.0%	$ 437,516	7.0%	$ 98,813	7.0%	$ 98,312	7.0%	$ 85,841	7.0%	$ 79,555	7.0%	
TOTAL OPCC EST	**$ 24,802,013**		**$ 23,465,725**		**$ 6,687,738**		**$ 1,510,425**		**$ 1,502,775**		**$ 1,312,140**		**$ 1,216,051**		**$ 60,496,866**
MULTIPLIER	**1.47**		**1.73**		**1.59**		**1.47**		**1.60**		**1.67**		**1.67**		**1.59**

TABLE E-2 COST COMPARISON ASSUMPTIONS	
Year of Analysis	2014
Analysis Period	20 years
Net Discount Rate (general)	4% per year
Net Discount Rate (power)	2% per year
Uniform Series Present Worth Factor (general)	13.59
Uniform Series Present Worth Factor (power)	16.35
Single-Payment Present Worth Factor	
5-Year	0.8219
6-Year	0.7903
7-Year	0.7599
10-Year	0.6756
13-Year	0.6006
15-Year	0.5553
Energy	
Electricity	$0.06 / KWH
Propane	$2.50/gal
Fuel (diesel)	$3.00 /gal
Chemicals	
Sodium Hypochlorite (12.5%)	$1.35/gal
Sodium Hydroxide (25%)	$0.25/lb
Citric Acid (50%)	$1.20/lb
Calcium Thiosulfate (30%)	$0.36/lb
Aluminum Chlorhydrate	$0.48/lb
Labor	$31.00/hour
Generalized O&M	
Structures	0.5% of capital cost per year
Mechanical/Electrical Equipment	4% of capital cost per year
Building operations & maintenance	$1.50/square foot/year

MODELING ANALYSIS
APPENDIX F

MODELING ANALYSIS

To assist the VE Team in better understanding the project and the distribution of resources within the project, the VE Team prepared seven models of project resources for the project. All of the resource models were based on the information provided by the designer.

- Table F-1 is a summary capital cost model
- Table F-2 is a detailed capital cost model
- Table F-3 is an energy cost model
- Table F-4 is a labor hours model
- Table F-5 is a labor cost model
- Table F-6 is a maintenance cost model
- Table F-7 is a life cycle cost model based on the previous cost models and the economic data shown in Table E-2

The cost models were used by the team for the following purposes:

- to identify parts of the project with the greatest costs;
- to estimate the greatest differences between cost and worth;
- to aid in focusing the efforts of the team during the study.

A review of the cost models prepared for this project indicated:

- More than 40% of the cost of the project will be expended for the new transmission main
- Two thirds of the total construction cost will be spent for the following four elements:
  - Piping (28%)
  - Process Equipment (23%)
  - Miscellaneous electrical construction (9%)
  - Imported soil and rock (5%)
- The highest cost components from a life cycle cost perspective are:
  - Process equipment (44%)
  - Piping (18%)
  - Miscellaneous electrical (7%)

- Pumps (4%)

Those cost elements of the project with large percentages of the project cost, either on a capital or life cycle cost basis were particular focus areas for VE team attention.

FUNCTION ANALYSIS
APPENDIX G

FUNCTION ANALYSIS

Function Determination

Defining functional requirements for the project allowed the Owner to be sure that the facility, as designed, would fulfill needed purposes. The entire project was analyzed to determine what functions are being accomplished by the current design. These functions were then evaluated to determine which were essential to project success (basic functions) and which were not (secondary). Some functions were identified as not necessary for achievement of project functions, but, nonetheless required because of requirements to implement the project (required secondary). Secondary functions became significant focus areas for VE team attention.

Function analysis was used as a tool to help the team to think in terms of specific project functions and their costs. It provided a function-based structure for a comprehensive analysis of the project design. This analysis was the catalyst for the idea generation that resulted in the ideas that are presented later in this report as recommendations for cost savings.

The function analysis worksheets are included at the end of this appendix.

TABLE G-1
FUNCTION ANALYSIS

Surfacewater Improvement Project — **Bend, OR**

	FUNCTION				
COMPONENT	**VERB**	**NOUN**	**KIND**	**COST**	**WORTH**
Entire Project	Meet	LT2			
	Assure	Needed Surfacewater Supply			
Raw Water Conduit	Convert	Energy	S		
	Relocate	Energy	S		
	Maintain	Water Quality	S		
	Assure	Water Supply	B		
	Improve	Maintenance Access	S		
	Convey	Needed Surfacewater	B		
Treatment Plant	Meet	LT2	B		
	Reduce	Turbidity	RS		
	Provide	Fire Insurance	B		
Hydropower Plant	Generate	Revenue	S		
	Dissipate	Energy	RS		
FiberOptic Link	Increase	Bandwidth	S		
Intake Modifications	Allow	Hydropower	S		
	Enclose	New Equipment	S		
	Reduce	Earthquake Risks	B?		
	Reduce	Wildfire Risks	B		
Waste Forcemain	Transport	Process Waste	RS		
	Transport	Sanitary Waste	S		
Emergency Discharge	Control	Erosion	S		

B – Basic Function; S – Secondary Function; RS – Required Secondary Function

CREATIVE IDEA LIST
APPENDIX H

TABLE H-1 CREATIVE IDEAS & EVALUATIONS		
SURFACEWATER IMPROVEMENT PROJECT	BEND, OR	
Idea No.	**Description**	**Votes**
	Raw Water Conduit (C)	
C-1	Size for 21 CFS	3
C-2	Size for energy dissipation	1
C-3	Use HDPE pipe all the way	1
C-4	Minimize restrained joint construction	2
C-5	Utilize existing alignment	4
C-6	Replace 1928 pipe only	4
C-7	Replace bridge with buried crossing	1
C-8	Span pipe without bridges	4
C-9	Reuse on-site materials for backfill	5
C-10	Explore PVC pipe	0
C-11	Explore ductile pipe	2
C-12	Explore fused PVC pipe	0
C-13	Use expansion joints at bridges	2
C-14	Use surface mounted pipeline	0
C-15	Move pipeline alignment outside of roadway	2
C-16	Reduce minimum cover to 42"	2
C-17	Reduce minimum cover to 36"	5
C-18	Use controlled density fill & reduce trench width	2
C-19	Use steel pipe for entire length	1
C-20	Use steel pipe for bridge crossing	4
C-21	Use narrow trench & CDF & only layback trench at joints	4
C-22	Performance spec the pipe	0
C-23	Put wider bike lane on only one side of road	0
C-24	Put manways every 5000 feet instead of every 2000 feet	0
C-25	Put blowoffs at alternative low spots	1
C-26	Reduce or eliminate air release valves in high pressure areas	1

	Emergency Discharge (E)	
E-1	Eliminate emergency discharge through redundancy	1
E-2	Do not restore watercourse	5
E-3	Abandon surface discharge	0
E-4	Use corrugated metal pipe	2
E-5	Use corrugated plastic pipe	0
E-6	Retain standpipe	0
	Fiber Optic Link (F)	
F-1	Eliminate fiber optic conduit	3
F-2	Reduce conduit from 4" to 2"	4
F-3	Use existing T1 & video accelerator	6
F-4	Use radio frequency	0
F-5	Install empty conduit for now	1
F-6	Install both 2" & 4" conduits	3
F-7	Install parallel conduit for 3-phase power	3
F-8	Use satellite communication & internet	0
F-9	Use microwave communication	0
	Hydropower Plant (H)	
H-1	Eliminate hydropower	4
H-2	Maximize power generation	1
H-3	Use a different turbine system	0
H-4	Bifurcate penstock install two turbines	1
H-5	More efficient turbines for a given flow	0
H-6	Don't break head through turbine	2
H-7	Dramatically smaller turbine capacity	2
H-8	Dual bypass system to enable maintenance on bypass valve	2
H-9	Decouple afterbay from powerhouse	1
H-10	Use staged globe valves	0
H-11	Multiple inline turbines between intake and outback	1
H-12	Right-size base slab for power house	0
H-13	Smaller power house	3

H-14	Don't connect to grid	0
H-15	Ensure spec assures competition for turbine	2
H-16	Eliminate jib crane	2
H-17	Couple turbine to feed pump	4
H-18	Raise power house to pressurize filter	3
H-19	Eliminate second flowmeter	1
H-20	Sell power to school	1
H-21	Merchant power sales	3
H-22	Install membrane filter in afterbay of hydro plant	2
H-23	Install open channel screens in afterbay	0
H-25	Raise hydroplant some to remove head on feed pumps	1
H-26	Eliminate both flow meters	2
H-27	Replace paddle meter with mag meter	0
H-28	Reduce paddle meter with ultrasonic meter	2
H-29	Construct hydro project on its own schedule	ABD
H-30	Construct hydro plant with private partner to maximize tax benefits	2
H-31	Put in dual energy dissipation valves	3
H-32	Put in two smaller energy dissipation valves	0
H-33	Make valve vault smaller	2
H-34	Generate at primary voltage	2
H-35	Make provisions for two turbine generators	0
H-36	Two turbines – 1 sized for 6 cfs and 1 sized for balance of summer flows	2
H-37	Reduce size of thrust block	1
H-38	Rock anchor replaces thrust block	4
H-39	Put both flowmeters into vaults	0
	Intake (I)	
I-1	Eliminate fish ladder	4
I-2	Design screens to maintain pool water elevation	DS
I-3	Remove existing superstructure & don't replace	2
I-4	Refurbish dam	0
I-5	Seismically upgrade spring connection	2
I-6	Refurbish/upgrade spring diversion system	4

