Record of Decision
Soil/Solid Waste and Soil Gas
Operable Unit 2

Laboratory for Energy-Related Health Research/Old Campus Landfill Superfund Site

University of California
Davis, California

U.S. Environmental Protection Agency
Region 9
San Francisco, California

September 2016

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Acronyms and Abbreviations

°C	degrees Celsius
µg/L	microgram per liter
µg/m^3	microgram per cubic meter
ACGIH	American Conference of Governmental Industrial Hygienists
ARAR	applicable or relevant and appropriate requirement
BBL	Blasland, Bouck, & Lee, Incorporated
BC	Brown & Caldwell
bgs	below ground surface
Cal-EPA/the State	State of California Environmental Protection Agency
CAMU	corrective action management unit
CCR	California Code of Regulations
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHE	Center for Health and the Environment
CHHSL	California Human Health Screening Level
COC	constituent of concern
COPC	constituent of potential concern
CSM	Conceptual Site Model
DCA	dichloroethane
DCE	dichloroethene
DCP	dichloropropane
DDC	density-driven convection
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DL	designated level
DOE	United States Department of Energy
DTSC	California Department of Toxic Substances Control
EPC	exposure point concentration
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FS	feasibility study
ft	feet
GHG	greenhouse gas
HDPE	high-density polyethylene
HFSDA	Hopland Field Station Disposal Area
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HSU	hydrostratigraphic unit
IARC	International Agency for Research on Cancer
IC	institutional control
IRA	interim removal action
IRIS	Integrated Risk Information System
LCRS	leachate collection and recovery system
LCY	loose cubic yard
LEHR	Laboratory for Energy-related Health Research
LFU	landfill unit

LLRW	low-level radioactive waste
LRDP	Long-Range Development Plan Final Environmental Impact Report
LUC	land use control
mg/kg	milligram per kilogram
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
MIP	membrane interface probe
MMP	Materials Management Plan
MS4	Storm Water Discharges from Small Municipal Separate Storm Sewer Systems
MWH	Montgomery Watson Harza
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
No.	number
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NUFT	Non-isothermal Unsaturated Flow and Transport
O&M	operations and maintenance
OCL	Old Campus Landfill
OEHHA	Office of Environmental Health Hazard Assessment
OU	operable unit
OWTP	Old Wastewater Treatment Plant
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PHC	principal hazardous constituent
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
RSL	regional screening level
ROD	record of decision
RWQCB	Central Valley Regional Water Quality Control Board
SARA	Superfund Amendment and Reauthorization Act
SCDS	South Campus Disposal Site
SF	slope factor
SVOC	semi-volatile organic compound
SWERA	Side-Wide Ecological Risk Assessment
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TBC	to be considered
TCA	trichloroethene
TCP	trichloropropane
TLV	Threshold Limit Value
UC Davis	University of California, Davis
UCOP	University of California Office of the President
URF	unit risk factor
USC	United States Code
U.S. EPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service

VELB	Valley Elderberry Longhorn Beetle
VISL	Vapor Intrusion Screening Level
VOC	volatile organic compound
WBH	Waste Burial Holes
WDR	waste discharge requirement
Weiss	Weiss Associates

PART 1: THE DECLARATION

1.0 SITE NAME AND LOCATION

This Record of Decision (ROD) addresses the Soil/Solid Waste and Soil Gas contamination for Operable Unit (OU) 2 at the Laboratory for Energy-related Health Research/Old Campus Landfill Superfund Site, University of California, Davis, California (the LEHR/OCL Site or the Site). OU 2 is defined as the portion of the Site for which the University of California, Davis is responsible, whereas OU 1 is defined as the portion of the Site for which the U.S. Department of Energy is responsible. The Site is located in Solano County, south of the city of Davis, California (Figure 1). This ROD covers contamination associated with the Soil/Solid Waste at OU 2, and selects a remedy for the following portions of the Site, defined as disposal units: the Eastern Trenches, Landfill Unit 1 (LFU-1), LFU-2, LFU-3, the Southern Trenches, the Hopland Field Station Disposal Area (HFSDA), and the Waste Burial Holes (WBH). This ROD also addresses public comments on the Proposed Plan. The Groundwater associated with OU 2 will be addressed in a later ROD.

The Site was listed on the U.S. Environmental Protection Agency's (U.S. EPA) National Priorities List (NPL) and an Administrative Order on Consent is in effect that establishes the framework for Remedial Investigations (RIs) and Feasibility Studies (FSs). The Site was listed on the NPL on May 31, 1994, National Superfund database identification number CA2890290000.

2.0 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for the soil/solid waste and soil gas portions of OU 2 for the LEHR/OCL Site, in Davis, California, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this Site. The State of California concurs with the selected remedy.

In 2004 and 2006, the University of California, Davis (UC Davis) completed two risk assessments to evaluate the risk to human health and to ecological receptors from exposure to contaminated soil, solid waste, and soil gas that are associated with the past use of Site areas as landfills. The *Final Remedial Investigation Report LEHR/SCDS* [South Campus Disposal Site] *Environmental Restoration, University of California, Davis* (the RI Report) was published in December 2004. UC Davis completed the *Feasibility Study Data Gaps Technical Report* (the FS Data Gaps Report) in February 2010, and *the Final Feasibility Study for the University of California, Davis Areas Volume 1, Soil/Solid Waste and Soil Gas* (the Soil FS) in April 2012. Risk summaries were generated; however, given the heterogeneous nature of landfill wastes and unknown disposal practices, the risk and hazard were likely underestimated.

The remedy addresses landfill waste and constituents of concern (COCs) left at the LEHR/OCL Site, including radiological contaminants (strontium-90, cesium-137, carbon-14, tritium, and potassium-40), polychlorinated biphenyls (PCBs; Aroclor-1260), metals (lead, arsenic, cadmium, barium, manganese, selenium, copper, etc.), volatile organic compounds (VOCs), and various semi-volatile organic compound (SVOC) contaminants (benzo(a)pyrene, benzo(a)anthracene, benzo(a)fluoranthene, naphthalene, etc.). The selected remedy presented in this document leaves soil and waste largely undisturbed, and uses containment in on-site corrective action management units (CAMUs) to prevent direct contact with landfill wastes and potentially unknown risks and hazards, minimizes infiltration and the resulting leaching of contaminants to groundwater, and controls surface water runoff and erosion. The selected remedy includes excavation and off-site disposal of the two VOC “hot spot” areas, and includes implementation of institutional controls (ICs) and ongoing groundwater monitoring in order to protect human health and ecological receptors. The selected remedy is consistent with the presumptive remedy for landfills (containment), which does not require complete characterization, so further characterization of the LEHR/OCL Site is not required. However, exploratory excavations in the HFSDA and the Southern Trenches will be conducted as part of the selected remedy to determine if these areas need to be capped.

3.0 ASSESSMENT OF THE SITE

As a result of past Site activities, hazardous substances and pollutants or contaminants were buried in the landfills and disposal units. Contaminants have been released to the soil and groundwater in the area. The response action selected in this ROD is necessary to protect public health or welfare and the environment from actual or threatened releases of hazardous substance into the environment, which may present an imminent and substantial endangerment to public health or welfare.

4.0 DESCRIPTION OF SELECTED REMEDY

U.S. EPA selected the remedy for the LEHR/OCL Site, Alternative SW-6, based on the Site characterization and risk information detailed in the RI Report (Geomatrix, 2004), the Site-Wide Human Health Risk Assessment (HHRA) Part A (Montgomery Watson Harza [MWH], 2004) and Part C (Blasland, Bouck, & Lee, Inc. [BBL], 2006), the Site-Wide Ecological Risk Assessment (SWERA) (Brown & Caldwell [BC], 2006), the Feasibility Study (Weiss Associates [Weiss], 2012), and the FS Data Gaps Report (Weiss, 2010). The response action selected in this ROD is necessary to protect human health and the environment.

The selected remedy addresses areas of the LEHR/OCL Site with soil, solid waste, and soil gas contamination by excavation of VOC “hot spots” and containment of the disposal units. The ICs will restrict land use such that the contaminated portion of the property may not be used for sensitive uses such as homes, day care centers, health care centers, or public or private schools for persons under 18 years of age. A ROD addressing soil contamination in the United States Department of Energy (DOE) area was finalized in December 2009 (DOE, 2009; the 2009 DOE ROD), and remedial actions consisting of ICs and groundwater monitoring began in January 2011. Groundwater cleanup will be addressed separately in a future ROD.

The selected remedy includes the following components:

- Removal and off-site disposal of two VOC “hot spot” areas to a depth of 20 feet below ground surface (ft bgs), to reduce potential migration to groundwater and to minimize the potential for vapor intrusion into buildings;
- Excavation of soil and solid waste beneath drainage swales and ditches, stormwater retention ponds, and the northeastern corner of LFU-2 and the Eastern Trenches and consolidation of the excavated materials into the CAMUs.
- Installation of multiple-layer caps at CAMUs and other areas where contaminated soils and solid waste remain in place to reduce infiltration and leaching of contaminants to groundwater and to limit human exposure;

- Expansion of the storm water drainage system to divert water away from the soil/solid waste remaining in place and reduce infiltration;
- Implementation of ICs to protect remedy components, prohibit residential land use, and restrict non-residential land use. This includes the requirement for a soil management plan for post-remediation earthwork activities; and
- Long-term groundwater monitoring to verify the efficacy of groundwater protection and operations and maintenance (O&M) of the landfill cover and other components to maintain the functionality of the remedy.

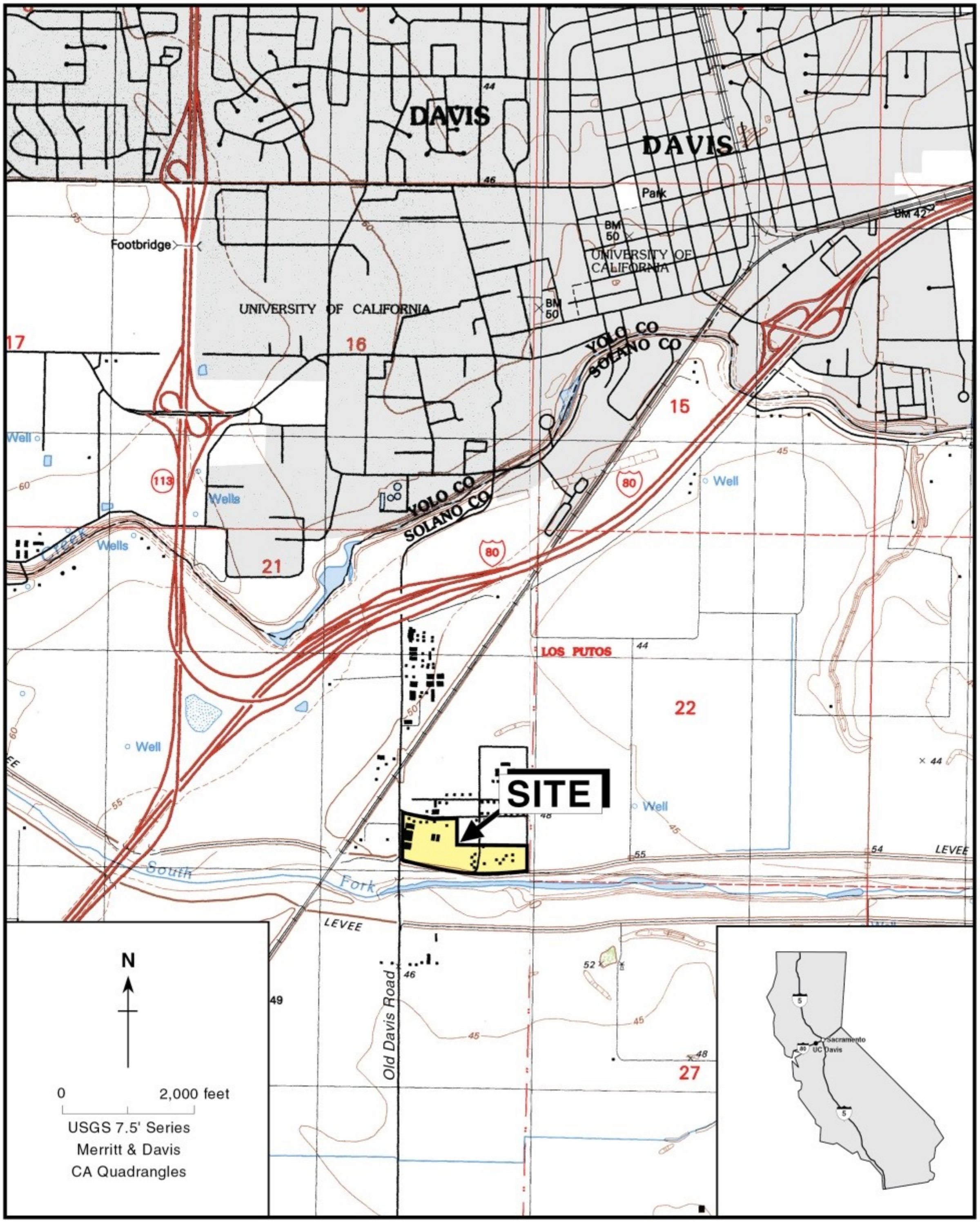


Figure 1. Site Vicinity Map - Laboratory for Energy-related Health Research/Old Campus Landfill, University of California, Davis

Adapted from Weiss Associates, 2012, Final Feasibility Study for the University of California, Davis Areas Volume 1: Soil, Solid Waste, and Soil Gas, April 30. 7/16/13

Figure 1 LEHR/OCL Site Location

5.0 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 remedy, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

This remedy does not satisfy the statutory preference for treatment as a principal element of the remedy, because it will result in untreated hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure in accordance with the presumptive remedy for landfills, containment. Consistent with EPA Guidance on the selection of a remedy for landfills, the selected remedy is a containment remedy with long-term groundwater monitoring. U.S. EPA is not making a determination as to whether the contamination in the soil is low-level threat waste or principal threat waste because the types and quantity of chemicals used by UC Davis research laboratories and disposed onsite are unknown. A statutory review will be conducted within five years after initiation of selected remedy to ensure that the remedy is, or will be, protective of human health and the environment, because the remedy will leave contaminated soil and waste on-site.

6.0 DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD:

- COCs and their respective concentrations (Section 7.1.1)
- Baseline risk represented by the COCs (Sections 7.1.4 and 7.1.6)
- Cleanup levels established for COCs and the basis for these levels (Section 8.3)
- How source materials constituting principal threats are addressed (Section 11)
- Current and reasonably anticipated future land use assumptions used in the baseline risk assessment and ROD (Section 6.0)
- Potential land use that will be available at the Site as a result of the selected remedy (Section 12.4)
- Estimated capital, annual O&M, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 12.3 and Table 8)
- Key factor(s) that led to selecting the remedy (Section 12.1)

Additional information can be found in the Administrative Record file for this Site.

7.0 AUTHORIZING SIGNATURES

This ROD documents the selected remedy for solid waste, soil gas, and soil contamination at the LEHR/OCL Site. The remedy was selected by EPA with the concurrence of the California Department of Toxic Substances Control. The Acting Assistant Director of the Superfund Division, Region 9, has been delegated the authority to approve this ROD.

JOHN LYONS
Acting Assistant Director
California Site Cleanup and Enforcement Branch
Superfund Division
U.S. EPA, Region 9

September 29, 2016
Date

PART 2: THE DECISION SUMMARY

This Decision Summary describes the site-specific factors and analyses based on which U.S. EPA has selected a remedy for the OU 2, the soil/solid waste area of LEHR/OCL Site. It includes background information about the nature and extent of contamination and the rationale for the selection of the remedy.

1.0 SITE NAME, LOCATION, AND DESCRIPTION

The LEHR/OCL Site covers approximately 25 acres and is part of the UC Davis South Campus in Solano County (Figure 1). It is south of Interstate 80, west of Old Davis Road, and about 250 feet north of the South Fork of Putah Creek. The Site is separated from Putah Creek by a levee, but is located in an historical floodplain. The property is a mix of laboratory and research buildings and animal facilities. The surrounding land is largely agricultural.

The LEHR/OCL Site was added to the U.S. EPA NPL on May 31, 1994, National Superfund database identification number CA2890290000. The primary regulatory agencies overseeing the Site cleanup are the U.S. EPA and Cal-EPA, represented by the DTSC and the RWQCB. Funding for the selected remedy will be provided for by the Regents of the University of California.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The LEHR/OCL Site contains laboratory buildings and undeveloped land owned and maintained by UC Davis. The LEHR/OCL Site was used as the location of multiple landfills; UC Davis operated three landfill disposal units, LFU-1, LFU-2, and LFU-3, that received municipal type waste from the main campus between the early 1940s and 1967 (Figure 2). In addition to receiving municipal-type waste, UC Davis burned and/or buried campus wastes, including laboratory wastes within trenches. Information specific to each of the disposal units can be found in the paragraphs below. From the 1950s until the 1980, the LEHR/OCL Site also was used for studies of the long-term health effects of low-level radiation on laboratory animals. The radiation studies at the Site were largely funded by the DOE.

LFU-1 was used to dispose of campus refuse, sewage sludge, and potentially laboratory waste, in the 1940s and 1950s. The landfill occupies 1.9 acres and approximately 10,150 cubic yards of waste were deposited in LFU-1. No inventory records were located for LFU-1, however, geophysical anomalies were identified throughout the unit. According to the RI Report, waste observed at LFU-1 includes glass, metals, and burned material including ash, charcoal, and melted glass (Geomatrix, 2004). Sludge from the adjacent sewage treatment plant was also reportedly disposed of in this landfill (DOE, 1988). The solid waste is presumed to be located throughout the entirety of LFU-1.

LFU-2 received campus wastes between 1956 and 1967. A 1986 UC Davis employee questionnaire indicated 19,260 cubic yards of waste were placed within twelve east-west trending cells (DOE, 1988). No records were found that indicated waste type, however, UC Davis personnel noted that municipal, construction, laboratory, chemical, petroleum, and campus incinerator waste were likely disposed in LFU-2. The Eastern Dog Pens were constructed between 1968 and 1970 on top of the southern portion of the area previously used as LFU-2 and were used to house beagles that were used for radioactive experimentation. The Eastern Dog Pens were addressed through the 2009 DOE ROD's selection of a land use restrictions remedy, including the implementation of a soil management plan. Residual soil contamination in the area of the dog pens is addressed in this ROD.

LFU-3 was used for disposal between 1963 and 1967 in two distinct cells. The landfill occupies 1.1 acres and approximately 3,351 cubic yards of waste were deposited in LFU-3. According to the RI Report, waste observed at LFU-3 includes glass, rusted metal, concrete, bricks, ceramic material, and other household and laboratory waste (Geomatrix, 2004).

Eleven waste burial trenches located along the eastern site of LFU-2 were identified in the Eastern Trenches. The Eastern Trenches occupy approximately 0.8 acres, hold approximately 426 cubic yards of waste, and were used for disposal between 1957 and 1965. Waste observed at the Eastern Trenches include laboratory waste, pesticide containers, gravel with bones and feces, and low-level radioactive waste (LLRW).

Historical records for the WBH indicate that LLRW material was buried in 49 10-foot-deep holes within the WBH area between 1956 and 1974 (Geomatrix, 2004). Waste was removed from 32 of the 49 discrete waste burial holes during a 1999 removal action and disposed of off-site. The waste included LLRW, laboratory chemicals, vials, syringes, laboratory glassware, and animal carcasses. The WBH occupy approximately 0.2 acres.

Historical records for the Southern Trenches indicate that LLRW was placed in this area between 1957 and 1965 in three waste burial trenches. The Southern Trenches occupy approximately 0.16 acres and contain approximately 111 cubic yards of waste. Waste observed at the Southern Trenches includes gravel with bones, animal feces, and laboratory waste. The southwestern corner of the Southern Trenches, defined by its historical boundary, was removed during a 1998 DOE Southwest Trenches Removal Action.

Between 1965 and 1968, two experiments, including radionuclide injections into deer and sheep were performed at the Hopland Field Station, a 5,300-acre UC Davis research facility located in Mendocino County. Historical records suggest that experimental animals were buried at the Site, in the area designated as the HFSDA (Weiss, 2012a).

Characterization investigations began at the LEHR/OCL Site in 1984 and have been ongoing. Studies began with an Initial Assessment Survey in 1984 (Rockwell International, 1984). The most recent investigation to evaluate data gaps was conducted in 2009 to study chromium contamination in groundwater. General groundwater and soil gas impacts from the UC Davis landfills were also investigated, as LFU-1, LFU-2, and LFU-3 are a source of groundwater contamination. UC Davis completed two risk assessments in 2004 and 2006 to evaluate the risk to human health and to ecological receptors from exposure to contaminated soil, solid waste, and soil gas that are associated with the past use of Site areas as landfills. The RI Report was published in December 2004. UC Davis completed two FS documents: the FS Data Gaps Report in February 2010, and the Soil FS in April 2012.

3.0 COMMUNITY PARTICIPATION

In January 2015, U.S. EPA released to the site information repositories a Proposed Plan and Proposed Plan Summary Fact Sheet for public review and published a public notice in the Davis Enterprise on January 27, 2015. On February 10, 2015, U.S. EPA convened a public meeting at Hoagland Hall on the UC Davis Campus and presented the Proposed Plan to address soil/solid waste and soil gas contamination on the Site and recorded verbal comments. The public comment period was from January 28, 2015 through February 26, 2015. Comments received from the public are addressed in the Responsiveness Summary of this ROD. The transcript of this meeting is in the LEHR/OCL Administrative Record.

In 2011, U.S. EPA issued a fact sheet by mail to inform the public about progress at the site. Additionally, U.S. EPA performed community and Site worker interviews in November 2011 to gather local perspectives to incorporate in a future Community Involvement Plan update.

4.0 SCOPE AND ROLE AND RESPONSE ACTIONS

The LEHR Site is divided into two separate areas of responsibility, the UC Davis areas (referred to as the LEHR/OCL Site) and the DOE areas, based on an agreement between the parties allocating responsibility for remediation of environmental impacts associated with their respective past activities. UC Davis is responsible for groundwater; LFU-1, LFU-2, and LFU-3; the WBH; the HFSDA; the Eastern Trenches; and the Southern Trenches. UC Davis also is responsible for the Old Wastewater Treatment Plant (OWTP) and Putah Creek; however, results from the Site-Wide Human Health Risk Assessment and the Site-Wide Ecological Risk Assessment for these areas indicate that exposure to constituents of potential concern (COPCs) would not result in adverse health effects and UC Davis therefore proposed these areas for no further evaluation in the Soil FS (Weiss, 2012a). The DOE areas include the former Eastern Dog Pens, which was constructed on top of LFU-2, as well as Dry Wells A-3, the Radium/Strontium Treatment Area, the Western Dog Pens, and several domestic septic systems. Soil contamination associated with the former Eastern Dog Pens was addressed in the DOE ROD with ICs, while soil, solid waste, and soil gas contamination at the UC Davis areas (the LEHR/OCL Site) are addressed in this ROD. The Eastern Dog Pens were addressed by the 2009 DOE ROD's selection of land use restrictions to prevent exposure as the remedy, pending selection of the remedy for LFU-2 (DOE, 2009b); the contamination associated with this area was left in place based on the assumption that the area would be capped when LFU-2 was addressed. Groundwater will be addressed separately under a future ROD.

The groundwater at the LEHR Site has been divided into four hydrostratigraphic units (HSUs), numbered in descending order of depth. In 1997 UC Davis began a groundwater extraction interim removal action from the second hydrostratigraphic unit to remove VOCs from groundwater and control plume migration. This system is located downgradient of LFU-1 and LFU-2 and is still in operation. In 1999 UC Davis initiated a removal action at the WBH, excavating containers and other items from soil and disposing of them at an off-site landfill; excavated soil was returned to the excavations. In 2000, a pilot test to remove VOCs from the upper HSU groundwater in the chloroform source area began in the northern LFU-2 area. This system was expanded and is still operating to remove chloroform from the source area to minimize contaminant migration.

RODs completed or planned for the LEHR Site include:

- The 2009 DOE ROD (DOE, 2009), which addresses the soil contamination at the Eastern Dog Pens. The remedy under the DOE Area ROD consists of ICs, including implementation of a soil management plan, and groundwater monitoring. The remedy was implemented in January 2011.
- The LEHR/OCL ROD (this ROD) addresses contaminants in soil, solid waste, and soil gas at the LEHR/OCL Site.
- The future Groundwater ROD will address contaminants in groundwater at the LEHR Site.

It is anticipated that these three RODs will address all of the contamination at the LEHR Site.

5.0 SITE CHARACTERISTICS

The LEHR/OCL Site contains laboratory buildings and undeveloped land (Figure 2). Of the 25 acres, approximately 35 percent is paved or covered by structures; approximately 55 percent is unpaved and relatively free of vegetation; and approximately 10 percent is covered by large, deep-rooted vegetation, which include elderberry trees and shrubs (Geomatrix, 2004). On-Site elderberry trees and shrubs are known to provide habitat for the special-status Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*; VELB) (BBL, 2006).

The land and buildings are owned and maintained by the Regents of the University of California, which is the governing board for the University of California System; UC Davis is one campus within this system. Investigations at the LEHR/OCL Site have been conducted over 20 years to characterize the contamination. Site characterization information is detailed in the RI Report (Geomatrix, 2004) and the FS Data Gaps Report (Weiss, 2010). Characterization sampling included analysis of soil and solid waste samples, including VOCs, SVOCs, pesticides, PCBs, metals, radionuclides, and inorganic compounds. The volume of contamination and solid waste deposited in each UC Davis area was calculated using geophysical, exploratory trench, and soil boring data and totals approximately 102,973 loose cubic yards (LCY) (Geomatrix, 2004). This volume was updated in the Soil FS to 123,386 LCY (Weiss, 2012a).

Additional investigations were conducted prior to completion of the Soil FS to address data gaps that needed to be filled. These investigations addressed data gaps related to the: 1) areas of elevated hexavalent chromium in groundwater; 2) potential impact to groundwater from constituents present at the LEHR/OCL Site; and, 3) potential vapor intrusion into indoor air for volatile constituents present at the LEHR/OCL Site. (Weiss, 2010). Recent investigations conducted in the groundwater source areas in the northern portions of LFU-2 and the Eastern Trenches found that the source areas are more extensive laterally and vertically than previously identified.

The State Historic Preservation Officer has indicated that there are no known historic or cultural resources identified within or adjacent to the LEHR/OCL Site.

The development of remedial alternatives to address soil, solid waste, and soil gas at the LEHR/OCL Site are detailed in the Soil FS (Weiss, 2012a). U.S. EPA, DTSC, and the RWQCB concurred on these findings.

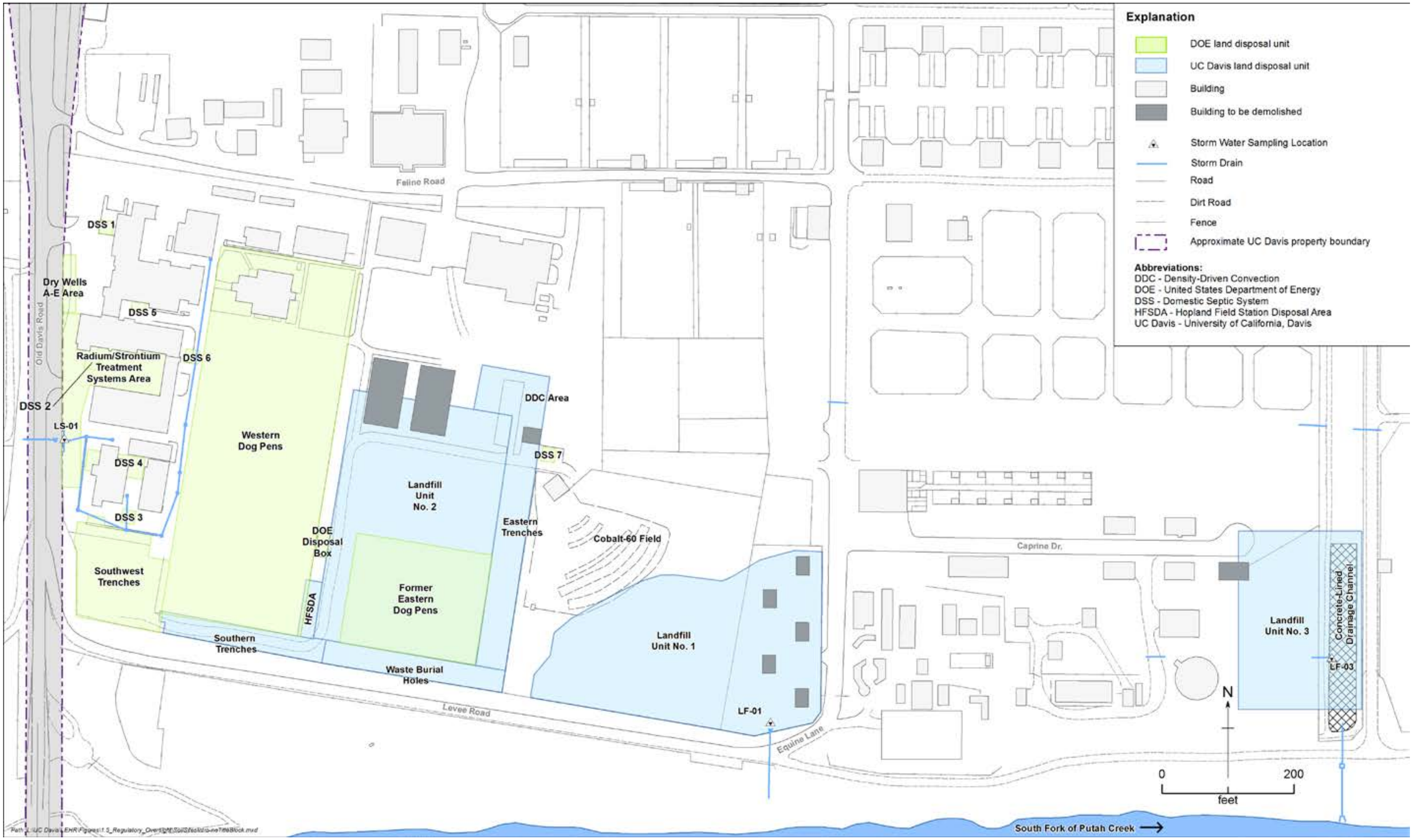


Figure 2 LEHR/OCL Site Features

5.1 NATURE AND EXTENT OF LANDFILLS AND CONTAMINATION

A summary is provided below of the nature and extent of the landfills and other areas of contamination for which UC Davis is responsible and addressed in this ROD. COCs in soil and solid waste have the potential to migrate through the vadose zone, contaminating the soil and potentially impacting groundwater, while COCs in soil gas potentially pose risk via the vapor inhalation pathway. COCs in surface soil have the potential to impact surface water and sediment via stormwater runoff. The information found in these subsections was taken from the Soil FS (Weiss, 2012b), unless otherwise noted.

5.1.1 Landfill Unit 1

Disposal of wastes occurred at LFU-1 during the 1940s and 1950s and included campus wastes (e.g., glass, metal, ash, charcoal, etc.), sewage treatment plant sludge, and, potentially, laboratory chemical waste. No inventory records are available for LFU-1 so waste was identified in the exploratory trenches and by the correlation of sample results with geophysical data. LFU-1 is approximately 1.9 acres and waste is presumed to be located throughout the entirety of this unit (Geomatrix, 2004). Contamination and wastes at LFU-1 are found in north-south trending trenches located south of the former cobalt-60 field and in east-west trending trenches in the eastern portion of the unit. The top of the waste is between 1 and 5 ft bgs and waste extends to depths of 4 to 8 ft bgs. The estimated volume of contaminated material is 39,204 LCY.

Known chemical wastes found by exploratory trenching included blue and green crystalline material. Soil COCs identified in the Soil FS include arsenic, lead, carbon-14, and benzo(a)pyrene; soil gas COCs include 1,3-butadiene; and soil COCs with the potential to impact groundwater include carbon-14, copper, and selenium. However, given the heterogeneous nature of landfill waste, other chemicals may be present.

5.1.2 Landfill Unit 2

Based on interviews with UC Davis employees, disposal of wastes occurred at LFU-2 from 1956 through 1967 and included municipal and campus general refuse, animal parts, campus incinerator waste, and laboratory chemicals. LFU-2 is approximately 2.1 acres. Contamination and wastes at LFU-2 are found in 12 east-west trending disposal trenches in the eastern portion of the unit. The top of the waste depth is between 1 and 4 ft bgs and waste extends to depths of 8 to 14 ft bgs. The estimated volume of contaminated material is 41,095 LCY. Geophysical surveys were not conducted in the majority of the southern part of LFU-2 because, at the time of the survey, the Eastern Dog Pens were located in the area. However, geophysical anomalies identified towards the southwestern part of the unit indicate that waste likely continues beneath the former Eastern Dog Pens. In addition to soil/solid waste, elevated VOC concentrations in soil gas samples (specifically chloroform) suggest the presence of a VOC “hot spot” in the northern portion of LFU-2, south of Geriatrics Building H-293.

Known chemical wastes identified by exploratory trenching included lead (possibly a battery), ampules, and a lead casing with white crystalline powder. Soil COCs identified in the Soil FS include lead, carbon-14, cesium-137, potassium-40, strontium-90, Aroclor-1260, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene. Soil gas COCs include 1,2-dichloropropane (DCP), chloroform, and tetrachloroethene (PCE). Soil COCs with the potential to impact groundwater include cadmium, carbon-14, and chloroform. However, given the heterogeneous nature of landfill waste, other chemicals may be present.

The Eastern Dog Pens, formerly used to house beagles for radioactive experimentation, was constructed on top of LFU-2. The primary sources of contamination in the Eastern Dog Pens were related to feces and urine (containing radioactive material) and flea control material (containing pesticides). In 1999, samples were collected from the upper two feet of soil but did not include waste associated with LFU-2 underneath; gravel and concrete curbing materials were also sampled. Residual cancer risk for the hypothetical on-site resident at the Eastern Dog Pens was estimated at 4×10^{-6} (DOE, 2009b). The Eastern Dog Pens were addressed by the 2009 DOE ROD's selection of land use restrictions to prevent exposure as the remedy, pending selection of the remedy for LFU-2 (DOE, 2009b); the contamination associated with this area was left in place based on the assumption that the area would be capped when LFU-2 was addressed.

5.1.3 Landfill Unit 3

Disposal of wastes occurred at LFU-3 from 1963 through 1967 and included general municipal waste (mainly glass), construction debris (e.g., rusted metal, concrete, bricks, and ceramic material), and potentially minor quantities of laboratory waste. LFU-3 is approximately 1.1 acres, and contamination at LFU-3 is found in two east-west trending cells approximately 60 feet wide by 120 feet long. A north-south trending ditch located along the east side of the unit was lined with concrete to prevent erosion of the waste. The top of the waste is between 1 and 4 ft bgs and waste extends to depths of 3 to more than 11 ft bgs. The estimated volume of contaminated material is 12,153 LCY. Geophysical data were obtained from the west side of the unit. Based on soil sample results, it is likely that waste is not widespread throughout the unit, but exists primarily within the two cell boundaries.

Soil COCs identified in the Soil FS included lead, manganese, carbon-14, cesium-137, strontium-90, and Aroclor-1260. No soil gas COCs were identified. Soil COCs with the potential to impact groundwater include barium, cadmium, copper, and carbon-14. However, given the heterogeneous nature of landfill waste, other chemicals may be present.

5.1.4 Waste Burial Holes

Disposal of wastes occurred at the WBH from 1956 through 1974 and included LLRW, laboratory chemicals, vials, animal carcasses, and laboratory glassware. The WBH area is approximately 0.2 acres. Contamination at the WBH was buried in 49 10-foot deep holes that were filled with waste material; however, an interim removal action (IRA) was conducted in 1999 due to high carbon-14 and tritium activities. Waste, including LLRW, was removed from 32 of 49 burial holes to a depth of 12 ft bgs. It is believed that some of the excavated burial holes were contiguous (i.e., that the excavations did not identify all of the separate burial holes). Contaminated soil was used to backfill the holes following excavation of waste material. The estimated volume of contaminated soil is 3,488 LCY.

Most radiological debris is no longer present at the WBH because it was removed during the 1999 interim removal. However, the contaminated soil surrounding the debris still remains because it was placed back in the excavation areas after the interim removal. No geophysical surveys were performed in the WBH area after completion of the interim removal action. Soil COCs identified in the Soil FS include carbon-14, cesium-137, strontium-90, tritium, and naphthalene. No soil gas COCs were identified. Soil COCs with the potential to impact groundwater include carbon-14 and tritium. However, given the heterogeneous nature of landfill waste, other chemicals may be present.

