BOUNTIFUL/ WOODS CROSS –
5th SOUTH PCE PLUME

Operable Unit 2
Source Area Soils and Groundwater
Superfund Site
EPA ID # UT001119296

Davis County, Utah

Value Engineering Study
For
U.S. Environmental Protection Agency
Regional office in Denver, Colorado

Study Date: June 1l - 15, 2007
Final Report
July 31, 2007

US Army
Corps of Engineers

US Environmental
Protection Agency

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EXECUTIVE SUMMARY

General

The United States Army Corp of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise (CX) performed a Value Engineering Screen and Study (VE Study) on the Bountiful/Woods Cross – 5th South PCE Plume (Source Soils and Groundwater) Superfund Site, Operable Unit Number Two (OU2) project. The Bountiful/Woods Cross OU2 study area covers approximately 400 acres, located about 10 miles North of Salt Lake City. This area is bounded on the North and South by the streets 750 South and 300 North and on the East and West by 500 West to 1400 West streets. These streets are located in the cities of Bountiful, West Bountiful, and Woods Cross, Utah. The OU2 study area, which includes the impacted soils at the source area and the groundwater plume, is contaminated mainly with PCE. The VE Study was conducted at the USEPA Regional office in Denver, Colorado on June 11 – 15, 2007. The study included a site visit on June 11, 2007.

The VE Studies are based on the principals and standards used in the Value Engineering (VE) Study process consisting of six phases. The EPA VE process is broken into two components, the screening component that addresses the first four phases (Information Gathering, Function Analysis, Speculation, Analysis) and the study component that encompasses the final two phases (Development and Presentation). A VE process studies the functions of individual items of a project and the relationships of those functions to the overall function of the project. The result of studying the functions in this way allows the team to take a critical look at how these functions are being met and then develop alternative ways to achieve the same function while increasing the value and maintaining the primary function of the project. In the end, it is hoped that the project will realize a reduction in cost, increase or maintain the execution of the primary function, and improve or maintain the bidability, constructability and maintainability of the completed operable unit thereby improving the site environment.

Another objective in executing a VE Study is to meet the requirements of the Office of Solid Waste and Emergency Response (OSWER) Directive OSWER 9335.5-24, Value Engineering for Fund Financed Remedial Design and Remedial Action Projects dated 14 April, 2006. The VE process accomplishes this within the existing design schedule with minimal disruption.

Preliminary recommendations and comments resulting from a VE Study are briefed to the primary stakeholder, EPA, for comment and content, and screened to eliminate those considered to be outside the scope prior to full development to eliminate lost effort. The resulting recommendations are then developed and provided to the EPA RPM, remedial action design team, or others designated by the RPM for comment. Following review comment incorporation, the final report is presented to the designer for incorporation within the design concurrently with comments from the EPA, USACE, State, or other stakeholder with no impact on the overall schedule. The RPM is then requested to prepare a written response for the record that explains reasons for accepting or rejecting each VE recommendation (or task a contractor or the project designer to prepare such a response), and send this written response to Lindsey Lien, Leader of the USACE VE Team.

Estimate of Construction Costs and Budget
The total projected capital construction cost for all the entire scope of OU2, as identified in the *Final Feasibility Study Addendum for Bountiful/Woods Cross Superfund Site Operable Unit 2 (OU2), 5th South PCE Plume Davis County, Utah August 2006* is $4.9 million (total capital construction costs). Total present value O&M costs were estimated at $11.5 million, and include long term monitoring costs.

Summary of VE Study Results
During the speculation phase of this study, 39 creative ideas were identified. Seven of these ideas were developed into VE recommendations with cost implications where applicable. Seventeen ideas were developed into design comments.

The following table presents a summary of the ideas that were developed into recommendations and cost addressed where considered feasible. Cost is an important issue for comparison of VE recommendations. Cost estimates as prepared for this VE Study are from the FFS Addendum, published cost databases and/or VE team member experience. The estimates provided should be of sufficient detail to allow a decision regarding implementation, but the estimates should not be used to compute actual savings associated with adoption of any one recommendation.

SUMMARY OF RECOMMENDATIONS

REC # NUMBER	DESCRIPTION	POTENTIAL SAVINGS (COST)
1	Install infiltration gallery in the base of the source area excavation.	($97,000)
2	Install additional Multiport Monitoring Well between new multiport monitoring well MW-9 and MW-5 near the SW corner of the strip mall. Revise sampling frequency in years 5 – 30.	$157,000
3	Buy water for injection (phase 3) in lieu of extraction.	$4,335,000
4	Decouple the extraction system from the injection system for addressing the down-gradient plume. Consider alternative extraction well locations and alternative water sources for injection.	$4,335,000
5	Passive Conduit wells strategically placed near the distal end of the plume to meet 5 ppb criteria and Utah nondegradation criteria.	$4,933,000
6	Conduct an investigation that will consider the mass lost at the fault zone from the upper unit; model alternatives based on middle zone concentration.	($50,000)

REC # NUMBER	DESCRIPTION	POTENTIAL SAVINGS (COST)
7	Release a separate ROD for the Source Area (OU2-Phase 2) and a separate ROD for the Downgradient Groundwater Plume Containment (OU2-Phase 3).	Not Calculated

Acknowledgments

The study members should be commended for their effort and perseverance in accomplishing this very successful study. Special thanks are extended to the EPA RPM, the design firm, CDM, for their cooperation and full participation in this team VE study effort. Combined with the members from the USACE, the State of Utah, and EPA Region 8, these experts shared information with each other and generated several significant ideas that could improve the value of this remediation. The designers and EPA RPM and other technical personnel are always encouraged to participate in these studies to the maximum extent possible.

The combined efforts of all of these individuals are what produced the positive results of this study. The facilities and support provided to the team at the EPA regional office was outstanding. All of the teams' requests for any type of support were granted in a timely manner and with a can-do attitude. Special thanks are extended to the RPM, Mario Robles for his interest, corporation, support, and organization before and during the study. This is the best support the VE team has experienced working with EPA.

Significant Aspects of the VE Study

A key component to the selection and implementation of remedial actions for Bountiful/Woods Cross OU2 is the understanding of potential water rights issues. Several of the proposed remedies may require acquisition of water rights from entities yet to be identified, to perform groundwater extraction and/or injection. Issues/complications that could arise include:

- Existence of an over appropriated aquifer (lack of new available water rights).
- Potential water shortage.
- Potential complications associated with acquiring existing water rights.
- Potential complications associated with negotiating the purchase of water for injection purposes.
- Disposal concerns for extraction water.
- Effects upon existing water rights and existing well conditions.
- Attainment of public and political acceptance of remedial design.
- Potential legal issues associated with the acquisition and use of groundwater.
- Potential effects on hydrological connections to surface waters.

Because of the complexity of water rights, it is difficult to foresee all the issues that may arise during the course of the project. Once a specific remedy is selected, it will be easier to identify the issues/complications that may need to be addressed.

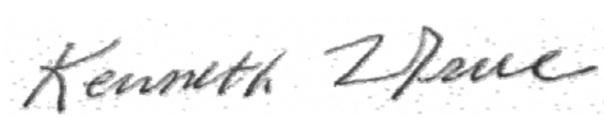
VALUE ENGINEERING SCREENING STUDY TEAM MEMBERS

NAME	ORGANIZATION
Ken True	CVS, Contractor
Hugh Rieck	USACE-HTRW CX
Lindsey Lien	USACE-HTRW CX
Tim Gallagher	USACE
Curtis Payton	USACE
Mario Robles	USEPA-RPM
Helen Dawson	USEPA Region 8 Hydrogeologist
Michael Pereira	Utah State- DEQ
Alan V. Jones	Utah State-DEQ
Todd Bragdon	CDM
Frank Morris	CDM
Ryan Wymore	CDM
Mike Smith	CDM

NOTICE
Application of Results of this Value Engineering Study

This VE Study constitutes a review of the proposed remediation as identified in the Proposed Plan and pending ROD. As with all VE studies, the project plans are reviewed using VE principles in an effort to improve its overall value and worth. Numerous recommendations for changes and design comments have resulted from this effort. The team believes these end results add to the overall value and goals of this project. However, this effort does not in any way constitute or imply approval, consent, or acceptance of the proposed remediation as identified in the Proposed Plan and pending ROD by any of the team members or the organizations that they represent. Nor does acceptance of any of the recommendations and design comments imply that the proposed remediation as identified in the Proposed Plan and pending ROD are therefore approved. It is the team's position that incorporation of the recommendations and design comments into the proposed remediation would potentially aid in the approval process.

Certification
This is to verify that the Value Engineering Screening Study was conducted in accordance with standard Value Engineering principles and practices.



Kenneth True, PE, CVS
Value Engineering Screening Study Team Leader

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SECTION 1 – INTRODUCTION

This report documents the results of "the VE Study", on the Bountiful/Woods Cross – 5th South PCE Plume (Source Soils and Groundwater) Superfund Site, Operable Unit Number Two (OU2) project Davis County, Utah. The VE Study was conducted at USEPA Regional office in Denver Colorado on June 12 - 14, 2007 following a site visit on June 11. The study team was from the USACE HTRW Center of Expertise, the EPA RPM, EPA Region 8, Utah State DEQ, the design firm CDM, and facilitated by Kenneth True, a Certified Value Specialist (CVS) and Professional Engineer. The names and telephone numbers of all participants in the study are listed in Appendix A.

The Job Plan

This study followed the basic VE methodology as endorsed by Society of American Value Engineers (SAVE) International, the professional organization of Value Engineering. This report does not include any detailed explanations of the value engineering/value analysis processes used during the workshop in development of the results presented herein. A summary of the basic processes used in the study are included to give the reader an idea of the standard VE methodology, consisting of six phases:

> **Information Phase:** The Team studied the current intermediate Design, Basis of Design Report dated March 26, 2007, the Record of Decision (ROD), portions of the Remedial Investigation and Feasibility Study, EPA criteria documents, figures, descriptions of project work, and the cost estimate to fully understand the project scope and required functions. This phase was largely done by the team prior to the on site portion of the VE Study.

> **Function Analysis Phase:** The purpose of this phase is to clearly identify the function(s) of the project, and to formulate a concept from which new directions can be taken. A Function Analysis Study Technique (FAST) Diagram is an end product of the Functional Analysis Phase. The FAST Diagram is included in Appendix C.

> **Speculation Phase:** The CVS led the Team brainstorming sessions to generate ideas that could potentially be beneficial to the remedial action. All team members contributed ideas and critical analysis of the ideas was discouraged until the Analysis Phase (see Appendix B).