I-7	Use 3 smaller drum screens	1
I-8	Use flat plate screens	1
I-9	Use T screens	0
I-10	Don't install screens or fish ladder	4
I-11	Eliminate window	0
I-12	Use 2MM screens & eliminate screens at plant	0
I-13	Use diesel water heater	0
I-14	Add provision to connect small propane tanks in winter	DS
I-15	Micro hydro to provide power near intake	0
I-16	Address potential icing of water heater supply line	0
I-17	Bring in water heater supply from plant in fiber optic conduit	1
I-18	Use construction process needs to expand parking	DS
I-19	Specify extent of demo	DS
I-20	Verify concrete condition	DS
I-21	Assess dam condition	DS
I-22	Install coarser screens	0
	Miscellaneous (M)	
M-2	Validate hydropower payback	DS
M-3	Provide full-time caretaker at intake	1
M-4	Ranney collector at intake plus UV at Outback	R/R
	Treatment Plant (T)	
T-2	Move pumps to afterbay	2
T-3	Use split case pumps	1
T-4	Eliminate treatment plant	0
T-5	Half size treatment plant	1
T-6	Eliminate vacuum option	3
T-7	Stage treatment plant construction. First meet system demand above ground water supply	3
T-8	Eliminate employee spaces	1
T-9	Eliminate lab	1
T-10	Pre-select membrane supplier now	2
T-11	Eliminate pre-treatment	0
T-13	Eliminate concrete masonry units	2

T-14	Use traditional pitched roof	2
T-15	Reduce fenestration	1
T-16	Rearrangement equipment in building	3
T-17	Put chemicals under awning	0
T-18	Outdoor chemicals	0
T-19	Disinfect with Chlorine gas	1
T-20	Eliminate standby power generation	4
T-21	Eliminate bridge crane	0
T-22	Expand lab	2
T-23	Find another location for lab	1
T-24	Drop finish floor to rock elevation	4
T-25	Cut pre-treatment system in half, use split stream treatment system	1
T-26	Eliminate solids collection in pre-treatment	0
T-28	Use air supported structure	0
T-30	Consolidate HVAC areas	2
T-31	Use lagoon for pre-treatment	2
T-32	Locate process equipment outside	0
T-33	Drill wells in lieu of pre-treatment	3
T-34	Direct tap spring	3
T-35	Delay pre-treatment until fire occurs	0
T-36	Limit design to 21 CFS	4
T-37	Don't build pre-treatment now, plan for emergency settling lagoon when needed	2
T-38	Use aquifer storage and recovery system instead of treatment	3
T-39	Obtain NPDES permit for backwash	0
T-40	Treat and dispose of onsite solids	1
T-41	Clear cut watershed and remove fuel	0
T-42	Install emergency intake near treatment plant to deal with wildfire	0
T-43	Route intake line from neighboring watershed	0
T-44	Use redundant PLC and remote I/O	4
T-45	Decouple pipeline from treatment plant	ABD
T-46	Eliminate citric acid	0
T-47	Use slab on grade construction	0

T-48	Use fewer treatment units	5
T-49	Recycle backwash to sedimentation	2
T-50	Use DAF on backwash	4
T-51	Use DAF for settling (Install now)	4
T-52	Use actiflow for settling	0
T-53	Install pre-treatment equipment for now	DS
T-54	Eliminate daily chemical cleaning	4
	Waste Forcemain (W)	
W-1	Use single lagoon for settling and for process waste settling and septic tank for sanitary waste	5
W-2	Send backwash solids to pre-treatment for removal	3
W-3	Septic tank for sanitary waste	3
W-4	Use filter press	0
W-5	Clarify backwash & discharge to surface	2
W-6	Use smaller 4" line	1
W-7	Well injection of all backwash	0
W-8	Use HDPE pipe (trench in)	1
W-9	Storage tank upstream	0
W-10	Direct non-sanitary to Tumalo Creek	0
W-11	Composting toilets	1
W-12	Spray irrigation	2
W-13	Out of road, non-paved alignment	3
W-14	Use 2" forcemain	3
W-15	Smaller gravity main	0
W-16	Use sand drying beds for process solids & septic tank for sanitary waste	0

MATERIAL GIVEN TO THE VE TEAM
APPENDIX I

APPENDIX I		
MATERIALS GIVEN TO THE VE TEAM		
Document Title/Description	**Source/Author**	**Date**
Presentation handout with map of Bridge Creek Surface Water System	City of Bend	October 4, 2010
Presentation handout package of City of Bend Surface Water System Opportunities and Constraints	City of Bend, HDR Engineering	January 17, 2011
11x17 drawings of Miscellaneous Details, Tumalo Creek, Water Supply Line and Intake	John W. Cunningham & Assoc.	September 1954
City of Bend Surface Water Improvement Project, Design Criteria Report [DRAFT]	HDR Engineering	January 2011
City of Bend Surface Water Improvement Project, Design Criteria Report [DRAFT] – *Appendix A, Summary of General Pipe Parameters and Available Linings and Coatings for Steel Pipe, Ductile Iron Pipe and Bar-Wrapped Concrete Cylinder Pipe*	HDR Engineering	January 2011
Geotechnical Engineering Report, Watershed Sourcewater Improvement Project	Shannon & Wilson	December 17, 2010
Project Identification Report for Skyliners Road Improvements (MP 1.67 TO MP 10.04), Oregon Forest Highway Route 247, Deschutes County, Oregon	U.S. DOT Fed Hwy Admin Western Federal Lands Hwy Div.	September 28, 2009
City of Bend, Surfacewater Improvement Project, Preliminary Procurement Documents, Specifications, Vol. 1 (HDR Project No. 139080)	HDR Engineering	December 13, 2010
Utilities System Master Plan for the City of Bend, Vol. 1: Population, Sewerage System & Water System	David Evans and Assoc., Economic and Engineering Services, Inc. and CH2M Hill	June 8, 1992
City of Bend Water System Master Plan	Century West Engineering Corp. and Central Oregon Engineering and Surveying	July 1980
City of Bend, Water System Master Plan Update, Final Report	Murray, Smith & Associates, Inc.	March 2007
City of Bend, Water Supply Alternatives Study	Brown and Caldwell, Black & Veatch, and MWA Architects	November 19, 2009

RESPONSES TO VE TEAM RECOMMENDATIONS
APPENDIX J

DRAFT
Response to Preliminary VE Study Report
Prepared by HDR Engineering, Inc.

City of Bend
Surface Water Improvement Project
February 2011

HDR | ONE COMPANY *Many Solutions*℠

DRAFT
Response to Preliminary VE Study Report

City of Bend
Surface Water Improvement Project
February 2011

Prepared by HDR Engineering, Inc.
920 N.W. Bond Street, Suite 202
Bend, Oregon 97701
541-323-2331

HDR | ONE COMPANY *Many Solutions*™

Summary of VE Recommendations

Idea No.	Description	Capital Cost Savings	Present Worth of O&M Cost Savings	Life Cycle Cost Savings
Raw Water Conduit (C)				
C-5, C-6	Replace 1928 pipeline with new in existing alignment	$12,300,000	--	$12,300,000
C-8	Span pipe without bridges	$358,000	--	$358,000
C-9	Reuse on-site materials for backfill	$915,000	--	$915,000
C-17	Reduce minimum cover to 36"	$440,000	--	$440,000
C-20	Use steel pipe for bridge crossing	$60,000	--	$60,000
C-21	Use narrow trench & CDF & only layback trench at joints	$380,000	--	$380,000
Emergency Discharge (E)				
E-2	Do not restore watercourse	$668,000	--	$668,000
Fiber Optic Link (F)				
F-2	Reduce conduit from 4" to 2"	$520,000	--	$520,000
F-3	Use existing T1 & video accelerator	$1,370,000	--	$1,370,000
Hydropower Plant (H)				
H-17	Couple turbine to feed pump	$410,000	--	$410,000
H-38	Rock anchor replaces thrust block	$46,000	--	$46,000
Intake (I)				
I-1	Eliminate fish ladder	$168,000	--	$168,000
I-2	Design screens to maintain pool water elevation	Design Suggestion		
I-6	Refurbish/upgrade spring diversion system	($61,000)	--	($61,000)
I-10	Don't install screens or fish ladder	$880,000	$310,000	$1,190,000
I-14	Add provision to connect small propane tanks in winter	Design Suggestion		
I-18	Use construction process needs to expand parking	Design Suggestion		
I-19	Specify extent of demo	Design Suggestion		
I-20	Verify concrete condition	Design Suggestion		
I-21	Assess dam condition	Design Suggestion		
Miscellaneous (M)				
M-2	Validate hydropower payback	Design Suggestion		

