RECORD OF DECISION

BOUNTIFUL/WOODS CROSS 5TH SOUTH

PCE PLUME NPL SITE

Operable Unit 2

DAVIS COUNTY
BOUNTIFUL, UTAH

PREPARED BY

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 8

DENVER, COLORADO

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ACRONYMS

A-3	Area of Interest
AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirements
BCI	Bountiful Cleaners Incorporated
BFC	Bountiful Family Cleaners
bgs	Below the Ground Surface
BHHRA	Baseline Human Health and Ecological Risk Assessment
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-DCE	Dichloroethene (Chemical of Concern, Degradation Product of Trichloroethylene)
COC	Chemical of Concern
COPC	Chemicals of Potential Concern
DERR	Division of Environmental Response and Remediation
DPE	Dual Phase Extraction
DWQ	Division of Water Quality
EAB	Enhanced Anaerobic Bioremediation
ECD	Electron Capture Detector
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Differences
FFS	Focused Feasibility Study
FSA	Feasibility Study Addendum
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HQ	Hazard Quotient
IC	Institutional Control
IRIS	Integrated Risk Information System
LGAC	Liquid Granular Activated Carbon
LOAEL	Lowest Observed Adverse Effects Level
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
mg/kg	milligrams per kilogram or parts per million
MIP	Membrane Interface Probe
MTBE	Methyl Tertiary-Butyl Ether
MW	Monitoring Well
OU1	TCE Groundwater Plume, Hatchco Property, Area-3,
OU2	PCE Groundwater Plume
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbons
PID	Photo-Ionization Detector
PCE	Tetrachloroethene – Chemical of Concern
ppb	parts per billion

RA	Remedial Action
RAO	Remedial Action Objectives
RBC	Risk Based Concentrations
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
Site	Bountiful/Woods Cross 5th South PCE Plume NPL Site, OU2
SVE	Soil Vapor Extraction
TCE	Trichloroethene (Chemical of Concern)
UDEQ/DERR	Utah Department of Environmental Quality, Division of Environmental Response and Remediation
UDEQ/DWQ	Utah Department of Environmental Quality, Division of Water Quality
ug/kg	micrograms per kilogram (ppb)
ug/L	micrograms per Liter (ppb)
VC	Vinyl Chloride (Chemical of Concern – Degradation Product of TCE)
VOC	Volatile Organic Compound
<	less than
>	greater than

THE DECLARATION

1.1 Site Name and Location

This Record of Decision (ROD) is for the Bountiful/Woods Cross 5th South PCE Plume NPL Site (Site), Operable Unit 2 (OU2). The Site is located in Davis County, Utah, approximately 10 miles north of Salt Lake City and covers an area of about 400 acres (Figure 1). OU2 is bound to the north and south by 300 North and 750 South streets and to the west and east sides by 500 West and 1400 West streets. These streets are located in the cities of Bountiful, West Bountiful, and Woods Cross, Utah (Figure 2). The EPA Site Identification Number is UT0001119296.

1.2 Statement of Basis and Purpose

This decision document presents the Selected Remedy for OU2 of the Bountiful/Woods Cross 5th South PCE Plume NPL Site. The Selected Remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for (AR) the National Priorities List (NPL) Site.

The remedy was selected by EPA Region 8. The Utah Department of Environmental Quality (UDEQ) concurs with the Selected Remedy.

1.3 Assessment of OU2

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances and pollutants or contaminants into the environment.

1.4 Description of Selected Remedy

The Bountiful/Woods Cross 5th South PCE Plume NPL Site has two Operable Units. The ROD for Operable Unit 1 (OU1) was signed by EPA and UDEQ on September 28, 2006. The Selected Remedy for OU1 addresses both sub-surface soil and groundwater contaminated with tetrachloroethene (PCE), trichloroethene (TCE), cis dichloroethene (cis-DCE), vinyl chloride (VC) and other volatile organic compounds (VOCs) at the W.S. Hatchco property. The Selected Remedy for OU1 will remove the potential threat to human health and it will achieve a risk reduction through treatment/destruction of contaminants in groundwater.

The Selected Remedy for OU2 addresses the source of PCE contamination and a groundwater plume emanating from the property known as "Bountiful Family Cleaners" (BFC), owned and operated by Bountiful Cleaners Incorporated (hereafter referred to as BCI). The property is located at 344 South 500 West, Bountiful, Utah. The Selected Remedy for OU2 also will meet the statutory preference for the selection of a remedy that involves treatment as a principal element. The major components for the Selected Remedy for OU2 include:

PCE Source Area Cleanup

- Excavation and disposal of shallow source area soil located in the northwest corner of the parking lot of the property. Post excavation and soil confirmation sampling, clean backfill will be placed in the excavated area and covered with asphalt. Excavated material will be tested, characterized, and transported offsite for disposal at a licensed facility.

- Installation of a bioremediation recirculation groundwater treatment system consisting of injection and extraction wells. The wells will be installed in and around the source area. In this system, contaminated groundwater will be extracted from about 130 ft below the ground surface (bgs). The extracted groundwater will be mixed with natural substances such as soybean oil and natural bacteria to accelerate the natural transformation/decomposition of the PCE. Depending on the vapor concentrations, the vapors released by the soil located next to the groundwater table will be extracted via a vacuum, treated (i.e., granular activated carbon) and/or released directly to ambient air.

Hydraulic Containment

Groundwater at the Site is a current and a potential source for drinking water for surrounding communities. Absent of any plume containment/treatment (even if the source is removed and treated) the groundwater plume will continue to expand. Therefore, the Selected Remedy provides for an alternate water supply to impacted residents to prevent unacceptable exposure to ingestion of untreated groundwater, or to prevent breathing of vapors emitted from the indoor uses of groundwater.

Key components of the Selected Remedy for the containment system include:

- Providing alternate drinking water supply to impacted residents. It is estimated that up to 15 domestic wells may be impacted as the plume expands to the northwest.

- Installation of an extraction and injection system to contain the groundwater plume. The system will consist of approximately two extraction and four injection wells. Extraction wells will be used for hydraulic gradient control. The extracted groundwater will be cleaned as necessary using granular/liquid activated carbon and as necessary clean water will be injected into the aquifer.

- Monitoring groundwater to ensure the remedy responds as designed over time. New and selected existing monitoring wells will be used to confirm the effectiveness of the containment system and to demonstrate compliance with the cleanup standards. The first

monitoring event will establish a baseline and will take place prior to the commencement of the Remedial Action (RA) for OU2. Monitoring will continue until the Remedial Action Objectives (RAOs) are met.

- Institutional controls (ICs) will be required to restrict the use of groundwater as a drinking water source and to ensure protectiveness of the remedy. At the source, the primary form of ICs will be an environmental covenant under Utah law, which in addition to restriction on groundwater uses, will require consultation with EPA/UDEQ-DERR prior to any earth disturbing activity (i.e., excavation of soil). ICs are described in detail in Section 7.1 and Section 11.1.

- Five-year reviews - EPA, in consultation with UDEQ/DERR, will review the monitoring data and evaluate the protectiveness of the remedy. Also, in consultation with UDEQ/DERR, EPA may modify the groundwater monitoring strategy as appropriate to ensure that the data gathered supports the cleanup objectives. Five-year reviews will be required until the RAOs are met.

1.5 Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the RA. The Selected Remedy is cost effective, utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

This action also satisfies the statutory preference for treatment as a principal element of the remedy. The remedy reduces the toxicity, mobility and volume of hazardous substances, pollutants or contaminants through treatment and enhances the chemical and biological degradation of the chemicals of concern (COCs) in groundwater at the source. Also, the remedy contains the PCE plume, increases the rate of contaminant mass removal through treatment of the extracted groundwater, and prevents the expansion of the plume to uncontaminated areas.

Because this remedy may take more than five-years to attain RAOs and meet the cleanup levels, a statutory review will be conducted within five-years of the initiation of the RA. The five-year review will ensure that the remedy is, or will be, protective of human health and the environment.

1.6 Data Certification Checklist

The following information is included in the decision summary section of this ROD. Additional information can be found in the AR file for this Site.

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the Baseline Risk Assessment and ROD (Section 2.4.1)

- Baseline risk represented by the COCs (Section 4)
- COCs and their respective concentrations (Section 4.2)
- Compliance with federal or state statutes and regulations (threshold criteria, primary balancing criteria, modifying criteria) (Section 8.0)
- How source materials constituting principal threats are addressed (Section 9)
- Key factor(s) that led to selecting the remedy (i.e. describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 10.1)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 12.0)
- Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy (Section 13.1)
- Cleanup levels established for COCs and the basis for these levels (Section 13.2)

1.7 Authorizing Signatures

This ROD documents the selected RA to address the groundwater contamination emanating from the Bountiful/Woods Cross 5th South PCE Plume NPL Site, OU2.

EPA Region 8 approves the Selected Remedy as described in this ROD.

_____ _____

Carol Rushin
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Date

The following authorized official at the State of Utah concurs with the Selected Remedy for the Bountiful/Woods Cross 5th South PCE Plume NPL Site, OU2.

_____ _____

Richard W. Sprott
Executive Director
Utah Department of Environmental Quality

Date

THE DECISION SUMMARY

2.0 Site Name, Location, and Brief Description

The Site is called the Bountiful/Woods Cross 5th South PCE Plume NPL Site, Operable Unit 2 (OU2), also known as the Bountiful Family Cleaners (BFC), owned and operated by Bountiful Cleaners Incorporated (hereafter referred to as BCI). The property is located at 344 South 500 West, in Bountiful, Utah. The BCI property geographic coordinates are 40°53'09" north latitude and 111°53'33" west longitude (Figure 2). The boundaries of OU2 are approximately from 300 North to 750 South streets and from 500 West to 1400 West streets and includes the BCI property and the tetrachloroethene (PCE) groundwater plume. The OU2 terrain slopes to the west towards the Great Salt Lake.

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number is UT0001119296. The lead agency for OU2 is the U. S. Environmental Protection Agency (EPA). The supporting agency is the Utah Department of Environmental Quality, Division of Environmental Response and Remediation (UDEQ/DERR). The Site was proposed for listing on the National Priorities List (NPL) in the Federal Register on December 1, 2000, and was placed on the final NPL on September 13, 2001. The Site cleanup is planned to be conducted using Superfund trust funds.

2.1 OU2 History and Enforcement Activities

2.1.1 Site History and Land Uses

A dry cleaning business has operated on the Site since the early 1940's. Since then, the BCI property and dry cleaning business has been sold several times. In 1967, Mr. Grant E. Freer sold the dry cleaning facility to Mr. Roland LaMar Bangerter and Ms. Carol Bangerter. In 1977, the Bangerters incorporated the business into BCI, now owned and operated by members of the family under the name "Bountiful Family Cleaners".

On April 13, 1966, the South Davis County Sewer Improvement District issued a permit to connect the dry cleaning facility, owned and operated at that time by Mr. Freer, to the main sewer lateral. The permit was to connect a "Solvent Saver Unit" and one dryer to the main sewer lateral. A "Solvent Server Unit" is a machine attached to a clothes dryer used to reclaim PCE. Prior to the lateral connection, the wastewater from the dry cleaning facility likely discharged to a septic system.

The most likely release mechanisms for contaminants at OU2 include the wastewater from the Solvent Saver Unit discharging into the septic system and potentially some leaks and spills that occurred through operations at the facility. Media effected by the potential releases include sub-surface soil, groundwater, and air. No surface water impacts were identified within the OU2 groundwater plume boundary.

Primary land uses at OU2 include residential, commercial, industrial, and agricultural. Secondary land uses include an interstate highway, railroad tracks, shopping mall, and a petroleum refinery.

2.1.2 Previous Investigations and Actions Taken at OU2

As part of a storm water pond closure in 1984, the former Phillips 66 Refinery installed monitoring wells (MWs) downgradient (west) of the refinery. Subsequent sampling events identified PCE and trichloroethene (TCE) contamination in groundwater (Dames and More, 1984; 1986 analytical results). Golder Associates conducted an investigation in May 1987 at the Woods Cross Refinery (former Phillips 66) to identify potential sources of PCE detected in shallow groundwater. PCE was detected in the parts per billion (ppb) range in groundwater both upgradient and downgradient of the refinery; however, no source was identified.

Annual sampling conducted by the former Phillips 66 Refinery during the late 1990s showed elevated PCE, TCE, and vinyl chloride (VC) concentrations in three downgradient MWs on the western side of the refinery (MW2S, -2D, and -3S) (Figure 17). Additional samples collected by EPA in 2000 confirmed the presence of PCE and detected low concentrations of TCE in various domestic wells in the area.

In 1996, through a cooperative agreement with EPA, UDEQ/DERR conducted a Preliminary Assessment (PA) for the Bountiful/Woods Cross 5th South PCE plume. Although a source was not identified, the PA confirmed a considerable release of PCE contamination to groundwater. Concentrations of PCE in groundwater were detected at depths as shallow as 24 ft and as deep as 140 ft, with the PCE concentrations ranging from 7 to 30 micrograms per liter (ug/L). The plume covered an area of approximately 160 acres. Consequently, groundwater was identified as the primary exposure pathway. The PA identified the refinery, several dry cleaners, and various automotive maintenance facilities as potential sources of the PCE contamination in groundwater.

In the fall of 1998, UDEQ/DERR collected five groundwater samples by cone penetrometer on the east side of Interstate 15 (I-15). One sample, collected downgradient of the BCI property, contained PCE at 8 ug/L. A definitive PCE source/facility was not identified as part of the investigation (UDEQ 1999). Also, in 1998 UDEQ/DERR conducted a PA on the Hatchco/Jack B. Kelley Trucking property (Figure 3). The PA identified 45 public supply wells which served 104,477 people in 1998 and over 2,000 privately owned wells located within a four mile radius of the Site.

EPA placed the Site on the final NPL on September 13, 2001. Following the listing, the Site was subdivided into two Operable Units (OU1 and OU2). OU1 was formerly called the "Woods Cross 800 West Plume," and OU2 was formerly called the 5th South PCE Plume with an unknown source or the "Unknown Source Plume."

The ROD for OU1 was signed by EPA and UDEQ on September 28, 2006. The Selected Remedy for OU1 is a combination of In-Situ Biological/Chemical Remediation and Monitored Natural Attenuation with institutional controls (ICs). Additional information on the Selected Remedy for the TCE groundwater plume is presented in the ROD for OU1.

2.1.3 Remedial Investigation/Feasibility Study (RI/FS), 2001-2006

In April 2003, EPA and BCI entered into an Administrative Order on Consent (AOC) to conduct a RI at the BCI property (approximately ½ acre land parcel), EPA Docket No. CERCLA-8-2003-0002. During the same time, EPA was conducting an RI to identify other potential sources of volatile organic compounds (VOCs) and to determine the nature and extent of groundwater contamination emanating from the BCI property. The EPA RI covered a geographical area of approximately 400 acres of land.

EPA completed the Site-wide RI/FS in August 2006. The purpose of the RI/FS was to determine the nature and extent of contamination caused by the release or threatened release of hazardous substances, pollutants, or contaminants from the BCI property and/or other potential unknown sources, if any. The purpose of the FS was to determine and evaluate alternatives to prevent, mitigate, or otherwise respond to, or to remedy, any release or threatened release from the source(s) of PCE contamination. The EPA RI confirmed the presence of hazardous substances, pollutants and contaminants in sub-surface soils at the BCI and the former David Early properties (*the source*).

Results from the RI for OU2 identified 26 domestic wells and a municipal water supply well located downgradient of *the source* and within the PCE groundwater plume. Seven of these wells are contaminated with PCE concentration levels above the MCL. The PCE contaminated plume covers an area of approximately 400 acres of land (Figure 3). The groundwater monitoring results are presented in Section 2.6 of this ROD.

2.1.4 Ecological Risks

Ecological risks were determined to be below a level of concern. This conclusion was based on an evaluation of the low potential for contaminated groundwater to discharge to surface water, the lack of suitable natural habitat in the area, and the residential, industrial/commercial, and agricultural land uses at OU2. Aquatic impacts are deemed unlikely due to the distance between the Site and the Great Salt Lake (approximately 2.5 miles).

2.1.5 Enforcement Activities

In July of 1997, EPA completed an initial/preliminary potentially responsible party (PRP) search for the Site, which was augmented by the issuance of information request letters to parties of interest in January of 2001, June of 2002, and February of 2003.

On September 23, 2002, EPA issued a General Notice of Potential Liability letter to BCI.