5.1.5 Eastern Trenches

Disposal of wastes occurred at the Eastern Trenches from 1957 through 1965 and included LLRW, general laboratory chemicals, pesticide containers, bones, and dog pen waste. Contamination at the Eastern Trenches is found in six north-south trending trenches and five east-west trending trenches. The top of the waste is between less than 1 and 4 ft bgs and waste extends to depths of 5 to 6 ft bgs. The estimated volume of contaminated material is 5,777 LCY. Little sampling or exploratory trenching has been performed in the northern portion of the Eastern Trenches. However, in the southern portion of the area, north-south-trending geophysical anomalies are common and waste is presumed to be located throughout the entirety of this unit. Elevated VOC concentrations in soil gas samples (specifically chloroform) suggest the presence of a second VOC "hot spot" in the northern portion of the Eastern Trenches.

Known chemical wastes identified by exploratory trenching included bottles/vials with clear/amber/reddish-brown liquids, orange/yellow/yellowish-olive/white powders, light green solids, jars with white crystalline powder, large ceramic crocks with white granular powder, olive-colored glass bottles with volatile liquid, wide-mouth bottles with thick liquid, a 5-gallon bucket of "weedkiller," and large glass bottles containing fluid. Soil COCs identified in the Soil FS include carbon-14 and tritium. Soil gas COCs include 1,2-dichloroethane (1,2-DCA), 1,2-DCP, 1,3-butadiene, and chloroform. Soil COCs with the potential to impact groundwater include carbon-14, tritium, 1,2-DCA, and chloroform. However, given the heterogeneous nature of landfill waste, other chemicals may be present.

5.1.6 Southern Trenches

Disposal of wastes occurred at the Southern Trenches from 1957 through 1965 and included low-level radioactive material, bones, animal feces, and laboratory waste mixed with gravel. The Southern Trenches area is approximately 0.16 acres and contamination at the Southern Trenches is found in two east-west trending trenches, each approximately 250 feet long and 2 to 4 feet wide. The top of the waste is between less than 0.5 and 1.5 ft bgs and waste extends to depths of 3 to 5.5 ft bgs. The estimated volume of contaminated material is 1,274 LCY. The Southern Trenches consist of mostly gravel and sand with some bones; only limited waste was found during exploratory trenching. The southwestern corner of the historical boundary of the Southern Trenches was removed during the 1998 DOE Southwest Trenches Removal Action (DOE, 2001). Therefore, this portion of the Southern Trenches does not need to be addressed in this ROD.

The primary COC identified in the Soil FS was carbon-14. No soil gas COCs were identified. The primary soil COC with the potential to impact groundwater is carbon-14. However, given the heterogeneous nature of landfill waste, other chemicals may be present.

5.1.7 Hopland Field Station Disposal Area

In 1965 and 1968, experiments with radionuclide injections into deer and sheep were performed at the Hopland Field Station, a 5,300-acre UC Davis research facility in Mendocino County. Historical information suggests that the animal carcasses are buried in the HFSDA, which is located adjacent to the southwestern edge of LFU-2 and north of the western end of the Southern Trenches (DOE, 1988). Sampling has not been performed in this area, and the single trench that crosses from LFU-2 into the HFSDA did not indicate the presence of waste. Geophysical anomalies suggest that disturbance to the soil has occurred. No information is available about wastes or contaminants in this area; this area will be investigated during the Remedial Design (RD) phase and if it contains contamination above industrial Regional Screening Levels, it will be remediated. The investigation may include limited trenching to evaluate the presence or absence of wastes.

5.2 TOPOGRAPHY AND GEOLOGY

Land at the LEHR/OCL Site is typical of the broad, relatively flat Sacramento Valley. Ground surface elevations are approximately 50 feet above mean sea level, and relief across the LEHR/OCL Site is approximately two feet. According to the Federal Emergency Management Agency (FEMA) Flood

Insurance Map, updated in May 2009, the LEHR/OCL Site is within a Zone A area, meaning it is subject to inundation by the one-percent annual chance flood event. This conclusion was made using approximate methodologies; no detailed hydraulic analyses have been performed (FEMA, 2010).

Subsurface geology below the LEHR/OCL Site consists of two units: the Putah Creek Fan and the Pliocene-Pleistocene Tehama Formation. The Putah Creek Fan consists primarily of silt and clay, with coarse-grained sediments occurring locally. The Tehama Formation, which lies beneath the Putah Creek Fan, primarily consists of clayey silt to silty clay, with deeper coarse-grained sand and gravel. A more detailed discussion of LEHR/OCL Site geology is presented in Section 1.5.3 of the RI Report (Geomatrix, 2004).

5.3 HYDROLOGY

5.3.1 Surface Water

There are no surface water bodies located on the LEHR/OCL Site. The nearest surface water body is the South Fork of Putah Creek, an east-flowing, engineered channel that lies 250 feet from the southern boundary of the LEHR/OCL Site and is separated from the LEHR/OCL Site by a levee that was constructed during the 1940s and 1950s. This levee is approximately 30 feet high, forms the southern boundary of the LEHR/OCL Site, and is used as a road for vehicular traffic. The southern levee of the creek is located several hundred feet south of the LEHR/OCL Site. The creek flow rate is regulated by releases from the Monticello Dam and the Putah Creek Diversion Dam. The South Fork of Putah Creek receives a minimum water flow rate of 31,000 acre-feet during non-dry years, as required in the settlement agreement between the Solano County Water Agency (and other Solano County parties) and the Putah Creek Council (and other Yolo County parties) (BBL, 2006). The UC Davis wastewater treatment plant discharges up to 2.7 million gallons per day of treated wastewater to the South Fork of Putah Creek at a location just west of the Old Davis Road Bridge (RWQCB, 2003). The South Fork of Putah Creek is a losing stream that recharges shallow (HSU-1) groundwater (Geomatrix, 2004). The Creek serves as habitat for many aquatic and riparian biota, including amphibians, fish, birds, and benthic invertebrates.

5.3.2 Storm Water Drainage

Runoff at the LEHR/OCL Site is collected at three locations: storm water sampling locations LS-01, LF-01, and LF-03. Water flows in these areas only after moderate to heavy winter storms. LS-01 captures runoff from buildings and parking lots; when runoff is present, it is pumped to a drainage swale along Old Davis Road. The occasional runoff from the other two surface drainages (LF-01 and LF-03) eventually flows through discharge pipes into Putah Creek. It is estimated that the pipe from LF-01 discharges an average of eight days per year into Putah Creek; discharges from LF-03 occur less frequently (Geomatrix, 2004). A concrete-lined drainage channel overlays the eastern portion of LFU-3, but runoff rarely occurs in this area.

5.3.3 Groundwater

The HSUs at the LEHR/OCL Site include, in order of descending depths, HSU-1, HSU-2, HSU-3, HSU-4, and an unnamed aquitard (see Figure 3). HSU-2 and HSU-4 are the most permeable of these HSUs, consisting predominantly of sand and gravel deposits. HSU-1 and HSU-2 form the upper and lower units, respectively, of the Putah Creek Fan. HSU-3, HSU-4, and the unnamed aquitard form the upper, intermediate, and lower units, respectively, of the Tehama Formation. HSU-1, HSU-3, and the unnamed aquitard are generally composed of silt and clay and are less permeable than HSU-2 and HSU-4. Hydraulic conductivity is estimated to be between 2 and 11 feet per day in HSU-1, and the horizontal seepage velocity is estimated to be approximately four feet per year. HSU-2 is estimated to have a hydraulic conductivity of approximately 1,020 feet per day and a horizontal seepage velocity of 1,500 feet per year (Geomatrix, 2004).

Groundwater levels have been monitored in LEHR/OCL Site wells for over 20 years. Levels are typically highest in March (first quarter) and April (second quarter), decline rapidly from April (second quarter) to August (third quarter) due to pumping of off-site agricultural wells, and recover from September (third quarter) to March (first quarter). During this annual cycle, groundwater depths in HSU-1 and HSU-2 wells typically fluctuate between 20 and 40 ft bgs (Weiss, 2012b). The solid wastes in the landfills at the Site do not extend into groundwater, but groundwater sampling indicates that some leachate has migrated to groundwater based on concentrations of total dissolved solids, chromium, nitrate, chloroform and other VOCs, 1,4-dioxane, carbon-14, and tritium.

The groundwater flow direction generally is to the northeast in HSU-1, east/northeast in HSU-2, and east in HSU-4, but can be locally influenced by irrigation wells during the agricultural pumping season. In 2010, horizontal groundwater gradients varied between 0.0001 feet per foot (winter) and 0.01 feet per foot (fall) in HSU-1; between 0.0003 feet per foot (winter) and 0.003 feet per foot (fall) in HSU-2; and between 0.0001 feet per foot (winter) and 0.001 feet per foot (spring/summer) in HSU-4 (Weiss, 2012b).

Seasonal trends show upward vertical gradients between HSU-1 and HSU-2 in the fall and downward gradients in the spring (Weiss, 2012b). The variation in vertical groundwater gradients by season is largely attributable to seasonal and weather-related use of irrigation wells in the area.

5.4 CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) was used to develop an understanding of the disposal units at the Site and to evaluate potential risks to human health and the environment. The CSM is a three-dimensional "picture" of site conditions that illustrates contaminant sources, release mechanism, exposure pathways, migration routes, and potential human and ecological receptors.

The seven disposal units at the LEHR/OCL Site pose varying degrees of potential risks to human health and the environment from chemicals and radiological constituents related to past Site activities. These constituents may be present in the Site soil matrix as a result of historical waste disposal practices or the activities associated with the radiological studies. Other activities associated with the radiological investigations are also thought to be a source for both radionuclide and chemical contaminants: residual radionuclides may have been released to the soil matrix via dog excreta, and pesticides were applied to the dogs outside where release onto soil was possible (BBL, 2006). Although removal activities have occurred at some of the Site disposal units, residual chemical and/or radioactive constituents are still present.

COCs in soil and solid waste have the potential to migrate through the vadose zone, contaminate the soil and create a secondary source. This secondary source then has the potential to leach, migrate, and impact groundwater. COCs in soil gas (i.e., VOCs) potentially pose a risk through the vapor inhalation pathway. COCs in surface soil have the potential to impact surface water and sediment via erosion from stormwater runoff and may be available to ecological receptors. The CSM considered contamination from organic and inorganic chemicals and radiological constituents in soil and solid waste, and VOC contamination in soil gas. The CSM was developed in accordance with U.S. EPA guidance and included known and suspected sources of contamination, types of contaminants and affected media, known and potential routes of migration, and known or potential human and ecological receptors. Figure 3 depicts the contaminant sources and transport pathways and Figure 4 presents the exposure pathway analysis applicable to the HHRA. For the ecological risk assessment, Figure 5 depicts the CSM for the Terrestrial Exposure Pathways.

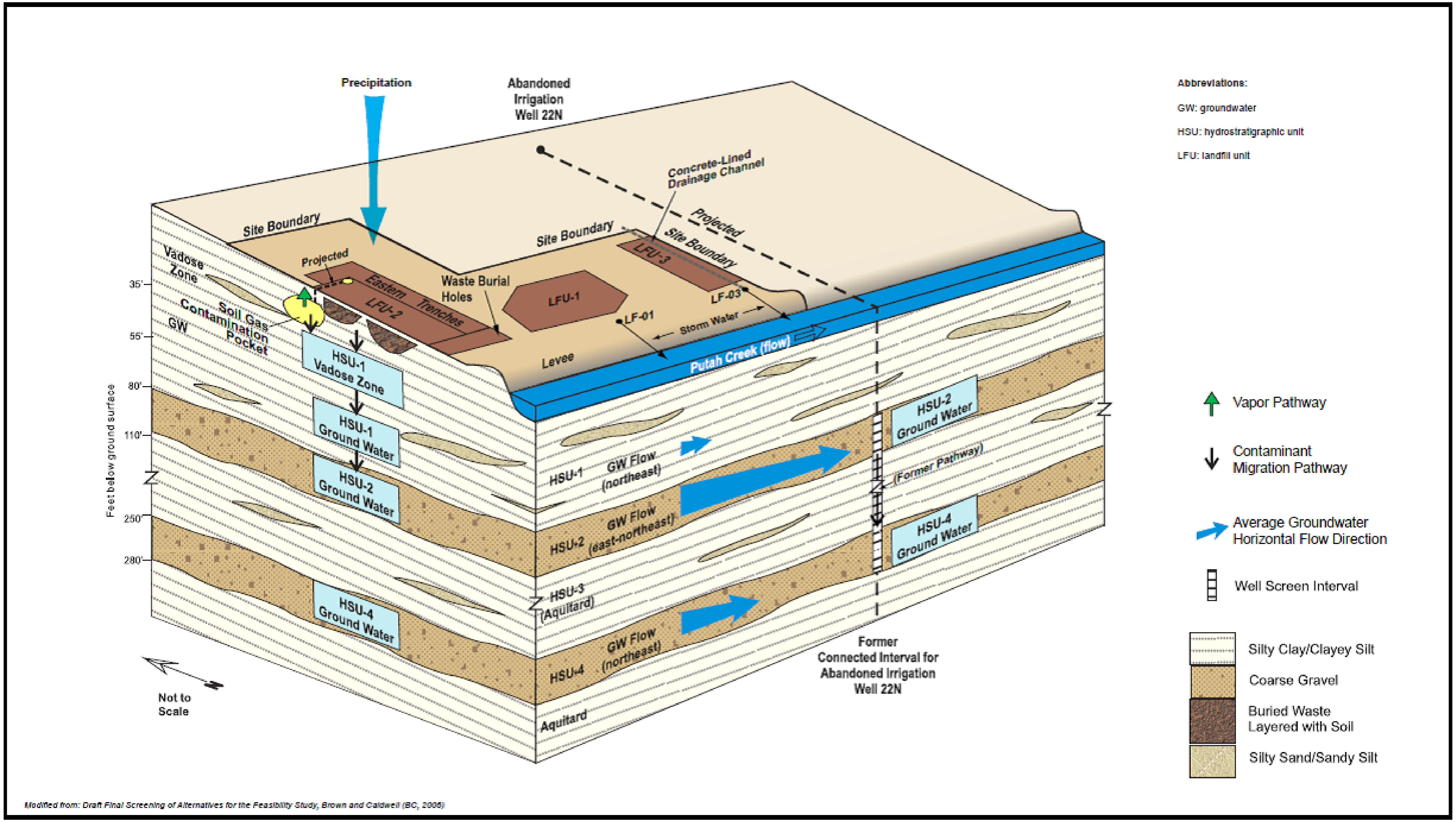


Figure 3 Conceptual Site Model for the LEHR/OCL Site

6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

The LEHR/OCL Site currently has one- and two-story laboratory and office buildings, animal handling facilities, and vegetated open areas. Specific land uses on the LEHR/OCL Site and in the immediate adjacent areas are under the control of UC Davis and are consistent with the Long-Range Development Plan Final Environmental Impact Report (LRDP) (UC Davis, 2003). The areas adjacent to the LEHR/OCL site include veterinary facilities associated with the School of Veterinary medicine, the campus wastewater treatment plant, Putah Creek, and farm fields. The LRDP indicates that the Central Campus area, two miles to the north of the Site and separated from the LEHR/OCL Site by a waterway, an interstate highway, and railroad tracks, will continue to be the portion of campus most intensely developed for academic and co-curricular activities. The LEHR/OCL Site is identified for low-density academic/administrative purposes and it is anticipated that land use will remain the same.

UC Davis currently operates the Center for Health and the Environment (CHE) at the former LEHR/OCL facility. Research activities at CHE focus on the effect of environmental agents, including chemicals and radiation, on the health of humans, animals, and other organisms (UC Davis, 2010a). Also, currently located on the LEHR/OCL Site is the California Raptor Center, an educational and research facility dedicated to the rehabilitation of injured and orphaned birds of prey (UC Davis, 2010b). Various laboratories for the School of Veterinary Medicine, such as the Center for Equine Health and the Animal Resource Service V, are also located on the LEHR/OCL Site. These organizations are likely to continue their activities for the foreseeable future, based on the LRDP.

7.0 SUMMARY OF SITE RISKS

Potential risks posed to human health and the environment at the LEHR/OCL Site include:

- Exposure to chemicals and radiological constituents in soil and soil gas that are related to past Site activities
- Exposure to buried landfill contents
- Leaching of chemicals present in soil, soil gas, and solid waste to groundwater
- Migration of COCs in surface soil to surface water and sediment via stormwater runoff

7.1 HUMAN HEALTH RISKS

The baseline risk assessment estimates the risks a site would pose if no further action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. There are four elements required in a baseline risk assessment process: identification of COCs, exposure assessment, toxicity assessment, and risk characterization. A baseline HHRA for the LEHR/OCL Site was completed in 2004 (MWH, 2004), refined in 2006 (BC, 2006), and updated in 2012 (Weiss, 2012a) as summarized below.

7.1.1 Identification of Constituents of Concern

For human health risks, COCs were determined for two depth ranges: 0 to 10 ft bgs and 10 to 20 ft bgs.

Soil and Solid Waste

The 2004 *Site-Wide Risk Assessment, Volume 1: Human Health Risk Assessment* (MWH, 2004; HHRA Part A) established a list of COPCs using procedures outlined in U.S. EPA's Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (U.S. EPA, 1989). The COPC list was further refined to a list of COCs in the *Site-Wide Risk Assessment*, *Volume I Human Health Risk Assessment (Part C – Risk Characterization for UC Davis Areas)* (BC, 2006; HHRA Part C).

Since publication of the HHRA Part A and HHRA Part C, additional data were collected and the risk-based screening values for soil constituents were updated. Therefore, the previously-identified COCs were re-evaluated. Soil/solid waste data from each disposal unit were evaluated in a five-step process. COCs retained through this qualitative evaluation were designated as Soil FS COCs. This evaluation identified new COCs and eliminated some of the COCs identified in the earlier risk assessments (Weiss, 2012a). This approach is fundamentally flawed because of uncertainties related to the heterogeneous nature of landfills and disposal units and is discussed in more detail in Section 7.1.5, Uncertainty Analysis. Therefore, any chemical exceeding its applicable screening level is retained as a COC for the purposes of addressing contamination related to disposal activities.

Soil Gas

The risk screening was conducted in two phases using soil gas data collected from depths of 5 ft bgs, 15 ft bgs, and 25 ft bgs in the Eastern Trenches, LFU-1, LFU-2, LFU-3, the Southern Trenches, and the WBH areas in September 2008. Maximum detected soil gas concentrations were compared with soil gas screening values. If the maximum detected concentration of a particular constituent was greater than the screening value, then the constituent was retained as a COPC.

7.1.2 Exposure Assessment

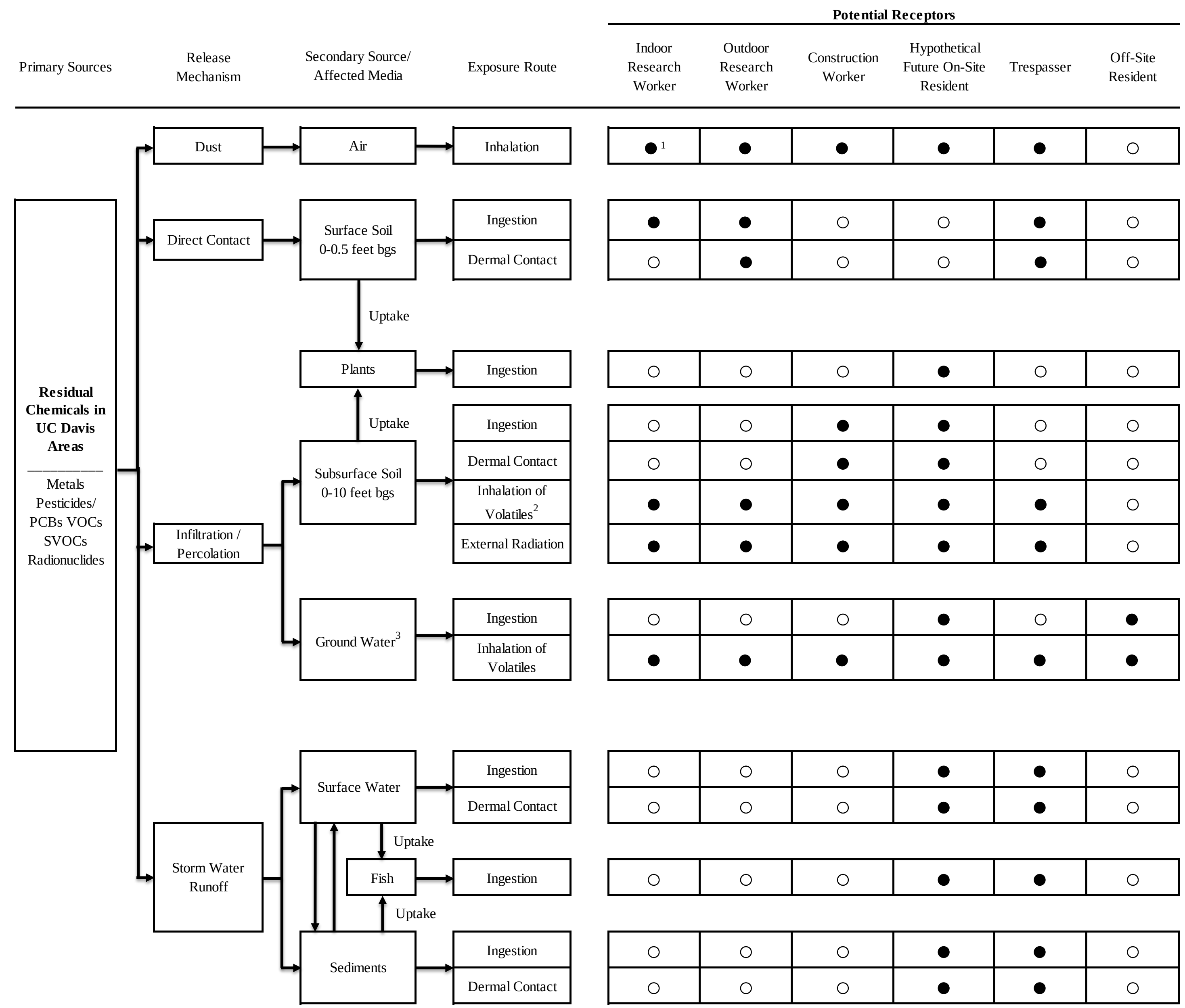
The exposure pathways that were considered in assessing human health risks are illustrated on Figure 4.

Soil and Solid Waste

Risks were originally evaluated for six on-site receptor groups in the HHRA Part A and HHRA Part C: age-adjusted adults, resident children, indoor researchers, outdoor researchers, construction workers, and trespassers. Exposure pathways that were evaluated included soil ingestion, soil dermal exposure, ingestion of homegrown produce, external radiation, dust inhalation, and inhalation of vapors from soil and groundwater in indoor and outdoor air. As part of later revisions to the HHRA, the Soil FS Appendix C re-evaluated risk only for a residential exposure scenario because it is the most conservative, and used default exposure parameters built into the Regional Screening Levels (RSLs), preliminary remediation goals (PRGs), and lead California Human Health Screening Levels (CHHSLs).

Soil Gas

Human receptors that could be exposed to the VOCs in indoor air include on-site indoor researchers and hypothetical future on-site residents (MWH, 2004). Research facility buildings currently overlie the northernmost part of LFU-2, the north end of the Eastern Trenches, and the northeast corner of LFU-2 areas as shown on Soil FS Appendix Figure B-1. Building H-292 is regularly occupied by workers.



Definitions:
● Potentially complete exposure pathway.
○ Incomplete exposure pathway.

bgs	below ground surface
HHRA	Human Health Risk Assessment
HSU	Hydrostratigraphic Unit
PCBs	polychlorinated biphenyls
SVOCs	semivolatile organic compounds
VOCs	volatile organic compounds

Notes:
- Figure reproduced from Figure 1-4 in the HHRA Part C (BC, 2006). Although the risk characterization in the HHRA Part C has since been discredited, the exposur pathway analysis presented above shows possible exposure pathways that were evaluated and currently apply.

1 This pathway is complete but was not included in the quantitative risk calculations because the contribution to risk is negligible. Using the risk for outdoor research worker as a surrogate fro the indoor research worker, the total risk for the indoor research worker would not increase if inhalation of dust is included.

2 Evaluated using soil gas data

3 HSU-1, 2, and 4

Figure 4 Exposure Pathway Analysis for Human Receptors

7.1.3 Toxicity Assessment

The toxicity assessment provides information regarding the potential of a chemical to cause cancer and other adverse health effects. Toxic chemical effects are separated into carcinogenic effects and non-carcinogenic effects based on the understanding that the mechanisms of action for cancer-causing and non-cancer-causing chemicals differ.

Soil and Solid Waste

The sources discussed below provide the basis for evaluating the toxicity of various substances and identifying COCs.

The Soil FS COCs were identified based on a qualitative evaluation of risks from constituents that passed initial screening based on comparison to residential 2011 RSLs, 2010 PRGs (radionuclides only), and CHHSLs (lead only). The RSLs for chemical toxicity were developed using toxicity values from six sources in hierarchical order. The risk-based PRGs for radionuclides are based on the carcinogenicity of the contaminants estimated using cancer slope factors by the Center for Radiation Protection Knowledge (U.S. EPA, 2015b). Lead toxicity is measured by blood lead levels. Lead health effects are based on estimate blood-lead concentrations in people exposed to lead in the environment. CHSSLs were developed to estimate a concentration of lead in soil that would lead to an incremental increase in blood-lead concentrations of up to 1 microgram per deciliter in people exposed to that soil (Office of Environmental Health Hazard Assessment [OEHHA], 2009).

Soil Gas

Inhalation unit risk factors (URFs) and non-cancer toxicity reference concentrations (RfCs) were obtained from U.S. EPA and Cal EPA sources.

7.1.4 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of a population of individuals developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk due to exposures to carcinogens through ingestion and skin contact is calculated from the following equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where:

Risk = a unitless probability (e.g., 2×10^{-5}) of a population of individuals developing cancer
CDI = chronic daily intake averaged over 70 years (milligrams per kilograms per day [mg/kg-day])
SF = slope factor, expressed as $(\text{mg/kg-day})^{-1}$

Quantitative estimates of risk due to inhalation are evaluated using the URF. Using the same equation shown immediately above, dose is replaced by the exposure level based on the contaminant concentration in air and the length of exposure. The exposure level is multiplied by the URF instead of the SF. An excess lifetime cancer risk of 1×10^{-6} indicates that a population of individuals experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of exposure to site-related contaminants. This is referred to as an “excess lifetime cancer risk” because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of a population of individuals developing cancer from all other causes has been estimated to be as high as one in three. U.S. EPA's risk management range for site-related exposures is 1×10^{-6} to 1×10^{-4}. Determination of what constitutes acceptable levels of residual risk within this range is made on a site-specific basis.

Health effects due to exposures to non-carcinogens are estimated using the hazard quotient (HQ) approach. The HQ is the ratio of exposure to toxicity. An HQ less than 1 indicates that toxic non-carcinogenic effects from that chemical are unlikely. The hazard index (HI) is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given population of individuals may reasonably be exposed. An HI less than 1 indicates that toxic non-carcinogenic effects from all contaminants are unlikely. An HI greater than 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI/RfD}$$

where:

CDI = chronic daily intake
RfD = reference dose

As in risk estimates due to inhalation of carcinogens, the hazard quotient due to inhalation of a non-carcinogen is calculated by replacing the dose with the exposure level based on the COPC concentration in air and the length of exposure. The RfD is replaced by the RfC.

In general, calculated cumulative cancer risks greater than 1×10^{-4} and HIs greater than 1 require consideration of cleanup alternatives. Cancer risks between 1×10^{-4} and 1×10^{-6} (between 1 in ten-thousand and 1 in one-million) fall within EPA's risk management range. Cumulative incremental lifetime cancer risk related to site contamination below 1×10^{-6} is considered a *de minimis* level and typically does not warrant active risk/exposure mitigation.

Soil and Solid Waste

Potentially unacceptable risks and hazards were estimated in both the HHRA Part C and the Soil FS HHRA. After selecting COCs, the Soil FS compared the results to those of the original human health risk assessments and eliminated some of the final 2006 HHRA Part C COCs. COCs common to both were included in the final list of COCs in the Soil FS. The most recent estimate of these risks is from the Soil FS and is presented as Table 1. However, it should be noted that this approach was flawed because of the heterogeneous nature of landfill contents. Because landfills are heterogeneous, limited sampling is not likely to have identified all COCs or the maximum extent of contamination. As a result, all COCs are retained.

Soil Gas

The estimated vapor intrusion risks to on-site indoor researchers and hypothetical future residents that were calculated for soil gas in the Soil FS are summarized in Table 2. Risks are highest at the north end of LFU-2, in the vicinity of the Geriatrics buildings and the known VOC "hot spot" location. Significant risks are also posed by the Eastern Trenches area, near the other known VOC "hot spot" area. Risks in the remaining areas are near or below 1×10^{-6}. The HI estimated for each receptor at each disposal area was less than 1.0. The Soil FS selected the following COCs for soil gas:

- 1,2-DCA, 1,2-DCP, 1,3-butadiene, and chloroform in the Eastern Trenches;
- 1,3-butadiene in LFU-1; 1,2-DCP, chloroform, and PCE in LFU-2; and
- Formaldehyde in the WBH.

The approach used in the Soil FS identified new COCs and eliminated some of the COCs identified in the earlier risk assessments. There are issues with this approach as discussed below. Also, recent investigations have identified additional chemicals in soil and groundwater.

Table 1 Summary of Cancer Risks and Non-Carcinogenic Hazards for Soil for the Hypothetical Residential Receptor at the LEHR/OCL Site

Disposal Unit	Depth Interval (ft bgs)	Total Residential Risk[1] or Hazard[2]
Eastern Trenches	0-10	**6.8×10^{-5}**
	10-20	**1.4×10^{-5}**
	Total Depth 0-20	**8.2×10^{-5}**
Landfill Unit 1	0-10	**1.4×10^{-4}**
	10-20	**5.3×10^{-6}**
	Total Depth 0-20	**1.4×10^{-4}**
Landfill Unit 2	0-10	**2.3×10^{-5}**
	10-20	**1.4×10^{-4}**
	Total Depth 0-20	**1.6×10^{-4}**
Landfill Unit 3	0-10	**2.0×10^{-5}** **2.2 (total hazard)**
	10-20	**1.4×10^{-6}**
	Total Depth 0-20	**2.2×10^{-5}**
Southern Trenches	0-10	**1.1×10^{-5}**
	Total Depth 0-20	**1.1×10^{-5}**
Waste Burial Holes	0-10	**2.0×10^{-2}**
	10-20	**5.7×10^{-4}**
	Total Depth 0-20	**2.1×10^{-2}**

Notes:

gray indicates risk above the risk management range or a Hazard Index greater than one.

[1] Total calculated risk posed by current EPCs to a potential on-site resident.

[2] Total calculated hazard quotient posed by current EPCs to a potential on-site resident; hazards denoted with italic font. Note that hazards were indicated only at Landfill Unit 3.

Acronyms/Abbreviations:

bgs – below ground surface
EPC – exposure point concentration
ft - feet

Table 2 Summary of Elevated Soil Gas Risks and Hazards from the Vapor Intrusion Risk Assessment at the LEHR/OCL Site

Disposal Unit	Receptor	Total Risk or Hazard[1]	Risk Drivers[2]	Depth (ft bgs)
Eastern Trenches	Indoor Researcher	9.1×10^{-6}	1,3-Butadiene; Chloroform	5
		3.3×10^{-5}	1,2-DCP; Chloroform	15
		1.4×10^{-6}	Chloroform	25
	Age-Adjusted Adult	1.9×10^{-5}	1,3-Butadiene; Chloroform	5
		7.0×10^{-5}	1,2-DCA; 1,2-DCP; Chloroform	15
		3.0×10^{-6}	Chloroform	25
	Resident Child	7.2×10^{-6}	Chloroform	5
		2.6×10^{-5}	Chloroform; 1,2-DCP	15
		1.1×10^{-6}	Chloroform, Formaldehyde[3]	25
Landfill Unit 1	Indoor Researcher	2.7×10^{-6}	1,3-Butadiene	15
	Age-Adjusted Adult	5.7×10^{-6}	1,3-Butadiene	15
	Resident Child	2.1×10^{-6}	1,3-Butadiene	15
Landfill Unit 2	Indoor Researcher	1.3×10^{-5}	Chloroform	5
		1.5×10^{-5}	Chloroform	15
	Age-Adjusted Adult	1.6×10^{-4}	1,2-DCP; Chloroform; PCE	5
		1.2×10^{-4}	Chloroform; PCE	15
		4.3×10^{-6}	Chloroform	25
	Resident Child	5.9×10^{-5}	1,2-DCP; Chloroform; PCE	5
		4.4×10^{-5}	Chloroform	15
		1.6×10^{-6}	Chloroform	25
Landfill Unit 3	Age-Adjusted Adult	1.2×10^{-6}	1,3-Butadiene; Formaldehyde[3]	25
Waste Burial Holes	Age-Adjusted Adult	1.4×10^{-6}	Formaldehyde	5

Notes: red indicates risk above the risk management range.

[1] Sum of risks from all constituents. Only risks greater than 10^{-6} are shown. The hazard index estimated for each receptor at each disposal area was less than 1.0.
[2] Risk drivers shown are those constituents contributing more than 10^{-6} toward total risk unless otherwise noted.
[3] Primary contributors to risk that are shown contribute less than 10^{-6} each.

Acronyms/Abbreviations:

DCA – dichloroethane
DCP – dichloropropane
PCE – tetrachloroethene

7.1.5 Uncertainty Analysis

The HHRA Part C and the Soil FS each present an interpretation of the risks and hazards that exist should no action be taken. These risks were estimated so that a range of potential remedial alternatives could be evaluated. Although potentially unacceptable risks and hazards are identified in each risk assessment, these likely are not representative of actual risks because of uncertainties which may have overestimated or underestimated Site risks. The following uncertainties associated with prior site investigations and risk calculations may have overestimated Site risks.

- Use of generic screening levels such as RSLs, PRGs, and CHHSLs to screen detected chemicals and then estimate risks and hazards inherently introduces uncertainty and may have overestimated actual risks (as compared to calculating site-specific risks) because the default exposure parameters built into the RSLs, PRGs, and lead CHSSL are conservative and intended to represent the worst case scenario.
- The exposure assessment assumed Site receptors are exposed to the same contaminant concentrations for the entire period of exposure and did not account for decreases in concentrations over time. Risks attributed to VOCs will decrease as VOCs degrade or volatilize. Similarly, as tritium decays, risk attributed to tritium will be reduced and then eliminated because it has a half-life of 11.3 years.
- Toxicity data is based largely on animal studies. Toxicity data from animal studies typically is adjusted conservatively to extrapolate effects on humans, which could overestimate risks.

Several other factors may have contributed to an underestimation of Site risks, as summarized below.

- Any experimental chemicals generated by laboratories and disposed of in the landfills may have undergone transformation through mixing with other chemicals. There may not be any analytical methods that would detect these chemicals. Therefore, risk estimates would not include contributions from these chemicals.
- A limited number of characterization samples were collected and analyzed.
- Analysis of samples from past investigations may not have detected some chemicals because of elevated reporting limits.
- Risks could be underestimated for a worker who is present at the Site for longer durations (i.e., longer than 25 years or more than 8 hours per day regularly, the standard worker exposure used for risk estimates) than a standard worker.
- Toxicity data (screening values) were not available for some analytes detected in soil gas when the HHRAs were conducted, including 1,3-dichlorobenzene and 4-ethyltoluene; therefore an evaluation of their contribution to vapor intrusion risk was not possible.

However, the most significant uncertainty that may have contributed to an underestimation of Site risks is the inability to fully characterize landfills and land disposal units because of their heterogeneous nature. Although the Soil FS refined the list of COCs, there are significant uncertainties associated with this approach because historical sampling conducted at the Site was not sufficient to fully characterize all the disposal units (i.e., to detect all of the chemicals and their maximum concentrations) and homogeneity across the disposal units cannot be assumed. For example, LEHR UCD is a research institution and each laboratory conducted unique research. Thus, each contributed varied and unique “waste streams” to the landfills. In addition, the disposal units are known to have received typical domestic and commercial wastes. Lack of historical documentation makes it impossible to know every type of waste that may have been placed into the landfills and disposal units as well as waste distribution patterns. Based on these uncertainties, it can be concluded that the Soil FS HHRA failed to consider the heterogeneity of the landfills and the standard statistical analyses that were used to eliminate COCs are not valid. The HHRA Parts A and C used even older datasets with the same limitations, which were subsequently updated with current data and used to calculate risks and hazards in the Soil FS HHRA. As a result, it is likely that Site risks were underestimated.

