REPORT

Aerojet-General Corporation

PART 2
Perimeter Groundwater Operable Unit (OU-5) Remedial Investigation/Feasibility Study

RI/FS Report for PGOU Lands

Aerojet Superfund Site
Sacramento, California

25 June 2009

Project No. 20648.03

Document Control No. SR10129799

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2525 Natomas Park Drive, Suite 350
Sacramento, California 95833

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LIST OF ACRONYMS

µg/dL	Micrograms per deciliter
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
1,1,1-TCA	1,1,1-Trichloroethane
1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethene
1,2-DCA	1,2-Dichloroethane
1,2-DCE	1,2-Dichloroethene
1,2,4-TMB	1,2,4-Trimethylbenzene
ACM	Asbestos-containing material
AF	Attenuation factor
ARAR	Applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
AWRA	Auburn-White Rock-Argonaut
bgs	Below ground surface
BERA	Baseline Ecological Risk Assessment
BCF	Bioconcentration Factor
BLRA	Baseline Risk Assessment
BOU	Boundary Operable Unit
BTEX	Benzene, toluene, ethylbenzene, and xylenes
°C	Degrees Celsius
CCL	Carbon tetrachloride
CDA	Central Disposal Area
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CG	Cleanup goal
CHHSL	California human health screening level

CNDDB	California Natural Diversity Database
COC	Chemical of concern
COPC	Chemical/Constituent of Potential Concern
CVEI	Central Valley Environmental, Inc.
DAF	Dilution attenuation factor
DNAPL	Dense nonaqueous-phase liquid
DQO	Data quality objective
DTSC	California Department of Toxic Substances Control
EDQL	Ecological Data Quality Levels
EE/CA	Engineering evaluation/cost analysis
EM	Electromagnetic
EMSI	Engineering Management Support, Inc.
ERA	Ecological Risk Assessment
ERM	ERM-West, Inc.
°F	Degrees Fahrenheit
FCS	Former Company Store
FR	Federal Register
FS	Feasibility study
FWBZ	First water-bearing zone
GAC	Granular activated carbon
GET D	Sector D groundwater extraction and treatment facility
GPR	Ground-penetrating radar
GRA	General response action
HASP	Health and Safety Plan
HDPE	High density polyethylene
HEAST	Health Effects Assessment Summary Tables
HH	Human health
HRA	Human Health Baseline Risk Assessment
HQ	Hazard Quotient
HI	Hazard Index
ICFKE	ICF Kaiser Engineers, Inc.

ILCR	Incremental lifetime cancer risk
IRIS	Integrated Risk Information System
J&E	Johnson and Ettinger
kg	Kilogram
KVA	Kilovolt-ampere
LNAPL	Light nonaqueous-phase liquid
LUFT	Leaking Underground Fuel Tank
MCL	Maximum contaminant level
MDEP	Massachusetts Department of Environmental Protection
MEK	Methyl ethyl ketone
mg/m^3	Milligrams per cubic meter
mg/day	Milligrams per day
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MTBE	Methyl tertiary-butyl ether
NCEA	National Center for Environmental Assessment
NCP	*National Oil and Hazardous Substance Pollution Contingency Plan*
NDMA	N-nitrosodimethylamine
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OSWER	Office of Solid Waste and Emergency Response
PCB	Polychlorinated biphenyl
PCD	Partial Consent Decree
PCE	Tetrachloroethene
pg/g	Picograms per gram
PGOU	Perimeter Operable Unit
PHG	Public health goal
PPE	Personal protective equipment

PRG	Preliminary remediation goal
PQL	Practical quantitation limit
QAPP	Quality Assurance Project Plan
QA/QC	Quality assurance/quality control
RAO	Remedial action objective
RAP	Remedial action plan
RCR	Redding-Corning-Red Bluff
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting limit
ROD	Record of decision
ROI	Radius of influence
RPD	Relative percent difference
RTL	Regulatory threshold level
RWQCB	California Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
scfm	Standard cubic feet per minute
SIM	Selective ion mode
SLERA	Screening Level Ecological Risk Assessment
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMDP	Scientific Management Decision Point
SOP	Standard Operating Procedure
SSL	Soil screening level
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound
SVSL	Soil vapor screening level
SWRCB	State Water Resources Control Board
TBC	Requirement "to be considered"
TCDD	Tetrachlorodibenzodioxin
TCA	Trichloroethane
TCE	Trichloroethene

TEQ	Toxic equivalent quotient
TIC	Tentatively identified compound
TPH	Total petroleum hydrocarbons
TPH-D	Total petroleum hydrocarbons as diesel
TRV	Toxicity Reference Value
UCL	Upper confidence limit
UF	Uncertainty Factors
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound
WET	Waste Extraction Test
WMU	Waste Management Unit
WQO	Water quality objective

1.0 INTRODUCTION

On behalf of Aerojet-General Corporation (Aerojet), ERM–West, Inc., (ERM) prepared this *Revised Remedial Investigation/Feasibility Study Report for Perimeter Groundwater Operable Unit (OU-5) Lands* (Revised PGOU Soils RI/FS) for submittal to the United States Environmental Protection Agency (USEPA), California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB). The remedial investigation (RI) and feasibility study (FS) activities described in this report were conducted in accordance with the modified Partial Consent Decree (PCD, 2002) and the *Draft Workplan to Complete the Remedial Investigation/Feasibility Study (RI/FS) for Selected Sites in Areas 20, 21, and 49* (ERM, 2003a).

This report also incorporates comments from the USEPA, DTSC, and RWQCB (referred hereafter as the agencies) on the *Draft Remedial Investigation Report for Selected Soil Sites in Areas 20, 21, and 49* (Draft RI Report, ERM, 2004); the *Final Perimeter Groundwater Operable Unit Remedial Investigation/Feasibility Study* (Final PGOU RI/FS, ERM and Central Valley Environmental, Inc. [CVEI], 2005); and the *Perimeter Groundwater Operable Unit Remedial Investigation/Feasibility Study* (PGOU RI/FS, ERM and CVEI, 2008) and Aerojet's responses to those comments. Agency comments on the above documents and ERM and Aerojet's responses to those comments are listed below in chronological order and are included in Appendices A through E.

- Agency comments on *Draft Baseline Risk Assessment for the Perimeter Groundwater Operable Unit (OU-5)* (Draft BLRA, ERM, 2003b) provided in a letter dated 29 July 2004 and responses from ERM and Aerojet in a letter dated 9 July 2004 (Appendix A).
- Agency comments on Draft RI Report provided in a letter dated 11 May 2004 and responses from ERM and Aerojet in letter dated 23 September 2004 (Appendix B).
- Agency comments on the Final PGOU RI/FS provided in a letter dated 14 April 2005 and preliminary responses from ERM and Aerojet in a letter dated 2 August 2005 (Appendix C).
- Agency comments on Aerojet's Preliminary Responses to Agency Comments on the Final PGOU RI/FS provided in a letter dated 24 October 2005 and responses from ERM and Aerojet in a letter dated 16 December 2005 (Appendix D).

- Additional agency comments on the Final PGOU RI/FS provided in a letter dated 20 January 2006, responses from ERM and Aerojet in a letter dated 15 March 2006, and agency comments on ERM and Aerojet's responses to agency comments dated 13 April 2006 (Appendix E).
- Aerojet's responses to the following agency comments on the PGOU RI/FS dated August 2008 (Appendix E):
  - Agency comments on the risk assessment section of the PGOU RI/FS provided in a letter dated 2 December 2008;
  - Agency comments on the PGOU RI/FS in a letter dated 21 January 2009;
  - Comments from Weston Solutions, Inc. (Weston) on Aerojet's implementation of responses to agency comments in the PGOU baseline risk assessments provided in an email dated 27 January 2009; and
  - Weston's comments on revised Appendix Z and Section 7 tables for Lands Feasibility Study provided in an email dated 3 February 2009.
- Agency comments on Aerojet's responses to agency comments on the PGOU RI/FS dated August 2008 (Appendix E).

This section describes the purpose of this report and document organization.

1.1 PURPOSE

This report presents the results of previous (prior to 2003) and recent (2003) RI activities for chemicals in soil at the 24 sites listed below within Areas 20, 21, and 49 and the eastern and western portions of the Aerojet Superfund site in Sacramento County, California.

- Areas 20 and 21 and eastern portion of the Aerojet site: All or portions of potential source sites 4D, 5D, 7D, 10D, 11D, D(e), and Former Company Store (FCS); carve-out assessment sites C29, C32, and C41; and the Sector D groundwater extraction and treatment (GET D) facility.
- Area 49 and western portion of the Aerojet site: Potential source sites 32D through 39D and associated septic tanks; carve-out

assessment sites C4, C10, C14, and C15; and Building 49093 (former location of a bulk fuel tank farm operated by Chevron).

The locations of the 24 sites addressed in this report are shown in Figure 1-1. As shown, the sites transect, border, or are surrounded by lands removed from the boundary of the Aerojet Superfund site.

The purpose of an RI/FS is to characterize the nature and extent of potentially hazardous substances for the protection of human health and the environment and to evaluate appropriate remedial actions.

The results of this RI were used to complete a Human Health Baseline Risk Assessment (HRA), Screening Level Ecological Risk Assessment (SLERA), and FS. The PGOU Lands Risk Assessment, submitted under separate cover at the request of the agencies, presents the HRA and SLERA to assess human health and ecological risks associated with chemicals of concern in soil and perched groundwater. An HRA for the hypothetical use of groundwater for domestic use and the potential migration of volatile organic compounds (VOCs) from groundwater into soil and indoor air is presented in Appendix E to Part 1 of this PGOU RI/FS. The FS for the soil sites encompassed by the PGOU is presented as Section 7 of this report. The FS establishes remedial action objectives for those chemicals identified by the HRA and SLERA as having the potential to pose an unacceptable risk to human health or the environment and evaluates various remedial alternatives to reduce or eliminate the risk.

1.2 DOCUMENT ORGANIZATION

Following this introductory section, this report is organized as follows:

- Section 2 briefly summarizes the history of the Aerojet site, topography, land use, groundwater use, and previous investigations relevant to the areas addressed by this report.
- Section 3 describes the investigation activities and sample analyses conducted during the recent RI, describes the data validation and data management procedures, and presents preliminary screening levels used to identify potential constituents of concern and to evaluate the need for additional sampling.
- Section 4 provides a description of the 11 sites in Areas 20 and 21 and the eastern portion of the Aerojet site, summarizes background information and the scope and results of the previous (prior to 2003)

and recent (2003) RIs, and provides a discussion of the cumulative results.

- Section 5 provides a description of the 13 sites in Area 49 and the western portion of the Aerojet site, summarizes background information and the scope and results of the previous (prior to 2003) and recent (2003) RIs, and provides a discussion of the cumulative results.
- Section 6 identifies potential routes of migration for the constituents detected in soil during this RI/FS, discusses the persistence of those constituents in the environment, and presents evaluations on the potential for identified constituents to impact groundwater and/or surface water.
- Section 7 presents the FS for sites where the results of the RI, HRA, and SLERA indicate that constituents of concern pose an unacceptable risk to human health, groundwater and surface water quality, and the environment.
- Section 8 lists references cited in this document.
- Figures and tables follow the report text.
- Appendix A contains agency comments on the *Draft Baseline Risk Assessment for the Perimeter Groundwater Operable Unit (OU-5)* (Draft BLRA, ERM, 2003b) provided in a letter dated 29 July 2004 and responses from ERM and Aerojet in a letter dated 9 July 2004.
- Appendix B contains agency comments on the *Draft Remedial Investigation Report for Selected Sites in Areas 20, 21, and 49* (ERM, 2004) provided in a letter dated 11 May 2004 and responses from ERM and Aerojet in a letter dated 23 September 2004.
- Appendix C contains agency comments on the *Final Perimeter Groundwater Operable Unit Remedial Investigation/Feasibility Study* (Final PGOU RI/FS, Aerojet, 2005) provided in a letter dated 14 April 2005 and preliminary responses from ERM and Aerojet in a letter dated 2 August 2005.
- Appendix D contains agency comments on Aerojet's Preliminary Responses to Agency Comments on the Final PGOU RI/FS provided in a letter dated 24 October 2005 and responses from ERM and Aerojet in a letter dated 16 December 2005.
- Appendix E contains additional agency comments on the Final PGOU RI/FS provided in a letter dated 20 January 2006 and responses from ERM and Aerojet in a letter dated 15 March 2006.

- Appendix F includes the analytical data for soil, soil vapor, and groundwater samples.
- Appendix G includes lists of samples for which the analytical data were submitted for data validation.
- Appendix H contains the data validation reports.
- Appendix I contains tables summarizing the analytical results for field quality assurance/quality control (QA/QC) samples.
- Appendix J contains data and models supporting the selected soil vapor attenuation factor.
- Appendix K contains analytical data supporting the evaluation of the detection and occurrence of 1,3-butadiene in soil vapor samples.
- Appendix L presents the statistical comparison of PGOU metals data to the 1994 background dataset.
- Appendix M presents the development of the 2007 background metals dataset and statistical comparison to PGOU metals data.
- Appendix N includes laboratory analytical reports and data summary tables for surface emission isolation flux chamber samples.
- Appendix O includes a summary of the geophysical survey findings.
- Appendix P contains results of VLEACH© modeling to support selection of protection of groundwater concentrations for VOCs.
- Appendix Q contains tables presenting estimated costs for proposed remedial actions.

2.0 AEROJET SITE BACKGROUND AND SETTING

This section summarizes the site history, land use, groundwater use, topography, and local surface water hydrology at the Aerojet site presented in the *Draft Perimeter Groundwater Operable Unit Remedial Investigation Report* (CVEI, 2003). Previous investigations relevant to this RI/FS are summarized at the end of this section. Local geology, hydrogeology, and surface water hydrology for Areas 20, 21, and 49 are discussed later in this document.

2.1 SITE HISTORY

Since the 1950s, the 8,500-acre Aerojet facility in Sacramento has primarily been used for the design, development, and testing of solid and liquid fuel rocket propulsion systems. Industrial activities conducted in support of this work included solid rocket motor manufacturing, testing, and rehabilitation; liquid rocket engine manufacturing and testing; and chemical development and manufacturing. Chemicals used at the site included solvents, propellants, fuels, lubricants, oxidizers, and metals.

2.2 TOPOGRAPHY

The Aerojet site is characterized by a relatively flat topographic surface gently sloping to the west. Most of the on-site topography is dominated by rows of dredge tailings left from gold mining operations that began in the early 1900s. The dredge tailings consist of alternating rows of cobble piles separated by low areas filled with silt and clay ("slickens"). The depth of dredging ranged from approximately 10 to 90 feet below ground surface (bgs).

2.3 CLIMATE

The Sacramento area has a mild, subtropical climate with abundant sunshine most of the year. Climatic information for the area was originally obtained from *Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1951-1980, California* (National Oceanic and Atmospheric Administration [NOAA], 1982), and *Local Climatological Data 1992,*

Annual/Monthly Summary (NOAA, 1993), but has been updated based on data obtained from the Western Regional Climate Center (www.wrcc.dri.edu).

The mean annual temperature in Sacramento is a relatively mild 62.2 degrees Fahrenheit (°F). Maximum average temperatures during the summer range from 87.1°F to 93.1°F. Temperatures may occasionally exceed 100°F during hot spells. Winter temperature maximums vary from 54.5°F to 60.6°F. Average lows in the winter are 40.2°F to 43.7°F. Temperatures in the winter rarely drop below freezing.

Average annual precipitation is 18.33 inches, with about 80 percent of the total rainfall occurring from November through March. The highest rainfall generally occurs in January, which averages 3.80 inches of precipitation. The driest month is August, averaging only 0.03 inch of rain.

2.4 LAND USE

The Aerojet site is zoned for industrial use and facilities are grouped into manufacturing areas consisting of multiple buildings. Large areas of undeveloped land are present within the manufacturing areas and along the site perimeter. The undeveloped lands served as buffer zones between operations and neighboring properties.

Land use off site includes residential, commercial, industrial, agricultural, recreational, and undeveloped areas. The greatest amount of development is north and northwest of the site in the communities of Rancho Cordova and Gold River. Land use immediately south and east of the site consists primarily of undeveloped land, including the Inactive Rancho Cordova Test Site, formerly used for rocket testing operations, and the State Vehicle Recreation Area.

Aerojet's anticipated or probable future use of the lands encompassed by the sites addressed in this report is presented on Table 2-1. Proposed development plans filed by Aerojet for lands removed from the Superfund site and outside boundaries of the Superfund site can be accessed through the following websites maintained by the county of Sacramento, city of Rancho Cordova, and city of Folsom:

www.saccounty.net/Easton/: Departments; Environmental Review and Assessments; Major Project; Easton Gen Plan Amend.

www.cityofrancho.org/: Departments; Planning; Environmental Review; Environmental Documents; Rio and Westborough.

www.folsom.ca.us/about/whats_new/sphere.asp.

Aerojet's anticipated redevelopment of the property includes a mixture of residential and commercial land use with final determination dependent upon the results of risk assessment using the data obtained during this RI.

2.5 *GROUNDWATER USE*

Groundwater beneath the Aerojet site is designated as a municipal drinking water source (RWQCB-CVR, 1998), but is not currently used for any purpose. Future groundwater use on lands owned by Aerojet and recently removed from the Superfund site is limited through environmental restrictions. Groundwater north and west of the Aerojet site is used for public and domestic water supply, irrigation, industrial, and recreational use.

2.6 *SUMMARY OF RELEVANT PREVIOUS INVESTIGATIONS*

Soil and groundwater characterization at the Aerojet site has been ongoing since the early 1980s. Since that time, numerous investigations have been conducted in accordance with USEPA guidance and the PCD to identify potential sources, characterize the nature and extent of chemicals in soil and groundwater, define exposure pathways, and evaluate potential risks to human health and the environment. Documents summarizing the scope and results of investigations that have been conducted at the sites addressed in this report are listed below.

- *Scoping Report* (ICF Technology, Inc., 1989) – identifies potential source sites at the Aerojet facility, documents operations and activities performed in each area, and lists chemicals used at various facilities.
- *Aerojet Site, Phase 1 RI/FS Workplan Stage 1* (ICF Technology, Inc., 1991) – developed using information obtained during preparation of the Scoping Report and includes a detailed Sampling and Analysis Plan (SAP) for the Stage 1 RI. The SAP provides details regarding collection and analysis of soil and soil vapor samples.
- *Stage 1 Reports for Zones 1, 2, 3, and 4* (ICF Kaiser Engineers, Inc. [ICFKE], 1993) – provide a description and history for each potential

source site, summarize the results of investigations conducted prior to 1991, and provide the results of Stage 1 of the RI/FS conducted between 1991 and 1993 at each site. These reports also evaluate chemical fate and transport and potential exposure pathways, and identify potential receptors.

- *Aerojet Background Geochemistry Study* (Borch, 1994) – documents the results of an intensive study on background levels for metals at the Aerojet site and associated off-site areas. The study established background concentrations of metals in soil and concluded that naturally occurring concentrations of several metals (including arsenic) exist in soil at the Aerojet facility above regulatory action levels.
- *Workplan for Pilot Study of Low Flow Soil Vapor Extraction at Sites 38D and 35D, 4900 Area* (Aerojet, 1997b) – describes the installation of six soil vapor extraction (SVE) wells and presents a scope of work to conduct a low flow SVE pilot study for the removal of chlorinated VOCs from the shallow vadose zone at potential source sites 38D and 35D in Area 49.
- *Stage 2 Report for Aerojet Site 10D* (ERM, 1997) – summarizes investigations conducted at potential source site 10D prior to 1997 and presents the results of the Stage 2 RI of soil and groundwater performed between May and July 1997.
- *Revised Sampling and Analysis Plan for the Candidate Carve-Out Lands* (ERM, 1999) – outlines an approach for assessing historical Aerojet use, and potential environmental impacts that may have resulted from that use, of approximately 3,500 acres of buffer land along the northern and western boundaries of the Aerojet Superfund site. The SAP presents results of the initial assessment of the buffer lands and proposes the collection and analysis of soil vapor and soil samples to assess potential impacts and risk to human health and the environment.
- *Revised Phase 1 RI/FS Stage 2 Sampling Plan, Zone 1 – Tables and Maps* (Aerojet, 1999) – proposes data collection activities to complete the RI of the vadose zone and perched groundwater at each potential source site in Zone 1 and presents figures showing proposed sampling locations. The data collection activities proposed in the Stage 2 Sampling Plan were based on an evaluation of existing data for each potential source site presented in the Stage 1 RI report and were approved by the agencies. All the Stage 2 sampling approved in this plan was conducted as part of the RI activities described herein.
- *Final Site Assessment Report for the Candidate Carve-Out Lands* (ERM, 2000) and Revision to *Final Site Assessment Report for the Candidate*

Carve-Out Lands (ERM, 2001) – presents the comprehensive results of the assessment of the buffer land, identifies potential sites of concern, and presents results of sampling conducted at those sites. The report evaluates sampling results with respect to potential risks to human health and the environment and recommends the removal of buffer land from the Aerojet Superfund site based on the results of the assessment.