Design Suggestion –Not Costed

Treatment Plant (T)				
T-20	Eliminate standby power generation	$90,000	$290,000	$380,000
T-24	Drop finish floor to rock elevation	$53,000	--	$53,000
T-36	Limit design to 21 CFS	$7,090,000	$120,000	$7,210,000
T-44	Use redundant PLC and remote I/O	$109,000	--	$109,000
T-48	Use fewer treatment units	$865,000	--	$865,000
T-50	Use DAF on backwash.	$594,000	$1,436,000	$2,030,000
T-51	Use DAF for settling (Install now)	($56,000)	$1,045,000	$989,000
T-53	Install pre-treatment equipment for now	Design Suggestion		
T-54	Eliminate daily chemical cleaning	($1,016,000)	$82,000	($934,000)
Waste Forcemain (W)				
W-1	Use single lagoon for settling and for process waste settling and septic tank for sanitary waste	($189,000)	$1,271,000	$1,082,000

Design Suggestion –Not Costed

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: C-5 & C-6

VE Recommendation Title: Replace 1928 Pipeline with New in Existing Alignment

RESPONSE: Jacob, Ben

Accept_____ Partially Accept_____ Reject__X__ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__X__

Revised estimate of savings (if savings disputed):		
	Capital	$ 3,092,000
	Presented worth of O&M	$ (2,819,000)
	Total Present worth	$ 272,000

Discussion (Explain reasons fro rejection, partial rejection or further study):

Summary: HDR rejects the notion that installation of a new conduit (28 CFS) and renewal of the 1957 conduit (8 CFS), within Bend's existing easement corridor, reduces the life-cycle costs of Bend's raw water conveyance system. The *Original Concept*, a single new conduit (36 CFS) located under Skyliner Road and FS 4603 Road, has a lower lifecycle cost than the *Proposed Concept*. The reported cost savings of VE Idea C-5 & C-6 are the result of errors in conduit diameter selection and cost estimating, omission of the future replacement cost of the 1957 conduit, and failure to account for the opportunity cost of net hydropower revenue. HDR has serious reservations about operating a pressurized conduit system (outlet control) at greater than 12 ft/s velocity; such a high velocity system may be more safely operated as an inlet control non-pressurized system (this inlet control alternative is not analyzed hereunder). The environmental impact of major construction within the existing easement corridor may be significant and involve additional permitting and public relations risk. See attached for detailed reply.

Cost analysis presented above is the difference between the *Corrected Proposed Concept* (23/20-inch steel conduit in the existing easement corridor) and the *Original Concept (36-inch steel conduit in Skyliner Road)*.

VE Idea C-5 & C-6 Reply
Cost Estimate Summary 2/9/2011

Life-Cycle Cost Analysis of Proposed Concept, Summary

Capital Cost Savings

$7,100,000	Capital Cost Savings Elimination of Hydropower Project (construction, engineering, & CM)
$3,092,000	Capital Cost Savings Corrected Proposed Concept vs. Origional Concept (36")
$10,192,000	

O&M or Deferred Capital Costs (Present Value)

($2,819,000)	1957 Conduit Replacement Cost
($15,992,000)	50-year Present Value Hyropower Revenue (low end of range)
($18,811,000)	

($8,619,000) **Total Savings Idea C-5 & C-6**

Additional Cost Analysis/Breakdown of Idea C-5 & C-6 Proposed Concept

Additional Capital Cost Due to Change of Alignment from Skyliners Road to Easement Corridor
($3,592,000) and Rehabilitation of Existing 1957 Conduit
Additional Capital Cost Deferred (present value) due to change of Alignment Change
($2,819,000)
Capital Cost Savings due to Change from 36" dia Conduit to High Velocity 36 CFS Equivalent 25"/23" dia Conduit
$6,683,000
Net Cost Savings of Idea C-5 & C-6 Without Considering Hydropower
$272,000
Lost Net Present Value of Hydropower Project due to High Velocity Conduit
($8,892,000)
Net Total Cost Savings of Idea C-5 & C-6
($8,620,000)

VE Idea C-5 & C-6 Reply
Cost Estimate Backup 2/9/2011

			Original Concept, Skyliner Road Alignment		Proposed Concept, Existing Easement Corridor	
	Unit	Unit Cost	Quantity	Total	Quantity	Total
Fell/Remove Ext Trees	EA	$425.00			2,000	$850,000
General Brush Cleanup	AC	$3,500.00			46	$161,000
Inspection 1957 Conduit	LF	$6.00			50,000	$300,000
Replace 10ft Lengths of 14" WSP	EA	$1,322.31			30	$39,669
Replace Appurtenances	EA	$5,000.00			30	$150,000
Remove 1926 Conduit	LF	$30.00			50,000	$1,500,000
Remove Old Fittings	EA	$500.00			27	$13,500
Protect in Place Exst 1957 WSP	LF	$5.00			50,500	$252,500
Consruction and Access Road 6" base	CY	$20.00			9,300	$186,000
Restoration, natural surface	AC	$2,000.00			23	$46,000
Erosion Control	LF	$2.43			100,000	$243,000
Regrade/finish Surface, asphalt	SY	$6.97	83,334	$580,838	0	$0
Dewatering Allowance	EA	$500,000.00	1	$500,000	1	$500,000
Cathodic Protection	EA	$100,000.00	1	$100,000	1	$100,000
Cultural Resources Allowance	EA	$150,000.00	1	$150,000	2	$300,000
Construction Survey Allowance	EA	$35,000.00	1	$35,000	2	$70,000
Design Topo Survey	EA	$180,000.00	0	$0	1	$180,000
Geotech	EA	$100,000.00	1	$100,000	1	$100,000
Traffic Control	EA	$50,000.00	6	$300,000	1	$50,000
Total Additional Alignment Costs				**$1,765,838**		**$5,041,669**

VE 28 CFS, Existing Easement Corridor, *Corrected Proposed Concept*						
Excavate New Trench 21", Soil	CY	$4.22			19,831	$83,686
Excavate New Trench 21", Rock	CY	$21.03			19,831	$417,040
Spoil Excess Excavation, 21"	CY	$16.53			17,419	$287,938
Pipe Bed & Zone - CDF, 21.5"	CY	$90.00			12,641	$1,137,700
Backfill above Zone, Native, 21.5"	CY	$3.08			22,223	$68,447
New 0.25" x 23" WSP (456psi)	LF	$127.34			25,000	$3,183,583
New 0.25" x 20" WSP (525psi)	LF	$110.73			25,500	$2,823,700
Blow Offs, complete	EA	$5,000.00			12	$60,000
Air-Vac Release	EA	$5,000.00			15	$75,000
Isolation Valves, complete	EA	$35,000.00			2	$70,000
Manways/Access	EA	$5,000.00			25	$125,000
Surge Tank Due to High Velocity	EA	$1,000,000.00			1	$1,000,000
Conduit Construction Subtotal						$9,332,095
Additional Alignment & 1957 Conduit Rehabiliation Costs						$5,041,669
Contractor Cost Subtotal						$14,373,764
Contractor Multipliers (Total 0.47)						$6,755,669
1957 Conduit Replacement Cost, Present Value						$2,818,721
Owner Total Life-Cycle Cost (Excluding Cost of Lost Hydropower Revenue)						**$23,948,154**

36 CFS, *Skyliner Road High Velocity Comparision Concept*				
Excavate New Trench 23.5", Soil	CY	$4.22	23,623	$99,690
Excavate New Trench 23.5", Rock	CY	$21.03	23,623	$496,795
Spoil Excess Excavation, 23.5"	CY	$16.53	20,853	$344,697
Pipe Bed & Zone - CDF, 23.5"	CY	$90.00	13,732	$1,235,856
Backfill above Zone, Native, 23.5"	CY	$3.08	26,372	$81,226
New 28" HDPE DR 32.5	LF	$80.00	600	$48,000
New 0.25" x 25" WSP	LF	$138.42	24,400	$3,377,367
New 0.25" x 22" WSP	LF	$121.81	25,500	$3,106,070
Blow Offs, complete	EA	$5,000.00	10	$50,000
Air-Vac Release	EA	$5,000.00	13	$65,000
Isolation Valves, complete	EA	$45,000.00	3	$135,000
Manways/Access	EA	$5,000.00	25	$125,000
Surge Tank Due to High Velocity	EA	$1,000,000.00	1	$1,000,000
Conduit Construction Subtotal				$10,164,700
Additional Alignment Costs				$1,765,838
Contractor Cost Subtotal				$11,930,538
Contractor Multipliers (Total 0.47)				$5,607,353
Owner Total Life-Cycle Cost (Excluding Cost of Lost Hydropower Revenue)				**$17,537,891**