Since heterogeneity is common to most landfills, including the land disposal units at LEHR OCL, U.S. EPA has developed containment as the presumptive remedy for CERCLA municipal landfills. Although the LEHR OCL land disposal units are also known to contain hazardous wastes, the locations of all of the hazardous wastes are unknown and the risk of exposure associated with completely excavating and testing the disposal units to find all of the hazardous waste is high. The presumptive remedy (containment) specifies that as a matter of policy, for the source area of municipal landfills, a quantitative risk assessment that considers all chemicals, their potential additive effects, etc., is not necessary to establish a basis for action if ground-water data are available to demonstrate that contaminants clearly exceed established standards or if other conditions exist that provide a clear justification for action (U.S. EPA, 2015c). The potential unacceptable risks and hazards identified in the risk assessments combined with the uncertainties above provide a clear justification for action.

7.2 ECOLOGICAL RISKS

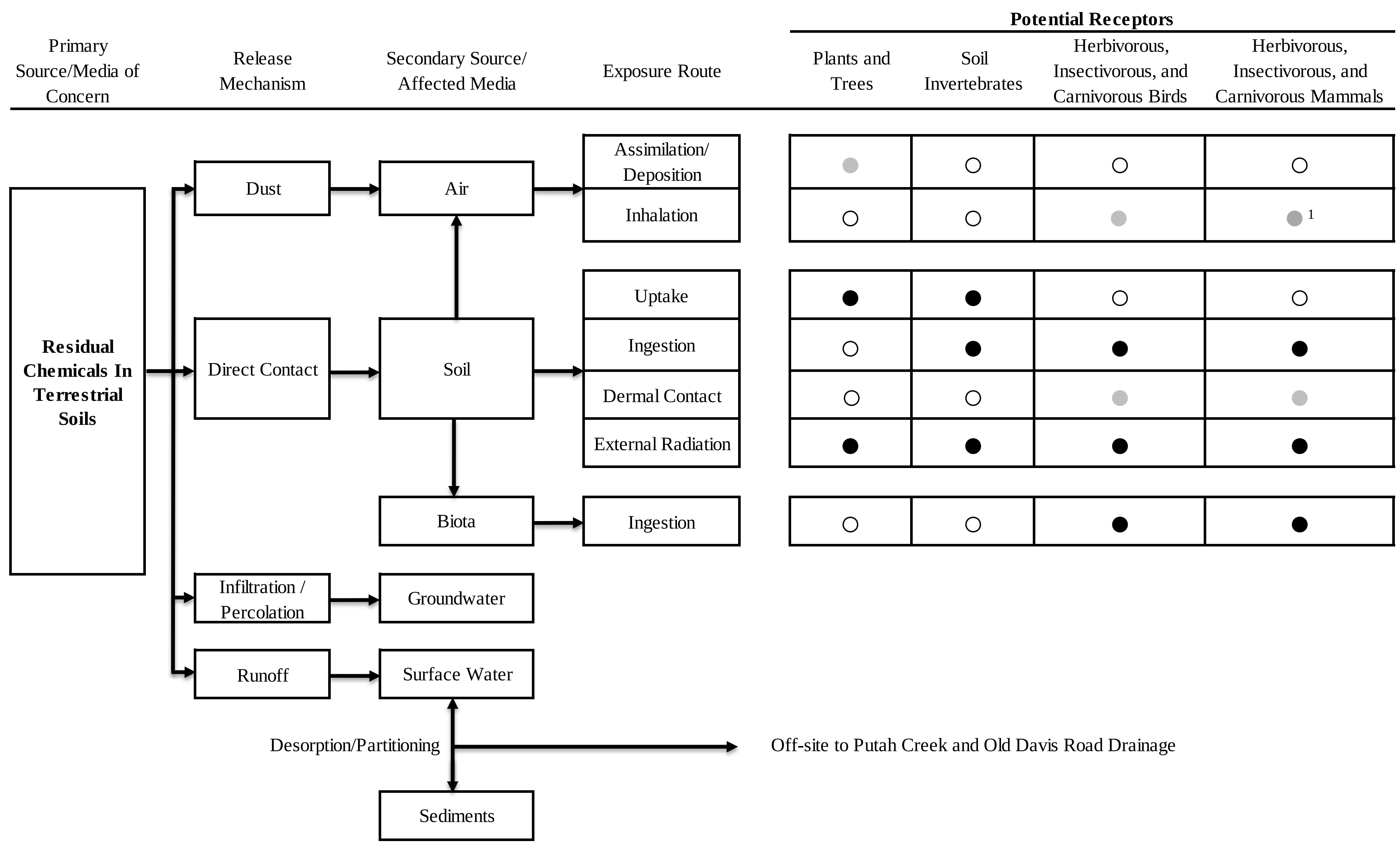
A site-wide ecological risk assessment (SWERA) was conducted for 14 on-site areas in 2006, including the LEHR/OCL Site (BBL, 2006). The primary objective of the SWERA was to evaluate potential on-site and offsite ecological risks associated with the Site using existing Site data and characterization reports. The CSM for evaluating ecological risks to terrestrial receptors for the soil/solid waste areas is presented on Figure 5.

For the on-site ecological risk evaluation, as described briefly in the subsections below, the SWERA consisted of a problem formulation, an exposure and effects assessment, a risk characterization, and an uncertainty analysis. Ecological COCs were selected based on a comparison of maximum detected concentrations to conservative benchmarks protective of ecological receptors. Potential risk was evaluated using ecological COCs occurring in the 0 to 10 foot depth interval bgs, rather than the standard ecological risk evaluation depth interval 0 to 6 ft bgs; this was done to maintain consistency with exposure estimates used in the human health risk assessment and to minimize rework that would not substantially change the results of the SWERA.

For the off-site ecological risk evaluation, the only identified ecological risk exposure pathway was from the desorption and partitioning of sediments in stormwater run-off; however, there is no indication the LEHR/OCL Site stormwater discharges significantly impact the sediment or the benthic community adjacent to or downstream (e.g., Putah Creek) of the Site (BBL, 2006).

7.2.1 SWERA Conclusions

Ecological risks were found to be acceptable for the Eastern Trenches, the Southern Trenches, and the WBH, and no further evaluation of ecological receptors was recommended for these parts of the Site. The risk evaluation identified ecological COCs in soil at LFU-1, LFU-2, and LFU-3 (Weiss, 2012a). The ecological COCs are presented in Table 3. In addition to the risks calculated for soil in LFU-2, a hazard quotient of 3.6 was calculated for chloroform in soil gas for the burrowing mammal receptor. This was the only soil gas ecological COC.



Definitions:
● Potentially complete exposure pathway.
○ Incomplete exposure pathway.
● Potentially complete, but minor exposure pathway.

Notes:
- Figure reproduced from Figure 2-5 in the SWERA (BBL, 2006).
1 Potentially complete exposure pathway for burrowing mammals only at Eastern Trenches and Landfill Unit No. 2.

Figure 5 Exposure Pathway Analysis for Terrestrial Habitat Ecological Receptors

Table 3 Summary of Ecological COCs from Exposure to Soil/Solid Waste Constituents at the LEHR/OCL Site

Receptor	Landfill Unit 1	Landfill Unit 2	Landfill Unit 3
Plants	As, Cu, Pb, Mn, Se, Ag, Tl, Zn	Cu, Pb, Mn, Mo, Ag, Tl, Zn	Sb, Cu, Pb, Mn, Mo, Se, Ag, Zn
Soil Invertebrates	Ba, Cu, Zn	Cu, Zn	Ba, Cu, Pb, Zn
Botta's Pocket Gopher	Cd, Cu, Pb, Se, Zn	Cd, Cu, Pb, Zn	Sb, Cd, Cu, Pb, Mn, Mo, Se, Zn
Ornate Shrew	As, Cd, Cu, Pb, Mn, Se, Zn	Sb, Cd, Cu, Pb, Mn, Zn	Sb, Cd, Cu, Pb, Mn, Mo, Se, Zn
American Robin	Cd, Cu, Pb, Mn, Se, Zn, 4,4'-DDE	Cd, Cu, Pb, Mn, Zn, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT	Cd, Cu, Pb, Mn, Se, Zn, Aroclor-1260
Horned Lark	Cd, Cu, Pb, Mn, Se, Zn, 4,4'-DDE	Cd, Cu, Pb, Mn, Zn, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT	Cd, Cu, Pb, Mn, Se, Zn, Aroclor-1260

Acronyms/Abbreviations:

Ag – silver
As – arsenic
Ba – barium
Cd – cadmium
COC – constituent of concern
Cu – copper
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethene
DDT – dichlorodiphenyltrichloroethane
Mn – manganese
Mo – molybdenum
PB – lead
Sb – antimony
Se – selenium
Tl – thallium
Zn – zinc

7.2.2 Uncertainty Analysis

Uncertainties were inherent in each phase of the SWERA process. However, the ecological risk values are likely to overestimate the true risk associated with the Site because protective assumptions were made at many different steps during the ecological risk evaluation process and are compounded in the calculation of the risk estimates. For example, ecological COPCs were selected based on a comparison of maximum detected concentrations to conservative benchmarks protective of ecological receptors. In addition, the Tier 1 problem formulation identified receptors of concern that are representative species for each assessment endpoint. Receptors of concern were selected conservatively with consideration of their life history characteristics to maximize estimates of potential exposure. Finally, in the effects assessment, toxicological effects data were compared to ecological COPC concentrations or modeled doses. Benchmarks were selected as conservative estimates of potential toxic effects to minimize the possibility of reaching a finding of no risk when risk actually exists (BBL, 2006). To reiterate, the quantitative risk results of the SWERA were estimated based on modeled exposure and non-site-specific, literature-based toxicity benchmarks, and therefore are screening-level in nature. Thus, any determinations of potential risk based on the quantitative evaluation should not be considered definitive conclusions but should be interpreted as conservative estimates of potential risk.

7.2.3 Biological Assessment and U.S. FWS Biological Opinion

Because elderberry trees and shrubs are known habitat for the threatened VELB, and elderberry trees and shrubs located over land disposal areas will be impacted by the remedy, ICF International prepared a biological assessment to determine to what extent the actions specified in the remedy may affect the VELB and its habitat. The biological assessment reported that 20 of the 81 elderberry shrubs located in proposed remedial action areas had exit holes on live stems that were similar in size and shape to those exit holes made by VELB, which suggests that the species occurs within the remedial action area. It should be noted that although elderberry trees and shrubs are designated critical habitat in some areas of the Sacramento River Valley, the biological assessment states, "The action area is not located within designated critical habitat" for the VELB (ICF International, 2016).

The biological assessment concluded that the remedy is likely to adversely affect the VELB (ICF International, 2016). This biological assessment triggered formal consultation with the U.S. Fish and Wildlife Service (USFWS). USFWS evaluated potential impacts to the VELB and prepared a biological opinion. The biological opinion noted that construction and activities associated with the remedy will directly affect 17 elderberry shrubs, some of which showed evidence of the VELB being present. To address these effects, UC Davis will transplant shrubs located outside the areas to be remediated to a designated mitigation area. Eight elderberry shrubs are located outside the areas to be remediated. UC Davis also will purchase conservation credits to offset the uprooting and destruction of 9 elderberry shrubs rooted in the areas affected by remedial action. For these reasons, the USFWS concluded that the remedy is not likely to jeopardize the continued existence of the VELB (USFWS, 2016).

7.3 GROUNDWATER IMPACT ASSESSMENT

An appropriate evaluation of remedial options for the UC Davis disposal units requires consideration of protection of groundwater from COCs because of the potential for their migration from the disposal units to groundwater. For this reason, a groundwater impact assessment was performed to assess the current and potential future impacts to groundwater by COCs identified in the UC Davis disposal units (Weiss, 2012a).

A number of VOCs were added as COPCs based on their detection in data gap soil gas samples collected at 5, 10, and 15 ft bgs. With the exception of isopropanol, hexane, and ethanol, all VOCs detected in soil gas were retained as COPCs for evaluation through vadose zone modeling to simulate contaminant transport from the vadose zone to groundwater. The results of this vadose zone modeling were used to estimate the time required for UC Davis area source material to migrate through the vadose zone and to determine soil cleanup levels protective of groundwater quality (designated levels [DLs]). The primary source of groundwater goals was the California Maximum Contaminant Levels (MCLs) for drinking water. If MCLs were unavailable, the U.S. EPA RSLs for tap water were used. The Cal EPA risk-based target of 1.1 microgram per liter (µg/L) for groundwater was used for chloroform. California notification levels were used as goal concentrations for carbon disulfide, 1,4-dioxane and formaldehyde. Background levels for inorganic constituents and sample detection limits for organic constituents were also used to provide baseline goals (Weiss, 2010).

To facilitate risk management decisions, the risk characterization evaluated and made recommendations on whether groundwater COPCs should be evaluated as a COCs in the Soil FS. Groundwater COPCs were examined on an individual basis to evaluate the lines of evidence indicating whether a threat to groundwater resources exists.

Once the modeling was completed, the resultant DLs were used, along with Site groundwater monitoring data and disposal unit soil/soil gas characterization data, to conduct a three-step risk estimate procedure for each DL COPC in each disposal unit. DL COPCs whose peak impact was predicted to occur in less than 500 years were identified as groundwater COPCs and carried forward into the risk characterization, while those with longer peak impact times were eliminated (Weiss, 2010).

Based on the results of the risk characterization, the following COCs with the potential to impact groundwater were identified:

- **Eastern Trenches:** carbon-14; tritium; chloroform; 1,1-DCA; 1,2-DCA; 1,2-DCP; 1,4-dioxane
- **LFU-1:** copper; selenium; carbon-14
- **LFU-2:** cadmium; carbon-14; acetone; chloroform; 1,1-DCA; 1,2-DCP; 1,4-dioxane
- **LFU-3:** barium; cadmium; copper; carbon-14, formaldehyde
- **WBHs:** carbon-14; tritium; 1,4-dioxane
- **Southern Trenches:** none identified

Soil gas COCs that were identified in the groundwater impact assessment as having the potential to impact groundwater were evaluated in conjunction with additional groundwater data collected during the first quarter of 2010. As a result of this evaluation, acetone, formaldehyde, 1,1-DCA, 1,2-DCP, and 1,4-dioxane were eliminated as Soil FS COCs (Weiss, 2012a); however, these contaminants may be retained as groundwater COCs in the future. The final soil gas COCs with the potential to impact groundwater are chloroform and 1,2-DCA at the Eastern Trenches and chloroform at LFU-2. It should be noted that although the Soil FS established preliminary soil cleanup goals for these COCs to evaluate alternatives other than containment with engineered covers, the cleanup goals are not applicable if engineered covers are installed over the landfills because a containment-based remedy does not treat or reduce concentrations.

7.4 SUMMARY OF SITE RISKS AND BASIS FOR REMEDIAL ACTION

The response action selected in this ROD is necessary to protect public health or welfare and the environment from actual or threatened releases of hazardous substances into the environment, which may present an imminent and substantial endangerment to public health or welfare. The response action is warranted because:

- Soil contamination in the waste disposal units has the potential to migrate via precipitation infiltration through the vadose zone and affect groundwater quality, or surface water via erosion and stormwater run-off. In addition, humans may be exposed to contaminants and buried waste.
- VOC soil gas concentrations exceed screening levels for the protection of on-site workers and potential future residents.
- Metals, non-metals, pesticides, and PCBs pose unacceptable risk to on-site ecological receptors.

8.0 REMEDIAL ACTION OBJECTIVES

U.S. EPA has developed remedial action objectives (RAOs) to describe how the remedy is expected to address Site risks. These RAOs take into consideration current and reasonably anticipated future land uses and address exposure risks based on the removal of contamination and the isolation of potential receptors from remaining contamination. RAOs for the Site include those for the protection of human health, groundwater quality, and the environment as described below:

- Prevent human contact (ingestion, inhalation, and dermal) with contamination in soil/solid waste, and soil gas which poses an excess cumulative cancer risk greater than the risk management range of 1 x 10^{-6} to 1 x 10^{-4}, or a cumulative cancer risk greater than 1 x 10^{-6} for persons (i.e., students) living in the dairy goat barn.

- Prevent human contact (ingestion, inhalation, and dermal) with contamination in soil/solid waste and soil gas which poses a non-cancer hazard with an HI greater than 1.0;
- Prevent landfill waste and contaminated soil and soil gas from migrating and affecting groundwater quality;
- Minimize ecological receptor exposure, including, but not limited to, sensitive and critical habitats of species protected under the state and federal Endangered Species Acts; and
- Prevent surface water or storm water contact with landfill waste or soil contaminated above cleanup levels.

8.1 BASIS AND RATIONALE FOR REMEDIAL ACTION OBJECTIVES

RAOs provide a general description of what the cleanup will accomplish at the Site. These objectives serve as the design bases for the remedial alternatives, which are presented in Section 9.

Additionally, the RAOs were selected in consideration of the Site's current and reasonably anticipated future land use for the construction of low-density buildings serving academic and administrative purposes[1].

8.2 HOW THE REMEDIAL ACTION OBJECTIVES ADDRESS RISKS

The RAOs address unacceptable risks identified in the risk assessments by targeting the minimization of exposure to ensure that the risks remaining after implementation of the remedy will be below or within the U.S. EPA's risk management range (1 x 10^{-6} to 1 x 10^{-4}) for the reasonably anticipated future land use. Because the selected remedy involves leaving contamination in place that is acceptable for industrial/commercial use, the RAOs for residential exposure will be achieved by ICs which prevent residential use until cleanup levels are achieved.

8.3 BASIS OF CLEANUP LEVELS

As described further in the subsection below, Site-specific cleanup levels for soil/solid waste and soil gas were developed for the VOC "hot spot" excavation areas needed to achieve protection of human health and groundwater resources. Existing soil gas data indicate that the "hot spots" are located above a depth of 15 ft bgs and excavation to 20 ft bgs is planned. The lateral extent of the excavation areas will be determined by sampling during the RD stage.

8.3.1 Cleanup Levels – Soil/Solid Waste and Soil Gas

Cleanup levels in the two VOC "hot spot" areas for the identified VOCs in soil and VOCs in soil gas that potentially could impact groundwater quality and pose unacceptable human health risks are presented in Table 4. The list of VOCs includes additional chemicals that have been detected during sampling conducted at the Site after the Soil FS sampling was completed in 2010. U.S. EPA industrial RSLs for soil and indoor air were selected as the final cleanup levels for VOCs of concern in soil gas. RSLs are calculated at a 10^{-6} risk and a Hazard Index less than 1. Due to the uncertainty associated with the time

[1] Residential use and use by sensitive receptors (e.g., day care centers, public or private schools for persons under 18 years of age, hospitals, etc.) on the Site will be prohibited.

elapsed since cleanup levels were developed in the soil vapor risk assessment and the groundwater impact assessment, U.S. EPA industrial RSLs (U.S. EPA, 2016a) were selected as the final cleanup levels for VOCs of concern for soil and soil gas. RSLs for industrial air will be used as a screening tool to define the lateral extent of each VOC "hot spot" excavation. RSLs for industrial soil will be used to confirm whether or not excavation of "hot spots" is complete. Further, because of the heterogeneous nature of the landfills, there is potential that sampling may identify other contaminants that are not currently identified as COCs during excavation of the VOC "hot spots." These contaminants will be addressed as follows:

- For portions of the landfill or burial areas that are excavated and placed under a multiple-layer cap, the soil cleanup levels will be industrial RSLs.

- For metals and non-metals, the higher of background or the industrial soil RSLs will be used, except for lead. The commercial/industrial CHSSL will be the soil cleanup level for lead.

- For other contaminants, the industrial soil RSLs will be used.

The cleanup levels only apply during excavation of the VOC "hot spots," unless VOCs are detected in soil when the retention basins or drainage channels are excavated. Cleanup levels are documented as the May 2016 RSLs for soil and indoor air (except lead as noted above) and are included in Attachment A. The RSLs are based on a risk of 1×10^{-6} and a hazard index of 1.0.

Importantly, U.S. EPA did not develop chemical-specific cleanup levels for other Site COCs (e.g., copper) outside the VOC "hot spots" because of (1) uncertainties related to the heterogeneous nature of the contents of the landfills, (2) uncertainties associated with the HHRA methodology, and (3) the invalid elimination of COCs in the Soil FS. To address these uncertainties and to minimize the potential for contact with buried wastes, the selected remedy specifies construction of multiple-layer caps and drainage enhancements and utilizes land use controls. The multiple-layer caps will protect current and potential future receptors by preventing exposure to soil/soil gas contaminants and landfill wastes. The multiple-layer caps and drainage enhancements will also protect groundwater quality by minimizing precipitation infiltration through soil contamination and buried wastes, thereby minimizing the potential for leaching and transport of Site COCs to groundwater.

Similarly, EPA did not develop COC-specific cleanup levels for the protection of ecological receptors because of the uncertainties in the risk estimates (BBL, 2006). Nevertheless, the selected presumptive containment remedy will protect ecological receptors by preventing exposure to contaminated soil and landfill wastes.

Table 4 VOC Cleanup Levels for the LEHR/OCL Site

COC	Soil Cleanup Level (mg/kg)	Soil Gas Cleanup Level (ug/m^3)	Basis
1,1-DCA	16	7.7	Industrial RSL
1,1-DCE	1000	880	"
1,1,2-TCA	5	0.77	"
1,2-DCA	2	0.47	"
1,2-DCP	4.4	1.2	"
1,2,3-TCP	0.11	1.3	"
1,3-Butadiene	0.26	0.41	"
Bromodichloromethane	1.3	0.33	"
Chloroform	1.4	0.53	"
PCE	100	47	"

Notes:

The list of VOCs of concern includes additional chemicals that have been detected during sampling conducted at the Site after the Soil FS sampling was completed in 2010, in addition to those previously identified as COCs. Due to the uncertainty with the time elapsed since cleanup levels developed in soil vapor risk assessment and the groundwater impact assessment, as a conservative measure, the U.S. EPA industrial RSLs for soil and indoor air were selected as the final cleanup levels for VOCs of concern in soil gas. RSLs are calculated at a 10^{-6} risk.

Acronyms/Abbreviations:

ug/m^3 – microgram per cubic meter
COC – constituent of concern
DCA – dichloroethane
DCE – dichloroethene
DCP – dichloropropane
mg/kg – milligram per kilogram
PCE – tetrachloroethene
RSL – Regional Screening Level
TCA – trichloroethane
TCP – trichloropropane

References:

U.S. EPA, 2016a. Regional Screening Level (RSL) Summary Table (TR=1E-6, HQ=1) May 2016.

9.0 DESCRIPTION OF ALTERNATIVES

Ten remedial alternatives were considered for the LEHR/OCL Site. Alternatives were screened out if they were not protective of human health and the environment or if they did not comply with applicable or relevant and appropriate requirement (ARARs). The alternatives that met these two criteria are described in detail below. A No Further Action alternative (SW-1), which is not protective of human health and does not comply with ARARs, is included as a baseline for comparative analysis.

The ten evaluated alternatives are as follows:

- SW-1 – No Action/No Further Action;
- SW-2 – Institutional Controls and Groundwater Monitoring;

- SW-3 – Soil, Solid Waste, and VOC "Hot Spot" Removal, Three CAMUs with Graded Covers, Institutional Controls, Drainage Controls, Groundwater Monitoring;
- SW-4 – Soil, Solid Waste, and VOC "Hot Spot" Removal, Three CAMUs with Evapotranspiration Covers, Institutional Controls, Drainage Controls, Groundwater Monitoring;
- SW-5 – Soil, Solid Waste, and VOC "Hot Spot" Removal, Three CAMUs with Asphalt Covers, Institutional Controls, Drainage Controls, Groundwater Monitoring;
- SW-6 – VOC "Hot Spot" Removal, Three CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, Groundwater Monitoring;
- SW-7 – Soil, Solid Waste, and VOC "Hot Spot" Removal, Two CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, Groundwater Monitoring;
- SW-8 – Soil, Solid Waste, and VOC "Hot Spot" Removal, One CAMU with Multiple-Layer Cap, Institutional Controls, Drainage Controls, Groundwater Monitoring;
- SW-9 – Excavate and Dispose of Most Soil and Solid Waste Off-Site, One CAMU with Multiple-Layer Cap, Institutional Controls, Drainage Controls, Groundwater Monitoring; and
- SW-10 – Excavate and Dispose Soil and Solid Waste Off-Site, Institutional Controls, Drainage Controls, Groundwater Monitoring.

9.1 COMMON ELEMENTS, SW-2 THROUGH SW-10

All of the alternatives, with the exception of Alternatives SW-1 and SW-10, include the following common elements (Alternative SW-10 includes all the elements discussed below with the exception of leaving waste in place):

Leaving contamination and waste in place: All of the alternatives considered for LEHR/OCL Site are containment remedies, meaning contamination and/or solid waste, to varying degrees, would be left in place. COCs would be left in the subsurface.

Groundwater Monitoring: Long-term groundwater monitoring will be conducted to confirm that the remedy remains protective of migration to groundwater and contamination does not migrate off-site. A remedy for groundwater will be selected in a future groundwater ROD.

Elderberry Shrub Mitigation: Elderberry shrubs, the sole host plant for the VELB, which is listed as threatened under the Endangered Species Act (ESA), grow on the Site. In compliance with the Biological Opinion issued by the USFWS pursuant to the ESA, mitigation is required for the nine shrubs that will be destroyed during the remedial action. Eight shrubs will be moved to a mitigation area.

Stormwater Monitoring: Long-term storm water monitoring will be required.

Institutional Controls: Land use covenants and ICs will prevent future development or activities incompatible with the designated land use. ICs include the following components:

- Codified land use restriction in coordination with the University of California Office of the President (UCOP), Real Estate Services Group, and the UC Davis Office of Administrative and Resource Management;

- Recordation with Solano County of a land use covenant to prohibit residential and other land use by sensitive populations, and to restrict the non-residential use of the approximately 6.4 acres of disposal areas including LFU-1, LFU-2, LFU-3, the Eastern Trenches, the Southern Trenches, WBH, the HFSDA, and any other co-located areas. This includes:
  - Access to designated monitoring wells;
  - Restriction of drilling or other subsurface penetration and access to groundwater;
  - Restriction to surface changes affecting drainage, infiltration, and potential COC mobilization;
- Assessment and mitigation of potential vapor intrusion hazards to buildings during remedial design;
- A soil management plan to manage future excavations, drainage repair and enhancements, and any other future soil work; and
- Signs to notify workers of potential subsurface hazards.

Five-year Reviews: Because the property will not be cleaned up to allow for unrestricted future use, five-year reviews will be required in perpetuity.

<u>Other Common Elements</u>: The following elements are included in most but not all alternatives. None of these elements are included in Alternatives SW-1 and SW-2.

Engineered Cap: Alternatives SW-4 through SW-9 include one or more engineered caps.

Corrective Action Management Units: Alternatives SW-3 through SW-9 include "CAMUs", which are on-site areas for management/containment of wastes generated during environmental cleanup activities.

Removal of Known Soil Contamination and Solid Waste: All Alternatives except SW-2 and SW-6 include excavation of known chemical wastes and solid waste.

Removal of VOC "Hot Spots": Alternatives SW-3 through SW-10 include excavation of VOC "hot spots."

Building Removal: Alternative SW-3 includes the removal of one building [Cobalt-60 Annex (H-290)] to allow for excavation, construction, and proper grading of a CAMU. Alternatives SW-4 through SW-10 include removal of at least nine buildings [Cobalt-60 Annex (H-290), Geriatrics Building No. 1 (H-292), Geriatrics Building No. 2 (H-293), X-1, X-2, X-3, X-4, X5, and W3] to allow for excavation, construction, and proper grading of one or more CAMUs.

Data Gap Investigation: Alternatives SW-3 through SW-6 include further investigation of the Hopland Field Station Disposal Area and Southern Trenches during the remedial design to determine the extent of wastes. If soil does not meet Regional Screening Levels, it will be excavated or capped.

Backfill and Grading: Alternatives SW-3 through SW-10 include backfilling of excavated areas with clean soil followed by grading.

Drainage Enhancement: Alternatives SW-3 through SW-10 include drainage enhancements. Monitoring and maintenance of drainage enhancements are also required.

Monitoring Requirements: Alternatives SW-3 through SW-9 require cover/cap monitoring and maintenance. Long-term maintenance is required to ensure cap integrity.

9.2 DESCRIPTION OF ALTERNATIVES, UNIQUE FEATURES

This section presents each of the cleanup alternatives and describes the features that are unique to each remedial option. For each alternative the key components, O&M activities, monitoring requirements, length of time for implementation, and present value costs are included. A summary of the components of Alternatives SW-2 through SW-10 is provided in Table 5.

Alternative SW-1 – No Action/No Further Action.

U.S. EPA is required to consider a no action alternative. Under this alternative, no more steps would be taken to reduce the risk to human health and the environment and no use restrictions would be placed on the property.

Alternative SW-2 – Institutional Controls and Groundwater Monitoring

- Soil, waste, and soil gas left largely undisturbed
- 332 cubic yards excavated to investigate HFSDA and Southern Trenches
- Groundwater monitoring

This alternative has an estimated time frame of 1 year and a present value cost of approximately $6.4 million.

Alternative SW-3 – Soil, Solid Waste, and VOC "Hot Spot" Removal, Three CAMUs with Graded Covers, Institutional Controls, Drainage Controls, Groundwater Monitoring

- Excavation and off-site disposal of known chemical wastes, solid waste, and two soil gas VOC "hot spot" areas to a depth of 20 ft bgs (approximately 3,360 cubic yards)
- Most soil and waste left on-Site in three CAMUs with graded soil covers (10,895 cubic yards excavated and placed in CAMUs)
- Two storm water retention basins and numerous drainage swales

This alternative has an estimated time frame of 1 year and a present value cost of approximately $13.1 million.

Alternative SW-4 – Soil, Solid Waste, and VOC "Hot Spot" Removal, Three CAMUs with Evapotranspiration Covers, Institutional Controls, Drainage Controls, Groundwater Monitoring

- Excavation and off-site disposal of known chemical wastes, solid waste, and two soil gas VOC "hot spot" areas to a depth of 20 ft bgs (approximately 3,360 cubic yards)
- Most soil and waste left on-Site in three CAMUs with evapotranspiration covers (16,109 cubic yards excavated; the difference from SW-3 is the soil/solid waste that will be excavated from drainage channels adjacent to LFU-1 and from within the boundaries of LFU-3 and placed in CAMUs)
- Two storm water retention basins and numerous drainage swales

This alternative has an estimated time frame of 1 year and a present value cost of approximately $18.2 million.

Alternative SW-5 – Soil, Solid Waste, and VOC "Hot Spot" Removal, Three CAMUs with Asphalt Covers, Institutional Controls, Drainage Controls, Groundwater Monitoring

- Excavation and off-site disposal of known chemical wastes, solid waste, and two soil gas VOC “hot spot” areas to a depth of 20 ft bgs (approximately 3,360 cubic yards)
- Most soil and waste left on-Site in three CAMUs with high density polyethylene-lined asphalt pavement covers (16,109 cubic yards excavated and placed in CAMUs)
- Two storm water retention basins and numerous drainage swales

This alternative has an estimated time frame of 1 year and a present value cost of approximately $20.7 million.

Alternative SW-6 – VOC “Hot Spot” Removal, Three CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, Groundwater Monitoring

- Excavation and off-site disposal of two soil gas VOC “hot spot” areas to a depth of 20 ft bgs (approximately 2,420 cubic yards)
- Excavation of the northern portions of LFU-2 and the Eastern Trenches and consolidation of the excavated materials under a CAMU cover and leave known chemical wastes in place
- Most soil and waste left on-Site in three CAMUs with multiple-layer covers (foundation layer, low-permeability synthetic layer, compacted clay layer, drainage layer, bio-protection layer, and upper soil layer) (21,883 cubic yards excavated, including the northeastern portion of LFU-2 and the Eastern Trenches, and placed in CAMUs)
- Two storm water retention basins and numerous drainage swales

This alternative has an estimated time frame of 1 year and a present value cost of approximately $15.7 million.

Alternative SW-7 – Soil, Solid Waste, and VOC “Hot Spot” Removal, Two CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, Groundwater Monitoring

- Excavation and off-site disposal of known chemical wastes, solid waste, and two soil gas VOC “hot spot” areas to a depth of 20 ft bgs (approximately 3,360 cubic yards)
- Most soil and waste left on-Site in two CAMUs with multiple-layer covers (36,576 cubic yards excavated, including all of LFU-3, and placed in CAMUs)
- One storm water retention basin and fewer drainage swales than SW-5 or SW-6

This alternative has an estimated time frame of 1 year and a present value cost of approximately $20.4 million.

Alternative SW-8 – Soil, Solid Waste, and VOC “Hot Spot” Removal, One CAMU with Multiple-Layer Cap, Institutional Controls, Drainage Controls, Groundwater Monitoring

- Excavation and off-site disposal of known chemical wastes, solid waste, and two soil gas VOC “hot spot” areas to a depth of 20 ft bgs (approximately 3,360 cubic yards)
- Most soil and waste left on-Site in one CAMU with multiple-layer cover, bottom liner, and leachate collection system (270,931 cubic yards and placed in CAMUs)
- Underground culverts, one storm water retention basin and fewer drainage swales than SW-7

This alternative has an estimated time frame of 2 years and a present value cost of approximately $32.7 million.

Alternative SW-9 – Excavate and Dispose of Most Soil and Solid Waste Off-Site, One CAMU with Multiple-Layer Cap, Institutional Controls, Drainage Controls, Groundwater Monitoring

- Excavation and off-site disposal of most waste (approximately 114,326 cubic yards) to a depth of 20 feet, including soil from the VOC "hot spot" areas
- Excavation and consolidation of wastes from the HFSDA and Southern Trenches into the Waste Burial Holes CAMU with a multiple-layer cover (2,832 cubic yards excavated and placed in CAMU)
- Limited drainage enhancements

This alternative has an estimated time frame of 2 years and a present value cost of approximately $101.7 million.

Alternative SW-10 – Excavate and Dispose of Soil and Solid Waste Off-Site, Institutional Controls, Drainage Controls, Groundwater Monitoring;

- Excavation and off-site disposal of all known chemical wastes and solid waste, including soil from the VOC "hot spot" areas (approximately 123,386 cubic yards) to a depth of 20 feet
- Limited drainage enhancements

This alternative has an estimated time frame of 2 years and a present value cost of approximately $108.3 million.

Table 5 Major Components of the Remedial Alternatives for the LEHR/OCL Site

Components Included in the Remedial Alternatives[1]	SW-2	SW-3	SW-4	SW-5	SW-6[2]	SW-7	SW-8	SW-9	SW-10
Elderberry Shrub Cluster Relocation		✓	✓	✓	✓	✓	✓	✓	✓
Data Gap Investigation (HFSDA and Southern Trenches)	✓	✓	✓	✓	✓				
Demolish Cobalt-60 Annex		✓							
Demolish Animal Buildings X-1 through X-5, Geriatrics Building No. 1 (H-292), Geriatrics Building No. 2 (H-293), Storage Building W-3, and the Cobalt-60 Annex			✓	✓	✓	✓	✓	✓	✓
Decommissioning of Groundwater Monitoring Wells			✓	✓	✓	✓	✓	✓	✓
Area Excavation for CAMU Construction		✓	✓	✓	✓	✓	✓	✓	
Known Chemical Waste Excavation		✓	✓	✓		✓	✓	✓	✓
Excavation of VOC "hot spots," Confirmation Sampling, Backfill		✓	✓	✓	✓	✓	✓	✓	✓
Establish Graded Cover		✓							
Consolidate Waste and Evapotranspiration Cover			✓						
Consolidate Waste and Asphalt Cap				✓					
Consolidate Waste and Multiple-Layer Cap					✓	✓	✓	✓	
Levee Easement Setback		✓	✓	✓	✓	✓	✓	✓	
Landfill Liner							✓		
LFU-3 Concrete-Lined Drainage Channel Sealed		✓							
LFU-3 Concrete-Lined Drainage Channel Demolition/Reconstruction - Portion of concrete-lined drainage channel demolished, concrete re-established after excavation			✓	✓	✓				
LFU-3 Concrete-Lined Drainage Channel - Entire concrete-lined drainage channel demolished, replaced with a vegetated drainage channel after excavation. Erosion controls would be installed as appropriate, and may include geotextiles and/or rip-rap						✓	✓	✓	✓
LFU-3 East-West-Trending Drainage Ditch Relocation		✓	✓	✓	✓	✓	✓	✓	✓
LFU-1 Concrete-Lined Drainage Channel		✓							
LFU-1 Drainage/Vegetated Swale			✓	✓	✓	✓	✓	✓	✓
Storm Water Collection and Conveyance System		✓	✓	✓	✓	✓	✓		
Storm Water Lift Station at LFU-2/WBH/Eastern Trenches		✓	✓	✓	✓	✓	✓		
Storm Water Lift Station at LFU-3		✓	✓	✓	✓				
Extended Detention Basin		✓	✓	✓	✓	✓	✓		
Cover/Cap Monitoring and Maintenance		✓	✓	✓	✓	✓	✓	✓	
Drainage Controls Monitoring and Maintenance		✓	✓	✓	✓	✓	✓	✓	✓
Groundwater Monitoring Well Installation	✓	✓	✓	✓	✓	✓	✓	✓	✓
Groundwater and Storm Water Monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓
Land Use/Institutional Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Five-Year Reviews	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:
1 Alternative SW-01 has not been included in the table because there are no remedy components for the No Action/No Further Action alternative.
2 This alternative has been modified since it was originally presented in the Soil FS to align it more closely with the presumptive remedy for landfills.