- *Draft Perimeter Groundwater Operable Unit Remedial Investigation Report* (Central Valley Environmental, Inc., 2003) – presents the investigation results for site-related chemicals in groundwater at or beyond the Aerojet site perimeter not previously addressed by the Western Groundwater Operable Unit.
- *Draft Baseline Risk Assessment for the Perimeter Groundwater Operable Unit (OU-5)* (ERM, 2003b) – presents the results of a human health risk assessment for site-related chemicals in groundwater at or beyond the Aerojet site perimeter not previously addressed by the Western Groundwater Operable Unit.
- *Draft Workplan to Complete the Remedial Investigation/Feasibility Study (RI/FS) for Selected Sites in Areas 20, 21, and 49* (ERM, 2003a) – presents the results of previous investigations at the soil sites within the PGOU and proposes additional investigations to complete the RI/FS.
- *Draft Remedial Investigation Report for Selected Soil Sites in Areas 20, 21, and 49* (Draft RI Report, ERM, 2004) – presents the results of the remedial investigation conducted at the PGOU soil sites in accordance with the Workplan.
- *Evaluation of the Occurrence and Detection of 1,3-Butadiene in Soil Vapor at the Aerojet Superfund Site, Rancho Cordova, California* (ERM, 2005) – summarizes the results of evaluations and investigations related to the occurrence and detection of the VOC 1,3-butadiene in soil vapor samples. This study was conducted to track sporadic occurrences of 1,3-butadiene in Aerojet soil vapor samples and to address the possibility that these detections were false positives. The study concluded that detections of 1,3-butadiene were, indeed, false positives and should be removed from consideration as a constituent or potential concern (COPC) at the Aerojet Superfund Site.
- *Background Metals in Xerorthents and Redding-Corning-Red Bluff Surface Soils at the Aerojet Superfund Site Main Plant, Sacramento, California* (Aerojet, 2007) – documents the revised results of the original background geochemistry study conducted in 1994 (Borch, 1994). The new study was meant to provide background samples that were

analyzed by similar methods as the RI/FS samples. The revised study provided background levels that were generally lower than those provided in the 1994 background report but still concluded that naturally occurring concentrations of several metals at the Aerojet facility were above regulatory action levels.

3.0 SUMMARY OF FIELD INVESTIGATION ACTIVITIES AND PROGRAM METHODS

This section describes the vadose zone investigation activities and sample analyses conducted during the PGOU RI, describes data validation and data management procedures, presents the analytical results for field QA/QC samples, and presents preliminary screening levels used to identify potential constituents of concern.

3.1 SUMMARY OF INVESTIGATION ACTIVITIES

The recent RI for the PGOU soil sites in Areas 20 and 21 and the eastern portion of the Aerojet site was conducted in July and August 2003 and November 2004 and consisted of the following activities in accordance with the approved Workplan:

- Collection of 65 primary soil vapor samples for VOCs using direct-push methods;
- Collection of 45 primary surface soil samples for semivolatile organic compounds (SVOCs), metals, and/or polychlorinated biphenyls (PCBs);
- Collection of 10 primary subsurface soil samples for SVOCs, metals, and/or total petroleum hydrocarbons (TPH) using hollow-stem auger drilling techniques; and
- Collection of primary groundwater samples from 11 existing monitoring wells.

The recent RI for sites in Area 49 and the western portion of the Aerojet site was conducted between July and October 2003 and in November 2004 and consisted of the following activities in accordance with the approved Workplan:

- Collection of 102 primary soil vapor samples for VOCs;
- Collection of 55 primary surface soil samples for metals and/or dioxins and furans;
- Collection of 73 primary subsurface soil samples for SVOCs, metals, pH, and/or TPH using air-rotary drilling techniques; and

- Collection of primary groundwater samples from three existing monitoring wells.

In addition to the activities outlined above, additional soil vapor sampling was conducted at selected sites in Areas 20, 21, and 49 in August 2006 to evaluate the presence and occurrence of 1,3-butadiene in soil vapor. The results of this investigation are discussed in Section 3.3 of this report.

3.2 *SAMPLE ANALYSIS, DATA VALIDATION, AND DATA MANAGEMENT*

The seven-step USEPA data quality objective (DQO) process (USEPA, 1993) was used as guidance to collect the type, quantity and quality of data needed to complete the characterization of potential source sites and evaluate potential risks and remedial options. The analytical methods used for sample analysis, the procedures used to validate the analytical results, and management of the data collected during the recent RI are described below. Laboratory analytical reports for all soil, soil vapor, and groundwater samples collected during the recent RI are included in Appendix F.

3.2.1 *Analytical Methods*

The analytical methods used to test for the presence of VOCs, SVOCs, metals, perchlorate, diesel, PCBs, dioxins and furans, nitrate, and sulfate in soil vapor, soil, and/or groundwater samples are outlined below. Sample analyses were conducted in compliance with the procedures and methodologies outlined in the most current version of the *Final Quality Assurance Project Plan for Aerojet Superfund Site* (Aerojet QAPP; 2003) at the time sampling was conducted.

3.2.1.1 *Volatile Organic Compounds*

The majority (118 of 145) of the primary soil vapor samples were analyzed for VOCs using USEPA Method TO-14. A list of the individual VOCs analyzed for using USEPA Method TO-14 and their respective reporting limits was included in Appendix B of the approved Workplan. Twenty-seven soil vapor samples were analyzed using USEPA Method 8260B with a reporting limit of 0.1 milligrams per cubic meter (mg/m^3) for all compounds.

As proposed in the approved Workplan, groundwater samples were analyzed for VOCs using Methods 8010 and 8020 to obtain lower reporting limits than could be obtained using USEPA Method 8260.

3.2.1.2 *Semivolatile Organic Compounds*

Soil and groundwater samples collected for SVOCs were analyzed using USEPA Method 8270C. The analysis included the reporting of all tentatively identified compounds (TICs). A list of individual SVOCs detected using that method, and their respective practical quantitation limits (PQLs), was included in Appendix B of the approved Workplan.

3.2.1.3 *Metals and General Minerals*

Soil, groundwater, and soil leachate samples collected for metals and general minerals were analyzed using USEPA 6000 and 7000 Series Methods. Samples collected to evaluate the presence of lead-based paint were analyzed using USEPA Method 6020. A list of the individual metals analyzed for, the analytical method used, and the reporting limit (RL) for each metal was included in Appendix B of the approved Workplan.

3.2.1.4 *Perchlorate*

Soil samples were analyzed for perchlorate using USEPA Method 314.0 with a RL of less than 40 micrograms per kilogram (µg/kg).

Groundwater samples were analyzed for perchlorate using USEPA Method 314.0 with a RL of 1 microgram per liter (µg/L).

3.2.1.5 *Total Petroleum Hydrocarbons as Diesel*

Soil and groundwater samples collected for TPH as diesel (TPH-D) were analyzed using USEPA Method 8015B. The RLs for diesel in soil and groundwater were 10 milligrams per kilogram (mg/kg) and 50 µg/L, respectively.

3.2.1.6 *Polychlorinated Biphenyls*

Soil samples collected for PCBs as Aroclors were analyzed using USEPA Method 8082. Appendix B of the approved Workplan includes a list of the PCB Aroclors detected by this method, and their respective reporting limits.

3.2.1.7 *Dioxins and Furans*

Soil samples collected for dioxins and furans were analyzed using USEPA Method 8290. The individual dioxins and furans detected by this method, and their respective laboratory reporting limits, are listed in Appendix B of the approved Workplan.

3.2.1.8 *Nitrate and Sulfate*

Groundwater samples collected for nitrate and sulfate were analyzed using USEPA Method 300. The RLs for nitrate and sulfate in groundwater were 0.025 milligrams per liter (mg/L).

3.2.2 *Field Quality Assurance/Quality Control Procedures*

This section describes the QA/QC procedures used in the field during the RI.

3.2.2.1 *Sample Collection*

All sampling was conducted in strict accordance with the *Revised Standard Operating Procedures Manual for Water Quality Sampling and RI/FS Investigation* (Revised SOP; Aerojet, 1997a). Additionally, soil vapor sampling was conducted in consideration of the methodologies outlined in the *Advisory – Active Soil Gas Investigations* published by the DTSC and RWQCB – Los Angeles Region in January 2003.

3.2.2.2 *Field Documentation*

Field activities were documented in daily logbooks and on field forms. Subsurface lithologies for soil borings were recorded on drilling logs. Soil vapor and soil sampling were recorded in field notes. Groundwater monitoring information was recorded on groundwater monitoring forms.

3.2.2.3 *Equipment Decontamination*

Before use, all soil sampling equipment that would directly contact the samples was scrubbed with a solution of potable water and Liquinox, then rinsed with potable water and American Society for Testing and Materials (ASTM) Type II water. In addition to the above procedures, soil sampling equipment used for the collection of PCBs was initially scrubbed with laboratory-grade isopropanol. Flight augers and other drilling equipment were decontaminated before each use by high-pressure hot water.

The submersible pump used for purging the monitoring wells was decontaminated by disassembling the pump, scrubbing with Liquinox solution, followed by a rinse with potable water and ASTM Type II water. Tubing and bailers used during the sampling of wells were disposed of after each use.

3.2.2.4 *Quality Assurance/Quality Control Samples*

The collection of QA/QC samples during the recent investigation is described below.

Soil and Soil Vapor

Field duplicate (split) samples, equipment rinsate blanks, field blanks, and trip blanks were submitted to the analytical laboratory as a means of assessing the quality of the data resulting from the field-sampling program.

Split samples were analyzed to assess sample homogeneity and were collected at the frequency of 1 for approximately every 10 samples per each analyte. A summary of the number of split/duplicate samples per total number of samples collected is provided on Table 3-1. Split samples were submitted blind to the analytical laboratory (i.e., using non-indicative sample identifiers) to provide a QA check on analytical procedures and results.

Matrix spike samples provide information about the effect of the sample matrix on the analytical methodology. The analytical laboratory prepared and analyzed the matrix spike samples. All matrix spikes were performed in duplicate. One matrix spike/matrix spike duplicate was designated for every 20 samples per sample matrix.

Equipment rinsate and train blanks were collected on a daily basis and submitted for analysis to check for potential contamination associated with sampling procedures or ambient conditions at the site. The analytical results for the equipment rinsate and train blanks are discussed in Section 3.2.3.3.

3.2.3 *Data Validation and Management*

Data validation and management procedures used during this RI are outlined below.

3.2.3.1 *Analytical Deliverables*

To ensure that accurate and reproducible results were produced during this investigation, and because the data would be used for risk assessment and remedial action decisions, the laboratories were required to provide USEPA Level IV data validation packages for all analyses. The Level IV analytical reports included extraction and preparation date, analysis date, case narrative, laboratory control sample results, sample results in standard units (mg/m^3, mg/kg, µg/kg, mg/L, and/or µg/L), surrogate recoveries, spike recoveries, duplicate data, and method blank results, as well as acceptable limits for surrogate, spike, and precision recoveries; raw data (chromatograms, spectral, and quantitation reports) for initial and continuing calibrations; associated QC data; sample analyses; preparation or extraction logs; instrument tuning; and injection sequences.

3.2.3.2 *Data Validation*

Review and validation of chemical data were performed to ensure that data are of acceptable quality and that any limitations to data usability are identified prior to making decisions based on data results. A percentage of the analytical data for organics and inorganics were reviewed in accordance with USEPA Level III and Level IV guidelines published in the following documents:

- Contract Laboratory Program National Functional Guidelines For Organic Data Review (USEPA, 1999a);
- Contract Laboratory Program National Function Guidelines for Inorganic Data Review (USEPA, 1994a); and
- Quality Assurance Project Plan for Aerojet Superfund Site (Aerojet, 2003).

The protocol for conducting Level III and Level IV data validation to ensure the accuracy and completeness of these analytical results included the following:

- Level III – Review of holding times, initial calibration, continuing calibration, matrix spike recoveries, laboratory duplicate relative percent differences (RPDs), blind field duplicate RPDs, method blank results, equipment and trip blanks, surrogate recoveries, and overall assessment of data in the sample delivery group.
- Level IV – In addition to the Level III procedures described above, Level IV data validation of organic analyses included the recalculation

of 100 percent of all detects, verification of compound identification and TICs, and quantitation and PQLs. For inorganic analyses, 10 percent of all detects are typically recalculated, as well as review of the inductively coupled plasma (ICP) interference checks.

Tables listing the soil vapor and soil samples submitted for data validation, and the level of validation performed on each sample, are provided in Appendix G. The number and percentage of samples validated in accordance with Level III and IV guidelines are summarized on Table 3-1.

The data validation results are provided in Appendix H and summarized in the text and tables presented in this report, including any necessary applied data qualifiers. Additionally, the data and any data qualifiers have been incorporated into the electronic data deliverables provided by the laboratory and entered into the Aerojet Environmental Remediation database. Data qualifiers applied as a result of data review and validation are included in analytical tables and are listed below.

- U The analyte was analyzed for, but was not detected at or above the reported laboratory reporting limit.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."
- UJ The analyte was not detected above the reported laboratory reporting limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified.
- A Indicates the finding is based on technical validation criteria.
- P Indicates the finding is related to a protocol/contractual deviation.

Only two data points were rejected based on the data review. All data that were not rejected, including data flagged as having estimated or tentative values, were acceptable and were used for decision-making purposes.

3.2.3.3 *Field Quality Assurance/Quality Control Sample Results*

The analytical results for field QA/QC samples are presented in Appendix I and summarized below. The number and percentage of duplicate samples collected per each analyte is summarized on Table 3-1.

Volatile Organic Compounds

A total of 145 primary soil vapor samples were collected for VOCs during the recent investigation activities, excluding samples collected as part of the 1,3-butadiene evaluation. Fourteen sample train blanks and one field blank were also collected and analyzed for VOCs. Additionally, 18 field duplicates (10.7 percent of total samples) were collected and analyzed for VOCs and 13 replicate samples (8.4 percent of total samples) were analyzed by the laboratory for VOCs.

Acetone was detected in 2 of the 14 train blanks at concentrations of 0.05 and 0.07 milligrams per cubic meter (mg/m^3). No other VOCs were detected in the train blanks at concentrations above their respective laboratory reporting limits.

Semivolatile Organic Compounds

A total of 106 primary soil samples were collected during the recent investigation activities. Thirteen equipment blanks (one per each day of sampling) were collected and analyzed for SVOCs. Additionally, 11 field duplicate samples (10 percent of total samples) were collected and analyzed for SVOCs. No SVOCs were detected above their respective laboratory reporting limits in the equipment blanks.

Metals

A total of 77 primary soil samples were collected for metals during the recent investigation activities. Three equipment blanks and five field duplicate samples (6 percent of total primary samples) were also collected and analyzed for metals.

Metals detected in one or more equipment blank included arsenic up to an estimated concentration of 3.7 µg/L, copper up to 21 µg/L, lead up to 4.8 µg/L, manganese up to 22 µg/L, nickel up to an estimated concentration of 8.4 µg/L, and zinc up to 450 µg/L.

Arsenic

Two primary soil samples were collected only for arsenic during the recent investigation activities. No field duplicate samples were collected only for arsenic analysis. The arsenic samples were collected by hand and the collection of an equipment blank was not necessary.

Chromium

Three soil samples were collected only for chromium during the recent investigation activities. No field duplicate samples were collected only for chromium analysis. The samples were collected by hand and the collection of an equipment blank was not necessary.

Lead

A total of 58 primary soil samples were collected for lead during the recent investigation activities. Three equipment blanks and one field duplicate sample (2 percent of total primary samples) were also collected and analyzed for lead.

Lead was detected in two of the three equipment blanks at an estimated concentration of 2.1 µg/L and 4.8 µg/L.

Total Petroleum Hydrocarbons as Diesel

A total of 37 primary soil samples were collected for TPH-D analysis during this RI investigation. Four equipment blanks and four field duplicate samples (11 percent of total primary samples) were collected and analyzed for TPH-D.

TPH-D was detected in three of the four equipment blanks at concentrations ranging from 0.052 to 0.078 mg/L.

pH

Seventeen primary soil samples were collected and analyzed for pH. Two field duplicate samples (12 percent of total primary samples) were also collected and analyzed for pH.

Polychlorinated Biphenyls

Eighteen primary bank samples were collected and analyzed for PCBs. Two field duplicate samples (11 percent of total primary samples) were also collected and analyzed for PCBs. With the exception of one near-surface soil sample, all soil samples collected for PCBs during this investigation were collected by hand and no equipment blanks were necessary. Because the shovel used to collect the one near-surface soil sample for PCBs was not used in the collection of other samples, no equipment blank was collected. The shovel was, however, properly decontaminated following use.

Dioxins and Furans

Six primary soil samples were collected and analyzed for dioxins and furans. The samples were collected by hand and no equipment blanks or duplicate samples were collected.

Asbestos

Two primary soil samples were collected and analyzed for asbestos. No duplicate or equipment blanks were collected.

3.3 DEVELOPMENT AND USE OF CHARACTERIZATION SCREENING LEVELS

Screening levels were developed during preparation of the approved Workplan to provide a way to evaluate the analytical results and determine the need for additional "step-out" sampling to complete characterization. These characterization screening levels were developed from applicable or relevant and appropriate requirements (ARARs) and requirements "to be considered" (TBCs).

The comparison of the data to screening levels in the RI is made in response to the request of the Agencies and to assist the reader in the identification of those constituents that may potentially be of concern. Because potential risks to human and ecological receptors are cumulative rather than dependent on a single constituent, no constituents were eliminated from further evaluation of potential migration or risk based on the comparison. The potential migration of all constituents and their potential risk to groundwater is addressed in Section 6 of this report. The potential risk posed by chemicals detected in soil and soil vapor to human

and ecological receptors is addressed in the PGOU Lands Risk Assessment, submitted under separate cover. The potential risk posed by chemicals detected in groundwater to human and ecological receptors is addressed in Part 1, Appendix E of this PGOU RI/FS Report.

The development of screening levels for chemicals in soil vapor and soil and their use in this RI Report for comparison to site-specific data to identify COPCs and evaluate the completeness of sampling is described below. The development of background concentrations for metals in soil at the Aerojet site is also discussed.

3.3.1 Development and Use of Human Health Soil Vapor Screening Levels

Human health risk-based screening levels for VOCs in soil vapor under residential and commercial land use scenarios were developed during preparation of the approved Workplan (ERM, 2003a) to evaluate the need for additional data collection activities. Human health (HH) soil vapor screening levels (SVSLs) for those VOCs that had been detected in soil vapor during the Stage 1 RI were calculated as a product of two factors:

- An acceptable risk-based concentration in air derived using methods consistent with the procedures used by USEPA Region IX to derive preliminary remediation goals (PRGs) for air; and
- An attenuation factor (AF) derived using the DTSC's version (December 2001) of USEPA's Johnson and Ettinger (J&E) model (DTSC, 2001).

In June 2003, in response to demands from the Agencies, the SVSLs for VOCs were revised using slope factors from USEPA's PRG table dated October 2002 and AFs derived using the 2001 version of the J&E model using site-specific parameters. Additionally, revision of the SVSLs was performed in accordance with the approach outlined in Tier 3 – Site-Specific Pathway Assessment of the *Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air Pathway* (EPA 530-F-02-052, 2002b). The revised SVSLs were provided in a table (Table 3-2) included with ERM's response to agency comments dated 16 June 2002 on the RI Workplan.

In comments on the *Draft RI Report for Selected Sites in Areas 20, 21, and 49* (ERM, 2004), the agencies indicated that screening levels for VOCs should be derived based on applying an appropriate AF to the ambient air PRGs published in USEPA Region IX PRG table updated in October 2004. SVSLs for VOCs using the agency recommended approach and, as agreed upon at a meeting on 9 June 2004, are presented on Table 3-2. SVSLs were calculated

by applying an AF of 2,000 to the ambient air PRGs published in the USEPA Region IX table dated October 2004 or, in the case of TCE, using the California modified ambient air PRG.

The conservative AF of 2,000 used in calculation of the SVSLs is based on the lowest of the range of AFs calculated using USEPA's version 2 (USEPA, 2003a) screening and advanced J&E models with varying site-specific and default parameters. To determine the most conservative AF to be used in the calculation, ERM initially developed AFs for each of the 45 VOCs identified in soil vapor during the recent RI. The calculation used USEPA's screening J&E model at sample depths of 5 and 10 feet and site-specific parameters and conservative default assumptions. The AF represents the ratio of the indoor air concentration ($C_{building}$) to the soil vapor or source concentration (C_{source}). That is,

$$AF = C_{building}/C_{source}.$$

ERM then calculated AFs for those VOCs having the highest and lowest calculated AFs plus four other VOCs with AFs between the highest and lowest using both the screening and advanced versions of USEPA's J&E model with sample depths of 5 and 10 feet and varying site-specific and conservative default assumptions. A summary of the soil vapor AFs calculated using the models, the parameters and assumptions used in each of the models, and copies of the models are included in Appendix J.

It should be noted that the SVSLs presented in the approved Workplan were developed to guide the characterization of VOCs in soil vapor. Potential risks to human health posed by the migration of VOCs from the vadose zone and groundwater were calculated using an agency approved AF developed as a result of the comprehensive site-wide study conducted by Dr. Robert Ettinger (Geosyntec, 2008a). The results of the human health risk assessment is presented in the PGOU Lands Risk Assessment published under separate cover and the Baseline Groundwater Risk Assessment included in Appendix E to Part 1 of the PGOU RI/FS.

Protection of groundwater (PGW) SVSLs were not developed during preparation of the approved Workplan (ERM, 2003a) and therefore characterization of VOCs based on that criteria was not performed during the PGOU RI . However, the potential for VOCs detected in soil vapor to migrate into groundwater is addressed in Section 6.2 of this PGOU RI/FS based on the results of VLEACH modeling using site-specific data and default parameters agreed upon with the RWQCB.

3.3.1.1 *Use of the Human Health Soil Vapor Screening Levels*

In this RI Report, concentrations for each VOC, with the exception of 1,3-butadiene, detected in the soil vapor samples are compared to their respective HH SVSLs to assist in the identification of potential sources and areas where VOCs are present in soil vapor at concentrations that could potentially pose a risk to human receptors or migrate into groundwater. The exclusion of 1,3-butadiene from the comparisons is discussed in Section 3.1.2. It should be emphasized that VOCs detected in soil vapor samples at the sites within the PGOU are compared to screening levels in this RI to assess the need for additional characterization. No VOCs were excluded from further consideration in the human and ecological risk assessment based on these comparisons.

3.3.1.2 *Evaluation of 1,3-Butadiene in Soil Vapor Samples*

Because of its volatility and rapid biodegradation, and the state (gas) in which this compound is used in manufacturing, 1,3-butadiene is not a compound expected to be identified in soil vapor. However, 1,3-butadiene has been commonly, but sporadically, detected (i.e., detected at 10 feet and not at 5 feet at the same location and at 10 feet at one location but not at 10 feet at several other proximal locations) in soil vapor samples collected at various locations on the Aerojet site.