Records discovered during BCI investigation indicated that the BCI property was the location of a former septic drain field. BCI did not operate the septic drain field. When BCI purchased the subject property in 1967, the building was already connected to the city sewer system. The information submitted by BCI, is consistent with EPA's conclusion that the operation of the septic drain field was the source of the PCE groundwater contamination and that the release of PCE from the property occurred prior to BCI's ownership.

2.2 Community Participation

Community involvement efforts for OU2 included issuance of fact sheets, holding public meetings, publishing public notices and press releases, and updating the Community Involvement Plan. The public is able to view documents used in making the decisions for OU2 at the information repository located at the Davis County Library, South Branch, at 725 Main Street, Bountiful, Utah. A summary of these activities is included in this Section.

In December 2000, the EPA announced its decision to propose the listing of the Bountiful/Woods Cross 5th South PCE Plume NPL Site on the NPL. A news release announcing the final listing of the Site was published in local papers in September 2001.

In 2002, EPA and UDEQ/DERR, produced a Community Involvement Plan identifying the issues and potential concerns of the community. This document acts as guidance, outlining methods to keep the public informed and involved in the decision-making process. This document, also available for view at the Davis County Library repository, is based on information acquired during local interviews of community members, elected officials, city engineers, and public works directors.

Since 2002, EPA and UDEQ/DERR have met with officials from the cities of Woods Cross, Bountiful, and West Bountiful and the Davis County Health Department to keep them informed about work being performed at the Site. Fact sheets and public meetings have been the primary methods for keeping the public informed. Additional information on pertinent documents is also available at http://www.epa.gov/region8/superfund/ut/bountifulwoods/index.html#docs.

The Administrative Record (AR), established after listing the Site, was last updated in September 2007. A copy of the AR is located at the Davis County Library, South Branch, and the EPA Region 8 Superfund Record Center.

In March 2006, a drop-in session for community members to ask specific questions was offered to alleviate concerns citizens had expressed about the contaminated groundwater, indoor air, cleanup options, and the length of time to complete the remedy.

A briefing was given to public officials from the cities of Woods Cross, West Bountiful, and Bountiful in September 2006 regarding the preferred alternative for OU2.

The Proposed Cleanup Plan OU2 fact sheet was mailed to the public at the end of September 2006 announcing the comment period. The comment period was open from October 2 to October 31, 2006. On October 10, 2006, a public meeting was held to discuss the preferred alternative and the other alternatives considered. The meeting also provided the opportunity for the public to ask questions and submit comments. A public notice announcing the dates of the comment period and the availability of the AR was published in the Davis County Clipper on October 19, 2006.

The minutes of the public meeting proceedings are included in appendix A. Two sets of written comments were submitted during the open comment period. Responses to the comments are provided in the Responsiveness Summary in Appendix B.

2.3 Scope and Role of Operable Unit or Response Action

Due to the complexity of the groundwater contamination, the Bountiful/Woods Cross 5th South PCE Plume NPL Site was divided into two Operable Units (OU1 and OU2). The OU1 TCE groundwater plume from the Hatchco property is addressed under the OU1 ROD signed in September of 2006. The Holly Refinery methyl tertiary-butyl ether (MTBE) groundwater plume, which is commingled with other contaminants within the OU1 and OU2 plumes, is addressed under a corrective action plan through the UDEQ, Division of Water Quality (UDEQ/DWQ).

This ROD addresses OU2 and identifies the Selected Remedy to clean up the source and the contaminated groundwater plume. The remedy documented in this ROD includes the remedial actions necessary to protect human health and the environment.

A comparison of all the multi-level data of the MWs shows a clear pathway and a high probability that the contamination from *the source* is reaching the domestic wells completed in the middle and the lower zones of the aquifer. Analytical results from groundwater samples collected from 26 domestic wells located downgradient from *the source* show that seven of these wells are contaminated with VOCs above the MCLs.

The risk assessments concluded that there are several locations at the Site where there may be a risk to residents and workers, should exposure occur. Risk of cancer is above EPA's level of concern due to PCE, TCE, VC, and MTBE.

Non-cancer risks are below a level of concern for current and future residents and workers. Except at two locations (MW03U, Figure 3) where the risks are above a level of concern for residents due to MTBE, and at the BCI building (See Section 4.8.5).

The sub-surface soil at *the source* is contaminated with VOCs and is a continuous source of contamination to groundwater. The VOCs released from contaminated soil (and potentially groundwater) beneath the building migrate into indoor air in the basement of the BCI building. The Selected Remedy for OU2 has two components, one for the contaminated sub-surface soil and the surrounding saturated zone at *the source*, and one for the PCE downgradient groundwater plume. The remedy for the sub-surface soil and the saturated zone utilizes excavation and disposal of the shallow sub-surface soil and treats the deep sub-surface soil and the saturated zone (approximately 10 to 80 ft below the ground surface) by Enhanced Anaerobic Bioremediation, Soil Vapor Extraction, and Monitoring.

The Selected Remedy for the downgradient groundwater plume uses "Hydraulic Containment." Contaminated groundwater will be extracted, treated as necessary, and clean water will be injected back into the aquifer.

The Selected Remedy will clean VOCs at *the source*, will accelerate the degradation rate of VOCs in the saturated zone, will contain and clean the groundwater plume, and will reduce the risks to human health and the environment.

The remedy will also require ICs at *the source* and within the delineated groundwater plume. The ICs will prohibit the installation of new domestic wells and will set controls to prevent the indoor use of groundwater from existing wells. The Selected Remedy will require ICs until the Remedial Action Objectives (RAOs) are met.

2.4 Summary of OU2 Characteristics

2.4.1 Conceptual OU2 Model

As discussed in Section 2.1.1, the dry cleaning facility started operations in the early 1940's. In 1966, the South Davis County Sewer Improvement District issued a permit to connect the dry cleaning facility to the main sewer lateral. Prior to the lateral connection, the wastewater from a "Solvent Server Unit" and dryer likely discharged to a septic system.

The most likely release mechanisms for contaminants at OU2 include the wastewater from the "Solvent Server Unit" and "Dryer" discharging into the septic system and some leaks and spills that may have occurred from operations at the facility. Media affected by the potential releases include sub-surface soil, groundwater, and indoor air in the basement of the BCI building. No surface water impacts were identified within the OU2 groundwater plume boundary.

Primary land uses at OU2 include residential, commercial, industrial, and agricultural. Secondary land uses include an interstate highway, railroad tracks, shopping mall, and a petroleum refinery. Currently, the remaining contaminated sub-surface soil at *the source* is the primary source of groundwater contamination. In addition to presenting a continuous source of groundwater contamination, the contaminated sub-surface soil presents a direct human health exposure concern in the basement of the BCI building via the inhalation of vapors emanating from sub-surface soil contamination to indoor air.

Based on the current and likely future land uses in the area of the PCE plume, the human populations most likely to be exposed include current and future residents and current and future workers in area businesses. Potential exposure pathways by which residents and workers might be exposed to VOCs in groundwater include the following:

- Direct ingestion of the water (from a well) as drinking water
- Dermal contact with the water while showering or bathing
- Inhalation of VOCs that are released to indoor air during indoor water usage
- Inhalation of VOCs that migrate through soil into indoor air released from contaminated soil or groundwater beneath the building
- Inhalation of VOCs released from groundwater migrating through soil into outdoor air
- Incidental ingestion of groundwater that is expressed at the surface

However, not all of these potential exposure routes to groundwater are likely to be of equal concern. Exposure scenarios that are considered most likely to be of concern are shown in the Conceptual Site Model (Figure 4). Greatest attention is focused on quantification of exposure from these pathways in order to determine if the pathways contribute significant risk. Pathways

that are judged to contribute only minor exposures are also shown on Figure 4. Section 3.2 of the Baseline Human Health and Ecological Risk Assessment (BHHRA) presents a detailed description of these pathways, and an analysis of their relative importance for human exposure. Section 3.0 of the BHHRA Addendum presents a detailed description of the human exposure scenarios due to indoor air and sub-slab air measured in and near the BCI property. These scenarios were considered based on the expected current and future land use.

Downgradient from *the source*, contaminated groundwater is flowing to the northwest where several domestic groundwater wells are located. EPA tested groundwater samples from 26 domestic wells located within the boundary of the groundwater plume (Figure 3). The sample results of 21 of these wells detected concentrations of PCE and/or TCE in groundwater. Seven of these results show PCE concentrations above the MCL. One of these wells (DW05) is the only source of drinking water to a residence located within the leading edge of the plume. The remaining six wells are not used for drinking water but are used for irrigation, stock watering and other outdoors uses. If people were to use, or continue to use groundwater from these seven wells for drinking and/or indoor uses, they would incur an unacceptable risk to their health.

2.4.2 Overview of OU2

OU2 includes *the source* plus the extent of the PCE downgradient groundwater plume. The groundwater plume is located mainly in West Bountiful, Davis County, Utah, but it extends to sections located in the cities of Bountiful and Woods Cross, Utah. The contaminated plume extends approximately 8,000 ft downgradient from *the source* and covers an area of approximately 400 acres.

The highest PCE soil concentration[1] was detected within the BCI property at a level of 196,650 ppb at 8 ft bgs. The highest recorded shallow PCE groundwater contamination, 264 ug/L, occurs directly below the source area (Figure 3). A groundwater plume contaminated with VOCs, mainly PCE, starts at this location and extends to the northwest.

2.4.3 Geology

OU2 is located west of the Wasatch Mountains and east of the Great Salt Lake in an area known as the Wasatch Front. The BCI property is located on a bench terrace in the Basin and Range province on the southern portion of the East Shore Aquifer. The Basin fill deposits are characterized by unconsolidated and semi-consolidated sediments eroded from the mountains. The sediments tend to be thicker and coarser at the base of the mountains where delta, alluvial fan, and mudflow deposits predominate. The sediments become inter-bedded with gravel, sand, silts, and clay towards the Great Salt Lake.

1 Based on Membrane Interface Probe (MIP) testing of off-gas samples

Below the Site, sediments are a mixture of lake-bottom sediments, and low and high energy alluvial deposits which comprise much of the bench terraces in the area.

The Holly Refinery is located about 3,000 ft downgradient from *the source*. Below the refinery, a relative continuous clay and silt unit is found in the uppermost 15 ft of lake-bottom deposits. The depth of the Lake Bonneville Group is estimated to be at 80 ft below the refinery. A Conceptual Site Model of the geology as presented in the RI report is shown in Figure 5. The Warm Springs Fault is observed as part of the Wasatch system; the fault runs through the west-central portion of the Site (Figure 3). The northeast to southwest trending fault is reported to have approximately 20 ft of displacement in the upper Lake Bonneville Group sediments in the vicinity of West Bountiful. Numerous natural springs and seeps are noted along the trace of the fault extending through the western portion of the Holly Refinery.

2.4.4 Hydrogeology

East Shore Aquifer

Groundwater in the area is part of the East Shore Aquifer. The aquifer has been subdivided into the shallow, intermediate, and the deep artesian aquifers. Wells believed to be completed within the shallow aquifer have completion depths between 60 to 250 ft bgs. The intermediate aquifer is generally about 250 to 500 ft bgs, and the deep aquifer has depths greater than 500 ft bgs. A plan view of section lines for cross-sections A to A' and B to B' is also presented in Figure 6. Cross-sections of the geologic framework for defining the upper, middle, and lower (U, M, and L) aquifer zones interpreted across the Site can be seen in Figures 7 and 8. The shallow, intermediate, and deep portions of the East Shore aquifer may also be hydraulically connected with one another. Aquifer recharge is generally interpreted to be at the base of the Wasatch Mountains where the coarser deposits are present and runoff infiltration occurs. Groundwater flow is generally northwest, following the topography towards the Great Salt Lake.

Historically, the shallow aquifer in the area is mainly used for industrial and irrigation purposes. However, the shallow aquifer is classified by the State of Utah as a Class II drinking water source (drinking water quality groundwater) and some domestic wells are believed to be installed in this aquifer.

The aquifer system underlying the Site is comprised primarily of sediments consisting of alternating layers of fluvial gravels, sand, poorly sorted mudflow deposits, discontinuous clays to the east (upgradient), and finer lake bottom sand, silts, and clays to the west (downgradient). Static groundwater elevations vary about 28 ft over the 400 acre site. In general, a very shallow to flat horizontal gradient exists in the eastern portion of the Site with wide fluctuations apparent during periods of heavy municipal pumping and drought. These fluctuations result in local reversals of flow direction from the presumed regional flow direction (northwest). Based on 2003 water level measurements, the lowest water levels were measured between September and November 2003, and the highest water levels were measured between March and May 2003.

2.4.5 Sampling Strategy

The sampling strategy during the RI focused on collecting samples from surface soil, sub-surface soil, groundwater, and private domestic wells. The field investigation was conducted in three phases. The Phase 1 investigation identified a shallow PCE groundwater plume. *The source* area was determined to be in the vicinity of the BCI property and the David Early property. During the same time frame, UDEQ/DERR sampling also reconfirmed a deeper PCE plume west of the refinery. Questions remained at that point whether a connection existed between the deeper PCE contamination detected in the domestic wells and the presumed upgradient source area associated with BCI property and the former David Early property. The Phase 2 investigation was designed to address specific data gaps resulting from the Phase 1 field investigation evaluation, determine the full vertical and horizontal extent of PCE plume, and to gather quarterly water quality data samples. The first objective was primarily concerned with the characterization of deeper portions of the shallow East Shore Aquifer.

To address the extent of the PCE plume, five strategically located borings (MW01 through MW05) were installed with three samplers each at various depths (up to 250 ft) targeting different saturated zones (Figure 3). These 15 samplers (five BarCad® wells) were used to collect groundwater quality data on a three dimensional scale. Placement of these borings was based on the delineation of the upper groundwater PCE plume and spaced so that groundwater flow direction could be evaluated between the shallow and deep contamination across the entire area.

EPA installed two wells (MW06 and MW07) to evaluate the shallow aquifer conditions upgradient of *the source* (maximum 150 ft). MW06 was installed upgradient of the BCI property. MW07 and the existing back ground well BK01 were planned for monitoring any migration of PCE from *the source* towards the Bountiful Shop Well.

The Phase 3 field investigation was designed to locate the areas of highest concentrations of contaminants in surface and sub-surface soils (vadose zone) of the suspected source area and to identify potential residual or free product contamination under the BCI, the former David Early property, and the retail stores to the west. The investigation involved collecting indoor air and sub-slab vapor samples inside the buildings directly in contact with the soil in *the source* area and characterizing the subsurface by means of Membrane Interface Probe (MIP) technology to depths of up to 74 ft bgs. Figure 9 shows the indoor air and sub-slab sample locations. Figure 10 shows the MIP locations. The former locations of chemical storage tanks, sumps, and the highest soil concentrations noted during the RI were considered in determining the sample locations.

2.4.6 Known and/or Suspected Sources of Contamination

The RI confirmed VOC contamination at *the source*, in the sub-surface soil and groundwater. The VOC groundwater plume starts at *the source* and extends approximately 1.6 miles to the northwest. The main chemical of concern (COC) is PCE. The data from the RI report supports that contamination infiltrated into the ground and then to groundwater at *the source* (See Sections 2.6.4 and 2.7.1). To date the plume emanating from *the source* has contaminated an area of approximately 400 acres located within the iso-concentration contours shown on Figure 3.

2.5 Types of Contamination and Affected Media

2.5.1 Surface Soil

Surface soils are not contaminated above a level of concern; therefore, surface soils do not pose a threat to human health and the environment. The surface at *the source* is paved and used as a parking lot.

2.5.2 Sub-surface Soil

MIP procedures developed by Geoprobe Systems Inc. provided real-time detection of VOCs, including dense non-aqueous phase liquids (DNAPLs) in both the vadose and saturated zones under the BCI and the former David Early properties. A single point standard was used for probe calibration, and the results are considered qualitative screening data, providing relative concentrations of VOCs at various locations and depths. The detectors do not provide a quantitative concentration of VOCs in the soil; however, the response level from the detector corresponds to the amount of VOCs present in the carrier gas, which is proportional to the amount of VOCs in the medium at that particular location (unsaturated or saturated zones).