Acronyms/Abbreviations:
CAMU – corrective action management unit
LFU – landfill unit
O&M – operations and maintenance
VOC – volatile organic compound
WBH – waste burial holes

10.0 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDY ALTERNATIVES

In accordance with 40 C.F.R. § 300.430(e)(9)(iii), U.S. EPA evaluated and compared the remedial alternatives using nine evaluation criteria to determine which alternative to select.

The nine evaluation criteria, described in greater detail below, are:

1. Overall protection of human health and the environment;
2. Compliance with applicable or relevant and appropriate requirements (ARARs);
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume through treatment;
5. Short-term effectiveness;
6. Implementability;
7. Cost;
8. State acceptance; and
9. Community acceptance

The first two criteria, overall protection and compliance with ARARs, are defined under CERCLA as “threshold criteria.” If an alternative does not meet both of these criteria, it is not eligible for selection. Criteria three through seven are defined as “balancing criteria.” These criteria are used to weigh major trade-offs among alternatives. The last two criteria, state and community acceptance, are defined as “modifying criteria.” In the final comparison of alternatives, modifying criteria and balancing criteria are of equal importance. Table 6 ranks the alternatives in terms of in terms of whether they satisfy each threshold and balancing criterion.

Alternatives SW-1 through SW-4 do not meet one or both of the threshold criteria and are not eligible for selection; therefore, Alternatives SW-2 through SW-4 are not included in the evaluation of the balancing and modifying criteria. For purposes of comparison as required by the NCP, Alternative SW-1 is included in the evaluation. Table 7 summarizes the comparative analysis of threshold, balancing, and modifying criteria for Alternatives SW-5 to SW-10. Additional information regarding the comparison of alternatives can be found in the Soil FS (Weiss, 2012a).

Table 6 Ranked Comparative Analysis of Alternatives for the LEHR/OCL Site

Remedial Alternative	Overall Protection of Human Health and Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume via Treatment[1]	Short-term Effectiveness	Implementability	Approximate Present Value Cost ($ Millions)
SW-1: No Action/No Further Action	No	No	⊕	⊕	⊕	●	$0
SW-2: Institutional Controls and Groundwater Monitoring	No	No	—[2]	—[2]	—[2]	—[2]	$6.4
SW-3: Soil, Solid Waste, and VOC "Hot Spot" Removal, Three On-Site CAMUs with Graded Covers, Institutional Controls, Drainage Controls, and Groundwater Monitoring	No	No	—[2]	—[2]	—[2]	—[2]	$13.1
SW-4: Soil, Solid Waste, and VOC "Hot Spot" Removal, Three On-Site CAMUs with Evapotranspiration Covers, Institutional Controls, Drainage Controls, and Groundwater Monitoring	No	No	—[2]	—[2]	—[2]	—[2]	$18.2
SW-5: Soil, Solid Waste, and VOC "Hot Spot" Removal, Three On-Site CAMUs with Asphalt Caps, Institutional Controls, Drainage Controls, and Groundwater Monitoring	Yes	Yes	◑	⊕	●	◕	$20.7
SW-6[3]: VOC "Hot Spot" Removal, Three On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, and Groundwater Monitoring	Yes	Yes	◑	⊕	●	◕	$15.7
SW-7: Soil, Solid Waste, and VOC "Hot Spot" Removal, Two On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, and Groundwater Monitoring	Yes	Yes	◑	⊕	◕	◑	$20.4
SW-8: Soil, Solid Waste, and VOC "Hot Spot" Removal, One On-Site Lined CAMU with Multiple-Layer Cap, Institutional Controls, Drainage Controls, and Groundwater Monitoring	Yes	Yes	◕	⊕	◕	◑	$32.7
SW-9: Excavate and Dispose Most Soil and Solid Waste Off-Site, One On-Site CAMU with Multiple-Layer Cap, Institutional Controls, Drainage Controls, and Groundwater Monitoring	Yes	Yes	●	⊕	◑	◑	$101.7
SW-10: Excavate and Dispose of Soil and Solid Waste Off-Site, Institutional Controls, Drainage Controls, and Groundwater Monitoring	Yes	Yes	●	⊕	◑	◑	$108.3

Notes:

⊕ ◔ ◑ ◕ ● →

Not acceptable → More acceptable

1 Alternatives SW-1 and SW-2 do not include the use of treatment technologies. Alternatives SW-3 through SW-10 may include ex situ treatment (e.g., soil solidification/stabilization) of a fraction of the hazardous and mixed waste to render it non-hazardous prior to off-site disposal.

2 Alternatives SW-2 through SW-4 failed to meet the threshold criteria, so the remaining criteria are not evaluated here. Alternative SW-1 also failed to meet the threshold criteria, but is evaluated as a baseline for comparative analysis purposes.

3 This alternative has been modified since it was originally presented in the Soil FS to align it more closely with the presumptive remedy for landfills. Excavation of known chemical wastes was eliminated.

Table 7 Comparative Analysis of Alternatives

Remedial Alternative[1]	SW-5	SW-6[3]	SW-7	SW-8	SW-9	SW-10
Overall Protection of Human Health and Environment	ICs would prohibit residential development and restrict non-residential development. Monitoring would confirm long-term protection of human health and the environment. Additional protectiveness would be achieved through removal of 150 LCY of known chemical wastes, removal of 2,516 LCY of hazardous material (including the two VOC "hot spot" areas), and minimizing infiltration via asphalt caps and storm water drainage enhancements. This alternative meets each RAO.	ICs would prohibit residential development and restrict non-residential development. Monitoring would confirm long-term protection of human health and the environment. Additional protectiveness would be achieved through removal of 15 LCY of known chemical wastes, removal of 3,380 LCY of hazardous and non-hazardous material (including the two VOC "hot spot" areas), and minimizing infiltration via multiple-layer caps and storm water drainage enhancements. This alternative meets each RAO.	ICs would prohibit residential development and restrict non-residential development. Monitoring would confirm long-term protection of human health and the environment. Additional protectiveness would be achieved through removal of 387 LCY of known chemical wastes, removal of 4,550 LCY of hazardous and non-hazardous material (including the two VOC "hot spot" areas), and minimizing infiltration via multiple-layer caps and storm water drainage enhancements. This alternative meets each RAO.	ICs would prohibit residential development and restrict non-residential development. Monitoring would confirm long-term protection of human health and the environment. Additional protectiveness would be achieved through removal of 1,116 LCY of known chemical wastes, removal of 21,471 LCY of hazardous and non-hazardous material (including the two VOC "hot spot" areas), and minimizing infiltration via multiple-layer caps and storm water drainage enhancements. This alternative meets each RAO.	ICs would prohibit residential development and restrict non-residential development. Monitoring would confirm long-term protection of human health and the environment. Additional protectiveness would be achieved through removal of 1,116 LCY of known chemical wastes, removal of 115,231 LCY of hazardous and non-hazardous material (including the two VOC "hot spot" areas), and minimizing infiltration via multiple-layer cap over the WBH. This alternative meets each RAO.	ICs would prohibit residential development and restrict non-residential development. Monitoring would confirm long-term protection of human health and the environment. Additional protectiveness would be achieved through removal of 1,116 LCY of known chemical wastes, removal of 124,269 LCY of hazardous and non-hazardous material (including the two VOC "hot spot" areas) and minimizing infiltration via storm water drainage enhancements. This alternative meets each RAO.
Compliance with ARARs	Compliant with all ARARs. Wastes and/or contaminated soil would remain in place. Potential vertical migration of COCs would be curtailed by limiting infiltration, isolating waste, and removing VOC source material. ARARs for designating and constructing CAMUs at the Site would be met. Action- and chemical-specific ARARs for air emissions would be met by developing and implementing appropriate engineering and administrative controls during demolition, excavation, grading, construction, covering/capping, and maintenance activities, including compliance with levee access requirements.	Compliant with all ARARs. Wastes and/or contaminated soil would remain in place. Potential vertical migration of COCs would be curtailed by limiting infiltration, isolating waste, and removing VOC source material. ARARs for designating and constructing CAMUs at the Site would be met. Action- and chemical-specific ARARs for air emissions would be met by developing and implementing appropriate engineering and administrative controls during demolition, excavation, grading, construction, covering/capping, and maintenance activities, including compliance with levee access requirements.	Compliant with all ARARs. Wastes and/or contaminated soil would remain in place. Potential vertical migration of COCs would be curtailed by limiting infiltration, isolating waste, and removing VOC source material. ARARs for designating and constructing CAMUs at the Site would be met. Action- and chemical-specific ARARs for air emissions would be met by developing and implementing appropriate engineering and administrative controls during demolition, excavation, grading, construction, covering/capping, and maintenance activities, including compliance with levee access requirements.	Compliant with all ARARs. Wastes and/or contaminated soil would remain in place. Potential vertical migration of COCs would be curtailed by limiting infiltration, isolating waste, and removing VOC source material. ARARs for designating and constructing CAMUs at the Site would be met. Action- and chemical-specific ARARs for air emissions would be met by developing and implementing appropriate engineering and administrative controls during demolition, excavation, grading, construction, covering/capping, and maintenance activities, including compliance with levee access requirements.	Compliant with all ARARs. Wastes and/or contaminated soil would remain in place. Potential vertical migration of COCs would be curtailed by limiting infiltration, isolating waste, and removing VOC source material. ARARs for designating and constructing CAMUs at the Site would be met. Action- and chemical-specific ARARs for air emissions would be met by developing and implementing appropriate engineering and administrative controls during demolition, excavation, grading, construction, covering/capping, and maintenance activities, including compliance with levee access requirements.	Compliant with all ARARs. Action- and chemical-specific ARARs for air emissions would be met by developing and implementing appropriate engineering and administrative controls during demolition, excavation, backfilling, and grading, including compliance with levee access requirements.
Long-Term Effectiveness and Permanence	Soil/solid waste would be consolidated within three CAMUs. Sampling in the Southern Trenches and HFSDA would better characterize risk in these disposal areas. The VOC "hot spot" areas would be excavated and hazardous material taken off-site for disposal. Known chemical wastes from historical and proposed trenches would be removed. Asphalt caps and storm water drainage enhancements would be installed to reduce infiltration. Periodic asphalt cap maintenance would be required. Enforcement of ICs and	Soil and waste would be largely undisturbed except where necessary to consolidate solid wastes to facilitate capping. The VOC "hot spot" areas would be excavated and hazardous material taken off-site for disposal. Excavations would be backfilled with clean soil and the CAMUs would be covered with multiple-layer caps and the existing storm water drainage system would be expanded. Multiple-layer cap maintenance would be required to limit infiltration. Development and enforcement of ICs and groundwater monitoring would be conducted to confirm long-term	Soil/solid waste would be consolidated within two CAMUs. The VOC "hot spot" areas would be excavated and hazardous material taken off-site for disposal. Known chemical wastes from historical and proposed trenches would be removed. The Eastern Trenches, Southern Trenches, HFSDA, and LFU-3 waste cells would be excavated and known chemical wastes sent off-site for disposal. Other soil/solid waste from the Eastern Trenches North, LFU-3 waste cells, the Southern Trenches, and HFSDA would be consolidated within the CAMUS, thereby	Soil/solid waste would be consolidated within one lined and capped CAMU. The VOC "hot spot" areas would be excavated and hazardous material taken off-site for disposal. The Eastern Trenches, Southern Trenches, HFSDA, LFU-1, LFU-2, and the LFU-3 waste cells would be excavated and segregated, and known chemical wastes would be sent off-site for disposal. Other soil/solid waste from the Eastern Trenches North, Southern Trenches, HFSDA, and LFU-3 waste cells would be consolidated within the CAMU, thereby permanently removing soil/solid waste from the excavated	The VOC "hot spot areas, Eastern Trenches, LFU-1, LFU-2 waste cells, and LFU-3 waste cells would be excavated and material would be sent off-Site for disposal, thereby permanently removing soil/solid waste from these areas. Known chemical wastes from the Southern Trenches and HFSDA would be sent off-site for disposal, and other soil/solid wastes would be consolidated within the WBH CAMU. A multiple-layer cap over the WBH and storm water drainage enhancements would be installed to reduce infiltration. Multiple-layer cap maintenance would be required to limit infiltration. Enforcement of ICs and	The VOC "hot spot" areas, Eastern Trenches, Southern Trenches, HFSDA, WBH, LFU-1, LFU-2 waste cells, and LFU-3 waste cells would be excavated and material sent off-Site for disposal, thereby permanently removing soil/solid waste from these areas. Some leachate-contaminated soil may remain in place. Storm water drainage enhancements would be installed to reduce infiltration. Enforcement of ICs and groundwater monitoring would be conducted to confirm long-term protection of human health and the environment. This alternative is considered effective in the long-term.

Remedial Alternative[1]	SW-5	SW-6[3]	SW-7	SW-8	SW-9	SW-10
	groundwater monitoring would be conducted to confirm long-term protection of human health and the environmental. This alternative is considered effective in the long-term. The potential for CAMU cap failure, resulting in exposure of the public or ecological receptors to COCs, is considered unlikely. The adequacy and reliability of controls would be approximately the same as long as the integrity of the landfill covers/caps is maintained and ICs enforced. This alternative requires periodic O&M for the storm water drainage enhancements asphalt caps and would result in the greatest long-term O&M and periodic requirements due to maintenance of the asphalt caps. Provides moderate future land use options due to the requirement to maintain the capped areas.	protection of human health and the environment. The potential for landfill cap failure, resulting in exposure of the public or ecological receptors to COCs, is considered unlikely. The adequacy and reliability of controls would be approximately the same as long as the integrity of the landfill caps is maintained and ICs enforced. This alternative requires periodic O&M for the storm water drainage enhancements CAMU caps. Provides moderate future land use options due to the requirement to maintain the capped areas.	permanently removing soil/solid waste from these areas. Multiple-layer caps and storm water drainage enhancements would be installed to reduce infiltration. Multiple-layer cap maintenance would be required to limit infiltration. Enforcement of ICs and groundwater monitoring would be conducted to confirm long-term protection of human health and the environment. This alternative is considered effective in the long-term. The potential for landfill cap failure, resulting in exposure of the public or ecological receptors to COCs, is considered unlikely. The adequacy and reliability of controls would be approximately the same as long as the integrity of the landfill caps is maintained and ICs enforced. This alternative requires periodic O&M for the storm water drainage enhancements and CAMU caps. Provides moderate future land use options due to the requirement to maintain the capped areas.	areas. A multiple-layer cap and storm water drainage enhancements would be installed to reduce infiltrations. Multiple-layer cap maintenance would be required to limit infiltration. Additional protection of groundwater would be achieved via the installation of a bottom liner and leachate collection and recovery system (LCRS). Enforcement of ICs and groundwater monitoring would be conducted to confirm long-term protection of human health and the environment. This alternative is considered effective in the long-term. The potential for landfill cap failure, resulting in exposure of the public or ecological receptors to COCs, is considered unlikely. The adequacy and reliability of controls would be approximately the same as long as the integrity of the landfill cap is maintained and ICs enforced. This alternative requires periodic O&M for the storm water drainage enhancements and surface cap and would provide additional protection to groundwater if the integrity of the bottom liner and leachate collection system is compromised. Provides moderate future land use options due to the requirement to maintain the capped areas.	groundwater monitoring would be conducted to confirm long-term protection of human health and the environment. This alternative is considered effective in the long-term. The potential for landfill cap failure, resulting in exposure of the public or ecological receptors to COCs, is considered unlikely. The adequacy and reliability of controls would be approximately the same as long as the integrity of the CAMU cap is maintained and ICs enforced. This alternative requires periodic O&M for the storm water drainage enhancements and CAMU cap. Provides moderate future land use options due to the requirement to maintain the capped area. The second greatest volume of soil/solid waste would be removed, thus providing for additional land use options because there would be fewer land use restrictions, and potential human exposure to residual contamination would be lower than other alternatives.	This alternative includes O&M for the storm water drainage enhancements and would be the least reliant on controls, since all solid waste and most contaminated soil would be removed from the Site. The greatest volume of soil/solid waste would be removed, thus providing for additional land use options because there would be fewer land use restrictions, and potential human exposure to residual contamination would be lower than other alternatives.
Reduction of Toxicity, Mobility, or Volume via Treatment[2]	A fraction of hazardous waste from the VOC “hot spot” excavations only may be treated via ex situ solidification/stabilization prior to off-Site disposal; the actual amount would depend on the hazardous characteristics of the wastes. 86 LCY of material are assumed to be treated.	A fraction of hazardous waste from the VOC “hot spot” excavations only may be treated via ex situ solidification/stabilization prior to off-Site disposal; the actual amounts would depend on the hazardous characteristics of the waste. 95 LCY of material are assumed to be treated.	A fraction of hazardous waste from the VOC “hot spot” excavations only may be treated via ex situ solidification/stabilization prior to off-site disposal; the actual amount would depend on the hazardous characteristics of the wastes. 106 LCY of material are assumed to be treated.	A fraction of hazardous waste from the VOC “hot spot” excavations only may be treated via ex situ solidification/stabilization prior to off-site disposal; the actual amount would depend on the hazardous characteristics of the wastes. 168 LCY of material are assumed to be treated.	A fraction of hazardous waste from the VOC “hot spot” excavations only may be treated via ex situ solidification/stabilization prior to off-site disposal; the actual amount would depend on the hazardous characteristics of the wastes. 5,127 LCY of material are assumed to be treated.	A fraction of hazardous waste from the VOC “hot spot” excavations only may be treated via ex situ solidification/stabilization prior to off-site disposal; the actual amount would depend on the hazardous characteristics of the wastes. 5,129 LCY of material area assumed to be treated.
Short-term Effectiveness	Short-term impacts include fugitive dust generation, air emissions, vehicular traffic, and construction site hazards. Site construction impacts, including localized noise and ground vibrations, would persist for several months during the excavation of known chemical wastes, the VOC “hot spot” areas, and contaminated soil/solid waste.	Short-term impacts include fugitive dust generation, air emissions, vehicular traffic, and construction site hazards. Site construction impacts, including localized noise and ground vibrations, would persist for several months during the excavation of the VOC “hot spot” areas and contaminated soil/solid waste. Air monitoring, dust control, and personal	Short-term impacts include fugitive dust generation, air emissions, vehicular traffic, and construction site hazards. Site construction impacts, including localized noise and ground vibrations, would persist for several months during the excavation of the known chemical wastes, the VOC “hot spot” areas, and contaminated soil/solid waste. Air monitoring, dust	Short-term impacts include fugitive dust generation, air emissions, vehicular traffic, and construction site hazards. Site construction impacts, including localized noise and ground vibrations, would persist for several months during the excavation of known chemical wastes, the VOC “hot spot” areas, and contaminated soil/solid waste for potentially up to two	Short-term impacts include fugitive dust generation, air emissions, vehicular traffic, and construction site hazards. Site construction impacts, including localized noise and ground vibrations, would persist for several months during the excavation of known chemical wastes, the VOC “hot spot” areas, and contaminated soil/solid waste for potentially up to two construction seasons. Air monitoring, dust	Short-term impacts include fugitive dust generation, air emissions, vehicular traffic, and construction site hazards. Site construction impacts, including localized noise and ground vibrations, would persist for several months during the excavation of known chemical wastes, the VOC “hot spot” areas, and contaminated soil/solid waste for potentially up to two construction

Remedial Alternative[1]	SW-5	SW-6[3]	SW-7	SW-8	SW-9	SW-10
	Air monitoring, dust control, and personal protective equipment would be required to identify and mitigate these effects. This alternative would take one year to implement and poses more risk to workers and the community than Alternative SW-6.	protective equipment would be required to identify and mitigate these effects. This alternative would take one year to implement and represents the least risk to site workers and the community because known contamination would not be excavated and less excavated material (i.e., only the VOC "hot spot" areas) would be handled and transported off-site for disposal.	control, and personal protective equipment would be required to identify and mitigate these effects. This alternative would take two years to implement and poses more risk to workers and community than Alternative SW-6.	construction seasons. Air monitoring, dust control, and personal protective equipment would be required to identify and mitigate these effects. This alternative would take two years to implement and represents the third highest risk to workers and the community.	control, and personal protective equipment would be required to identify and mitigate these effects. This alternative would take two years to implement and represents the second highest risk to workers and the community.	seasons. Air monitoring, dust control, and personal protective equipment would be required to identify and mitigate these effects. This alternative would take two years to implement and represents the highest risk to workers and the community.
Implementability	Technically and administratively feasible to implement in one year. The excavation, segregation, and disposal of soil/solid waste would be moderately complex to coordinate and implement. The installation of asphalt caps would only be slightly more complex than the graded covers as the asphalt would be placed on top of a graded cover. Required equipment and contractors are available. Additional land for storm water drainage enhancements is readily available and would not pose a burden to the University's mission.	Technically and administratively feasible to implement in one year. The excavation, segregation, and disposal of soil/solid waste from the VOC "hot spot" and consolidation areas would be moderately complex to coordinate and implement. The consolidation of soil/solid waste and installation of multiple-layer caps would be more complex than some other cover/cap options (e.g., asphalt caps (SW-5)]. Required equipment and contractors are available. Additional land for storm water drainage enhancements is readily available and would not pose a burden to the University's mission.	Technically and administratively feasible to implement in one year. The excavation, segregation, and disposal of soil/solid waste would be moderately complex to coordinate and implement. The excavation and consolidation of soil/solid waste into two CAMUs and installation of two multiple-layer caps would be more complex than other cover/cap options [e.g., asphalt cap (SW-5), one multiple-layer cap (SW-6, SW-8, SW-9)]. Required equipment and contractors are available. Additional land for storm water drainage enhancements is readily available and would not pose a burden to the University's mission.	Technically and administratively feasible to implement in two years. The excavation, segregation, and disposal of soil/solid waste would be moderately complex to coordinate and implement. The excavation and consolidation of all soil/solid wastes into a single CAMU with installation of a bottom liner, LCRS, and multiple-layer cap would be substantially more complex than the other alternatives. Required equipment and contractors are available. Additional land for storm water drainage enhancements and for the installation of the bottom liner and LCRS between LFU-1 and LFU-2/Eastern Trenches/WBH is readily available and would not pose a burden to the University's mission.	Technically and administratively feasible to implement in two years. The excavation, segregation, and disposal of soil/solid waste would be moderately complex to coordinate and implement. Required equipment and contractors are available. Additional land for storm water drainage enhancements and for the installation of the bottom liner and LCRS between LFU-1 and LFU-2/Eastern Trenches/WBH is readily available and would not pose a burden to the University's mission.	Technically and administratively feasible to implement in two years. The excavation, segregation, and disposal of hazardous material would be moderately easy to coordinate and implement. Required equipment and contractors are available. Additional land for storm water drainage enhancements is readily available and would not pose a burden to the University's mission.
Approximate Present Value Cost ($ Millions)	$20.7	$15.7	$20.4	$32.7	$101.7	$108.3
State Acceptance		DTSC supports EPA's selection of Alternative SW-6 for the LEHR/OCL Site.				
Community Acceptance	During the public comment period, the community expressed its support for the Site cleanup.					

Notes:

1 Alternatives SW-1 through SW-4 failed to meet the threshold criteria, so the alternatives are not evaluated here.
2 Alternatives SW-5 through SW-10 may include ex situ treatment (e.g., soil solidification/stabilization) of a fraction of the hazardous and mixed waste to render it non-hazardous prior to off-site disposal.
3 This alternative has been modified since it was originally presented in the Soil FS to align it more closely with the presumptive remedy for landfills.

Acronyms:

ARAR – applicable or relevant and appropriate requirements
CAMU – corrective action management unit
FS – feasibility study
HFSDA – Hopland Field Station Disposal Area
IC – institutional control
LCRS – leachate collection and recovery system

10.3.3 Summary of Comparative Analysis of Alternatives

Based on the comparative analyses, Alternative SW-6, which includes VOC "Hot Spot" Removal, On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, and Groundwater Monitoring, satisfies the threshold criteria, is effective in the both the short-term and long-term, is the most implementable, and is the most cost effective remedy for addressing the risks from contaminated soil and solid waste at the LEHR/OCL Site. None of the alternatives reduces toxicity, mobility or volume of waste through treatment. Although Alternatives SW-9 and SW-10 reduce toxicity, mobility and the volume of contaminated media on-site, they do so through excavation and off-site disposal at a cost which is almost three to six times greater than the costs of Alternatives SW-5 through SW-8.

11.0 PRINCIPAL THREAT WASTES

Principal threat wastes are those hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination and are considered to be highly toxic or highly mobile, which generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. The NCP establishes an expectation that U.S. EPA will use treatment to address the principal threats posed by a site wherever practicable.

U.S. EPA is not making a determination as to whether the source materials in the LEHR/OCL landfills and disposal areas are principal threat wastes or low level threat wastes, because these potential wastes were not characterized when they were found during trenching. Because U.S. EPA followed its presumptive remedy policy for landfills, thorough characterization of the landfill's contents was not necessary and the toxicity and mobility of contaminants was not assessed. The cap of the selected remedy will reduce mobility of contaminants and contaminant migration to groundwater will be monitored. Groundwater contamination will be addressed in the future Groundwater ROD.

12.0 SELECTED REMEDY

U.S. EPA, in consultation with DTSC and the RWQCB, is selecting the remedial alternative SW-6 as described below for the LEHR/OCL Site. Remedial alternative SW-6 was presented as U.S. EPA's preferred alternative in the Proposed Plan, and no information has come to U.S. EPA's attention which calls into questions its preferred status. U.S. EPA has determined that the selected remedy is protective of human health and the environment, for the current and reasonably anticipated future land use of the LEHR/OCL Site.

identified by a state in a timely manner and are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site.

This criterion addresses whether a remedial alternative will meet all of the applicable or relevant and appropriate federal and state environmental requirements or provides a basis for invoking a waiver. See Attachment B for a complete list of all ARARs.

Under Alternative SW-1, no remedial action would be taken, and therefore, compliance with ARARs is not relevant. Alternatives SW-2, SW-3 and SW-4 are not compliant with RWQCB ARAR Title 27 because they do not include a Resource Conservation and Recovery Act (RCRA)-compliant cover with a biotic barrier. Alternatives SW-3 and SW-4 include waste excavation and placement in a CAMU, but do not include a RCRA-compliant CAMU cover. Because Alternatives SW-2, SW-3 and SW-4 do not comply with ARARS, they are not eligible for selection and are not discussed further in the comparative analysis.

Alternatives SW-5 through SW-10 are compliant with all ARARs. Under each alternative, wastes and/or contaminated soil would remain in place. Potential vertical migration of COCs would be curtailed by limiting infiltration, isolating waste, and removing COC source material. ARARs for designating and constructing CAMUs at the Site would be met for Alternatives SW-5 through SW-9. Although it is expected that net storm water runoff would increase under Alternatives SW-5 through SW-8, each alternative would involve several storm water drainage enhancements designed to address these increases and meet the post-construction requirements of the Draft 2011 Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (MS4) permit (State Water Resources Control Board [SWRCB], 2011). Action- and chemical-specific ARARs for air emissions would be met by developing and implementing appropriate engineering and administrative controls during demolition, excavation, grading, construction, covering/capping, and maintenance activities, including compliance with levee access requirements.

10.2 BALANCING CRITERIA

Only Alternatives SW-5 through SW-10 meet the threshold criteria and are included in the comparative analysis of balancing criteria. Alternative SW-1 is included as a baseline for comparison. Alternatives SW-2 through SW-4 do not meet the threshold criteria and are not evaluated further.

10.2.1 Long-Term Effectiveness and Permanence

This criterion considers residual risk and the ability of an alternative to maintain reliable protection of human health and the environment over time, once remedial action objectives have been met. This criterion includes the consideration of residual risk that will remain on site following remediation and the adequacy and reliability of controls.

Alternative SW-1 includes no remedial actions so this alternative would not provide protection of human health and the environment. Increasing volumes of soil and solid waste removal, including VOC "hot spot" areas and for Alternatives SW-5 and SW-7 through SW-10, areas with known chemical waste; and installation of surface covers/caps under Alternatives SW-5 through SW-10 would lessen the reliance on ICs and reduce potential exposure to hazardous material, thus reducing the potential for residual risk. In the event of IC failure, these additional remedial actions would lessen the potential for future exposure to hazardous material and the potential for leaching to groundwater. The bottom liner and leachate collection system constructed as part of Alternative SW-8 would further minimize the potential for contaminants to migrate to groundwater, although it could not be replaced if it fails. Uncertainty with respect to unknown hazardous materials within the disposal units also would decrease as more waste is removed and sent off-site for disposal; Alternative SW-10 is the most effective due to the complete removal of soil and solid waste and disposal off-site.

Excavation and off-site disposal of soil/solid waste and the VOC “hot spot” areas in Alternatives SW-5, SW-7, and SW-8, excavation and off-site disposal of the VOC “hot spot” areas under SW-6, and excavation of most soil/solid waste under Alternative SW-9 (except for the WBH, Southern Trenches, and HFSDA) and all solid waste and most contaminated soil under Alternative SW-10 would be effective in reducing risk. Alternative SW-10 permanently removes most contaminated soil and all solid waste from the Site. Alternatives SW-5 and SW-7 through SW-10 would increasingly lower the amount of soil/solid waste with COC concentrations exceeding cleanup levels, while Alternative SW-6 would reduce VOC sources via excavation and off-site disposal of the VOC “hot spot” areas. Alternative SW-10 would provide the greatest long-term effectiveness and permanence because all of the solid waste and the majority of contaminated soil would be removed and sent off-site for disposal.

In addition to the off-site disposal of waste, Alternatives SW-5 through SW-9 would include on-site consolidation of waste in CAMUs. Under Alternatives SW-7, SW-8, and SW-9, the Southern Trenches and HFSDA would be excavated, and soil/solid waste would be consolidated within a capped CAMU after off-site disposal of known chemical wastes. Under Alternatives SW-7 and SW-8, soil/solid waste within the LFU-3 waste cells would be excavated and consolidated within the capped CAMUs that would be constructed over LFU-1 and LFU-2/Eastern Trenches/WBH after segregation of known chemical wastes. Consolidation under these alternatives would lead to greater long-term effectiveness and permanence at the Southern Trenches, HFSDA, and LFU-3 by eliminating future exposure, potential risk, and COC migration in these areas. Under SW-8 the underlying liner and leachate collection system result in increased long-term effectiveness and permanence. Under Alternatives SW-5 through SW-9, LLRW and hazardous waste would likely remain on-site but within the designated CAMUs. These areas would be isolated from human and ecological exposure via engineered surface covers/caps.

The potential for landfill cap failure, resulting in exposure of the public or ecological receptors to COCs, is considered unlikely. The adequacy and reliability of controls for Alternatives SW-5 through SW-10 would be approximately the same as long as the integrity of the landfill covers/caps is maintained and ICs enforced. Alternatives SW-5 through SW-9 would require periodic O&M for the storm water drainage enhancements and surface covers or caps; Alternative SW-10 would include O&M for the storm water drainage enhancements. Alternative SW-5 would result in the greatest long-term O&M and periodic requirements due to maintenance of the asphalt caps. Alternative SW-8 would provide additional protection to groundwater if cap failure occurs due to the bottom liner and leachate collection system. Alternative SW-10 would be the least reliant on controls, since all solid waste and most contaminated soil would be removed from the Site.

10.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion evaluates an alternative's use of treatment to 1) reduce the harmful effects of contaminants; 2) reduce the ability of contaminants to move in the environment; or 3) reduce the amount of contamination present.

None of the alternatives include in-situ treatment as part of the remedy. The actual amount of treated waste would depend on specific volumes of waste generated and the requirements for treatment based on hazardous characteristics of the excavated materials. Assuming that the total volume of ex-situ treatment is proportional to the waste volume sent off-site for disposal, Alternative SW-10 would involve the greatest potential reduction of toxicity, mobility, or volume of hazardous material. The volume of waste undergoing ex-situ treatment is expected to be a low percentage of the total waste volume for each of the alternatives.

10.2.3 Short-Term Effectiveness

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

Alternative SW-1 includes no remedial actions so this alternative would not provide protection of human health and the environment. Short-term impacts from Alternatives SW-5 through SW-10 include fugitive dust generation, air emissions, vehicular traffic, and construction site hazards. Site construction impacts, including localized noise and ground vibrations, would persist for several months during the excavation of known chemical wastes, the VOC “hot spot” areas, and contaminated soil/solid waste in Alternatives SW-5, SW-6, and SW-7, and, potentially, for up to two construction seasons for Alternatives SW-8, SW-9, and SW-10. Air monitoring, dust control, and personal protective equipment would be required to identify and mitigate these effects. Alternative SW-6 would represent the least risk to site workers and the community because known chemical wastes would not be excavated and less excavated material (i.e., only the VOC “hot spot” areas) would be handled and transported off-site for disposal.

Alternatives SW-5, SW-6, and SW-7 would achieve protection in one construction season, and Alternatives SW-8, SW-9 and SW-10 would achieve protection in two construction seasons.

10.2.4 Implementability

Implementability considers 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.

Alternative SW-1 is simple to implement because it includes no remedial actions, but this alternative would not provide protection of human health and the environment. Alternatives SW-5 through SW-8 are readily implementable as the technology is available to excavate, segregate, and dispose soil/solid waste off-site capping or covering the remaining waste under three asphalt caps (Alternative SW-5); three multiple-layer caps (Alternative SW-6); two multiple-layer caps (Alternative SW-7); or one multiple-layer cap with a liner and leachate collection system (Alternative SW-8). However, implementation of Alternative SW-6 is less complex because no known chemical wastes would be excavated. The design of the asphalt covers associated with Alternative SW-5 is less complex than the multiple-layer caps associated with Alternatives SW-5 through SW-9. The large-scale removals proposed in Alternatives SW-9 and SW-10 would be relatively straightforward to implement because they include the fewest design requirements. Because Alternative SW-9 includes a multiple-layer cap over the WBH CAMU, where excavated materials from the Southern Trenches and HFSDA would be consolidated, this alternative is more complex than Alternative SW-10, which involves the excavation and off-site disposal of each disposal unit.

Alternative SW-8 is the most complex of the alternatives, as it would require installation of a bottom liner and leachate collection system. In addition, should monitoring indicate that further remedial action is necessary, implementation of changes under this alternative would be difficult, because the constructed liner, leachate collection system, and CAMU cap could be compromised, but could not be repaired or replaced.

The administrative feasibility of each alternative is not a barrier to implementability. Each alternative (SW-5 through SW-10) would require coordinating with the UCOP Real Estate Services Group and UC Davis Office of Administrative and Resource Management to gain approval for recording the required land use control (LUC). Since the Site is located at the southern end of the property, at about two miles from the Main Campus, the implementation of the proposed ICs is not identified as a burden to the University's mission. Additionally, activities conducted in the nine structures that are proposed for removal under Alternatives SW-5 through SW-10 could be relocated in existing structures or are not mission-critical, and as such the structures could be demolished. Some additional land at the Site would be required to implement the storm water drainage enhancements for Alternatives SW-5 through SW-10. Alternative SW-8 would require the use of additional land between the Eastern Trenches and LFU-1 that has no history of waste disposal. This additional land is readily available. However, the off-site disposal proposed in Alternatives SW-5 through SW-10 may expose the University to future CERCLA liability at the off-site disposal facilities.

10.2.5 Cost

A cost summary for all six alternatives is presented in Table 8. It includes the capital cost, O&M costs, and total present value costs, and the number of years over which the remedy cost estimate is projected. The present value costs are calculated using a 2.7% discount rate.

Alternative SW-1 is cost effective because it includes no remedial actions and no cost, but this alternative would not provide protection of human health and the environment. Alternative SW-6 has the lowest overall cost to complete, approximately $15.7 million. Alternative SW-10 has the highest cost to complete, approximately $108.3 million. The primary driver of total cost is related to the total volume of excavated material sent off-site for disposal. Because two of the unlined capping alternatives, Alternatives SW-5 and SW-7, would include the off-site disposal of similar volumes of soil/solid waste and SW-6 would only require disposal of the material excavated from the VOC "hot spot" areas, overall estimated costs are in a narrow range of $15.7 million to $20.7 million. Alternative SW-8 has a higher estimated cost of approximately $32.7 million, reflecting capital costs associated with the much greater excavation volume as well as the installation of a bottom liner and leachate collection system. Alternatives SW-9 and SW-10, with overall costs of approximately $101.7 and $108.3 million, respectively, are about 3 to 17 times more costly than the other alternatives, reflecting the high cost of excavation, import of clean backfill, and off-site disposal of most or all waste.