Cost Savings Due Change of Alignment to Existing Easement Corridor ($6,410,263)

VE Idea C-5 & C-6 Reply
Cost Estimate Backup 2/9/2011

	Unit	Unit Cost	Quantity	Total
36 CFS, *Skyliner Road High Velocity Comparision Concept*				
Excavate New Trench 23.5", Soil	CY	$4.22	23,623	$99,690
Excavate New Trench 23.5", Rock	CY	$21.03	23,623	$496,795
Spoil Excess Excavation, 23.5"	CY	$16.53	20,853	$344,697
Pipe Bed & Zone - CDF, 23.5"	CY	$90.00	13,732	$1,235,856
Backfill above Zone, Native, 23.5"	CY	$3.08	26,372	$81,226
New 28" HDPE DR 32.5	LF	$80.00	600	$48,000
New 0.25" x 25" WSP	LF	$138.42	24,400	$3,377,367
New 0.25" x 22" WSP	LF	$121.81	25,500	$3,106,070
Blow Offs, complete	EA	$5,000.00	10	$50,000
Air-Vac Release	EA	$5,000.00	13	$65,000
Isolation Valves, complete	EA	$45,000.00	3	$135,000
Manways/Access	EA	$5,000.00	25	$125,000
Surge Tank Due to High Velocity	EA	$1,000,000.00	1	$1,000,000
Conduit Construction Subtotal				$10,164,700
Additional Alignment Costs				$1,765,838
Contractor Cost Subtotal				$11,930,538
Contractor Multipliers (Total 0.47)				$5,607,353
Owner Total Life-Cycle Cost (Excluding Cost of Lost Hydropower Revenue)				**$17,537,891**

Original Concept 36", 36 CFS	Unit	Unit Cost	Quantity	Total
Excavate New Trench 36", Soil	CY	$4.22	38,426	$162,158
Excavate New Trench 36", Rock	CY	$21.03	38,426	$808,099
Spoil Excess Excavation, 36"	CY	$16.53	34,028	$562,483
Pipe Bed & Zone - CDF, 36"	CY	$90.00	20,938	$1,884,420
Backfill above Zone, Native, 36"	CY	$3.08	42,824	$131,898
New 36" HDPE DR 32.5	LF	$94.48	600	$56,688
New 0.25" x 36" WSP	LF	$191.18	30,400	$5,811,872
New 0.313" x 36" WSP	LF	$214.18	7,000	$1,499,260
New 0.375" x 36" WSP	LF	$245.18	5,000	$1,225,900
New 0.438" x 36" WSP	LF	$282.18	7,500	$2,116,350
Blow Offs, complete	EA	$5,000.00	10	$50,000
Air-Vac Release	EA	$5,000.00	13	$65,000
Isolation Valves, complete	EA	$70,665.00	3	$211,995
Manways/Access	EA	$5,000.00	25	$125,000
Conduit Construction Subtotal				$14,711,122
Additional Alignment Costs				$1,765,838
Contractor Cost Subtotal				$16,476,960
Contractor Multipliers (Total 0.47)				$7,744,171
Owner Total Life-Cycle Cost				**$24,221,132**

Cost Savings due to High Velocity Conduit Design Criteria **$6,683,241**
Excludes Lost Hydrpower Revenue & Alignment Change

VE Idea C-5 & C-6 Reply
Cost Estimate Backup 2/9/2011

VE	8 CFS, *Corrected Proposed Concept, 1957 Conduit Future Replacement*			
Excavate New Trench 13", Soil	CY	$4.22	11,991	$50,601
Excavate New Trench 13", Rock	CY	$21.03	11,991	$252,164
Spoil Excess Excavation, 13"	CY	$16.53	10,532	$174,102
Pipe Bed & Zone - CDF, 13"	CY	$90.00	7,643	$687,912
Backfill above Zone, Native, 13"	CY	$3.08	13,437	$41,386
New 0.25" x 14" WSP	LF	$77.51	25,000	$1,937,833
New 0.25" x 12.3" WSP	LF	$68.10	25,500	$1,736,576
Protect in Place Exst 2014 WSP	LF	$5.00	0	$0
Restoration, natural surface	AC	$2,000.00	10	$20,000
Cathodic Protection	EA	$50,000.00	1	$50,000
Blow Offs, complete	EA	$5,000.00	12	$60,000
Air-Vac Release	EA	$5,000.00	20	$100,000
Isolation Valves, complete	EA	$20,000.00	4	$80,000
Manways/Access	EA	$5,000.00	25	$125,000
Contractor Cost Subtotal				$5,315,574
Contractor Multipliers (Total 0.47)				$2,498,320
Engineering, Construction Management, Admin & Legal (Total 0.25)				$1,328,893
Owner Cost Total, Future				$9,142,787
Discounted Present Value, 30 Years, 4% (real), 0.3083 factor				**$2,818,721**

VE IDEA C-5 & C-6
HDR Reply, Addendum
Feb. 9, 2011
Ben Jacob

1. The evaluation of the cost and engineering differences between the *Proposed Concept* and the *Original Concept* is complicated by changes to three key conduit design criteria simultaneously. Three key changes: 1) relocation of the new conduit to the existing easement corridor, 2) reducing the size of the new conduit by rehabilitating and leaving the existing 1957 conduit in service, and 3) maximizing the conduit flow velocity to the extent that the residual hydraulic head at the Outback site is insufficient to support hydropower production. The first two changes have been evaluated together; however, the impact of changing design velocity and friction loss profile is independent of conduit alignment and must be analyzed separately.
2. Major changes have been made to the *Proposed Concept* to correct for calculation and cost estimating errors. Assumptions of ground slope have been corrected and the diameter of the existing 1957 steel conduit has been corrected, resulting in an existing capacity of 8 CFS vs. 9.4 CFS. The corrected design flow criteria is corrected to 28 CFS vs. 21.6 CFS, which reflects the lower capacity of the existing 1957 conduit and correction of a calculation error. The corrected diameter is 23-in for the upper 25,000 LF, and 20-in for the lower 25,500 LF vs. 18-in. A $1M allowance for a surge tank, or surge mitigation, has been included due to design velocity exceeding 12 ft/s. Because the *Proposed Concept* includes continued service of a 54 year old conduit, the present value ($2.8M) of the ultimate replacement of this conduit in 30 years is assumed. A multi-million dollar error in the unit cost of steel pipe for the *Original Concept* was also corrected. Additional minor changes are documented below.
3. In order to fairly analyze the cost/benefit of relocating the new conduit to the existing easement corridor and taking advantage of the existing capacity of the 1957 conduit, the cost of a *Corrected Proposed Concept* has been compared to a hydropower-neutral *Skyliner Road High Velocity Comparison Concept. The Corrected Proposed Concept* is a new 23"/20" steel conduit (28 CFS capacity) with 8 CFS assumed for maximum capacity for the 1957 conduit. The *Skyliner Road High Velocity Comparison Concept* is a single 25"/22" steel conduit with a full 36 CFS capacity under a maximum velocity assumption. Both alternatives have the same negative impact to the hydropower project. The net result is that the *Corrected Proposed Concept* has a $6.4M greater estimated life-cycle cost. The benefit of keeping the 1957 conduit in service is small relative to the high cost of construction within the existing easement corridor.
4. To isolate the cost/benefit of downsizing the new conduit, by increasing the design velocity to the point that all potential energy (elevation head) is consumed by conduit wall friction, the *Skyliner Road High Velocity Comparison Concept* is benchmarked against the *Original Concept*. The *Original Concept* is a 36-in diameter steel conduit that retains sufficient hydraulic head at the Outback site to make hydropower production economically viable. The additional capital cost of the *Original Concept* vs. the *High Velocity Comparison Concept* is $6.7M; however, the net lost revenue of the hydropower project with the *High Velocity Comparison Concept* is $8.9M.

5. A direct cost comparison between the *Corrected Proposed Concept* and the *Original Concept* reveals that the combined concepts within Idea C-5 & C-6 yields zero life-cycle cost savings. In fact, the implementation of Idea C-5 & C-6 would have a life-cycle cost of $8.6M more than the *Original Concept*—due principally to loss of hydropower revenue and high construction costs within the existing easement corridor.

Additional Technical Notes:

6. HDR's conduit capacity calculations for this study assume a C-factor of 130 to allow for an imperfect future condition, a modest tolerance for minor losses, and full conduit flow conditions. Existing steel conduit diameters are based on as-built drawings obtained from City records.