The MIP survey consisted of 25 direct push borings, with depths averaging 65 ft bgs. The initial location (MP01) (Figure 11) was selected based on a previous high passive soil gas sample result and the highest groundwater iso-concentration contour (200 ug/L). Subsequent boring locations were determined by evaluating the results observed at each previous offset boring. A total of 61 off-gas samples were analyzed. Chromatograms for all off-gas samples are included in the RI report. The areas highlighted in yellow on Figure 11 indicate zones where the detector response exceeded the 1 volt level which in turn can be related to off-gas containing VOCs (e.g., PCE). The areas highlighted in dark red on Figure 11 indicate where the detector read 15 volts. Associated off-gas speciation indicates qualitatively that the compound relative concentrations are primarily PCE and VC. In a similar manner, photo-ionization detector (PID) results over 1-volt are shown in Figure 11A. Note that the highest response is limited to the southwest corner of the grid on the former David Early property side, which is likely because of the higher concentration of other hydrocarbons (i.e., BTEX) released from the automotive repair facility. Although PID responses were detected on the north side of BCI property, very little benzene, toluene, ethylbenzene, and xylene (BTEX) compounds were detected and total response was less than 1-volt. A summary of results is recorded on Table 1.

In order to get a better understanding of the distribution of COCs in the vadose zone, the MIP results are also presented in a 3-D perspective view from different angles and directions (Figures 12 through 14). The electron capture detector (ECD) results are shown for detections over 1 volt (yellow to red) because they are the most indicative of the PCE levels. In addition, these contaminant zones can also be seen in relation to electroconductivity (EC) values that are indicative of clay-rich zones (dark gray), which can perch contamination and are potential barriers to vertical movement. A follow up to the MIP investigation was a limited soil-sampling event, which attempted to target the higher ECD and speciation anomalies. A total of 14 soil samples were collected from these zones by direct push methods described in the Sampling and Analysis Plan Addendum (CDM 2005). The soil sample locations could not be placed exactly where the MIP borings were because they were abandoned with bentonite. As a result, offsets of

approximately two feet were marked from the original MIP borings (Figure 11).

Table 2 lists the sample results for selected COCs. The location and depths of each sample can be determined from the sample ID. For example, the sample number 05B-SA04-SB01V-SB-061 was located in soil boring SB01 and the depth indicated by the last two digits (i.e., 61 ft bgs). Although results show that PCE was detected in most of the samples, the concentrations are very low. This is probably due to the residual product being widely dispersed and only locally concentrated in the media (i.e., hard to target) and/or due to the loss of volatiles inherent in both the sampling and analytical process. The highest PCE concentration was 190 ug/kg (diluted) from a zone 6 ft bgs near boring MP22.

A review of the MIP data illustrates that in general, the contaminated zone ranges from 8 to 65 ft bgs.

2.5.3 Indoor Air and Sub-slab Soil Vapor

Three indoor air and 12 sub-slab samples (including one duplicate) were collected from the BCI building, David Early property, and the adjacent retail stores. The indoor air samples were collected prior to sub-slab drilling. Three 6-liter Summa® canisters (two placed in separate areas of BCI building and one in the retail store hallway) drew air for a 24-hour sample period by means of a calibrated flow regulator.

After the indoor air canisters were removed, sub-slab sampling was performed in accordance with "Draft Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations." Holes were drilled though the concrete slab, and capped stainless steel vapor probes were set into the slab using a cement/bentonite slurry. The probes were allowed to cure overnight before the sample vacuum canisters were attached. The sub-slab air was collected in six liter Summa® canisters over a 30-minute sampling period.

PCE was the predominant target compound, detected at the highest concentrations throughout all of the air samples. Some BTEX compounds and trimethylbenzenes were also detected (Table 3). The highest indoor air PCE concentration was found in the interior portion of the dry cleaner building next to the sauna (IA02A; 19,000 micrograms per cubic meter [ug/m^3]). The highest sub-slab PCE concentration was found in the basement of BCI building (AS03V; 120,000 ug/m^3). Figure 15 shows the distribution of sub-slab vapor concentrations for PCE under the buildings and is color coded for areas where the indoor air would demonstrate risk-based concentration (RBC) levels over a target cancer risk (TCR) of 1E-04 (red for workers [7,150 ug/m^3] and yellow for residents [2,810 ug/m^3]), using a 1/100 attenuation factor for vapor intrusion. The RBCs for PCE in indoor air were calculated as follows:

$$C_{(subslab+air)} = C_{(indoorair)}\ X\ AF$$

Where:

C = concentration
AF = attenuation factor

$$C(indooorair) = TCR(CF)/HIF(SF)$$

CF = conversion factor = 1000 ug/mg
HIF = human intake factor
SF = slope factor

The HIF at 6.99E-02 for a worker and 1.78 E-01 for a resident, and the inhalation SF of 2.0 E-02 for PCE are from Tables 3-3 and 3-5 of the BHHRA addendum (SRC 2005).

2.6 Groundwater

2.6.1 Monitoring Wells

A total of 48 MWs were sampled from March 2003 to May 2006 (Table 4). Reporting limits were required below the MCL of 5 ug/L for PCE. Therefore, the groundwater samples were analyzed through the Contract Laboratory Program (CLP) method OLC03.2, Low Concentration Organic Statement of Work, with a base reporting limit of 0.50 ug/L for the COCs. Splits of all groundwater samples were also sent to a subcontract laboratory for natural attenuation analyses to determine the potential for natural attenuation of PCE in groundwater. The natural attenuation parameters selected included the following: dissolved iron and manganese, nitrate-nitrite, chloride, sulfate, total organic carbon, and alkalinity. Field measurements consisted of pH, ferrous iron, conductivity, oxidation reduction potential (ORP), dissolved oxygen (DO), turbidity, and temperature. VOC results for groundwater are listed on Table 4. Round 6 results indicate that the portion of the Site centered on *the source* still had the highest PCE concentrations (110 ug/L) for shallow groundwater. Figure 16 shows the Site-wide distribution of PCE and degradation compounds detected in all monitoring wells (including U, M, and L aquifer zones) and domestic wells sampled during April 2005 (Round 5).

2.6.2 Municipal Well - West Bountiful 5th South Well

An existing municipal production well is located approximately 1 mile southwest/cross-gradient of *the source*. The well (West Bountiful 5th South Well) belongs to the Weber Basin Water Conservancy District and is located at the intersection of 500 South Street and 1100 West Street. The district briefly operated this well in 2003, but ceased operations after receiving complaints from local residents that their domestic wells had lost significant water pressure. Currently, the district is not using the well, but in the future it intends to operate the well to meet irrigation demands. The Weber Basin Water Conservancy District has not reported COCs in the well to date.

2.6.3 Groundwater Contamination

The groundwater flow direction follows the Site's topography, flowing from the higher area contours at the eastern edge of *the source* area toward the northwest to the Great Salt Lake. The Warm Springs Fault is located approximately at the same location as the leading edge of the upper PCE groundwater plume (Figure 3). Several artesian domestic wells and the West Bountiful 5th South Well are located within the western edge of the PCE plume (Figure 3). Although some of these wells are screened at deeper zones of the aquifer, geographically they

are located 1.5 miles downgradient from *the source* and are included within the delineated groundwater plume. Although the city has not reported detection of COCs in the municipal well, detections of PCE and TCE have been reported in the sample results from 21 out of 26 domestic wells (See Table 4). Seven of these wells exceed the MCL for PCE of 5 ug/L. It is worth noting that these wells operate under artesian conditions. The well screens are set in the middle and the lower aquifers and the fate and transport of the COCs to the domestic wells has not been fully defined. However, results from the RI support that the Warm Springs Fault may allow contamination to migrate downward in the aquifer.

The vertical gradient between the unconfined (shallow) and the confined (lower) aquifer was obtained through the BarCad® wells (Upper, Middle and Lower Aquifers). The potentiometric surface of the shallow aquifer indicates the dominant groundwater flow is to the northwest. The horizontal hydraulic gradient at the Site over the RI investigation period ranged from 0.0015 to 0.0053 ft/ft. Where the middle and lower zones of the aquifer were tested, the horizontal gradient ranged on the order of 0.001 to 0.002 ft/ft.

Vertical hydraulic gradients from each of the multi-port BarCad® MWs were also calculated and reported. A significant amount of variation was evident across the Site, from upgradient unconfined to confined artesian conditions, and over the seasonal sampling periods. The head difference between the upper and middle zones generally showed the greatest separations ranging from an upward -11.33 ft (artesian) to a downward 3.12 ft (recharge). Corresponding vertical gradients ranged from an upward -0.15 ft/ft to a downward 0.11 ft/ft. The middle to lower zone yielded vertical gradients from -0.03 to 0.01 ft/ft. Seasonal fluctuations in some cases indicated reversal of the vertical flow directions during drops in water levels (MW02).

2.7 Location of Contamination and Migration

2.7.1 Lateral and Vertical Extent of Contamination

The hydraulic vertical gradients discussed in Section 2.4 through 2.6 support the premise that DNAPL contaminants were released to the environment below *the source*, have reached the lower portions of the East Shore Aquifer downgradient of *the source*. Under *the source*, the aquifer system is composed of discontinuous clay lenses, mudflow deposits (poorly sorted and only slightly permeable), and stream channel deposits (coarse-grained and highly permeable). Further to the west, over the lowland plain, the subsurface strata consist of alternating layers of gravel, sand, and clay. Unconfined portions of the aquifer system, especially where Mill Creek alluvium is present, are generally lateral extensions of the confined aquifers upgradient. Here, downward migrating contaminants, due to either specific gravity or recharge-dominated hydraulic components can then potentially migrate laterally to the confined aquifer units and contaminate the domestic wells.

In general, the PCE contamination in the upper zone of the aquifer is well delineated by the earlier Phase 1 investigation (CDM 2002a). Figure 3 depicts the shallow (upper zone) PCE plume clearly indicating the highest levels of contamination (>100 ug/L) centered on *the source*. Analytical results from the Phase 2 multi-port BarCad® MWs constructed along the general east-west axis of the shallow plume support the Phase 1 shallow PCE contaminant levels as

described in Section 2.5. In addition, these data points confirm decreasing levels of PCE in the upper portion of the shallow aquifer from east to west away from *the source*. The PCE contamination is virtually absent in the upper zone from the Warm Springs Fault west. The middle and lower portions of the shallow aquifer, on the other hand, demonstrate increasing concentrations of PCE to the west as the contaminant migrates vertically where it then moves laterally within the middle and lower confined artesian aquifer zones as evidenced in numerous domestic wells in the vicinity of 1100 West.

Figure 3 shows lines of iso-concentration values for PCE in each of the three zones by color code (U – red, M – blue, and L – green). The outer boundary of each plume level is depicted by an iso-concentration contour of 1 ug/L. The second iso-concentration contour represents the MCL concentration for PCE (5 ug/L). Additional iso-concentration contours represent the 50 ug/L, 100 ug/L, and 200 ug/L observed in the shallowest portion of the aquifer at *the source*. Although PCE is the focus of the contaminant plume, TCE and other degradation compounds were detected in shallow groundwater at significant levels above MCLs at two locations, BFC05 and BFC17. These locations are centered on *the source* and have also detections of BTEX compounds in the soil and groundwater. The localized TCE results may be due to a small cell of hydrocarbon (BTEX) electron donor in the soil and groundwater, initiating a PCE degradation pathway. Very little, if any, migration of the degradation compounds has been observed in combination with the OU2 PCE plume. This is likely due to dilution of these compounds outside of the hydrocarbon (election donor) source area.

The extent of the PCE plume is also fairly well defined in the lower zone by analyses at domestic wells DW01, DW07, DW15, and DW24. However, the potential still exists that the contaminated middle zone may extend further to the west and is thus inferred by using a dashed line on the plume map. The extent of the plume, as defined by the furthest detected value of PCE, is approximately 1.6 miles northwest from *the source*. This direction matches the regional groundwater flow. Using an average flow rate of 1.66 ft/day, based on average linear velocities calculated in the RI, advection travel times would take a minimum of 14.3 years to reach this point, discounting mobility and retardation factors and seasonal groundwater gradient changes that would increase the overall travel time.

As can be seen in Figure 3, the southern boundary of the plume has not been clearly defined. This data gap has been partially addressed by the installation of another BarCad® well system MW08U-M-L located southwest of the I-15 and 500 South interchange. This location is directly between the OU1 Hatchco/Kelly property and the BCI property. Analytical data from this BarCad® well system sampled on April 15, 2004, provides important hydraulic gradient and chemical data from each aquifer zone. The data more accurately defines the southern boundary of the PCE plume and indicates that influence from the Bountiful Well pumping has limited effects in this area to draw contamination to the south and east.

Secondary to delineating the OU2 PCE plume, elevated levels of MTBE (maximum 13,000 ug/L in MW03U) were observed in MWs and groundwater grab samples collected along the southern boundary of the Site (SA-1 and SA-3). Figure 17 shows the affected wells and/or sample locations. The UDEQ/DWQ, which has access to these data, requested Holly Refinery to conduct a "contaminant investigation" of its Light Oil Dock property. Although MTBE is not the focus of this investigation, a distinct plume extends along the direction of groundwater flow

and apparently is slightly north of but co-mingled with the Hatchco plume and extending into SA-3 (See Figure 3).

Sub-surface soils are contaminated and they pose a potential continuous source of VOCs to indoor air at the BFC property and to groundwater. This sub-surface soil contamination is at a depth averaging from 9 to 65 ft bgs (See Table 1). The thickness of the contaminated sub-surface soils layer is not continuous but it is encountered in layers located at approximately 8 and 60 ft bgs. The inferred area of sub-surface soil contamination is presented in Figures 12 to 14.
Groundwater at OU2 is contaminated with VOCs and BTEX compounds; however, the main COC at OU2 is PCE. At some locations TCE and MTBE are the main COCs; however, TCE (HatchCo OU1), and MTBE (Holly Refinery) are addressed under the ROD for OU1 and the UDEQ/DWQ corrective action plan for the Holly Refinery. PCE concentrations in groundwater exceed the state and federal drinking water standards. The plume extends approximately 1.6 miles downgradient from *the source*. The domestic wells where PCE has been detected are located within the shallow East Shore aquifer in the Upper (0 to 59 ft bgs), Middle (60 to 160 ft bgs), and the Lower (greater than 160 ft bgs) aquifer zones (Figure 7).

3.0 Current and Potential Future Surface and Sub-Surface Routes of Human or Environmental Exposure

The land at OU2 is utilized for commercial, industrial, agricultural, and residential purposes. It is anticipated that the land use at OU2 will be consistent with its current uses. Properties adjacent to *the source* include retail stores such as Michael's, Ross, Famous Footwear, a tire store, and a bank. Downgradient from *the source* are I-15, a residential trailer park, the Holly Refinery and Marketing Company, farm land, and residential properties.

Based on the current and likely future land uses in the area of the PCE plume, the human populations most likely to be exposed include current and future residents and current and future workers in area businesses. Potential exposure pathways by which residents and workers might be exposed to VOCs in groundwater include the following:

- Direct ingestion of the water (from a well) as drinking water
- Dermal contact with the water while showering or bathing
- Inhalation of VOCs released from indoor water use
- Inhalation of VOCs that are released from groundwater and migrate through soil into indoor air
- Inhalation of VOCs that are released from groundwater and migrate through soil into outdoor air
- Incidental ingestion of groundwater that is expressed at the surface; and,

At the Source

- Volatilization from sources within the BCI building
- Intrusion of vapors released from contaminated soil or groundwater beneath the building
- Contamination in ambient air

However, not all of these potential exposure routes to groundwater are likely to be of equal concern. Exposure scenarios that are considered most likely to be of concern are shown in Figure 4 by boxes containing a solid circle. Greatest attention is focused on quantification of exposure from these pathways in order to determine if the pathway contributes significant risk. Pathways that are judged to contribute only minor exposures are shown by boxes with an open circle. Section 3-2 of the BHHRA presents a more detailed description of these pathways and provides an analysis of their relative importance for human exposure.

An assessment of potential ecological risks was limited to a discussion of the current conditions at OU2 and a reconnaissance to assess the potential for contaminated groundwater to discharge to surface water. No groundwater discharge points to surface water were observed within the area impacted by the groundwater plume. As a result, ecological risks are considered to be below a level of concern.

The sub-surface soil at *the source* is contaminated and it presents a potential source for contaminants to leach to groundwater and soil vapors to migrate from the soil to indoor air at the BCI building.

3.1 Likelihood for Migration

The likelihood for migration of the COCs is high. The groundwater at OU2 is contaminated and it will continue to migrate outside *the source* area. Heavy rains, fluctuating groundwater levels, and potential vapor transport from contaminated sub-surface soils could cause COCs to disperse or diffuse from the sub-surface soils into groundwater and flow towards a residential area where several domestic wells are located.

3.2 Current and Potential Future Land and Water Uses

3.2.1 Land Uses

The BCI property is currently used as a dry cleaning facility. The parking lot is paved and the property is zoned for commercial use. It is anticipated that future use of the properties will be consistent with their current uses. Other land uses of the area impacted by the contaminated groundwater are expected to be consistent with the current uses; that is, commercial, industrial, agricultural, and residential.