The presence and detection of 1,3-butadiene in the soil vapor at the Aerojet site has been the subject of evaluations by Aerojet and USEPA with the expert assistance of Air Toxics, Limited (ATL) and Laboratory Data Consultants (LDC). ATL specializes in the analysis of gas and vapor samples and LDC specializes in the review and validation of analytical data and procedures. Because of its toxicity, low concentrations of 1,3-butadiene may be harmful to humans; therefore, additional information was needed to determine the presence of that chemical in soil vapor and its potential to migrate into indoor air.

ERM conducted experiments between June 2005 and September 2006 to 1) verify the presence of 1,3-butadiene in the soil vapor samples; 2) identify potential sources of that compound in soil vapor or the soil vapor samples; and 3) assess the reproducibility of the detection of that compound in soil vapor at the Aerojet site. Additionally, soil vapor sampling conducted during the Boundary Operable Unit (BOU) RI also provided information related to the reproducibility of the analytical results for 1,3-butadiene. The scope and results of the experiments, the

results of soil vapor sampling conducted during the BOU RI, and conclusions based on those results are summarized below.

Presence of 1,3-Butadiene in Soil Vapor Samples

Split soil vapor samples were collected at multiple locations in one area of the Aerojet site in March 2005 and sent to ATL in Folsom, California, and to Environmental Analytical Service, Inc. (EAS) in San Luis Obispo, California. ATL had performed the analysis of all previous soil vapor samples collected at the site that had detections of 1,3-butadiene. Split soil vapor samples were sent to EAS because their analysis of 1,3-butadiene in vapor samples was based on the identification of two ions, as opposed to the one ion identification method used by ATL.

The split soil vapor samples were collected at a depth of 10 feet bgs using standard direct-push soil vapor sampling techniques and following guidance published by DTSC. The soil vapor samples were collected in batch certified summa canisters using a vapor stream splitter provided by ATL that evenly divided the extracted soil vapor into the two canisters. Due to concerns that leak check gas could potentially be a source of 1,3-butadiene, a leak check was not performed during sampling.

The analytical results for the soil vapor samples from the two laboratories included variations in concentrations for individual VOCs, but 1,3-butadiene was detected in the soil vapor samples analyzed by both laboratories.

Reproducibility of 1,3-Butadiene Detections

Although the analytical data indicated that 1,3-butadiene was present in the soil vapor sample, the source of the 1,3-butadiene had not been identified. Potential sources of 1,3-butadiene in the samples were either soil vapor from the pore space in the soil or contamination from outside sources. Contamination from outside sources included exhaust from motor vehicles, introduction during analysis by the laboratory, or off-gassing from materials used during collection of the soil vapor samples. ERM conducted experiments between June 2005 and September 2006 to 1) identify the source of the 1,3-butadiene detected in the soil vapor samples; and 2) evaluate the reproducibility of 1,3-butadiene detections in soil vapor. The results of the experiments conducted in June and July 2005 were presented in the *Evaluation of the Occurrence and Detection of 1,3-Butadiene in Soil Vapor at the Aerojet Superfund Site* (ERM, 2005). The scope and results of these experiments and conclusions based on those results are presented below.

The analytical data for soil vapor samples collected during the 1,3-butadiene evaluations are presented in Appendix K.

Scope

- Collection of soil vapor samples in June and July 2005 at four previous locations and at depths where 1,3-butadiene had previously been detected.
- The installation of nested temporary soil vapor sampling probes (stainless steel rods) at 5, 10, and 15 feet bgs at two locations.
- Installation of nested semi-permanent vapor ports at 5, 10, and 15 feet bgs at two locations. The semi-permanent vapor ports were constructed of tubing that was placed at the desired depth and the annular space surrounding the tubing was backfilled with bentonite grout. Teflon tubing was used at one location and polyethylene tubing was used at the other location.
- The collection of soil vapor samples from the temporary probes and semi-permanent ports on three separate occasions in June and July 2005. The first samples were collected after allowing 30 minutes for the probes/ports to equilibrate. Second samples were collected 2 to 3 days after installation and the third samples were collected 33 days after installation.
- Primary and duplicate soil vapor samples from the probes and ports were collected in a combination of batch and individually certified Summa canisters. Duplicate samples were collected at each soil vapor sampling location during each sampling event, but at a different depth. Vehicles were present near the locations during the first sampling event, but vehicles and other potential sources of hydrocarbons that could include 1,3-butadiene were prohibited within 500 feet of the locations during the second and third sampling events. 1,1-difluoroethane (1,1-DFA) was used as a leak check gas during the collection of all samples.
- The collection of soil vapor between 31 August and 6 September 2006 from the ports/probes at three of the nested locations and at nine other locations on the site where 1,3-butadiene had previously been detected.
- Analysis of all soil vapor samples for VOCs by ATL using modified USEPA Method TO-14A; and
- Testing of all materials (sand, bentonite, tubing, etc) used in construction of the probes/ports for potential off-gassing of

1,3-butadiene. The materials were placed into a sealed container, heated to induce volatilization, a vapor sample was collected from the headspace of the container, and analyzed using USEPA Method TO-15.

Results

- 1,3-Butadiene was detected at concentrations ranging from 12 to 95 $\mu g/m^3$ in every initial soil vapor sample collected from the nested probes/ports, except one. The one soil vapor sample that did not have a detected concentration of 1,3-butadiene had elevated practical quantitation limits (PQLs) resulting from the presence of the leak check gas in the sample.
- 1,3-Butadiene was not detected above the PQL (2.4 to 99 $\mu g/m^3$) in any of the soil vapor samples collected from the ports/probes 2 to 3 days after installation.
- 1,3-Butadiene was not detected above the PQL (2.5 to 19 $\mu g/m^3$) in any of the soil vapor samples collected from the ports/probes 33 days after installation.
- 1,3-Butadiene was not detected above the PQL (2.2 to 15 $\mu g/m^3$) in any of the soil vapor samples collected from the ports/probes over a year after installation.
- 1,3-Butadiene was not detected above the PQL (2.2 to 1,200 $\mu g/m^3$) in any of the soil vapor samples collected in August and September 2006 at locations where it had previously been detected.
- 1,3-Butadiene was not detected in headspace vapor samples collected

Conclusions Regarding the Occurrence and Detection of 1,3-Butadiene in Soil Vapor

Conclusions concerning the occurrence and reproducibility of 1,3-butadiene in soil vapor samples at the Aerojet site based on the results of the experiments conducted to date are presented below.

- The analytical results for soil vapor samples performed by two laboratories using different methods indicate that 1,3-butadiene is actually present in the samples, and the detections are not false positives. However, it has not been conclusively established if the 1,3-butadiene in the samples originates from the soil or is a contaminant introduced during sampling and/or analysis. Testing did not identify the potential off-gassing of 1,3-butadiene from any of the materials used in the construction of the probes/ports.

- The results of the experiments performed by ERM indicate that the detections of 1,3-butadiene are not reproducible. Repeat soil vapor sampling performed as part of the BOU RI also confirmed the irreproducibility of 1,3-butadiene detections.

In addition to the results of the experiments and sampling described above, 1,3-butadiene was not detected in flux chamber samples collected in July 2003 in an area where 1,3-butadiene had been detected in soil vapor samples.

Based on the information presented above and its physical properties, it appears unlikely that 1,3-butadiene is present in soil vapor. Even if it is present in soil vapor, the fact that the detections cannot be reproduced indicates that the compound quickly degrades and, as indicated by the results of the flux chamber samples, appears unlikely to migrate into outdoor or indoor air. Additionally, the sporadic nature of the detections makes it impossible to accurately characterize the potential nature and extent or develop a remedial alternative. Because the data indicate that 1,3-butadiene may not be present in soil vapor and is unlikely to migrate into outdoor and indoor air even if it were present, 1,3-butadiene was not included as a COPC in this RI/FS Report or compared to its HH or PGW SVSL to evaluate completeness of characterization.

It should also be noted that the detection of 1,3-butadiene in soil vapor is not restricted to the Aerojet site. ATL said that they had received numerous enquiries from other consulting firms at various locations in the United States about 1,3-butadiene in soil vapor samples. ERM and Aerojet, along with several consulting firms that had encountered the presence of 1,3-butadiene in soil vapor samples, participated in a teleconference hosted by ATL. The other consultants also observed the same characteristics for 1,3-butadiene in the soil vapor samples noted at the Aerojet site. 1,3-Butadiene was detected in samples at sites where no historical activities had been reported and documented and did not have contaminated groundwater, was sometimes the only compound detected in the soil vapor samples, and the detections could not be reproduced. To date, ERM is not aware of a conclusive resolution regarding the detection of 1,3-butadiene in soil vapor samples.

3.3.2 *Development and Use of Background Data and Characterization Screening Levels for Metals in Soil*

The development and use of background data and characterization screening levels for metals in soil is described below.

3.3.2.1 *Development of Characterization Screening Levels for Metals in Soil*

Human health risk based characterization screening levels for metals in soil presented in the approved Workplan (ERM, 2003a) are summarized on Table 3-3. The screening levels were based on residential and/or industrial soil PRGs established by Region IX of the USEPA (USEPA, 2004b,d) and to PRGs modified by the State of California. The target risk level for the soil PRGs was 1E-06 for carcinogenic constituents and a hazard quotient of 1 for noncarcinogenic constituents.

3.3.2.2 *Development of Background Data for Metals in Soil*

The metals data for the PGOU were initially compared to facility-specific background concentrations. Because an agency-approved background dataset for metals had not been completed at the time the Draft PGOU RI/FS was prepared, the background evaluation for metals was developed using previous background data published in 1994 (Borch, 1994). The entire metals data set was statistically compared to the 1994 background data set using the Mann-Whitney U test to compare the means of the two data sets. This background comparison is included in Appendix L. Metals detected in soil at the PGOU sites at concentrations determined to be statistically higher than the 1994 background data were antimony, cadmium, copper, lead, mercury, silver, and zinc. In the Draft PGOU RI/FS, the analytical results for metals were also compared to the 90 percent upper confidence limit (UCL) of the mean for dredge tailings (Xerorthents soil group), the predominant soil type for the sites within the PGOU. Metals detected at concentrations above their 90 percent UCL were shown on figures in the report with metals detected above their screening levels highlighted.

In 2006, Aerojet performed a second detailed study of background concentrations of metals in surface (0 to 1 foot bgs) soil at the Aerojet site in response to agency comments on analytical methods used in the 1994 Background Study. The results of the study and statistical evaluation of the data were presented in *Background Metals in Xerorthents and Redding-Corning-Red Bluff Surface Soils at the Aerojet Superfund Site, Main Plant, Sacramento, California* (Aerojet, revised January 2007), hereafter referred to as the 2007 Background Report. Background data reported in the 2007 Background Report have been review and approved by the Agencies. A summary of the study is provided below.

- A total of 156 soil samples were collected within the boundaries of the Aerojet site to evaluate naturally occurring background concentrations

of metals in soil. Samples were collected from the three major soil types present at the site: Xerorthents, Redding-Corning-Redbluff (RCR) complex, and the Auburn-White Rock-Argonaut (AWRA) complex.

- Thirty-nine samples were collected from Xerorthents and 38 were collected from the RCR complex, the two major soil types found in the areas encompassed by the BOU.
- Samples were initially analyzed using USEPA Methods 6010 and re-analyzed using USEPA Method 6020 to achieve lower practical quantitation limits for the following nine metals: antimony, arsenic, cadmium, chromium, lead, molybdenum, selenium, silver, and thallium. In addition to achieving a lower limit, the purpose of analyzing the samples for those nine metals using USEPA Method 6020 was to reduce or eliminate false-positive detections for those metals common in USEPA Method 6010.
- Data outliers were removed from the dataset based on the presence of inflection points in probability plots.
- Background metal concentrations were established for each of the three major soil types for both analytical methods resulting in the following six background data sets:
  - Xerorthents 6010 data;
  - Xerorthents 6020 data (nine metals only);
  - RCR soil 6010 data;
  - RCR soil 6020 data (nine metals only);
  - AWRA 6010 data; and
  - AWRA 6020 data (nine metals only).

To promote a straightforward establishment of background metals data, ERM developed an approach consistent with USEPA guidance and field duplicate protocols currently being used at Aerojet. The results from background soil samples analyzed using both analytical methods were considered to be "duplicate" results and the following decision rule was applied to the data:

1. When both duplicates are nondetects, the lesser of the detection limits is used;
2. When one of two duplicates is a nondetect, the detected value is used;

3. When both duplicates are detects, the greater of the detected values is used; and
4. Duplicates include field duplicates as well as method-related duplicates.

Using this approach, ERM was able to combine the 6010 and 6020 background data sets for each soil type into a single data set specific to the soil type that could then be statistically compared to the site data to identify "elevated" metal concentrations. Details on the methods used to establish the background concentration data set for metals are presented in Appendix M.

3.3.2.3 *Use of Background Data and Characterization Screening Levels for Metals in Soil*

In this RI, concentrations of metals detected in soils collected within the PGOU were statistically compared to the Aerojet background concentrations for the Xerorthents soil type using both the Gehan and Quantile tests. Comparisons to background using these statistical tests are consistent with USEPA's (2002d) *Guidance for Comparing Background and Chemical Concentrations in Soil for the Comprehensive Environmental Response, Compensation, and Liability Act* (*CERCLA) Sites* and were performed using USEPA's ProUCL Version 4.0.1 software. If either the Gehan or the Quantile test found that the concentrations of a particular metal were greater than background, that metal was identified as a COPC. Metals detected in soil at the PGOU sites at concentrations determined to be statistically higher than background using the 2007 Background Report are antimony, cadmium, lead, mercury, silver, and zinc. All concentrations for those metals were compared to their respective soil screening levels (SSLs).

Metals identified as COPCs with concentrations above their respective SSLs are identified in this RI and discussed with respect to the location of the exceedance and completeness of characterization. Details concerning the statistical comparison of site data to background are presented in Appendix M.

It should be noted that naturally occurring background concentrations of arsenic in soil at the Aerojet site typically exceed both the residential and industrial PRGs of 0.062 mg/kg and 0.025 mg/kg, respectively. Additionally, naturally occurring background concentrations of vanadium typically exceed the current (2004) residential SSL of 78 mg/kg. Additionally, the analysis of soil samples using USEPA Method 6020

instead of USEPA Method 6010 on select samples during this PGOU RI confirmed that elevated detections of thallium in soil prior to 1999 were due to matrix interference.

3.3.3 *Development and Use of Characterization Screening Levels for Other Non-Volatile Organic Compounds in Soil*

Human health risk based characterization SSLs for non-VOCs other than metals presented in the approved Workplan (ERM, 2003a) are summarized on Table 3-3 and below.

- The analytical results for all non-VOCs except TPH were compared to residential and/or industrial soil PRGs established by Region IX of the USEPA (USEPA, 2004b,d) and to PRGs modified by the State of California. The target risk level for the soil PRGs was 1E-06 for carcinogenic constituents and a hazard quotient of 1 for noncarcinogenic constituents.
- Because PRGs have not been established for TPH, extractable (diesel and motor oil) and purgeable (gasoline) compounds detected in soil were compared to the most conservative concentration of 100 mg/kg for extractable TPH and 10 mg/kg for purgeable TPH presented in the California Leaking Underground Fuel Tank (LUFT) Manual (State Water Resources Control Board [SWRCB], 1989). The values represent the highest concentrations of diesel and gasoline that are protective of groundwater assuming the most conservative conditions listed on Table 2-1 of the LUFT Manual and may be allowed to be left in-place.

In this RI, all non-VOCs were identified as COPCs and all detected concentrations were compared to their respective SSLs. Non-VOCs having concentrations above background and their respective SSLs are identified in this RI and discussed with respect to the location of the exceedance and completeness of characterization.

3.3.4 *Screening Levels for Metals in Extracts*

To evaluate which metals have the potential to leach from soil into groundwater and surface water, concentrations of metals detected in extracts from selected soil samples collected from the bottom of ditches were compared to those detected in background soil sample extracts. Background metals extract sampling locations are shown in Figure 3-1 and the analytical results for the soil samples and their respective extracts are presented on Table 3-4. An evaluation of the potential for metals to leach

into groundwater and surface water is presented in Section 6 (fate and transport).

4.0 *SUMMARY AND RESULTS OF REMEDIAL INVESTIGATIONS FOR SITES IN AREAS 20 AND 21 AND EASTERN PORTION OF THE AEROJET SITE*

Area 20 is the historical and current administration and liquid rocket manufacturing area at the Aerojet propulsion facility. Area 21 was historically the location of a water filtration plant. Sites within Areas 20 and 21 and the eastern portion of the Aerojet site addressed in this PGOU RI/FS Report are:

- All or portions of seven potential source sites [Sites 4D, 5D, 7D, 10D, 11D, FCS, and D(e)];
- Three carve-out assessment sites (Sites C29, C32, and C41); and
- The GET D facility.

The locations of the sites in Areas 20 and 21 are shown in Figure 4-1. As shown in Figure 1-1, the sites listed above transect, border, or are surrounded by lands removed from the boundary of the Aerojet Superfund site under the modified PCD (April 2002).

This section provides a description of Areas 20 and 21, including geology and hydrogeology, and a discussion regarding the presence and distribution of chemicals in the first unconfined groundwater layer. Additionally, the following information is presented for each of the sites:

- A summary of background information including historical operations and activities;
- A summary of the scope and results of previous (prior to 2003) investigations for VOCs, metals, and other non-VOCs in soil and, if present, perched groundwater;
- A summary of the scope and results of recent (2003) investigations for VOCs, metals, and other non-VOCs in soil and, if present, perched groundwater; and
- A discussion of the investigation results.

Sites 4D, 5D, 7D, 10D, and 11D are drainage ditches that are hydraulically connected. To facilitate discussion, these sites are presented in the order of the furthest upstream to the furthest downstream (4D, 11D, 10D, 7D, and 5D) rather than in numerical order. The presentation of the data for

the sites in this order provides a better understanding and evaluation of the movement and presence of surface soil and chemical constituents within the drainage system.

4.1 *PHYSICAL DESCRIPTION OF AREAS 20 AND 21*

Physical characteristics of Areas 20 and 21, including topography and local surface water drainage, local geology, and local hydrogeology are described below.

4.1.1 *Topography and Surface Water Hydrology*

The majority of Area 20 has been graded and paved, and is relatively flat with a gentle slope towards the north and west. The primary topographic relief is provided by the presence of a northeast-southwest trending ancestral American River terrace along the southern and southeastern portion of Area 20.

Surface water runoff in Area 20 is channeled into a system of man-made ditches that eventually discharge into the Westlake storm water retention cells (Figure 4-1). Water is temporarily stored in the Westlake storm water retention cells where it infiltrates the soil or occasionally is discharged to Buffalo Creek, and ultimately to the American River. Discharges to Buffalo Creek from the Westlake storm water retention cells are regulated through the National Pollutant Discharge Elimination System (NPDES) and analytical sampling is conducted prior to discharges. Additionally, analytical sampling is conducted along the American River at locations upstream and downstream of the point of discharge from the Westlake storm water retention cells.

Surface water runoff in Area 21 flows into a man-made ditch and a low area where it infiltrates the soil (Figure 4-1).

4.1.2 *Local Geology*

The surface and near-surface lithologies in the northern and central portion of Areas 20 and 21 are primarily composed of Quaternary-aged fluvial deposits of cobbles, sand, silt, and clay that have been extensively dredged for gold. The depth of the dredge deposits in Area 20 ranges from a maximum of about 20 to 30 feet in the northern and central portion to 5 feet or less in the southern portion. Because much of Area 20 has been graded and paved, the areal extent of the dredged areas has not been

completely defined. A review of borehole logs indicated that the thickness of the dredge deposits in the northern portion of Area 20 is not uniform and some areas may not have been dredged. Dense, brown, silty sand and sandy silt, and cemented and hard layers of silty sand and gravels generally underlie the dredge deposits. Hard, indurated deposits of silty clay and silts and a volcanoclastic mudflow (lahar) outcrop along the southern boundary of Area 20.

4.1.3 Local Hydrogeology

The first saturated sediments encountered beneath Areas 20 and 21 are either part of perched or unconfined groundwater. Unconfined groundwater is defined as saturated sediments that are laterally continuous across the Administration Area.

The general hydrogeology of the perched groundwater and unconfined groundwater beneath Areas 20 and 21 is discussed below. Details regarding the occurrence of groundwater within Areas 20 and 21 and distribution of chemicals in the groundwater are presented in Part 1 of this RI/FS Report.

4.1.3.1 Perched Groundwater

Perched groundwater is the shallowest saturated unit and typically occurs in ancestral American River sediments that have been reworked by historical gold-dredging activities. Dredging activities disturbed the natural stratigraphy and the resulting spoils were deposited as unconsolidated and somewhat stratified sediments. As a result, the dredged materials are very permeable and are underlain by sediments that are typically less permeable. The base of perched groundwater often coincides with the interface between dredged and undredged materials.

The highest perched groundwater elevations on record in the Administration Area since the start of monitoring in 1982 were in 1983, following a year of above-average precipitation. The lowest perched groundwater levels generally occurred between 1988 and 1992 during a period of below-average precipitation.

In 1983 and 1984, the FWBZ was present at elevations nearly equal to the perched groundwater elevations. During this period, the perched groundwater was in hydraulic continuity with the FWBZ and it technically did not exist.

During the BOU RI, perched groundwater was commonly encountered in the eastern portion of the Administration Area near Buildings 20002 and 20004 and in the western portion of the Administration Area near Building 20009. The perched groundwater in these two areas may be hydraulically connected, based on similar water level elevations and the relatively uniform hydraulic gradient between the two areas. In April 2006, the depth to perched groundwater within the Administration Area ranged from 7.2 to 25.1 feet bgs and the median depth was 14 feet bgs. The base of perched groundwater ranges from approximately 4 to 13 feet above the top of the FWBZ.