    Maximum Capacity Existing Steel 1957 Conduit
    Top 25k LF: 14.0" ID, avg slope 13.5/1000
    Bottom 25k LF = 12.3" ID, avg. slope 23.5/1000
    Max capacity = 8 CFS

    28 CFS Capacity Steel Conduit, Assuming Maximum Head Loss
    Top 25k LF: 23" ID, avg slope 13.5/1000
    Bottom 25k LF = 20" ID, avg. slope 23.5/1000

    21.6 CFS Capacity Steel Conduit, Assuming Maximum Head Loss
    Top 25k LF: 21" ID, avg slope 13.5/1000
    Bottom 25k LF = 18" ID, avg. slope 23.5/1000

    36 CFS Capacity Steel Conduit, Assuming Maximum Head Loss
    Top 25k LF: 25" ID, avg slope 13.5/1000
    Bottom 25k LF = 22" ID, avg. slope 23.5/1000

7. Construction of a new conduit within the existing easement corridor will incur additional costs to protect-in-place the shallow buried 1957 14/12-in conduit. Existing 1957 conduit not likely designed for highway wheel loads or construction loads.
8. Root damage to trees less than 10-feet from excavation of new conduit trench within forest likely to require doubling of the pipeline corridor to 40 feet. With tree species native to the Central Oregon area, damaged roots within the drip-line is assumed fatal.
9. Construction within the existing conduit corridor will increase risks of encountering cultural resources vs. construction within the existing road prism.
10. The environmental impacts of major construction within the existing easement are not yet quantified.
11. The cost and complexity of a 1957 conduit condition assessment is underestimated. CCTV inspection method proposed has significant limitations and will not alone deliver adequate condition assessment information—most pipe deterioration is likely external. Van access to the

conduit route is limited. No camera insertion points likely exist. The conduit will likely have several sections that cannot be dewatered without major effort. Supplemental external inspection activities will be required.

Additional Cost Estimation Notes:

1. Cost of tree removal has been doubled to provide a 40 wide clear corridor.
2. Cost of general brush cleanup is underestimated by a factor of 10 relative to ODOT 2009 average unit cost from bid tabulations. $3,500/acre.
3. Increase repair cost for existing pipeline.
4. Construction activities and future maintenance within the existing conduit easement would require construction of an access road.
5. Steel pipe cost estimates for the 36" *Original Concept* appeared extremely high, and have been corrected.
6. Erosion control should be included for *Proposed Concept*.
7. Higher allowance for construction issues related to cultural resources should be included for *Proposed Concept*.
8. Add $180k for new design survey of easement alignment. Lower sight distances, impaired satellite reception below tree canopy, and constrained vehicle access.
9. Additional cost related to cultural resources should be included for *Proposed Concept*.
10. Add restoration cost following construction within conduit easement.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: C-8

VE Recommendation Title: Span Pipe Without Bridges

RESPONSE: Jacob, Ben

Accept_____ Partially Accept_____ Reject__X__ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__X__

Revised estimate of savings (if savings disputed):		
	Capital	$ (34,700)
	Presented worth of O&M	$
	Total Present worth	$ (34,700)

Discussion (Explain reasons for rejection, partial rejection or further study):

1. Structural calculations do not incorporate 300 PSF snow load. Resulting pipe beam would more than double the weight of steel per linear foot to provide sufficient structure. Lower crossing would be at least 1.25" thick 54" diameter pipe, 2.25 times the original weight of steel / LF. Multiplying the cost of steel by 2.5 will add $393k to the cost of this alternative, making it more expensive than the bridge alternative.
2. Proposed concept places span support piers in close proximity to Tumalo Creek and within areas likely to be considered wetlands. This alternative increases environmental impact. The initial bridge design intentionally increased span length to reduce fill and disturbance in the wetland area.
3. Idea does not recognize any value of a dedicated pedestrian or bicycle crossing.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: C-9

VE Recommendation Title: Reuse On-Site Material for Pipe Zone and Backfill Material

RESPONSE: Jacob, Ben

Accept__X__ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__X__

Revised estimate of savings (if savings disputed):

Capital	$ 0.00
Presented worth of O&M	$
Total Present worth	$ 0.00

Discussion (Explain reasons for rejection, partial rejection or further study):

1. This concept is already the intent of the HDR design team to maximize the use of native materials, and was brought up by HDR in the design presentation. The current imported material within the cost estimate is a conservative place-holder until results from the second phase of the geotechnical study can estimate the volume of material that may be reused within the pipe zone, specification recommendations, onsite processing required, likely cost of onsite material, and bid strategy for excavation and backfill.
2. The savings above is corrected to zero to represent that this concept is already included within the design to the extent possible at this stage of design. It is also not conservative at this time to assume that all pipe zone material can be supplied from this lower cost source.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: C-17r1

VE Recommendation Title: Reduce Minimum Cover to 36 Inches

RESPONSE: Jacob, Ben

Accept__X__ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__X__

Revised estimate of savings (if savings disputed):	Capital	$ 0.00
	Presented worth of O&M	$
	Total Present worth	$ 0.00

Discussion (Explain reasons for rejection, partial rejection or further study):

1. For most of the conduit alignment this is already the excavation concept included in the design. See Conduit Detail sheet 03D-01. The conduit will first be installed under 3' of cover relative to the existing Skyliners Road surface elevation. Following pipeline construction, the Forest Service will lay a new road section of approximately 12-inches for a total of 4' of cover. (The detail will be corrected to show a 12-inch road section vs. 18-inch.)

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: C-20

VE Recommendation Title: Use Steel Pipe For Bridge Crossing

RESPONSE: Jacob, Ben

Accept___ ___ Partially Accept_____ Reject_____ Further Study____X_____

Agree with estimated savings_____ Disagree with estimated savings___X__

Revised estimate of savings (if savings disputed): Capital $ 0.00

Presented worth of O&M $

Total Present worth $ 0.00

Discussion (Explain reasons for rejection, partial rejection or further study):

1. VE Cost analysis is not correct:
   a. The calculated savings in hydropower revenue from this idea are treated as reduced capital cost and effectively increased by 47%. Treat as O&M and reduce total savings by $21,000.
   b. The friction loss is calculated assuming the conduit flows 21 CFS all year for 50 years. Actual flows, including modeled flows within hydropower revenue model, assume flow rate varies seasonally by more than 50%. Hydropower revenue savings are likely twice what is reasonable. Reduce total savings by $22,300.
   c. The unit cost of fused and installed DR 11 30" pipe is overstated. Replace unit cost with $180/LF, a reduction of $80/LF and total reduction of $29,400.
   d. Total reduction in savings, $72,700, exceeds the original amount of savings.
2. The VE team's technical comments will be considered as design suggestion and the pipe material over the bridge will be reviewed during final design.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: C-21

VE Recommendation Title: Use Narrow Trench and CDF and Lonely Lay Back Trench at Joints

RESPONSE: Jacob, Ben

Accept___ ___ Partially Accept__ **X** ___Reject_____ Further Study_____ _____

Agree with estimated savings_____ Disagree with estimated savings__ **X** __

Revised estimate of savings (if savings disputed): Capital $ 100,000.00

___

Presented worth of O&M $_____

Total Present worth $ 100,000.00

Discussion (Explain reasons forro rejection, partial rejection or further study):

1. It is not clear how the CDF could be used as bedding under the pipe unless laborers entered the trench to set sand bags above the base of the trench prior to placement of pipe and the CDF. This access would violate the viability of the steepened trench section, one of the cost saving assumptions of this value idea.
2. HDR agrees with the VE's former comment that at a significant amount of the trench excavation may be processed onsite and reused in the pipe zone. Reusing onsite material appears to result in greater savings per linear foot of trench than this CDF idea. For example, reusing only 10k CY of excavated material as select native in the pipe zone(~25% of pipe zone material), with a unit cost approximately $20/CY less than imported select plus reduction of waste by 10k CY, will save more than $500,000. Whereas this CDF alternative proposes a cost savings of only $380,000 for the entire project.
3. This idea is presented as "all or nothing" CDF in the pipe zone. This is not a reasonable assumption. HDR can write specifications to allow a narrow trench section with self-compacting fill as an alternate; although, with the expertise of local excavation contractors in processing and reusing on-site materials the use of a narrow excavation with CDF fill is likely to be implemented only in constrained areas or the lowest productivity rock excavation zones.
4. HDR agrees this idea can give the contractor additional options to make the project more efficient. This may result in a cost savings of approximately $100,000.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: E-2

VE Recommendation Title: Emergency Discharge (E) - Do Not Restore Watercourse

RESPONSE: Prull, David / Bryan Black

Accept_____ Partially Accept_____ Reject_____ Further Study__X___

Agree with estimated savings_____ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed):

Capital	$ 0
Presented worth of O&M	$
Total Present worth	$ 0

Discussion (Explain reasons for rejection, partial rejection or further study):

The existing raw water conduit is not designed for static and operating pressures associated with outlet flow control. When the raw water conduit is made capable of withstanding full static pressure (either by rehabilitation, reconstruction, or replacement), outlet flow control can be added to the system. Only then can water flow in the conduit be restricted to an as needed rate, and flow to the existing overflow channel be reduced to zero during normal operating conditions. The existing watercourse downstream of the Overflow pipeline would be expected to change to a new 'natural' condition when overflow is eliminated from the normal operating condition.