> **Analysis Phase:** Evaluation, testing, and critical analysis of all ideas generated during speculation was performed to determine potential for savings or improvement to the site remediation. Ideas that did not survive critical analysis were deleted. Those feasible ideas that survive the analysis phase are then developed into recommendations. Those surviving ideas were assigned to members of the team for further development and validation of the merit of the recommendation. Sometimes this attempt to substantiate the recommendation results in the modification or even elimination of the original idea.

> **Development Phase:** Usually during a full VE Study more research and in-depth resolution is pursued with the entire group present to substantiate an idea. The ideas were

developed enough on site to determine that they were worthy of refinement. After returning to their individual offices, the VE Study Team Members completed development of the surviving ideas into written recommendations. Recommendation descriptions, along with technical support documentation, and cost estimates were prepared to support implementation of ideas. Development generally takes the form of a written document that clearly expresses the proposed idea, with a "Before" and "After" depiction. In addition, the VE Study Team identified items of interest as Comments that were not developed as recommendations. These comments follow the study recommendations.

Presentation Phase: This portion of the study was done in a short presentation on the afternoon of June 14, 2007 by the team to the EPA Region staff. See list of attendees in appendix A. The recommendations were in draft form at the time of the presentation. This report will be distributed for review by EPA to project supporters and decision makers. The EPA will determine responsibilities for implementation of accepted recommendations.

This study differs slightly from a "standard" VE study. The differences lie in the applications of some of the methodologies and the way they can be applied to an ongoing HTRW Superfund site that has numerous operable units in order to achieve the desired end result. Also, the time the team spent together was considerably decreased in part to attempt to reduce costs, save or accommodate team members' schedules and/or other obligations. The recommendations were initially developed during the June 11 – 15 meeting, and completed when team members returned to their offices. In any case, the results should be considered as completion of a Value Engineering Study for this site.

Boundary of the Study

This study was performed for OU2 Bountiful/Woods Cross - 5th South PCE Plume (Source Soils and Groundwater) for this site. The study evaluated the proposed remediation as identified in the Proposed Plan and pending ROD.

Ideas and Recommendations

Part of the VE methodology is to generate as many ideas as is practical, evaluate each idea, and then select as candidates for further development only those ideas that offer added value to the project. If an idea thus selected, turns out to work in the manner expected, that idea is put forth as a formal VE recommendation. Recommendations represent only those ideas that are proven to the VE team's satisfaction.

Comments

Some ideas that did not make the selection for development as recommendations were nevertheless judged worthy of further consideration. These ideas have been written up as Design Comments and are included in Section 4.

Level of Development

VE Studies are working sessions for the purpose of developing and recommending alternative approaches to a given project. As such, the results and recommendations presented are of a conceptual nature, and are not intended as a final design. Detailed feasibility assessment and final design development of any of the recommendations presented herein, should they be accepted, remain the responsibility of the EPA.

SECTION 2 – PROJECT DESCRIPTION

Background

This report presents the results of the VE Study on the project "Bountiful/Woods Cross Superfund Site, OU2", located between Interstate 15 and 800 West Street, Davis County, Utah. The VE study is intended to add value to projects, in terms of improved quality, enhanced construction methods, reduction in waste volume generated, or money expended on the remediation process. This VE Study was funded as part of a pilot program funded by HQ EPA, and coordinated by EPA Region 8 and the USACE HTRW-CX.

Authority for the performance of these studies is contained in the Office of Solid Waste and Emergency Response (OSWER) Directive OSWER 9335.5-24, Value Engineering for Fund Financed Remedial Design and Remedial Action Projects, signed on 14 April 2006. This directive provides guidance concerning requirements addressing Value Engineering for Superfund Remedial Design and Remedial Action Projects.

Project Description

The Bountiful/Woods Cross – 5th South PCE Plume (Source Soils and Groundwater) Superfund Site, Operable Unit Number Two (OU2) project. The Bountiful/Woods Cross OU2 study area covers approximately 400 acres, located about 10 miles north of Salt Lake City. This area is bounded on the north and south by the streets 750 South and 300 North and on the east and west sides by 500 West to 1400 West streets. These streets are located in the cities of Bountiful, West Bountiful, and Woods Cross, Utah. The OU2 study area, which includes the impacted soils at the source area and the groundwater plume, is contaminated mainly with PCE.

In 1996, UDEQ conducted a preliminary assessment (PA) after PCE contamination was confirmed at various monitoring points on and surrounding the former Phillips 66 Refinery. The PA identified groundwater as the primary exposure pathway. The PA also identified the oil refinery, several dry cleaners, and various automotive maintenance facilities as potential sources of the PCE contamination in groundwater. Due to the potential impact to drinking water in the area, EPA placed the Site on the National Priorities List (NPL) in October 2001. Following the listing, the Site was subdivided into the two operable units (OUs) - OU1 and OU2. The OU1 area was called the "Woods Cross 800 West Plume," and OU2 was the 5th South PCE Plume with an unknown source, or the "Unknown Source Plume." Results from the Remedial Investigation for OU2 concluded that contaminants (primarily PCE) originate from the Bountiful Family Cleaners (BFC) property, the source area. Contamination from the source area is reaching the domestic wells to the west of the Holly Refinery Company. The highest PCE soil concentration at the source (197 parts per million (ppm)), was measured at a depth of 8 feet. Documentation from the South Davis Sewer District supports the premise that this "hot spot" may have been the approximate location of the original dry cleaner septic system drain field prior to the facility hooking up to the main city sewer line in 1966.

Estimate of Construction Costs

The total projected capital construction cost for all the entire scope of OU-2, as identified in Table 4-2 of the *Final Feasibility Study Addendum for Bountiful/Woods Cross Superfund Site Operable Unit 2 (OU2), 5th South PCE Plume Davis County, Utah August 2006* is $4.9 million (total capital construction costs). Total present value O&M costs were estimated at $11.5 million, and include Long Term monitoring costs.

SECTION 3 – VE RECOMMENDATIONS

Organization of Recommendations
This section contains the complete documentation of all recommendations resulting from this study. Each recommendation has been marked with a unique identification number. The parent idea, or ideas from which the recommendation began, can be determined from the Creative Idea List located in Appendix B of this report. For tracking purposes, the original idea numbers that make up a recommendation are shown within the recommendation.

Each recommendation is documented by a separate write-up that includes a description of both the original design and recommended change, a list of advantages and disadvantages, sketches where appropriate, calculations, cost estimate, and the economic impact of the recommendation on the first cost, and where applicable, the life cycle cost. The economic impact is shown in terms of savings or added cost.

VALUE ENGINEERING RECOMMENDATION # 1

PROJECT: Bountiful / Woods Cross - 5th South PCE Plume NPL Site OU-2

LOCATION: Davis County, Utah EPA ID: UT001119296; Site ID: 080158

STUDY DATE: June 11-14, 2007

DESCRIPTIVE TITLE OF RECOMMENDATION:

Install infiltration gallery in the base of the source area excavation (permanganate).

This recommendation is related to Design Comments 11, 39
11: Consider SVE in shallow zone to capture any VOCs not accessible by excavation under the buildings.
39: South and west sides of the excavation will likely require sheet piling, if so, cut out a window in the sheet pile after installed, and possibly install a horizontal SVE well.

Creative Idea 3

ORIGINAL DESIGN:

Original Design calls for excavation & backfill (clean bulk soil) of a pit no greater than 15 feet. CDM estimates removal of 232 cubic yards of soil. An excavation of 15 foot depth would be roughly 25 x 25 feet.

RECOMMENDED CHANGE:

Install a gravel base with delivery piping within the excavation upon reaching the design depth. Cover the gravel bed with a geo-fabric followed by backfill with common clean fill material. The gallery would consist of a 1 to 2-foot thick gravel bed. A rounded pea gravel would provide the most effective and predictable porosity for the application desired. In addition, delivery piping would be placed in the gravel for infiltration of the oxidizing media.

SUMMARY OF COST ANALYSIS

	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$88,000	$0	$88,000
RECOMMENDED DESIGN	$106,000	$78,800	$184,800
ESTIMATED SAVINGS OR (COST)	($18,000)	($78,800)	($96,800)

VALUE ENGINEERING RECOMMENDATION # 1

ADVANTAGES:

- Creates a gallery for treatment fluids to “pond” and have an opportunity to bleed in to the underlying clay
- Provides delivery system for cleanup of clay at 17-20 feet
- This can be abandoned as a concept or option if the excavation does not leave behind contamination (in the clay layer). This will be shown when geoprobe results are received
- Treatment media placed in the gallery MIGHT follow preferential migration pathways that contamination had followed

DISADVANTAGES:

- Slightly increases materials handling and purchase costs
- Delivery of oxidizing treatment media creates an O&M process that was not in the original design unless the application is a one time effort.
- No way of tracking uniformity of delivery if there is only one input point.
- Might short-circuit the design described in item 8 (SVE under building between 0-15 feet)

JUSTIFICATION:

Based on thee cost of retroactively attempting to clean up clay that could not be removed during the excavation process, the additional costs are justifiable. However, if a geoprobe sampling effort can determine that the clay material around 15 feet and below does not contain appreciable amounts of the PCE contaminant, then such a gallery would be unnecessary. Otherwise the treatment method is simple and easy to operate. The main costs of O&M would be cost of media to be added. This could be offset by using other contracting methods or credit card purchases to pay for irregularly scheduled site visits to apply the media.

REFERENCES:

CDM. 2005; *Final Focused Feasibility Study Report for Bountiful/Woods Cross 5th South PCE Plume (OU2) Davis County, Utah*. Camp Dresser & McKee Federal Programs Corporation (CDM). July 2005.

VALUE ENGINEERING RECOMMENDATION # 1

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Excavation	cy	4.64		232	$1,076	232	$1,076
mileage qty	*mi*			*200*		*200*	
Soil Disposal	cy-mi	0.60		46,400	$27,840	46,400	$27,840
Fill Import	cy	20.00		232	$4,640	186	$3,720
Fill Plaement	cy	4.00		232	$928	186	$744
Pea Gravel Import	cy	22.00			$0	46	$1,012
Pea Gravel Plaement	cy	5.00			$0	46	$230
Geomembrane Puchase	sq ft	1.00			$0	625	$625
Geomembrane Plaement	sq ft	3.00			$0	625	$1,875
Piping Puchase	ln ft	8.00			$0	200	$1,600
Piping Plaement	ln ft	4.00			$0	200	$800
					$0		$0
					$0		$0
Subtotal					$34,484		$39,522
Mark-up		@	156%		$53,796		$61,655
Redesign Costs							$5,000
Total					$88,280		$106,178
oxidizing media purchase	gal	4.00		0	$0	6,000	$24,000
oxidizing media delivery	ls	3,000.00		0	$0	2	$6,000
Subtotal					$0		$30,000
Mark-up		@	156%		$0		$46,800
Redesign Costs							$2,000
O&M Total					$0		$78,800

VALUE ENGINEERING RECOMMENDATION # 2

PROJECT: Bountiful / Woods Cross - 5th South PCE Plume NPL Site OU-2

LOCATION: Davis County, Utah EPA ID: UT001119296; Site ID: 080158

STUDY DATE: June 11-14, 2007

DESCRIPTIVE TITLE OF RECOMMENDATION:

Install an additional multi-port monitoring well into the middle Water Bearing Zone (WBZ) (200+ feet bgs) downgradient from the source area near the southwest corner of strip mall (Ross), generally between planned source area multi-port monitor well (MW-9) and existing well MW-5. Reduce monitoring frequency in years 6 – 30.