The direction of flow in the perched groundwater in the eastern portion of the Administration Area is variable and has the steepest hydraulic gradient (approximately 0.07 feet per foot [ft/ft]). The direction of flow in the perched groundwater in the western portion of the Administration Area appears to be towards the west-northwest with a hydraulic gradient of approximately 0.01 ft/ft.

4.1.3.2 *Unconfined Groundwater*

Unconfined groundwater occurs in the upper portion of a sand and gravel unit containing variable amounts of silt ranging from approximately 50- to 75-feet thick, and that thins to the east. This sand and gravel unit generally corresponds to Layer C of the Western Groundwater Operable Unit Groundwater Flow Model (Aerojet, 2004).

The depth to the top of unconfined groundwater ranges from 25 to 45 feet bgs, typically increasing in depth from east to west across the Administration Area. Unconfined groundwater is deeper (50 to 75 feet bgs) south of the Administration Area due to the increased ground surface elevations associated with the ancestral American River terrace described in Section 4.1.1.

Since the start of monitoring in 1982, the highest water levels were recorded in 1983. Water levels in the uppermost unconfined groundwater decreased an average of approximately 30 feet between 1983 and 1990, when the lowest water levels were recorded. Between October 2004 and April 2006, the water table elevation increased approximately 6 feet.

Based on data from April 2006, flow direction in the uppermost unconfined groundwater across the Administration Area appears to be relatively uniform towards the west-northwest. The average hydraulic gradient for the uppermost unconfined groundwater across the

Administration Area is approximately 0.01 ft/ft. The gradient is steeper (0.03 ft/ft) in the southeastern portion of the Administration Area and flattens (0.009 ft/ft) to the northwest.

4.2 *POTENTIAL SOURCE SITE 4D*

This report addresses the section of the Site 4D ditch system along Alabama Avenue and east of Building 20004 (Figure 4-2). This section of ditch potentially receives drainage from the ditch east of Building 20022 (Potential Source Site 11D) plus surface water runoff from the parking area, vacant land south of Building 20022, and from the vicinity of Building 20034. Building 20034 is identified as an inactive X-ray facility. The direction of surface water flow in the ditches is shown in Figures 4-1 and 4-2.

4.2.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 4D*

The scope and results of the RI for VOCs conducted at Potential Source Site 4D are summarized below.

4.2.1.1 *Previous Volatile Organic Compound Investigations*

During the Stage 1 RI, two shallow soil vapor samples and two traditional soil samples were collected at a depth of 10 feet along the ditch (Figure 4-3). The traditional soil samples were collected because no vapor flow was achieved in the central portion of the ditch. The analytical results for the samples are summarized below.

Shallow Soil Vapor and Soil Samples

- Total VOC concentrations detected in the two shallow soil vapor samples were nondetect and 0.2 mg/m^3. Trichloroethene (TCE) was the only VOC detected.
- The only VOC detected in the soil samples was dichloromethane, or methylene chloride, at 6.57 and 7.05 µg/kg. The concentrations of dichloromethane are well below its residential SSL of 9,100 µg/kg.

4.2.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 4D indicated that additional soil vapor sampling was needed to assess the potential presence of VOCs at

concentrations below the laboratory reporting limits used during the Stage 1 RI.

In accordance with the approved Workplan, soil vapor samples were collected from the very shallow (1 to 5 feet bgs) and shallow (6 to 11 feet bgs) layers at one location (4D-SP23) along the ditch at Site 4D. No flow conditions were encountered at one other location (4D-SP22) and no sample was collected. Soil vapor sampling location 4D-SP23 corresponds to the approximate location of the Stage 1 RI location (4D-SP01) where TCE had been detected in the shallow layer. A comparison of proposed and actual soil vapor sampling activities at Site 4D along with a summary of sample identifications and sampling depths are provided on Table 4-1.

The analytical results for the very shallow and shallow soil vapor samples are included in Appendix F and summarized on Table 4-2 and below. A comparison of the soil vapor results to screening levels is also provided on Table 4-2. Soil vapor sampling locations and analytical results are shown in Figure 4-3.

Very Shallow Soil Vapor Sample

- Acetone at 0.12 mg/m^3 and cyclohexane at 0.015 mg/m^3 were detected in the soil vapor sample (4D-SP23) collected at 5 feet bgs.
- The detected concentrations of acetone and cyclohexane are below their respective SVSLs.

Shallow Soil Vapor Sample

- No flow conditions were encountered at 10 feet bgs at location 4D-SP22 and no sample was collected.
- VOCs detected in the shallow soil vapor sample (4D-SP23) collected in 2003 were acetone estimated at 0.22 mg/m^3, Freon 113 at 0.27 mg/m^3, benzene at 0.033 mg/m^3, toluene at 0.042 mg/m^3, hexane at 0.087 mg/m^3, heptane at 0.051 mg/m^3, and tetrahydrofuran at 0.081 mg/m^3.
- The concentrations of all VOCs detected are below their respective SVSLs.

A soil vapor sample was collected at a depth of 10 feet bgs at location 4D-SP23 in August 2006 as part of the 1,3-butadiene evaluation. VOCs detected in the soil vapor sample included chlorobenzene (CB) at 0.076 mg/m^3, 1,4-dichlorobenzene at 0.012 mg/m^3, benzene at 0.037 mg/m^3, toluene at 0.0096 mg/m^3, ethylbenzene (EB) at 0.006 mg/m^3, xylenes at

0.11 mg/m^3, styrene at 0.018 mg/m^3, propylbenzene at 0.0078 mg/m^3, acetone at 0.048 mg/m^3, and methyl ethyl ketone (MEK) at 0.025. The detected concentrations were all below their respective SVSLs.

4.2.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 4D*

The scope and results of the RIs for non-VOCs conducted at Site 4D are summarized below.

4.2.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, five surface and near-surface soil samples were collected for metals analysis at the three locations (4D-SNS03, 4D-SNS04, and 4D-SNS05) shown in Figure 4-4. The analytical results for metals, and their respective residential and commercial SSLs, are summarized on Table 4-3. Metals identified as having concentrations statistically above background are shown in Figure 4-4.

With the exception of arsenic and vanadium, no metals were detected in the surface and near-surface soil at concentrations above their respective residential or commercial SSLs.

4.2.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data for Site 4D presented in the approved Workplan indicated that no additional data for metals in surface soils were needed to complete the RI/FS.

4.2.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 4D*

The scope and results of RIs for perched groundwater at Site 4D are summarized below.

4.2.3.1 *Previous Perched Groundwater Investigations*

During the Stage 1 RI, a screening-level shallow groundwater sample was collected at one location (4D-HP01) along the ditch and analyzed for VOCs. The location of 4D-HP01 is shown in Figure 4-4. No VOCs were detected above their respective laboratory reporting limits in the sample.

4.2.3.2 *Recent Perched Groundwater Investigations*

Evaluation of the previous data for Site 4D presented in the approved Workplan indicated that no additional perched groundwater investigation or sampling was needed at Site 4D to complete the RI/FS.

4.2.4 *Discussion of Investigation Results – Site 4D*

The cumulative results of the investigations conducted at Site 4D are summarized below.

4.2.4.1 *Soil*

Volatile Organic Compounds

VOCs were not detected at concentrations above their respective SVSLs in the recent very shallow and shallow soil vapor samples collected at Site 4D.

Metals

With the exception of arsenic and vanadium, no metals above commercial or residential SSLs were detected in the five soil samples collected at Site 4D.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemicals in soil at Site 4D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.2.4.2 *Perched Groundwater*

No perched groundwater was encountered during the soil vapor sampling at Site 4D.

4.3 *POTENTIAL SOURCE SITE 11D*

Potential Source Site 11D includes the ditch system surrounding Building 20022 (Figure 4-2). This PGOU RI/FS Report addresses the following sections of the Site 11D ditch system:

- The ditches north and east of Building 20022;

- A 170-foot section of ditch north of Building 20B73; and
- The underground culvert between Sites 11D and 10D.

The locations of the ditches and underground culvert and direction of surface water flow in the drainages are shown in Figures 4-1 and 4-2. Background information for Building 20022 and the ditches is summarized below.

Building 20022 may have been used as a warehouse in the late-1950s to mid-1960s, but was later used for dye-penetrating operations and degreasing operations. Materials that may have been handled at the building were dye-penetrating materials, caustics, and degreasing solvents. A concrete collection pit was formerly located on the west side of Building 20022, and an underground acid storage tank and TCE degreaser were formerly located on the east side of the building. The concrete collection pit was possibly backfilled in the early 1980s; the former location of the pit could not be determined during the Stage 1 RI. The underground acid storage tank was removed in September 1992.

The ditch north of Building 20022 potentially received discharges from Building 20022 via an underground drainpipe, and surface water runoff from Atlanta Street and paved areas north of Building 20022.

The ditch east of Building 20022 received surface water runoff from Building 20022 and paved and unpaved parking and storage areas surrounding the building.

The 170-foot section of ditch north of Building 20B73 received surface water runoff from Atlanta Street and paved parking and storage areas north of Building 20B73 (Figure 4-2). Building 20B73 is identified as a Resource Conservation and Recovery Act facility (RCRA-X) where oil/water separation of machine lubricating oil was performed. RCRA-X was decommissioned and demolished in 2003 in accordance with a Closure Plan approved by the DTSC.

The underground culvert between Sites 11D and 10D received surface water runoff from the 170-foot section of ditch north of Building 20B73, and a drainage ditch west of Building 20022 (Figure 4-2). The drainage ditch west of Building 20022 receives surface water runoff from buildings and paved and unpaved parking and storage areas between Baltimore Street and Atlanta Street (Figure 4-2). That section of ditch is within the BOU and was investigated in 2005 and 2006. Sampling conducted

historically and during the BOU RI shows that PCBs are present in surface and near-surface soils within the drainage ditch. PCBs at concentrations up to 720,000 µg/kg were detected in historical surface soil samples collected in the southern portion of this ditch. PCBs detected in surface and near-surface soils collected from that section of the ditch during the BOU RI and their maximum concentrations were Aroclor 1016 at 83 µg/kg, Aroclor 1254 at 10,000 µg/kg, and Aroclor 1260 at 1,300 µg/kg. Aroclors 1254 and 1260 were the most commonly detected PCBs. The presence of PCBs in the ditch are attributed to historical releases of oils containing PCBs from a former aboveground storage tank. The analytical results for samples collected from the ditch west of Building 20022 are presented in Section 4.2 of the *Boundary Operable Unit Remedial Investigation/Feasibility Study Report* (BOU RI/FS Report, ERM, 2008).

4.3.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 11D*

The scope and results of RIs for VOCs conducted at Potential Source Site 11D are summarized below.

4.3.1.1 *Previous Volatile Organic Compound Investigations*

During the Stage 1 RI, 16 shallow (6 to 11 feet bgs) soil vapor samples were collected along the ditch system, adjacent to the acid holding tank east of the building, at the location of a former TCE degreaser on the east side of the building, and in the area where the former concrete collection pit was potentially located. The analytical results for the shallow soil vapor samples are summarized below.

Shallow Soil Vapor Samples

Only trace to low levels of the following VOCs were detected in the soil vapor samples: Freon 113 (2.15 to 4.36 mg/m^3); TCE (nondetect to 3.78 mg/m^3); 1,1,1-trichloroethane (1,1,1-TCA) (nondetect to 0.53 mg/m^3); dichloromethane (1.40 mg/m^3); and toluene (0.74 mg/m^3).

4.3.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the previous data for Site 11D presented in the approved Workplan indicated that soil vapor sampling was needed to assess the potential presence of VOCs at concentrations below the reporting limits used during the Stage 1 RI.

In accordance with the approved Workplan, nine soil vapor samples (excluding QA/QC samples) were collected at eight locations along the ditches north and east of Building 20022 and the 170-foot section of ditch north of Building 20B73. A comparison of proposed and actual soil vapor sampling activities at Site 11D along with a summary of sample identifications and sampling depths is provided on Table 4-1. The results of the soil vapor sampling are summarized below.

Ditch East of Building 20022

Soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer at three locations (11D-SP18, 11D-SP19, and 11D-SP20) along the ditch east of Building 20022 (Figure 4-3). The sampling locations were placed at the approximate former location of Stage 1 RI soil vapor sampling points. The analytical results for the soil vapor samples are provided in Appendix F and summarized on Table 4-2 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-2 and below. VOC concentrations detected in the soil vapor samples are shown in Figure 4-3.

Shallow Soil Vapor Samples

- VOCs detected in the three shallow soil vapor samples (11D-SP18, 11D-SP19, and 11D-SP20) collected along the ditch east of Building 20022 included Freon 11 up to 0.027 mg/m^3; Freon 113 up to 0.19 mg/m^3; dichloromethane up to 0.06 mg/m^3; chloroform up to 0.14 mg/m^3; toluene up to 0.02 mg/m^3; hexane up to 0.02 mg/m^3; acetone up to 0.24 mg/m^3; MEK up to 0.09 mg/m^3; and ethanol up to 0.09 mg/m^3.
- The detected concentrations for all VOCs are below their respective SVSLs.

Ditch and Septic Tank North of Building 20022

Soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer at two locations (11D-SP21 and 11D-SP22) along the ditch north of Building 20022 and at one location (11D-SP24) in the approximate vicinity of the septic tank north of Building 20022. The sampling locations were placed at the approximate former location of Stage 1 RI soil vapor sampling points. The analytical results for the soil vapor samples are included in Appendix F and are summarized on Table 4-2 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-2. VOC concentrations detected in the soil vapor samples are shown in Figure 4-3.

Shallow Soil Vapor Samples

- VOCs detected in the two shallow soil vapor samples (11D-SP21 and 11D-SP22) collected along the ditch north of Building 20022 included dichloromethane up to 0.02 mg/m^3; chloroform up to 0.46 mg/m^3; heptane up to 0.03 mg/m^3; acetone up to 0.05 mg/m^3; and MEK up to 0.25 mg/m^3.
- VOCs detected in the shallow soil vapor sample (11D-SP24) collected in the approximate location of the septic tank north of Building 20022 were dichloromethane at 0.02 mg/m^3; hexane at 0.02 mg/m^3; heptane at 0.02 mg/m^3; acetone at 0.68 mg/m^3; MEK at 0.16 mg/m^3; and ethanol at 0.12 mg/m^3.
- Concentrations for all VOCs detected in the shallow soil vapor samples are below their respective SVSLs.

170-Foot Section of Ditch North of Building 20B73

Soil vapor samples were collected from the very shallow (1 to 5 feet bgs) layer at two locations (11D-SP23 and 11D-SP25) and from the shallow (6 to 11 feet bgs) layer at one location (11D-SP25) along the 170-foot section of ditch north of Building 20B73. The analytical results for the soil vapor samples are included in Appendix F and summarized on Table 4-2 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-2 and below. VOC concentrations detected in the soil vapor samples are shown in Figure 4-3.

Very Shallow Soil Vapor Samples

- VOCs detected in the very shallow (1 to 5 feet bgs) soil vapor samples (11D-SP23 and 11D-SP25) collected along the 170-foot section of ditch north of Building 20B73 were dichloromethane up to 0.02 mg/m^3; cyclohexane up to 0.02 mg/m^3; acetone up to 0.24 mg/m^3; and MEK up to 0.05 mg/m^3.
- The concentrations for all VOCs detected in the very shallow soil vapor samples are below their respective SVSLs.

Shallow Soil Vapor Samples

- VOCs detected in the shallow (6 to 11 feet bgs) soil vapor sample (11D-SP25) collected along the 170-foot section of ditch north of Building 20B73 were dichloromethane at 0.04 mg/m^3 and tetrachloroethene (PCE) at 0.07 mg/m^3.

- The detected concentrations of dichloromethane and PCE are below their respective SVSLs.

4.3.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 11D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site 11D are summarized below.

4.3.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, surface soil samples for metals analysis were collected at three locations (11D-SNS05, 11D-SNS06, and 11D-SNS07) in the ditches north and east of Building 20022 (Figure 4-4). Due to the presence of cobbles, a near-surface soil sample was collected at only one (11D-SNS05) of the three locations. Additionally, surface and near-surface soil samples for metals analysis were also collected during the Stage 1 RI at two locations (11D-SNS03 and 11D-SNS04) from the 170-foot section of ditch north of Building 20B73 (Figure 4-4).

Because the ditches north and east of Building 20022 received surface water runoff or discharges from different areas than the 170-foot section of ditch north of Building 20B73 and underground culvert, the analytical results for the surface soil samples collected from the those sections of ditch are discussed separately below. The Stage 1 RI analytical results for metals, and their respective SSLs are summarized on Table 4-3 and below.

Ditches North and East of Building 20022

- No metals at concentrations above background and their respective residential or commercial SSLs were detected in the surface and near-surface soil samples collected at the two locations (11D-SNS05 and 11D-SNS06) in the ditch north of Building 20022.
- Cadmium was the only metals detected at a concentration above background and its SSL (based on the residential California human health screening level [CHHSL]) in only one of three surface soil collected from the ditch east of Building 20022 (Figure 4-4). The detected concentration of cadmium (3.39 mg/kg) is, however, well below the commercial/industrial CHHSL of 7.5 mg/kg.

170-Foot Section of Ditch North of Building 20B73 and Underground Culvert

- With the exception of cadmium, no metals above background and respective SSLs were detected in the surface and near-surface samples collected at location 11D-SNS03 at the east and furthest downstream end of the 170-foot ditch north of Building 20B73 (Figure 4-4). The detected concentration of cadmium (2.47 mg/kg) is above the residential CHHSL of 1.7 mg/kg, but well below the commercial/industrial CHHSL of 7.5 mg/kg.
- Cadmium and lead were detected above background and their respective SSLs in the surface soil sample collected at location 11D-SNS04 at the west end of the 170-foot ditch north of Building 20B73 (Figure 4-4). Concentrations of cadmium (3.89 mg/kg) and lead (288 mg/kg) in the surface sample were above their SSL (residential CHHSL), but below their commercial/industrial CHHSLs of 7.5 mg/kg and 800 mg/kg, respectively.
- No metals at concentrations above background and their respective SSLs were detected in the near-surface soil samples collected at locations 11D-SNS03 and 11D-SNS04.

4.3.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 11D presented in the approved Workplan indicated that the following data were needed to complete the RI/FS:

- Assess metal concentrations in surface soil upstream and downstream of Stage 1 RI location 11D-SNS07 in the ditch east of Building 20022;
- Assess metal concentrations in near-surface soil samples at two locations (11D-SNS05 and 11D-SNS06) in the ditch north of Building 20022;
- Assess presence of PCBs in surface soil in the 170-foot section of ditch north of Building 20022; and
- Assess presence of PCBs in surface soil at the entrance and discharge points of the underground culvert between Sites 11D and 10D.

Recent surface and near-surface soil sampling conducted in the ditches north and east of Building 20022, the 170-foot section of ditch north of Building 20B73, and underground culvert are summarized below.

Ditches North and East of Building 20022

Recent surface and near-surface soil sampling conducted in the ditches north and east of Building 20022 in accordance with the approved Workplan included the following:

- Near-surface soil samples were collected at 1.5 feet bgs at Stage 1 RI sampling locations 11D-SNS05 and 11D-SNS06 in the ditch north of Building 20022 and analyzed for metals; and
- Surface and near-surface soil samples were collected at two locations (11D-SNS08 and 11D-SNS09) from the ditch east of Building 20022 and analyzed for metals. The sampling locations were placed upstream and downstream of Stage 1 RI sampling location 11D-SNS07.

A comparison of proposed and actual soil sampling activities at Site 11D and a summary of sample identifications and sampling depths is provided on Table 4-4. The results of the metals analysis of the surface and near-surface soil samples are included in Appendix F and summarized on Table 4-3 and below. Metals detected at concentrations above background and their respective SSLs are shown in Figure 4-4.

Metals

No metals at concentrations above background and their respective SSLs were detected in the surface and near-surface soil samples collected from the ditches north and east of Building 20022.

Metals Extract

To evaluate the potential for metals to leach from the soil and impact groundwater and surface water, a Waste Extraction Test (WET) for metals was performed on the two samples (11D-SNS08 and 11D-SNS09) collected from the ditch east of Building 20022. The two samples were selected based on the number of metals detected above average background concentrations. The metals analysis of the two samples and the sample extracts is included in Appendix F and summarized on Table 4-5 and below. An evaluation of the potential for metals to leach into and impact groundwater and surface water is presented in Section 6 (fate and transport) of this report.

- Metals detected in the leachate from the two samples included barium at estimated concentrations up to 0.12 mg/L, hexavalent chromium at

an estimated concentration of 0.007 mg/L, and zinc at estimated concentrations up to 3.6 mg/L.

170-Foot Section of Ditch North of Building 20B73 and Underground Culvert

Recent surface soil sampling conducted in the 170-foot section of ditch north of Building 20B73 and the underground culvert included the following:

- A surface soil sample was collected from the bottom of the 170-foot section of ditch at one location (11D-SNS11) and analyzed for lead and PCBs; and
- Surface soil samples were collected at the entrance (11D-SNS10) and outfall (10D-SNS24) points of the underground culvert between Sites 11D and 10D and analyzed for PCBs.

A comparison of proposed and actual soil sampling activities at Site 11D and a summary of sample identifications and sampling depths is provided on Table 4-4. The results of the lead and PCB analysis of the surface soil samples are summarized below.

Lead

The results of the lead analysis of the surface soil sample are included in Appendix F and summarized on Table 4-3 and below. The sampling location and results are shown in Figure 4-4.

- Lead at 87 mg/kg was detected in the surface soil sample (11D-SNS11) collected approximately 75 feet west and downstream of the sampling location (11D-SNS04) having lead at 288 mg/kg. The detected concentration of lead is well below its SSL of 150 mg/kg and commercial/industrial CHHSL of 800 mg/kg.