Long-term O&M and periodic costs play a secondary role in the difference in total cost between each alternative. Comparison of O&M costs shows that there is an approximate 1.4 times difference in these costs: minimum estimated O&M cost of $5.6 million for Alternative SW-10 and maximum estimated O&M cost of $7.8 million for Alternative SW-5. Alternative SW-5 has the highest O&M cost because of the recurring maintenance required for the asphalt cap and the need to periodically resurface or repave the asphalt.

10.3 MODIFYING CRITERIA

10.3.1 State Acceptance

DTSC supports EPA's selection of Alternative SW-6 for the LEHR/OCL Site. DTSC and the RWQCB did not express opinions regarding the other alternatives.

10.3.2 Community Acceptance

U.S. EPA received written comments from three parties during the 30-day comment period and received an oral comment from one party at the Proposed Plan public meeting. However, the oral comment consisted of reading a written letter that was later provided to U.S. EPA.

U.S. EPA has addressed the comments in the Responsiveness Summary section of this ROD Amendment. U.S. EPA does not believe that any of the issues raised in the comments warrant selection of a different remedy to address the contamination at the LEHR/OCL Site.

Table 8 Remedial Alternatives Cost Summary

Remedial Alternative	Description	Period (Years)	Capital Cost ($)	O&M Cost ($)	Periodic Cost ($)	Total Cost ($)	Present Value[1]
SW-1	No Action/No Further Action	No costs are associated with the No Action/No Further Action alternative.					
SW-2	Institutional Controls and Groundwater Monitoring	100	$318,780	$6,018,220	$173,297	$6,510,297	$6,365,443
SW-3	Soil, Solid Waste, and VOC “Hot Spot” Removal, Three On-Site CAMUs with Graded Covers, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring	100	$6,507,885	$6,921,681	$185,523	$13,615,089	$13,117,896
SW-4	Soil, Solid Waste, and VOC “Hot Spot” Removal, Three On-Site CAMUs with Evapotranspiration Caps, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring	100	$11,571,188	$6,893,510	$185,523	$18,680,222	$18,233,303
SW-5	Soil, Solid Waste, and VOC “Hot Spot” Removal, Three On-Site CAMUs with Asphalt Caps, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring	100	$13,176,476	$7,764,868	$185,523	$21,126,868	$20,709,962
Alternate SW-6[2]	VOC “Hot Spot” Removal, Three On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring	100	$9,691,992	$7,029,624	$185,523	$16,907,140	$15,740,690
SW-7	Soil, Solid Waste, and VOC “Hot Spot” Removal, Two On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring	100	$13,836,609	$6,842,252	$181,448	$20,860,309	$20,443,387
SW-8	Soil, Solid Waste, and VOC “Hot Spot” Removal, One On-Site Lined CAMU with Multiple-Layer Cap, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring	100	$26,239,041	$6,948,273	$181,448	$33,368,762	$32,738,977
SW-9	Excavate and Dispose of Most Soil and Solid Waste Off-Site, One On-Site CAMU with	100	$95,979,224	$5,990,304	$173,297	$102,142,825	$101,725,897

	Multiple-Layer Cap, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring						
SW-10	Excavate and Dispose of Soil and Solid Waste Off-Site, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring	100	$102,950,982	$5,561,706	$173,297	$108,685,985	$108,269,066

Notes:

1. Discount factor for present value analysis is 2.7%; the period of analysis is 100 years. Per the Office of Management and Budget Circular A-94 Appendix C, 2.7% is the discount factor that was used in the FS, which was the real treasury interest rate in effect in 2009 and 2010 when the FS cost estimates were done.
2. This alternative has been modified since it was originally presented in the Soil FS to align it more closely with the presumptive remedy for landfills.

10.3.3 Summary of Comparative Analysis of Alternatives

Based on the comparative analyses, Alternative SW-6, which includes VOC "Hot Spot" Removal, On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, and Groundwater Monitoring, satisfies the threshold criteria, is effective in the both the short-term and long-term, is the most implementable, and is the most cost effective remedy for addressing the risks from contaminated soil and solid waste at the LEHR/OCL Site. None of the alternatives reduces toxicity, mobility or volume of waste through treatment. Although Alternatives SW-9 and SW-10 reduce toxicity, mobility and the volume of contaminated media on-site, they do so through excavation and off-site disposal at a cost which is almost three to six times greater than the costs of Alternatives SW-5 through SW-8.

11.0 PRINCIPAL THREAT WASTES

Principal threat wastes are those hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination and are considered to be highly toxic or highly mobile, which generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. The NCP establishes an expectation that U.S. EPA will use treatment to address the principal threats posed by a site wherever practicable.

U.S. EPA is not making a determination as to whether the source materials in the LEHR/OCL landfills and disposal areas are principal threat wastes or low level threat wastes, because these potential wastes were not characterized when they were found during trenching. Because U.S. EPA followed its presumptive remedy policy for landfills, thorough characterization of the landfill's contents was not necessary and the toxicity and mobility of contaminants was not assessed. The cap of the selected remedy will reduce mobility of contaminants and contaminant migration to groundwater will be monitored. Groundwater contamination will be addressed in the future Groundwater ROD.

12.0 SELECTED REMEDY

U.S. EPA, in consultation with DTSC and the RWQCB, is selecting the remedial alternative SW-6 as described below for the LEHR/OCL Site. Remedial alternative SW-6 was presented as U.S. EPA's preferred alternative in the Proposed Plan, and no information has come to U.S. EPA's attention which calls into questions its preferred status. U.S. EPA has determined that the selected remedy is protective of human health and the environment, for the current and reasonably anticipated future land use of the LEHR/OCL Site.

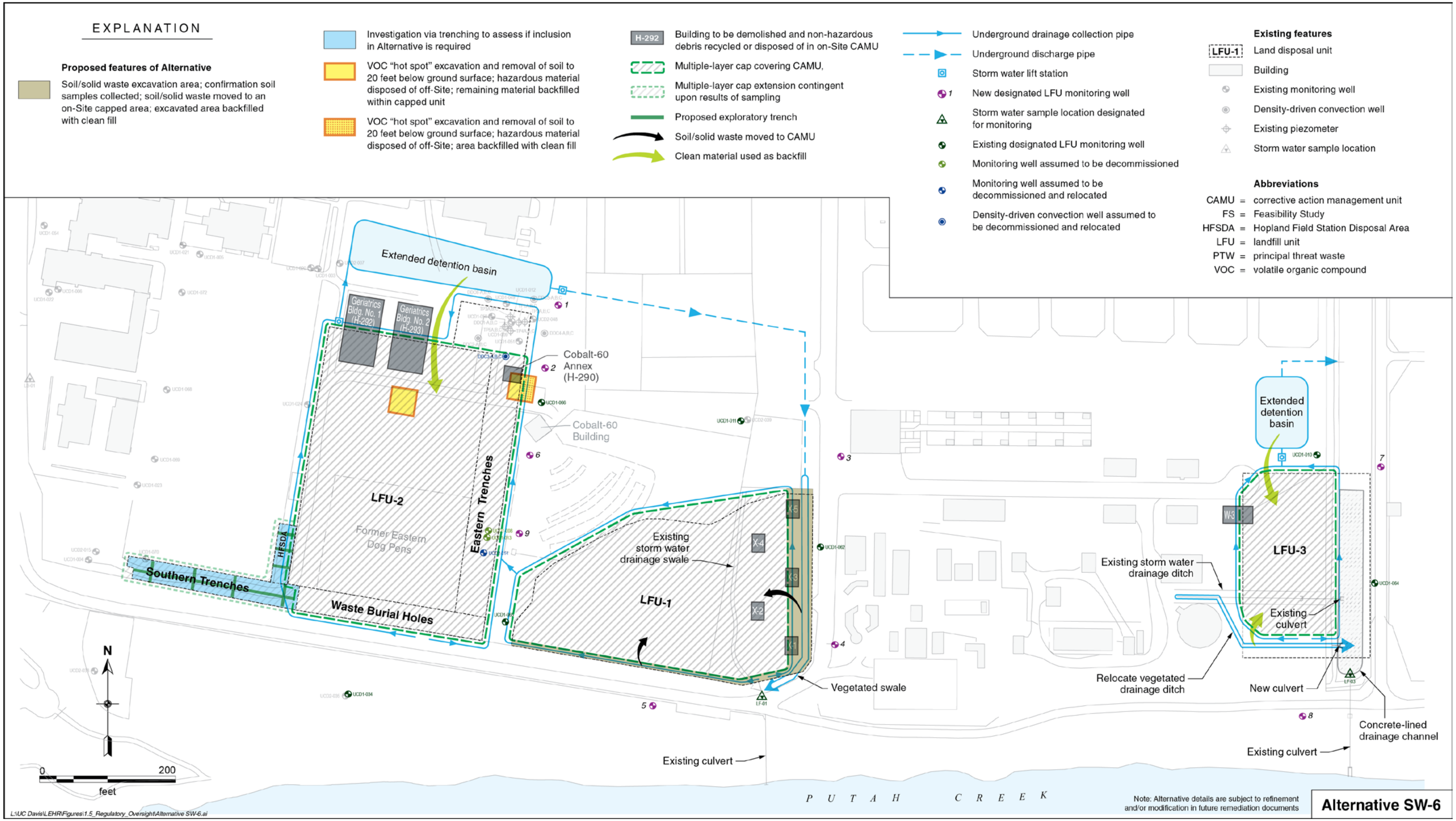


Figure 6 Alternative SW-6 (VOC "Hot Spot" Removal, Three On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Enhancements, and Groundwater Monitoring)

12.1 SUMMARY OF RATIONALE FOR THE SELECTED REMEDY

Alternative SW-6 is selected as the remedy for the LEHR/OCL Site because it will protect human health and the environment and comply with ARARs, while providing the best balance with respect to the nine NCP criteria compared to the other alternatives. Alternative SW-6 protects human health and the environmental in part by removing the VOC “hot spot” areas. Multiple-layer caps over the CAMUs will reduce potential COC migration to groundwater by limiting infiltration and will limit human exposure to COCs by creating a physical barrier. The multiple-layer caps over the CAMUs will also limit access of deep-rooted vegetation and burrowing animals to contaminated material. Drainage enhancements will further reduce infiltration and will control potential COC migration to surface water. The long-term prevention of human and ecological exposure will be maintained through an IC prohibiting residential land use and restricting non-residential land use and long-term O&M of the remedy components. Alternative SW-6 provides the best short-term protection by limiting the amount of material excavated and requiring transportation for disposal off-site. Alternative SW-6 is cost-effective and is implementable. The estimated time to complete implementation of Alternative SW-6 is one construction season, which is comparable to Alternatives SW-5 and SW-7 and less time than Alternatives SW-8, SW-9 and SW-10.

12.2 DETAILED DESCRIPTION OF THE SELECTED REMEDY

Alternative SW-6 has been modified since it was originally presented in the Soil FS to align it more closely with the presumptive remedy for landfills. The original version of the alternative included the additional component excavation of known chemical wastes, but this component was removed because it would not address all hazardous chemical waste. The alternative leaves soil and waste largely undisturbed, but includes excavation and off-site disposal of the two VOC “hot spot” areas. The VOC “hot spot” excavations will be backfilled with clean soil and the CAMUs (LFU-1, LFU-2/WBH/Eastern Trenches, and LFU-3) each will be covered with multiple-layer caps. The existing storm water drainage system will be expanded. Prior to initiation of the remedial action, the Southern Trenches and Hopland Field Station Disposal Area will be investigated and if solid wastes or contamination above ROD cleanup levels is found, the areas will be capped or excavated and backfilled. Each multiple-layer cap will consist of a foundation layer, a low-permeability synthetic liner, a compacted clay layer, a drainage layer, a bio-protection layer, and an upper soil layer to reduce infiltration and leaching of contaminants to groundwater. The LFU-1, LFU-2/WBH/Eastern Trenches/HFSDA, and LFU-3 multiple-layer capped CAMUs will cover areas of approximately 2 acres, 3.4 acres, and 0.7 acres, respectively. In LFU-3, the portion of the waste cells underneath the concrete-lined drainage channel will be excavated and placed into the LFU-3 CAMU, and the concrete-lined drainage channel will be reconstructed to match original conditions. During construction of the vegetated drainage swale in LFU-1, an area overlying the proposed channel location will be excavated to approximately 10 ft bgs and any soil/solid waste, known chemical wastes, or excavated material will be placed within the capped LFU-1 CAMU. Buildings (Cobalt-60 Annex [H-290], Geriatrics Building No. 1 [H-292], Geriatrics Building No. 2 [H-293], X-1, X-2, X-3, X-4, X5, and W3) will be removed to allow excavation, construction, and proper grading of the three on-site CAMUs. Non-recycled building waste and waste excavated for drainage controls will be placed beneath the cap of the adjacent CAMU. Elderberry shrubs will be moved to a mitigation area or, if they are rooted in waste or contaminated soil will be shredded and placed under the CAMU caps. Additional storm water drainage enhancements, including extended detention basins, will further reduce infiltration in the disposal units.

Alternative SW-6 includes ICs and groundwater monitoring. ICs are non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use (such as permits, zoning, and/or deed restrictions). The ICs associated with Alternative SW-6 are intended to minimize the potential for human exposure to the soil, solid waste, and soil gas contamination that will remain in place at the LEHR/OCL Site. ICs will also preserve access to monitoring wells and prevent damage to remedy components (e.g., landfill caps, drainage systems, etc.). A codified land use restriction will be implemented in coordination with the UC Davis Office of the President, Real Estate Services Group, and the UC Davis Office of Administrative and Resource Management. A land use covenant will be recorded with Solano County that prohibits residential land use and restricts non-residential use of the disposal units. Signage will be posted to notify workers of potential subsurface hazards both during remedial action phases and post-construction activities. Signs will be posted to warn of subsurface hazards. The maintenance, monitoring, enforcement, and reporting will ensure that the selected ICs will be protective of human health and the environment and comply with ARARs. Signage will be posted to notify of potential subsurface hazards, and an IC will be recorded to prohibit residential land use, restrict non-residential land use, and include a requirement for a soil management plan for post-remediation earthwork activities. Long-term groundwater monitoring will verify the efficacy of groundwater protection under this alternative. Long-term O&M on the groundwater wells, storm water drainage system, and multiple-layer caps will maintain the functionality of the remedy, as designed.

The following elements are part of the SW-6 remedy:

1. Planning and oversight activities will include document preparation of a field sampling plan, a quality assurance project plan, a health and safety plan, a sampling and analysis plan, a quality assurance project plan, a construction quality assurance/quality control (QA/QC) plan, a stormwater pollution prevention plan (SWPPP), O&M Plan, Long-Term Monitoring Plan, and construction site environmental controls (established for demolition, excavation, filling, grading, and capping activities).
2. During pre-remediation activities, monitoring wells will be decommissioned and relocated, as appropriate and in accordance with an approved well decommissioning work plan. Pre-remediation elements include trenching in the HFSDA and Southern Trenches and elderberry shrub cluster relocation and mitigation consistent with the USFWS Biological Opinion for the VELB. New groundwater monitoring wells will be installed at the conclusion of capping and drainage control installation. As the current density-driven convection (DDC) system lies within the boundaries of the Eastern Trenches North, implementation of the remedial action in this area may require its decommissioning. Although the future configuration of the DDC system is subject to change upon further evaluation of HSU-1 groundwater treatment strategies, for alternative comparison and costing purposes, it is assumed that the wells within the Eastern Trenches North boundary will be decommissioned, and that three DDC wells and three nested piezometers will be replaced after capping and construction of the drainage improvements are complete. Integration of future groundwater remedial activities will be considered during the remedial design. The landfill caps will be designed so that remediation of the groundwater VOC source areas that are below the water table or deeper than practical excavation depths can be conducted.
3. A Materials Management Plan (MMP) will be developed for implementation during excavation and disposal phases of the alternative. The MMP will describe procedures for the sorting and screening of excavated materials from the VOC “hot spot” areas, stockpiling, sampling and analysis (i.e., waste characterization), potential treatment, and disposal. Materials sent off-site for disposal will meet the acceptance criteria for the licensed facility. Descriptions of the processes and standards for the ex situ solidification/stabilization of fractions of the hazardous and mixed waste streams, including threshold criteria for its implementation, will be included.

4. Soil at the Southern Trenches and HFSDA will be investigated to assess the extent of contamination in these areas. If contamination is above ROD cleanup levels, these areas will be remediated either by capping or excavation.

5. On-site buildings will be decommissioned and demolished, including the Cobalt-60 Annex [H-290], Geriatrics Building No. 1 [H-292], Geriatrics Building No. 2 [H-293], X-1, X-2, X-3, X-4, X5, and W3. A utility survey will be completed prior to demolition to identify electrical, sewer, water, fiber optic, gas, storm water, and other utilities that may be present within the area to be excavated. If buildings were used for radiological experimentation, a radiological survey and characterization sampling will be conducted prior to building demolition to determine if material can be recycled. If possible, non-hazardous and non-radiologically impacted material will be recycled. Any remaining non-hazardous demolition debris will be disposed of within the CAMUs; hazardous demolition debris and LLRW will be sent off-site for disposal at licensed facilities. The State Historic Preservation Officer has indicated that there are no known historical or cultural resources identified within or adjacent to the LEHR/OCL Site.

6. Nine elderberry shrubs are on top of the landfills and disposal units (i.e., potentially rooted in wastes); they will be removed and shredded. The shredded materials may be placed under the landfill caps or disposed off-site to minimize methane production. Eight elderberry shrubs located in adjacent areas where drainage improvements will be made or in areas where access is needed will be moved to a mitigation area as outlined in item 1 above and as discussed in the biological assessment.

7. The two VOC “hot spots,” one south of the Geriatrics Buildings (H-292 and H-293) and one on the east side of the Eastern Trenches, will be excavated to approximately 20 ft bgs to remove the soil and soil gas containing elevated concentrations of VOCs; this ensures excavation of maximum VOC concentrations measured at 15 ft bgs, unless pre-design sampling indicates that soil vapor concentrations are below cleanup levels. VOC contaminated soil will be sent off-site for disposal at licensed facilities. Since the eastern half of the Eastern Trenches VOC “hot spot” will not be graded and covered, it will be backfilled with clean fill.

8. Contaminated soil/solid waste will be left on-site, consistent with the presumptive remedy for landfills.

9. A storm water drainage system will be installed to route precipitation away from the CAMUs. Drainage swales will direct water to a perimeter collection system that includes stormwater retention basins. Soil and solid wastes that are excavated to construct the stormwater drainage system will be placed in the CAMUs. The need for armoring the drainage swales will be determined during the remedial design.

10. In LFU-3, areas of the concrete-lined drainage channel overlying the identified waste cells will be demolished and incorporated into the capped area of LFU-3. The waste and contaminated soil underlying the drainage channel will be excavated, including material as far as 10 feet from the channel’s western edge. Additional excavation may be necessary if wastes or significant contamination is found on the east side of the channel. After confirmation samples are collected and evaluated, the excavation will be backfilled with clean fill, and any demolished sections of the concrete channel will be reconstructed to match original conditions.

11. At the Eastern Trenches, soil/solid waste will be excavated within both the northern and southern sections. Wastes and contaminated soil will be placed within the existing footprint of each CAMU to be consistent with the presumptive remedy for landfills. The northern part of the Eastern Trenches is one of the VOC “hot spots” that will be excavated and backfilled with clean fill. Material that is not contaminated with VOCs will be consolidated within the LFU-2/Eastern Trenches/WBH CAMU footprint.

12. A multiple-layer cap will be installed for each of the designated CAMUs. Each multiple-layer cap will consist of a foundation layer, a low-permeability layer comprising a geo-membrane over a compacted clay or geosynthetic clay liner (or an equivalent performance layer), a drainage layer, a biotic barrier and protection layer, and an upper vegetated (topsoil) layer. The cap construction adjacent to the northern landward levee toe of Putah Creek will comply with the levee maintenance easement requirements.
13. ICs will be implemented to prevent future Site development or activities incompatible with the designated land use. Land-use restrictions will consist of implementing a codified land use restriction in coordination with the UCOP, Real Estate Services Group, and the UC Davis Office of Administrative and Resource Management. A land use covenant prohibiting residential and sensitive land use and restricting non-residential use of the approximately 6.4 acres of disposal areas will be recorded with Solano County and will include LFU-1, LFU-2, LFU-3, the Eastern Trenches, the HFSDA, the WBH, and any other co-located areas. ICs will include: 1) maintain access to designated monitoring wells; 2) restrict drilling or other subsurface penetration and access to groundwater; 3) restrict surface changes affecting drainage, infiltration, and potential COC mobilization; and 4) require assessment and mitigation of potential vapor intrusion hazards to buildings. The requirement for a soil management plan will also be identified as a requirement for implementation during post-remediation earthwork and construction activities.
14. Annual inspections and maintenance will be performed on the installed storm water infrastructure and disposal unit capped areas. Routine maintenance will be performed as needed.
15. New groundwater monitoring wells will be installed surrounding each CAMU to monitor the effectiveness of the remedy and potential releases. Because the groundwater flow direction varies, monitoring wells will be installed east, west, north, and south of each of the CAMUs. Existing wells that can be preserved during construction and are appropriately located will be incorporated into the groundwater monitoring network. Groundwater samples for analysis of the full suite of landfill parameters will be collected from these detection and compliance monitoring wells.
16. Post-remediation activities include including storm water monitoring, maintenance of ICs, and five-year reviews. Since landfill wastes will be left in place, post-remediation activity is required in perpetuity. For each five-year period, documents associated with compliance, performance, and ICs will be reviewed. This will include updating and correcting remedial program manuals, specifications, and record documents. The conclusions from each five-year review will be compiled in a summary report for the entire Site.

Alternative SW-6 will be compatible with a future groundwater remedy to be selected for the Site. In addition, the remedy may change somewhat as a result of the remedial design and construction processes. Changes to the remedy described in the ROD will be documented using a technical memorandum in the Administrative Record, an ESD, or ROD amendment, in accordance with the procedures described in Chapter 7 of U.S. EPA's ROD Guidance.

12.3 ESTIMATED REMEDY COSTS

The cost of SW-6 is $15,740,690. The detailed cost summary presented in Attachment C is based on information provided in the Proposed Plan (U.S. EPA, 2015a) and in the FS Addendum (U.S. EPA, 2016b), where complete cost details can be found. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the selected remedial alternative. Changes in the cost elements may occur as a result of new information and data collected during the engineering design of the remedial alternative. Changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Difference, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

12.4 EXPECTED OUTCOMES

Following implementation of Alternative SW-6, the expected outcomes of the selected remedy will meet all of the remedial action objectives set forth in Section 8.0. The expected outcomes are:

- Prevention of human contact with contamination in soil, solid waste, and soil gas;
- Reduction of migration of contaminants in soil;
- Improved on-site habitat for plants and animals through reduced soil toxicity; and
- Improved quality of surface water and storm water

The remedy is anticipated to require one construction season to implement, once the remedial design is complete. Following implementation of the remedy, the LEHR/OCL Site will be available for low-density academic/administrative purposes, which is consistent with the current land use. Groundwater is not addressed in this ROD and will be addressed separately in a future ROD.

13.0 STATUTORY DETERMINATIONS

This section provides a brief description of how the selected remedy satisfies the CERLA statutory requirements. Under CERCLA §121 and the NCP, the lead agency must a select remedy that is protective of human health and the environment, complies with ARARs (unless a statutory waiver is justified), is cost-effective, and uses permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum 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 a bias against off-site disposal of untreated wastes.

13.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy will protect human health and the environment through a series of actions, including excavating VOC "hot spot" areas, construction of on-site CAMUs with multiple-layer caps, ICs to restrict land use, drainage enhancements, and groundwater monitoring. The selected remedy will protect human health and the environment by removing the VOC "hot spot" areas. ICs implemented as part of the selected remedy will also protect human health and the environment by restricting Site uses that would allow exposure to contamination left in place. Drainage enhancements will control potential COC migration to surface water and reduce infiltration, and the installation of multiple-layer caps over the CAMUs will reduce potential COC migration to groundwater and limit exposure to contamination left in place. Operation and maintenance of the multiple-layer caps and drainage enhancements, as well as groundwater monitoring, will help maintain the continued protection of human health and the environment. The selected remedy will not pose unacceptable short-term risks or result in cross-media impacts.

13.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Section 121(d) of CERCLA states that remedial actions on CERCLA sites must attain (or justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be ARARs. Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically apply to the situation at a CERCLA site. Relevant and appropriate requirements are federal or state cleanup standards, requirements, criteria, or limitations that, while not “applicable” to a hazardous substance, action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those found at the Site. The selected remedy will meet all federal or state standards, requirements, criteria or limitations that have been determined to be ARARs for the LEHR/OCL Site contamination. These ARARS are presented in Attachment B.

13.3 CAMU DESIGNATION CRITERIA AND SPECIFIC INFORMATION

This section discusses the definition of a CAMU, how LFU-1, LFU-2 and LFU-3 at the LEHR/OCL Site satisfy the CAMU designation criteria, and specific information for the three CAMUs. As described in this ROD, designation of the three LFUs as CAMUs will facilitate the cleanup of the Site by allowing UC Davis to dispose on-site of the majority of waste generated during the remedial action. Waste classification requirements in Title 22 California Code of Regulations (CCR) § 66262.11 are ARARs for excavated wastes. Construction of permanent landfill caps over each of the LFUs at the Site is scheduled to follow immediately after completion of excavation and consolidation. UC Davis will not place VOC-contaminated soil into the CAMUs. LLRW will be left in place in the HFSDA, WBH, and Southern Trenches.

13.3.1 Definition of a CAMU

As defined in 22 CCR 66264.552(a), a CAMU is “an area within a facility that is used only for managing CAMU-eligible wastes for implementing corrective action or cleanup at the facility.” Wastes placed at a CAMU must be “CAMU-eligible wastes” which are “[a]ll solid and RCRA hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris, that are managed for implementing cleanup,” 22 CCR 66264.552(a)(1)(A), except as otherwise provided in 22 CCR 66264.552(a)(1)(B). The substantive requirements for CAMUs under RCRA are ARARs for CERCLA actions.

Placement of CAMU-eligible waste in a CAMU does not constitute land disposal, and so does not trigger the land disposal restrictions under 22 CCR Chapter 18. The CAMU regulations identify seven criteria by which to determine the appropriateness of designating a CAMU, 22 CCR 66264.552(c):

- The CAMU facilitates the implementation of reliable, effective, protective, and cost-effective remedies.
- Waste management activities associated with the CAMU do not create unacceptable risks to human health and the environment resulting from exposure to RCRA or non-RCRA hazardous wastes or hazardous constituents.
- The CAMU includes uncontaminated areas of a facility only if including such areas for the purpose of managing CAMU-eligible waste is more protective than management of such wastes using contaminated areas of a facility.
- Areas within the CAMU, where wastes remain in place after closure of the CAMU, are managed and contained to minimize future releases, to the extent practicable.
- The CAMU expedites the implementation timing of the corrective action activity, when appropriate and practicable.

- The CAMU enables the use, when appropriate, of treatment technologies (including innovative technologies) to enhance the long-term effectiveness of corrective actions by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the CAMU.

- The CAMU, to the extent practicable, minimizes the land area of the facility upon which wastes will remain in place after closure of the CAMU.

The following section discusses how LFU-1, LFU-2 and LFU-3 satisfy the CAMU designation criteria.

13.3.2 CAMU Criteria Evaluation

Designation of LFU-1, LFU-2 and LFU-3 as CAMUs satisfies the CAMU designation criteria in 22 CCR 66264.552(c) as explained below.

Facilitate Reliable, Effective, Protective and Cost-Effective Remedies. As shown in this ROD, consolidation of wastes, contaminated soil and building and plant debris generated during implementation of the remedial action will provide a reliable remedy that is effective, protective, and cost-effective. Excavation and surface grading are well developed and reliable technologies. Standard construction techniques and earthmoving equipment will be used.

Costs for consolidation are anticipated to be less than for off-site disposal. Excavation and off-site disposal would cost three to six times more than consolidation in CAMUs. Consolidation of wastes to the LFUs also will be more effective than imposing institutional controls across even larger areas of the Site.

Do Not Create Unacceptable Risks. Exposures to construction workers could occur during the excavation and consolidation activities. Excavation of wastes is a potentially hazardous activity. Effective implementation of a health and safety plan, however, will minimize the risk of exposure during excavation and consolidation activities. The Remedial Design/Remedial Action Work Plan will determine the disposition of containers of liquid wastes or identifiable hazardous wastes are excavated.

Use Uncontaminated Areas Only if More Protective. LFU-1, LFU-2 and LFU-3 already are contaminated areas. Uncontaminated areas will not be needed for the consolidation of wastes in to the CAMUs.

Minimize Potential for Future Releases. Consolidating wastes excavated from various areas around the Site in the course of implementing the selected remedy will reduce the overall area occupied by wastes at the Site and so reduce the subsequent potential for exposure. Consolidation of wastes also will help reduce the potential for leachate formation by placing uncapped wastes in the CAMUs and isolating them through the implementation of engineering controls, such as capping. Consolidation of wastes to fewer locations also allows more focused monitoring efforts.

Expedite Remedy Implementation. Excavation and consolidation of wastes into the three LFU CAMUs will facilitate remedy implementation, shorten the timeframe for remedy implementation, and reduce costs.

Enhance Long-Term Effectiveness. Consolidating wastes to the three Site CAMUs will reduce the overall area occupied by wastes at the Site, reduce the subsequent potential for exposure, and enhance the long-term effectiveness of the remedial action. Neither consolidation nor capping involves treatment; therefore, neither will substantially reduce the toxicity or volume of wastes. However, capping of the consolidated wastes will reduce the mobility of contaminants by limiting infiltration of water through the wastes.

Minimize Land Areas Where Wastes Remain After Closure. Consolidation of wastes from various areas around the Site to LFUs -1, -2 and -3 CAMUs will reduce the land area where wastes remain in place and will allow future reuse of the Site that would not be possible if wastes were left in place and addressed, for example, through institutional controls.

Summary of Designation Criteria. Designation of LFUs -1, -2 and -3 as CAMUs satisfy the CAMU designation criteria. Key aspects of the evaluation include (1) the increased reliability of containing the waste at the LFU CAMUs; (2) the increase in long-term effectiveness gained by isolating the wastes; (3) the reduction in total contaminated land area at the Site; and (4) the moderate remediation cost.

13.3.3 Specific Information for the LFU CAMUs

The CAMU regulations require that a CAMU designation include specific information about the CAMU (22 CCR 66264.552(e)). This specific information includes:

- The areal configuration of the CAMU
- Requirements for CAMU-eligible waste management including applicable design, operation [and treatment- if PTW identified]
- Groundwater monitoring and reporting requirements
- Closure and post-closure requirements

The following discussion addresses these requirements.

Areal Configuration. Figure 6 indicates the location of the three LFU CAMUs. These areas are the same general areas proposed to be covered by three separate caps. Minor adjustments to the capped areas and drainage features may be necessary as determined during remedial design of the caps due to engineering design requirements.

Remediation Waste Management Requirements. CAMU-eligible waste management requirements include specification of the appropriate design and operation methods. Design of the LFU CAMU caps will meet the hazardous waste landfill closure performance standards in the applicable substantive portions of 22 CCR § 66264.310 (40 Code of Federal Regulations (CFR) 264.310). The cap performance standards specified in Section 66264.310 require that the final cover be designed and constructed to:

(1) Prevent the downward entry of water into the closed landfill throughout a period of at least 100 years;

(2) Function with minimum maintenance;

(3) Promote drainage and minimize erosion or abrasion of the cover;

(4) Accommodate settling and subsidence so that the cover's integrity is maintained;

(5) Accommodate lateral and vertical shear forces generated by the maximum credible earthquake so that the integrity of the cover is maintained;

(6) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present; and

(7) Conform to the provisions of subsections (e) through (r) of section 66264.228, except that the Department shall grant a variance from any requirement of subsections (e) through (r) which the owner or operator demonstrates to the satisfaction of the Department is not necessary to protect public health, water quality or other environmental quality.

In addition to the cap requirements, other waste management features which will be incorporated at the Site include an enhanced drainage system that includes stormwater retention basins.

Operations at the Site during excavation and consolidation activities will satisfy requirements that are relevant and appropriate for hazardous waste landfill operations.

Groundwater Monitoring Requirements. According to 22 CCR 66264.552(e)(5), groundwater monitoring at a CAMU must be sufficient to:

(1) Continue to detect and characterize the nature, extent, concentration, direction, and movement of existing releases of hazardous constituents in groundwater from sources located within the [CAMU]; and

(2) Detect and subsequently characterize releases of hazardous constituents to groundwater that may occur from areas of the [CAMU] in which wastes will remain in place after closure of the [CAMU].

Groundwater monitoring requirements are specified in substantive portions of 22 CCR Division 4.5, Chapter 14, Article 6, and 23 CCR Division 3, Chapter 15, Article 5 and 40 CFR Subpart F and include detailed requirements for evaluating the items described in 22 CCR 66264.552(e)(5). Specific ARARs for groundwater monitoring at the Site are contained in Attachment B.

Closure and Post-Closure Requirements. Closure of a CAMU must:

(1) Minimize the need for maintenance; and

(2) Control, minimize, or eliminate, to the extent necessary to protect human health and the environment, for areas where wastes remain in place, post-closure escape of RCRA hazardous wastes, hazardous constituents, leachate, contaminated runoff, or RCRA hazardous waste decomposition products to the ground, to surface waters, or to the atmosphere.

For the LFU CAMUs, these requirements focus on capping requirements (closure) and operation and maintenance requirements (post-closure). Title 22 66264.552(e)(4)(C) directs the state to consider the following factors in establishing closure requirements: (1) CAMU characteristics, (2) volume of waste in place after closure, (3) physical and chemical characteristics of the waste, (4) hydrogeological and relevant environmental conditions that may influence the migration of potential releases, and (5) potential risks to human health and environmental receptors if a release were to occur. Similarly, post-closure requirements must be established to protect human health and the environment. For example, monitoring and maintenance activities must be conducted to ensure the integrity of the cap.

The design of the LFU caps will comply with the closure standards listed in 22 CCR § 66264.310 (40 CFR 264.310). The objectives of the Title 22 and RCRA Subtitle C requirements are the same as those for closure of a CAMU: protection of human health and the environment by minimizing the potential for off-site migration of contaminants and minimization of ongoing maintenance needs. The landfill closure standards of Title 22 and RCRA Subtitle C consider similar factors in establishing the closure requirements as are required for CAMU closure. Factors considered for CAMU closure including waste volume, waste characteristics, hydrogeological conditions, and potential risks from a release are all addressed by the Title 22 and 40 CFR 264,310 requirements. Likewise, post-closure requirements for CAMUs such as monitoring and maintenance are contained within the Title 22 and RCRA Subtitle C standards. In addition to the protection, provided by the caps, the storm water drainage control system will help control, minimize or eliminate potential future releases at the Site. Specific ARARs for landfill closure and post-closure activities at the Site are contained in Attachment B. By satisfying the Title 22 standards, CAMU closure and post-closure requirements will be addressed.

Summary of Specific Information. Requirements for design, operation, closure, and post-closure incorporated into the landfill cap remedial action at Site 1 will meet the requirements for design, operation, closure, and post-closure of the three CAMUs at the Site. Attachment B lists the ARARs for these activities. In achieving the substantive standards of CCR Title 22 and 40 CFR 264.310, whichever are more stringent, the requirements for a CAMU will be met. Designating LFU-1, LFU-2 and LFU-3 as CAMUs will ensure protection of human health and the environment by minimizing the potential for offsite migration of contaminants and will comply with ARARs. The three LFUs therefore satisfy the criteria and requirements for CAMU designation.

CAMU Designation. By concurring on the ROD, EPA and the state designate LFU-1, LFU-2 and LFU-3 as shown on Figure 6 as CAMUs under the selected remedial alternative. The CAMU regulation is an ARAR as discussed in Section 13.2.1 of this ROD. This ROD documents the CAMU designation pursuant to 40 CFR 264.552(c) as implemented through the California EPA, Department of Toxic Substances Control, Hazardous Waste Regulations, Title 22, Chapter 14, § 66264.552. The proposed plan for this ROD shall satisfy public notice requirements under the CAMU regulations. In designating the CAMU, EPA and the state have considered the criteria set forth in Section 66264.552 and determined that the CAMU satisfies each of these criteria.