Creative Idea 10

ORIGINAL DESIGN:

Install only one 250 ft-deep multi-port well (MW-9) to about 250 ft bgs, near SW corner of Bountiful Family Cleaners property to investigate and monitor the middle WBZ in source area. Monitor downgradient effects of source area treatment at existing well MW-5.

RECOMMENDED CHANGE:

Install one additional multi-port monitoring well between new source area well (MW-9) and MW-5, near SW corner of strip mall (Ross), into middle WBZ (200+ feet bgs). Modify the sampling frequency from quarterly in years 1 – 30 to quarterly in years 1 – 5, semiannually in years 11 – 20, and annually in years 21 – 30.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$415,710	$655,000	$1,070,700
RECOMMENDED DESIGN	$484,995	$428,642	$913,637
ESTIMATED SAVINGS OR (COST)	(-69,285)	$226,786	$157,063

VALUE ENGINEERING RECOMMENDATION #2

ADVANTAGES:

Would provide a downgradient monitoring point proximal to the source area to provide data as soon as possible to evaluate the downgradient effects of pilot-scale and full-scale performance of source area treatment and Enhanced Anaerobic Biodegradation (EAB) recirculation and downgradient plume capture. It also would provide a long-term monitoring point for early detection of any contaminant rebound after active treatment is ended. The information obtained from this well will help insure that EAB is treating all targeted groundwater moving from the source area.

Would provide information to characterize the vertical movement of groundwater, and vertical plume extent, a relatively short distance downgradient from the source area. Even if no PCE is found in the middle water bearing zone immediately beneath the source area (planned well MW-9), the plume may extend down into the middle zone within a short distance of the source area. Such information may aid in design of the EAB injection/extraction wells, and should be monitored.

Would help define horizontal groundwater flow direction in middle water bearing zone near source. Flow direction in the middle zone is currently not well-defined and is suspected to be more southerly than flow direction in the upper water bearing zone.

DISADVANTAGES:

None, other than cost.

JUSTIFICATION:

An additional monitoring well will provide the clearest picture, in the shortest possible time, to evaluate effectiveness of excavation and EAB treatment a short distance downgradient of the source area. The nearest existing well to observe downgradient effects of source area treatment is MW-5, which is a relatively long travel time (2+ years?) from the source area. Also, the location of MW-5 with respect to the axis of the contaminant plume is not well known. The effects of source area treatment at MW-5 will be much delayed and less pronounced than at a point closer to the treatment area. The relatively modest increase in capital and monitoring costs to obtain the earliest possible and highest quality downgradient performance data will help insure the most effective EAB design and treatment at the lowest overall long-term cost.

VALUE ENGINEERING RECOMMENDATION #2

Cost Item	Units	$/Unit	Source Code	Original Design		Recommended Design	
				Num of Units	Total $	Num of Units	Total $
Monitoring Well Installation	ea	69,285.00		6	$415,710	7	$484,995
Total Capital Costs					$415,700		$484,995
O&M Costs Monitoring							
yr 1- 5 Discnt Fac 4.1	ea	52,780.00		4.10	$216,398		$0
yr 6-10 Discnt Fac 2.92	ea	52,780.00		2.92	$154,118		$0
yr 11- 30 Discnt Fac 5.39	ea	52,780.00		5.39	$284,484		$0
					$0		$0
yr 1- 5 Discnt Fac 4.1	ea	61,577.00			$0	4.10	$252,466
yr 6-10 Discnt Fac 2.92	ea	30,800.00			$0	2.92	$89,936
yr 11- 30 Discnt Fac 5.39	ea	16,000.00			$0	5.39	$86,240
					$0		$0
Total O&M Costs					$655,000		$428,642
					$0		$0
					$0		$0
					$0		$0
					$0		$0
					$0		$0
					$0		$0
					$0		$0
Subtotal					$1,070,700		$913,637
Mark-ups applied in unit costs		@			$0		$0
Redesign Costs NA							
Total					$1,070,700		$913,637

O&M costs for 6 monitoring wells were assumed to be equal to 7 wells, added monitoring costs are reflected for quarterly sampling and analysis for years 1-5, reduced to semiannually for years 6-10, annually thereafter

Present worth based on 7% discount factor

Costs from 2006 FS Addendum

VALUE ENGINEERING RECOMMENDATION # 3

PROJECT: Bountiful / Woods Cross - 5th South PCE Plume NPL Site OU-2

LOCATION: Davis County, Utah EPA ID: UT001119296; Site ID: 080158

STUDY DATE: June 11-14, 2007

DESCRIPTIVE TITLE OF RECOMMENDATION:

Buy water for injection wells (phase 3) in lieu of using water from extraction wells.

Creative Idea 13

ORIGINAL DESIGN:

The original concept in the Final Feasibility Study Addendum (FSA) and the preferred alternative in the Proposed Plan (PP) recommends a hydraulic containment/extraction component for the plume upgradient of the proposed extraction wells. The proposed containment will be accomplished by installing two groundwater extraction wells inside the Holly Refinery property. Each well would pump 300 gpm from the middle water bearing zone (WBZ). Extracted water will be treated and conveyed to the distal end of the plume and injected back into the middle WBZ. The injected flow will ensure the distal isoconcentration line at the MCL does not expand. This is intended to meet the anti degradation ARAR identified in the documents cited by diluting the impacted water with clean water.

RECOMMENDED CHANGE:

Provide alternative source(s) for injection water used to dilute that portion of the plume subject to degradation (e.g., to meet the anti degradation ARAR). The water extracted for plume containment can be used for other purposes. Refer to Idea List items 27 and 29 for alternate extraction locations and uses.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$2,036,000	$4,139,000	$6,175,000
RECOMMENDED DESIGN	$1,406,000	$434,000	$1,840,000
ESTIMATED SAVINGS OR (COST)	$630,000	$3,705,000	$4,335,000

VALUE ENGINEERING RECOMMENDATION #3

ADVANTAGES:

- Reduce or eliminate conveyance piping/trenching and associated pumping
- Less infrastructure installation such as pumps, power, controls and treatment is necessary
- If potable water or irrigation district water is used, variable seasonal flow requirements in the injection well system can be met efficiently by simply adjusting flow rate from the pressurized source
- Potential significant cost savings
- Reduces access/right of entry requirements

DISADVANTAGES:

- The water chemistry from other sources may differ significantly from the receiving aquifer, additional monitoring and oversight may be necessary
- Disinfection byproducts (chloroform) may be present in the injection water supply
- Treatment may be necessary prior to injection
- May involve issues related to coordination and administration of water rights

JUSTIFICATION:

By allowing the flexibility of selecting from a number of sources for injection water, it also provides flexibility in selection of the most advantageous extraction point or points to control plume migration. If a pressurized supply (city) is selected, long pipe runs and associated right of way clearances from multiple landowners will be eliminated, although coordination and buy in with appropriate water purveyors or other water sources would be needed. Costs for this option based on an injection rate of 200 gpm would likely be significantly lower than treatment and conveying water from the proposed extraction wells to the injection wells.

VALUE ENGINEERING RECOMMENDATION #3

Cost Item	Units	$/Unit	Original Design		Recommended Design	
			Num of Units	Total $	Num of Units	Total $
Injection Well Installation	ea	116,250.00	4	$465,000	4	$465,000
Pump Tests	LS	46,500.00	1	$46,500	1	$46,500
Treatment System & Piping	LS	1,026,700.00	1	$1,026,700		$0
Extraction Wells	ea	249,250.00	2	$498,500	2	$498,500
Potable Water Purchase	1000/gal	1.20	0		105,120	$126,144
GAC Dechlorination System	ea	270,000.00	0	$0	1	$270,000
Total Capital Costs				$2,036,700		$1,406,144
				$0		$0
O&M Costs Trt Sys				$0		$0
yr 1- 5 Discnt Fac 4.1	ea	333,500.00	4.10	$1,367,350		$0
yr 6-10 Discnt Fac 2.92	ea	333,500.00	2.92	$973,820		$0
yr 11- 30 Discnt Fac 5.39	ea	333,500.00	5.39	$1,797,565		$0
				$0		$0
Total O&M Costs Current				$4,138,735		$0
				$0		$0
O&M Costs Trt Sys				$0		$0
yr 1- 5 Discnt Fac 4.1	ea	35,000.00		$0	4.10	$143,500
yr 6-10 Discnt Fac 2.92	ea	35,000.00		$0	2.92	$102,200
yr 11- 30 Discnt Fac 5.39	ea	35,000.00		$0	5.39	$188,650
				$0		$0
Total O&M Costs Proposed				$0		$434,350
				$0		$0
				$0		$0
Subtotal				$6,175,435		$1,840,494
Mark-ups applied in unit costs		@				
Redesign Costs NA						
Total				$6,175,435		$1,840,494

Cost for GAC system and O&M based on mfr literature and RACER Model and 6000# GAC changed out/yr for Cl removal
Present worth based on 7% discount factor
O&M not calculated for extraction wells since that cost was assumed to be the same for both scenarios
Costs for original design from 2006 FS Addendum

VALUE ENGINEERING RECOMMENDATION # 4

PROJECT: Bountiful / Woods Cross - 5th South PCE Plume NPL Site OU-2

LOCATION: Davis County, Utah EPA ID: UT001119296; Site ID: 080158

STUDY DATE: June 11-14, 2007

DESCRIPTIVE TITLE OF RECOMMENDATION:

Decouple the extraction system from the injection system for addressing the down-gradient plume. Consider alternative extraction well locations and alternative water sources for injection.

Creative Ideas 27 & 29

ORIGINAL DESIGN:

Original design called for a coupled extraction and injection system in which the extracted water is treated (if necessary) and piped to the injection system. The separation between the two systems was estimated at several thousand feet.

RECOMMENDED CHANGE:

Decouple the extraction system from the injection system for addressing the down-gradient plume. Consider alternative extraction well locations and alternative water sources for injection.