Polychlorinated Biphenyls

The results of the PCB analysis of the three surface soil samples are included in Appendix F and summarized on Table 4-6 and below. Sampling locations and the analytical results are shown in Figure 4-5.

- Aroclor 1260 at 90 µg/kg was detected in the surface soil sample (11D-SNS11) collected from the 170-foot section of ditch. The detected concentration is well below the commercial and residential SSLs of 740 and 220 µg/kg, respectively.

- Aroclor 1260 at 150 µg/kg was detected in the surface soil sample (11D-SNS10) collected from the entrance to the underground culvert. The detected concentration is below the commercial and residential SSLs of 740 and 220 µg/kg, respectively.
- Aroclor 1260 at 290 µg/kg was detected in the surface soil sample (10D-SNS24) collected at the outfall of the underground culvert. The concentration of Aroclor 1260 detected in the sample is below the commercial SSL of 740 µg/kg.

4.3.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 11D*

The scope and results of the RI for perched groundwater conducted at Site 11D are summarized below.

4.3.3.1 *Previous Perched Groundwater Investigations*

No perched groundwater investigations were previously conducted at Site 11D.

4.3.3.2 *Recent Perched Groundwater Investigations*

Evaluation of the existing data for Site 11D presented in the approved Workplan indicated that data were needed to evaluate the presence of perched groundwater at Site 11D. The approved Workplan proposed the collection of screening-level groundwater samples if perched groundwater was encountered during soil vapor sampling at Site 11D.

Perched groundwater was not encountered during the collection of soil vapor samples along the sections of ditches; therefore, no screening-level groundwater samples were collected.

4.3.4 *Discussion of Investigation Results*

The cumulative results of the investigations associated with the ditches north and east of Building 20022, and the 170-foot section of ditch north of Building 20B73, are discussed below.

4.3.4.1 *Soil - Ditch and Septic Tank North of Building 20022*

Volatile Organic Compounds

- VOCs were not detected at concentrations above their respective SVSLs in the soil vapor samples collected along the ditch north of Building 20022 and near the septic tank north of Building 20022 (Table 4-2).

Metals and Metals Extract

- No metals were detected above background and their respective residential and commercial SSLs in the previous and recent surface and near-surface soil samples collected in the ditch north of Building 20022.
- Metals detected in the extracts from the two surface soil samples were barium, hexavalent chromium, and zinc.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemicals in soil in and adjacent to the ditch and septic tank north of Building 20022 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.3.4.2 *Soil - Ditch East of Building 20022*

Volatile Organic Compounds

- No VOCs at concentrations above their respective SVSLs were detected in the recent soil vapor samples collected along the ditch east of Building 20022. Additionally, two VOCs (TCE and 1,1,1-TCA) detected in the previous Stage 1 RI soil vapor were not identified in the recent samples.

Metals

- Cadmium was the only metal detected above background and residential SSL in soil samples collected from the ditch east of Building 20022. The detected concentration of cadmium is below its commercial SSL.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemicals along the ditch east of Building 20022 have been

sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.3.4.3 *Soil - 170-Foot Section of Ditch North of Building 20B73 and Underground Culvert*

Volatile Organic Compounds

- No VOCs at concentrations above their respective SVSLs were detected in the recent soil vapor samples collected along the 170-foot section of ditch north of Building 20B73 (Table 4-2).

Metals

- No metals were detected above background and their respective commercial SSLs in the surface and near-surface samples collected at two locations (11D-SNS03 and 11D-SNS04) from the 170-foot section of ditch north of Building 20B73 during the Stage 1 RI (Figure 4-4).
- Cadmium and/or lead above background and their respective residential SSLs were detected in the Stage 1 RI surface soil samples collected at locations 11D-SNS03 and 11D-SNS04.
- Lead above the residential SSL of 150 mg/kg was not detected in the recent surface soil sample (11D-SNS11) collected approximately 75 feet east and downstream of Stage 1 RI location 11D-SNS04.
- The results of the investigations indicate that lead above residential SSLs is limited to surface soil in the western 75 feet of the 170-foot section of ditch north of Building 20B73.

Polychlorinated Biphenyls

- Aroclor 1260 was detected in the surface soil samples collected from the 170-foot section of ditch but at concentrations well below the commercial SSL of 740 µg/kg (Figure 4-5).
- The results of the investigations indicate that Aroclor 1260 at concentrations less than the commercial SSL, and generally less than the residential SSL, are present in surface soil at the bottom of the ditch.
- Historical data and data collected during the BOU RI indicate that PCBs at concentrations above residential and commercial SSLs are present in surface soils in a section of ditch upstream of the underground culvert. These PCBs could potentially migrate into those sections of the Site 11D ditches included in the PGOU.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemicals in and along the ditch north of Building 20B73 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options. Remedial options for the underground culvert would need to address the potential future migration of PCBs from the upstream ditch.

4.3.4.4 *Perched Groundwater*

No perched groundwater was encountered during the collection of soil vapor samples along the ditches north and east of Building 20022 or along the 170-foot section of ditch north of Building 20B73.

4.4 *POTENTIAL SOURCE SITE 10D*

Potential Source Site 10D is the principal drainage ditch in Area 20 and parallels Folsom Boulevard (Figure 4-6). Between the beginning of the ditch directly north of Area 19 to the entrance of an underground culvert approximately 75 feet east of Aerojet Road, the ditch is unlined (Figure 4-6). The underground culvert extends from the entrance point east of Aerojet Road to the beginning of the lined ditch designated as Site 7D.

The Site 10D ditch receives drainage from the 11D ditch system and surface water runoff from Atlanta and Baltimore Streets; Aerojet Road; Alabama Avenue parking lots; Buildings 20001, 20002, 20004, 20006, 20014, 20015, 20019, 20026, 20034, and 20037; and the FCS. Chemicals that may have been potentially discharged to the ditch include chemical laboratory waste, chromium, x-ray and dye penetrant materials, solvents, waste cutting oil, sulfuric acid, nitric acid, phosphoric acid, sodium hydroxide, and sodium chromate. As discussed in Section 4.3, PCBs are present in soil within portions of the Site 11D ditch system upstream of the Site 10D ditch.

Two 12- to 14-inch underground corrugated steel culverts and two 6-inch steel drainpipes are located along the drainage ditch east of Aerojet Road (Figure 4-6). The easternmost underground culvert conveys surface water runoff from the Site 11D ditch system to the Site 10D ditch. The westernmost corrugated steel storm drain channels storm water runoff from the roofs of the buildings and surface streets in Area 20 to the drainage ditch.

The two 6-inch-diameter steel drainpipes appear to originate from Building 20002, but the origin or purpose of these drainpipes has never been fully documented. The easternmost 6-inch drainpipe passes along the western end of a former chemical laboratory sump north of Building 20002, but it is unknown whether the line is associated with the sump. Both 6-inch drainpipes are capped and have not discharged to the ditch for at least 15 years (ICFKE, 1993).

4.4.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 10D

The scope and results of the RI for VOCs at Potential Source Site 10D are summarized below.

4.4.1.1 Previous Volatile Organic Compound Investigations

During the Stage 1 RI, soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer at eight locations along the ditch and drain pipe. The analytical results for the shallow soil vapor samples are summarized below.

Shallow Soil Vapor Samples

- No VOCs were detected except for very low concentrations of Freon 113 ranging from 0.68 to 3.82 mg/m^3 in soil vapor samples collected at three locations along the western end of the ditch. Because of the proximity to the FCS, the low levels of Freon 113 detected in the samples are presumed to represent the eastern edge of the Freon 113 plume associated with the FCS, west of Aerojet Road and Gate 3.

4.4.1.2 Recent Volatile Organic Compound Investigations

Evaluation of the previous data for Site 10D presented in the approved Workplan indicated that soil vapor sampling was needed to assess the potential presence of VOCs at concentrations below the reporting limits used during the Stage 1 RI.

In accordance with the approved Workplan, soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer at five locations (10D-SP30 through 10D-SP34) along the Site 10D ditch. The sampling locations were placed at the approximate location of the Stage 1 RI sampling points. Following a review of the soil vapor data for the five soil vapor samples, a soil vapor sample was collected from the very shallow (1

to 5 feet bgs) layer at one location (10D-SP34). A comparison of proposed and actual soil vapor sampling activities at Site 10D along with a summary of sample identifications and sampling depths are provided on Table 4-1. The results of the VOC analysis of the soil vapor samples are included in Appendix F and summarized on Table 4-2 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-2 and below. Soil vapor sampling locations and VOCs detected in the soil vapor samples are shown in Figure 4-7.

Very Shallow Soil Vapor Samples

- Acetone at 0.05 mg/m^3 was the only VOC detected in the soil vapor sample (10D-SP34) collected at 5 feet bgs. The detected concentration of acetone is well below it SVSL of 6,600 mg/m^3.

Shallow Soil Vapor Samples

- VOCs detected in the five shallow soil vapor samples collected along the Site 10D ditch were Freon 113 (nondetect to 0.15 mg/m^3), dichloromethane (nondetect to 0.03 mg/m^3), toluene (nondetect to 0.02 mg/m^3), xylenes (nondetect to 0.06 mg/m^3), 1,2,4-trimethylbenzene (1,2,4-TMB) (nondetect to 0.02 mg/m^3), hexane (nondetect to 0.02 mg/m^3), heptane (nondetect to 0.02 mg/m^3), acetone (nondetect to 0.34 mg/m^3), MEK (nondetect to 0.12 mg/m^3), tetrahydrofuran (nondetect to 0.07 mg/m^3), and ethanol (nondetect to 0.31 mg/m^3).
- The concentrations of all VOCs detected in the five shallow soil vapor samples are below their respective SVSLs (Table 4-2).

4.4.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 10D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site 10D are summarized below.

4.4.2.1 *Previous Non-Volatile Organic Compound Investigations*

Soil investigations conducted at Site 10D in 1980 and 1986 indicated that cadmium, copper, lead, and zinc at concentrations above background levels established at that time were present in surface soil downstream of the point of discharge of the two drainpipes.

The Stage 1 RI of Site 10D conducted in 1993 consisted of the following activities:

- Surface soil samples were collected at four locations (10D-SNS01 through 10D-SNS04) from the unlined portion of the ditch and analyzed for metals (Figure 4-8). Three (10D-SNS01 through 10D-SNS03) of the four surface soil samples were collected at and downstream of the drainpipe potentially associated with the chemical laboratory sump (Figure 4-8). The fourth surface soil sample (10D-SNS04) was collected at the discharge point of the underground culvert from Site 11D to the Site 10D drainage ditch (Figure 4-8).
- Subsurface soil samples were collected at 1, 5, and 10 feet bgs from a boring (10D-AH01) drilled on the south bank of the ditch near the discharge point for the pipe that may have been associated with the chemical laboratory sump (Figure 4-8). The subsurface soil samples were analyzed for metals, SVOCs, and TPH-D.

The results of the Stage 1 RI sampling are summarized below.

Semivolatile Organic Compounds

- Two SVOCs were detected in the subsurface soil samples collected from boring 10D-AH01. Di-n-butyl phthalate, a compound identified during the Stage 1 RI as a laboratory contaminant, was detected in the samples at concentrations up to 1.12 mg/kg. 1,1,2,2-tetrachloroethane at 0.9 mg/kg was detected in the soil sample collected at 1 foot bgs. The detected concentration of 1,1,2,2-tetrachloroethane is above the residential SSL of 0.41 mg/kg, but below the commercial SSL of 0.93 mg/kg.
- TICs reported as part of the SVOC analysis of the subsurface soil samples included hexadecanoic acid up to 2 mg/kg, octadecanoic acid up to 0.8 mg/kg, unknown compounds up to 17 mg/kg, and unknown phthalates up to 1 mg/kg.

Metals

- The results for surface soil samples 10D-SNS01, 10D-SNS02, and 10D-SNS03 confirmed that the highest metal concentrations tended to be present in surface soil downstream of the drainpipe potentially associated with the chemical laboratory sump (ICFKE, 1993). Metals detected in the surface soil samples above their respective average Stage 1 RI background concentrations and residential SSLs included chromium, lead, silver, and thallium. The analytical results for these

samples are not presented on the tables and figures because additional sampling was conducted downstream of the drainpipes during the Stage 2 RI in 1997. The analytical results for the Stage 2 RI samples collected west of the two steel drainpipes are presented later in this section.

- Thallium was detected above the residential SSL, but below the commercial SSL, in sample 10D-SNS04 collected at the discharge point for the underground culvert from Site 11D (Table 4-7 and Figure 4-8). Metals detected in the sample above background included lead (28.2 mg/kg), thallium (7.71 mg/kg), and zinc (634 mg/kg).
- No metals above their respective commercial or residential SSLs were detected in the subsurface soil samples collected from boring 10D-AH01 (Table 4-7).
- Metals detected in the subsurface soil samples collected from boring 10D-AH01 at concentrations above site background levels being used at the time included arsenic, copper, nickel, and mercury (Table 4-7 and Figure 4-8). Arsenic at 9.77 mg/kg and nickel at 71.3 mg/kg were detected at 1 foot bgs. Copper at 47.7 and 38.7 mg/kg was detected in the samples collected at 1 and 10 feet bgs, respectively. Mercury at 0.16 and 0.96 mg/kg was detected in the samples collected at 1 and 5 feet bgs, respectively.

Total Petroleum Hydrocarbons

- No TPH-D was detected in the soil samples collected from the boring.

The Stage 2 RI of Site 10D conducted in 1997 consisted of the following activities:

- Surface soil samples were collected from the bottom of the ditch at seven locations (10D-SNS05 through 10D-SNS11) to evaluate the presence and concentrations of metals and perchlorate in the ditch between the point of discharge for the two steel drainpipes and the entrance to the underground culvert just east of Aerojet Road (Figure 4-8). The surface soil samples were analyzed for metals and perchlorate.
- Surface soil samples for metals analysis were collected at six locations (10D-SNS12 through 10D-SNS17) from the south bank of the ditch and six locations (10D-SNS18 through 10D-SNS23) from the north bank of the ditch (Figure 4-9). The surface samples were collected to evaluate metal concentrations in surface soil historically removed from the ditch to promote drainage and placed on the banks of the ditch.

- Soil samples for metals analysis were collected at 2.5, 5, 7.5, and 10 feet bgs from one boring (10D-SB02) drilled in the bottom of the ditch at the discharge point for the drainpipe potentially associated with the chemical laboratory sump (Figure 4-8). The boring was drilled at the location of surface soil sample 10D-SNS05. Auger refusal was encountered at 11 feet bgs.

The analytical results for the Stage 2 RI surface soil, ditch bank soil, and subsurface soil samples are summarized below.

Metals

The analytical results for the Stage 2 RI surface soils from the bottom and banks of the ditch and subsurface soil samples for metals, and their respective residential and commercial SSLs, are summarized on Table 4-7 and below.

Surface Soil Samples from Bottom of Ditch

- No metals were detected in the surface soil samples collected from the bottom of the ditch at concentrations above their respective commercial SSLs (Figure 4-8).
- Cadmium at concentrations above its residential SSL was detected in only three (10D-SNS05, 10D-SNS08, and 10D-SNS10) of the seven soil samples collected from the bottom of the ditch.

South Bank Soil Samples

- Cadmium was the only metal detected above background and its residential SSL in the soil samples collected from the south bank of the ditch (Figure 4-9).

North Bank Soil Samples

- No metals at concentrations above their respective residential or commercial SSLs were detected in the surface soil samples collected from the north bank of the ditch.

Subsurface Soil Samples

- Cadmium at a concentration of 4.58 mg/kg, above its residential SSL, was detected in the subsurface soil sample collected at 2.5 feet bgs from boring 10D-SB02.

- No metals above their respective residential or commercial SSLs were detected in the subsurface soil samples collected at 5, 7.5, and 10 feet bgs from boring 10D-SB02.

Perchlorate

- No perchlorate above the laboratory quantitation level of 4 mg/kg was detected in any of the seven surface soil samples collected from the bottom of the ditch.

4.4.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data for Site 10D presented in the approved Workplan indicated that the following data were needed to complete the RI/FS:

- Complete the characterization of metals in surface soil between the discharge point of the underground culvert from Site 11D and the pipe potentially associated with the chemical laboratory sump;
- Confirm the detections of thallium in Stage 1 RI samples;
- Assess the potential for impact to surface water and groundwater posed by the metals present in the surface soil in and adjacent to the Site 10D ditch;
- Confirm the presence of the SVOC, 1,1,2,2-tetrachloroethane, and TICs in subsurface soil at the former location of boring 10D-AH01;
- Evaluate the potential presence of PCBs in surface soil in the Site 10D ditch downstream of the underground culvert from Site 11D; and
- Evaluate potential impacts to surface water and groundwater posed by the metals present in the surface soil in and adjacent to the Site 10D ditch.

In accordance with the approved Workplan, recent sampling conducted at Site 10D consisted of the activities listed below. A comparison between proposed and actual surface and subsurface soil sampling activities and sampling depths are provided on Table 4-4.

- Subsurface soil samples were collected at 1, 2.5, 5, and 10 feet bgs from one boring (10D-SB03) placed at the approximate former location of Stage 1 RI soil boring 10D-AH01 (Figure 4-8) and analyzed for SVOCs.
- Surface soil samples were collected at five locations (10D-SNS24 through 10D-SNS28) between the discharge point of the culvert from

Site 11D and the discharge point of the 6-inch pipe potentially associated with the chemical laboratory sump and analyzed for metals (Figure 4-8);

- Surface soil samples were collected at four previous sampling locations (10D-SS04, 10D-SS10, 10D-SS21, and 10D-SS22) and analyzed for thallium;
- Four surface soil samples (10D-SS10, 10D-SS21, 10D-SS22, and 10D-SNS27) were leached using the WET procedure and analyzed for selected metals;
- Surface soil samples were collected at five locations (10D-SNS10 and 10D-SNS25 through 10D-SNS28) from the bottom of the Site 10D ditch and analyzed for PCBs; and
- Soil samples were collected at eight locations (10D-SNS29 through 10D-SNS36) on the south and north banks of the Site 10D ditch between the discharge point of the culvert from Site 11D and the entrance to the underground culvert east of Aerojet Road and analyzed for PCBs.

In response to agency comments on the Draft RI Report, and as agreed upon with the agencies during a meeting on 22 September 2005, the following additional soil sampling was conducted at Site 10D in November 2004 and January 2006:

- Surface and near-surface (2 feet bgs) soil samples were collected at the location (10D-SNS31) where the highest concentration of PCBs was detected. The samples, including a duplicate surface soil sample, were analyzed for PCBs.
- Additional surface soil samples were collected at two locations (10D-SNS11 and 10D-SNS21) where the maximum concentrations of arsenic (20 and 27 mg/kg) had been detected in previous samples collected in 1997. The samples were analyzed for arsenic.
- Soil samples were collected at 2, 5, and 10 feet bgs from two borings (10D-SB07 and 10D-SB10) in the bottom of the ditch to evaluate the leaching of metals into the vadose zone. The borings were drilled at two surface sampling locations (10D-SNS07 and 10D-SNS10) where the highest concentrations of lead were detected in surface soil. Boring 10D-SB07 was drilled at surface soil sample location 10D-SNS07 and boring 10D-SB10 was drilled at surface soil sample location 10D-SS10/10D-SNS10.

The analytical results for the surface, near-surface, and subsurface soil samples at Site 10D are included in Appendix F and summarized below.

Semivolatile Organic Compounds

The results of the SVOC and SVOC TIC analysis of the subsurface soil samples collected from boring 10D-SB03 are summarized on Tables 4-8 and 4-9, respectively, and below.

- The common analytical and sampling contaminant bis(2-ethylhexyl)-phthalate was the only SVOC detected in soil samples collected from boring 10D-SB03. Bis(2-ethylhexyl)phthalate was detected at an estimated concentration of 49 µg/kg in the sample collected at 2.5 feet bgs. The detected concentration is well below the residential SSL of 34,740 µg/kg.
- TICs were detected at concentrations greater than 10 µg/kg in only one of the four subsurface soil samples collected from boring 10D-SB03. TICs reported in SVOC analysis of the soil sample collected from boring 10D-SB03 at 2.5 feet bgs included tebuthiuron at an estimated concentration of 200 µg/kg, unknown alkanes at an estimated concentration of 400 µg/kg, and unknown cycloalkanes at 300 mg/kg.

Metals

The results of the metals analysis of the recent surface and subsurface soil samples collected at Site 10D are summarized on Table 4-7 and below. Metals detected in the surface and subsurface soil samples at concentrations above background and their respective SSLs are shown in Figure 4-8.

Surface Soil Samples from Bottom and Banks of Ditch

- Except for cadmium, no metals were detected above their respective residential or commercial SSLs in the five surface soil samples collected from the ditch between the discharge point of the culvert from Site 11D and the discharge point of the 6-inch pipe potentially associated with the chemical laboratory sump.
- Cadmium was detected at a concentration (2.2 mg/kg) above its residential SSL in only one (10D-SNS28) of the five surface soil samples collected from the bottom of the ditch.
- As discussed in Section 3.3.2.2, comparison of all the metals data collected at Site 10D with the 2007 Background data indicated that

arsenic and thallium in soil at Site 10D were not statistically different than background. Additionally, the absence of thallium in samples collected in 2003 indicates that elevated concentrations of that metal in previous samples are due to interferences inherent in USEPA Method 6010.

Subsurface Soil Samples

- No metals were detected above their respective residential or commercial SSLs in the six near-surface and subsurface soil samples collected from soil borings 10D-SB07 and 10D-SB10 in the bottom of the ditch. .
- The metals analytical data for surface soil sample 10D-SNS07 and subsurface soil samples collected from co-located boring 10D-SB07 show that concentrations of most metals did not vary significantly with depth. Lead concentrations attenuated with depth from 33 and 32 mg/kg at 2 and 5 feet bgs, respectively, to 5.5 mg/kg at 10 feet bgs.
- The metals analytical data for surface soil samples 10D-SNS10 and 10D-SS10 and subsurface soil samples collected from co-located boring 10D-SB10 also indicated that concentrations for most metals were generally consistent with depth. Metals such as lead and zinc that were above average background in surface soils attenuated with depth.