3.2.2 Groundwater Use

There are four municipal wells within a mile of *the source*. Three of the wells are to the southeast, cross-gradient from the plume (Bountiful Shop Well, Woods Cross #1, and Bountiful Well), and one well (West Bountiful 5th South Well) to the southwest, cross-gradient from the plume. There are also 26 domestic wells located within the PCE plume study area (Figure3). Sample results from 7 out of the 26 wells showed PCE concentrations above the MCL. Twenty-five of the domestic wells are currently used for irrigation and stock watering only. In the past, some wells have been used for drinking water, and it is possible these wells could also be used for drinking or other indoor water use in the future. The residence at the location of DW05 is not connected to City water. Groundwater at DW05 is the only drinking and indoor water source that is above MCLs. Two of the 26 wells in the West Bountiful area are completed in the shallow (upper-unconfined, 0 to 59 ft bgs) zone. The remaining wells are completed in the middle (confined aquifer, approximately 60 to 160 ft bgs) or the lower (> 160 ft bgs) zones.

The Weber Basin Water Conservancy District operates a municipal well (West Bountiful 5th South Well). The well is located geographically within the south fringe of the PCE plume. The well intake screen is placed between 325 to 600 ft bgs. No COCs have been reported in this well. The District plans to use this well for irrigation as the demand for water increases with future population growth.

4.0 Summary of OU2 Risks

4.1 Summary of Human Health and Ecological Risk Assessment

The BHHRA estimates the potential risk to humans and ecological receptors from COCs related to the Site, assuming that no action is taken to clean the contamination. The risk assessment identifies the contaminants and exposure pathways that need to be addressed by the RA.

For human receptors, EPA's decision to take action is based primarily on the presence of contamination in groundwater at levels that exceed drinking water standards. Because the concentration of contaminants in groundwater tends to decrease as a function of distance from *the source*, and because most humans who use groundwater draw their water from a single well, human exposure was evaluated on a well-by-well basis. Currently there are seven domestic wells that have been impacted by PCE contamination emanating from *the source*. PCE concentrations at these wells are above MCL levels. One of these wells (DW05) provides the only source of drinking water to a residence. The water from the remaining six contaminated wells is used only for irrigation and stock watering. Because it is believed that most workers or residents do not drink water from the shallow aquifer, the exposure pathway to groundwater ingestion is considered mainly hypothetical, although some exceptions may occur.

In October 2005**,** EPA and UDEQ/DERR conducted interviews to assess if any property owners with domestic wells were drinking contaminated groundwater. Results from the interviews indicate that there are up to seven residences where the well water is used for drinking; however, in all cases, the contamination levels are below the MCL. None of the well owners interviewed were interested in being connected to potable municipal water as long as the contaminant levels remained below the MCL.

For ecological receptors, exposure can only occur if the groundwater is discharged at the surface (e.g., into streams, lakes, or wetlands). If contaminated groundwater is expressed at the surface, ecological receptors can be exposed by several different routes. Wildlife could be exposed to groundwater expressed at the surface by ingestion as drinking water and also by ingestion of aquatic food-web items. However, because VOCs tend to be rapidly lost from surface water and do not tend to build up in the food chain, and because limited data suggest that VOCs are not detectable in surface waters collected on or near the Site (UDEQ 2002), these pathways were judged to be unlikely to be of concern and were not evaluated in this risk assessment.

Also, it is important to note that no ecologically sensitive scenarios were identified at the Site. This is due to the lack of suitable habitat, and the industrial, commercial, and residential land uses at OU2. Consequently, ecological risks will not be presented in subsequent sections of this ROD. Additional information on the ecological exposure pathways and exposure point concentrations are provided in the BHHRA (SRC 2005).

4.2 Identification of Chemicals of Concern

The BHHRA evaluated soil, sub-surface soil, and groundwater. Only the sub-surface soil at *the source* and the groundwater are contaminated with Chemicals of Potential Concern (COPCs) for human health. COPCs are chemicals derived, at least in part, from Site-related sources and exist in sub-surface soil and/or in groundwater at concentration levels that might pose risks of adverse health effects in exposed humans or ecological receptors. The COPCs for OU2 evaluated quantitatively in the BHHRA risk assessments are presented in Tables 5 and 6.

The selection procedure is designed to eliminate chemicals that are not likely to contribute significant risk, while chemicals that might be of potential health concern are retained. It is important to note that this COPC selection procedure is intended to be conservative. It is expected that some chemicals will be identified as COPCs that are actually of little or no health concern, but that no chemicals of authentic health concern will be overlooked. Results of COPC quantitative screening evaluation identified the following chemicals as the primary risk drivers for human exposure in *the source* area and in the groundwater plume:

Groundwater at the source: *PCE/TCE/VC/Benzene*
Indoor air (BCI building): *PCE/TCE/VC/1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene*
Groundwater plume: *PCE/TCE/VC/MTBE/Benzene*

Risks at OU2 are primarily due to PCE, with the exception of two locations. At location MW03U the risks are due mainly to high concentrations of MTBE. The source for the MTBE contamination is the former Phillips Refinery (now owned and operated by Holly Refinery and Marketing Co.). The MTBE is being addressed under a corrective action plan under the oversight of UDEQ/DWQ . In the proximity of OU1 the COC is TCE and its degradation products are the primary drivers of risk; however, TCE contamination is being addressed under the ROD for OU1.

The principal reason for concern at OU2 is groundwater contamination and the expansion of the plume to residential areas. Figure 3 shows the iso-concentrations of PCE in groundwater derived

from the MW sampling results. The COCs in groundwater, the frequency of detection, the range of concentrations, and the exposure point concentrations are presented in Table 7.

4.3 Exposure Assessment – Source Area

At *the source*, risks from inhalation of VOCs in air were evaluated on a building-by-building basis. In cases where different uses were currently occurring within a building (e.g., at the BCI property), current risks were evaluated on a room-by-room basis. Under current conditions, the populations of primary concern at OU2 are workers who may be exposed by inhalation of vapors within buildings near *the source* area. In addition, visitors to the buildings (clients, shoppers) may also be exposed, although at a lower level.

Based on the evaluations provided by the OU2 BHHRA-Addendum, the VOCs in indoor air may be derived from three sources:

- Volatilization from sources within the building
- Intrusion of vapors released from contaminated soil or groundwater beneath the building
- Contamination in ambient air

Vapors in sub-slab air are derived from upward migration of vapors from contaminated soil or groundwater beneath the building. Assuming that the building foundation contains cracks or other openings, the sub-slab vapors may serve as a continuing source of contamination of indoor air. Table 8 summarizes exposure units evaluated in the risk assessment addendum that present a risk to current and future workers and visitors.

Risk to residents was also evaluated in the BHHRA-Addendum; however, since the residential land use is not consistent with the current or the expected future land uses at *the source*, this exposure scenario is not presented in this ROD. Only human exposure pathways that present a risk consistent with the current or anticipated land uses are presented in this ROD.

4.4 Exposure Assessment - Groundwater Plume

Based on the evaluations provided by the OU2 Risk Assessment, only three exposure pathways warranted a quantitative risk evaluation, and are presented in this ROD.

- Direct ingestion of water (from a well) as drinking water
- Inhalation of VOCs that are released to indoor air from indoor use of groundwater
- Inhalation of VOCs that are released from groundwater and migrate through soil into indoor air

4.5 Human Pathways

4.5.1 Direct Ingestion of Contaminated Groundwater

As noted in Section 2.4.4, the shallow aquifer is classified by the State of Utah as a Class II drinking water source. Several wells have been installed in this aquifer including: 26 domestic wells, two production wells (Holly Refinery and Marketing Co.), and one municipal well (West Bountiful 5th South Well). Twenty-two out of 26 domestic wells are located within the perimeter of the PCE groundwater plume. Therefore, it is possible that humans may ingest groundwater as drinking water. If so, drinking water ingestion is likely to be a major source of exposure; therefore, this pathway was evaluated quantitatively.

4.5.2 Inhalation of VOCs Released to Indoor Air from Indoor Water Uses

When VOCs are present in water that is used for indoor purposes by residents (e.g., showering, dishwashing, clothes washing, toilets, sinks, cooking) or commercial operations (e.g., process water), these VOCs may escape from the water into indoor air, leading to inhalation exposure. Measurements and calculations both indicate that this pathway can be significant; therefore, this pathway was evaluated quantitatively for both residents and workers.

4.5.3 Inhalation of VOCs Released from Groundwater to Air Via Soil Transport

Groundwater contaminated with VOCs may release those VOCs into soil gas, and the VOCs may diffuse upward through pores in the soil and be released at the surface. If the surface is not covered by a building, the VOCs enter outdoor air where they are diluted and dispersed by wind. Hence, inhalation of VOCs in outdoor air is not considered to be an important exposure route. However, if the VOCs approach the surface at a location near a building, the soil gas may be drawn into the building and the concentration in the building may tend to build up. Inhalation of VOCs in indoor air volatilized from soil gas emanating from groundwater and/or sub-surface soil is considered a complete and potentially significant pathway; therefore, this pathway was evaluated quantitatively.

4.6 Toxicity Assessment

The toxicity assessment considered both carcinogenic and non-carcinogenic effects. Tables 9 and 10 list the default exposure parameters recommended by EPA for evaluation of workers' and residents' exposure by ingestion of groundwater and inhalation of VOCs in indoor air resulting from groundwater. The BHHRA utilized information from the Integrated Risk Information System (IRIS), EPA Provisional Values, or as cited by EPA-related reports.

The non-cancer reference dose (RfD) and cancer slope factor (SF) values used in evaluating inhalation risks in this addendum were selected using the recommended hierarchy for selecting toxicity values for human health risk assessment at Superfund sites (USEPA 2003a) and are summarized in Tables 9 and 10.

4.7 Risk Characterization

For carcinogens, the risks of cancer from exposure to a chemical are generally expressed as the incremental probability of an individual's developing cancer over a lifetime, 70 years, as a result of exposure to each chemical. This value is calculated from the average chronic daily intake of the chemical from the Site, averaged over a lifetime (CDI_L), and the SF for the chemical. Excess lifetime cancer risk is calculated from the following equation:

Cancer Risk = CDI_L x SF

where:
Cancer Risk = a unitless probability (e.g., 2E-04) of an individual's developing cancer
CDI_L = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor, expressed as (mg/kg-day)-1.

Excess cancer risks are summed across all COCs and all exposure pathways that contribute to exposure of an individual in a given population.

In general, the EPA considers excess cancer risks that are below one in one million (1E-06) to be so small as to be negligible and excess risks above one in ten thousand (1E-04) to be sufficiently large to merit some sort of intervention or remediation. Excess cancer risks that range between 1E-04 and 1E-06 are generally not considered large enough to warrant action under Superfund (USEPA 1991b), although this is evaluated on a case-by-case basis.

The potential for non-cancer effect is evaluated by calculating the ratio of exposure (CDI) to toxicity level (RfD) for a chemical over a specified time period (e.g., lifetime). The RfD represents a level that an individual may be exposed to and not expected to have any harmful effects. This ratio is called the Hazard Quotient and is calculated as follows:

HQ = CDI_L / RfD

where:

HQ = Hazard Quotient
CDI_L = Chronic Daily Intake (mg/kg-day) for non-cancer effects
RfD = Reference Dose (mg/kg-day)
HI = Hazard Index

If the HQ for a chemical is equal to or less than 1 ($HQ \leq 1$), it is believed that there is no appreciable risk that non-cancer health effects will occur. If an HQ is greater than 1 ($HQ > 1$), there is some possibility that non-cancer effects may occur, although an HQ above 1 does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all RfD values. However, the larger the HQ value, the more likely it is that an adverse effect may occur.

If exposure to the chemical occurs by more than one pathway, the HQ values are added across

pathways to yield a total indicator risk referred to as a HI. If exposure occurs to more than one chemical, and if two or more chemicals act on the same target tissue or organ system (e.g., the liver), then the total risk of adverse effects in that tissue is calculated by adding the HI values across those chemicals.

4.8 Risks to Human Receptors

4.8.1 Risks from Ingestion of Groundwater

Results for current or future residents and workers are summarized in Tables 11 and 12. As noted previously, it is believed that most residents and workers do not currently ingest water from the shallow aquifer for drinking water. Thus, risks from this pathway are largely hypothetical, although some exceptions may occur. Note that only risks that exceed 1E-04 are listed on the tables provided in this ROD. Additional information on exposure risks are provided in the BHHRA for each exposure station.

Non-cancer risks from the ingestion of groundwater are below a level of concern in all cases (HI<1) for current or future residents and workers and therefore are not included in this ROD. At most locations, excess cancer risks are within or below EPA's target risk range of (1E-04 to 1E-06) for residents and workers. However, there are several areas where cancer risks exceed the upper end of EPA's target risk range. Most of these locations are within the extent of the PCE plume and the risks are driven by PCE. The remaining areas, where cancer risks exceed EPA's target risk range, are located along the southern boundary of OU2, including the Holly Refinery, within Study Area 3, the Hatchco property, and in the vicinity of the Hatchco property. Risks in these areas are primarily due to TCE and/or VC. Risks to TCE and VC are addressed under the ROD for OU1. At one location near the southern boundary of the Site, (MW03U), high concentrations (2,400 to 13,000 ug/L) of MTBE are the main source of the excess cancer risks. The risk from MTBE contamination is being addressed under a corrective action plan under the oversight of the UDEQ/DWQ.

4.8.2 Risks from Inhalation of VOCs Intruding from Groundwater by Vapor Intrusion

For current or future residents and workers, cancer and non-cancer risks from the vapor intrusion pathway are below a level of concern in all cases; therefore, risks resulting from the PCE groundwater plume are not presented in this ROD. However, there are a few locations where excess cancer risks to current or future residents from TCE may exceed 1E-04. Risks resulting from inhalation of TCE vapors intruding from groundwater to indoor air are presented in the ROD for OU1.

4.8.3 Risks from Inhalation of VOCs Released During Indoor Use of Groundwater

As noted previously, it is believed that most current residents do not use water from the shallow aquifer for indoor purposes, although some exceptions may exist. Thus, risks from this pathway to residents are considered to be mainly hypothetical.

With the exception of station MW03U, non-cancer risks are at or below a level of concern in all cases (HI<1) for current or future residents and workers, and therefore are not discussed in this ROD. At MW03U, the non-cancer risk is slightly above a level of concern (HI = 2E+00) for residents due to MTBE. At most stations, excess cancer risks are within or below EPA's target risk range of (1E-04 to 1E-06) for residents and workers. However, as presented in Tables 13 and 14, there are several stations where cancer risks exceed the upper end of EPA's target risk range. These stations are located in likely source areas including the BCI property, Study Area 3, the former Hatchco property, and the TCE groundwater plume. Risks associated within Study Area 3, the Hatchco property, and the TCE groundwater plume are addressed under the ROD for OU1. The risk associated with station MW03U is being addressed under a corrective action plan by UDEQ/DWQ. At station WPH10 VC also contributes to excess cancer risks (Figure 3).

4.8.4 Combined Risks from All Exposure Pathways

Tables 15 and 16 present a summary of the range of risks which might occur if the same resident or worker were exposed by all three of the primary exposure pathways at a well (groundwater ingestion, inhalation of VOCs intruding into indoor air from groundwater, and inhalation of VOCs released to indoor air from indoor water). As seen, excess cancer risks exceed the upper end of EPA's target risk range (1E-04) for residents and workers at several locations. These exceedences are due mainly to risks attributable to ingestion of groundwater with lower risks from inhalation of VOCs released to air from indoor use of groundwater and inhalation of VOCs intruding from groundwater. In cases where excess cancer risks to residents and workers are due to TCE, the risks are primarily due to the inhalation of VOCs from the indoor use of groundwater pathways. With the exception of MTBE, when all exposure pathways are combined, non-cancer risks are below a level of concern (HI < 1) for workers for all locations; therefore, non-cancer risks are not discussed in this ROD. The source of the MTBE contamination is not attributed to the Hatchco property and is being addressed under a corrective action plan by UDEQ/DWQ (UDEQ November 1, 2005). Consequently, MTBE contamination is not subject to the remedy specified in this ROD.