Extract contaminated groundwater from the middle zone under Holly Refinery and provide the extracted water to Holly Refinery to supplement their process water supply, with potential treatment, if necessary. Alternately, extract contaminated groundwater from the middle zone near MW-4 and provide the extracted water to Bountiful via a new pipeline connection to an existing water main to supplement their irrigation distribution system.

To meet Utah's anti-degradation criteria and maintain MCLs at the distal end of the plume, concentrations at the distal end of the plume would still require dilution either by injecting clean water (discussed in # 13) or through the installation of passive conduit wells (discussed in # 31), unless an ARAR waiver is granted (discussed in # 28). The cost breakdowns, summarized below, would be similar to those identified in Recommendation 3.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$2,036,000	$4,139,000	$6,175,000
RECOMMENDED DESIGN	$1,406,000	$434,000	$1,840,000
ESTIMATED SAVINGS OR (COST)	$630,000	$3,705,000	$4,335,000

VALUE ENGINEERING RECOMMENDATION #4

ADVANTAGES:

- Large capital cost savings; eliminates need for piping from extraction to injection systems
- Large O&M cost savings; assumes Holly Refinery or Bountiful will assume well operation
- Reduce impacts to deeper aquifer by reducing Holly's need to pump water from the deeper zone and development of an upward gradient from deep zones to the middle zone, driven by the new well
- PR opportunity for Holly
- May serve to integrate and support Holly's remediation
- May serve to alleviate water rights issues

DISADVANTAGES:

- Holly Refinery and Bountiful Irrigation District demand may not meet Superfund extraction needs. Extraction will be conducted on a year-round basis; Holly and particularly Bountiful may not have a year-round demand
- Liability issues in taking Superfund effluent and operating a remediation facility
- Administrative implementation issues
- May add treatment costs to Holly
- May potentially develop a downward gradient from the upper zone to the middle zone that could increase downward migration of contaminants
- (Note: Any disadvantage to Holly would be a disadvantage to EPA)

JUSTIFICATION:

By allowing the flexibility of selecting from a number of sources for injection water, it also provides flexibility in selection of the most advantageous extraction point or points to control plume migration. If a pressurized supply (city) is selected, long pipe runs and associated right of way clearances from multiple landowners will be eliminated, although coordination and buy in with appropriate water purveyors or other water sources would be needed. Costs for this option would be significantly lower than treatment and conveying water from the proposed extraction wells to the injection wells.

VALUE ENGINEERING RECOMMENDATION # 5

PROJECT: Bountiful / Woods Cross - 5th South PCE Plume NPL Site OU-2

LOCATION: Davis County, Utah EPA ID: UT001119296; Site ID: 080158

STUDY DATE: June 11-14, 2007

DESCRIPTIVE TITLE OF RECOMMENDATION:

Investigate using Passive Conduit Wells strategically placed near the distal end of the plume for diffuse plume concentration management to meet 5 ppb PCE and Utah non-degradation criteria for an acceptable remedy

Creative Idea 31

ORIGINAL DESIGN:

Inject GAC-treated water pumped from new, upgradient extraction wells to dilute diffuse concentrations at distal plume margin and slow downgradient advance of 5 ppb isoconcentration line in the middle water bearing zone. Treated water would be conducted to distal end of plume by pipeline(s). Alternatives discussed include buying/trading for irrigation or PWS (chlorinated) water for injection (Recommendation #3).

RECOMMENDED CHANGE:

Consider installing passive conduit wells designed to conduct water locally from deeper, clean Water Bearing Zone(s) (WBZ) upward into the middle WBZ by natural, existing potentiometric head differences between deep confined zones and middle WBZ (i.e. "artesian" flow).

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$2,036,700	$4,138,735	$6,175,435
RECOMMENDED DESIGN	$1,242,500	$0	$1,242,500
ESTIMATED SAVINGS OR (COST)	$794,200	$4,138,735	$4,932,935

VALUE ENGINEERING RECOMMENDATION # 5

ADVANTAGES:

- Would deliver uncontaminated water to locations in the middle WBZ necessary for distal plume management to meet non- degradation and MCL criteria
- Eliminate four injection wells and pumps; eliminate treatment for PCE or alternative chlorinated PWS water; eliminate pipeline construction and right-of-way issues; reduce or eliminate need for two extraction wells
- Eliminate Long-Term O&M for extraction and injection pumps; treatment; pipeline maintenance/repair costs
- Avoid impact to private well water levels and chlorination issues (THHM)
- Avoid water rights issues and UIC regulations – simply allowing water to move more freely toward natural potentiometric equilibrium within the same aquifer (East Shore Aquifer)
- Provides clean water in a more widely distributed pattern than a few injection points; may allow more flexibility in placement of introduced water
- Avoid seasonal demand/supply issues associated with groundwater withdrawal

DISADVANTAGES:

- May not have sufficient upward gradient potential necessary everywhere that introduction of water is desirable. However, sufficient upward gradient is demonstrated to be regionally present in deeper artesian irrigation and PWS wells (*e.g.* West Bountiful 5^{th} South Well)
- Requires deeper wells (400+ feet bgs) than extraction from the middle WBZ
- May require several small wells to achieve the same total flow as a single injection well operating at high pressure. (There may also be an advantage to having more numerous locations for introduction of clean water)
- Some chance of losing sufficient regional upward flow gradient over the long term if confined potentiometric level is lowered by regional development/pumping, drought, *etc*. This could be overcome by installing relatively small capacity “booster” pumps in the conduit wells
- May have water chemistry / water quality differences between contributing and accepting zones that need to be addressed. This may not be a problem because the zones are within same aquifer system
- Community acceptance; this recommendation may change the Preferred Alternative as it has been presented to the public
- Novel, innovative approach - will require up-front investigation and prove-out before acceptance

VALUE ENGINEERING RECOMMENDATION # 5

JUSTIFICATION:

Simplest, lowest life cycle cost solution to manage contaminant concentrations at distal plume margin. Potential for very large life-cycle cost savings in O&M for extraction, treatment, and injection, and avoidance of numerous legal, right-of-way, and regulatory issues.

VALUE ENGINEERING RECOMMENDATION # 5

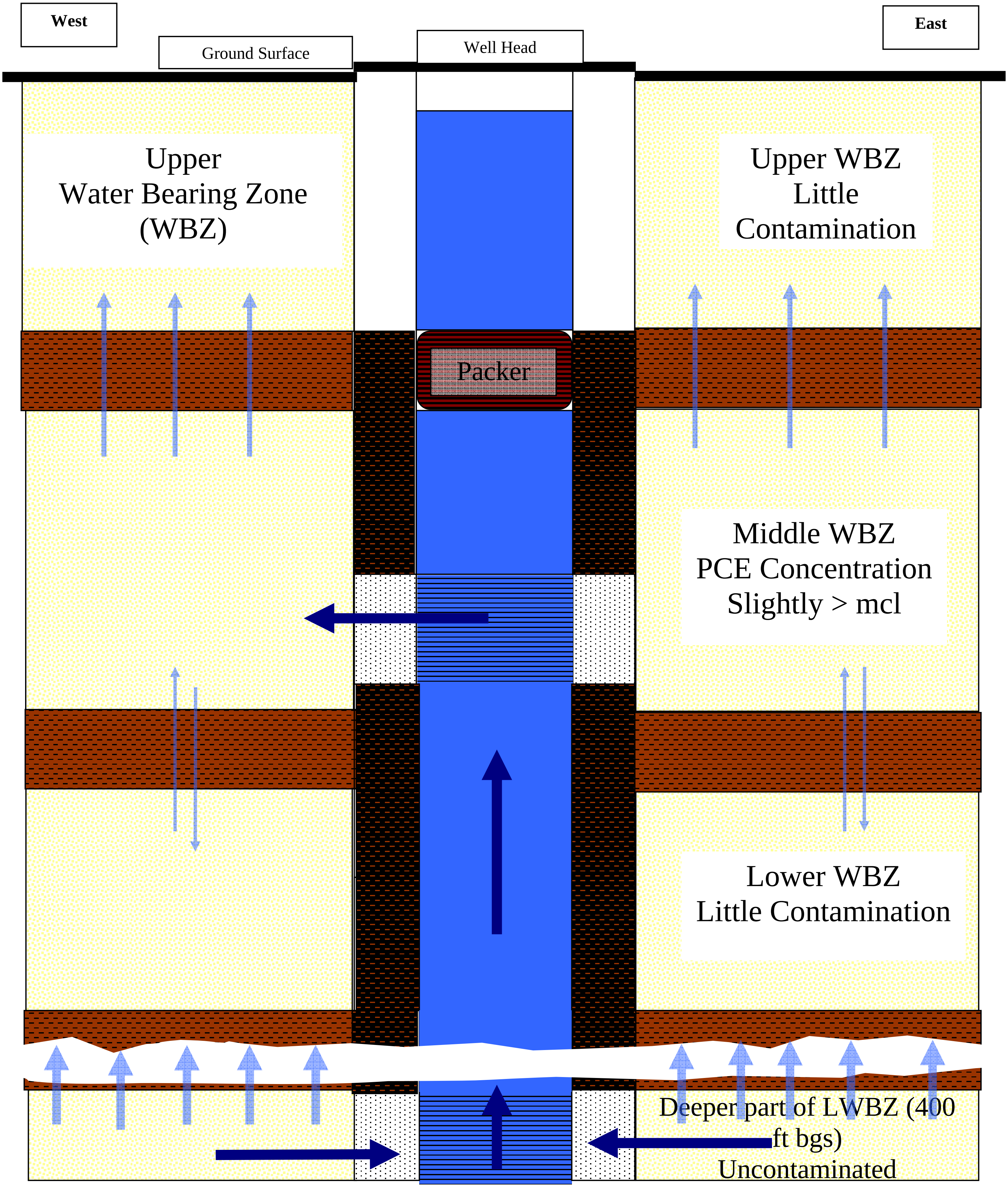
Cost Item	Units	$/Unit	Original Design		Recommended Design	
			Num of Units	Total $	Num of Units	Total $
Injection Well Installation	ea	116,250.00	4	$465,000	6	$697,500
Pump Tests	LS	46,500.00	1	$46,500	1	$46,500
Treatment System & Piping	LS	1,026,700.00	1	$1,026,700		$0
Extraction Wells	ea	249,250.00	2	$498,500	2	$498,500
				$0		$0
Total Capital Costs				$2,036,700		$1,242,500
				$0		$0
O&M Costs Trt Sys				$0		$0
yr 1- 5 Discnt Fac 4.1	ea	333,500.00	4.10	$1,367,350		$0
yr 6-10 Discnt Fac 2.92	ea	333,500.00	2.92	$973,820		$0
yr 11- 30 Disc Fac 5.39	ea	333,500.00	5.39	$1,797,565		$0
				$0		$0
Total O&M Costs				$4,138,735		$0
				$0		$0
				$0		$0
				$0		$0
Subtotal				$6,175,435		$1,242,500
Mark-ups applied in unit costs		@		$0		$0
Redesign Costs NA						
Total				$6,175,435		$1,242,500

O&M for 6 passive injection wells were assumed to be equal to 4 active injection wells

Present worth based on 7% discount factor

O&M not calculated for extraction wells since that cost was assumed to be the same for both scenarios

Costs from 2006 FS Addendum



Schematic of Passive Conduit Well
In Downgradient Portion of Plume

VALUE ENGINEERING RECOMMENDATION # 6

PROJECT: Bountiful / Woods Cross - 5th South PCE Plume NPL Site OU-2

LOCATION: Davis County, Utah EPA ID: UT001119296; Site ID: 080158

STUDY DATE: June 11-14, 2007

DESCRIPTIVE TITLE OF RECOMMENDATION:

Conduct an investigation that will consider the mass lost at the fault zone from the upper unit; model alternatives based on middle zone concentration.