Metals Extract

The results of the metals analysis of the four surface soil samples (10D-SS10, 10D-SS21, 10D-SS22, and 10D-SNS27) collected from the bottom of the ditch and the extracts from the samples are summarized on Table 4-5 and below.

- Metals detected in the extract from at least one of the four surface soil samples from the bottom of the ditch were barium up to an estimated concentration of 0.29 mg/L, manganese up to 0.08 mg/L, and zinc up to an estimated concentration of 2 mg/L.

Polychlorinated Biphenyls

The results of the PCB analysis of surface soil collected from the bottom and banks of the ditch are summarized on Table 4-6 and below. PCBs detected in the surface soil samples from the bottom and banks of the ditch are shown in Figure 4-5.

- Aroclor 1260 was detected in all five surface soil samples collected from the bottom of the ditch at Site 10D at concentrations ranging from 79 to 490 µg/kg (Figure 4-5). The concentrations of Aroclor 1260 detected in the samples are below the commercial SSL of 740 µg/kg. The maximum concentrations of Aroclor 1260 were detected in surface soil samples collected within 300 feet downstream of the discharge point of the culvert from Site 11D. As shown in Figure 4-5, concentrations of Aroclor 1260 appear to attenuate with distance downstream from the point of discharge of the culvert from Site 11D.
- Aroclor 1260 was detected in seven of the eight soil samples collected from the north and south banks of the ditch at concentrations ranging from 110 to 1,200 µg/kg (Figure 4-5). Additionally, Aroclor 1254 was detected at 500 µg/kg in one soil sample (10D-SNS34) collected from the south bank of the ditch. With one exception, the concentrations of Aroclor 1260 and Aroclor 1254 detected in the samples were below the commercial soil PRG of 740 µg/kg. Aroclor 1260 detected in one sample (10D-SNS31) was above the commercial SSL of 740 µg/kg.
- Although Aroclor 1260 at 1,200 µg/kg was detected in the surface soil sample collected at 10D-SNS31 in July 2003, Aroclor 1260 concentrations (170 and 94 µg/kg) detected in a primary and duplicate sample collected at that location in November 2004 was significantly lower and below the residential SSL. Additionally, no PCBs above their respective laboratory reporting limits were detected in the near-surface soil samples collected at 2 feet bgs at that location.

Following a review of the PCB analysis of the surface soil samples from the bottom and banks of the ditch, a WET was conducted on two soil samples (10D-SNS31 and 10D-SNS34) containing Aroclor 1254 and Aroclor 1260 (Table 4-10). No PCBs were detected above the laboratory reporting limit in the WET extract from the two samples.

4.4.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 10D*

The scope and results of the RI for perched groundwater conducted at Site 10D are summarized below.

4.4.3.1 *Previous Perched Groundwater Investigations*

A total of 25 groundwater monitoring wells in Area 20 were sampled for VOCs, metals, perchlorate, and TPH-D during the Stage 2 RI in 1997. Of the 16 auger wells monitoring the perched groundwater in Area 20, only

1 well (Auger Well 675) within 500 feet of the Site 10D ditch contained water and could be sampled (Figure 4-6). The analytical results for that sample are summarized below.

Volatile Organic Compounds

- VOCs were not detected in the perched groundwater collected from Auger Well 675 (Figure 4-6), located north of the drainage ditch.

Non-Volatile Organic Compounds

- No TPH-D or perchlorate was detected in the perched groundwater sample collected from Auger Well 675. No metals at concentrations above federal or state maximum contaminant levels (MCLs) or other action levels were detected in the perched groundwater collected from Auger Well 675.

4.4.3.2 *Recent Perched Groundwater Investigations*

Evaluation of the previous data for Site 10D presented in the approved Workplan indicated that no additional data were needed to evaluate perched groundwater. The evaluation did indicate, however, that groundwater data were needed to evaluate the potential for metals in the ditch to leach into and impact groundwater.

In accordance with the approved Workplan, groundwater samples were collected from four monitoring wells (38, 108, 3109, and 3093) upgradient of Site 10D and three wells (279, 3086, and 3096) downgradient of Site 10D and analyzed for dissolved metals and general minerals. A summary of proposed and actual groundwater sampling activities, as well as information on depth to groundwater and well depth, are provided on Table 4-11. The results of the metals analysis of the groundwater samples are presented in Section 4.12. An evaluation of the potential for metals present in the ditch at Site 10D to leach into groundwater and surface water is presented in Section 6 of this report.

4.4.4 *Discussion of Investigation Results – Site 10D*

The cumulative results of the investigations conducted at the Site 10D ditch are discussed below.

4.4.4.1 *Soil*

Volatile Organic Compounds

- Very low concentrations of Freon 113 (0.68 to 3.82 mg/m^3) below the screening level were detected in the Stage 1 RI soil vapor samples collected along the western end of the Site 10D ditch.
- No VOCs at concentrations above their respective SVSLs were detected in the six soil vapor samples collected from the very shallow (1 to 5 feet bgs) and shallow (6 to 11 feet bgs) layer during the recent investigation.

Semivolatile Organic Compounds

Subsurface Soil

- Di-n-butyl phthalate, a compound identified during the Stage 1 RI as a laboratory contaminant, and 1,1,2,2-tetrachloroethane were detected in a soil sample collected at 1 foot bgs during the Stage 1 RI. TICs reported in the analysis included hexadecanoic acid, octadecanoic acid, unknown compounds, and unknown phthalates.
- The common analytical and sampling contaminant, bis(2-ethylhexyl)-phthalate, was the only SVOC detected in a soil sample collected at 2.5 feet bgs during the recent investigation. TICs reported in the analysis of that same soil sample were tebuthiuron, unknown alkanes, and unknown cycloalkanes at 300 mg/kg.
- The detection of different TICs in the recent samples from those detected in the previous samples indicates that the identification of TICs is not reproducible and not necessarily indicative of contamination.

Metals

Surface Soil from Bottom of Ditch

- Except for cadmium, no metals were detected above their respective residential or commercial SSLs in the surface soil samples collected from the bottom of the Site 10D ditch (Figure 4-8).
- Although thallium was detected above the residential SSL in two previous surface soil samples, no thallium was detected above the laboratory reporting limit of 0.2 mg/kg in four samples collected at locations where thallium had been detected in previous samples.

Additionally, no thallium was detected at concentrations greater than 0.2 mg/kg in any of the eight surface soil samples collected from the bottom and banks of the ditch during the recent sampling event. The results of the recent investigation indicate that the detection of elevated levels of thallium in previous soil samples was due to matrix interference during analysis.

- Although an elevated concentration (27 mg/kg) of arsenic was detected in a surface soil sample collected at one location (10D-SNS11) in the ditch in 1997, arsenic at only 4.3 mg/kg was detected in a surface soil sample collected at the same location in November 2004. The results indicate that either the elevated level of arsenic detected in the 1997 sample was anomalous or the distribution of arsenic in surface soil in the Site 10D ditch is highly variable.
- Although an elevated concentration (20 mg/kg) of arsenic was detected in a surface soil sample collected from the north bank at one location (10D-SNS21) in 1997, arsenic at only 8.4 mg/kg (10D-SS21, July 2003) and 4.4 mg/kg (10D-SNS21, November 2004) was detected in surface soil samples collected at the same location. The results indicate that either the elevated level of arsenic detected in the 1997 sample was anomalous or the distribution of arsenic in surface soil in the Site 10D ditch is highly variable.
- As discussed in Section 3.3.2.2, comparison of all the metals data collected at Site 10D with the 2007 Background data indicated that arsenic and thallium in soil at Site 10D were not statistically different than background. Concentrations for those metals (antimony, cadmium, lead, mercury, silver, and zinc) identified as COPCs were below their respective residential and commercial SSLs.

<u>South Bank of Ditch</u>

- With the exception of cadmium, no metals were detected in the soil samples collected fro the south bank of the ditch at concentrations above their respective residential or commercial SSLs. Cadmium concentrations in five of the six samples were above its residential SSL, but below its commercial SSL.

<u>North Bank of Ditch</u>

- Except for cadmium in only sample, no metals at concentrations above their respective residential or commercial SSLs were detected in the surface soil samples collected from the north bank of the ditch.

- Based on the statistical comparison of the PGOU metals data with the 2007 metals background dataset, arsenic and thallium concentrations in PGOU soils are not statistically higher than background and therefore not identified as COPCs. The results of the sampling show that arsenic concentrations in soil, especially soil in the bottom of ditches, can vary significantly over short distances.
- The results of the investigation also indicate that elevated detections of thallium in soil is due to interferences inherent in the analysis of samples using USEPA Method 6010.

Subsurface Soil

- No metals identified as COPCs were detected above their respective commercial or residential SSLs in the subsurface soil samples collected during the previous (1992 and 1997) investigations at Site 10D.
- No metals identified as COPCs were detected above their respective residential or commercial SSLs in the subsurface soil samples collected during the recent (2006) investigation at Site 10D.

Polychlorinated Biphenyls

Surface Soil from Bottom of Ditch

- Aroclor 1260 was detected at concentrations ranging from 79 to 490 µg/kg in surface soil samples collected from the ditch at Site 10D. The detected concentrations of Aroclor 1260 are well below the commercial SSL of 740 µg/kg.
- The highest concentrations of Aroclor 1260 were detected in surface soil samples collected within 300 feet downstream of the discharge point of the culvert from Site 11D.
- Concentrations of Aroclor 1260 appear to attenuate with distance downstream from the point of discharge of the culvert from Site 11D.
- The results of WETs performed on two samples indicate that the PCBs in the samples are not soluble.

South Bank of Ditch

- Aroclor 1260 was detected at 220 and 520 µg/kg in two of the three soil samples collected from the south bank of the ditch. Additionally, Aroclor 1254 was detected at 500 µg/kg in the sample having Aroclor 1260 at 520 µg/kg.

- The detected concentrations of Aroclor 1260 and 1254 were below the commercial SSL of 740 µg/kg.
- The results of WETs performed on two samples indicate that the PCBs in the samples are not soluble.

North Bank of Ditch

- Aroclor 1260 was detected at concentrations ranging from 110 to 1,200 µg/kg in all five soil samples collected from the north bank of the ditch (Figure 4-5). Aroclor 1254 was not detected in the samples.
- The detected concentration of Aroclor 1260 in only one (10D-SNS31) of the five samples was above the commercial SSL. However, Aroclor 1260 in surface soil samples collected at that same location in November 2004 were significantly less (170 and 94 µg/kg) than in the original sample and less than the residential SSL.
- No PCBs were detected in the near-surface (2 feet bgs) soil sample collected at the location (10D-SNS31) where the maximum concentration of Aroclor 1260 was detected in the surface soil.
- The results of WETs performed on two samples indicate that the PCBs in the samples are not soluble.

Perchlorate

Surface Soil from Bottom of Ditch

- No perchlorate was detected above the laboratory quantitation level of 4 mg/kg in the seven surface soil samples collected from the bottom of the ditch in 1997.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemicals in soil at Site 10D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options. Remedial options for the Site 10D ditch would need to address the potential future migration of PCBs from ditches upstream.

4.4.4.4 *Perched Groundwater*

The presence of perched groundwater in Area 20 and the vicinity of Site 10D has decreased significantly over the past 15 to 20 years. In 1997, only 1 of 16 wells previously installed in the perched groundwater layer in Area 20 contained water.

- No VOCs, TPH-D, or perchlorate were detected in the perched groundwater.
- No metals above federal or state MCLs were detected in the perched groundwater.

Review of the cumulative data indicates that the presence and concentrations of chemical constituents in perched groundwater at Site 10D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.5 *POTENTIAL SOURCE SITE 7D*

Potential Source Site 7D is a concrete-lined ditch 400 feet north of Building 20009 (Figure 4-10). The ditch is the downstream continuation of the ditch identified as Potential Source Site 10D. This section of ditch is downgradient from the 10D and 11D ditch systems and received drainage from those sites. Additionally, the Site 7D ditch received surface water runoff from the adjacent former parking lots.

4.5.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 7D*

The scope and results of the RI for VOCs conducted at Site 7D are summarized below.

4.5.1.1 *Previous Volatile Organic Compound Investigations*

During the Stage 1 RI, shallow (6 to 11 feet bgs) soil vapor samples were collected at five locations (7D-SP02 through 7D-SP06) along the ditch and at the confluence of Sites 7D and 5D. The analytical results for the shallow soil vapor samples are summarized below.

Shallow Layer

Total VOC concentrations in the soil vapor samples ranged from nondetect to 17.9 mg/m^3, with the highest concentration detected at the east end of the ditch and close to the area of the FCS. The highest total VOC concentration of 17.9 mg/m^3 consisted of Freon 113 at 13.75 mg/m^3 and TCE at 4.15 mg/m^3.

4.5.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 7D indicated that additional soil vapor sampling was needed to assess the potential presence of VOCs at concentrations below the reporting limits used during the Stage 1 RI.

In accordance with the approved Workplan, soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer at four locations (7D-SP12 through 7D-SP15) along the ditch at Site 7D and at the confluence of Sites 7D and 5D. A comparison of proposed and actual soil vapor sampling activities at Site 7D and a summary of sample identifications and sampling depths is provided on Table 4-1.

The analytical results for the soil vapor samples are included in Appendix F and summarized on Table 4-2 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-2 and below. Soil vapor sampling locations and VOCs detected in the soil vapor samples are shown in Figure 4-11.

<u>*Shallow Soil Vapor Samples*</u>

- As with the previous investigation, the highest VOC concentrations were detected in the soil vapor sample at the east end of the ditch closest to the area of the FCS (Figure 4-11).
- VOCs detected in the shallow (6 to 11 feet bgs) soil vapor samples consisted of Freon 113 up to 14 mg/m^3, dichloromethane up to 0.02 mg/m^3, chloroform up to 0.17 mg/m^3, 1,1,1-TCA up to 0.04 mg/m^3, TCE up to 0.29 mg/m^3, PCE up to 2.1 mg/m^3, benzene up to 0.03 mg/m^3, toluene up to 0.03 mg/m^3, hexane up to 0.04 mg/m^3, heptane up to 0.03 mg/m^3, acetone up to 0.78 mg/m^3, MEK up to 0.18 mg/m^3, and ethanol up to 0.12 mg/m^3.
- PCE above its HH SVSL of 0.64 mg/m^3 was detected in all four of the shallow soil vapor samples (Figure 4-11).

4.5.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 7D*

The scope and results of the RI for non-VOCs conducted at Potential Source Site 7D are summarized below.

4.5.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, soil samples were collected for metals analysis at four locations (7D-SNS01, 7D-SNS02, 7D-SNS03, and 7D-SNS04) along the Site 7D concrete-lined drainage ditch (Figure 4-12). In addition, a composite sample (7D-CS01) for metals analysis was collected from soil that had been removed from the ditch to facilitate drainage and stockpiled in an unpaved area (Figure 4-12) at the east end of the ditch (the former location of the company store). The stockpiled soil has since been removed. The analytical results for metals in the ditch and stockpiled soil, and their respective residential and commercial SSLs, are summarized on Table 4-12 and below.

Metals

Surface Soils in Ditch

Cadmium was the only metal detected above its residential SSL, but below its commercial SSL, in the soil samples collected from the Site 7D ditch. Cadmium was detected at 2.09 mg/kg in soil sample 7D-SNS04 (Figure 4-12).

Stockpiled Soil

Cadmium was the only metal detected above its SSL in the sample (7D-CS01) collected from the stockpiled soil. Cadmium was detected in the sample at a concentration of 2.56 mg/kg, above its residential SSL but below its commercial SSL.

4.5.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous metals data for Site 7D presented in the approved Workplan indicated that additional data were needed to confirm the presence of thallium in surface soil.

No soil was present in the Site 7D ditch during the recent investigation and no samples were collected. However, the analysis of samples during the recent investigation at Site 10D indicates that the detection of elevated levels of thallium in previous soil samples was the result of matrix interference during analysis.

4.5.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 7D*

The scope and results of the RIs for perched groundwater conducted at Site 7D are summarized below.

4.5.3.1 *Previous Perched Groundwater Investigations*

Two groundwater monitoring wells (Wells 42 and 507) previously believed to be completed in a perched groundwater zone are located at the west end of the Site 7D ditch (Figure 4-13). Further evaluation of the data for those two wells as part of the PGOU RI indicates that those wells are completed within unconfined Layer B. During the Stage 1 RI, groundwater samples were collected from Well 42 in March 1992 and in January and April 1993. Well 507 was dry. Nitrate up to 13 mg/L and sulfate up to 11 mg/L were detected in the samples collected in March 1992 and January 1993. The concentrations of nitrate detected in the samples were above the MCL of 10 mg/L.

4.5.3.2 *Recent Perched Groundwater Investigations*

Evaluation of the previous data for Site 7D presented in the approved Workplan indicated that additional data were needed to determine if groundwater is present in Wells 42 and 507 and evaluate the presence of nitrate. Evaluation of the well completion and depth to groundwater data for those wells conducted as part of the PGOU RI indicated that those wells are completed within unconfined groundwater Layer B. In accordance with the approved Workplan, Wells 42 and 507 were monitored for the presence of water. Well 42 was dry. Well 507 contained water and was sampled for nitrates. The analytical results for the sample collected from Well 507 are summarized in Section 4.12.

4.5.4 *Discussion of Investigation Results – Site 7D*

The cumulative results of the investigations conducted at Site 7D are discussed below.

4.5.4.1 *Soil*

<u>*Volatile Organic Compounds*</u>

- PCE was the only VOC detected in the recent shallow (10 feet bgs) soil vapor samples collected at Site 7D at a concentration above its

screening level of 0.64 mg/m^3. As shown in Figure 4-11, PCE concentrations in the four shallow soil vapor samples ranged from 0.79 to 2.1 mg/m^3.

Metals

- Previous soil sampling at Site 7D indicated the presence of cadmium and thallium above their residential SSLs.
- No soil was present in the Site 7D concrete-lined ditch during the recent investigation.
- The analytical results for recent soil samples collected during the investigation of Site 10D indicate that the detection of elevated levels of thallium is the result of matrix interference during analysis.

Review of the cumulative data indicates that with the exception of PCE, the presence, concentrations, and extent of all non-VOCs and VOCs in soil at Site 7D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options. The extent of PCE in soil vapor at Site 7D has not been characterized to levels below its SVSL.

4.5.4.2 *Perched Groundwater*

Review of the cumulative data indicates that perched groundwater is not present beneath Site 7D.

4.6 *POTENTIAL SOURCE SITE 5D*

This report presents the results of previous (prior to 2003) and recent (2003) investigations conducted on the section of the Site 5D ditch north of the confluence with the Site 7D ditch (Figure 4-10). This section is upstream of all potential source sites, and the road along the west side of the ditch and topography prevents surface water runoff from the GET D facility from entering the ditch.

4.6.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 5D*

No soil vapor sampling was conducted along this section of the Site 5D ditch during the Stage 1 RI. Evaluation of groundwater data as presented in the approved Workplan indicated that Site 5D is not a source of VOCs

and, therefore, no sampling for VOCs was proposed to complete the RI/FS.

4.6.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 5D*

The scope and results of the RI for non-VOCs conducted at Site 5D are summarized below.

4.6.2.1 *Previous Non-Volatile Organic Compound Investigations*

No soil sampling was conducted along this section of the Site 5D ditch during the Stage 1 RI.

4.6.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data presented in the approved Workplan indicated that data were needed to assess the presence of metals in the section of the Site 5D ditch addressed in this PGOU RI/FS.

In accordance with the approved Workplan, surface soil samples were collected from the section of the Site 5D ditch addressed in this RI at three locations and analyzed for metals. A comparison of proposed and actual soil sampling activities at Site 5D and a summary of sample identifications and depths are provided on Table 4-4. The analytical results for the samples are included in Appendix F and summarized on Table 4-12 and below. Sampling locations and metals detected above background and their respective residential SSLs are shown in Figure 4-12.

Metals

Cadmium above background and its residential SSL was detected in only one of three surface soil samples collected from the Site 5D ditch. The detected concentration of cadmium at 2.2 mg/kg is below the commercial SSL.

To assess the potential for metals to leach from the soils and impact groundwater and surface water, a WET was conducted on surface soil sample 5D-SNS07. The selected sample contained several metals at concentrations above average and maximum background. The results of the metals analysis of the soil sample and sample extract are presented on Table 4-5. Metals detected in the sample extract were barium (estimated

concentration of 0.15 mg/L) and zinc (estimated concentration of 0.39 mg/L).

4.6.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 5D*

The scope and results of the RI for perched groundwater conducted at Site 5D are summarized below.

4.6.3.1 *Previous Perched Groundwater Investigations*

One groundwater monitoring well (Well 42) previously believed to be completed in a perched groundwater zone is close to the confluence of the Site 5D ditch and the Site 7D ditch (Figure 4-13). Further evaluation of the data for that well as part of the PGOU RI indicated that the well is completed within unconfined Layer B.

4.6.3.2 *Recent Perched Groundwater Investigations*

Evaluation of the previous data presented in the approved Workplan indicated that data were needed to determine if groundwater was present in Well 42. In accordance with the approved Workplan, Well 42 was monitored for the presence of groundwater. Well 42 was dry.

4.6.4 *Discussion of Investigation Results – Site 5D*

The following sections summarize the results of investigations conducted to date.

4.6.4.1 *Soil*

Volatile Organic Compounds

No soil vapor sampling was conducted along this section of the Site 5D ditch during the Stage 1 RI or recent investigation.

Metals

Cadmium was detected above its residential SSL, but below its commercial SSL, in only one of the three surface soil samples collected from the Site 5D ditch.

Metals Leachate

Metals detected in the leachate were barium (estimated concentration of 0.15 mg/L) and zinc (estimated concentration of 0.39 mg/L).