Although not restoring the water course may prove feasible following negotiation and risk assessment, there is too much uncertainty regarding channel restoration to reduce the budget substantially at this time.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: F-2

VE Recommendation Title: Reduce Conduit From 4-inch to 2-inch

RESPONSE: Jacob, Ben

Accept___ Partially Accept___ Reject___ Further Study____X_____

Agree with estimated savings_____ Disagree with estimated savings___X__

Revised estimate of savings (if savings disputed): Capital $ 110,000.00

Presented worth of O&M $

Total Present worth $ 110,000.00

Discussion (Explain reasons for rejection, partial rejection or further study):

1. Materials cost difference between 2" Sch 40 PVC and 4" Sch 40 PVC is approximately $1.00 per LF. Maximum reduction in cost between 4" and 2" size is $1.50/LF, allowing some reduction in handling labor for the smaller pipe.
2. The fiber optic conduit is already planned to be installed in the backfill of the water conduit trench. While $8/LF may be a conservative estimate, the maximum difference between 2" and 4" is still likely to be $1.50/LF. Maximum project savings of this idea is $110,000.
3. The current fiber optic conduit design is still under review with City of Bend staff. The final design criteria for the fiber cable, and future potential cable needs, are yet to be defined.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: F-3

VE Recommendation Title: Use Existing T1 & Video Accelerator

RESPONSE: Jacob, Ben

Accept___ Partially Accept___ Reject___ Further Study___X___

Agree with estimated savings___ Disagree with estimated savings___X___

Revised estimate of savings (if savings disputed):

Capital	$ 690,533
Presented worth of O&M	$ (45,010)
Total Present worth	$ 645,522

Discussion (Explain reasons fro rejection, partial rejection or further study):

VE cost estimate contained several errors and omissions. See below for corrected cost model.
Idea requires further review with City of Bend staff and consideration of long term communication objectives.

			Original concept		**Proposed Concept**	
	Unit	Unit Cost	Quantity	Total	Quantity	Total
4-Inch Conduit	LF	$8.00	50500	$404,000	0	$0
Fiber Optic Cable	LF	$8.00	50500	$404,000	0	$0
Pull Boxes	EA	$4,000.00	55	$220,000	55	$220,000
2-inch Conduit (See F-2 Reply)	LF	$6.50	0	$0	50500	$328,250
Video Accelerator	EA	$5,000.00	0	$0	2	$10,000
				$1,028,000		$558,250
Contractor Multipliers (0.47)				$483,160		$262,378
Capital Cost Totals				$1,511,160		$820,628
Capital Cost Savings, Elimination of Fiber Optic Cable			$1,511,160 - $820,628 =			$690,533
T1 Service Annual Fee O&M Costs	$3,312.00	x PV Factor	13.59	0		($45,010)
Net Savings, Elimination of Fiber Optic Cable						**$645,522**

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: H-17

VE Recommendation Title: Couple turbine to feed pump

RESPONSE: Fonnesbeck, Ken

Accept_____ Partially Accept_____ Reject __X__ Further Study ____

Agree with estimated savings_____ Disagree with estimated savings __X__

Revised estimate of savings (if savings disputed):	Capital	$_____0_____
	Presented worth of O&M	$_____0_____
	Total Present worth	$_____0_____

Discussion (Explain reasons fro rejection, partial rejection or further study):

The hydropower team has contacted a manufacturer of the hydro-pump, or turbo booster, systems. After initial sizing calculations were performed, it was determined that directly coupling a turbine that operates at 1000 ft of head to a pump that operates at 30-40 psi is technically infeasible. Because of the lack of equipment available in this size, the hydropower team rejects the VE recommendation.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: H-38

VE Recommendation Title: Rock anchor replaces thrust block

RESPONSE: Fonnesbeck, Ken

Accept_____ Partially Accept_____ Reject_____ Further Study __X__

Agree with estimated savings_____ Disagree with estimated savings_X_

Revised estimate of savings (if savings disputed):	Capital	$_____0_____
	Presented worth of O&M	$_____0_____
	Total Present worth	$_____0_____

Discussion (Explain reasons for rejection, partial rejection or further study):

The powerhouse design has not been developed to a sufficient level to determine if the thrust block at the bifurcation can safely be replaced with a concrete collar and rock anchors.

During 60% and 90% design, and after water conduit transient studies, determination of the ultimate powerhouse configuration and additional geotechnical work, this decision can be finalized.

At this point in time, the hydropower team does not recommend reducing the estimated cost for the thrust block, without sufficient geotechnical exploration and engineering to fully understand the thrust restraint needs.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-1

VE Recommendation Title: Eliminate Fish Ladder

RESPONSE: Haupt, Susan

Accept_____ Partially Accept_____ Reject_____ Further Study__X__

Agree with estimated savings__X___ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

In short, more coordination with ODFW would be required to determine if providing passage and or pursuing a waiver is the most prudent path forward. First, the City needs to make a decision if they will be building hydropower now, later, or never.

The VE recommendation indicates that a waiver could be sought on the grounds that

1) There are no ESA-listed species in Bridge Creek,
2) That the additional opened habitat is of minimal value, and
3) The City is pursuing a minimum-cost project.

It is important to note that

1) Fish passage requirements are not driven by presence of ESA-listed species. The trigger is current or historic presence of *native migratory fish*, which are present
2) The value of the additional opened habitat is determined by ODFW and the City will likely pay for the analysis required for ODFW to place a value on that resource, and
3) The waiver process requires a net benefit mitigation that might or might not be more cost-effective. ODFW is not likely to grant a waiver based on potential cost savings to the City.

Development of a waiver package could require substantial time and resources, ODFW's waiver review process is rigorous, and the outcome is not guaranteed. The waiver process requires the City to demonstrate a net benefit (mitigation that delivers a benefit to native migratory fish that is greater than the fish ladder would have provided) and approval is at the discretion of ODFW and their commission. ODFW will look to the net benefit package to demonstrate outcomes that would result in an increase in fish numbers. Extensive information and data collection to define baseline conditions and proposed mitigation benefits are typically requested in terms of quality of habitat and quantity of habitat at the waiver site and mitigation site(s). Lastly, the waiver process could delay the project schedule as the approval would be needed prior to environmental permit issuance (section 404 and removal fill permits). In short, the waiver process carries risk, outcomes are not known, and it is not predictable or in the control of the City or project team.

- ***Note:*** *The VE team might have used the term "waiver" when they were actually referring to an "exemption". The project clearly does not qualify for an exemption from passage requirements.*

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-2

VE Recommendation Title: Design Screens to maintain pool water surface

RESPONSE: Nelson, John

Accept_____ Partially Accept___X__ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed): Capital $_____N/A_____

Presented worth of O&M $_____ N/A _____

Total Present worth $_____ N/A _____

Discussion (Explain reasons for rejection, partial rejection or further study):

If replacement of the existing screens becomes a component of the 100% design, HDR will evaluate maintaining existing dam board / low pool elevation with smaller screens. The screen manufacturer was contacted to discuss smaller diameter retractable screen units, which can be fabricated. The controlling factor is a 1.5 length to diameter ratio. The increase in length also needs to be evaluated for clearance into the service building. Regarding adding an additional screen, there is not enough room for three screens and removing more concrete slab may impact structural integrity of existing structure.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-6

VE Recommendation Title: Refurbish/Upgrade Spring Diversion System

RESPONSE: Haupt, Susan

Accept_____ Partially Accept_____ Reject_____ Further Study__**X**__

Agree with estimated savings__**NA**__ Disagree with estimated savings__**NA**__

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

While pursuing upgrades to the Spring Diversion might be a prudent investment, further study is needed to determine if the recommended approach and methods would be the most effective options. Ultimately, the City needs to decide if modifications to the Spring Diversion are warranted and necessary to include in the initial work phase, or if such work should be deferred. Upgrades at the Spring Diversion would expand the scope of the Forest Service NEPA document and study area, and initiating studies now to assess impacts to fish habitat, Northern Spotted Owls, water quality and quantity, and cultural resources (among other resources) could result in project delays of a year or greater due to 2-year survey requirements for some species. Further, coordination with ODFW would be required to determine if modifications to the Spring Diversion could trigger fish passage requirements.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-10

VE Recommendation Title: Do not install Intake Screens or Fish Ladder

RESPONSE: Haupt, Susan

Accept_____ Partially Accept_____ Reject_____ Further Study__X__

Agree with estimated savings__X___ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

In short, more coordination with ODFW would be required to determine if providing passage and screening or pursuing a waiver is the most prudent path forward. First, the City needs to make a decision if they will be building hydropower now, later, or never.