Creative Idea 32

ORIGINAL DESIGN:

The analysis presented in the FS did not consider any mass loss mechanisms, other than vertical mixing and sorption onto the aquifer matrix.

RECOMMENDED CHANGE:

The projections of plume migration and cleanup times should include the loss of mass along the Warm Springs fault, provided that field studies support this hypothesis. Currently, the plume in the upper aquifer terminates near the fault zone, where seeps are observed. This suggests that groundwater is upwelling along this fault zone, carrying with it the PCE. Future modeling should include both the seepage quantity and loss of mass of contaminant in the upper zone in developing projections of future contaminant migration and cleanup times.

SUMMARY OF COST ANALYSIS

	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	$0	$0	$0
RECOMMENDED DESIGN	$50,000	Not Calculated	Not Calculated
ESTIMATED SAVINGS OR (COST)	($50,000)	Not Calculated	Not Calculated

VALUE ENGINEERING RECOMMENDATION #6

ADVANTAGES:

- This will necessitate evaluation of risk issues, primarily to ecological receptors, in the seepage area that has not been evaluated in the current RI. This will quantify the risk to determine if any action needs to be taken.
- Removal of mass from groundwater may be significant, resulting in a more rapid downgradient cleanup time than currently projected. This seepage zone may also impact (reduce) the quantity of water that may need to be injected at the leading edge of the plume.
- Provides needed data concerning aquifer degradation at the distal end

DISADVANTAGES:

- This will require collection of additional data to define the presence and magnitude of the potential loss term.
- Evaluation will require more sophisticated modeling included in the Phase 3 pilot, rather that the existing 2-D model that is available.
- Aquifer testing necessary to develop the 3-D model will be required to analyze this issue

JUSTIFICATION:

Cost of $50,000 could be off set by savings realized by targeting the extraction points more accurately on the basis of a more realistic model. The results of the investigation will refine the fate and transport model such that it addresses VOC losses to the surface near the warm springs fault, possibly reducing cleanup times and volume of water needed for injection to contain the dilute portion of the plume at the MCL.

VALUE ENGINEERING RECOMMENDATION # 7

PROJECT: Bountiful / Woods Cross - 5th South PCE Plume NPL Site OU-2

LOCATION: Davis County, Utah EPA ID: UT001119296; Site ID: 080158

STUDY DATE: June 11-14, 2007

DESCRIPTIVE TITLE OF RECOMMENDATION:

Release a separate ROD for the Source Area (OU2-Phase 2) and a separate ROD for the Downgradient Groundwater Plume Containment (OU2-Phase 3).

Creative Idea 34

ORIGINAL DESIGN:

The "Proposed Plan" presented the preferred alternatives to the public in October 2006. The alternatives proposed are:

- Source Area, Alternative 3 – Enhanced Anaerobic Bioremediation/Soil Vapor Extraction, Excavation and Disposal (Phase 2).
- Groundwater Plume, Alternative B – Hydraulic Containment (extraction, treatment of groundwater and injection of clean water into the aquifer (Phase 3).

Based on the Proposed Plan and the public meeting, EPA proceeded to draft a ROD to address both phases concurrently for the source area and the downgradient groundwater plume.

RECOMMENDED CHANGE:

To protect public health and the environment and to stay within the timeline to meet the administrative requirements, it is recommended two RODs be released; one for OU2 Phase 2, and one for OU2 Phase 3.

SUMMARY OF COST ANALYSIS			
	First Cost	O & M Costs (Present Worth)	Total LC Cost (Present Worth)
ORIGINAL DESIGN	Not Calculated	Not Calculated	Not Calculated
RECOMMENDED DESIGN	Not Calculated	Not Calculated	Not Calculated
ESTIMATED SAVINGS OR (COST)	Not Calculated	Not Calculated	Not Calculated

VALUE ENGINEERING RECOMMENDATION # 7

ADVANTAGES:

- Accelerate the RA in the source area
- Meet timeline for administrative requirements (ROD)
- Provide an earlier remedy completion at the source area
- Provides EPA with funding flexibility (funding for separate remedial actions)
- Will allow collection of supplemental RI information to support the RD for Phase 3
- Reduce uncertainties with the effectiveness of the selected remedy for the groundwater plume containment
- Better understanding of the life cycle cost for the project
- May reduce O&M cost

DISADVANTAGES:

- May delay the remedial action start target date for phase 3
- May need a public meeting (Adds to schedule duration)
- May delay process for a phase 3 remedy selection
- May lead to request concurrence for ARARs waivers

JUSTIFICATION:

At the source area, contamination has been delineated with a degree of certainty to proceed with a pilot study to support the RD/RA at OU2. However, size of the impacted area (Approximately 400 acres), the complexity with the Site's geology, hydrogeology, contaminant distribution/transport mechanisms within aquifer (U, M, L), there are uncertainties and concerns on the effectiveness of the remedy. For this reason the VE team recommends to collect supplemental information to support the RI, the PP, the ROD and the RD.
Releasing two RODs will allow EPA/UDEQ to proceed to implement the selected remedy at the source and to collect supplemental information needed to support the RD/RA for the downgradient groundwater plume.

SECTION 4 - DESIGN COMMENTS

DESIGN COMMENTS

ID # CMT #	Design Comment / Description
4	**USE GEOPHYSICS TO DETERMINE IF THE SEPTIC TANK/TILE FIELD ARE STILL IN PLACE.** Discussions with the RPM and Designers indicated it is uncertain whether the existing septic system was removed when the facility was connected to the municipal sewer system. Employ the use of appropriate geophysical methods to locate any artifacts that are associated with the septic system. If the septic tank is still present, it will act as a continuing source of contamination via leaks.
5	**USE A VIDEO CAMERA TO INDICATE IF THE MUNICIPAL SEWER CONNECTION WAS MADE TO THE SEPTIC TANK EFFLUENT OR IF IT WAS CONNECTED UPSTREAM OF THE SEPTIC SYSTEM.** If the septic tank is still present, it will act as a continuing source of contamination via leaks. If the waste from the building is in contact with solvents leaks in the sewer may also be a continuing source of contamination to the vadose and saturated zones.
6, 17	**VIBRATORY SHEET PILE INSTALLATION AROUND SOURCE EXCAVATION. USE SOIL NAILING/EARTH ANCHORS FOR EXCAVATION STABILITY.** (Assuming a shoring system is necessary). Any number of excavation support systems may be utilized at the site (vibratory sheeting, drilled piers and lagging, soil nailing, etc.). It should be left up to the specialty contractor to decide which system is most appropriate for this installation. However, the prime contractor should include, in the contract specifications, language similar to the following: 1. 'Choice of shoring system must accommodate the possibility that penetration(s) through the shoring sidewalls may be necessary at some point to access the soils beyond.' 2. '…The contractor shall be responsible to ensure that all adjacent structures shall not incur damage as a result of the support system installation…' Also suggest that the adjacent property owner(s) be encouraged to accompany the contractor in a comprehensive inspection of their property, prior to work start, to document the existing conditions.
7	**CONSIDER SWING/GRAVEYARD SHIFT FOR RA ACTIVITIES FOR SOURCE REMOVAL EXCAVATION.** This approach would have the advantages of (1) eliminating the need for a night watchman; (2) eliminating the impacts to commercial/retail operations other than long standing infrastructure; and (3) decreases to need for traffic control. This must consider, however, the effect the construction noise might have on the residential community.
8	**CONSIDER USING A HORIZONTAL WELL FOR SVE UNDER THE BUILDING AT 20 TO 70-FOOT LEVEL (VADOSE ZONE) AND ANGLE BORINGS FOR THE GW RECIRCULATION.** A horizontal well has the advantage of allowing the user to deliver an extraction zone along a linear profile and

DESIGN COMMENTS	
ID # CMT #	**Design Comment / Description**
	at a targeted depth instead of at single vertical points of extraction. This may require a larger capacity for vacuum.
11	**CONSIDER SVE IN SHALLOW ZONE TO CAPTURE ANY VOCS NOT ACCESSIBLE BY EXCAVATION (UNDER THE BUILDINGS).** This approach would also use horizontal drilling technology to get under the buildings and if necessary install a SVE to capture unexcavated contaminated soil in the 0- to 15-foot zone.
23	**MAP FAULT AND OR PERFORM SEISMIC FAULT ANALYSES (SUPPLEMENTAL PHASE 3 RI).** This design comment is part of he overall subject heading of "Supplemental Remedial Investigation – Phase 3". This approach would include performing the equivalent of a "special studies zone" investigation (e.g. Calif. Alquist Priolo Special Studies Zone Act). This would include performing seismic geophysics to trace the fault as deep as possible and if possible identify stratigraphy near the fault as well as determine the dip of the fault and thickness of the zone. This would also include trenching across the race of the fault in an effort to define the near surface expression of the fault.
24	**INVESTIGATE WHETHER THE HOLLY REFINERY HAS DONE ANY FAULT ANALYSIS FOR EXISTING STRUCTURES (ALSO ASK UGS) (SUPPLEMENTAL PHASE 3 RI). THIS IS SUBSET OF THE WORK IDENTIFIED IN 23.** This approach would also include researching whether Holly Refinery, the City of Bountiful, or County of Davis has any records or reports detailing any past fault trace investigations. See item 24 above.
25	**MOVE THE SANITARY SEWER SERVICE TO THE FRONT OF THE BUILDING OUTSIDE OF EXPECTED EXCAVATION AREA.** *Prior* to the commencement of the pilot test activities, which include geoprobe installation, monitoring well installation, injection and extraction well installation, sewer line investigation, etc., abandon the existing sewer line and install a new service line to the main. Installation of a new lateral will be necessary prior to the source removal activities anyway. The new lateral shall be installed at such a point within the building that will ensure that it will not be affected by future investigative and remediation activities. All other potentially affected utilities (i.e. water service) should be treated in the same manner. Early abandonment will make the existing line easily accessible for video operations. * The possibility exists that either one or both of the following conditions currently exist in this 40-year old line: 1) The existing sewer line is structurally deficient (cracked, loose joints, etc.) and is leaking into the source area and providing downward/outward mobility of