Review of the cumulative data indicates that the presence, concentrations, and extent of chemicals at Site 5D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.6.4.2 *Perched Groundwater*

Review of the cumulative data indicates that perched groundwater is not present beneath Site 5D.

4.7 *FORMER COMPANY STORE*

The FCS (Building 20014) was located in the north-central portion of Area 20, approximately 10 feet north of the underground drainage culvert at Site 10D (Figure 4-10). The FCS was demolished in 1989. A vehicle and refrigeration unit repair and maintenance facility was located on the west side of the FCS. Large refrigeration units for the store were located along the south side of the building. The FCS is not listed as a potential source site in the PCD, but was discovered during the Stage 1 RI of the Site 10D drainage.

4.7.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Former Company Store*

The scope and results of the RI for VOCs conducted at the FCS are summarized below.

4.7.1.1 *Previous Volatile Organic Compound Investigations*

During the Stage 1 RI, approximately 35 soil vapor samples were collected from the shallow (6 to 11 feet bgs) and intermediate (12 to 20 feet bgs) layers in the area of the FCS. Previous soil vapor sampling locations are shown in Figures 4-14 and 4-15. The analytical results for the soil vapor samples are summarized below.

- Freon 113 was the predominant VOC detected in the soil vapor samples with concentrations up to 18,400 mg/m^3 in the intermediate

layer. Freon 113 concentrations in the shallow and intermediate layers are shown in Figures 4-16 and 4-17, respectively. Other VOCs detected in the vicinity of the FCS included TCE (up to 325 mg/m^3); PCE (up to 34.9 mg/m^3); 1,2-dichloroethene (1,2-DCE) (up to 32.6 mg/m^3); and vinyl chloride (up to 4.5 mg/m^3). TCE concentrations in the Stage 1 RI shallow and intermediate soil vapor samples are shown in Figures 4-18 and 4-19, respectively.

In October 1998, vapor samples were collected from two vapor wells (FCS-SVE1 and FCS-SVE2) installed in the central portion of the VOC plume at the FCS (Figure 4-10). VOCs detected in the vapor samples included Freon 113 at 366 and 421 mg/m^3; PCE at 5.03 and 6.07 mg/m^3; and acetone at 1.91 mg/m^3. Acetone was also detected at 0.005 mg/m^3 in a laboratory blank sample.

4.7.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for the FCS presented in the approved Workplan indicated that additional soil vapor sampling was needed to confirm the presence and concentrations of the VOCs detected in the vadose zone during the Stage 1 RI.

In accordance with the approved Workplan, a total of 35 soil vapor samples (excluding QA/QC samples) were collected at 17 locations in the area of the FCS. Three soil vapor samples were collected from the very shallow (1 to 5 feet bgs) layer, 17 were collected from the shallow (6 to 11 feet bgs) layer, and 15 were collected from the intermediate (12 to 20 feet bgs) layer. Additionally, vapor samples were collected from the two vapor wells (FCS-SVE1 and FCS-SVE2) in the central portion of the FCS and surface emission flux chamber samples were collected at three locations. A comparison of proposed and actual soil vapor sampling activities at the FCS and a summary of sample identifications and depths are provided on Table 4-1.

The analytical results for the recent soil vapor samples and vapor samples collected from the two vapor wells are included in Appendix F and summarized on Table 4-13 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-13 and below. The analytical results for three surface emission flux chamber samples collected at the FCS are presented in Appendix N. Flux chamber sampling locations are shown in Figure 4-20.

VOCs detected in the recent very shallow, shallow, and intermediate soil vapor samples at concentrations above their respective SVSLs are shown in Figures 4-20, 4-21, and 4-22, respectively. Freon 113 concentrations in the recent shallow and intermediate soil vapor samples are shown in Figures 4-23 and 4-24, respectively. TCE concentrations in the recent shallow and intermediate soil vapor samples are shown in Figures 4-25 and 4-26, respectively.

Very Shallow Soil Vapor Samples

- Nine VOCs were detected in the three soil vapor samples collected from the very shallow (1 to 5 feet bgs) layer at the FCS (Figure 4-20).
- The nine VOCs and their maximum detected concentrations were Freon 113 (38 mg/m^3); chloroform (0.1 mg/m^3); TCE (0.34 mg/m^3); PCE (4.1 mg/m^3); benzene (0.02 mg/m^3); hexane (0.02 mg/m^3); acetone (0.49 mg/m^3); and ethanol (0.03 mg/m^3).
- PCE was the only VOC detected in the very shallow soil vapor samples at concentrations above its respective screening level. PCE at 4.1 mg/m^3 and 1.7 mg/m^3 was detected in soil vapor samples FCS-SP07 and FCS-SP10, respectively.

Shallow Soil Vapor Samples

- Seventeen VOCs were detected in the 17 soil vapor samples collected from the shallow layer.
- The 17 VOCs and their maximum detected concentrations were Freon 113 (200 mg/m^3); dichloromethane (0.4 mg/m^3); cis-1,2-DCE (0.14 mg/m^3); chloroform (0.92 mg/m^3); TCE (0.19 mg/m^3); PCE (7.6 mg/m^3); benzene (0.02 mg/m^3); toluene (0.09 mg/m^3); xylenes (0.08 mg/m^3); hexane (0.08 mg/m^3); cyclohexane (0.03 mg/m^3); heptane (estimated concentration of 0.06 mg/m^3); acetone (0.79 mg/m^3); MEK (estimated concentration of 0.2 mg/m^3); tetrahydrofuran (0.07 mg/m^3); and ethanol (0.04 mg/m^3).
- PCE and chloroform were the only VOCs detected in the soil vapor samples collected from the shallow layer at concentrations above their respective SVSLs (Table 4-13 and Figure 4-21). PCE above its SVSL of 0.64 mg/m^3 was detected in 13 of the 17 soil vapor samples. Chloroform above its SVSL of 0.7 mg/m^3 was detected in only one soil vapor sample (FCS-SP17).
- Freon 113 and PCE were the most predominant VOCs detected in the soil vapor samples collected from the shallow layer. Freon 113 and

TCE concentrations detected in the recent shallow soil vapor samples are shown in Figures 4-23 and 4-25, respectively.

Intermediate Soil Vapor Samples

- Thirty VOCs were detected in the 15 soil vapor samples collected from the intermediate layer at the FCS.
- The 30 VOCs and their maximum detected concentrations were Freon 113 (120 mg/m^3); dichloromethane (0.63 mg/m^3); cis-1,2-DCE (0.08 mg/m^3); chloroform (0.59 mg/m^3); 1,1,1-TCA (0.06 mg/m^3); TCE (0.2 mg/m^3); PCE (5.8 mg/m^3); cis-1,3-dichloropropene (0.04 mg/m^3); trans-1,3-dichloropropene (0.08 mg/m^3); benzene (0.04 mg/m^3); toluene (0.28 mg/m^3); ethylbenzene (0.08 mg/m^3); xylenes (0.49 mg/m^3); styrene (0.06 mg/m^3); 1,3,5-trimethylbenzene (0.06 mg/m^3); 1,2,4-TMB (0.2 mg/m^3); alpha chlorotoluene (0.11 mg/m^3); hexane (0.14 mg/m^3); cyclohexane (0.09 mg/m^3); heptane (0.14 mg/m^3); cumene (0.14 mg/m^3); propyl benzene (0.13 mg/m^3); acetone (2.4 mg/m^3); carbon disulfide (0.13 mg/m^3); 2-propanol (0.06 mg/m^3); MEK (0.57 mg/m^3); 4-ethyltoluene (0.22 mg/m^3); methyl tert-butyl ether (MTBE) (0.06 mg/m^3); and ethanol (0.38 mg/m^3).
- PCE and alpha-chlorotoluene were the only VOCs detected in the soil vapor samples collected from the intermediate layer at concentrations above their respective SVSLs (Table 4-13 and Figure 4-22). PCE at concentrations above its SVSL of 0.64 mg/m^3 was detected in 9 of the 15 soil vapor samples. Alpha-chlorotoluene above its SVSL of 0.8 mg/m^3 was detected in only one soil vapor sample (FCS-SP07).
- Freon 113 and PCE were the most predominant VOCs detected in the soil vapor samples collected from the intermediate layer. Freon 113 and TCE concentrations detected in the recent intermediate soil vapor samples are shown in Figures 4-24 and 4-26, respectively.

Vapor Well Samples

- VOCs detected in the vapor samples collected from the two vapor wells (FCS-SVE1 and FCS-SVE2) in the central portion of the FCS were Freon 113 at 67 and 35 mg/m^3, chloroform at 0.43 and 0.71 mg/m^3, and PCE at 1.1 and 0.36 mg/m^3, respectively.

4.7.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Former Company Store*

The scope and results of the RIs for non-VOCs conducted at the FCS are summarized below.

4.7.2.1 *Previous Non-Volatile Organic Compound Investigations*

Subsurface soil samples were collected at 1, 7, 14, 20, and 25 feet bgs from one soil boring (FCS-SB01) placed in the center of the Freon 113 plume at the FCS (Figure 4-27). The samples were analyzed for SVOCs, TPH-D, and metals. The analytical results for the samples are summarized below. The analytical results for metals, and their respective residential and commercial SSLs, are summarized on Table 4-12.

Semivolatile Organic Compounds

- No TPH-D or SVOCs, other than the common laboratory contaminant di-n-butyl phthalate (up to 3.45 mg/kg), were detected in the subsurface soil samples.
- TICs reported as part of the SVOC analysis included hexadecanoic acid up to 8.7 mg/kg, unknown compounds up to 3 mg/kg, and unknown phthalates up to 20 mg/kg.

Metals

- No metals above background or respective residential and commercial SSLs were detected in the Stage 1 RI soil samples collected at the FCS (Figure 4-27).

Total Petroleum Hydrocarbons

- No TPH-D was detected in the subsurface soil samples.

4.7.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data for the FCS presented in the approved Workplan indicated that additional data were needed to confirm the presence of TICs detected in the SVOC analysis of soil samples from Stage 1 RI boring FCS-AH01.

In accordance with the approved Workplan, subsurface soil samples were collected from one soil boring (FCS-SB01) placed at the approximate former location of boring FCS-AH01 (Figure 4-27). Soil samples were

collected at 2.5, 5, 10, 15, and 20 feet bgs and analyzed for SVOCs. Depth to groundwater encountered while drilling was 24 feet bgs. All sampling proposed in the approved Workplan was completed. A comparison between proposed and actual subsurface sampling activities and a summary of sample identifications and depths are provided on Table 4-14.

The results of the SVOC and SVOC TIC analysis of the samples collected from boring FCS-SB01 are summarized on Tables 4-8 and 4-9, respectively, and below. Laboratory analytical reports for the samples are included in Appendix F.

Semivolatile Organic Compounds

- The common analytical and sampling contaminant, bis(2-ethylhexyl)-phthalate, was the only SVOC detected in soil samples collected from boring FCS-SB01. Bis(2-ethylhexyl)phthalate was detected at estimated concentrations of 64 and 31 µg/kg in the samples collected at 2.5 and 20 feet bgs, respectively. The detected concentrations are well below the residential SSL of 35,000 µg/kg.
- With the exception of sulfur, no TICs were detected at concentrations greater than 10 µg/kg in the SVOC analysis of the soil samples collected from boring FCS-SB01 (Table 4-9). Sulfur was detected at 100 µg/kg in the soil sample collected at 5 feet bgs.

4.7.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Former Company Store*

The scope and results of the RIs for perched groundwater conducted at the FCS are summarized below.

4.7.3.1 *Previous Perched Groundwater Investigations*

During the Stage 1 RI, a perched groundwater sample was collected from Well 868 (Figure 4-10) and analyzed for VOCs, SVOCs, metals, and hexavalent chromium. Additionally, an attempt was made to collect a screening-level sample of the perched groundwater at the location (10D-HP01) shown in Figure 4-10. Wet soil was encountered at a depth of 30 feet, but did not produce enough water for a sample. The analytical results for the perched groundwater sample collected from Well 868 are summarized below.

Volatile Organic Compounds

- No VOCs were detected above their respective laboratory reporting limits in the perched groundwater sample.

Semivolatile Organic Compounds

- Bis(2-ethylhexyl)phthalate was detected at 1,100 µg/L in the groundwater sample. The detected concentration is higher than would be expected from laboratory or sampling contamination, but is suspect because the concentration exceeds the water solubility (400 µg/L) of that compound.

Metals

- Metals detected in the perched groundwater sample included aluminum (0.4 mg/L), barium (0.03 mg/L), magnesium (2.2 mg/L), manganese (0.05 mg/L), and zinc (0.4 mg/L). The detected concentrations are below their respective MCLs.

4.7.3.2 *Recent Perched Groundwater Investigations*

Evaluation of the existing data for the FCS presented in the approved Workplan indicated that additional sampling was needed to verify the presence or absence of bis(2-ethylhexyl)phthalate in Well 868 and evaluate the presence of VOCs and SVOCs in groundwater potentially present in the vapor extraction wells installed in 1998.

In accordance with the approved Workplan, Well 868 and the two vapor extraction wells (FCS-SVE1 and FCS-SVE2) were monitored for the presence of groundwater. Groundwater was present in Well 868 at 19.3 feet bgs and in vapor extraction wells FCS-SVE1 and FCS-SVE2 at approximately 23 feet bgs. Groundwater samples were collected from the wells and analyzed for VOCs and SVOCs. A comparison between proposed and actual groundwater sampling activities and sample analyses is provided on Table 4-11.

A review of well completion and groundwater data indicated that Well 868 is completed within a perched groundwater zone and vapor extractions wells FCS-SVE1 and FCS-SVE2 are completed in unconfined groundwater Layer B. The results of the VOC and SVOC analysis of the sample collected from Well 868 are shown in Figure 4-13 and summarized on Tables 4-15 and 4-16, respectively, and below. The results of the VOC and SVOC analysis of the samples collected from vapor extraction wells

FCS-SVE1 and FCS-SVE2 are presented in Section 4.12 of this report. Laboratory analytical reports for the samples are included in Appendix F.

Volatile Organic Compounds

- VOCs detected in the perched groundwater sample collected from Well 868 included cis/trans-1,2-DCE at 1.2 µg/L, Freon 113 at 1.1 µg/L, PCE at 4.9 µg/L, and chloroform at 2.2 µg/L.

Semivolatile Organic Compounds

- No SVOCs were reported at concentrations above their respective laboratory reporting limits in the perched groundwater samples collected from Well 868.
- TICs reported in the SVOC analysis of perched groundwater from Well 868 were unknown compounds estimated at 55 µg/L, unknown hydrocarbons estimated at 56.6 µg/L, an unknown phenol estimated at 8.5 µg/L, cholesterol estimated at 22 µg/L, and molecular sulfur estimated at 1,300 µg/L.

4.7.4 *Discussion of Investigation Results - Former Company Store*

The cumulative results of the soil and perched groundwater investigations conducted at the FCS are discussed below.

4.7.4.1 *Soils*

Volatile Organic Compounds

- VOCs detected in the Stage 1 RI soil vapor samples collected at the FCS included Freon 113; TCE; PCE; 1,2-DCE; and vinyl chloride. Freon 113 was the predominant VOC detected in the Stage 1 RI soil vapor samples with concentrations up to 8,970 mg/m^3 in the shallow layer and 18,400 mg/m^3 in the intermediate layer (Figures 4-16 and 4-17, respectively). TCE was also detected in the soil vapor samples collected at the FCS during the Stage 1 RI at concentrations up to 325 mg/m^3 in the shallow layer and 3.36 mg/m^3 in the intermediate layer (Figures 4-18 and 4-19, respectively).
- VOCs detected in the recent (2003) soil vapor samples collected at the FCS, and their maximum concentrations, included Freon 113 (200 mg/m^3); dichloromethane (0.63 mg/m^3); cis-1,2-DCE (0.14 mg/m^3); chloroform (0.92 mg/m^3); 1,1,1-TCA (0.06 mg/m^3); TCE (0.34 mg/m^3); PCE (5.8 mg/m^3); cis-1,3-dichloropropene (0.04 mg/m^3);

trans-1,3-dichloropropene (0.08 mg/m^3); benzene (0.04 mg/m^3); toluene (0.28 mg/m^3); ethylbenzene (0.08 mg/m^3); xylenes (0.49 mg/m^3); styrene (0.06 mg/m^3); 1,3,5-trimethyl-benzene (0.06 mg/m^3); 1,2,4-TMB (0.2 mg/m^3); alpha chlorotoluene (0.11 mg/m^3); hexane (0.14 mg/m^3); cyclohexane (0.09 mg/m^3); heptane (0.14 mg/m^3); cumene (0.14 mg/m^3); propyl benzene (0.13 mg/m^3); acetone (2.4 mg/m^3); carbon disulfide (0.13 mg/m^3); 2-propanol (0.06 mg/m^3); MEK (0.57 mg/m^3); tetrahydrofuran (0.07 mg/m^3); 4-ethyltoluene (0.22 mg/m^3); MTBE (0.06 mg/m^3); and ethanol (0.38 mg/m^3).

- Review of the data on Table 4-13 indicates that VOC concentrations detected in the recent soil vapor samples were generally higher in the shallow (6 to 11 feet bgs) layer than in the intermediate (12 to 20 feet bgs). Additionally, comparison of the analytical results for the soil vapor samples collected at 5 feet bgs with those collected at 10 feet bgs show that in general, VOC concentrations in the 5-foot samples were lower than those detected in the 10-foot samples.
- Comparison of Freon 113 concentrations detected in the shallow and intermediate Stage 1 RI soil vapor samples (Figures 4-16 and 4-17) with those detected in the recent soil vapor samples (Figures 4-23 and 4-24) shows that while the extent of Freon 113 in the vadose zone at the FCS has remained relatively similar over the past 10 years, concentrations have decreased several orders of magnitude at some locations. As shown in Figures 4-17 and 4-24, Freon 113 was detected at only 58 mg/m^3 in the recent soil vapor sample (FCS-SP03) collected at the same location as the Stage 1 RI sample (10D-SP01) having a Freon 113 concentration of 18,400 mg/m^3.
- Comparison of TCE concentrations detected in the shallow and intermediate Stage 1 RI soil vapor samples (Figures 4-18 and 4-19) with those detected in the recent soil vapor samples (Figures 4-25 and 4-26) shows that both the extent and concentrations of TCE in the vadose zone at the FCS have attenuated significantly over the past 10 years. As shown in Figures 4-18 and 4-25, TCE was detected at only 0.12 mg/m^3 in the recent soil vapor sample (FCS-SP07) collected at the same location as the Stage 1 RI sample (10D-SP16) having TCE at 325 mg/m^3.
- PCE and chloroform were the only VOCs detected at concentrations above their respective SVSLs in the very shallow, shallow, and intermediate soil vapor samples collected at the FCS (Table 4-13 and Figures 4-20, 4-21, and 4-22). PCE was the most common VOC detected in soil vapor samples at concentrations above its SVSL. As

shown in Figures 4-20, 4-21, and 4-22, the lateral extent of PCE in soil vapor at the FCS has generally been characterized to levels below the SVSL of 0.64 mg/m^3.

Semivolatile Organic Compounds

- The common laboratory contaminant di-n-butyl phthalate was the only SVOC detected in the previous (Stage 1 RI) and recent (2003) subsurface soil samples collected at the FCS.
- TICs reported in the SVOC analysis of the previous (Stage 1 RI) samples were hexadecanoic acid, unknown compounds, and unknown phthalates.
- Sulfur was the only TIC reported in the SVOC analysis of the recent soil samples.
- The results of the sampling indicate that SVOCs are not constituents of concern at the FCS and that the detection of TICs appears to be random.

Metals

No metals were detected at concentrations above background and their respective residential and commercial SSLs in soil samples collected at the FCS.

Total Petroleum Hydrocarbons

No TPH-D was detected in previous subsurface soil samples collected at the FCS.

Review of the cumulative data indicates that the presence, concentrations, and extent of non-VOC constituents in soil at the FCS have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options. The extent of PCE in soil vapor at the FCS above its conservative SVSL of 0.64 mg/m^3 has not been fully characterized.

4.7.4.2 *Perched Groundwater*

Volatile Organic Compounds

- No VOCs were detected above their respective laboratory reporting limits in the perched groundwater sample collected from Well 868 during the previous (Stage 1 RI) investigation.
- VOCs detected in the perched groundwater sample collected from Well 868 during the recent RI were cis/trans-1,2-DCE; Freon 113; PCE; and chloroform.
- The analytical results for the recent (2003) perched groundwater samples indicate that VOCs in the vadose zone at the FCS have migrated vertically and into the perched groundwater.

Semivolatile Organic Compounds

- Although bis(2-ethylhexyl)phthalate was detected in the perched groundwater sample collected from Well 868 during the previous investigation, no SVOCs were detected in the recent (2003) perched groundwater samples collected from Well 868.
- TICs reported in the SVOC analysis of perched groundwater from Well 868 were unknown compounds, unknown hydrocarbons, an unknown phenol estimated, cholesterol, and sulfur.

Metals

- Metals detected in the perched groundwater sample included aluminum (0.4 mg/L), barium (0.03 mg/L), magnesium (2.2 mg/L), manganese (0.05 mg/L), and zinc (0.4 mg/L). The detected concentrations are below their respective MCLs.

Review of the cumulative data indicates that the occurrence of perched groundwater and the presence of chemical constituents in perched groundwater at the FCS have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.8 *POTENTIAL SOURCE SITE D(E)*

Potential Source Site D(e) consists of three ponds formerly used to contain backwash water from the filtration plant (Figure 4-28). The filtration plant was built to remove solids in water taken from Natomas Ditch for use in

the on-site industrial water supply. Water was filtered by percolation through a permeable cistern filled with diatomaceous earth, sodium silicate, and celite. After filtering, the water was chlorinated and introduced into the industrial water supply. When the filter became clogged with solids, the filter was cleaned by reversing the flow (backwashing) through the filter. The backwash water was contained in a water storage tank and, when necessary, the backwash water, along with diatomaceous earth, was discharged to the three ponds adjacent to the facility (Figure 4-28). Chlorine was the only chemical used at the filtration plant. The filtration plant was not used after about the mid-1970s and was demolished in 1992.