4.8.5 Risks from Inhalation of VOCs Released Indoors at the BCI Building

Risks to Workers

Predicted risks to workers at the BCI building are shown in the upper panel of Table 17. Based on measurements in indoor air, cancer risks to workers from VOCs exceed EPA's target risk levels (1E-04 to 1E-06) at all exposure units at the BCI building. Predictions from sub-slab air (assuming AF = 1/10) are similar, with risks from VOCs exceeding EPA's target risk level at all exposure units. Based on predictions from sub-slab air (assuming AF = 1/100), risks are lower, but most exposure units (3 out of 4) would still exceed EPA's target risk levels for cancer. Cancer risks from both indoor air and sub-slab air are almost entirely due to concentrations of PCE in air, with much smaller contributions from TCE and other VOCs. Predicted non-cancer

risks to workers at the BCI building are also shown in Table 17. Based on indoor air measurements, non-cancer risks to workers from VOCs exceed EPA's target risk levels at all exposure units at the BCI building. Based on predictions from sub-slab air (assuming AF = 1/10), non-cancer risks exceed a level of concern (HI > 1E+00) at almost all (3 out of 4) of the exposure units. Based on predictions from sub-slab air (assuming Attenuation Factor = 1/100), risks are lower, and only one exposure unit would still exceed a non-cancer level of concern. Non-cancer risks are primarily driven by PCE and/or 1,2,4-trimethylbenzene, and to a lesser extent by 1,3,5-trimethylbenzene. In comparing the risk estimates based on measured indoor air to values based on intrusion of sub-slab vapors, it is apparent that measured indoor air concentrations are one to two orders of magnitude higher than predicted if the only source were intrusion of sub-slab vapors. This strongly suggests that there are other sources contributing to the concentrations of VOCs in indoor air at the BCI building. Based on these findings, it has been concluded that current indoor air concentrations are of potential concern to current workers, and that intrusion for sub-slab vapors would likely be of concern even if other indoor sources were eliminated.

Risks to Clients Visiting the BCI Building

Based on the results for workers, screening level calculations indicate that risks to clients visiting the BCI building are not likely to be of concern, assuming that exposures do not exceed approximately 30 minutes per day, one day per week, over a period of 25 years. If an individual were to visit the BCI building more often or for longer times than this, then estimated cancer risks might begin to approach or exceed the upper end of EPA's target risk range (1E-04).

5.0 Uncertainties

Quantitative evaluation of the risks to human or ecological receptors from environmental contamination is frequently limited by uncertainty (lack of precise knowledge) regarding a number of important exposure and toxicity factors. Thus, exposure and risk calculations are usually derived using a number of estimated values. In general, when data are limited or absent, the exposure and risk parameters selected are chosen in a way that is intentionally conservative. That is, the values selected are more likely to overestimate than underestimate actual risk. However, some assumptions and approaches used in risk assessment may tend to underestimate risks. It is important for risk managers and the public to keep these uncertainties in mind when interpreting the results of a risk assessment. Additional information on the main sources of uncertainties in the exposure and risk calculations is provided in Section 6.0 of the BHHRA (SRC 2005).

5.1 Summary of Uncertainties

Table 18 summarizes the direction and potential magnitude of the errors introduced by the uncertainties discussed above. Because of these uncertainties, none of the exposure and risk calculations presented above should be interpreted as accurate measures of the true risk. Rather, all values should be interpreted as uncertain estimates. Because many (but not all) of the approaches for dealing with uncertainty are intended to be conservative (i.e., are more likely to

overestimate than underestimate), the risk values above should generally be thought of as high-end estimates of the true risk, and actual risks are probably somewhat lower than the calculated values. The exposure assumptions used to calculate risks were, in general, conservative. This generally results in the overestimation of risks. For several COPCs, the maximum concentrations were used instead of the 95 percent Upper Concentration Limit of the Mean. This typically results in the overestimation of risk. Quantitative risk calculations for future residential exposure to groundwater were calculated on the maximally impacted wells, or worst-case analysis.

Evaluation of all the uncertainties utilized in the BHHRA suggests that the risks have been overestimated. Thus, the EPA's goal to ensure that health risks are not underestimated was accomplished.

Additional information on the main sources of uncertainties in the exposure and risk calculations performed are provided in Section 6.0 of the BHHRA for the Bountiful/Woods Cross Site (July 2004).

6.0 Remedial Action Objectives

RAOs for OU2 were developed from a review of the results of the Site-wide sampling data for OU1 and OU2, evaluation of the BHHRA for OU2, fate and transport evaluations, and review of Applicable or Relevant and Appropriate Requirements (ARARs).

Groundwater at the Bountiful/Woods Cross 5th South PCE Plume NPL Site is a current and potential source of drinking water to residents and communities at the Site. The properties at *the source* are used for commercial purposes. The indoor air inside the BCI building is contaminated with PCE in most sections of the building. Volatilization of PCE from the shallow soils and the soil under the BCI building pose a potential health threat to current and future workers. Therefore, the RAOs developed for groundwater at OU2 and for indoor air in the BCI building are to protect human health by:

- Preventing direct ingestion of untreated groundwater as drinking water
- Preventing exposure via inhalation of VOCs in contaminated groundwater that are released into indoor air from indoor water uses
- Preventing exposure via inhalation of VOCs released from groundwater and soils that migrates upward through soil into indoor and sub-slab air
- Restoring groundwater to its beneficial use.

6.1 Need for Remedial Action

Past operations conducted at the BCI property resulted in contamination of sub-surface soils and groundwater. The main COC for both sub-surface soils and groundwater is PCE. MTBE, TCE and degradation products are also present on the southern edge of the PCE groundwater plume;

however, as presented in Section 4.0, these contaminants are addressed under a corrective action plan by the UDEQ/DWQ and the ROD for OU1.

The PCE groundwater plume, under current conditions, will continue to expand and the contaminant concentrations in groundwater underlying residences and in domestic wells may also increase if left alone. Only active remediation will eliminate and/or reduce potential exposure pathways for human receptors. Effective remediation at OU2 will treat sub-surface soils and groundwater at *the source*, and will restore groundwater to its beneficial use within a reasonable time. The response actions selected in this ROD are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

6.2 Cleanup Goals

The cleanup goals were derived predominantly from the BHHRA and ARARs. At OU2, the potential cancer risk from exposure to contaminated groundwater exceeds $1x10^{-6}$ for residents and workers.

Under the National Contingency Plan (NCP), EPA's goal is to reduce the excess cancer risk to the acceptable range of $1x10^{-4}$ (1E-4) to $1x10^{-6}$ (1E-6). For residential exposures, $1x10^{-6}$ is the threshold risk factor for making risk management decisions, but risk managers may consider risk factors up to $1x10^{-4}$ before taking action. For OU2, EPA selected the MCLs or RBCs based on a HI of one (HI=1) and a cancer risk factor of 1E-4 assuming a Reasonable Maximum Exposure (RME) through ingestion of contaminated groundwater and inhalation of soil and groundwater vapor via the vapor intrusion pathway. Also, EPA selected soil cleanup levels protective of the soil vapor transfer to indoor spaces, soil vapor transfer to groundwater, and contamination leaching to groundwater. Chemical-specific cleanup levels for groundwater, soil, and soil vapor are provided in Section 13.2.

With the exception of the BCI building and location MW03U non-cancer risks are below a level of concern (HQ < 1). Ecological risks are below a level of concern. (See Section 3.0 for further information concerning ecological risks).

7.0 Description of Alternatives

Several options and technologies were considered to clean up the groundwater at OU2. This section summarizes each of the six alternatives selected for detailed analysis in the Focused Feasibility Study Report OU2 (2005) and the Final Feasibility Study Addendum (2006). For consistency and clarity, the alternatives are numbered to correspond with the numbers provided in the feasibility study reports.

7.1 Common Elements

Institutional Controls (ICs)

Each alternative (except the "No Action") includes ICs to prevent or restrict the use of

groundwater until the aquifer is returned to its beneficial use. Since the remedy for groundwater will not result in an unrestricted use in the short term, ICs are necessary to limit unacceptable exposures at OU2.

The principal concern at OU2 is the ingestion of groundwater contaminated with PCE, and the potential inhalation of VOC vapors from soil (at the BCI building) and/or groundwater that could accumulate in indoor spaces. The target areas for potential future inhalation concerns are where new residential or commercial structures may be constructed and the current residential areas located downgradient from the current extent of the groundwater plume. Groundwater modeling can be used to predict the correlation between solvent plumes and VOC accumulation in buildings. However, modeling alone is usually not a reliable indicator where buildings are located above solvent plumes. Groundwater monitoring coupled with soil vapor intrusion testing will alert the agencies to the potential vapor intrusion impacts for current and future residential/commercial areas. ICs (including land use controls, restricting groundwater uses on domestic wells or municipal wells, restricting new well development, or requiring mitigation for vapor intrusion) may be used to limit these potential exposure pathways. These ICs are a common element to all alternatives presented in this ROD. The objectives of the ICs are presented below:

IC Objectives

1) Restrict the use of groundwater as a drinking water source until the MCLs are met;
2) Restrict new well development for drinking water and domestic use along the projected path of the contaminated groundwater plume until the MCLs are met;
3) Recommend vapor intrusion mitigation in all permits for new construction of commercial (office space) and/or residential buildings planned on or along the projected path of the contaminated plume;

Implementation of ICs will depend upon agreements with the State, the appropriate local jurisdictions, and/or individual land owners. ICs may consist of activity and land use limitations imposed by state regulations, County or City ordinances, environmental covenants, and/or restrictive covenants or easements. None of the remedies rely exclusively on ICs to achieve protectiveness.

Monitoring

Except for the "No Action" alternative, groundwater monitoring (as well as IC monitoring) is a common element to all alternatives. Monitoring is a key component to ensure protection of human health and the environment and to measure the effectiveness of the remedy. New MWs will be installed in *the source* and plume area downgradient of the Warm Springs fault line. The wells will serve as a "first detection" before the domestic and targeted municipal water supply wells. Groundwater and soil vapor samples will be collected during the life of the project. The sample results will be evaluated every year to assess contamination trends and to alert the agencies to potential exposure pathways. The data will be used to assess the overall performance of the remedy and evaluate any occurrences of natural attenuation processes within the plume. A data base will be created and maintained by EPA/UDEQ-DERR for the life of the remedy. The frequency of the monitoring events will be established during the Remedial Design (RD) in the

O&M plan.

The monitoring program will be subjected to five-year reviews by EPA and UDEQ. The five-year reviews will continue until the groundwater is returned to unrestricted use.

7.2 Alternative 1 - No Action Alternative

Estimated construction time frame: None

Regulations governing the Superfund program require evaluation of the "no action" alternative to establish a baseline for comparison of alternatives. Under the "no action" alternative, EPA would leave soil and groundwater in its current condition and would not take any action at OU2 to prevent human exposure to contaminated groundwater, to prevent exposure via inhalation of VOCs released from groundwater and soils that migrates upward through soil into indoor air, and to prevent further degradation of groundwater resources. The source material and contaminated groundwater would remain in its current state without treatment, allowing the continued migration of the COCs. Any reduction of contaminants in soil and in groundwater would be due to natural migration, dispersion, attenuation, and degradation processes. Since contamination would be left in place, five-year reviews are included with the implementation of this alternative.

7.3 Proposed Alternatives for Source Removal

The sub-surface soil at *the source* is contaminated with VOCs and poses a threat to human health and the environment. If the sub-surface soil is not cleaned up, it will continue to release hazardous substances into groundwater and the environment. The following remedial alternatives to address PCE contamination at the *the source* passed the general screening process in Section 3 of the Final Focused Feasibility Study Report (July 2005).

7.3.1 Alternative 2 - Dual Phase Extraction/Soil Vapor Extraction (DPE/SVE), Excavation, Disposal, Groundwater Extraction, Treatment, Discharge, and Monitoring

This alternative provides for the remediation of soil and groundwater at *the source* area through a combination of dual phase extraction (DPE) and soil vapor extraction (SVE) systems. DPE wells would be located in portions of *the source* area containing the highest groundwater contaminant concentrations. DPE wells would be installed at approximately 20 ft below the water table. SVE wells would be installed in targeted vadose zone areas and permanent soil gas probes would be installed to provide points for monitoring SVE performance.
Vapors from both the DPE and SVE wells would be piped to a common manifold and treated as necessary in a common activated carbon system. Extracted groundwater from the DPE wells would be piped to a common collection header and treated as necessary with activated carbon or an air stripper. For the Focused Feasibility Study (FFS), a liquid granular activated carbon system (LGAC) option was assumed for costing purposes. Should an air stripper be selected as the preferred treatment option for extracted groundwater in the detailed design, vapors from the

air stripper would be routed to the same LGAC system used to treat SVE and DPE vapors. Treated groundwater would either be injected into the aquifer or sent to a local Publicly Owned Treatment Works (POTW).

Pilot Study

A pilot study will be necessary prior to the RD to evaluate and refine the design parameters to implement DPE and SVE systems to support this alternative.

Source Area Excavation and Disposal

Excavation of shallow source area soil in the parking lot of the BCI property would address the ongoing potential exposure of workers to VOC emissions. This excavation would involve removing approximately a 25 x 25 foot area beneath the parking lot adjacent to the BCI building in *the source* area. The excavation would be accomplished using a small trackhoe. Dust suppression measures, consisting of spraying water on the soils, will be applied during excavation to mitigate fugitive emissions into the air. The excavation depth would be approximately 10 to 20 ft. Confirmation sampling (analyzing for PCE in the soils) would be accomplished upon completion of the excavation. Sampling methods and acceptable levels of PCE remaining after excavation will be determined during the RD of this alternative. The excavated area would be filled in with clean backfill and covered with asphalt. Excavated material will be sampled and if needed it will be transported to a RCRA landfill for disposal in a permitted hazardous waste landfill. The trucks used to transport the excavated material would be covered to mitigate fugitive dust emissions from the waste during transportation.

Five-Year Reviews

Periodic reviews will be required to evaluate the effectiveness of this remedial alternative. These reviews would be performed at least every five-years as long as hazardous substances, pollutants, or contaminants remain above levels that allow unrestricted use and unlimited exposure.

7.3.2 Alternative 3 - Alternative 3: Enhanced Anaerobic Bioremediation (EAB), Soil Vapor Extraction (SVE), Excavation, Disposal, and Monitoring

Alternative 3 has many of the same elements as Alternative 2 except that it replaces DPE and deep groundwater pump-and-treat with EAB. The similar elements include the SVE well and ancillary equipment, the source area excavation and disposal, ICs, the groundwater monitoring program, and 5-year reviews. Descriptions of those elements that are shared with Alternative 2 are not repeated here. The general elements of the alternative are presented in Section 4.2.2 and Section 4.2.3 of the FFS (July 2005). Each of the elements that are unique to Alternative 3 are described in more detail in the following paragraphs.

This alternative provides for the remediation of groundwater at *the source* through installation of an EAB system consisting of injection and extractions wells. These wells will operate such that a recirculation cell will be created in *the source* area for EAB treatment of groundwater

contamination. In this system, contaminated groundwater will be extracted from approximately 130 ft bgs. The extracted groundwater will be mixed with natural substances (amendments) such as soybean oil and possibly natural bacteria (i.e. *Dehalococcoides* sp) to accelerate the natural degradation/transformation/decomposition of the PCE and then recirculated. It is assumed that the recirculation system will operate continuously and amendment will be pulsed in periodically. EAB performance monitoring will be conducted in *the source* area through sampling of the extraction wells. Initially, the extraction wells will be sampled once per month, approximately one week and five weeks following completion of an injection event. Parameters to be monitored will include contaminants and degradation products, redox-sensitive parameters, biological activity indicators, and water quality parameters[2]. The frequency, locations, and parameters monitored and the injection strategy (i.e. flow rate, concentration, volume, and/or frequency) may be adjusted during the remedy optimization or if the operations data suggest that changes are appropriate. Based on groundwater modeling simulations performed in support of the FFS and the relatively low PCE concentrations present in *the source* area, it is expected that remedial activities for this alternative will be conducted for a period of two-years.

The contaminated vapors released by the soil located next to the groundwater table will be extracted via a vacuum (SVE) and treated (i.e., granular activated carbon). ICs will be in place to restrict the use of groundwater as a drinking water source. The remedy will be evaluated every five-years until standards are met.

Pilot Study

As with Alternative 2, a pilot study will be necessary to evaluate design parameters to implement the technologies proposed with this alternative.

7.4 Proposed Alternatives for Groundwater Remediation

Groundwater at the Site is a potential drinking water source for surrounding communities. Absent of any treatment, the RI, FFS, and FSA concluded that, even if *the source* is removed, the groundwater plume may continue to expand. Some residences may require an alternate water supply to prevent unacceptable exposure to direct ingestion of untreated groundwater or to prevent breathing of vapors emitted from the indoor uses of groundwater. Presented below are the remedial alternatives that passed the general screening process to treat the groundwater plume emanating from *the source*. Each of the remedial alternatives for the groundwater plume provides for the remediation of the aquifer through removal of the contaminant source area soils as described in Section 7.3.1. As described in the FFS (CDM 2005c), contaminant source removal would be accomplished through a combination of the following: (1) excavation and disposal of contaminated soils, (2) DPE, (3) SVE, (4) EAB, or (5) groundwater extraction and treatment.