DESIGN COMMENTS	
ID # CMT #	**Design Comment / Description**
	contaminants. 2) The original septic tank remains in-line and any operation of the sanitary line introduces (new) sanitary water into any residual contamination. To reduce disturbance to the property owner, the sewer line video operations should be scheduled at the time (prior to or immediately thereafter) of the lateral replacement. Refer to comments 4 and 5.
26	**INSTALL WELLS WITH FLEXIBILITY FOR EXTRACTION FROM UPPER, MIDDLE, AND/OR LOWER ZONES.** The design of extraction wells should consider a construction method that would allow withdrawal from one or more contaminated zones while allowing other unaffected (or less contaminated) zones to be at least temporarily shut-in or isolated. In order to accomplish this goal, the extraction well should be screened across precise intervals of the most productive or transmissive sand and gravel units. Blank casing would ideally separate the screened intervals and be constructed across discrete confining zones that could be considered effective aquitards. The annular space between the screen intervals should be carefully sealed with a non-shrinking bentonite grout material. A single or straddle-packer could be placed appropriately to isolate the preferred extraction zone(s) from the others.
28	**EPA, CDM AND UDEQ SHOULD MEET TO DISCUSS THE POSSIBILITY OF AN ARAR WAIVER, ACLS OR OTHER ALTERNATIVES.** At the very least the proposed alternative that is selected must stop migration of the contaminant(s) at the current plume boundary. According to UAC R311-211-4, Prevention of Further Degradation, "In determining background concentrations, cleanup standards, and significance levels, levels of contaminants in groundwater, surface water, soils or air will not be allowed to degrade beyond the existing contamination levels determined through appropriate monitoring or the use of other data accepted by the Board of Executive Secretary as representative".
30	**CONSIDER ADDRESSING IDENTIFIED DATA GAPS IN A SUPPLIMENTARY RI FOR THE PHASE 3 REMEDIATION.** The primary data gaps are identified in Design Comments 23, 24, 35, 36 and 37.
35	**CONSIDER USING TREE CORE SAMPLES FOR QUALITATIVE (PRESENCE/ABSENCE) HORIZONTAL DELINEATION OF PCE PLUME EXTENT UPGRADIENT AND DOWNGRADIENT OF WARM SPRINGS FAULT IN SHALLOWEST GROUNDWATER** (for Phase 3 Supplementary RI)**.** Trees and other plants draw VOC and other contaminants dissolved in groundwater and soil pore water into their vascular tissue. If PCE is present in the root zone of trees, either as groundwater or in pore water of the unsaturated zone by upward capillary transport, PCE can be present in small diameter cores from the trunk at concentrations detectable by portable GC. Concentrations of PCE accumulated in wood tissue are different for different tree species and exposure times; higher VOC concentrations commonly are obtained from lower in the trunk. Although the method is strictly qualitative and no inference regarding PCE concentrations in the

DESIGN COMMENTS	
ID # CMT #	**Design Comment / Description**
	groundwater or pore water can be made, it is a relatively low-cost screening method that can be used to delimit PCE plumes in shallow groundwater. (examples: Vroblesky, D.A. et al., 1999; or Schumacher, J.G. et al., 2004)
36	**COLLECT PASSIVE POLYETHYLENE VAPOR DIFFUSION (PVD) SAMPLES FROM GROUNDWATER SURFACING AT SEEPS AND SURFACE DISCHARGE AREAS TO CONFIRM LOSS OF PCE MASS FROM SHALLOW GROUNDWATER TO AIR ON DOWNGRADIENT SIDE OF WARM SPRINGS FAULT** (for Phase 3 Supplementary RI)**.** PVD or other passive samplers buried at shallow depths (12 inches) offer low-cost screening methods to delimit horizontal extent of near-surface VOC plumes discharging to marsh or wetlands. Micropiezometers, or several other passive sampling techniques are alternative options.
37	**DETERMINE INJECTION WATER FLOW RATE TO MEET THE DOWN GRADIENT ARAR** (for Phase 3 Supplementary RI)**.** The original FS and Phase 3 planning anticipated a balanced system, where all water pumped from within the plume is injected at the leading edge to prevent extension of the area exceeding the MCL. Decouple the extraction system from the injection system for addressing the down-gradient plume. Several other recommendations consider use of other water sources for this injection. The objective of this evaluation is to determine the quantity of water that would be injected to meet the requirement of stabilizing the MCL extent. This will require use of the planned 3-D model and supporting field data in order to assess these quantities. Limiting quantity of water necessary to meet ARAR will simplify water rights issues, and provides flexibility in water source for downgradient control of the plume although it will require additional data collection and modeling.
39	**SOUTH AND WEST SIDES OF THE EXCAVATION WILL LIKELY REQUIRE SHORING OF SOME KIND – THAT SHORING SYSTEM SHOULD BE DESIGNED TO ALLOW FOR THE CREATION OF A “WINDOW” IN THE SHORING SYSTEM DESIGNED TO PROVIDE ACCESS FOR SAMPLING AND OR SVE EXTRACTION SYSTEM INSTALLATION.** This technology could be used to place the injection and extraction points closer together. This method also allows the user to install the extraction points at least 75 feet away from the front of the Marshals/Ross Dept. Store

APPENDICES

The appendices in this report contain backup information supporting the body of the report, and the mechanics of the workshop. The following appendices are included.

CONTENTS

APPENDIX A
STUDY PARTICIPANTS

Workshop Attendance											
Attendees				Participation							
Bountiful / Woods Cross OU2 June 11-14, 2007				Meetings			Study Sessions				
Name	Organization and Address (Organization first, with complete address underneath)	Tel # and FAX. (Tel first with FAX underneath)	Role in wk shop	Site Visit	Mid Wk Rev	Out Brief	Day 1	Day 2	Day 3	Day 4	Day 5
Kenneth True	VE Contractor kentrue@maladon.com	402-339-1936 C 402-516-2635	Team Facilitator	X		X	X	X	X		
Tim Gallagher	USACE, Baltimore District Tim.gallagher@nab02.usace.army.mil	484-356-4312	CE, Construction	X		X	X	X	X		
Curtis Payton	USACE, Sacramento District Curtis.payton@usace.army.mil	916-557-7431	Geologist	X		X	X	X	X		
Lindsey Lien	USACE, HTRW CX Lindsey.k.lien@usace.army.mil	402-697-2580	Project Coordinator	X		X	X	X	X		
Frank Morris	CDM morrisfr@cdm.com	720-264-1119	Geologist	X		X	X	X	X		
Ryan Wymore	CDM wymorera@cdm.com	303-298-1311	Remediation Engineer				X				
Mario Robles	RPM EPA-R8 Robles.mario@epa.gov	303-312-6160	Project Manager	X		X	X	X	X		
Hugh Rieck	USACE Hugh.j.rieck@usace.army.mil	402-697-2660	Geologist	X		X	X	X	X		
Michael Pereira	UDEQ mpereira@utah.gov	801-641-0348	Project Manager	X		X	X	X	X		
Alan V. Jones	UDEQ ajones@utah.gov	801-536-4287	Hydrogeologist	X		X	X	X	X		
Tim Rehder	US EPA Rehder.timothy@epa.gov	303-312-6293	Observer			X					
Todd Bragdon	CDM	720-264-1113	Project Manager	X		X	X	X	X		
Kathleen Atencio	EPA Atencio.kathie@epa.gov	303-312-6803	Unit Chief			X					
Bill Murray	EPA Murray.bill@epa.gov	303-312-6401	Program Director			X					
Helen Dawson	EPA Dawson.helen@epa.gov	303-312-7841	Hydrogeologist			X	X	X	X		
Carol Pokorny	EPA Pokorny.carol@epa.gov	303-312-6970	Tech. Enforce.			X					
Mike Smith	CDM smithmj@cdm.com	303-383-2411	GW Modeling				X	X	X		
Richard Sisk	EPA Sisk.richard@epa.gov	303-312-6638	Attorney			X					

Attendees Role in this workshop (column 4 of the form). Use more than one description if appropriate.
C = Consultant   Cl = ClientD = Designer   DM = Design Manager   FM = Facility Manager   FO = Facility Operator
Ob = Observer   Ow = Owner   PM = Project Manager   PrM = Program Manager   TM = Team Member   U = User
Note: X = Present most of the day. O = Present part of the day   Blank = not present that day.

APPENDIX B
CREATIVE IDEAS LIST

List of CREATIVE IDEAS		
Idea Category: Bountiful Woods OU2 (6/12/2007) **R=Recommendation D=Design Comment E=Eliminate W=Withdrawn**		
ID #	**Name of Idea / description**	**Value Potential**
1	Back calculate SSL for Soil Cleanup Goal (already in sow)	E
2	Place treatment system in vault in source excavation	E
3	Install infiltration gallery in the base of the source area excavation	R
4	Geophysics for septic tank/tile field to locate it	D
5	Video Camera Sewer to determine if septic tank is still present	D
6	Vibratory sheet pile installation around source excavation	D
7	Consider swing/graveyard shift for RA activities for source removal excavation	D
8	Consider Using a horizontal well for SVE under the building and angled borings for GW Recirculation	D
9	Install deep (250') multiport well(s) as the first phase of a multi phased approach to the phase 2 design (near MP01)	E
10	Install a new multiport monitoring well between new well (9) and MW5 @ 200 ft depth in the middle zone (SW corner of strip mall)	R
11	Consider SVE in shallow zone to capture any VOCs not accessible by excavation (under the buildings).	D
12	Eliminate any wells in the middle zone near the source area	E
13	Buy water for injection (phase 3) in lieu of extraction	R
14	Use refinery NPDES discharge from cooling water process for injection	E
15	Reduce distance between extraction and injection points Ph3	E
16	Do source removal followed by 0-5 years of monitoring to assess the impact of source removal and natural attenuation	E
17	Use soil nailing/earth anchors for excavation stability	D
18	Supplement extracted water with purchased water for injection	E
19	Alternative surface water discharge locations – plume control or other uses	E
20	Exchange water rights for clean water	E
21	Use existing holly refinery water production wells as extraction wells	E