The VE recommendation indicates that a waiver could be sought on the grounds that

1) There are no ESA-listed species in Bridge Creek,
2) That the additional opened habitat is of minimal value, and
3) The City is pursuing a minimum-cost project.

It is important to note that

1) Fish passage requirements are not driven by presence of ESA-listed species. The trigger is current or historic presence of *native migratory fish*, which are present
2) The value of the additional opened habitat is determined by ODFW and the City will likely pay for the analysis required for ODFW to place a value on that resource, and
3) The waiver process requires a net benefit mitigation that might or might not be more cost-effective. ODFW is not likely to grant a waiver based on potential cost savings to the City.

Development of a waiver package could require substantial time and resources, ODFW's waiver review process is rigorous, and the outcome is not guaranteed. The waiver process requires the City to demonstrate a net benefit (mitigation that delivers a benefit to native migratory fish that is greater than the fish ladder would have provided) and approval is at the discretion of ODFW and their commission. ODFW will look to the net benefit package to demonstrate outcomes that would result in an increase in fish numbers. Extensive information and data collection to define baseline conditions and proposed mitigation benefits are typically requested in terms of quality of habitat and quantity of habitat at the waiver site and mitigation site(s). Lastly, the waiver process could delay the project schedule as the approval would be needed prior to environmental permit issuance (section 404 and removal fill permits). In short, the waiver process carries risk, outcomes are not known, and it is not predictable or in the control of the City or project team.

- ***Note:*** *The VE team might have used the term "waiver" when they were actually referring to an "exemption". The project clearly does not qualify for an exemption from passage requirements.*

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-14

VE Recommendation Title: Add provision to connect small propane tanks in winter

RESPONSE: Nelson, John

Accept___**X**__ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed):	Capital	$_____N/A_____
	Presented worth of O&M	$_____ N/A _____
	Total Present worth	$_____ N/A _____

Discussion (Explain reasons for rejection, partial rejection or further study):

Propane is preferred auxiliary power source. Quick connects for portable tanks will be included

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-18

VE Recommendation Title: Use construction process needs to expand parking

RESPONSE: Haupt, Susan

Accept_____ Partially Accept_____ Reject_____ Further Study__X__

Agree with estimated savings__NA__ Disagree with estimated savings__NA__

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

Expanding and (potentially) paving the public parking area near the intake facility could be a prudent investment and warrants further study and discussions with the City and the U.S. Forest Service. The proposed improvements would minimize public access and parking impacts during construction, and provide additional long-term parking for visitors.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-19

VE Recommendation Title: Specify Extent of Demolition

RESPONSE: Nelson, John

Accept___X__ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed):	Capital	$_____N/A_____
	Presented worth of O&M	$_____ N/A _____
	Total Present worth	$_____ N/A _____

Discussion (Explain reasons for rejection, partial rejection or further study):

If replacement of screen becomes a component of the 100% design, all concrete demolition work will be clearly shown on contract drawings and technical specifications.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-20

VE Recommendation Title: Verify Concrete Condition

RESPONSE: Nelson, John

Accept___**X**__ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed):	Capital	$_____N/A_____
	Presented worth of O&M	$_____ N/A _____
	Total Present worth	$_____ N/A _____

Discussion (Explain reasons for rejection, partial rejection or further study):

The integrity of the existing concrete will be addressed in the next phase of work. Recommend core samples at multiple locations of existing concrete structure, as well as within the dam structure.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: I-21

VE Recommendation Title: Assess Dam Condition

RESPONSE: Nelson, John

Accept__X___ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed):	Capital	$_____N/A_____
	Presented worth of O&M	$_____ N/A _____
	Total Present worth	$_____ N/A _____

Discussion (Explain reasons for rejection, partial rejection or further study):

Assessing the integrity of the existing concrete dam will be accomplished in the next phase of work. Recommend core samples at several locations of the dam structure. Additionally, scour/undermining of the dam apron will be investigated. It is assumed highly likely that undermining has occurred and that there will be some effort to restore apron foundation. This restoration work as well as any modification work to the screen would be presented to the Agencies as standard intake facility maintenance, thus reducing the in-river permitting cost and timelines.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: M-2

VE Recommendation Title: Validate hydropower payback

RESPONSE: Black, Bryan

Accept__X___ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings__N/A___ Disagree with estimated savings__N/A___

Revised estimate of savings (if savings disputed):	Capital	$_____N/A_____
	Presented worth of O&M	$_____N/A_____
	Total Present worth	$_____N/A_____

Discussion (Explain reasons for rejection, partial rejection or further study):

The original payback estimate was 25 years (not 45 years as listed in the preliminary VE report). The design team accepts the VE recommendation to perform a sensitivity analysis on hydropower economics for decision maker review. Sensitivity to the parameters listed in the VE report would be evaluated. Also, the potential benefit of private financing would be assessed.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-20

VE Recommendation Title: Eliminate standby power generation

RESPONSE: Lawson, Matt

Accept_____ Partially Accept_____ Reject__XX___ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__XX_

Revised estimate of savings (if savings disputed): Capital (**Cost increase**) $___-$120,000_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons fro rejection, partial rejection or further study):

The VE recommended using the hydro generating unit as backup power for the water treatment facility, and provided estimated savings and costs associated with eliminating the backup generator. The assumption was, the hydro generator was designed with the ability to manage load fluctuations and regulate speed, that is, operate isolated from the grid in an isochronous mode.

The Pelton hydro generator proposed for the Bend WTP was not anticipated to operate isolated from the grid and would require more sophisticated controls, a fly wheel, and additional integration with the bypass valve. We contacted one generator manufacturer (Gilkes) who provided a budget adder for including isolated operation capability for additional capital cost of $60k, which was not included in the VE evaluation.

The VE recommendation estimated the cost deduction of eliminating the backup generator itself to be $350k. We anticipate the actual cost deduction of eliminating the backup generator to be more on the order of $150 to $200 k. In addition, the standalone backup generator approach is easier to operate, provides more flexibility, and is a very common approach to providing reliable alternative plant power.

Therefore we reject the recommendation based on the expectation there would be no realization in cost savings, but in fact the recommendation would actually cost more, and that the backup generator provides better benefits at less cost.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-24

VE Recommendation Title: Drop Finished Floor to Rock Elevation

RESPONSE: Black, Bryan

Accept_____ Partially Accept_____ Reject__X___ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

This proposal is to locate the floor slab 14-feet or more below existing grade. The small potential cost savings is not sufficient to account for the access problems that this will cause and the risk of driving piles into the rocky subsurface.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-36

VE Recommendation Title: Limit Design to 21 cfs

RESPONSE: Koch, John

Accept___ ___ Partially Accept__X___ Reject_____ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__X___

Revised estimate of savings (if savings disputed): Capital **$1,754,820**

Presented worth of O&M $_____N/A_____

Total Present worth $_____N/A_____

Discussion (Explain reasons for rejection, partial rejection or further study):

VE recommendation cost savings for water treatment plant is based on gross area reductions which we believe are not realistic. The entire bldg will not be reduced by 25% as the "non-process" areas will remain relatively the same. Floor area for membranes could be reduced by approximately 20%. Electrical room floor space for VFD's for the future membranes may be reduced slightly; however the physical size of the basic switchboards, MCC modules, power distribution panels, lighting panels will remain relatively the same while the internal components amperage rating may be less. A gross reduction of 40% is not realistic. Reductions in HVAC/Plumbing/Fire Protection are not a linear reduction as the basic equipment is still required.

HDR has done an analysis on the pipeline reduction from 36-inch to 30-inch, the overall cost estimate for reducing the pipeline to 30-inch is $20,885,280 versus the VE estimated cost of $18,470,550. A design Technical Memorandum has been prepared for the City. Below Table represents 30-inch pipeline estimate.