13.4 COST EFFECTIVENESS

A cost-effective remedy is defined as one in which "costs are proportional to its overall effectiveness" (NCP §300.430(f)(1)(ii)(D). Assessing cost-effectiveness involves comparing costs to overall effectiveness, which is determined by evaluating the following three of the five balancing criteria: 1) longer-term effectiveness and permanence; 2) reduction in toxicity, mobility and volume through treatment; and 3) short-term effectiveness.

Only Alternatives SW-8, SW-9, and SW-10 rank higher in long-term effectiveness and permanence than the selected remedy (SW-6) but these alternatives have much higher costs. The selected remedy has the highest short-term effectiveness and the highest implementability of the alternatives that satisfy the two threshold criteria (i.e., Alternatives SW-5 through SW-10). The selected remedy is cost-effective. It is the lowest cost alternative that satisfies the two threshold criteria.

13.5 USE OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

U.S. EPA has determined that the selected remedy represents the maximum extent to which a permanent solution can be used in a practicable manner at the LEHR/OCL Site. Of those alternatives that are protective of human health and the environment that comply with ARARs, U.S. EPA has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principle element and bias against off-site treatment and disposal and considering State and community acceptance. The estimated lifespan of the caps is more than 100 years, which is considered permanent. When the caps no longer operate as designed they will need to be reconstructed. The selected remedy does not use alternative treatment technologies because they are not appropriate for Site circumstances. The selected remedy satisfies the criteria for long-term effectiveness by removing the VOC “hot spot” areas and by capping contamination remaining in place. Off-site disposal of contaminated soil effectively reduces the mobility of chemicals and potential for direct contact.

13.6 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy does not satisfy the statutory preference for treatment as a principal element because choosing treatment is impracticable and would dramatically increase costs while achieving the same level of risk reduction. This remedy is consistent with the presumptive remedy for landfills.

13.7 REQUIREMENTS FOR FIVE-YEAR REVIEWS

The NCP §300.430(f)(4)(ii) requires a five-year review if a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. Because this remedy will result in contaminants remaining on-site and the future property use will be limited, U.S. EPA will conduct the required statutory five-year reviews to ensure that the remedy is, and will continue to be, protective of human health and the environment.

Because the selected remedy is post-SARA and results in hazardous substances, pollutants, or contaminants remaining on the LEHR/OCL Site above levels that allow for unlimited use and unrestricted exposure, a statutory five-year review will be conducted for the LEHR/OCL Site. UC Davis will consolidate the protectiveness determinations for the remedy at the LEHR/OCL Site with the Five-Year Review for the DOE area. The first five-year review is triggered by completion of the ROD and will occur in January 2021 in coordination with the Five-Year Review being conducted by the DOE and every five years thereafter to ensure that the remedy is, or will be, protective of human health and the environment.

13.8 STATE ACCEPTANCE

The DTSC and the RWQCB have been an integral part of the CERCLA process for the LEHR/OCL Site, including review of the 2015 Proposed Plan and the review of this ROD. Both agencies support EPA’s selection of Alternative SW-6 as the remedy for the LEHR/OCL Site.

13.9 COMMUNITY ACCEPTANCE

U.S. EPA issued a final Proposed Plan (U.S. EPA, 2015a) for the LEHR/OCL Site for public comment on January 27, 2015. The public comment period on the Proposed Plan was open from January 28 to February 26, 2015, and a public meeting was held on February 10, 2015. Only three parties commented on the Proposed Plan. In addition, an oral comment from one party was received at the Proposed Plan public meeting; however, the oral comment consisted of reading a written letter that was later provided to U.S. EPA. A summary of the responses to all comments received is presented in Sections 1.0 and 2.0 of Part 3: Responsiveness Summary. The transcript of the public meeting is in the Site Administrative Record. U.S. EPA does not believe that any of the issues raised in the comments warrant selection of a different remedy to address the contamination at the LEHR/OCL Site.

14.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan was released for public comment in January 2015. The Proposed Plan identified Alternative SW-6 as the preferred alternative. U.S. EPA reviewed all written and verbal comments regarding the preferred alternative that were submitted during the public comment period. EPA has determined that no significant changes to the remedy, as originally identified in the Proposed Plan, are necessary or appropriate.

PART 3: RESPONSIVENESS SUMMARY

U.S. EPA received letters from two individuals and one organization and thoroughly reviewed all comments received. This section summarizes key issues expressed by the public during the public comment period (January 28, 2015 through February 26, 2015) and U.S. EPA's responses. The submitted written comments and U.S. EPA's responses are in the Site Administrative Record.

1.0 CONCERNS RELATED TO SUPPORTING INFORMATION

Four comments (I.A.1b through I.A.1d, I.C.10) questioned the need for any action given the remote location, limited access, and the future use of the LEHR/OCL Site.

U.S. EPA Response: Although the location of the Site is remote from the main campus and surrounded by high fences and gates that are locked at night, UC Davis students and staff who care for animals at the Animal Resource Service V and the Equine Health Center have access to the Site 24 hours a day, seven days a week, and there are students who live in the Goat Barn. In addition, a number of professors, researchers, workers, and students have access to the Site during class/working hours and the general public, volunteers, and staff have access to the UC Davis Raptor Center, which is located near Landfill 3. So there is significant human presence at the Site. To ensure protection of persons living and working at the site and because these and other UC Davis buildings are located immediately adjacent to or on top of some of the landfills, a hypothetical on-site resident (i.e., residential receptor) was used in the HHRA as it represents the most sensitive/conservative current and future receptor. Action is needed to protect the students, staff, researchers, workers, and volunteers who work and study at the LEHR/OCL Site due to risk that exceeds the U.S. EPA risk management range (1×10^{-6} to 1×10^{-4}).

Nine comments (I.A.1a and I.B.2 through I.B.9) questioned the appropriateness of EPA's preferred alternative given uncertainty regarding risk calculations and risk assumptions, including the classification of chloroform as a carcinogen and concentrations of airborne chloroform.

U.S. EPA Response: Chloroform is considered by the American Conference of Governmental Industrial Hygienists (ACGIH), U.S. EPA, and the International Agency for Research on Cancer (IARC) as a probable carcinogen in humans. Chloroform is given an overall weight-of-evidence classification of B2 by U.S. EPA and a classification of 2B by IARC. These classifications are based on these organizations' determination that there is sufficient evidence for the carcinogenicity of chloroform in animals and insufficient evidence in humans. Chloroform has been found at 13,000 micrograms per cubic meter (µg/m^3) in soil gas from the Eastern Trenches and 16,000 µg/m^3 in soil gas from Landfill 2. These concentrations significantly exceed both the residential RSL for indoor air of 0.12 µg/m^3 and the industrial RSL for indoor air of 0.53 µg/m^3. U.S. EPA's Vapor Intrusion Screening Level (VISL) calculator can be used to predict concentrations of VOCs in indoor air and corresponding cancer and non-cancer risks. Using the soil gas-to-indoor air tab of the most current version of the VISL calculator (version 3.4; U.S. EPA, 2015d) with default assumptions and assuming residential use, 16,000 µg/m^3 of chloroform equates to an excess lifetime cancer risk of 3.9×10^{-3} (i.e., 3.9 in 1000) and a hazard quotient of 4.7. Under commercial use assumptions, the excess lifetime cancer risk is 9.0 x 10^{-4} (i.e., 9 in 10,000) and the hazard quotient is 1.1. Other VOCs were also detected in landfill gas. The cancer risk associated with potential vapor intrusion under both scenarios is significant.

U.S. EPA acknowledges that uncertainty exists with respect to human response to carcinogens. However, U.S. EPA is required to ensure that an appropriate level of conservatism is used when assessing risk. As discussed in U.S. EPA's Guidelines for Carcinogen Risk Assessment (U.S. EPA, 2005), U.S. EPA generally takes public health-protective, default positions regarding the interpretation of toxicological and epidemiologic data: animal tumor findings are judged to be relevant to humans, and cancer risks are assumed to conform with low dose linearity.

13 comments (II.B.5 through II.B.7, II.C.8 through II.C.17) were related to concerns regarding landfill leachate.

U.S. EPA Response: As noted in Section I of the Proposed Plan, the intent of the multiple-layer caps is to isolate contaminated soil and waste and limit human exposure to COCs. In addition, the multiple-layer caps will be sloped to enhance drainage and vegetated to minimize precipitation infiltration and subsequent leachate production. Further, the average annual rainfall is approximately 19.66 inches. Since the yearly average monthly rainfall is 1.64 inches per month and the maximum average monthly rainfall is only 3.94 inches per month (January), it is unlikely that significant infiltration would occur that would not be captured by vegetation on the multiple-layer caps. Controlling infiltration will minimize potential leachate production in the event that the geomembrane is breached.

The presumptive remedy does not require extensive studies be conducted to determine whether the landfills are producing leachate that pollutes groundwater. However, the selected remedy includes installation of groundwater monitoring wells around the perimeter of the landfills, collection of baseline groundwater samples, and long-term groundwater monitoring. Comparison of the baseline and subsequent groundwater samples should indicate whether leachate production has been minimized and in the long-term will indicate whether the integrity of the geomembrane liner is maintained.

Two comments (II.D.18, II.D.19) related to uncertainty regarding the nature and extent of contamination at the LEHR/OCL Site.

U.S. EPA Response: As noted in the Presumptive Remedy for CERCLA Municipal Landfill Sites, U.S. EPA 540-F-93-035, dated September 1993, characterization of a landfill's contents is not necessary or appropriate for selecting a response action for these types of sites [municipal landfills] except in limited cases; rather, existing data are used to determine whether the containment presumption is appropriate. Due to the discovery of known chemical wastes during exploratory trenching, additional information regarding the nature and extent of the landfills was not obtained as it is not required to implement the presumptive remedy. The selected remedy was chosen as it leaves soil and waste largely undisturbed within the landfill areas with multi-layer caps to substantially reduce the infiltration of precipitation and production of leachate.

2.0 CONCERNS RELATED TO THE PERFORMANCE OF THE SELECTED REMEDY

13 comments (II.A.1 through II.A.4, III.A.1 through III.A.9) were related to uncertainty regarding the ability of Alternative SW-6 to meet RAOs and/or ARARs.

U.S. EPA Response: Based on Section 300.430 of 40 Code of Federal Regulations (CFR), the analysis of alternatives under review shall reflect the scope and complexity of Site problems and alternatives being evaluated and consider the relative significance of the factors within each criteria. The nine evaluation criteria are as follows: (a) Overall protection of human health and the environment; (b) Compliance with ARARs; (c) Long-term effectiveness and permanence; (d) Reduction of toxicity, mobility, or volume through treatment; (e) Short-term effectiveness; (f) Implementability; (g) Cost; (h) State acceptance; and, (i) Community acceptance. The selected alternative was evaluated and selected based on balancing the results of the comparison of the alternatives using the nine evaluation criteria.

As noted in the paper, Geomembrane Lifetime Prediction: Unexposed and Exposed Conditions, dated June 7, 2005 and updated February 8, 2011 (the White Paper), geomembrane longevity is strongly dependent on field temperature. Section 4.0 of the White Paper indicates that "HDPE [high density polyethylene] decreases its predicted lifetime (as measured by its half-life) from 446-years at 20°C [Celsius], to 69-years at 40°C." Given that groundwater temperatures in the most recent groundwater monitoring report ranged from 16.7 to 22.7°C, the potential exists for the geomembrane longevity to last a minimum of 200 years. The creation of free radicals, which could shorten the expected life-span of a geomembrane, is not anticipated to be an issue as long as the multiple-layer caps are installed during the dry season.

In addition, the multiple-layer caps will be sloped to enhance drainage and vegetated to minimize precipitation infiltration and subsequent leachate production. Further, the average annual rainfall in Davis is approximately 19.66 inches. Since the yearly average monthly rainfall is 1.64 inches per month and the maximum average monthly rainfall is only 3.94 inches per month (January), it is unlikely that significant infiltration would occur that would not be captured by vegetation on the multiple-layer caps. Controlling infiltration will minimize free radical production and in turn extend the life of the geomembrane. Also, the geomembrane liner will be installed on top of a clay layer and several feet of soil that are placed over the landfill wastes, to minimize the potential that wastes or vapors would interact with the geomembrane and reduce its longevity.

Lastly, some of the issues raised are based on Alternative SW-6 from the Final FS rather than the modified Alternative SW-6 (VOC "Hot Spot" Removal, Three On-Site CAMUs with Multiple-Layer Caps, Institutional Controls, Drainage Controls, and Groundwater Monitoring) that was presented in the Proposed Plan and which will be called Alternative SW-6 in these responses. The Soil FS version of Alternative SW-6 included the excavation and disposal of known chemical wastes and soil waste excavated from the Eastern Trenches and a portion of LFU-3 underlying the concrete-lined drainage channel. The known chemical wastes would be sent off-site for disposal while the solid waste would be placed within a nearby CAMU. The commenter appears to have assumed that excavation of this known chemical waste was still included in the Alternative SW-6. Alternative SW-6 proposes leaving soil and solid waste largely undisturbed and protected under landfill caps with the exception excavation of the two VOC "hot spot" areas. As a result of this modification, Alternative SW-6 minimizes excavation, segregation, and characterization of known chemical wastes for disposal at licensed off-site facilities; this is consistent with the presumptive remedy for landfills, since the location of all of the chemical wastes within the landfills is unknown.

Two comments (II.E.20, II.E.21) were related to the implementation of the presumptive remedy, including the need for long-term groundwater monitoring, groundwater remediation, and installation of a new cap.

U.S. EPA Response: The selected remedy includes monitoring and enforcement (e.g., annual site visits/inspections) and inspection and repair of the multiple-layer caps for a minimum of 200 years, as noted in the Alternative SW-6 cost estimate assumptions. Comparison of future groundwater sampling results with baseline groundwater sampling results will indicate whether the landfill caps are effectively minimizing leachate production. The need for groundwater remediation will be addressed in a future FS, Proposed Plan, and ROD.

The selected remedy assumes some erosion and settlement will occur, but does not include costs associated with a large scale failure, since factoring in costs for replacement of the multiple-layer caps would not make a significant difference in O&M costs. Specifically, the present value of a future cost (e.g., replacement of the multiple-layer caps) declines exponentially the further it is in time from the present (e.g., after 200 or more years). For example, in present dollars, the cost for cap replacement 200 years from now would be insignificant.

Five comments (II.F.22 through II.F.26) were related to uncertainty regarding implementation of Alternative SW-6, including whether annual inspections and five-year reviews would be effective and the long-term ability of UC Davis to implement the ICs.

U.S. EPA Response: Annual inspections and five-year reviews are a required part of the remedy. The selected remedy includes long-term groundwater monitoring and enforcement (e.g., annual site visits/inspections) and inspection and repair of the multiple-layer caps for 200 years or the lifetime of the remedy. The selected remedy includes the prevention of deep-rooted vegetation and addresses deficiencies caused by deep-burrowing animals. In addition, maintenance of the multiple-layer cap and drainage controls, as well as groundwater monitoring, will help ensure the continued protection of human health and the environment. Further, failure of the multiple-layer caps within 30 years is unlikely, as noted in the White Paper. Lastly, the selected remedy includes deed notification and restrictive covenants to ensure land-use controls are carried forward with the Site should the governing organization and/or entity change during the lifetime of the remedy. Although it is true that inspections and five-year reviews cannot visually evaluate the condition of the underlying layers of the caps, long-term groundwater monitoring will provide data to evaluate whether the caps are still effective.

Four comments (III.B.10 through III.B.13) were related to uncertainty regarding the ability of Alternative SW-6 to meet green remediation standards.

U.S. EPA Response: The quantities for Alternative SW-6 presented in the Soil FS were modified for Alternative SW-6 presented in this ROD by eliminating the excavation, segregation, characterization, and off-site disposal of known chemical wastes from the list of alternative components. Because of this, the amount of soil needed, the number of truck trips, and the amount of energy are less than the quantities listed for Alternative SW-6 (FS) in the Soil FS. However, the green remediation evaluation was not updated to capture the elimination of these components and results are expected to be more favorable if green remediation is re-evaluated.

Although green remediation issues are not promulgated regulations that are specifically utilized in the analysis of the alternatives in the ROD, green remediation issues should be considered during the Remedial Design stage. Based on Section 300.430 of 40 CFR, the analysis of alternatives under review shall reflect the scope and complexity of Site problems and alternatives being evaluated and consider the relative significance of the factors within each criterion. The nine evaluation criteria are as follows: (a) Overall protection of human health and the environment; (b) Compliance with ARARs; (c) Long-term effectiveness and permanence; (d) Reduction of toxicity, mobility, or volume through treatment; (e) Short-term effectiveness; (f) Implementability; (g) Cost; (h) State acceptance; and, (i) Community acceptance. As such, these are the only criteria considered in the remedy selection.

Three comments (III.C.14 through III.C.16) were related to concerns regarding the costs and cost assumptions associated with Alternative SW-6 and replacement costs for buildings that will be removed to construct the landfill caps.

U.S. EPA Response: While it is understood that the replacement costs for the nine buildings which will be demolished as a component of Alternative SW-6 are real, the costs cannot be included in the alternative assessment as they are not allowable under CERCLA. Only costs associated with the remedy can be included. As a result, the replacement costs cannot be used for comparison of alternatives.

3.0 PREFERRED ALTERNATIVES

One commenter expressed a preference for Alterative SW-1, one commenter expressed a preference for Alternative SW-3, and one commenter suggested the substitution of a geosynthetic clay liner rather for the compacted clay liner.

U.S. EPA Response: Alternatives SW-1 and SW-3 do not meet the remedy selection threshold requirements due in part to the potential for COCs remaining in place to leach, migrate and contaminate groundwater and the requirement for a RCRA-compliant cap to close the CAMUs. As noted in Section 10 of this ROD, EPA may not select a remedy that does not satisfy the threshold criteria. However, SW-1 was evaluated to provide a baseline for comparison to other alternatives, as required by the NCP.

Although most of the soil and waste would remain in place, the Alterative SW-6 would remove only the VOC "hot spot" areas, in order to reduce the potential for COCs to migrate into groundwater and minimize soil vapor production. The multiple-layer caps would isolate contaminated soil and waste, limiting human exposure to COCs. In addition, deep-rooted vegetation and deep-burrowing animals would not be able to access contaminated material. Maintenance of the multiple-layer caps and drainage controls, as well as groundwater monitoring, would help maintain the continued protection of human health and the environment.

Although a geosynthetic clay liner could be part of the design of the selected remedy rather than a compacted clay layer, the ROD does not mandate specific landfill cap components but instead provides performance standards. Landfill cap components to meet the performance standards specified in the ROD will be determined during the Remedial Design phase following issuance of the ROD.

4.0 TECHNICAL AND LEGAL ISSUES

There are no significant technical changes to the selected remedy other than those identified in the Document of Significant Changes. There are no additional significant technical or legal issues.

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6.0 GLOSSARY/ACRONYMS

Administrative Record—A collection of all the pertinent documents that support the final decisions for each site. This is located at the former McClellan Air Force Base and at U.S. EPA, Region IX.

Applicable or relevant and appropriate requirements (ARARs)— Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)— Legislation passed in 1980 and designed to respond to the past disposal of hazardous substances. The act was extensively amended in 1986 by the Superfund Amendments and Reauthorization Act, which added many provisions and clarified unclear areas in the original law.

Constituent of concern (COC)—A substance selected for environmental cleanup based on predicted impacts to groundwater resources and a health risk posed by the contaminant.

Exposure pathway—Ways that people can be exposed to contaminants. Common pathways include breathing, ingestion, or absorption through the skin.

Feasibility Study (FS)—A study of a hazardous waste site that must be completed before a cleanup remedy can be chosen and implemented. The Feasibility Study identifies and evaluates alternatives for addressing contamination.

Five-year review—Regular check-ups conducted on certain Superfund sites (where either treatment systems are still operating after 5 years or where waste is left behind) to make sure the site is still safe. Five-year review reports make recommendations on the continuation, modification, or elimination of annual reports and institutional control monitoring frequencies. Five-year reviews also represent an opportunity for the public to voice any concerns.

Groundwater—Underground water that fills pores between particles of soil, sand, and gravel or openings in rocks to the point of saturation. Where groundwater occurs in significant quantity, it can be used as a source of drinking water.

Hazard index (HI)—The ratio of contaminant concentration divided by the safe exposure level. If the hazard index exceeds 1, people are exposed to contaminants that may pose non-cancer health risks. Non-cancer health risks are contaminant-dependent but may include kidney disease, headaches, dizziness, and anemia. For more information, go to ToxFAQs at http://www.atsdr.cdc.gov/.

Industrial Use—When land is used for industrial, commercial, office, retail, or other occupational purposes.

Land Use Covenant (LUC)—A legal document that limits future land use.

Mitigate—The implementation of engineered controls or actions that prevent or make conditions less severe or harsh.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP)—The federal regulation that guides determination of the sites to be cleaned up under the Superfund program. This plan also provides the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances in accordance with CERCLA and the Clean Water Act.

National Priorities List (NPL)—The U.S. Environmental Protection Agency's published list of the highest priority hazardous waste sites in the U.S. for investigation and cleanup, which are subject to the Superfund program.

Non-cancer health risk—Health risks that do not result in cancer and may include kidney disease, headaches, dizziness, and anemia.

Non-volatile organic compounds (non-VOCs)—A group of compounds that do not readily evaporate at room temperature. They include metals, pesticides, SVOCs, petroleum hydrocarbons, dioxins/furans and radionuclides.

Occupational Worker—Includes indoor and outdoor workers who may be exposed to chemicals in soil, air, and water during the course of a workday.

Polychlorinated Biphenyls (PCBs)—A group of man-made compounds that were widely used, mainly in electrical equipment, but were banned at the end of the 1970s in many countries because of environmental concerns.

Preferred Alternative—U.S. EPA's suggested cleanup method(s) for the contaminated site(s). The preferred alternative is protective of human health and the environment, complies with applicable or relevant and appropriate requirements, and is cost-effective.

Proposed Plan—A summary of cleanup alternatives for a contaminated site, including a preferred alternative and the reasons for its selection. This step is the community's opportunity to review and comment on all cleanup alternatives under consideration. The responses to the comments are presented in the Record of Decision. All changes from the Proposed Plan are explained in the Record of Decision.

Radionuclides—Radioactive elements that may be naturally occurring or synthetic. There are hundreds of radionuclides, many of which are rarely encountered. People are much more likely to encounter a few that are used routinely for medical, military, or commercial purposes. Twelve radionuclides are most commonly found at Superfund sites, including cesium-137, radium, radon, and thorium.

Record of Decision (ROD)—A document explaining and legally committing the lead agency to the cleanup alternative(s) that will be used at a site. The Record of Decision is based on information and technical analyses generated during the Remedial Investigation, the Feasibility Study, and consideration of public comments and community concerns.

Remedial Investigation (RI)—A hazardous waste site study to examine the nature and extent of site contamination.

Remediation Goals—Levels set for the protection of human health, groundwater, or surface water. To protect human health, the set risk level is usually one in a million—an additional person in a million people may contract cancer.

Residential Receptor—A resident (child or adult) who may be exposed to chemicals through soil, air, and water from indoor and outdoor exposure.

Residential Use—When land is suitable for use as housing or any other purpose.

Responsiveness Summary—The section within the Record of Decision that summarizes comments received from the public during the public comment period and the responses from the lead agency.

Risk Assessment—A study based on the results of the Remedial Investigation to determine the extent to which chemical contaminants found at a Superfund site pose a risk to public health and the environment.

Semi-volatile organic compounds (SVOCs)—A group of chemical compounds that evaporate in air at a slower rate than VOCs. SVOC is a name for a class of compounds and includes PAHs, PCBs, pesticides, and dioxins/furans.

Soil gas—The air between soil particles that may be contaminated by contaminants that have vaporized in the soil.

Solid Waste—Non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes hazardous substances. Solid wastes also include sewage sludge, agricultural refuse, demolition wastes, and mining residues.

Total petroleum hydrocarbons—A wide range of liquid hydrocarbons, including gasoline and diesel fuel.

Unrestricted land use—A designation that risk is reduced to such a low level as to allow anything to be built, including homes and public or private schools for persons under 18 years of age.

Vapor inhalation pathway—A pathway used in risk analysis where contaminants in the soil volatilize into soil gas, migrate into buildings, and are inhaled by the occupants.

Volatile organic compound (VOC)—An organic compound containing carbon that evaporates (volatilizes) readily at room temperature. VOCs are used in the manufacturing of paints, pharmaceuticals, and refrigerants. VOCs typically are industrial solvents, such as trichloroethene. Some VOCs are known carcinogens. For more information, go to ToxFAQs at http://www.atsdr.cdc.gov/.

ATTACHMENT A.
CLEANUP LEVELS FOR THE LEHR OCL SITE

(U.S. EPA Regional Screening Levels, May 2016)

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Acephate	30560-19-1	2.6E+02	-
Acetaldehyde	75-07-0	4.9E+01	5.6E+00
Acetochlor	34256-82-1	1.6E+04	-
Acetone	67-64-1	6.7E+05	1.4E+05
Acetone Cyanohydrin	75-86-5	1.2E+07	8.8E+00
Acetonitrile	75-05-8	3.4E+03	2.6E+02
Acetophenone	98-86-2	1.2E+05	-
Acetylaminofluorene, 2-	53-96-3	6.0E-01	9.4E-03
Acrolein	107-02-8	6.0E-01	8.8E-02
Acrylamide	79-06-1	4.6E+00	1.2E-01
Acrylic Acid	79-10-7	4.2E+02	4.4E+00
Acrylonitrile	107-13-1	1.1E+00	1.8E-01
Adiponitrile	111-69-3	3.6E+07	2.6E+01
Alachlor	15972-60-8	4.1E+01	-
Aldicarb	116-06-3	8.2E+02	-
Aldicarb Sulfone	1646-88-4	8.2E+02	-
Aldicarb sulfoxide	1646-87-3	-	-
Aldrin	309-00-2	1.8E-01	2.5E-03
Allyl Alcohol	107-18-6	1.5E+01	4.4E-01
Allyl Chloride	107-05-1	3.2E+00	2.00E+00
Aluminum	7429-90-5	1.1E+06	2.2E+01
Aluminum Phosphide	20859-73-8	4.7E+02	-
Ametryn	834-12-8	7.4E+03	-
Aminobiphenyl, 4-	92-67-1	1.1E-01	2.0E-03
Aminophenol, m-	591-27-5	6.6E+04	-
Aminophenol, p-	123-30-8	1.6E+04	-
Amitraz	33089-61-1	2.1E+03	-
Ammonia	7664-41-7	-	4.4E+02
Ammonium Sulfamate	7773-06-0	2.3E+05	-
Amyl Alcohol, tert-	75-85-4	3.4E+02	1.3E+01
Aniline	62-53-3	4.0E+02	4.4E+00
Anthraquinone, 9,10-	84-65-1	5.7E+01	-
Antimony (metallic)	7440-36-0	4.7E+02	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Antimony Pentoxide	1314-60-9	5.8E+02	-
Antimony Tetroxide	1332-81-6	4.7E+02	-
Antimony Trioxide	1309-64-4	1.2E+06	8.8E-01
Arsenic, Inorganic	7440-38-2	3.0E+00	2.9E-03
Arsine	7784-42-1	4.1E+00	2.2E-01
Asulam	3337-71-1	4.1E+04	-
Atrazine	1912-24-9	1.0E+01	-
Auramine	492-80-8	2.6E+00	4.9E-02
Avermectin B1	65195-55-3	3.3E+02	-
Azinphos-methyl	86-50-0	2.5E+03	4.4E+01
Azobenzene	103-33-3	2.6E+01	4.0E-01
Azodicarbonamide	123-77-3	4.0E+04	3.1E-02
Barium	7440-39-3	2.2E+05	2.2E+00
Barium Chromate	10294-40-3	6.2E+00	8.2E-05
Benfluralin	1861-40-1	3.5E+05	-
Benomyl	17804-35-2	4.1E+04	-
Bensulfuron-methyl	83055-99-6	1.6E+05	-
Bentazon	25057-89-0	2.5E+04	-
Benzaldehyde	100-52-7	8.2E+02	-
Benzene	71-43-2	5.1E+00	1.6E+00
Benzenediamine-2-methyl sulfate, 1,4-	6369-59-1	2.3E+01	-
Benzenethiol	108-98-5	1.2E+03	-
Benzidine	92-87-5	1.0E-02	1.8E-04
Benzoic Acid	65-85-0	3.3E+06	-
Benzotrichloride	98-07-7	2.5E-01	-
Benzyl Alcohol	100-51-6	8.2E+04	-
Benzyl Chloride	100-44-7	4.8E+00	2.5E-01
Beryllium and compounds	7440-41-7	2.3E+03	5.1E-03
Bifenox	42576-02-3	7.4E+03	-
Biphenthrin	82657-04-3	1.2E+04	-
Biphenyl, 1,1'-	92-52-4	2.0E+02	1.8E+00
Bis(2-chloro-1-methylethyl) ether	108-60-1	4.7E+04	-
Bis(2-chloroethoxy)methane	111-91-1	2.5E+03	-
Bis(2-chloroethyl)ether	111-44-4	1.0E+00	3.7E-02
Bis(chloromethyl)ether	542-88-1	3.6E-04	2.0E-04
Bisphenol A	80-05-7	4.1E+04	-
Boron And Borates Only	7440-42-8	2.3E+05	8.8E+01
Boron Trichloride	10294-34-5	2.3E+06	8.8E+01