List of CREATIVE IDEAS		
Idea Category: Bountiful Woods OU2 (6/12/2007) **R=Recommendation D=Design Comment E=Eliminate W=Withdrawn**		
ID #	**Name of Idea / description**	**Value Potential**
22	Consider seismic fault impacts on infrastructure	E
23	Map seismic fault analysis	D
24	Investigate whether the refinery has done any fault analysis existing work (check with UGS)	D
25	Sanitary Sewer: Move to front of building outside of expected excavation area	D
26	Install wells with flexibility in extraction zones (upper, lower, middle)	D
27	Supplement deep Holly Refinery wells with new wells in the middle aquifer (water rights relative to depth, operational control, added treatment costs to Holly, differing water quality impacts to Holly, control the injection) Still maintain MCL at west end of plume	R
28	Summarize regulator conversation; ARAR Waiver, ACL Duane Mortenson, Michael Stork	D
29	Extract from a new well near MW4, inject into west bountiful south well irrigation distribution; inject into distal end of plume from another water source (consider water rights issues and capital cost liabilities)	R
30	Consider phase 3 supplemental RI	D
31	Passive Conduit wells strategically placed near the distal end of the plume to meet 5 ppb criteria	R
32	Consider mass lost at fault zone from the upper unit; model alternatives based on middle zone concentrations	R
33	Perform an aquifer test for ph 3; develop a new 3D model input data into the model and rerun to better assess plume expansion and remedial time frame	E
34	Separate RODs for Ph 2 and Ph 3 of OU2	R
35	Tree core samples for presence/absence of PCE on up and down gradient side of the fault	D
36	PVD samples for spring water discharging to wetlands (buried 12”) to confirm loss of mass from upper zone. Micropiezometers are another option.	D
37	Determine injection water flow rate to meet down gradient ARAR	D
38	Begin soil sampling outside the expected limits of the contaminated source soils and work in based on the real time results obtained (TRIAD)	E

List of CREATIVE IDEAS		
Idea Category: Bountiful Woods OU2 (6/12/2007) **R=Recommendation D=Design Comment E=Eliminate W=Withdrawn**		
ID #	**Name of Idea / description**	**Value Potential**
39	South and west sides of the excavation will likely require sheet piling, if so, cut out a window in the sheet pile after installed, and possibly install a horizontal SVE well	D

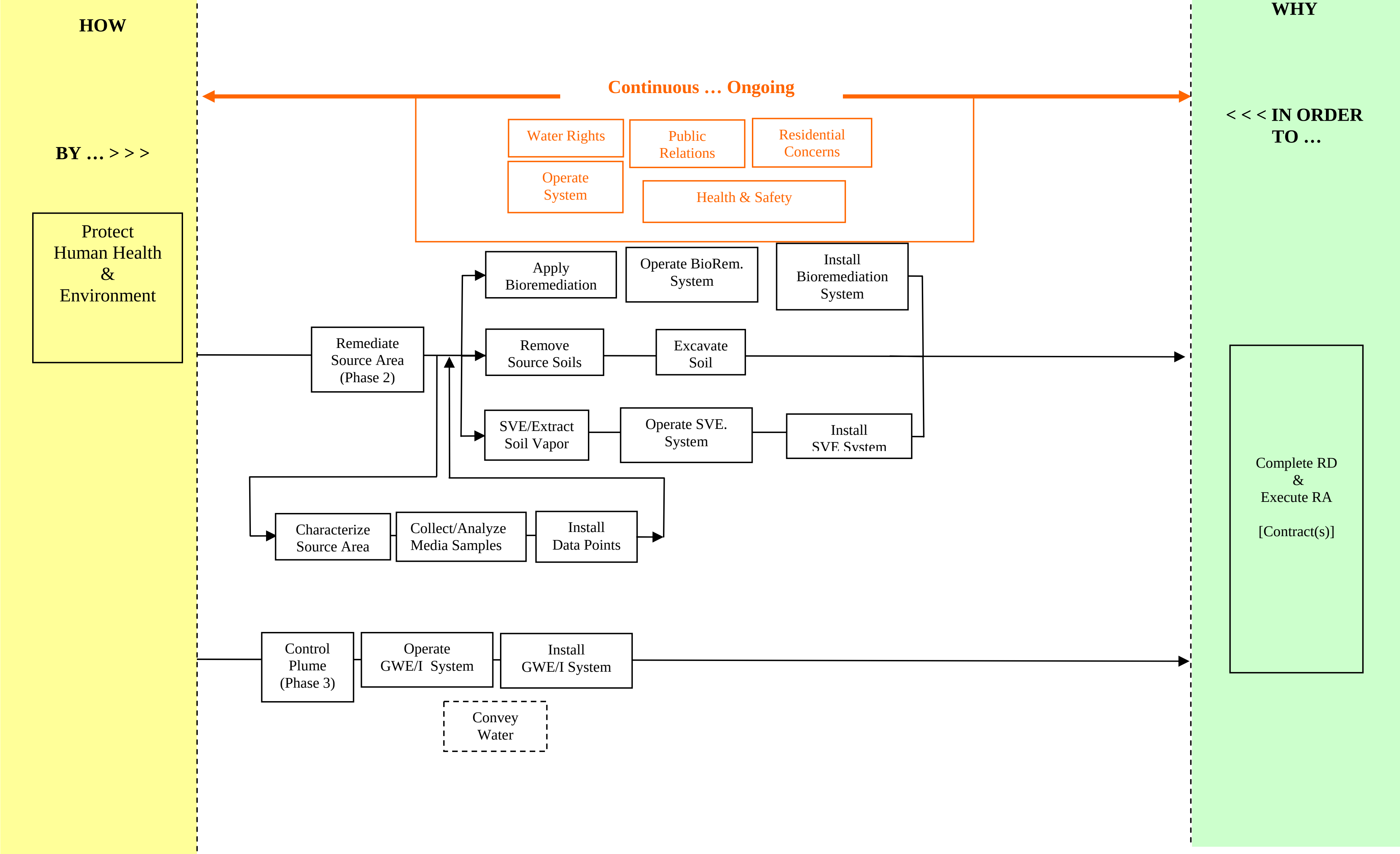
APPENDIX C
FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

Function Model

Item	Aspects of Item	Function
Remediate Source Area		
Remove Source Soils		
SVE		Extract VOHs
Bioremediation		Destroy Contaminants
Investigate Alternate Sources		
Extraction Wells Ph 2	Alter Gradient	Remove Groundwater
Injection Wells Ph 2	Deliver Substrate Alter Gradient	Inject Water
Multiport MWs		Locate Contaminants
Plume containment		
Convey Water Ph 2		Convey Water
Convey Water Ph 3	Transfer Water	Convey Water
Resident Concerns		
Extraction Wells Ph 3		
Injection Wells Ph3		
Treatment Ph3		
Stakeholder Concerns		
Infrastructure Avoidance		
Characterize Source Area		
Treatment Ph 2		

12 June 2007

Bountiful / Wood's Cross
OU2 - PCE Source and Groundwater Plume



US Army Corps of Engineers
HTRW CX

EPA - SUPERFUND PROGRAM VALUE ENGINEERING STUDY

FUNCTIONAL ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM
BOUNTIFUL/WOODS CROSS OU2 PCE PLUME

DAVIS COUNTY, UTAH

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
OMAHA, NEBRASKA

OMAHA DISTRICT
IN-HOUSE DESIGN
12565 WEST CENTER RD.
OMAHA, NE 68144

Designed by: R.C. PAYTON		Date: 12JUN07	Rev. 0
Dwn by: R.C.P.	Spec No.	Design file no. ___ - __ - __	
Reviewed by: L. Lien		Drawing Code:	
Submitted by: M. Mackenzie Sacramento, Geolog Sec.		File name: Plot date: Dwg scale:	

Figure:

1

APPENDIX D
PHOTOGRAPHS


PROFESSIONAL DRY CLEANING & LAUNDRY


BOUNTIFUL
Family Cleaners
SEMI ANNUAL
BRA SALE
OPRAH SAYS
GET A BRA FITTING


BOUNTIFUL
PROFESSIONAL DRY CLEANING & LAUNDRY


Michaels
famous footwear

APPENDIX D
RESUMES

Kenneth L. True, P.E., CVS.
Mobile: 402-516-2635
Home: 402-339-1936
E-mail kentrue@maladon.com

Summary

Six years working as an independent Value Engineering (VE) consultant and working part time for URS Corporation as a VE specialist. Thirty-one years with the Corps of Engineers (CE). Retired as the Northwest Division Value Engineer, coordinator for Division's Architect /Engineer selection process, and team leader for Engineering Divisions Engineering Quality Management System. Other CE work included cost engineering, Division construction quality control management team leader, District construction supervision and inspection, Engineering Division project management, District Value Engineer and nine years of construction field experience.

Major Accomplishments

- Participated in numerous CE VE studies in various roles.
- Achieved Certified Value Specialist Certificate from the nationally accredited program maintain by the Society of American Value Engineers, International.
- Successfully lead more than fifty VE studies.
- Leading role in the CE Value Engineering Advisory Committee.
- Prepared and presented a special one-day VE workshop for EPA regional office personnel. Delivered this presentation to the majority of the regional offices. This workshop highlighted some of the very successful Value Engineering applications performed on superfund sites.
- Taught in the CE PROSPECT program for fifteen years. Subjects included roofing, construction quality management, soils and masonry.
- Member of America Society of Civil Engineers, Society of American Value Engineers, and past member of American Society of Military Engineers.
- Active in many local community organizations.

Education

BS in Civil Engineering, University of Nebraska at Omaha
Mod I, VE workshop, Mod II, VE workshop
SAVE International yearly conferences and workshops
Numerous CE 40 hour workshops including HTRW overview program

Registrations

Professional Engineer, State of Colorado
Certified Value Specialist, SAVE International

Timothy Michael Gallagher, P.E.
Mobile: 484-356-4312
Evening Phone: 610-524-3382
Day Phone: 610-524-3382
Email tim.gallagher@nab02.usace.army.mil

Summary

- "Superfund Construction Engineer" providing technical assistance directly to Region III Remedial Project Managers through an Interagency Agreement that was developed between the USEPA and the USACE.

- Provide assistance on approximately 15 Superfund Sites in the form of design reviews, estimate preparation, present worth calculations, work oversight, attendance at meetings, consultation, etc.

- Project Engineer, Baltimore District, Northeast Resident Office. Current projects include FUDS and DERP sites, along with Superfund Program sites.

- Assigned to a Value Engineering team that visits Superfund projects in different regions throughout the US to evaluate certain aspects of the project(s) and to identify areas where the USEPA could improve the project if recommended actions are implemented.