[2] PCE and degradation products (TCE, DCE, VC, ethene, ethane, and chloride), redox-sensitive parameters (dissolved oxygen (DO), oxidation reduction potential (ORP), nitrate, ferrous iron, sulfate, and methane), electron donor parameters (chemical oxygen demand (COD)), biological indicator parameters (pH and alkalinity), and water quality parameters (specific conductance, turbidity, and temperature). In addition, groundwater from selected extraction wells may be analyzed for microbial community profiling - natural bacteria (i.e. *Dehalococcoides spp.)* or individual species detection during the first year after each amendment.

7.4.1 Alternative A – Contaminant Source Removal, Institutional Controls, Alternative Water Supply, and Monitored Natural Attenuation

This alternative includes one of the contaminant source removal alternatives and the common elements presented under Section 7.1 of this ROD. In addition, this alternative would provide an alternate water supply to exposed residents living on or near the plume and who are not connected to a municipal water supply. If a domestic drinking water well becomes contaminated in the cities of West Bountiful and/or Woods Cross (e.g., contamination above MCLs) the property owner will be offered a connection to a municipal water supply system, and a notice will be provided to the resident regarding the appropriate groundwater use.

Alternative A does not actively treat the plume; instead, it allows the plume to degrade via natural processes.

Five-Year Reviews

Periodic reviews will be required to evaluate the effectiveness of this remedial alternative. These reviews would be performed at least every five-years as long as hazardous substances, pollutants, or contaminants remain above levels that allow unrestricted use and unlimited exposure.

7.4.2 Alternative B – Hydraulic Containment

Alternative B includes all of the same components as Alternative A but also adds hydraulic containment of the plume. The plume containment will be accomplished by pumping water out of extraction wells. The wells will most likely be placed inside the Holly Refinery Company property and groundwater will be pumped at a rate of about 300 gallons/minute. The extraction wells will intercept the plume near the Warm Springs fault that cuts across the aquifer downgradient of the refinery. Operation of the extraction wells will prevent the contaminants from flowing past the extraction locations. Contaminants that are already downgradient of the extraction wells will naturally attenuate and will not be actively treated. The extracted groundwater will be treated as necessary using LGAC and the clean treated water will be injected into the aquifer, discharged into a publicly owned treatment plant, used to supplement for clean water to local stakeholders in exchange for water rights, or used to offset the O&M cost. These options may be considered during the design of the extraction/injection system. The appropriate option for handling the treated water shall be determined during the RD phase.

Pilot Study

As with Alternative 2, a pilot study will be necessary to evaluate design parameters to implement the proposed extraction system. The final design parameters, location and configuration of the groundwater remediation system will be determined via the pilot study and finalized in a Final RD.

Contaminant source removal, alternate water supply, and performance monitoring would be conducted as described in Sections 7.1, 7.3.1 and 7.4.1.

Five-Year Reviews

Periodic reviews will be required to evaluate the effectiveness of this remedial alternative. These reviews would be performed at least every five-years as long as hazardous substances, pollutants, or contaminants remain above levels that allow unrestricted use and unlimited exposure.

7.4.3 Alternative C – In Situ Bioremediation

Alternative C includes all of the same components as Alternative A but adds groundwater treatment via an in situ biobarrier (in-place treatment). The biobarrier will consist of about 35 fracturing wells installed along a line perpendicular to the contaminated groundwater plume, placed about the same location as the two extraction wells described in Alternative B. High permeability sand slurry will be pumped at high pressure into the ground forcing the formation to fracture, filling the open spaces with the sand and the treatment fluid slurry (slow release electron donors). Groundwater will flow throughout the treatment biobarrier which would stimulate the anaerobic degradation of PCE (in-place treatment).

About 92 fractures will be installed in each of the 35 fracturing wells generating approximately 3,220 fractures for in-place treatment. The depth of the fracture zone will range from 95 to 210 ft bgs. The total thickness of the fracture zone is approximately 115 ft. For the cost analysis of this alternative it is assumed that the barrier would need to be recharged every five-years for the duration of the remedy.

Five-Year Reviews

Periodic reviews will be required to evaluate the effectiveness of this remedial alternative. These reviews would be performed at least every five-years as long as hazardous substances, pollutants, or contaminants remain above levels that allow unrestricted use and unlimited exposure.

8.0 Comparative Analysis of Alternatives Criteria

The NCP requires the evaluation of remedial alternative according to specific criteria. The purpose of this evaluation is to promote consistent identification of the relative advantages and disadvantages of each alternative, thereby guiding selection of remedies offering the most effective and efficient means of achieving the OU2 cleanup goals. There are nine criteria by which feasible remedial alternatives are evaluated. While all nine criteria are important, they are weighted differently in the decision-making process depending on whether they describe or involve protection of human health and the environment or compliance with federal or state statutes and regulations (threshold criteria), a consideration of technical or socioeconomic merits (primary balancing criteria), or the evaluation of non-EPA reviewers that may influence an EPA decision (modifying criteria).

Threshold Criteria

(1) Overall Protection of Human Health and the Environment

(2) Compliance ARARs

Primary Balancing Criteria

(3) Long-term Effectiveness and Permanence
(4) Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment
(5) Short-term Effectiveness
(6) Implementability
(7) Cost

Modifying Criteria

(8) State Acceptance
(9) Community Acceptance

8.1 Evaluation of the Proposed Alternative

8.1.1 Overall Protection of Human Health and the Environment.

Table 19 presents a summary of the comparative analysis of alternatives. Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or ICs.

All the alternatives, except the "no action" alternative, would adequately protect human health and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, and/or ICs. The VOCs are either treated to safe levels or over time break down to safe levels through natural processes. It should be noted that for the remedy to be protective during the time it will take to reach safe levels, all the alternatives rely on ICs.

Alternative 1 contains no RA that addresses *the source* area, the groundwater plume, or contaminant loadings to air at OU2. This alternative does not meet the RAOs established in Section 6.0 and is not protective of human health or the environment. Groundwater and indoor/outdoor air contamination would continue to be present into the future. The overall risk of contaminant exposure to current and future human populations from contaminated groundwater and soil would not be significantly reduced. The purpose of providing a no action alternative is to provide a baseline against which the other remedial alternatives can be compared.

Because the "no action" alternative is not protective of human health and the environment, it will be eliminated from further consideration.

Alternatives 2 and 3 will treat soils and the groundwater plume at *the source* area but will not actively treat the plume downgradient from *the source* and/or prevent the plume expansion which can possibly further expose more residential/business properties. For these reasons, it is necessary to couple Alternatives 2 and 3 (proposed for *the source* area removal/treatment) with

the proposed Alternatives A, B, and C to address the downgradient PCE plume.

Alternatives A, B, and C, coupled with either Alternative 2 or 3, would be protective of human health and environment and meet all the RAOs. Provision of an alternate water supply to nearby residents will prevent direct exposure to untreated drinking water. ICs may be needed to restrict groundwater use. The indoor air quality at the BCI building will be addressed by the removal and treatment of source area soils.

Under Alternative A, the groundwater contamination above cleanup goals is predicted to persist and the plume may expand. Alternative B would provide additional protectiveness by preventing contamination from migrating further downgradient. Alternative C would provide additional protectiveness by treating the plume through the use of a biobarrier and would also prevent the migration of contaminants further downgradient.

8.1.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121(d) of CERCLA and 40 C.F.R. §300.430(f)(1)(ii)(B) of the NCP require that RA at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations, which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA 121(d)(4).

Alternative A would require a small-scale construction effort of approximately two to six months duration. Source removal activities will provide an immediate reduction in soil contamination, indoor air emissions, and groundwater contaminant concentrations near *the source* area. Alternative A would also provide an alternate water supply to local residents and prevents exposure to untreated drinking water. Groundwater contaminant plume modeling simulations were performed to evaluate the effectiveness of this alternative for removing contaminant mass and restoring the aquifer to its beneficial use (Appendix B, August 2006 FSA Final). The simulated plume under this scenario is shown after a 25-year, 50-year, and 100-year timeframe in Figures 18, 19, and 20, respectively. Results show that the contaminated plume mass is significantly reduced after 50 years but is not entirely removed. Thus, even with contaminant source removal, the plume will remain above MCLs for approximately 100 years. As shown on the Figures 18, 19, and 20, Alternative A will not treat or prevent the expansion of the groundwater plume, but should satisfy ARARs within 100 years time frame.

Alternative B, the active treatment component of this alternative, will reduce VOC concentrations in soil, groundwater, and air in *the source* area to levels that meet ARARs. Modeling of the groundwater contaminant plume (see Figures 21 and 22) indicates that MCLs will be met over time by extraction of contaminated groundwater and by natural attenuation processes (approximately 50 years). The groundwater model also indicates that only minor groundwater contaminant concentrations (i.e., near MCLs) will extend beyond the current groundwater plume, thus satisfying the requirement to prevent further degradation of the aquifer. The hydraulic containment system will also be operated in accordance with ARARs. Therefore, this alternative is compliant with ARARs.

Alternative C, the active treatment component of this alternative, will reduce VOC concentrations in soil, groundwater, and air in *the source* area to levels that meet ARARs.

Modeling of the groundwater contaminant plume (see Figures 23 and 24), indicates that MCLs will be met over time by biodegradation and by natural attenuation processes (approximately 55 years). The groundwater model also indicates that only minor groundwater contaminant concentrations (i.e., near MCLs) will extend beyond the current groundwater plume, thus satisfying the requirement to prevent further degradation of the aquifer. The biobarrier will also be installed in accordance with ARARs. Therefore, this alternative is compliant with ARARs.

Any combination of *the source* removal (Alternatives 2 and 3) and the groundwater treatment/containment alternatives (Aternatives A, B, and C) would meet their respective State and federal ARARs. See Tables 20 to 23.

8.1.3 Long-term Effectiveness and Permanence

This criterion evaluates the ability of an alternative to maintain protection of human health and the environment over time. The long-term effectiveness of the alternatives relies heavily on ICs for protection of human health. They also rely to a significant degree on natural processes to attain cleanup objectives.

For *the source*, Alternatives 2 and 3 provide long-term effectiveness and permanence by treating groundwater and removing soils, which are *the source* of contamination for both groundwater and indoor air. For the groundwater plume, following contaminant source removal, all three alternatives are effective in the long term by preventing exposure to contaminated groundwater through the provision of alternate drinking water to residents. Alternatives B and C are more effective than Alternative A in that they reduce the time to clean up groundwater by approximately 50 years.

8.1.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

This criterion considers the use of treatment to remove, reduce, or destroy the harmful effects of the contaminants. Alternative 1, the no action alternative, has no treatment component and therefore provides no reduction of toxicity, mobility, or volume of PCE in soil, indoor air, or groundwater. However, both Alternatives 2 and 3 remove *the source* material and treat the contaminated groundwater and sub-surface soil at *the source*. Therefore, both Alternatives 2 and 3 reduce toxicity, mobility, and volume of PCE through treatment. In addition, Alternative 3 will destroy the PCE contamination in soils and groundwater via biodegradation. Alternative 2 simply removes the contaminants and transfers them to another medium that will require treatment or disposal.

For the groundwater plume, Alternative A reduces toxicity, mobility, and volume via natural processes. Alternative B reduces toxicity, mobility, and volume by extracting the contaminated water, removing the contaminants, and injecting clean treated water into the aquifer. Alternative C reduces toxicity, mobility, and volume by in situ treatment of groundwater as it passes through a biobarrier.

Alternatives B and C provide better protection by providing active treatment and reducing the time to clean up the groundwater plume. Alternative B provides additional protection by

reducing mobility by hydraulic containment of the groundwater plume.

8.1.5 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

At *the source*, Alternative 1 would be ineffective in limiting short-term exposure to contaminated indoor air at the BCI building. Alternative 1 would not reduce short-term exposure to contaminated groundwater. Implementation of either Alternatives 2 or 3 would result in reductions in PCE levels at *the source*, in groundwater, and indoor air within a short time after construction completion. The soil removal component of both alternatives would provide an immediate reduction in indoor air contamination at the BCI building. Fugitive dust emissions and vapors from the excavation would be controlled and monitored. Short-term risk to workers associated with normal construction hazards and potential contact with contaminated water will be eliminated through appropriate controls and use of proper health and safety protocols. Therefore, both alternatives 2 and 3 are highly effective in the short term.

For the groundwater plume, all three alternatives (A, B, and C) are effective in the short-term by preventing exposure to contaminated groundwater, providing alternative drinking water, and completing the source removal.

8.1.6 Implementability

This criterion addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility and coordination with other governmental entities are also considered.

Preliminary discussions with state and local officials indicate that the ICs at the Site are implementable and the ICs will be based on State regulatory actions and local ordinances. In addition, the owners of BCI have indicated their willingness to implement ICs on their property.

At *the source*, both alternatives 2 and 3 use proven technologies and treatment systems which could be easily implemented at the Site. However, drilling wells for either alternative in *the source* area would require coordination with businesses and land owners in that area.

Alternative 2 requires installation of approximately 11 DPE wells, one groundwater extraction well, and one SVE well. The treatment system calls for a facility to treat the soil vapors and groundwater.

Alternative 3 requires installation of approximately three injection and four extraction wells, and a system to inject an electron donor solution (i.e., sodium lactate, emulsified oil) as well as organisms (microbes) to stimulate the degradation of PCE. The wells would be operated such that groundwater recirculation is created in *the source* area. Above ground treatment of the extracted groundwater will not be required. Therefore, due to slightly lower O&M cost, Alternative 3 is somewhat more implementable than Alternative 2.

For the groundwater plume, all alternatives are implementable. Alternative A would be the easiest to implement because it does not require active treatment for the downgradient groundwater plume. Therefore, Alternative A is highly implementable.

Alternatives B and C utilize proven technologies that are commercially available. Alternative B can be readily implemented with available and proven technologies. However, additional pre-design investigation and modeling activities will be required to further evaluate the aquifer hydraulic characteristics, including the potential hydraulic affects of the Warm Springs fault and commingling/capture of the OU1 plume, and above-ground treatment technologies. In addition, the size and layout of the treatment system poses additional challenges, as equipment and/or piping will need to be installed on private and commercial properties. Coordination with several property owners and businesses in *the source* area and downgradient plume will require a significant effort to prevent a negative impact on local businesses and residents. Therefore, Alternative B is moderately implementable.

Alternative C can be somewhat readily implemented with available and proven technologies but also relies on hydraulic fracturing technology, which has been demonstrated at numerous remediation sites, but not on the scale necessary for the barrier application at the Site. The size of the barrier (approximately 3,400 ft long) and the fact that the installation of about 35 pre-drilled wells would be required on private and commercial properties presents additional challenges, as these wells would be installed on private and commercial properties. Coordination with several property owners and businesses in *the source* area and downgradient plume would be required. As with Alternative B, additional pre-design investigation and modeling activities will be required to further evaluate the aquifer hydraulic characteristics. Therefore, implementability for Alternative C is moderate to low.

8.1.7 Cost

The 30 year present worth cost for Alternative 2 was estimated to be $1,648,000, with a capital cost of $893,300 (FFS July 2005) for *the source* area treatment and removal. The 30-year present value cost for Alternative 3 was estimated at $1,075,000, with a capital cost of $615,000 for *the source* area treatment and removal. The 2005 present value cost of Alternative 3 was lower than the cost of Alternative 2, and it meets cleanup goals more quickly.

Alternative A - Assuming an average contaminant treatment/source removal cost of $1,500,000 and a 30-year present worth cost of $3,323,000 to implement Alternative A, the present worth cost of the combined remedial alternatives is estimated to be $4,823,000, with a total combined alternative capital cost of $1,508,300. The main component of the capital cost results from the treatment/removal action installation and the alternate water supply installation.

Alternative B - Assuming an average contaminant treatment/source removal cost of $1,500,000 and a 30 year present worth cost of $11,446,200 to implement Alternative A, the present worth cost of the combined remedial alternatives is estimated to be $12,946,200, with a total combined alternative capital cost of $4,287,500. The main component of the capital cost results from the treatment/removal and installing the extraction/injection systems.

Alternative C - Assuming an average contaminant treatment/source removal cost of $1,500,000 and a 30 year present worth cost of $82,487,000 to implement Alternative C, the present worth cost of the combined remedial alternatives is estimated to be $83,987,000, with a total combined alternative capital cost of $18,773,800. The main component of the capital cost results from the installation of the injections wells for in situ bioremediation.