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Boron Trifluoride	7637-07-2	4.7E+04	5.7E+01
Bromate	15541-45-4	4.7E+00	-
Bromo-2-chloroethane, 1-	107-04-0	1.1E-01	2.0E-02
Bromobenzene	108-86-1	1.8E+03	2.6E+02
Bromochloromethane	74-97-5	6.3E+02	1.8E+02
Bromodichloromethane	75-27-4	1.3E+00	3.3E-01
Bromoform	75-25-2	8.6E+01	1.1E+01
Bromomethane	74-83-9	3.0E+01	2.2E+01
Bromophos	2104-96-3	5.8E+03	-
Bromoxynil	1689-84-5	1.6E+04	-
Bromoxynil Octanoate	1689-99-2	2.3E+04	-
Butadiene, 1,3-	106-99-0	2.6E-01	4.1E-01
Butanol, N-	71-36-3	1.2E+05	-
Butyl alcohol, sec-	78-92-2	1.5E+06	1.3E+05
Butylate	2008-41-5	5.8E+04	-
Butylated hydroxyanisole	25013-16-5	1.1E+04	2.2E+02
Butylated hydroxytoluene	128-37-0	6.4E+02	-
Butylbenzene, n-	104-51-8	5.8E+04	-
Butylbenzene, sec-	135-98-8	1.2E+05	-
Butylbenzene, tert-	98-06-6	1.2E+05	-
Cacodylic Acid	75-60-5	1.6E+04	-
Cadmium (Diet)	7440-43-9	9.8E+02	-
Cadmium (Water)	7440-43-9	-	6.8E-03
Calcium Chromate	13765-19-0	6.2E+00	8.2E-05
Caprolactam	105-60-2	4.0E+05	9.6E+00
Captafol	2425-06-1	1.5E+01	2.9E-01
Captan	133-06-2	1.0E+03	1.9E+01
Carbaryl	63-25-2	8.2E+04	-
Carbofuran	1563-66-2	4.1E+03	-
Carbon Disulfide	75-15-0	3.5E+03	3.1E+03
Carbon Tetrachloride	56-23-5	2.9E+00	2.0E+00
Carbonyl Sulfide	463-58-1	2.8E+02	4.4E+02
Carbosulfan	55285-14-8	8.2E+03	-
Carboxin	5234-68-4	8.2E+04	-
Ceric oxide	1306-38-3	5.4E+06	3.9E+00
Chloral Hydrate	302-17-0	1.2E+05	-
Chloramben	133-90-4	1.2E+04	-
Chloranil	118-75-2	5.7E+00	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Chlordane	12789-03-6	7.7E+00	1.2E-01
Chlordecone (Kepone)	143-50-0	2.3E-01	2.7E-03
Chlorfenvinphos	470-90-6	5.7E+02	-
Chlorimuron, Ethyl-	90982-32-4	1.6E+04	-
Chlorine	7782-50-5	7.8E-01	6.4E-01
Chlorine Dioxide	10049-04-4	3.4E+04	8.8E-01
Chlorite (Sodium Salt)	7758-19-2	3.5E+04	-
Chloro-1,1-difluoroethane, 1-	75-68-3	2.3E+05	2.2E+05
Chloro-1,3-butadiene, 2-	126-99-8	4.4E-02	4.1E-02
Chloro-2-methylaniline HCl, 4-	3165-93-3	5.0E+00	-
Chloro-2-methylaniline, 4-	95-69-2	2.3E+01	1.6E-01
Chloroacetaldehyde, 2-	107-20-0	1.2E+01	-
Chloroacetic Acid	79-11-8	-	-
Chloroacetophenone, 2-	532-27-4	1.8E+05	1.3E-01
Chloroaniline, p-	106-47-8	1.1E+01	-
Chlorobenzene	108-90-7	1.3E+03	2.2E+02
Chlorobenzilate	510-15-6	2.1E+01	4.0E-01
Chlorobenzoic Acid, p-	74-11-3	2.5E+04	-
Chlorobenzotrifluoride, 4-	98-56-6	2.5E+03	1.3E+03
Chlorobutane, 1-	109-69-3	4.7E+04	-
Chlorodifluoromethane	75-45-6	2.1E+05	2.2E+05
Chloroethanol, 2-	107-07-3	2.3E+04	-
Chloroform	67-66-3	1.4E+00	5.3E-01
Chloromethane	74-87-3	4.6E+02	3.9E+02
Chloromethyl Methyl Ether	107-30-2	8.9E-02	1.8E-02
Chloronitrobenzene, o-	88-73-3	7.7E+00	4.4E-02
Chloronitrobenzene, p-	100-00-5	3.8E+01	8.8E+00
Chlorophenol, 2-	95-57-8	5.8E+03	-
Chloropicrin	76-06-2	8.2E+00	1.8E+00
Chlorothalonil	1897-45-6	7.4E+02	1.4E+01
Chlorotoluene, o-	95-49-8	2.3E+04	-
Chlorotoluene, p-	106-43-4	2.3E+04	-
Chlorozotocin	54749-90-5	9.6E-03	1.8E-04
Chlorpropham	101-21-3	1.6E+05	-
Chlorpyrifos	2921-88-2	8.2E+02	-
Chlorpyrifos Methyl	5598-13-0	8.2E+03	-
Chlorsulfuron	64902-72-3	4.1E+04	-
Chlorthal-dimethyl	1861-32-1	8.2E+03	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Chlorthiophos	60238-56-4	6.6E+02	-
Chromium(III), Insoluble Salts	16065-83-1	1.8E+06	-
Chromium(VI)	18540-29-9	6.3E+00	1.5E-04
Chromium, Total	7440-47-3	-	-
Clofentezine	74115-24-5	1.1E+04	-
Cobalt	7440-48-4	3.5E+02	1.4E-03
Coke Oven Emissions	8007-45-2	-	2.0E-02
Copper	7440-50-8	4.7E+04	-
Cresol, m-	108-39-4	4.1E+04	2.6E+03
Cresol, o-	95-48-7	4.1E+04	2.6E+03
Cresol, p-	106-44-5	8.2E+04	2.6E+03
Cresol, p-chloro-m-	59-50-7	8.2E+04	-
Cresols	1319-77-3	8.2E+04	2.6E+03
Crotonaldehyde, trans-	123-73-9	1.7E+00	-
Cumene	98-82-8	9.9E+03	1.8E+03
Cupferron	135-20-6	1.0E+01	1.9E-01
Cyanazine	21725-46-2	2.7E+00	-
Cyanides			
~Calcium Cyanide	592-01-8	1.2E+03	-
~Copper Cyanide	544-92-3	5.8E+03	-
~Cyanide (CN-)	57-12-5	1.5E+02	3.5E+00
~Cyanogen	460-19-5	1.2E+03	-
~Cyanogen Bromide	506-68-3	1.1E+05	-
~Cyanogen Chloride	506-77-4	5.8E+04	-
~Hydrogen Cyanide	74-90-8	1.5E+02	3.5E+00
~Potassium Cyanide	151-50-8	2.3E+03	-
~Potassium Silver Cyanide	506-61-6	5.8E+03	-
~Silver Cyanide	506-64-9	1.2E+05	-
~Sodium Cyanide	143-33-9	1.2E+03	-
~Thiocyanates	NA	2.3E+02	-
~Thiocyanic Acid	463-56-9	2.3E+02	-
~Zinc Cyanide	557-21-1	5.8E+04	-
Cyclohexane	110-82-7	2.7E+04	2.6E+04
Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	1.0E+02	-
Cyclohexanone	108-94-1	1.3E+05	3.1E+03
Cyclohexene	110-83-8	3.1E+03	4.4E+03
Cyclohexylamine	108-91-8	2.3E+05	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Cyfluthrin	68359-37-5	2.1E+04	-
Cyhalothrin	68085-85-8	4.1E+03	-
Cypermethrin	52315-07-8	8.2E+03	-
Cyromazine	66215-27-8	6.2E+03	-
DDD	72-54-8	9.6E+00	1.8E-01
DDE, p,p'-	72-55-9	9.3E+00	1.3E-01
DDT	50-29-3	8.5E+00	1.3E-01
Dalapon	75-99-0	2.5E+04	-
Daminozide	1596-84-5	1.3E+02	2.4E+00
Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	3.3E+03	-
Demeton	8065-48-3	3.3E+01	-
Di(2-ethylhexyl)adipate	103-23-1	1.9E+03	-
Diallate	2303-16-4	3.8E+01	-
Diazinon	333-41-5	5.7E+02	-
Dibenzothiophene	132-65-0	1.2E+04	-
Dibromo-3-chloropropane, 1,2-	96-12-8	6.4E-02	2.0E-03
Dibromobenzene, 1,3-	108-36-1	4.7E+02	-
Dibromobenzene, 1,4-	106-37-6	1.2E+04	-
Dibromochloromethane	124-48-1	3.9E+01	-
Dibromoethane, 1,2-	106-93-4	1.6E-01	2.0E-02
Dibromomethane (Methylene Bromide)	74-95-3	9.9E+01	1.8E+01
Dibutyltin Compounds	NA	2.5E+02	-
Dicamba	1918-00-9	2.5E+04	-
Dichloro-2-butene, 1,4-	764-41-0	9.4E-03	2.9E-03
Dichloro-2-butene, cis-1,4-	1476-11-5	3.2E-02	2.9E-03
Dichloro-2-butene, trans-1,4-	110-57-6	3.2E-02	2.9E-03
Dichloroacetic Acid	79-43-6	4.6E+01	-
Dichlorobenzene, 1,2-	95-50-1	9.3E+03	8.8E+02
Dichlorobenzene, 1,4-	106-46-7	1.1E+01	1.1E+00
Dichlorobenzidine, 3,3'-	91-94-1	5.1E+00	3.6E-02
Dichlorobenzophenone, 4,4'-	90-98-2	7.4E+03	-
Dichlorodifluoromethane	75-71-8	3.7E+02	4.4E+02
Dichloroethane, 1,1-	75-34-3	1.6E+01	7.7E+00
Dichloroethane, 1,2-	107-06-2	2.0E+00	4.7E-01
Dichloroethylene, 1,1-	75-35-4	1.0E+03	8.8E+02
Dichloroethylene, 1,2-cis-	156-59-2	2.3E+03	-
Dichloroethylene, 1,2-trans-	156-60-5	2.3E+04	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Dichlorophenol, 2,4-	120-83-2	2.5E+03	-
Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	9.6E+03	-
Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6	6.6E+03	-
Dichloropropane, 1,2-	78-87-5	4.4E+00	1.2E+00
Dichloropropane, 1,3-	142-28-9	2.3E+04	-
Dichloropropanol, 2,3-	616-23-9	2.5E+03	-
Dichloropropene, 1,3-	542-75-6	8.2E+00	3.1E+00
Dichlorvos	62-73-7	7.9E+00	1.5E-01
Dicrotophos	141-66-2	8.2E+01	-
Dicyclopentadiene	77-73-6	5.4E+00	1.3E+00
Dieldrin	60-57-1	1.4E-01	2.7E-03
Diesel Engine Exhaust	NA	-	4.1E-02
Diethanolamine	111-42-2	1.6E+03	8.8E-01
Diethylene Glycol Monobutyl Ether	112-34-5	2.4E+04	4.4E-01
Diethylene Glycol Monoethyl Ether	111-90-0	4.8E+04	1.3E+00
Diethylformamide	617-84-5	1.2E+03	-
Diethylstilbestrol	56-53-1	6.6E-03	1.2E-04
Difenzoquat	43222-48-6	6.6E+04	-
Diflubenzuron	35367-38-5	1.6E+04	-
Difluoroethane, 1,1-	75-37-6	2.0E+05	1.8E+05
Dihydrosafrole	94-58-6	4.5E+01	9.4E-01
Diisopropyl Ether	108-20-3	9.4E+03	3.1E+03
Diisopropyl Methylphosphonate	1445-75-6	9.3E+04	-
Dimethipin	55290-64-7	1.6E+04	-
Dimethoate	60-51-5	1.6E+02	-
Dimethoxybenzidine, 3,3'-	119-90-4	1.4E+00	-
Dimethyl methylphosphonate	756-79-6	1.4E+03	-
Dimethylamino azobenzene [p-]	60-11-7	5.0E-01	9.4E-03
Dimethylaniline HCl, 2,4-	21436-96-4	4.0E+00	-
Dimethylaniline, 2,4-	95-68-1	1.1E+01	-
Dimethylaniline, N,N-	121-69-7	2.3E+03	-
Dimethylbenzidine, 3,3'-	119-93-7	2.1E-01	-
Dimethylformamide	68-12-2	1.5E+04	1.3E+02
Dimethylhydrazine, 1,1-	57-14-7	2.4E-01	8.8E-03
Dimethylhydrazine, 1,2-	540-73-8	4.1E-03	7.7E-05
Dimethylphenol, 2,4-	105-67-9	1.6E+04	-
Dimethylphenol, 2,6-	576-26-1	4.9E+02	-
Dimethylphenol, 3,4-	95-65-8	8.2E+02	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Dimethylvinylchloride	513-37-1	4.8E+00	9.4E-01
Dinitro-o-cresol, 4,6-	534-52-1	6.6E+01	-
Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5	1.6E+03	-
Dinitrobenzene, 1,2-	528-29-0	8.2E+01	-
Dinitrobenzene, 1,3-	99-65-0	8.2E+01	-
Dinitrobenzene, 1,4-	100-25-4	8.2E+01	-
Dinitrophenol, 2,4-	51-28-5	1.6E+03	-
Dinitrotoluene Mixture, 2,4/2,6-	NA	3.4E+00	-
Dinitrotoluene, 2,4-	121-14-2	7.4E+00	1.4E-01
Dinitrotoluene, 2,6-	606-20-2	1.5E+00	-
Dinitrotoluene, 2-Amino-4,6-	35572-78-2	2.3E+03	-
Dinitrotoluene, 4-Amino-2,6-	19406-51-0	2.3E+03	-
Dinitrotoluene, Technical grade	25321-14-6	5.1E+00	-
Dinoseb	88-85-7	8.2E+02	-
Dioxane, 1,4-	123-91-1	2.4E+01	2.5E+00
Dioxins			
~Hexachlorodibenzo-p-dioxin, Mixture	NA	4.7E-04	9.4E-06
~TCDD, 2,3,7,8-	1746-01-6	2.2E-05	3.2E-07
Diphenamid	957-51-7	2.5E+04	-
Diphenyl Sulfone	127-63-9	6.6E+02	-
Diphenylamine	122-39-4	2.1E+04	-
Diphenylhydrazine, 1,2-	122-66-7	2.9E+00	5.6E-02
Diquat	85-00-7	1.8E+03	-
Direct Black 38	1937-37-7	3.2E-01	8.8E-05
Direct Blue 6	2602-46-2	3.1E-01	8.8E-05
Direct Brown 95	16071-86-6	3.4E-01	8.8E-05
Disulfoton	298-04-4	3.3E+01	-
Dithiane, 1,4-	505-29-3	1.2E+04	-
Diuron	330-54-1	1.6E+03	-
Dodine	2439-10-3	3.3E+03	-
EPTC	759-94-4	2.9E+04	-
Endosulfan	115-29-7	7.0E+03	-
Endothall	145-73-3	1.6E+04	-
Endrin	72-20-8	2.5E+02	-
Epichlorohydrin	106-89-8	8.2E+01	4.4E+00
Epoxybutane, 1,2-	106-88-7	6.7E+02	8.8E+01
Ethanol, 2-(2-methoxyethoxy)-	111-77-3	3.3E+04	-
Ethephon	16672-87-0	4.1E+03	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Ethion	563-12-2	4.1E+02	-
Ethoxyethanol Acetate, 2-	111-15-9	1.4E+04	2.6E+02
Ethoxyethanol, 2-	110-80-5	4.7E+04	8.8E+02
Ethyl Acetate	141-78-6	2.6E+03	3.1E+02
Ethyl Acrylate	140-88-5	2.1E+02	3.5E+01
Ethyl Chloride (Chloroethane)	75-00-3	5.7E+04	4.4E+04
Ethyl Ether	60-29-7	2.3E+05	-
Ethyl Methacrylate	97-63-2	7.6E+03	1.3E+03
Ethyl-p-nitrophenyl Phosphonate	2104-64-5	8.2E+00	-
Ethylbenzene	100-41-4	2.5E+01	4.9E+00
Ethylene Cyanohydrin	109-78-4	5.7E+04	-
Ethylene Diamine	107-15-3	1.1E+05	-
Ethylene Glycol	107-21-1	1.6E+06	1.8E+03
Ethylene Glycol Monobutyl Ether	111-76-2	8.2E+04	7.0E+03
Ethylene Oxide	75-21-8	7.9E-01	1.4E-01
Ethylene Thiourea	96-45-7	5.1E+01	9.4E-01
Ethyleneimine	151-56-4	1.2E-02	6.5E-04
Ethylphthalyl Ethyl Glycolate	84-72-0	2.5E+06	-
Fenamiphos	22224-92-6	2.1E+02	-
Fenpropathrin	39515-41-8	2.1E+04	-
Fenvalerate	51630-58-1	2.1E+04	-
Fluometuron	2164-17-2	1.1E+04	-
Fluoride	16984-48-8	4.7E+04	5.7E+01
Fluorine (Soluble Fluoride)	7782-41-4	7.0E+04	5.7E+01
Fluridone	59756-60-4	6.6E+04	-
Flurprimidol	56425-91-3	1.6E+04	-
Flusilazole	85509-19-9	5.7E+02	-
Flutolanil	66332-96-5	4.9E+04	-
Fluvalinate	69409-94-5	8.2E+03	-
Folpet	133-07-3	6.6E+02	-
Fomesafen	72178-02-0	1.2E+01	-
Fonofos	944-22-9	1.6E+03	-
Formaldehyde	50-00-0	7.3E+01	9.4E-01
Formic Acid	64-18-6	1.2E+02	1.3E+00
Fosetyl-AL	39148-24-8	2.5E+06	-
Furans			
~Dibenzofuran	132-64-9	1.0E+03	-
~Furan	110-00-9	1.0E+03	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
~Tetrahydrofuran	109-99-9	9.4E+04	8.8E+03
Furazolidone	67-45-8	6.0E-01	-
Furfural	98-01-1	2.6E+03	2.2E+02
Furium	531-82-8	1.5E+00	2.9E-02
Furmecyclox	60568-05-0	7.7E+01	1.4E+00
Glufosinate, Ammonium	77182-82-2	3.3E+02	-
Glutaraldehyde	111-30-8	4.8E+05	3.5E-01
Glycidyl	765-34-4	2.1E+02	4.4E+00
Glyphosate	1071-83-6	8.2E+04	-
Guanidine	113-00-8	1.2E+04	-
Guanidine Chloride	50-01-1	1.6E+04	-
Haloxyfop, Methyl	69806-40-2	4.1E+01	-
Heptachlor	76-44-8	6.3E-01	9.4E-03
Heptachlor Epoxide	1024-57-3	3.3E-01	4.7E-03
Hexabromobenzene	87-82-1	2.3E+03	-
Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2	1.6E+02	-
Hexachlorobenzene	118-74-1	9.6E-01	2.7E-02
Hexachlorobutadiene	87-68-3	5.3E+00	5.6E-01
Hexachlorocyclohexane, Alpha-	319-84-6	3.6E-01	6.8E-03
Hexachlorocyclohexane, Beta-	319-85-7	1.3E+00	2.3E-02
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	2.5E+00	4.0E-02
Hexachlorocyclohexane, Technical	608-73-1	1.3E+00	2.4E-02
Hexachlorocyclopentadiene	77-47-4	7.5E+00	8.8E-01
Hexachloroethane	67-72-1	8.0E+00	1.1E+00
Hexachlorophene	70-30-4	2.5E+02	-
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	2.8E+01	-
Hexamethylene Diisocyanate, 1,6-	822-06-0	1.3E+01	4.4E-02
Hexamethylphosphoramide	680-31-9	3.3E+02	-
Hexane, N-	110-54-3	2.5E+03	3.1E+03
Hexanedioic Acid	124-04-9	1.6E+06	-
Hexanone, 2-	591-78-6	1.3E+03	1.3E+02
Hexazinone	51235-04-2	2.7E+04	-
Hexythiazox	78587-05-0	2.1E+04	-
Hydramethylnon	67485-29-4	2.5E+02	-
Hydrazine	302-01-2	1.1E+00	2.5E-03
Hydrazine Sulfate	10034-93-2	1.1E+00	2.5E-03

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Hydrogen Chloride	7647-01-0	1.2E+08	8.8E+01
Hydrogen Fluoride	7664-39-3	4.7E+04	6.1E+01
Hydrogen Sulfide	7783-06-4	1.2E+07	8.8E+00
Hydroquinone	123-31-9	3.8E+01	-
Imazalil	35554-44-0	1.1E+04	-
Imazaquin	81335-37-7	2.1E+05	-
Imazethapyr	81335-77-5	2.1E+05	-
Iodine	7553-56-2	1.2E+04	-
Iprodione	36734-19-7	3.3E+04	-
Iron	7439-89-6	8.2E+05	-
Isobutyl Alcohol	78-83-1	3.5E+05	-
Isophorone	78-59-1	2.4E+03	8.8E+03
Isopropalin	33820-53-0	1.8E+04	-
Isopropanol	67-63-0	2.4E+04	8.8E+02
Isopropyl Methyl Phosphonic Acid	1832-54-8	8.2E+04	-
Isoxaben	82558-50-7	4.1E+04	-
JP-7	NA	1.8E+09	1.3E+03
Lactofen	77501-63-4	1.6E+03	-
Lead Compounds			
~Lead Chromate	7758-97-6	6.2E+00	8.2E-05
~Lead Phosphate	7446-27-7	3.8E+02	1.0E+00
~Lead acetate	301-04-2	2.7E+02	1.0E+00
~Lead and Compounds	7439-92-1	3.2E+02 [1]	-
~Lead subacetate	1335-32-6	2.7E+02	1.0E+00
~Tetraethyl Lead	78-00-2	1.2E-01	-
Lewisite	541-25-3	5.8E+00	-
Linuron	330-55-2	1.6E+03	-
Lithium	7439-93-2	2.3E+03	-
MCPA	94-74-6	4.1E+02	-
MCPB	94-81-5	8.2E+03	-
MCPP	93-65-2	8.2E+02	-
Malathion	121-75-5	1.6E+04	-
Maleic Anhydride	108-31-6	8.0E+04	3.1E+00
Maleic Hydrazide	123-33-1	4.1E+05	-
Malononitrile	109-77-3	8.2E+01	-
Mancozeb	8018-01-7	2.5E+04	-
Maneb	12427-38-2	4.1E+03	-
Manganese (Diet)	7439-96-5	-	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Manganese (Non-diet)	7439-96-5	2.6E+04	2.2E-01
Mephosfolan	950-10-7	7.4E+01	-
Mepiquat Chloride	24307-26-4	2.5E+04	-
Mercury Compounds			
~Mercuric Chloride (and other Mercury salts)	7487-94-7	3.5E+02	1.3E+00
~Mercury (elemental)	7439-97-6	4.6E+01	1.3E+00
~Methyl Mercury	22967-92-6	1.2E+02	-
~Phenylmercuric Acetate	62-38-4	6.6E+01	-
Merphos	150-50-5	3.5E+01	-
Merphos Oxide	78-48-8	2.5E+01	-
Metalaxyl	57837-19-1	4.9E+04	-
Methacrylonitrile	126-98-7	1.0E+02	1.3E+02
Methamidophos	10265-92-6	4.1E+01	-
Methanol	67-56-1	1.2E+06	8.8E+04
Methidathion	950-37-8	8.2E+02	-
Methomyl	16752-77-5	2.1E+04	-
Methoxy-5-nitroaniline, 2-	99-59-2	4.7E+01	8.8E-01
Methoxychlor	72-43-5	4.1E+03	-
Methoxyethanol Acetate, 2-	110-49-6	5.1E+02	4.4E+00
Methoxyethanol, 2-	109-86-4	3.5E+03	8.8E+01
Methyl Acetate	79-20-9	1.2E+06	-
Methyl Acrylate	96-33-3	6.1E+02	8.8E+01
Methyl Ethyl Ketone (2-Butanone)	78-93-3	1.9E+05	2.2E+04
Methyl Hydrazine	60-34-4	6.2E-01	1.2E-02
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	1.4E+05	1.3E+04
Methyl Isocyanate	624-83-9	1.9E+01	4.4E+00
Methyl Methacrylate	80-62-6	1.9E+04	3.1E+03
Methyl Parathion	298-00-0	2.1E+02	-
Methyl Phosphonic Acid	993-13-5	4.9E+04	-
Methyl Styrene (Mixed Isomers)	25013-15-4	2.6E+03	1.8E+02
Methyl methanesulfonate	66-27-3	2.3E+01	4.4E-01
Methyl tert-Butyl Ether (MTBE)	1634-04-4	2.1E+02	4.7E+01
Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2	2.5E+02	-
Methyl-5-Nitroaniline, 2-	99-55-8	2.6E+02	-
Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	2.8E-01	5.1E-03
Methylaniline Hydrochloride, 2-	636-21-5	1.8E+01	3.3E-01

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Methylarsonic acid	124-58-3	8.2E+03	-
Methylbenzene,1-4-diamine monohydrochloride, 2-	74612-12-7	1.6E+02	-
Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	2.3E+01	-
Methylcholanthrene, 3-	56-49-5	1.0E-01	1.9E-03
Methylene Chloride	75-09-2	1.0E+03	1.2E+03
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	2.3E+01	2.9E-02
Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	5.0E+01	9.4E-01
Methylenebisbenzenamine, 4,4'-	101-77-9	1.4E+00	2.7E-02
Methylenediphenyl Diisocyanate	101-68-8	3.6E+06	2.6E+00
Methylstyrene, Alpha-	98-83-9	8.2E+04	-
Metolachlor	51218-45-2	1.2E+05	-
Metribuzin	21087-64-9	2.1E+04	-
Metsulfuron-methyl	74223-64-6	2.1E+05	-
Mineral oils	8012-95-1	3.5E+06	-
Mirex	2385-85-5	1.7E-01	2.4E-03
Molinate	2212-67-1	1.6E+03	-
Molybdenum	7439-98-7	5.8E+03	-
Monochloramine	10599-90-3	1.2E+05	-
Monomethylaniline	100-61-8	1.6E+03	-
Myclobutanil	88671-89-0	2.1E+04	-
N,N'-Diphenyl-1,4-benzenediamine	74-31-7	2.5E+02	-
Naled	300-76-5	2.3E+03	-
Naphtha, High Flash Aromatic (HFAN)	64742-95-6	3.5E+04	4.4E+02
Naphthylamine, 2-	91-59-8	1.3E+00	-
Napropamide	15299-99-7	8.2E+04	-
Nickel Acetate	373-02-4	8.1E+03	4.7E-02
Nickel Carbonate	3333-67-3	8.1E+03	4.7E-02
Nickel Carbonyl	13463-39-3	1.1E+04	4.7E-02
Nickel Hydroxide	12054-48-7	1.1E+04	4.7E-02
Nickel Oxide	1313-99-1	1.2E+04	4.7E-02
Nickel Refinery Dust	NA	1.1E+04	5.1E-02
Nickel Soluble Salts	7440-02-0	2.2E+04	4.7E-02
Nickel Subsulfide	12035-72-2	1.9E+00	2.6E-02
Nickelocene	1271-28-9	8.1E+03	4.7E-02
Nitrate	14797-55-8	1.9E+06	-
Nitrate + Nitrite (as N)	NA	-	-
Nitrite	14797-65-0	1.2E+05	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Nitroaniline, 2-	88-74-4	8.0E+03	2.2E-01
Nitroaniline, 4-	100-01-6	1.1E+02	2.6E+01
Nitrobenzene	98-95-3	2.2E+01	3.1E-01
Nitrocellulose	9004-70-0	2.5E+09	-
Nitrofurantoin	67-20-9	5.7E+04	-
Nitrofurazone	59-87-0	1.8E+00	3.3E-02
Nitroglycerin	55-63-0	8.2E+01	-
Nitroguanidine	556-88-7	8.2E+04	-
Nitromethane	75-52-5	2.4E+01	1.4E+00
Nitropropane, 2-	79-46-9	6.0E-02	4.5E-03
Nitroso-N-ethylurea, N-	759-73-9	8.5E-02	1.6E-03
Nitroso-N-methylurea, N-	684-93-5	1.9E-02	3.6E-04
Nitroso-di-N-butylamine, N-	924-16-3	4.6E-01	7.7E-03
Nitroso-di-N-propylamine, N-	621-64-7	3.3E-01	6.1E-03
Nitrosodiethanolamine, N-	1116-54-7	8.2E-01	1.5E-02
Nitrosodiethylamine, N-	55-18-5	1.5E-02	2.9E-04
Nitrosodimethylamine, N-	62-75-9	3.4E-02	8.8E-04
Nitrosodiphenylamine, N-	86-30-6	4.7E+02	4.7E+00
Nitrosomethylethylamine, N-	10595-95-6	9.1E-02	1.9E-03
Nitrosomorpholine [N-]	59-89-2	3.4E-01	6.5E-03
Nitrosopiperidine [N-]	100-75-4	2.4E-01	4.5E-03
Nitrosopyrrolidine, N-	930-55-2	1.1E+00	2.0E-02
Nitrotoluene, m-	99-08-1	8.2E+01	-
Nitrotoluene, o-	88-72-2	1.5E+01	-
Nitrotoluene, p-	99-99-0	1.4E+02	-
Nonane, n-	111-84-2	7.2E+01	8.8E+01
Norflurazon	27314-13-2	3.3E+04	-
Octabromodiphenyl Ether	32536-52-0	2.5E+03	-
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	5.7E+04	-
Octamethylpyrophosphoramide	152-16-9	1.6E+03	-
Oryzalin	19044-88-3	4.1E+04	-
Oxadiazon	19666-30-9	4.1E+03	-
Oxamyl	23135-22-0	2.1E+04	-
Oxyfluorfen	42874-03-3	2.5E+03	-
Paclobutrazol	76738-62-0	1.1E+04	-
Paraquat Dichloride	1910-42-5	3.7E+03	-
Parathion	56-38-2	4.9E+03	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Pebulate	1114-71-2	5.8E+04	-
Pendimethalin	40487-42-1	3.3E+04	-
Pentabromodiphenyl Ether	32534-81-9	2.3E+03	-
Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9	8.2E+01	-
Pentachlorobenzene	608-93-5	9.3E+02	-
Pentachloroethane	76-01-7	3.6E+01	-
Pentachloronitrobenzene	82-68-8	1.3E+01	-
Pentachlorophenol	87-86-5	4.0E+00	2.4E+00
Pentaerythritol tetranitrate (PETN)	78-11-5	5.7E+02	-
Pentane, n-	109-66-0	3.4E+03	4.4E+03
Perchlorates			
~Ammonium Perchlorate	7790-98-9	8.2E+02	-
~Lithium Perchlorate	7791-03-9	8.2E+02	-
~Perchlorate and Perchlorate Salts	14797-73-0	8.2E+02	-
~Potassium Perchlorate	7778-74-7	8.2E+02	-
~Sodium Perchlorate	7601-89-0	8.2E+02	-
Perfluorobutane Sulfonate	375-73-5	2.3E+04	-
Permethrin	52645-53-1	4.1E+04	-
Phenacetin	62-44-2	1.0E+03	1.9E+01
Phenmedipham	13684-63-4	2.1E+05	-
Phenol	108-95-2	2.5E+05	8.8E+02
Phenol, 2-(1-methylethoxy)-, methylcarbamate	114-26-1	3.3E+03	-
Phenothiazine	92-84-2	4.1E+02	-
Phenylenediamine, m-	108-45-2	4.9E+03	-
Phenylenediamine, o-	95-54-5	4.9E+01	-
Phenylenediamine, p-	106-50-3	1.6E+05	-
Phenylphenol, 2-	90-43-7	1.2E+03	-
Phorate	298-02-2	1.6E+02	-
Phosgene	75-44-5	1.3E+00	1.3E+00
Phosmet	732-11-6	1.6E+04	-
Phosphates, Inorganic			
~Aluminum metaphosphate	13776-88-0	5.7E+07	-
~Ammonium polyphosphate	68333-79-9	5.7E+07	-
~Calcium pyrophosphate	7790-76-3	5.7E+07	-
~Diammonium phosphate	7783-28-0	5.7E+07	-
~Dicalcium phosphate	7757-93-9	5.7E+07	-
~Dimagnesium phosphate	7782-75-4	5.7E+07	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
~Dipotassium phosphate	7758-11-4	5.7E+07	-
~Disodium phosphate	7558-79-4	5.7E+07	-
~Monoaluminum phosphate	13530-50-2	5.7E+07	-
~Monoammonium phosphate	7722-76-1	5.7E+07	-
~Monocalcium phosphate	7758-23-8	5.7E+07	-
~Monomagnesium phosphate	7757-86-0	5.7E+07	-
~Monopotassium phosphate	7778-77-0	5.7E+07	-
~Monosodium phosphate	7558-80-7	5.7E+07	-
~Polyphosphoric acid	8017-16-1	5.7E+07	-
~Potassium tripolyphosphate	13845-36-8	5.7E+07	-
~Sodium acid pyrophosphate	7758-16-9	5.7E+07	-
~Sodium aluminum phosphate (acidic)	7785-88-8	5.7E+07	-
~Sodium aluminum phosphate (anhydrous)	10279-59-1	5.7E+07	-
~Sodium aluminum phosphate (tetrahydrate)	10305-76-7	5.7E+07	-
~Sodium hexametaphosphate	10124-56-8	5.7E+07	-
~Sodium polyphosphate	68915-31-1	5.7E+07	-
~Sodium trimetaphosphate	7785-84-4	5.7E+07	-
~Sodium tripolyphosphate	7758-29-4	5.7E+07	-
~Tetrapotassium phosphate	7320-34-5	5.7E+07	-
~Tetrasodium pyrophosphate	7722-88-5	5.7E+07	-
~Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5	5.7E+07	-
~Tricalcium phosphate	7758-87-4	5.7E+07	-
~Trimagnesium phosphate	7757-87-1	5.7E+07	-
~Tripotassium phosphate	7778-53-2	5.7E+07	-
~Trisodium phosphate	7601-54-9	5.7E+07	-
Phosphine	7803-51-2	3.5E+02	1.3E+00
Phosphoric Acid	7664-38-2	2.9E+07	4.4E+01
Phosphorus, White	7723-14-0	2.3E+01	
Phthalates			
~Bis(2-ethylhexyl)phthalate	117-81-7	1.6E+02	5.1E+00
~Butyl Benzyl Phthalate	85-68-7	1.2E+03	-
~Butylphthalyl Butylglycolate	85-70-1	8.2E+05	-
~Dibutyl Phthalate	84-74-2	8.2E+04	-
~Diethyl Phthalate	84-66-2	6.6E+05	-
~Dimethylterephthalate	120-61-6	1.2E+05	-
~Octyl Phthalate, di-N-	117-84-0	8.2E+03	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
~Phthalic Acid, P-	100-21-0	8.2E+05	-
~Phthalic Anhydride	85-44-9	1.6E+06	8.8E+01
Picloram	1918-02-1	5.7E+04	-
Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3	8.2E+01	-
Picric Acid (2,4,6-Trinitrophenol)	88-89-1	7.4E+02	-
Pirimiphos, Methyl	29232-93-7	8.2E+03	-
Polybrominated Biphenyls	59536-65-1	7.7E-02	1.4E-03
Polychlorinated Biphenyls (PCBs)			
~Aroclor 1016	12674-11-2	2.7E+01	6.1E-01
~Aroclor 1221	11104-28-2	8.3E-01	2.1E-02
~Aroclor 1232	11141-16-5	7.2E-01	2.1E-02
~Aroclor 1242	53469-21-9	9.5E-01	2.1E-02
~Aroclor 1248	12672-29-6	9.5E-01	2.1E-02
~Aroclor 1254	11097-69-1	9.7E-01	2.1E-02
~Aroclor 1260	11096-82-5	9.9E-01	2.1E-02
~Aroclor 5460	11126-42-4	4.4E+02	-
~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	5.2E-01	1.1E-02
~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	5.1E-01	1.1E-02
~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	5.0E-01	1.1E-02
~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	5.0E-01	1.1E-02
~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	5.1E-04	1.1E-05
~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	4.9E-01	1.1E-02
~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	4.9E-01	1.1E-02
~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	4.9E-01	1.1E-02
~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	5.0E-01	1.1E-02
~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	1.5E-04	3.2E-06
~Polychlorinated Biphenyls (high risk)	1336-36-3	9.4E-01	2.1E-02
~Polychlorinated Biphenyls (low risk)	1336-36-3	-	1.2E-01
~Polychlorinated Biphenyls (lowest risk)	1336-36-3	-	6.1E-01
~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	1.6E-01	3.2E-03
~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	4.8E-02	1.1E-03

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9	3.6E+06	2.6E+00
Polynuclear Aromatic Hydrocarbons (PAHs)			
~Acenaphthene	83-32-9	4.5E+04	-
~Anthracene	120-12-7	2.3E+05	-
~Benz[a]anthracene	56-55-3	2.9E+00	1.1E-01
~Benzo(j)fluoranthene	205-82-3	1.8E+00	1.1E-01
~Benzo[a]pyrene	50-32-8	2.9E-01	1.1E-02
~Benzo[b]fluoranthene	205-99-2	2.9E+00	1.1E-01
~Benzo[k]fluoranthene	207-08-9	2.9E+01	1.1E-01
~Chloronaphthalene, Beta-	91-58-7	6.0E+04	-
~Chrysene	218-01-9	2.9E+02	1.1E+00
~Dibenz[a,h]anthracene	53-70-3	2.9E-01	1.0E-02
~Dibenzo(a,e)pyrene	192-65-4	1.8E-01	1.1E-02
~Dimethylbenz(a)anthracene, 7,12-	57-97-6	8.4E-03	1.7E-04
~Fluoranthene	206-44-0	3.0E+04	-
~Fluorene	86-73-7	3.0E+04	-
~Indeno[1,2,3-cd]pyrene	193-39-5	2.9E+00	1.1E-01
~Methylnaphthalene, 1-	90-12-0	7.3E+01	-
~Methylnaphthalene, 2-	91-57-6	3.0E+03	-
~Naphthalene	91-20-3	1.7E+01	3.6E-01
~Nitropyrene, 4-	57835-92-4	1.8E+00	1.1E-01
~Pyrene	129-00-0	2.3E+04	-
Potassium Perfluorobutane Sulfonate	29420-49-3	1.6E+04	-
Prochloraz	67747-09-5	1.5E+01	-
Profluralin	26399-36-0	7.0E+03	-
Prometon	1610-18-0	1.2E+04	-
Prometryn	7287-19-6	3.3E+03	-
Propachlor	1918-16-7	1.1E+04	-
Propanil	709-98-8	4.1E+03	-
Propargite	2312-35-8	1.6E+04	-
Propargyl Alcohol	107-19-7	2.3E+03	-
Propazine	139-40-2	1.6E+04	-
Propham	122-42-9	1.6E+04	-
Propiconazole	60207-90-1	1.1E+04	-
Propionaldehyde	123-38-6	3.1E+02	3.5E+01
Propyl benzene	103-65-1	2.4E+04	4.4E+03
Propylene	115-07-1	9.3E+03	1.3E+04

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Propylene Glycol	57-55-6	1.6E+07	-
Propylene Glycol Dinitrate	6423-43-4	1.6E+06	1.2E+00
Propylene Glycol Monomethyl Ether	107-98-2	3.7E+05	8.8E+03
Propylene Oxide	75-56-9	9.7E+00	3.3E+00
Propyzamide	23950-58-5	6.2E+04	-
Pyridine	110-86-1	1.2E+03	-
Quinalphos	13593-03-8	4.1E+02	-
Quinoline	91-22-5	7.7E-01	-
Quizalofop-ethyl	76578-14-8	7.4E+03	-
Refractory Ceramic Fibers	NA	1.8E+08	1.3E+02
Resmethrin	10453-86-8	2.5E+04	-
Ronnel	299-84-3	5.8E+04	-
Rotenone	83-79-4	3.3E+03	-
Safrole	94-59-7	1.0E+01	1.9E-01
Selenious Acid	7783-00-8	5.8E+03	-
Selenium	7782-49-2	5.8E+03	8.8E+01
Selenium Sulfide	7446-34-6	5.8E+03	8.8E+01
Sethoxydim	74051-80-2	7.4E+04	-
Silica (crystalline, respirable)	7631-86-9	1.8E+07	1.3E+01
Silver	7440-22-4	5.8E+03	-
Simazine	122-34-9	1.9E+01	-
Sodium Acifluorfen	62476-59-9	1.1E+04	-
Sodium Azide	26628-22-8	4.7E+03	-
Sodium Dichromate	10588-01-9	6.2E+00	8.2E-05
Sodium Diethyldithiocarbamate	148-18-5	8.5E+00	-
Sodium Fluoride	7681-49-4	5.8E+04	5.7E+01
Sodium Fluoroacetate	62-74-8	1.6E+01	-
Sodium Metavanadate	13718-26-8	1.2E+03	-
Sodium Tungstate	13472-45-2	9.3E+02	-
Sodium Tungstate Dihydrate	10213-10-2	9.3E+02	-
Stirofos (Tetrachlorovinphos)	961-11-5	9.6E+01	-
Strontium Chromate	7789-06-2	6.2E+00	8.2E-05
Strontium, Stable	7440-24-6	7.0E+05	-
Strychnine	57-24-9	2.5E+02	-
Styrene	100-42-5	3.5E+04	4.4E+03
Styrene-Acrylonitrile (SAN) Trimer	NA	2.5E+03	-
Sulfolane	126-33-0	8.2E+02	8.8E+00
Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9	6.6E+02	-

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Sulfur Trioxide	7446-11-9	6.0E+06	4.4E+00
Sulfuric Acid	7664-93-9	6.0E+06	4.4E+00
Sulfurous acid, 2-chloroethyl 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester	140-57-8	9.2E+01	1.7E+00
TCMTB	21564-17-0	2.5E+04	-
Tebuthiuron	34014-18-1	5.7E+04	-
Temephos	3383-96-8	1.6E+04	-
Terbacil	5902-51-2	1.1E+04	-
Terbufos	13071-79-9	2.9E+01	-
Terbutryn	886-50-0	8.2E+02	-
Tetrabromodiphenyl ether, 2,2',4,4'-(BDE-47)	5436-43-1	8.2E+01	-
Tetrachlorobenzene, 1,2,4,5-	95-94-3	3.5E+02	-
Tetrachloroethane, 1,1,1,2-	630-20-6	8.8E+00	1.7E+00
Tetrachloroethane, 1,1,2,2-	79-34-5	2.7E+00	2.1E-01
Tetrachloroethylene	127-18-4	1.0E+02	4.7E+01
Tetrachlorophenol, 2,3,4,6-	58-90-2	2.5E+04	-
Tetrachlorotoluene, p- alpha, alpha, alpha-	5216-25-1	1.6E-01	-
Tetraethyl Dithiopyrophosphate	3689-24-5	4.1E+02	-
Tetrafluoroethane, 1,1,1,2-	811-97-2	4.3E+05	3.5E+05
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	2.3E+03	-
Thallic Oxide	1314-32-5	2.3E+01	-
Thallium (I) Nitrate	10102-45-1	1.2E+01	-
Thallium (Soluble Salts)	7440-28-0	1.2E+01	-
Thallium Acetate	563-68-8	1.2E+01	-
Thallium Carbonate	6533-73-9	2.3E+01	-
Thallium Chloride	7791-12-0	1.2E+01	-
Thallium Selenite	12039-52-0	1.2E+01	-
Thallium Sulfate	7446-18-6	2.3E+01	-
Thifensulfuron-methyl	79277-27-3	1.1E+04	-
Thiobencarb	28249-77-6	8.2E+03	-
Thiodiglycol	111-48-8	7.9E+04	-
Thiofanox	39196-18-4	2.5E+02	-
Thiophanate, Methyl	23564-05-8	6.6E+04	-
Thiram	137-26-8	4.1E+03	-
Tin	7440-31-5	7.0E+05	-
Titanium Tetrachloride	7550-45-0	6.0E+05	4.4E-01
Toluene	108-88-3	4.7E+04	2.2E+04