Net Savings then becomes:

Description	Cost	Δ Difference in Cost
Original Pipeline (36") cost as presented in VE Study	$22,164,660	
HDR's Estimated Cost for 30" line	$20,885,280	
		$ 1,279,380
Reduction in membrane area footprint – 1,680 ft^2	From VE $283/$ft^2$	**$ 475,440**
Total Estimated Cost Savings		**$1,754,820**

Optimized Original Concept 30",				
Excavate New Trench 30", Soil	CY	$5.00	30,157	$150,786
Excavate New Trench 30", Rock	CY	$25.00	30,157	$753,930
Spoil Excess Excavation, 30"	CY	$16.53	26,621	$440,038
Pipe Bed & Zone - CDF, 30"	CY	$90.00	17,530	$1,577,688
Backfill above Zone, Native, 30"	CY	$3.08	33,667	$103,693
New 30" HDPE DR 32.5	LF	$90.00	600	$54,000
New 0.25" x 30" WSP	LF	$166.10	36,400	$6,046,040
New 0.313" x 30" WSP	LF	$193.97	8,000	$1,551,778
New 0.375" x 30" WSP	LF	$233.43	5,500	$1,283,883
Blow Offs, complete	EA	$5,000.00	10	$50,000
Air-Vac Release	EA	$5,000.00	13	$65,000
Isolation Valves, complete	EA	$60,000.00	4	$240,000
Manways/Access	EA	$5,000.00	25	$125,000
Conduit Construction Subtotal				$12,441,837
Additional Alignment Costs				$1,765,838
Contractor Cost Subtotal				$14,207,675
Contractor Multipliers (Total 0.47)				$6,677,607
Owner Total Life-Cycle Cost				**$20,885,282**

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-44

VE Recommendation Title: Use redundant PLC and remote I/O

RESPONSE: Black, Bryan

Accept__X___ Partially Accept_____ Reject_____ Further Study_____

Agree with estimated savings__N/A___ Disagree with estimated savings__N/A___

Revised estimate of savings (if savings disputed):	Capital	$_____N/A_____
	Presented worth of O&M	$_____N/A_____
	Total Present worth	$_____N/A_____

Discussion (Explain reasons for rejection, partial rejection or further study):

As noted on **01E-03 – PLC SYSTEM NETWORK DIAGRAM,** the Local Control Panels (LCP-XXXXX) have the CPU listed as optional. Included in the HDR team's cost estimate was for remote I/O for the individual skids with an "on-the-shelf" backup power supply, CPU, network cards, etc, to reduce the potential for a single point of failure. This issue will be further discussed with the City to provide them with the maximum flexibility at the minimal cost. Some LCPs may need a complete PLC to enhance the overall system reliability.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-48

VE Recommendation Title: Use Fewer Treatment Units

RESPONSE: Koch, John

Accept____ Partially Accept___X__ Reject_____ Further Study_____

Agree with estimated savings__N/A___ Disagree with estimated savings__N/A___

Revised estimate of savings (if savings disputed):	Capital	$_____None [1]_____
	Presented worth of O&M	$_____N/A_____
	Total Present worth	$_____N/A_____

Discussion (Explain reasons for rejection, partial rejection or further study):

Fewer racks could be used if membrane manufacturers were allowed to use larger racks to develop the optimum configuration while providing the necessary redundant rack. It is anticipated that 5 racks with 132 module could be sufficient. This configuration would allow for approximately 8 blanks per rack for future expansion or as a safeguard should long term water quality deteriorate.

Backwash recovery units could be smaller racks. Typical recovery for facilities with backwash recovery is in the range of 98-99.5%

In the pre-procurement process, potential manufacturers will be allowed to present their cost effective approach to providing a redundant filtration and backwash recovery rack. Actual cost saving will be established by the market place during bidding

[1]**In recent discussion with membrane manufacturer, allowing for large racks while requiring a redundant unit would not necessarily be cost effective and reduce the cost.**

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-50

VE Recommendation Title: Use DAF on backwash

RESPONSE: Bill, Karen

Accept_____ Partially Accept__X___ Reject_____ Further Study__X___

Agree with estimated savings_____ Disagree with estimated savings__X___

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

The use of a DAF system for treatment of the membrane backwash is a viable alternative to the use of membrane backwash recovery modules. A thorough analysis of the use of a DAF system with the total plant water balance should be used to determine:

1) a more accurate cost of the system
2) the effect of the recycled DAF liquid on the membranes
3) if the size of the sewer force main could be reduced.

It is apparent the cost per membrane module used in the proposed calculation is high. Recently (Newport WTP, HDR) replacement modules have been priced at ~$1,500 per module. It is uncertain that the DAF system would provide a capital cost saving of approximately $500,000.

			Original		VE Proposed		HDR Response	
Item	**Units**	**Unit Cost**	**Quan.**	**Total**	**Quan.**	**Total**	**Quan.**	**Total**
Original Total Membrane System	LS	$6,182,227	1	$6,182,227	0.9	$5,564,004	1	$6,182,227
Membrane Backwash Recovery System	LS	$250,000					1	($250,000)
DAF System	LS	$300,000			1	$300,000	1	$300,000
6" Sewer Line	LF	$70	12340	$863,800			12340	$863,800
3" Sewer Line	LF	$68			12340	$839,120		
Subtotal				$7,046,027		$6,703,124		$7,096,027
Markup		73%		$5,143,600		$4,893,281		$5,180,100
Totals				$12,189,627		$11,596,405		$12,276,127
Net Savings						**$593,222**		**($86,500)**

The size of the sewer force main is still under consideration. The size will be optimized once all the flows to the pump station have been determined. The force main will be sized as such that the minimum velocity at the design flow will be at least 2 ft/sec.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-51

VE Recommendation Title: Use DAF for settling (Install Now)

RESPONSE: Bill, Karen

Accept_____ Partially Accept_____ Reject__X___ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__X___

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

In VE-51 recommendation of using a DAF in lieu of membrane backwash recovery units was accepted for further study. Rapid Mix/Flocculation/Sedimentation has proven to be a robust process capable of handling large variations in raw water quality. DAF is a potential pretreatment process in conventional designs; however, using it prior to membranes with its inherent use of polymer is not recommended. Polymer is very detrimental to the overall longevity of membranes and is not advised by any of the polymeric membrane manufacturers. Blending the membrane backwash waste into the raw water stream may also increase the solids load to the membrane filters on a normal basis, lowering the operational flux. At this point, it is still undetermined whether or not a pretreatment system will be included in this project.

It is apparent the cost per membrane module used in the proposed calculation is high. Recently (Newport WTP, HDR) replacement modules have been priced at ~$1,500 per module.

The size of the sewer force main is still under consideration. The size will be optimized once all the flows to the pump station have been determined. The force main will be sized as such that the minimum velocity at the design flow will be at least 2 ft/sec.

Impact on City's conveyance system will be further mitigated by providing some equalization and discharging to the City sewer system during their low flow diurnal hours.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-53

VE Recommendation Title: Install pre-treatment equipment now.

RESPONSE: Koch, John

Accept_____ Partially Accept_____ Reject_____ Further Study__X___

Agree with estimated savings__N/A___ Disagree with estimated savings__N/A___

Revised estimate of savings (if savings disputed):	Capital	$_____N/A_____
	Presented worth of O&M	$_____N/A_____
	Total Present worth	$_____N/A_____

Discussion (Explain reasons for rejection, partial rejection or further study):

This idea will need to be thoroughly discussed with the City to prioritize capital expenditures. The rapid mix tank mixers, flocculators, plate settling equipment and small sludge pumps typically are available from manufacturers in the 12-16 week time frame especially since the basin geometry is already known. City and Forest Service have acknowledged that fires in the watershed are high and the occurrence is unpredictable. Historically, the high turbidity events occur during spring snow melts or a heavy rain event that happens in the late fall and early winter. Traditionally the forest fire season is late summer and early fall which is also typically the period of lowest runoff. A fire in the late fall could provide the City with enough time to purchase and install the pretreatment equipment prior to the heavy snow melt and the typical resultant runoff of debris laden water.

The purchase and installation of the pretreatment equipment could be optional bid items whereby if the bids are lower than the opinion of construction cost and the City has funds available, these items could be installed initially.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: T-54

VE Recommendation Title: Eliminate daily chemical cleaning

RESPONSE: Bill, Karen

Accept_____ Partially Accept_____ Reject_____ Further Study__ X ___

Agree with estimated savings__X___ Disagree with estimated savings_____

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

The membrane filtration system will be designed with the capability of daily cleanings. However, membrane manufacturers will submit conservative membrane bids based on the assumption of no daily chemical cleaning. Optimization of membrane flux and the chemical cleaning intervals will take place during the pilot testing phase and first year of membrane operation.

RESPONSE TO VALUE ENGINEERING RECOMMENDATION

Project Name: City of Bend Surface Water Improvement Project

Project Location: Bend, Oregon

VE Recommendation No.: W-1

VE Recommendation Title: Use single lagoon for settling and for process waste settling and septic tank for sanitary waste

RESPONSE: Bill, Karen

Accept_____ Partially Accept_____ Reject__X___ Further Study_____

Agree with estimated savings_____ Disagree with estimated savings__X___

Revised estimate of savings (if savings disputed): Capital $_____

Presented worth of O&M $_____

Total Present worth $_____

Discussion (Explain reasons for rejection, partial rejection or further study):

This option for waste handling is not compatible with the use of a DAF system to clarify backwash waste (T-50), which is the alternative the designer accepts.

The cost estimate for the proposed concept is missing the cost of the waste pump station.

W-1 does not eliminate the need for a sanitary force main to dispose of cleaning wastes.