Education

B.S., Civil Engineering Widener University, Chester, Pennsylvania
Leadership Education and Development Course
8-Hour HAZWOPR Refresher Training
Hazardous Waste Manifest/DOT Refresher Course
40-Hour HAZWOPR training
USACE Construction Safety Training

Registration

Professional License; Environmental Engineering, (# PE-070657)

R. Curtis Payton, II
(916) 557-7431
(916) 346-5613
curtis.payton@usace.army.mil

Summary

Registered geologist with over 20 years experience in environmental, geotechnical and seismic investigations. Prepares work plans, scopes of work, PA reports, SI reports, RI reports, cost estimates, proposals, design documents and public presentations for both government and private sector projects. Has directed multi-rig drilling efforts, performed trenching, borehole logging (including downhole), sampling (all media), aquifer testing, installation and development of water production and monitoring wells, groundwater modeling and contaminant fate and transport studies. He is an expert in the field of trench logging for both fault and forensic environmental investigations. Project Manager or Team Lead of several base wide environmental programs and brings experience in managing multiple contractor teams and Corps staff toward the goal of site closure and NPL delisting.

Major Accomplishments

- Coauthored, prepared and presented installation work plans and budgets to DA personnel in Maryland for BRAC & IRP installations.
- Implemented forensic environmental investigations to determine responsible parties along a petroleum pipe line corridor involving 4 pipelines and 5 RPs.
- Audited contractor efforts in the construction of UV-ox waste water treatment plant, 100-foot deep hydropunch operations, cleanup of pesticide contaminated infrastructure for a carnation farm, landfill grading, .
- Managed and completed performance of 21 Preliminary Assessments in 30 days to meet customer deadline.
- Created standard internal government estimate format used by more than 20% of current Sacramento Project Management Staff in the HTRW PPMD group.
- Completed mathematical analysis of two different risk assessment methodologies to identify which was more conservative depending on the types of analytes assessed.
- Liaison between multiple contractors toward a common goal of site closure for Army RCRA and CERCLA sites.
- Fault investigations at every major fault system. Identified (within 100 feet) the location of the northern split of the Tule Pond Splay on the Hayward fault.
- Earthquake assessments of residential and commercial structures for damage to foundations and structural walls. Currently a member of the USACE Structural Safety Assessment Team ready to deploy in the event of a major earthquake.
- Installed over 100 wells in a wide variety of depositional environments.
- Current member of USACE Center of Expertise Value Engineering Team for EPA Superfund Program.

Education

B.S. Earth Sciences (Geology) at the University of California at Santa Cruz

Ctr. for Army Leadership LEAD Class – Reno, NV

USACE Leadership Development Program II

Registrations

California State Registered Professional Geologist No. 5608

California Registered Environmental Assessor I No. 1930

Lindsey K. Lien
Geoenvironmental and Process Engineering Branch CENWO-HX-E
HTRW Center of Expertise
(402) 697-2580 (v)
(402) 697-2595 (fax)
lindsey.k.lien@usace.army.mil

Summary

Working knowledge of and practical experience with design and start-up of process equipment used in treatment systems. Provides technical assistance on granular activated carbon, advanced oxidation technologies, soil washing, solids handling and other soil and water treatment technologies. Writes technical guidance and design specifications for HTRW unit processes. Registered Professional Engineer NE-5616, July 1983 to present

Major Accomplishments

- I am the national coordinator for a HQ-EPA/HQ-USACE initiative to develop an implementation plan for application of the Value Engineering (VE) process nationally. The initiative involves developing a VE protocol concurrently with a pilot program for performing up to 10 VE Studies at fund lead sites.

- I have served as the HTRW-CX team leader for a variety of technical evaluations and resulting reports such as independent remedy assessments and Five Year Reviews with HTRW-CX staff in addition to authoring portions of those reports. One of those five year reviews was presented a national award for the Brown and Bryant Site by the USEPA as "The Outstanding Five Year Review of 2006", 2000 to present.

- Provided technical oversight during model development for the RACER budgeting cost estimating computer program used by Department of Defense agencies, and other private, local, state, and federal agencies, 1996-Present.

- Vineland Chemical Company, OU-2 Soils remedial action team member since initiation of remedial action – construction phase at the site. Activities included evaluation of requests for proposal, participation in the process design formulation, pilot studies, design and facility construction and ongoing operations, 2000 – present.

- Defense Depot Ogden, OU-4 start up and prove out of an innovative peroxide/ozone groundwater treatment plant treating vinyl chloride and chlorinated solvents, 1998.

- Maywood Formerly Used Site Remedial Action Program (FUSRAP). Full scale pilot plant study for segregating radioactive soils from clean soils using innovative soil sorting technologies, 1998-2000.

- Participated in numerous Remediation System Evaluations (RSE's) including Ellsworth AFB, SD, Oconomowoc, WI, Silresm, MA, Higgins Farm, NJ, Peerless Plating, WI, Hanford, WA as well as numerous others, 2000 to present.

Education

B.S. Civil Engineering, South Dakota State University, 1978
M.S. Civil/Environmental Engineering, University of Nebraska, 1985

Affiliations

Registered Professional Engineer, Nebraska E-5616, 1983
Gulf Coast Hazardous Substance Research Center, Technology Transfer Committee 1999-present

Publications

Prepared:
CEGS-02281 Soil Washing Through Separation/Solubilization
CEGS-02115 Underground Storage Tank Removal

EM 1110-1-4006 Removal of Underground Storage Tanks (USTs)
CEGS-11377 Advanced Oxidation Processes (AOP)

Coordinated Contractor preparation of:
CEGS-11360 Plate and Frame Filter Press System
ETL 1110-3-457 Plate and Frame Filter Press
ETL 1110-1-161 Ultraviolet/Chemical Oxidation

Conference Presentations

Design Considerations for Advanced Oxidation Processes, HAZMAT '97 Atlantic City, NJ, also included in the published conference proceedings.

Advanced Oxidation Processes, and Activated Carbon, Theory and Application, EPA Engineering Forum, July 1998.

Peroxone Treatment Technology Demonstration at Cornhusker AAP, Innovative Technology Advocates Conference, Las Vegas, NV, March 1997.

Optimization of the Groundwater Treatment Plant, Milan Army Ammunition Plant OU-1, Subsurface Remediation Conference, St. Louis, MO, June 1999. Proceedings published co-authors Chris Riley and Neil Anderson.

Hugh J. Rieck
Geologist
USACE HTRW-CX
Work: 402-697-2660
Email: hugh.j.rieck@usace.army.mil

Summary

Hugh Rieck is a geologist with the US Army Corps of Engineers - Hazardous, Toxic, and Radioactive Waste Center of Expertise in Omaha, NE. Before joining the HTRW-CX in 2006, Hugh worked six years as a hydrogeologist with the Arizona Department of Environmental Quality, Superfund Programs Section. Prior to his State technical regulatory experience, Hugh worked thirteen years as a research geologist with the U.S. Geological Survey, where he specialized in the application of paleomagnetic stratigraphy to investigations of geologic records of climate change.

Accomplishments

- Technical representative and alternate US Army Corps of Engineers liaison and to the Interstate Technology and Regulatory Council (ITRC) Board of Advisors.

- Member of the ITRC passive groundwater sampling technology team; coauthor on three ITRC Technical and Regulatory Guidance documents; instructor for EPA Clu-in internet-based training class on protocol for passive groundwater sampling techniques.

- Instructor for data analysis and evaluation portion of USACE two-day workshops on preparation of US EPA Five-Year Review Reports.

- Invited panelist for 2007 Battelle Bioremediation Conference panel discussion on the role of bioremediation in performance-based contracting.

- Invited participant, co-investigator, and/or project manager on US and international investigations of geologic records of climate change (National Science Foundation, USGS, Geological Survey of Canada, and New Zealand Antarctic Research Program research projects.) Recipient, National Science Foundation Antarctic Service Medal of the US.

Education

- B.S. in Geology, Northern Arizona University, Flagstaff, Arizona
- M.S. in Earth Science, Northern Arizona University, Flagstaff, Arizona

Professional Memberships

- Member, Geological Society of America, since 1984

APPENDIX F
ACRONYMS LIST

Acronyms List

°F	degrees Fahrenheit
µg / L	micrograms per liter
amsl	above mean sea level
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CAH	chlorinated aliphatic hydrocarbons
CCE	Certified Cost Engineer
CCV	Continuing calibration verification
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cis-DCE	cis-1,2, dichloroethene
CLP	Contract Laboratory Program
CM/ DAY	centimeters per day
cm/ sec	centimeter per second
COC	contaminant of concern
COPC	chemicals of potential concern
CPT	cone penetrometer technology
CVS	Certified Value Specialist
CWA	Clean Water Act
CX	center of expertise
DNAPL	dens non-aqueous phase liquid
DO	dissolved oxygen
DOE	U.S. Department of Energy
DPE	dual phase extraction
DPT	direct push technology
DQOs	data quality objectives
DW	domestic well
EAB	enhanced anaerobic bioremediation
ECD	electron capture detector
Eh	reduction/ oxidation potential
EPA	U.S. Environmental Protection Agency
FFS	focused feasibility study
FS	feasibility study
ft	feet
ft/ day	feet per day
ft^3	cubic feet
FWQC	Federal Water Quality Criteria
GAC	granulated activated carbon
gpm	gallons per minute
GPS	global positioning system
GRA	general response action
HTRW	Hazardous, Toxic and Radioactive Waste
in	inches
K	hydraulic conductivity
L	lower aquifer zone
LGAC	liquid granulated activated carbon

M	middle aquifer zone
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
mg/ L	milligrams per liter
MIP	membrane interface probe
mL	milliliter
mm / yr	millimeters per year
MTBE	methyl tert-butyl ether
MW	monitoring well
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OU	operable unit
PA	preliminary assessment
PAC	powdered activated carbon
PCE	tetrachloroethene
PE	Professional Engineer
POTW	publicly owned treatment works
PP	proposed plan
ppb	parts per billion
PRB	permeable reactive barrier
PRP	potentially responsible party
PVC	polyvinyl chloride
RA	remedial action
RAO	remedial action objectives
RCRA	Resources Conservation and Recovery Act
RD	remedial design
RI	remedial investigation
ROD	record of decision
RPM	remedial program manager
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
scfm	standard cubic feet per minute
SDWA	Safe Drinking Water Act
SPME	solid phase micro extraction
SVE	soil vapor extraction
TBC	to be considered
TCE	trichloroethene
TMDL	total maximum daily load
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
UV	ultraviolet
VC	vinyl chloride
VE	Value Engineering
VGAC	vapor granulated activated carbon
VOC	volatile organic compound
WBZ	water bearing zone