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Toluene-2,4-diisocyante	584-84-9	2.7E+01	3.5E-02
Toluene-2,5-diamine	95-70-5	1.3E+01	-
Toluene-2,6-diisocyante	91-08-7	2.2E+01	3.5E-02
Toluidine, o- (Methylaniline, 2-)	95-53-4	1.4E+02	2.4E-01
Toluidine, p-	106-49-0	7.7E+01	-
Total Petroleum Hydrocarbons (Aliphatic High)	NA	3.5E+06	-
Total Petroleum Hydrocarbons (Aliphatic Low)	NA	2.2E+03	2.6E+03
Total Petroleum Hydrocarbons (Aliphatic Medium)	NA	4.4E+02	4.4E+02
Total Petroleum Hydrocarbons (Aromatic High)	NA	3.3E+04	-
Total Petroleum Hydrocarbons (Aromatic Low)	NA	4.2E+02	1.3E+02
Total Petroleum Hydrocarbons (Aromatic Medium)	NA	6.0E+02	1.3E+01
Toxaphene	8001-35-2	2.1E+00	3.8E-02
Tralomethrin	66841-25-6	6.2E+03	-
Tri-n-butyltin	688-73-3	3.5E+02	-
Triacetin	102-76-1	6.6E+07	-
Triadimefon	43121-43-3	2.5E+04	-
Triallate	2303-17-5	1.5E+04	-
Triasulfuron	82097-50-5	8.2E+03	-
Tribenuron-methyl	101200-48-0	6.6E+03	-
Tribromobenzene, 1,2,4-	615-54-3	5.8E+03	-
Tributyl Phosphate	126-73-8	2.6E+02	-
Tributyltin Compounds	NA	2.5E+02	-
Tributyltin Oxide	56-35-9	2.5E+02	-
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	1.7E+05	1.3E+05
Trichloroacetic Acid	76-03-9	3.3E+01	-
Trichloroaniline HCl, 2,4,6-	33663-50-2	7.9E+01	-
Trichloroaniline, 2,4,6-	634-93-5	2.5E+01	-
Trichlorobenzene, 1,2,3-	87-61-6	9.3E+02	-
Trichlorobenzene, 1,2,4-	120-82-1	1.1E+02	8.8E+00
Trichloroethane, 1,1,1-	71-55-6	3.6E+04	2.2E+04
Trichloroethane, 1,1,2-	79-00-5	5.0E+00	7.7E-01
Trichloroethylene	79-01-6	6.0E+00	3.0E+00
Trichlorofluoromethane	75-69-4	3.5E+05	-
Trichlorophenol, 2,4,5-	95-95-4	8.2E+04	-
Trichlorophenol, 2,4,6-	88-06-2	2.1E+02	4.0E+00

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5	8.2E+03	-
Trichlorophenoxypropionic acid, -2,4,5	93-72-1	6.6E+03	-
Trichloropropane, 1,1,2-	598-77-6	5.8E+03	-
Trichloropropane, 1,2,3-	96-18-4	1.1E-01	1.3E+00
Trichloropropene, 1,2,3-	96-19-5	3.1E+00	1.3E+00
Tricresyl Phosphate (TCP)	1330-78-5	1.6E+04	-
Tridiphane	58138-08-2	2.5E+03	-
Triethylamine	121-44-8	4.8E+02	3.1E+01
Triethylene Glycol	112-27-6	1.6E+06	
Trifluoroethane, 1,1,1-	420-46-2	6.2E+04	8.8E+04
Trifluralin	1582-09-8	4.2E+02	-
Trimethyl Phosphate	512-56-1	1.1E+02	-
Trimethylbenzene, 1,2,3-	526-73-8	2.1E+02	2.2E+01
Trimethylbenzene, 1,2,4-	95-63-6	2.4E+02	3.1E+01
Trimethylbenzene, 1,3,5-	108-67-8	1.2E+04	-
Trimethylpentene, 2,4,4-	25167-70-8	1.2E+04	-
Trinitrobenzene, 1,3,5-	99-35-4	3.2E+04	-
Trinitrotoluene, 2,4,6-	118-96-7	9.6E+01	-
Triphenylphosphine Oxide	791-28-6	1.6E+04	-
Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8	1.6E+04	-
Tris(1-chloro-2-propyl)phosphate	13674-84-5	8.2E+03	-
Tris(2,3-dibromopropyl)phosphate	126-72-7	1.3E+00	1.9E-02
Tris(2-chloroethyl)phosphate	115-96-8	1.1E+02	-
Tris(2-ethylhexyl)phosphate	78-42-2	7.2E+02	-
Tungsten	7440-33-7	9.3E+02	-
Uranium (Soluble Salts)	NA	3.5E+03	1.8E-01
Urethane	51-79-6	2.3E+00	4.2E-02
Vanadium Pentoxide	1314-62-1	2.0E+03	1.5E-03
Vanadium and Compounds	7440-62-2	5.8E+03	4.4E-01
Vernolate	1929-77-7	1.2E+03	-
Vinclozolin	50471-44-8	2.1E+04	-
Vinyl Acetate	108-05-4	3.8E+03	8.8E+02
Vinyl Bromide	593-60-2	5.2E-01	3.8E-01
Vinyl Chloride	75-01-4	1.7E+00	2.8E+00
Warfarin	81-81-2	2.5E+02	-
Xylene, P-	106-42-3	2.4E+03	4.4E+02
Xylene, m-	108-38-3	2.4E+03	4.4E+02
Xylene, o-	95-47-6	2.8E+03	4.4E+02

Contaminant	CAS No.	Soil[1] (mg/kg)	Soil Gas[2] (ug/m^3)
Xylenes	1330-20-7	2.5E+03	4.4E+02
Zinc Phosphide	1314-84-7	3.5E+02	-
Zinc and Compounds	7440-66-6	3.5E+05	-
Zineb	12122-67-7	4.1E+04	-
Zirconium	7440-67-7	9.3E+01	-

Notes:

1 For all contaminants except lead, soil cleanup levels are the May 2016 U.S. EPA RSLs for industrial soil based on a risk of 1×10^{-6} and a hazard index of 1.0 (U.S. EPA, 2016a). For lead, the soil cleanup level is the commercial/industrial CHSSL, revised in 2009 (OEHHA, 2009).

2 Soil gas cleanup levels are the May 2016 U.S. EPA RSLs for industrial air based on a risk of 1×10^{-6} and a hazard index of 1.0 (U.S. EPA, 2016a).

\- indicates that there is no value for this contaminant

Acronyms/Abbreviations:

ug/m^3	microgram per cubic meter
mg/kg	milligram per kilogram
CAS	Chemical Abstract Service
CHSSL	California Human Health Screening Level
NA	not applicable
RSL	Regional Screening Level

ATTACHMENT B.
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Requirement	ARAR Determination	Description of Requirement	Applicability
CHEMICAL-SPECIFIC ARARs - FEDERAL			
U.S. EPA Industrial Regional Screening Levels ("Industrial RSLs;" May 2016)	To Be Considered (TBC)	Industrial RSLs are chemical-specific concentrations for individual contaminants in air, drinking water and soil used to determine whether further investigation or cleanup of a site used for industrial purposes is necessary or appropriate to protect human health.	Industrial RSLs to be used to determine the sufficiency of excavation of chemical contamination to protect human health in the VOC hot spots, and other areas slated for excavation.
U.S. EPA Preliminary Remediation Goals for Radionuclides ("Radionuclide PRGs;" May 2016)	TBC	Radionuclide PRGs are risk-based calculations that set concentration limits for radioactive contaminants used to determine whether further investigation or cleanup of a site used for industrial purposes is necessary or appropriate to protect human health.	Radionuclide PRGs to be used to determine the sufficiency of excavation of low-level radioactive waste contamination to protect human health in areas slated for excavation.
10 CFR 20, Subpart D, Radiation Dose Limits for Individual Members of the Public, Sections 20.1301(a) & (b), and 20.1302	Relevant and Appropriate	Establishes dose limits for individual members of the public from licensed operations and compliance monitoring requirements.	During soil disturbing activities, members of the public may be exposed to solid waste, soil, soil gas, and dust that may contain licensed radioactive materials that were disposed in Site land disposal units.
CHEMICAL-SPECIFIC ARARs - STATE/LOCAL			
DTSC Human Health Risk Assessment Note 3, DTSC-Modified Screening Levels, June 2016	TBC	DTSC's HERO recommended screening levels (derived using DTSC-modified exposure and toxicity factors) may be considered for constituents in soil and tap water.	DTSC Screening Levels to be used to determine the sufficiency of excavation of chemical contamination to protect human health in the VOC hot spots, and other areas slated for excavation.
LOCATION-SPECIFIC ARARs - FEDERAL			
Endangered Species Act of 1973 (16 USC Section 1536 (a)(1) and (2); Section 1538(a)	Applicable	Requires federal agencies to: utilize their authorities to further the purposes of the ESA through programs for the conservation of endangered and threatened species; and insure that its actions are not likely to jeopardize the continued existence of an endangered or threatened species, or the destruction or adverse modification of critical habitat. Prohibits the take of an endangered species of fish or wildlife, and the removal, destruction, etc., of an endangered plant in violation of state law or regulation.	Elderberry shrubs, designated as critical habitat for the Valley Elderberry Longhorn Beetle (VELB), are located at the site, some of which evidence the presence of the VELB. Substantive provisions of the ESA are ARARs, but EPA voluntarily complies with procedural consultation requirements.
LOCATION-SPECIFIC ARARs - STATE/LOCAL			
California Endangered Species Act (California Fish and Game Code Section 2080, 2080.1(a) and, as applicable, definitions in Sections 20161-2069.	Applicable	Requires action to preserve endangered species or threatened species. Prior to conducting any ground-disturbing activities in areas with potential for presence of such species, surveys are to be conducted for species of concern.	Applies to all remediation, well installation, monitoring, or maintenance activities that may impact the VELB.
ACTION-SPECIFIC ARARs - FEDERAL			
California Hazardous Waste Determination by Generator, 22 CCR 66262.11, 66261.10120 – 66261.24,	Applicable	Generators of waste are required to determine whether the waste is a hazardous waste, including whether it is a non-RCRA hazardous waste.	Implementation of the remedy will generate wastes which must be identified.
Hazardous Waste Determination by Generator, 22 CCR 66262.11, 66261.20 -66261.24 and 66261.30 – 66261.33 (40 CFR 262.11, 261.20 – 261.24 and 261.30 – 261.33)	Relevant and Appropriate	Generators of solid waste are required to determine whether the waste is a RCRA hazardous waste by virtue of exhibiting the characteristic of ignitability, corrosivity, reactivity or toxicity, or being so listed.	Implementation of the remedy will generate wastes which must be identified.

Requirement	ARAR Determination	Description of Requirement	Applicability
CAMU, Resource Conservation and Recovery Act (RCRA), and Non-RCRA Hazardous Wastes, 40 CFR Section 264.552 (22 CCR Section 66264.552)	Applicable	Defines a CAMU as an area within a facility that is used to consolidate, treat, store and/or dispose of waste for implementing Site cleanup (CCR 66264.552(a)). CAMU-eligible wastes are solid and hazardous wastes and media (groundwater, surface water, soils, and sediments), and debris that are managed for implementing cleanup (40 CFR 264.552(a)(1)). Includes minimum design requirements for disposal units including a composite liner and a leachate collection system. However, U.S. EPA can approve alternate requirements if: 1) the alternate design prevents the migration of hazardous constituents into groundwater or surface water at least as effectively as the required liner and leachate collection system; or 2) the CAMU will be established in an area of existing contamination and that the alternate design (including one that does not include a liner) prevents migration that would exceed long-term remedial goals (40 CFR 264.552(e)(3)). Consolidation or placement of cleanup wastes into a CAMU is not considered land disposal and does not trigger land disposal restrictions or create a unit subject to minimum technology requirements (40 CFR 264.552 (a)(5)). Minimum treatment of CAMU-eligible waste is required if principal hazardous constituents (PHCs) are identified in the waste media. PHCs are carcinogens that pose a direct risk from ingestion or inhalation at or above 10-3 or non-carcinogens that pose a potential direct hazard from ingestion or inhalation an order of magnitude or greater above the constituent-specific reference dose (40 CFR 264.552(e)(4)(i)(A)). If waste remains in place, a cap based on performance standards (40 CFR 264.552 (e)(6)(D)) and monitoring and notification program 264.552 (e)(5) will be installed.	The remedy relies on the designation of 3 existing landfills as CAMUs with waste that will be left in place, and for use in consolidating waste excavated at other areas on the Site in the course of the remedial action.
Closure and Post-Closure Requirements, 22 CCR Section 66264.310 (40 CFR Section 264.310)	Applicable	Establishes requirements for the closure and post-closure care of landfills.	Applies to the 3 existing landfills designated as CAMUs in the ROD. The remedy will comply with the standards set forth in 22 CR Section 66264.310.
Asbestos National Emission Standard for Hazardous Air Pollutants, 40 CFR, Subpart M, Section 61.145(a) & (c), 61.150.	Relevant and Appropriate	Establishes requirements for controlling emissions of asbestos in renovation and demolition projects, and for the disposal of asbestos from demolition projects.	Demolition of nine Site structures is required to excavate the VOC hot spots and construct CAMUs. Given the age of the structures requiring demolition, it is possible that they contain asbestos-containing materials.
ACTION-SPECIFIC ARARs - STATE			
Title 22 CCR Division 4.5, Section 66264.25	Applicable	Establishes design requirements for cover and drainage control systems.	Applies to the cover and drainage control systems required as part of the remedy.
Title 27 CCR, Section 20380(e)(2)(c) and Title 23 CCR, Section 2550.0	Relevant and Appropriate	Monitoring for corrective action programs.	Applies to any areas where a corrective action has occurred and monitoring is part of the approved remedy.
Title 27 CCR, Section 20430(b) and Title 23 CCR, Section 2550.10	Relevant and Appropriate	Establishment of a corrective action program that complies with water quality standards.	Applies to any areas where a corrective action has occurred and monitoring is part of the approved remedy.
Title 27 CCR, Section 20410 and Title 23 CCR, Section 2550.6(c)	Relevant and Appropriate	Requires monitoring of all soil cleaning activities for compliance with remedial action objectives for three years from the date of achieving cleanup levels.	Applies to all waste units, other than CAMUs, where residual soil contamination may impact water quality.
Title 27 CCR, Section 20415 and Title 23 CCR, Section 2550.7	Applicable	Requires general soil, surface water, and groundwater monitoring for all areas where waste has been discharged to land.	Applies to all waste units, other than CAMUs, where residual soil contamination may impact water quality.
22 CCR Section 66264.97, Standards for Water Quality Monitoring and System Requirements,	Relevant and Appropriate	Establishes requirements for water quality monitoring for detection, evaluation and corrective action monitoring programs.	Applies to the water quality monitoring component of the remedy.
Standards for Soil Gas Detection Monitoring, 22 CCR Section 66264.706	Relevant and Appropriate	Establishes requirements for monitoring air and soil-pore gas by the owner/operator of a permitted hazardous waste disposal facility.	Although the remedy includes the removal of VOC “hot spots,” it is possible that VOC contaminated areas will remain, or that future deterioration of containers in the landfills could cause the release of contaminants that could create soil gas.
27 CCR Section 21190(g), Post-closure Land Use	Relevant and Appropriate	Establishes requirements for mitigation measures for all post-closure construction within 1000 feet of a disposal area.	Applies to on-site construction within 1000 feet of the boundary of any of the CAMUs or VOC hot spot removal areas.

Requirement	ARAR Determination	Description of Requirement	Applicability
Control of Radioactive Contamination in the Environment (California Health and Safety Code, Section 114715, et seq.)	Applicable	Establishes state surveillance and control programs for activities that could lead to the introduction of radioactive materials into the environment. Requires disposal of radioactive waste in a manner that will not cause significant radioactive contamination of the environment.	Applies to the excavation and disposal activities associated with the remedy.
Porter-Cologne Water Quality Control Act (California Water Code, Div. 7 13000, et seq. and 23 CCR Chap. 15, 2521, 2530 – 2531, 2540 – 2548, 2550.1 – 2550.8, 2550.10 – 2550.9— and 2580	Relevant and Appropriate	Establishes authority for state and regional water boards to determine site-specific waste discharge requirements and to regulate disposal of waste to land. Authorizes regional boards to protect existing and probable future beneficial uses of waters of the state.	The Porter-Cologne Water Quality Control Act establishes the authority of the State Water Resources Control Board and the Regional Water Quality Control Board to regulate discharges into waters of the State. These requirements are relevant and appropriate for the remedy selected in this ROD to the extent that any actions taken under this ROD would impact surface water or groundwater.
Central Valley Regional Water Quality Control Board, Basin Plan, Chapters II and III	Relevant and Appropriate	Chapter II describes water basins in the Central Valley Region, establishes beneficial uses of ground and surface waters, establishes water quality objectives and numerical standards, establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies. Chapter III requires that groundwater not contain chemical constituents in concentrations that exceed beneficial uses. At a minimum, groundwater designated for use as municipal or domestic water supplies shall not contain chemical constituents in excess of the MCLs specified in Title 22. Groundwater shall be maintained free of toxic substances in concentrations that produce detrimental physiological response in human, plant, animal, or aquatic life associated with designated beneficial uses. Groundwater shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.	The Basin Plan establishes beneficial uses and water quality criteria based upon such beneficial uses (water quality objectives). The Basin Plan serves to protect the beneficial uses and water quality of the surface water and groundwater in the Basin. These requirements are relevant and appropriate for the remedy selected in this ROD to the extent that any actions taken under this ROD would impact surface water or groundwater.[1]
Title 27 CCR, Sections 20200 (c) and 20210	Applicable	Requires that designated waste be discharged to Class I or Class II waste management units.	Applies to discharges of designated waste (non-hazardous waste that could cause degradation of surface water or groundwater) to land for treatment, storage, or disposal. Applies to waste generated during remediation and monitoring activities that is not managed in a CAMU.
Title 27 CCR, Section 20230	Applicable	Provides that inert waste does not need to be discharged at classified units. Applies to discharges of inert waste to land for treatment, storage, or disposal.	Applies to inert waste generated during remediation and monitoring activities.
Title 27 CCR, Sections 20200 (c) and 20220	Applicable	Requires that non-hazardous solid waste be discharged to a classified waste management unit.	Applies to discharges of non-hazardous solid waste to land for treatment, storage, or disposal. Applies to non-hazardous solid waste generated during remediation and monitoring activities.
Yolo-Solano Air Quality Management District Rules and Regulations, Regulation II, Rule 2.3, sections 102, 204 and 206, 300 and 400	Applicable	Establishes a permissible limit on dust emissions (Ringlemann Chart).	Applies to all dust emissions which may be generated during remediation and O& M activities.

[1]The State of California, through the Central Valley Regional Water Quality Control Board ("RWQCB"), also has identified State Water Board Resolution ("SWBR") 92-49 in full as an ARAR for the LEHR/OCL soil remedy. EPA disagrees both with the scope of California's identification of SWBR 92-49 as an ARAR and its identification of SWBR 92-49 in the context of a soil remedy. EPA's position is that only Section III.G of 92-49 has substantive environmental standards which are potentially relevant and appropriate to CERCLA remedies. Section III.G sets a level or standard of control, albeit a narrative one, which can be summarized as follows: "clean up and abate the effects of discharges in a manner that promotes attainment of either background water quality or the best water quality which is reasonable if background levels of water quality cannot be restored…" California, in contrast, contends that all of Resolution 92-49 is a substantive environmental standard and so qualifies as an ARAR in full. EPA also does not consider Section III.G of 92-49 relevant and appropriate to a remedial action that, as with the LEHR/OCL soil ROD, involves only a soil cleanup and not a groundwater cleanup. California, however, asserts that Resolution 92-49 applies to the LEHR/OCL soil remedy because the remedy involves groundwater monitoring to evaluate the performance of the remedy and because the soil cleanup levels will be set at a level that is protective of groundwater quality. Notwithstanding these disagreements, California supports the remedy and the performance standards selected in this ROD. Moreover, EPA and California agree that the selected remedy will be protective of groundwater quality and thus in fact comply with Resolution 92-49. For purposes of the LEHR soil ROD, therefore, the parties agree to disagree on the status of SWBR 92-49 as an ARAR for the LEHR soil remedy, and both parties reserve all of their rights and legal arguments with respect to the status of SWBR 92-49 as an ARAR in any future RODs.

Requirement	ARAR Determination	Description of Requirement	Applicability
Health and Safety Code Section 41700 & 41701)	Applicable	Prohibits discharge of pollutants into the air that will cause injury, detriment, nuisance, or annoyance to any considerable number of persons or the public. Prohibits discharge of pollutants for "a period or periods aggregating more than 3 minutes" which exceeds the specified standard.	Applies to all emissions which may be generated during remediation and O&M activities.
Yolo-Solano Air Quality Management District Rules and Regulations, Regulation II, Rule 2.3, sections 102, 204 and 206, 300 and 400	Applicable	Establishes a permissible limit on dust emissions (Ringlemann Chart).	Applies to all dust emissions which may be generated during remediation and O& M activities.
California Air Resources Board, Rule 403, Fugitive Dusts- Section 403(B) (definitions as applicable), 403(C) and 403(D(2)(a)(i)	Applicable	Requires actions to prevent, reduce or mitigate fugitive dust emissions.	Applies to fugitive dust emissions from any anthropogenic source.
Yolo-Solano Air Quality Management District Rules and Regulations, Regulation II, Rule 2.5. Nuisance	Applicable	Prohibits discharge from any source such quantities of air contaminants or other material which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public; or which endanger the comfort, repose, health, or safety of any such persons or the public; or which cause or have a natural tendency to cause an injury or damage to business or property.	Applies to air emissions during; applies to both mobile and stationary sources. During soil disturbing activities such as excavation, demolition, waste segregation, or treatment operations, members of the public may be exposed to contaminated soil gas and dust.
Yolo-Solano Air Quality Management District ("Yolo-Solano AQMD") Rule 2.11, Particulate Matter Concentration	Applicable	Prohibits emissions of total particulate matter in excess of 0.1 grain per cubic foot of gas at dry standard conditions from any source operation (mobile or stationary) which emits, or may emit, dust, fumes, or total suspended particulate matter.	The remedy includes actions that may emit dust and or suspended particulate matter.
Yolo-Solano AQMD Rule 2.19- Particulate Matter Process Emission Rate	Relevant and Appropriate	Prohibits discharge from any process unit particulate matter of a weight in excess of the amount defined in the rule.	Soil sorting activities (i.e., for principle threat waste), may use a vibrating soil screening unit or other similar processing equipment.
Yolo-Solano AQMD Rule 9.9 – Asbestos, Sections 102, 110.2 - .3, 111, 202 (definitions as applicable), 300, 401.1 - .3, and 501	Relevant and Appropriate	Applies to all demolitions where the combined amount of Regulated Asbestos-Containing Material is equal to or greater than, 160 square feet, 260 linear feet (on pipes), or 35 cubic feet (where area or length not measurable in advance). Requires survey for asbestos prior to demolition, establishes requirements to prevent emissions of particulate asbestos material to outside air, and establishes requirements for the disposal of the asbestos material generated during demolition.	Demolition of nine Site structures is required to excavate the VOC hot spots and construct the CAMUs. Given the age of the structures requiring demolition, it is possible that they contain asbestos-containing materials.
State Water Resources Control Board Order No. 2012-0006 DWQ, National Pollution Discharge Elimination System (NPDES) Permit for Storm Water Discharges Associated with Construction Activity	Applicable	Regulates pollutants in discharge to storm water associated with construction activities (clearing, grubbing, or excavation) involving the disturbance of one acre or more. Ensures storm water discharges do not contribute to a violation of surface water quality standards. Includes measures to minimize and/or eliminate pollutants in storm water discharges and monitoring to demonstrate compliance.	The substantive requirements of Order 2012-0006 DWQ are applicable to activities that will disturb one or more acres of the Site.
California Department of Water Resources; Well Decommissioning/Well Destruction, California Well Standards, Bulletin 74-90.	TBC	Pursuant to California Water Code Section 13801, establishes minimum requirements for construction, alteration, maintenance, and destruction of water wells, monitoring wells, and cathodic protection wells in California.	Implementation of the selected remedy will require the destruction and installation of some number of on-site groundwater monitoring wells.
Civil Code Section 1471	Applicable	Establishes requirements for a restrictive land use covenant to run with the land.	Applies to all areas in which land use will be restricted because waste is left in place or the clean-up is not to a residential use standard.
Title 22 CCR, Division 4.5, Chapter 39, Section 67391.1(a), (d), (f) & (i)	Relevant and Appropriate	Provides requirements for land-use covenants.	Applies to all areas in which land use will be restricted because waste is left in place or the clean-up is not to a residential use standard.
Health and Safety Code Section 25227	Applicable	Prohibits construction of residences, hospitals for humans, schools for persons under 21 years of age, day care centers, or any permanently occupied human habitation on hazardous waste property. Restrictions apply to areas zoned for open space, maritime/industrial, and educational/cultural reuses.	Applies to all areas where land use restrictions are required for protection of human health and the environment due to contaminants left in place at concentrations exceeding clean up levels.

ATTACHMENT C.
DETAILED COST INFORMATION FOR THE SELECTED REMEDY

Table C-1 Components of the Selected Remedy

Planning/Oversight/General
Work Planning
Health & Safety
Construction Quality Assurance/Quality Control Program
Construction Site Environmental Controls
Materials Management Plan
Pre-Remediation
Land Surveying
Decontamination Facilities
Pre-Construction Biological Survey
Elderberry Shrub Cluster Relocation
Data Gap Investigation (HFSDA and Southern Trenches)
Building Decommissioning and Demolition
-Animal Buildings X-1 through X-5, Geriatrics Building No. 1 (H-292), Geriatrics Building No. 2 (H-293), Storage Building W-3, and the Cobalt-60 Annex
Decommissioning of Groundwater Monitoring Wells
Remediation – Excavation, Waste Segregation and Disposal, Backfill
Area Excavation
Volatile Organic Compound "Hot Spot" Removal
Non-hazardous material backfilled on-site, except for eastern half of the Eastern Trenches VOC "hot spot," which would be backfilled with clean fill
Confirmation Sampling
Segregation, Stockpiling, and Characterization of Excavated Material
Ex situ Treatment
On-site Disposal
Off-site Disposal
Backfill
Remediation - Capping
Consolidate Waste and Multiple-Layer Cap
Levee Easement Setback
Drainage Controls
LFU-3 Concrete-Lined Drainage Channel Demolition/Reconstruction -Portion of concrete-lined drainage channel demolished, concrete re-established after excavation
LFU-1 Drainage/Vegetated Swale
Storm Water Collection and Conveyance System
Storm Water Lift Station at LFU-2/WBH/Eastern Trenches
Storm Water Lift Station at LFU-3
Extended Detention Basin
Post-Remediation
Cover/Cap Monitoring and Maintenance
Drainage Controls Monitoring and Maintenance
Groundwater Monitoring Well Installation
Groundwater and Storm Water Monitoring
Land Use/Institutional Controls
Five-Year Reviews

Acronyms/Abbreviations:

CAMU – corrective action management unit
LFU – landfill unit
O&M – operations and maintenance
VOC – volatile organic compound
WBH – waste burial holes

Table C-2 Cost Estimate Summary for the Selected Remedy

Capital Costs for SW-6				
Description	Quantity	Unit	Unit Cost	Cost
1. Pre-Remediation Capital Costs				
- Biological Survey		LS		$86,304
- Elderberry Mitigation		LS		$270,000
- Data Gap Investigation		LS		$157,394
- Decontamination Facilities[a]	43,287	SF		$438,797
- Building D&D (including disposal)	13,900	SF		$314,966
- Decommission Groundwater Wells	4			$107,856
- Clearing and Grubbing[b]	2.42	Acre		$52,025
2. Excavation and Backfill Capital Costs				
- ET VOC “Hot Spot” Excavation and Backfill		LS		$181,700
- LFU-1 Drainage Area Excavation and Backfill		LS		$609,893
- LFU-2 VOC ‘Hot Spot” Excavation and Backfill		LS		$47,289
3. Materials Management and Disposal Capital Costs				
- Materials Management[c]		LS		$603,548
- Excavated Material Consolidations[d]		LS		$29,794
- Off-Site Transportation and Disposal		LS		$2,271,002
4. CAMU Construction Capital Costs				
- Install LFU-1 Multiple-Layer Cap		LS		$1,113,709
- Install LFU-2/ET/WBH Multiple-Layer Cap		LS		$1,861,724
- Install LFU-3 Multiple Layer Cap		LS		$408,092
5. Post Remediation Capital Costs				
- Install New Groundwater Wells		LS		$180,789
- Storm Drainage[e]		LS		$687,494
- LFU-1 Drainage Channel/Swale		LS		$18,841
- LFU-3 Drainage Channel		LS		$46,737
Total Capital Cost				$9,487,946
Annual Operation and Maintenance Costs for SW-6				
1. Operations and Maintenance Costs				
- Institutional Controls[f]				$1,144,900
- Groundwater and Storm Water Monitoring[g]				$4,383,323
- O&M Drainage System[h, i]				$200,901
- O&M of Caps[j]				$1,300,501
		Total O&M Cost		$7,029,624
2. Periodic Costs				
- Periodic Storm Water Lift Station Repair	0.1	Year	$4,012	$12,225
- Five Year Reviews	0.2	Year	$26,542	$173,297
Total Period Costs				$185,523
Total Present Value of Alternative[k]				**$16,703,093**
3. Contingent Action				
- Install ST and HFSDA Multiple Layer Cap		LS		$204,046

Year	Periodic Review Costs	Capital Cost	Annual O&M	Total Cost	Discount Factor	Present Worth
0		$9,691,992	$612,311	$10,304,303	1.000	$10,304,303
1			$185,192	$185,192	0.974	$180,323
2			$151,434	$151,434	0.948	$143,576
3			$151,434	$151,434	0.923	$139,802
4			$151,434	$151,434	0.899	$136,126
5	26,542		$151,434	$177,976	0.875	$155,779
6			$151,434	$151,434	0.852	$129,063
7			$151,434	$151,434	0.830	$125,670
8			$151,434	$151,434	0.808	$122,366
9			$151,434	$151,434	0.787	$119,149
10	30,554		$151,434	$181,988	0.766	$139,424
11			$151,434	$151,434	0.746	$112,966
12			$151,434	$151,434	0.726	$109,996
13			$151,434	$151,434	0.707	$107,104
14			$151,434	$151,434	0.689	$104,289
15	26,542		$151,434	$177,976	0.671	$119,345
16			$151,434	$151,434	0.653	$98,877
17			$151,434	$151,434	0.636	$96,278
18			$151,434	$151,434	0.619	$93,747
19			$151,434	$151,434	0.603	$91,282
20	30,554		$151,434	$181,988	0.587	$106,815
21			$151,434	$151,434	0.572	$86,545
22			$151,434	$151,434	0.556	$84,270
23			$151,434	$151,434	0.542	$82,055
24			$151,434	$151,434	0.528	$79,897
25	26,542		$151,434	$177,976	0.514	$91,432
26			$151,434	$151,434	0.500	$75,752
27			$151,434	$151,434	0.487	$73,760
28			$151,434	$151,434	0.474	$71,821
29			$151,434	$151,434	0.462	$69,933
30	30,554		$151,434	$181,988	0.450	$81,833
31			$151,434	$151,434	0.438	$66,304
32			$151,434	$151,434	0.426	$64,561
33			$151,434	$151,434	0.415	$62,864
34			$151,434	$151,434	0.404	$61,211
35	26,542		$151,434	$177,976	0.394	$70,048
36			$151,434	$151,434	0.383	$58,035
37			$151,434	$151,434	0.373	$56,509
38			$151,434	$151,434	0.363	$55,023

39		$151,434	$151,434	0.354	$53,577
40	30,554	$151,434	$181,988	0.344	$62,694
41		$151,434	$151,434	0.335	$50,797
42		$151,434	$151,434	0.327	$49,461
43		$151,434	$151,434	0.318	$48,161
44		$151,434	$151,434	0.310	$46,895
45	26,542	$151,434	$177,976	0.302	$53,665
46		$151,434	$151,434	0.294	$44,461
47		$151,434	$151,434	0.286	$43,292
48		$151,434	$151,434	0.278	$42,154
49		$151,434	$151,434	0.271	$41,046
50	30,554	$151,434	$181,988	0.264	$48,031
51		$151,434	$151,434	0.257	$38,916
52		$151,434	$151,434	0.250	$37,893
53		$151,434	$151,434	0.244	$36,897
54		$151,434	$151,434	0.237	$35,927
55	26,542	$151,434	$177,976	0.231	$41,114
56		$151,434	$151,434	0.225	$34,063
57		$151,434	$151,434	0.219	$33,167
58		$151,434	$151,434	0.213	$32,295
59		$151,434	$151,434	0.208	$31,446
60	30,554	$151,434	$181,988	0.202	$36,797
61		$151,434	$151,434	0.197	$29,814
62		$151,434	$151,434	0.192	$29,031
63		$151,434	$151,434	0.187	$28,267
64		$151,434	$151,434	0.182	$27,524
65	26,542	$151,434	$177,976	0.177	$31,498
66		$151,434	$151,434	0.172	$26,096
67		$151,434	$151,434	0.168	$25,410
68		$151,434	$151,434	0.163	$24,742
69		$151,434	$151,434	0.159	$24,091
70	30,554	$151,434	$181,988	0.155	$28,191
71		$151,434	$151,434	0.151	$22,841
72		$151,434	$151,434	0.147	$22,241
73		$151,434	$151,434	0.143	$21,656
74		$151,434	$151,434	0.139	$21,087
75	26,542	$151,434	$177,976	0.136	$24,131
76		$151,434	$151,434	0.132	$19,993
77		$151,434	$151,434	0.129	$19,467
78		$151,434	$151,434	0.125	$18,955
79		$151,434	$151,434	0.122	$18,457
80	30,554	$151,434	$181,988	0.119	$21,598
81		$151,434	$151,434	0.116	$17,499

82			$151,434	$151,434	0.113	$17,039
83			$151,434	$151,434	0.110	$16,591
84			$151,434	$151,434	0.107	$16,155
85	26,542		$151,434	$177,976	0.104	$18,487
86			$151,434	$151,434	0.101	$15,317
87			$151,434	$151,434	0.098	$14,914
88			$151,434	$151,434	0.096	$14,522
89			$151,434	$151,434	0.093	$14,140
90	30,554		$151,434	$181,988	0.091	$16,546
91			$151,434	$151,434	0.089	$13,406
92			$151,434	$151,434	0.086	$13,054
93			$151,434	$151,434	0.084	$12,711
94			$151,434	$151,434	0.082	$12,377
95	26,542		$151,434	$177,976	0.080	$14,163
96			$151,434	$151,434	0.077	$11,734
97			$151,434	$151,434	0.075	$11,426
98			$151,434	$151,434	0.073	$11,126
99			$151,434	$151,434	0.072	$10,833
100	30,554		$151,434	$181,988	0.070	$12,676
TOTAL	570,960	$9,691,992	$ 15,789,469	$ 26,052,421.00		$15,740,690

Notes:

Totaled values are rounded up to the nearest whole dollar.

[a] Includes temporary facilities for decontamination of personnel and equipment.

[b] Costs are related to the area to be cleared prior to remedial excavation or installation of a cap.

[c] Includes the cost of stockpiling and management of excavated materials, waste characterization sampling, and sifting/sorting waste streams.

[d] Includes the cost of consolidating non-known chemical wastes excavated material from on-Site excavations within the footprints of on-Site CAMUs and beneath the final caps.

[e] Includes costs of storm water detention basins and infrastructure for storm water conveyance from capped areas to the detention basins and final discharge.

[f] Base Year Cost of $328,407 and Annual Costs of $23,696.

[g] Base Year Cost of $283,904, Year 1 Cost of $161,496, and Annual Costs of $105,283.

[h] Year 2 Cost of $6,000 and Annual Costs of $6,000.

[i] Includes O&M costs for storm water detention basins and associated infrastructure, in addition to storm water drainage channels/swales.

[j] Year 2 Cost of $16,455 and Annual Costs of $39,492.

[k] Discount factor for present value analysis is 2.7%; the period of analysis is 100 years.

Acronyms/Abbreviations:

CAMU – corrective action management unit
D&D – decommissioning and demolition
ET – Eastern Trenches
HFSDA – Hopland Field Station Disposal Area
LFU – landfill unit
LS – lump sum
O&M – operation and maintenance
SF – square feet
ST – Southern Trenches
VOC – volatile organic compound
WBH – Waste Burial Holes