The cost of Alternative B is higher than Alternative A and much lower than Alternative C. However, Alternative B meets the RAO in one-half the time of Alternative A and about the same time as Alternative C. A summary of the total present worth cost of each alternative is presented in Table 19. A detailed cost estimate of all the alternatives presented in this ROD is presented in Appendix A of the FFS (2005c) and the FSA (2006).

8.1.8 State Acceptance

UDEQ/DERR participated in the development and review of the RI/FS reports, the Proposed Cleanup Plan and this ROD. UDEQ also provided technical comments and oversight support to all the sampling and field activities as they relate to OU2.

UDEQ/DERR supports a combination of Alternative 3 – EAB/SVE, Excavation, Disposal, and Monitoring and Alternative B – Hydraulic Containment. UDEQ/DERR has indicated that it believes that the Selected Remedy can accomplish the RAOs presented in this ROD. UDEQ/DERR will continue to work with EPA and the cities of Bountiful and Woods Cross to ensure the remedy is protective.

8.1.9 Community Acceptance

This criterion evaluates whether the local community agrees with EPA's analyses and preferred alternative. EPA received two sets of written comments from the community. During the public meeting there were no vocalized objections to any of the alternatives. Responses to written comments received are included in the Responsiveness Summary in Appendix B.

9.0 Principal Threat Wastes

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP, 40 C.F.R. §300.430(a)(1)(iii)(A)). Identifying principal threat waste combines concepts of both hazard and risk. In general, principal threat wastes are those source materials that include and contain hazardous substances, pollutants or contaminants that act as a reservoir for contamination to groundwater, surface water, or air, or act as a source for direct exposure. The source material in the sub-surface soil and the saturated zone below the BCI and the former David Early properties is considered to be highly toxic and highly mobile, which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. The contaminated sub-surface soil is considered to be principal threat wastes because the COCs are found at concentrations that pose a significant risk to either human health or the environment should exposure occur.

10.0 Selected Remedy

10.1 Summary of the Rationale for the Selected Remedy for Groundwater Contamination

The Selected Remedy for the OU2 PCE groundwater plume is a combination of Alternative 3 - EAB/ SVE, Excavation, Disposal, and Monitoring and Alternative B – Hydraulic Containment. The combination of these alternatives would achieve the RAOs via in situ bioremediation treatment by increasing the breakdown rate of PCE in *the source* area, extracting VOCs in the vadose zone soils, containing the groundwater plume and reducing the potential exposure to contaminated groundwater within the perimeter of the PCE plume. Hydraulic containment will prevent the lateral and vertical expansion of the plume beyond the extraction zone. Groundwater monitoring and ICs would be required until the RAOs are achieved.

Based on the information available at this time, EPA and UDEQ/DERR believe that the combination of Alternative 3 and Alternative B are the best options for meeting the RAOs at OU2. Alternative 3 was selected over Alternative 2 because it is estimated that the RAOs can be reached sooner than Alternative 2, making it slightly more effective. Alternative 3 does not require a groundwater treatment system above the ground surface; therefore, making it more implementable. Also, Alternative 3 has a lower capital and O&M cost. Alternative B was selected over Alternative A because it is estimated that Alternative B will meet the RAOs 50 years sooner than Alternative A. Alternative B was selected over Alternative C because Alternative B uses proven technology and can be implemented at a fraction of the cost of Alternative C.

The combination of Alternatives 3 and B, hereafter referred to as the Selected Remedy, reduces the risk within a reasonable time frame when compared to the other alternatives and provides for long-term effectiveness of the remedy. Also, the Selected Remedy is more cost effective when compared to the active groundwater treatment alternatives presented in the FFS (FFS-2005) and the FSA (FSA-2006).

Since the remedy may take up to 50 years to meet the RAOs, EPA in consultation with UDEQ/DERR will conduct five-year reviews as required by statute until contaminant levels at *the source* and groundwater do not pose an unacceptable risk to human health and the environment. During each five-year review, EPA will review the monitoring data and modify the groundwater monitoring plan as appropriate to ensure the information gathered continues to support the RAOs.

Based on the information available at this time, EPA and UDEQ/DERR believe that the Selected Remedy is protective of human health and the environment, complies with ARARs, is cost effective, achieves permanent solutions, and uses alternative treatment technologies to the maximum extent practicable.

11.0 Description of the Selected Remedy

A treatability study/pilot test SOW was initiated in July 2007 (Phase 2 and Phase 3 Work Plan)

to collect data necessary to support the design of the Selected Remedy. Five specific objectives contributed to the overall purpose of the treatability study:

- Determine substrate requirements for EAB/SVE at *the source*
- Determine the biodegradation capability of the indigenous microbial community
- Determine the extraction/injection strategy
- Determine the extraction/injection strategy for the groundwater plume containment
    - Evaluate groundwater extraction options with stakeholders
    - Evaluate clean water injection options with stakeholders
- Determine the specific location of extraction/injection wells

The data generated by the pilot study will support the Selected Remedy and will provide the basis for the RD. During the treatability study, EPA and UDEQ/DERR will also evaluate potential options to extract groundwater and options to discharge or inject clean water into the aquifer. The options for extraction of groundwater and injection of clean water will be considered for the RA if it presents a substantial cost savings to implement. A description of the Selected Remedy follows.

11.1 Step 1 - Institutional Controls

Since COCs will remain in groundwater until the remedy is completed, ICs will be required to protect public health and the environment. Results from the RI/FS for both OU1 and OU2, for the short and the long term do not allow for unrestricted groundwater use and/or unlimited exposure; therefore, ICs are necessary to limit unacceptable exposure resulting from contaminants emanating from OU1 and OU2. EPA will work with the State of Utah, UDEQ/DERR, local jurisdictions, and property owners to establish reliable ICs for the entire NPL Site. The ICs will remain in place until the groundwater quality improves to allow for unrestricted use. The combined IC objectives for both OU1 and OU2 are:

- Restrict the use of groundwater as a drinking water source until the MCLs are met

- Restrict new well development for drinking water and domestic use along the projected path of the contaminated groundwater plume until MCLs are met

- Recommend vapor intrusion mitigation in all permits for construction of new commercial (office space) and/or residential buildings planned on or along the projected path of the contaminated plumes

11.2 Step 2 - Monitoring

Design an O&M plan to assess the effectiveness of the in situ treatment process, to monitor groundwater and to evaluate the effectiveness of the Selected Remedy. The O&M plan for OU2 will be developed during the RD phase, and the monitoring events will be coordinated with OU1. A groundwater baseline for the entire PCE plume will be required prior to implementing the RA. The frequency of the monitoring events will be established during the RD in the O&M plan. Based on groundwater modeling, additional MWs may be installed at selected intervals to

understand the interaction between degradation rates and the in situ bioremediation treatment, and to determine the potential for natural attenuation processes. All groundwater samples will be analyzed for VOCs and a selected number of wells will be analyzed for MNA parameters as specified in Section 7.4. It is assumed that new MWs will be installed to monitor the groundwater quality upgradient of the domestic wells. These wells will be used to alert EPA and/or UDEQ/DERR to either increase or decrease the level of ICs (e.g., increase the area covered by groundwater use restrictions, coupled with monitoring for vapor intrusion from groundwater). Groundwater monitoring will be required during the first five years after the initiation of the RA. The data will be evaluated annually until the first five-year review. During the five-year review, EPA, in consultation with UDEQ/DERR, will evaluate the data and continue or opt to modify the groundwater O & M plan for the subsequent five-year review period.

11.3 Step 3 - Source Area Treatment

Excavation of Shallow Source Area Soils – Shallow contaminated source soils located under the BCI parking lot will be excavated to partially address the potential exposure of workers in the BCI building to VOC emissions. This excavation would involve removing approximately a 25 x 25 foot area about 15 ft deep under the parking lot adjacent to the BCI building. The excavated area would be filled in with clean back fill and covered with asphalt. Since the shallow excavation will not address the deep soil contamination, a SVE system will be used to extract VOCs throughout the vadose zone at *the source*. A vacuum blower system, consisting of vapor/liquid separator, air filter, vacuum blower, and associated controls and instrumentations, will be used to extract vapors from the SVE wells. The vacuum blower will be sized to maintain up to 12 inches of mercury vacuum in the well(s). The SVE well screens will be placed at a depth ranging from approximately 5 ft to 75 ft bgs. A condensate transfer pump will be included in the blower system to transfer the water from a vapor/liquid separator to a groundwater equalization tank. Vadose zone monitoring probes will be installed in *the source* area to collect data to measure the treatment system performance.

Operation of EAB injections extraction and recirculation system will start in *the source* area. It is assumed that the wells in this system will be installed to a total depth of approximately 105 ft bgs. These wells will be operated such that a recirculation cell is created in *the source* area for EAB treatment of groundwater contamination. The extracted groundwater will be amended with electron donor (and possibly a bioaugmentation consortium) and then injected into the aquifer, forming a recirculation cell.

Based on the FFS modeling simulations, it is anticipated that approximately 500 gallons of electron donor solution (i.e., sodium lactate, emulsified oil) will be injected every two months. It is assumed that the recirculation system will operate continuously and donor solution amendments will be pulsed in periodically. The injection specifications (i.e. flow rate, donor solution concentration, volume, and/or frequency) will be determined during the RD and the strategy may change as the remedy is optimized.

In addition, EAB performance monitoring will be conducted in *the source* area through sampling of the extraction wells. Initially, it is anticipated that the extraction wells will be sampled once per month, approximately one week and five weeks following completion of an injection event.

Parameters to be monitored will include contaminants and degradation products, redox-sensitive parameters, biological activity indicators, and water quality parameters. Monitoring for microbial community profiling and individual species detection (i.e. *Dehalococcoides* sp.) may also be performed. The frequency, locations, and parameters monitored may be modified based on the data collected during the RA if the data suggest that changes are appropriate.

11.4 Step 4 - Well Abandonment

All the MWs not selected for long-term monitoring will be abandoned according to the State of Utah's well abandonment requirements.

11.5 Step 5 - Downgradient Plume Hydraulic Containment

The next component of the remedy is to contain the contaminants from migrating past the presumed location of the Warm Springs Fault. Hydraulic containment will be accomplished by pumping water out of extraction wells.

Hydraulic Containment

The extraction system will prevent the contaminants from migrating past the presumed location of the Warm Springs fault. The conceptual model of the hydraulic containment is provided in Figures 21 and 22. Groundwater modeling simulations have shown that pumping two wells at 150 gallons per minute (gpm) will provide hydraulic containment of the plume. It is anticipated that the extraction wells would be screened in the middle aquifer zone (screened interval of approximately 120 to 160 ft bgs) to effectively capture the contaminant mass. The wells will most likely be placed inside the Holly Refinery Company property. The conceptual location of the extraction wells was selected based on the following:

- Prevention of Vertical Transport: Location of the extraction wells upgradient from the Warm Springs fault is effective in preventing the groundwater contaminant mass from further contaminating deeper aquifer zones. The fault appears to allow contamination to migrate within the aquifer.

- Protection of Domestic Wells: Location of the extraction wells upgradient of the residential area allows for effective protection of domestic drinking water wells. Following source removal, most of the remaining contaminant mass will be captured by the extraction wells. Location of extraction wells further to the east could result in additional contaminant mass impacting the domestic wells while location of the extraction wells further to the west would likely result in dewatering many of the domestic wells.

Initial concentrations of extracted groundwater would be similar to the current ambient groundwater concentrations near the fault (see Figure 3) and would likely be near the MCL of 5 ug/L. However, as the contaminant mass continues to migrate toward the extraction wells, extracted water concentrations would increase significantly with expected concentrations of 100 to 200 ug/L (see Figure 21).

The extraction wells at OU2 would be piped to a central location, and the extracted water would

initially be pumped into a flow equalization tank. The water would then pass through LGAC units as necessary to remove the VOC contaminants from the extracted water[3].

The FSA conceptual model assumed that the treated water would be injected downgradient of the extraction wells by means of four injection wells (see Figure 25.). The location of the extraction wells is approximately 3,300 ft east of the proposed injection wells. Therefore, pumps and about 3,300 ft of subsurface piping will be needed to transfer water from the extraction wells to the treatment system and then to the injection wells. The location of the injection wells was selected based on the following:

- Prevention of Recirculation: The location of the injection wells was selected sufficiently downgradient of the extraction wells to prevent recirculation and avoid extracting previously treated groundwater.

- Prevention of Impacts to Residences: The location of the injection wells was selected sufficiently downgradient of the residential area to prevent unwanted hydraulic mounding in the area of the homes. Injection well impacts are expected to be minor with small increases in hydraulic head predicted in the area of the domestic wells (i.e., approximately three to fourth feet; likely less than ten feet). Information regarding potential hydraulic impacts to domestic wells as a result of injection is provided in FSA, Appendix B.

- Prevention of Further Downgradient Migration: Injection of clean water effectively dilutes any remaining contaminant mass that may prevail downgradient of the extraction wells. Placing the injection wells in a "wall" type arrangement prevents further downgradient contaminant impacts. The clean water would be injected within the lower aquifer at approximately 120 ft bgs. This is expected to result in little or no increase in the hydraulic head in the shallow zone.

Contaminated groundwater past the extraction well location will not be treated; the contamination will be allowed to degrade via natural processes (absorption, dispersion and dilution). Based on groundwater modeling simulations performed in support of the FSA and the PCE concentrations present in the area, it is expected that the remedy will restore the aquifer to unrestricted use in approximately 50 years. During this time, groundwater will be monitored according to the O&M plan.

Although the FSA model assumed that the extracted water would be treated and injected near the leading edge of the plume, additional potential options to extract groundwater and inject clean water will be considered during the RD. The options to be considered include:

- Discharging the extracted water to the City of West Bountiful sanitary sewer
- Evaluate groundwater extraction options with stakeholders (VE recommendation number

[3] As per the Value Engineering Study Final Report – July 31, 2007, recommendations number 3, 4, and 5, other options for extracted groundwater uses and potential sources (as necessary) for injecting clean water may be considered after discussing the options with UDEQ/DERR and the stakeholders. Implementation of these options could preclude the installation of approximately 3,300 ft of a pipeline distribution system, could present a significant savings, remove administrative requirements (i.e., access, right of way clearances from multiple property owners), and significantly reduce O & M cost/oversight.

4)
- Evaluate clean water injection options with stakeholders (VE recommendation number 3, 4 and 5)

11.6 Step 6 - Exit Strategy

Groundwater monitoring will continue until the performance standards are reached (results at or below MCLs and/or RBCs) for a period of time to be specified in the O&M plan, which will be drafted during the RD. Once EPA, in consultation with UDEQ/DERR, concludes that *the source* area contamination and the groundwater quality has improved to allow for unrestricted use (results at or below MCLs and/or RBCs), the remedy shall terminate.

12.0 Summary of the Estimated Remedy Costs

The Selected Remedy is expected to cost approximately $12,946,000 (Tables 24 and 25). Groundwater modeling predicts that it will take about 50 years to reduce groundwater concentrations to levels that will allow for unrestricted use of groundwater. This estimate projects 30 years of groundwater monitoring and O&M cost. The time that will be required, and the actual cost of O&M will be further evaluated during the RD.

13.0 Expected Outcomes of the Selected Remedy

13.1 Available Land Use after Site Cleanup

The remedy for groundwater will be completed after the sample results show that the COCs in groundwater at *the source* and the downgradient plume are at or below the MCLs for a period of time to be specified in the O&M plan, which will be drafted during the RD. ICs restricting groundwater use will be terminated and approximately 400 acres of land will be returned to unrestricted groundwater use. For contaminated sub-surface soils in *the source* area, the remedy will be completed after demonstrating that the sub-surface soil and the soil vapor COCs are below the performance standards set in this ROD.

13.2 Cleanup Levels

For the groundwater plume, the cleanup levels are based on unrestricted groundwater use, MCLs and MCL goals (MCLG). CERCLA Section 121(d)(2)(A)(ii) and NCP, 40 C.F.R. §300.430(e)(i)(B) directs that MCLGs, set at a level above zero, may be relevant and appropriate remedial actions involving ground or surface water that are currently or potential sources of drinking water. If the MCLG is zero, the corresponding MCL will be relevant and appropriate instead. EPA and UDEQ have adopted the National and State Primary Drinking Water Standards (40 CFR Part 141 FR 8750 and UAC 309-103-2) (MCLs) as the groundwater cleanup levels for the Site.

For vapor intrusion at the source, the cleanup levels are based on the soil vapor and groundwater concentrations that are protective of the vapor intrusion pathway. These cleanup

levels follow the methodology described in EPA's "Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils," November 2002, using toxicological factors revised as of November 2006 (Table A). The calculated soil vapor and groundwater cleanup levels assume a target cancer risk of 10^{-4} and a target hazard quotient of 1.0. The soil vapor cleanup levels presented in Table A, will be applied at *the source*, throughout the soil column, starting at the base of the vadose zone immediately above the water table and compliance will be based on sampling results from permanent soil gas probes.

These soil vapor cleanup levels also will be used to determine when to shut off the SVE system. A correlation between the soil vapor and the SVE effluent concentrations that yield soil vapor concentrations at or below the cleanup levels will be determined by field testing.

The groundwater cleanup levels protective of the vapor intrusion pathway at *the source* shall be applied to groundwater underlying the building foundation and compliance will be based on sampling results from wells that are considered representative of the groundwater underlying the building.

Soil vapor transfer cleanup levels are based on soil vapor concentrations that will prevent contaminant transport from vapors to groundwater so that groundwater concentrations do not exceed the MCL. The soil cleanup levels protective of the transport of contaminants from soil to groundwater were obtained from the "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites," August 2001 assuming a Dilution-Attenuation Factor (DAF) of 20. These soil cleanup levels will be applied throughout the soil column where contaminated soils are subject to leaching.

Table A lists the cleanup levels for soil gas (vapor intrusion pathway), soil gas (vapor transfer to groundwater pathway), groundwater (vapor intrusion pathway), groundwater (MCL), and soil (contaminants leaching to groundwater). It must be noted that these tables list the core chemicals compounds detected in groundwater at the site; however, the COC (risk drivers) for the Site are:

For groundwater: Tetrachloroethylene, trichloroethylene, vinyl chloride, benzene

For Indoor air at the source: Tetrachloroethylene, trichloroethylene, vinyl chloride, 1,2,4 trimethylbenzene and 1,3,5-trimethylbenzene, benzene
Table A also include degradation products of the parent compounds. Since there is no inhalation pathway toxicity information for some of the compounds detected, they are indicated as being not sufficiently volatile or toxic (nvt). The toxicological factors used to calculate the cleanup levels are provided in Table B.

Table A. Cleanup Levels for Soil Gas, Soil, and Groundwater Protective of the Vapor Intrusion to Indoor Spaces and Migration to Groundwater Pathways for Commercial and Residential Settings at a Target Cancer Risk of 10^{-4} and Target Hazard Quotient of 1.

	Exposure Setting >	**Commercial (Source Area)** Cancer Risk Level = 10^{-4} Hazard Quotient = 1.0				**Residential** Lower of Cancer Risk Level 10^{-4} or Hazard Quotient = 1.0	**Residential**
	Pathway >	**Vapor Intrusion**		**Vapor Transfer to Ground Water**	**Leaching to Ground Water**	**Vapor Intrusion**	**Ingestion**
CASN	**Chemical Name**	**Target Soil Gas Conc.** (ug/m^3)	**Target Ground Water Conc**. (ug/L)	**Target Soil Gas Conc.** (ug/m^3)	**Target Soil Conc**. (mg/kg)	**Target Ground Water Conc**. (ug/L)	**Drinking Water MCL/MCLG** (ug/L)
71432	Benzene	1,314	932	705	0.03	221	5 / 0
75354	Dichloroethylene, 1,1-	8,760	1,195	5,130	0.06	285	7 / 7
156592	Dichloroethylene,cis-1,2-	nvt	nvt	7,420	0.4	nvt	70 / 70
156605	Dichloroethylene,trans-1,2-	2,628	1,041	25,243	0.7	248	100 / 100
100414	Ethylbenzene	43,800	24,648	124,393	13	5,868	700 / 700
127184	Tetrachloroethylene	2,079	484	2,148	0.06	96	5 / 0
108883	Toluene	219,000	137,941	158,768	12	32,843	1000/1000
79016	Trichloroethylene	6,132	2,403	1,276	0.06	477	5 / 0
95636	Trimethylbenzene,1,2,4-	74	59	1,524	324	14	12[a]
108678	Trimethylbenzene,1,3,5-	74	61	1,457	324	15	12[a]
75014	Vinyl chloride	1,394	169	1,647	0.01	34	2 / 0
108383	Xylene, m-	4,380	2,661	1,645,708	210	634	10,000
95476	Xylene,o-	4,380	3,797	1,153,415	190	904	10,000
106423	Xylene,p-	4,380	2,549	1,718,136	200	607	10,000

nvt - Not sufficiently volatile or toxic to pose an inhalation risk for the vapor intrusion pathway
a - Risk based HQ = 1

Table B. Background Information for Calculation of Cleanup Levels for Soil Gas and Groundwater Protective of the Vapor Intrusion Pathway in Residential Settings.

Selected Parameters	Value	Symbol
Enter Exposure Scenario	Residential	Scenario
Enter Target Risk for Carcinogens	1.00E-04	CR_G
Enter Target Hazard Quotient for Non-Carcinogens	1	HQ_G
Enter Average Groundwater Temperature (^{o}C)	15	Tgw

CASN	Chemical Name	Target Indoor Air Conc. @ R=0.0001 or HQ=1 Cia, target (ug/m^3)	Toxicity Basis C/NC	Target Sub-Slab or Soil Gas Conc. @ R=0.0001 or HQ=1 Csg (ug/m^3)	Target Ground Water Conc. @ R=0.0001 or HQ=1 Cgw (ug/L)	Is Target Ground Water Conc. < MCL? Cgw<MCL? Yes/No (MCL ug/L)	Toxicological Information: Unit Risk Factor URF (μg/m^3)$^{-1}$		Reference Conc. RfC (mg/m^3)		Target Indoor Air Conc. for Carcinogens Cia,c (ug/m^3)	Target Indoor Air Conc. for Non-Carcinogens Cia,nc (ug/m^3)
71432	Benzene	3.12E+01	C	3.12E+02	2.21E+02	No (5)	7.80E-06	I	3.00E-02	I	3.12E+01	3.13E+01
75354	Dichloroethylene, 1,1-	2.09E+02	NC	2.09E+03	2.85E+02	No (7)			2.00E-01	I		2.09E+02
156605	Dichloroethylene,trans-1,2-	6.26E+01	NC	6.26E+02	2.48E+02	No (100)			6.00E-02	P		6.26E+01
100414	Ethylbenzene	1.04E+03	NC	1.04E+04	5.87E+03	No (700)			1.00E+00	I		1.04E+03
127184	Tetrachloroethylene	4.12E+01	C	4.12E+02	9.60E+01	No (5)	5.90E-06	C	2.00E-01	M	4.12E+01	2.09E+02
108883	Toluene	5.21E+03	NC	5.21E+04	3.28E+04	No (1000)			5.00E+00	I		5.21E+03
79016	Trichloroethylene	1.22E+02	C	1.22E+03	4.77E+02	No (5)	2.00E-06	C	6.00E-01	C	1.22E+02	6.26E+02
95636	Trimethylbenzene,1,2,4-	1.77E+00	NC	1.77E+01	1.40E+01	--			1.70E-03	P		1.77E+00
108678	Trimethylbenzene,1,3,5-	1.77E+00	NC	1.77E+01	1.46E+01	--			1.70E-03	P		1.77E+00
75014	Vinyl chloride (chloroethene)	2.77E+01	C	2.77E+02	3.36E+01	No (2)	8.80E-06	I	1.00E-01	I	2.77E+01	1.04E+02
108383	Xylene,m-	1.04E+02	NC	1.04E+03	6.34E+02	Yes (10000)			1.00E-01	I		1.04E+02
95476	Xylene,o-	1.04E+02	NC	1.04E+03	9.04E+02	Yes (10000)			1.00E-01	I		1.04E+02
106423	Xylene,p-	1.04E+02	NC	1.04E+03	6.07E+02	Yes (10000)			1.00E-01	I		1.04E+02

Notes:

(1) **Inhalation Pathway Exposure Parameters (RME):**

	Units	Symbol	Value	Symbol	Value
Exposure Scenario			Residential		Commercial
Averaging time for carcinogens	(yrs)	Atc_R	70	Atc_C	70
Averaging time for non-carcinogens	(yrs)	Atnc_R	30	Atnc_C	25
Exposure duration	(yrs)	ED_R	30	ED_C	25
Exposure frequency	(days/yr)	EF_R	350	EF_C	250
Exposure time	m3/day	ET_R	24	ET_C	8

(2) **Generic Attenuation Factors:**

Source Medium of Vapors					
Groundwater	(-)	AFgw_R	0.001	AFgw_C	0.001
Sub-Slab or Soil Gas	(-)	Afss_R	0.1	Afss_C	0.1

(3) **Formulas**

Cia, target = MIN(Cia,c; Cia,nc)

Cia,c (ug/m3) = CR x ATc x 365 days/yr x 24 hrs/day/ (ED x EF x ET x URF) URF (ug/m3)-1 = CSf (ug/kg/day)-1x IR / BW

Cia,nc (ug/m3) = HQ x ATnc x 365days/yr x 24 hrs/day x RfC x 1000 ug/mg / (ED x EF x ET) RfC (mg/m3) = RfD (mg/kg/day) x BW / IR

I = EPA Integrated Risk Information System (IRIS) http://www.epa.gov/iris/subst/index.html
P = EPA Provisional Peer Reviewed Toxicity Values (PPRTVs) http://hhpprtv.ornl.gov/pprtv.shtml
M = Agency for Toxic Substances and Disease Registry Long-Term Inhalation Minimal Risk Levels (MRLs) http://www.atsdr.cdc.gov/mrls.html
C = California Environmental Protection Agency/Office of Environmental Health Hazard Assessment assessments http://www.oehha.ca.gov/risk/ChemicalDB/index.asp

13.3 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health welfare and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and provide permanent solutions to the extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and has a bias against off-site disposal of untreated waste. The following sections present how the Selected Remedy meets the statutory requirements.

13.4 Protection of Human Health and the Environment

The Selected Remedy will adequately protect human health and the environment through treatment, engineering controls, and/or ICs (NCP, 40 C.F.R. §300.430(f)(5)(ii)). The remedy will prevent unacceptable risks to current and future populations presented by direct contact, or ingestion of contaminated groundwater, and potential inhalation of vapors emanating from groundwater or soil to indoor air. Contaminated groundwater will be treated and monitored until the COCs for OU2 are at or below federal MCLs. At *the source*, soil vapors will be monitored until RBCs are achieved. EPA, in consultation with UDEQ/DERR, will issue notices to city officials and property owners on the status of the contaminated groundwater. The notices will be issued annually until the groundwater is returned to unrestricted use. ICs as discussed in Section 7.1 will be implemented to control exposures until the cleanup levels are met. These actions will reduce the risks to human health and are not expected to cause unacceptable short-term risks.

13.5 Compliance with Applicable or Relevant and Appropriate Requirements

Section 122(d) of CERCLA and the NCP, 40 C.F.R. §300.430(f)(l)(ii)(B) require that actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA Section 121(d)(4). Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address hazardous substances, the RA to be implemented at the site, the location of the site, or other circumstances present at the site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law which, while not applicable to the hazardous materials found at the site, the RA itself, the site location, or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the site.

There are three types of ARARs: chemical-specific; action-specific; and location-specific. Chemical-specific ARARs may determine cleanup levels for specific chemicals or discharge limits. Action-specific ARARs establish controls or restrictions on the remedial activities that are part of the remedial solution. Action-specific ARARs are triggered by the specific remedial

activity rather than the contaminants present. Location-specific ARARs set limitations on remedial activities as a result of the site's location or characteristics (such as being located in a flood plain). Also considered at the time ARARs are established are policies, guidance, and other sources of information which, though not enforceable, are "to be considered" in the selection of the remedy and the implementation of the ROD. These "to be considered" standards may provide additional important benchmarks that can be considered in selecting a remedy.

The chemical-specific ARARs for OU2 include: Safe Drinking Water Act (SDWA) of 1974, 42 U.S.C. Section 300(f) et seq., as amended in 1986, which establishes chemical-specific standards, applicable at the tap. Under the NCP, 40 C.F.R. §300.430(e)(2)(i)(B), these standards are relevant and appropriate to a cleanup of groundwater which is a current or potential source of drinking water. The SDWA's MCL is used for any contaminant whose MCLG is zero; otherwise, the MCLG is used. Tables 20 and 21 provide a list of the chemical-specific ARARs that apply to OU2.

The action-specific ARARs for the selected alternatives are set out in Table 22. Location-specific ARARs are provided on Table 23. The selected alternative will comply with all ARARs.

13.6 Cost Effectiveness

The Selected Remedy meets the statutory requirement that all Superfund remedies be cost-effective. A cost-effective remedy in the Superfund program is one whose “costs are proportional to its overall effectiveness” (NCP, 40 C.F.R. §300.430(f)(1)(ii)(D)). The “overall effectiveness” is determined by evaluating the following three of the five balancing criteria used in the detailed analysis of alternatives: (1) long-term effectiveness and permanence; (2) reduction in toxicity, mobility and volume (TMV) through treatment; and, (3) short-term effectiveness. The overall effectiveness of the Selected Remedy was determined to be proportional to its cost and, therefore, represents a reasonable cost vs. benefit value. For each alternative, information was presented on long-term effectiveness and permanence, reduction of toxicity, mobility and volume through treatment, and short-term effectiveness. The information in those three categories was compared to the prior alternative listed and evaluated as to whether it was more effective, less effective, or of equal effectiveness. When considering the entire PCE plume extent (approximately 400 acres), the Selected Remedy is considered to be cost effective, because it is a permanent solution that reduces risks to human health to acceptable levels.

13.7 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The Selected Remedy represents the maximum extent to which a permanent solution and innovative treatment technologies can be used with a practical outcome at OU2. Of all the alternatives considered, the Selected Remedy provides the best balance of the five balancing criteria, provides for the statutory preference for treatment as the principal element, and is accepted by the State and community.

13.8 Preference for Treatment as a Principal Element

The Selected Remedy satisfies the preference for treatment as a Principal Element. The Selected Remedy includes treatment of *the source* area soils and groundwater and hydraulic containment of the downgradient groundwater. The contaminated sub-surface soil at *the source* area contains high concentrations of substances that are highly toxic and mobile and act as a reservoir for contaminants to move into groundwater. In situ treatment of the saturated portion of *the source* will accelerate the degradation rate of the COCs and will reduce or eliminate the impact to groundwater. Hydraulic containment of the downgradient groundwater plume will reduce the current and potential impact to domestic wells located within the leading edge of the plume.

13.9 Five-Year Review Requirements

Because it may take up to 50 years to meet the RAOs and to reach the cleanup levels, the Site will be subject to five-year reviews. A statutory review will be conducted within five-years after the first electron donor injection (initiation of the RA) to ensure that the remedy is or will be protective of human health and the environment. At the end of each five-year review, EPA, in consultation with UDEQ/DERR, will evaluate the data, the long term monitoring plan, and opt to continue or to modify the groundwater monitoring program for the subsequent five-year review period. Five-year reviews will continue until the cleanup objectives are met.

14.0 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

The Proposed Plan for the Bountiful/Woods Cross 5th South PCE Plume Site, OU2 was released in September 2006. The initial public comment period was from October 2, 2006 to October 31, 2006. The public meeting took place at the Woods Cross city building on Tuesday, October 10, 2006. The Proposed Plan identified preferred alternatives, Enhanced Anaerobic Bioremediation/Soil Vapor Extraction, Excavation, Disposal, Monitoring, and Hydraulic Containment, which comprise the Selected Remedy in this ROD. The Proposed Plan also noted the State's support for the Selected Remedy. EPA reviewed the verbal comments submitted during the public meeting, which was transcribed by a court reporter. Two sets of written comments were submitted. Responses to the significant comments are provided in the Responsiveness Summary of this ROD, Appendix B. In addition, during the week of June 11, 2007, EPA conducted a Value Engineering Study (VE) on the conceptual design for the Selected Remedy. The VE study provided comments and recommendations on the conceptual design (Appendix C). It was determined that no significant changes to the selected preferred alternative were necessary or appropriate. Recommendations one through six from the VE study are consistent with the Proposed Plan and the Selected Remedy, have merit, and, if applicable, could present a significant O&M cost savings to EPA and the State. The remedy selected in this ROD is consistent with the preferred alternative in the Proposed Plan.

RESPONSIVENESS SUMMARY

Appendix A – Public Comment Meeting Transcript

Appendix B – Responses to Comments

Appendix C – Value Engineering Study Report