4.8.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site D(e)

The scope and results of the RIs for VOCs conducted at Potential Source Site D(e) are summarized below.

4.8.1.1 Previous Volatile Organic Compound Investigations

During the Stage 1 RI, soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer adjacent to the southern and central backwash ponds (Figure 4-29). Soil vapor probe refusal was encountered at 10 feet bgs. The northern backwash pond could not be accessed by vehicle and attempts to collect a soil vapor sample using a manual slam bar encountered refusal at 2 feet bgs.

During the assessment of the debris area identified as Site C32, a shallow soil vapor sample (C32-SV01) was collected at 5 feet bgs adjacent to the northern backwash pond at Site D(e).

The analytical results for the soil vapor samples collected at Site D(e) during previous investigations are summarized below. The analytical results for the very shallow soil vapor sample collected during the site assessment activities are summarized on Table 4-17 and below.

Very Shallow Soil Vapor Sample

- No VOCs were detected above their respective laboratory reporting limits in the very shallow soil vapor sample C32-SV01.

Shallow Soil Vapor Samples

- A trace level of TCE was detected at 0.34 mg/m^3 in the Stage 1 RI soil vapor sample collected near the southern backwash pond.
- No VOCs were detected in the soil vapor sample collected near the central backwash pond.

4.8.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the previous data for Site D(e) presented in the approved Workplan indicated that additional soil vapor sampling was needed to assess the potential presence of VOCs at concentrations below the laboratory reporting limits used during the Stage 1 RI.

In accordance with the approved Workplan, soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer at three locations [D(e)-SP05 through D(e)-SP07]. A comparison of proposed and actual soil vapor sampling activities at Site D(e) and a summary of sample identifications and sampling depths are provided on Table 4-1. The analytical results for the soil vapor samples are included in Appendix F and summarized on Table 4-17 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-17 and below. Soil vapor sampling locations and VOCs detected in the samples are shown in Figure 4-29.

Shallow Soil Vapor Samples

- VOCs detected in at least one of the three shallow soil vapor samples and their maximum detected concentrations were benzene (0.01 mg/m^3); toluene (0.03 mg/m^3); xylenes (0.06 mg/m^3); 1,2,4-TMB (0.03 mg/m^3); hexane (0.02 mg/m^3); heptane (estimated at 0.02 mg/m^3); acetone (1.6 mg/m^3); 2-propanol (0.05 mg/m^3); MEK (estimated at 0.34 mg/m^3); and ethanol (estimated at 0.2 mg/m^3).
- The concentrations of all VOCs detected in the shallow soil vapor samples are below their respective SVSLs.

4.8.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site D(e)*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site D(e) are summarized below.

4.8.2.1 *Previous Non-Volatile Organic Compound Investigations*

Sampling for non-VOCs was not conducted at Site D(e) during the Stage 1 RI. During the site assessment activities in 1999, a surface soil sample (C32-SS01) was collected from the northern backwash pond at the same location as the soil vapor sample and analyzed for metals (Figure 4-30). The metals analysis of the sample and SSLs are summarized on Table 4-18 and below.

<u>Metals</u>

Cadmium (2.1 mg/kg) and lead (175 mg/kg) were the only metals detected above background and their respective residential SSLs in the soil sample (Table 4-18).

4.8.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site D(e) presented in the approved Workplan indicated that additional data were needed to characterize the extent and concentrations of lead in the three backwash ponds.

In accordance with the approved Workplan, surface soil samples were collected at two locations in the northern backwash pond and at one location in both the central and southern backwash ponds. A comparison of proposed and actual soil sampling activities at Site D(e) and a summary of sample identifications and depths is provided on Table 4-4. Sampling locations in the backwash ponds are shown in Figure 4-30. Analytical results are included in Appendix F and summarized on Table 4-18 and below.

<u>Metals</u>

No lead was detected at concentrations above its residential SSL in the four surface soil samples collected from the three backwash ponds at Site D(e).

4.8.3 ***Summary and Results of Previous and Recent Perched Groundwater Investigations – Site D(e)***

No perched groundwater is present at Site D(e). An attempt to collect a screening-level groundwater sample at Site D(e) during the Stage 1 RI was unsuccessful due to auger refusal at 8 feet bgs. No investigation for perched groundwater was proposed in the approved Workplan.

4.8.4 *Discussion of Investigation Results – Site D(e)*

The following sections summarize the results of investigations conducted to date.

4.8.4.1 *Soil*

Volatile Organic Compounds

- No VOCs at concentrations above their respective SVSLs were detected in the three shallow soil vapor samples collected adjacent to the backwash ponds.

Metals

- During the site assessment in 1999, a surface soil sample collected from the northern backwash pond contained lead at a concentration above the residential SSL, but below the commercial SSL. Cadmium in the sample is above the current residential SSL based on the CHHSL, but was below the USEPA PRG of 37 mg/kg used as the screening level in 2004.
- No lead was detected above the residential or commercial SSL in the four surface soil samples collected from the three backwash ponds during the recent investigation.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site D(e) have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.8.4.2 *Perched Groundwater*

No perched groundwater is present at Site D(e).

4.9 *SITE C29*

Carve-out assessment Site C29 is an open area of land on the north side of Aerojet Road in Area 20 identified by the USEPA in a 1957 aerial photograph as a possible waste burial site (Figures 4-1 and 4-31). A reconnaissance of the site in December 1998 and March 1999 found small mounds of dirt and crushed rock, but no surface debris or other indications of excavation.

4.9.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site C29*

The scope and results of VOC investigations conducted at Site C29 are summarized below.

4.9.1.1 *Previous Volatile Organic Compound Investigations*

During the site assessment activities in 1999, soil vapor samples were collected from the very shallow (1 to 5 feet bgs) layer at two locations (C29-SV01 and C29-SV02) in areas of disturbed soil (Figure 4-31). The soil vapor samples were collected at the depth at which soil vapor probe refusal was encountered. The analytical results for the soil vapor samples are summarized on Table 4-17 and below. Sampling locations and VOC concentrations detected in the samples are shown in Figure 4-31.

Very Shallow Soil Vapor Samples

- Low concentrations of benzene (0.07 mg/m^3), toluene (up to 0.5 mg/m^3), ethylbenzene (0.11 mg/m^3), xylenes (0.58 mg/m^3), 1,2,4-TMB (0.12 mg/m^3), acetone (0.17 mg/m^3), and ethanol (0.13 mg/m^3) were detected in the soil vapor samples collected at Site C29.
- The detected concentrations of all the VOCs were below their respective SVSLs.

4.9.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site C29 presented in the approved Workplan indicated that no additional soil vapor sampling was needed to complete the RI/FS.

4.9.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site C29*

The scope and results of investigations for non-VOCs conducted at Site C29 are summarized below.

4.9.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the site assessment activities in 1999, an electromagnetic (EM) survey was conducted in the southern portion of the site and a surface soil sample was collected at one location (C29-SS01) and analyzed for SVOCs,

metals, perchlorate, and TPH-D (Figure 4-31). The results of the EM survey and the analytical results for the soil sample are summarized below.

- The EM survey found no evidence indicating the presence of buried metal.
- No SVOCs, perchlorate, or TPH-D were detected in the soil sample.
- No metals were detected at concentrations above background and their respective residential or commercial SSLs in the surface soil sample (Table 4-18).

4.9.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data indicated that a survey of the entire area encompassed by Site C29 using ground-penetrating radar (GPR) and EM techniques was needed to assess the presence of buried materials.

In accordance with the approved Workplan, the following geophysical activities were conducted at Site C29:

- An EM survey was conducted over the entire area designated as Site C29 to identify any anomalies that may indicate the presence of buried metal objects. The EM survey was conducted on north-south transects spaced approximately 6 feet apart. A description of the technique is provided in Appendix O.
- GPR was used to further evaluate anomalies identified during the EM survey.

Five anomalies were identified during the EM survey and four were assessed using GPR. One anomaly was in a ditch that was too steep to adequately assess using GPR. At a second location, a sheet-metal sign (approximately 14 by 20 inches) was found just below the ground surface. Based on the results of the GPR, the geophysicist performing the survey was able to make the following conclusions regarding the remaining three locations:

- Disturbed soil at approximately 3 to 3.5 feet bgs;
- Disturbed soil at approximately 2.5 to 3 feet bgs; and
- A very small (less than 4 inches in diameter) metal object at 2 feet bgs.

4.9.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site C29*

Evaluation of the previous data presented in the approved Workplan indicated that the dense lithologic material underlying Site C29, as evidenced by the probe refusal encountered at 4 to 5 feet bgs during soil vapor sampling, is not conducive to the occurrence of perched groundwater. No investigation of perched groundwater at Site C29 was proposed in the approved Workplan.

4.9.4 *Discussion of Investigation Results – Site C29*

The cumulative results of the soil and geophysical investigation conducted at Site C29 are discussed below.

4.9.4.1 *Soil*

Volatile Organic Compounds

- No VOCs were detected in the two very shallow soil vapor samples collected at Site C29 during the site assessment at concentrations above their respective SVSLs.

Semivolatile Organic Compounds, Perchlorate, and Total Petroleum Hydrocarbons as Diesel

- No SVOCs, perchlorate, or TPH-D were detected in a soil sample collected during the site assessment activities in 1999.

Metals

- No metals were detected at concentrations above background and their respective residential or commercial SSLs in the surface soil sample.

Geophysical Survey

- Survey of the entire area encompassed by Site C29 using EM techniques combined with GPR identified three anomalies. Two were classified as areas of disturbed soil at depths between 2.5 and 3.5 feet and one appeared to be a small metal object (less than 4 inches in diameter) at a depth of 2 feet. The depth of disturbed soil generally corresponds to the depth at which bedrock is encountered beneath the site.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site C29 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options. Additionally, the results of the geophysical surveys indicate that the site is not a disposal area.

4.9.4.2 *Perched Groundwater*

- The dense lithologic material underlying Site C29 is not conducive to the occurrence of perched groundwater.

4.10 SITE C32

Carve-out assessment Site C32 was an area of debris encompassing approximately 1.1 acres along the north side of Aerojet's property (Figures 4-1 and 4-28). The debris is believed to have originated from a junkyard (referred to as Wim's Acres) adjacent to Aerojet, as well as other dumping not authorized by Aerojet.

4.10.1 Summary of Previous Removal Activities – Site C32

A subsurface investigation was conducted in May 2001 to characterize the nature, extent, and volume of debris present at Site C32, and the debris was removed in September and October 2001. Details regarding the removal activities, the type and nature of the material identified, and the final disposition of all removed materials were presented in the *Final Debris Removal Report for Site C32* (ERM, 2002). The debris removal activities and findings are summarized below.

Surface and subsurface debris at Site C32 was excavated to the depth at which natural material was encountered and passed through a vibrating screen that removed all material larger than 2 inches. Debris smaller than 2 inches and soil that passed through the screen were placed in a large stockpile on site. Material that did not pass through the screen consisted of roughly 40 percent concrete; 40 percent cobbles; and 20 percent trash, debris, and tires. This material was placed in a designated area and the trash and debris were removed manually. Cobbles and concrete larger than 2 inches were crushed on site by a portable rock crusher and added to the stockpile of soil and debris that had passed through the screen. Following completion of the removal activities, the excavation area was backfilled with the material that passed through the screen (soil

containing minor amounts of debris) and the crushed rock and concrete. The fill material was compacted and rough graded.

The majority of the material identified at the site during removal activities consisted of inert demolition or construction debris including reinforced concrete, pieces of rusted metal, bricks, tires, and rebar; and domestic trash and debris including clothing, glass bottles, and metal and plastic cans and containers. No stainless steel or other materials typically associated with rocket motors or engines were observed. Subsurface debris throughout the site was mixed and covered with copious amounts of soil.

Exceptions to the generally inert character of the debris included one 55-gallon barrel of motor oil, two car batteries, small broken pieces of concrete pipe having the potential to contain asbestos, and roughly 1.4 cubic yards of wood ash. Orange and black soil discoloration encountered during the removal activities was associated with the rusting of metal and the deterioration of used tires.

All items and materials of potential environmental concern, including the barrel of used motor oil and all soil impacted during the removal of the barrel, pieces of concrete pipe that could potentially contain asbestos, the lead-acid car batteries, and any trash that appeared to have been burned, were properly removed, handled, and disposed of.

4.10.2 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site C32

The scope and results of VOC investigations conducted at Site C32 are summarized below.

4.10.2.1 Previous Volatile Organic Compound Investigations

During the site assessment activities in 1999, a shallow soil vapor sample (C32-SV02) was collected at 10 feet bgs from a low-lying area that could have potentially received surface water runoff (Figure 4-29). The analytical results for the sample are summarized on Table 4-17 and below.

Shallow Soil Vapor Samples

- A low concentration of benzene at 0.07 mg/m^3 was detected in the soil vapor sample.

4.10.2.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the previous data presented in the approved Workplan indicated that additional sampling was needed at Site C32 to evaluate the presence of 1,3-butadiene in soil vapor.

- In accordance with the approved Workplan, four soil vapor samples (excluding QA/QC samples) were collected at four locations (C32-SV02 through C32-SV05) to assess the extent of 1,3-butadiene detected in the previous soil vapor sample. Soil vapor samples were collected from the shallow (6 to 11 feet bgs) layer at three locations (C32-SV03 through C32-SV05). One soil vapor sample was collected from the intermediate (12 to 20 feet bgs) layer at one location (C32-SV02). A comparison of proposed and actual soil vapor sampling activities at Site C32 and a summary of sample identifications and sampling depths is provided on Table 4-1.
- The analytical results for the soil vapor samples are included in Appendix F and are summarized on Table 4-17 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-17 and below. Soil vapor sampling locations and VOCs detected in the soil vapor samples are shown in Figure 4-29.

<u>*Shallow Soil Vapor Samples*</u>

- Eight VOCs were detected in the three soil vapor samples collected from the shallow (6 to 11 feet bgs) layer at Site C32.
- The eight VOCs detected in soil vapor samples, and their maximum detected concentrations, were benzene (0.04 mg/m^3), toluene (0.03 mg/m^3), 1,3-butadiene (0.04 mg/m^3), hexane (0.06 mg/m^3), heptane (0.05 mg/m^3), acetone (0.82 mg/m^3), 2-butanone (0.15 mg/m^3), and ethanol (0.16 mg/m^3).
- The concentrations of all VOCs detected in the shallow soil vapor samples collected at Site C32 are below their respective SVSLs.

<u>*Intermediate Soil Vapor Samples*</u>

- Seven VOCs were detected in the soil vapor sample collected from the intermediate layer.
- The seven VOCs detected in intermediate soil vapor sample (C32-SV02) were benzene (0.04 mg/m^3), 1,3-butadiene (0.07 mg/m^3); hexane (0.1 mg/m^3); heptane (0.09 mg/m^3); acetone (2.6 mg/m^3); MEK (0.48 mg/m^3); and ethanol (0.15 mg/m^3).

- The concentrations of all VOCs detected in the intermediate soil vapor sample collected at Site C32 are below their respective SVSLs.

In September 2006, soil vapor samples collected at 10 and 20 feet bgs at location C32-SV02 as part of the 1,3-butadiene evaluation. The analytical results for the soil vapor samples are summarized on Table 4-17 and below.

- VOCs detected in the soil vapor samples included CB up to 0.042 mg/m^3, 1,4-dichlorobenzene at 0.0072 mg/m^3, 4-methyl-2-pentanone (4M2P) up to 0.0079 mg/m^3, Freon 113 up to 0.029 mg/m^3, TCE up to 0.011 mg/m^3, benzene up to 0.064 mg/m^3, toluene up 0.047 mg/m^3, EB up to 0.017 mg/m^3, xylenes at 0.073 mg/m^3, styrene at 0.074 mg/m^3, 1,3,5-TMB up to 0.0056 mg/m^3, 1,2,4-TMB up to 0.014 mg/m^3, hexane up to 0.02 mg/m^3, acetone up to 0.097 mg/m^3, carbon disulfide up to 0.032 mg/m^3, MEK up to 0.046 mg/m^3, and 4-ET up to 0.0097 mg/m^3.
- The detected concentrations for all VOCs are below their respective SVSLs.
- No 1,3-butadiene above the PQL was detected in the soil vapor samples.

4.10.3 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site C32*

The scope and results of investigations for non-VOCs conducted at Site C32 are summarized below.

4.10.3.1 *Previous Non-Volatile Organic Compound Investigations*

During the site assessment activities in 1999, a surface soil sample (C32-SS02) was collected at the same location as the soil vapor sample and analyzed for metals (Figure 4-30). The analytical results are summarized on Table 4-18 and below.

Metals

No metals were detected above background and their respective residential or commercial SSLs in the sample (Table 4-18).

4.10.3.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site C32 indicated that additional data were needed to assess the potential presence of SVOCs and confirm the absence of metals at concentrations above residential SSLs.

In accordance with the approved Workplan, soil samples were collected from the fill material at two locations (C32-SNS01 and C32-SNS02) at Site C32 and analyzed for SVOCs and metals. Sampling locations are shown in Figure 4-30. A comparison of proposed and actual soil sampling activities at Site C32 and a summary of sample identifications and depths are provided on Table 4-4. The analytical results for the samples analyzed for SVOCs, SVOC TICs, and metals are included in Appendix F and summarized below.

Semivolatile Organic Compounds

The analytical results for the samples analyzed for SVOCs and SVOC TICs are summarized on Tables 4-8 and 4-9, respectively, and below.

- No SVOCs were detected at concentrations above their respective residential and commercial SSLs in the surface soil samples.
- Five SVOCs were detected in at least one of the two surface soil samples at estimated concentrations. The five SVOCs and their maximum estimated concentrations were bis(2-ethylhexyl)phthalate at 150 µg/kg, chrysene at 40 µg/kg, fluoranthene at 110 µg/kg, phenanthrene at 170 µg/kg, and pyrene at 64 µg/kg. The detected concentrations for all SVOCs are well below their respective residential SSLs
- TICs reported in at least one of the two soil samples were glycerol tricaprylate estimated at 100 µg/kg, stigmast-4-en-3-one estimated at 200 µg/kg, cyclo-octa-cosane estimated at 400 µg/kg, hexadecanoic acid estimated at 200 µg/kg, octadecanoic acid estimated at 400 µg/kg, sitosterol estimated at 600 µg/kg, unknown compounds estimated up to 400 µg/kg, unknown aldehyde estimated at 200 µg/kg, unknown alkanes estimated at up to 1,400 µg/kg, and unknown PAHs estimated at up to 800 µg/kg.

Metals

The analytical results for the samples analyzed for metals are summarized on Table 4-18. No metals at concentrations above background and their

respective residential or commercial SSLs were detected in the surface soil samples.

4.10.4 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site C32*

No perched groundwater wells are located at Site C32 and perched groundwater was not encountered during the debris removal activities previously described in this report.

4.10.5 *Discussion of Investigation Results – Site C32*

The cumulative results of the investigations and cleanup activities conducted at Site C32 are discussed below.

4.10.5.1 *Soil*

Volatile Organic Compounds

- No VOCs at concentrations above their respective SVSLs were detected in the shallow and intermediate soil vapor samples collected at Site C32 during the recent investigation.

Semivolatile Organic Compounds

- Bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, phenanthrene, and pyrene were detected in at least one of the soil samples collected at Site C32, but at estimated concentrations well below their respective residential SSLs.
- Several TICs were reported in the SVOC analysis of the two soil samples at estimated concentrations ranging from 100 to 1,400 µg/kg.

Metals

No metals were detected at concentrations above background and their respective residential or commercial SSLs in the three soil samples collected at Site C32 during the previous and recent investigations.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents at Site C32 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.10.5.2 *Perched Groundwater*

No perched groundwater was encountered during the previous and recent investigations and activities conducted at Site C32.

4.11 *SITE C41*

Carve-out assessment Site C41 is a former railcar siding south of Aerojet Road in the northeast corner of the Central Disposal Area (Figures 4-1 and 4-32). The siding and an associated structure were first observed in a 1966 aerial photograph. The associated structure was identified in 1967 and 1982 Aerojet Buildings and Structures manuals as a shop building, Building 23-002. A site-wide map in the Buildings and Structures manuals indicated that the siding and structure were in EIV Test Area 23. The manuals did not, however, indicate the meaning of the acronym EIV. No listing for Building 23-002 was found in the 1985 and 1988 Buildings and Structures manuals. No information concerning the railcar siding and associated structure, or any reference to EIV Test Area 23, was identified in the PCD, the *Scoping Report*, or the *Stage 1 Report*.

ERM examined the site in 1998 as part of the carve-out site assessment activities. At that time, a railroad tank car was present on the siding and the site was being used to train firefighters to handle tank car emergencies. Building 23-002 was being used to store hoses, air compressors, tools, and miscellaneous equipment. Interviews with Aerojet personnel in 1998 indicated the following:

- Prior to 1991, the rail siding is believed to have been used for the transfer of chemicals and other materials from railcars to trucks for distribution at the Aerojet facility.
- In 1991 and 1992, secondary containment was constructed at the site and perchlorate and water solutions from the Aerojet RCRA facility were transferred from trucks to railcars for shipment to an off-site treatment facility.
- None of the employees interviewed were aware that the area was designated as Area 23 or were familiar with the acronym EIV.

Site C41 was removed from the carveout process in 2000 because it was a location where industrial activities had occurred.

4.11.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site C41*

The scope and results of the investigations for VOCs conducted at Site C41 are summarized below.

4.11.1.1 *Previous Volatile Organic Compound Investigations*

During the site assessment of Site C41 in 1999, soil vapor samples were collected from depths ranging from 3.6 to 5 feet bgs at four locations (C41-SV01 through C41-SV03 and C41-SV05) along the railroad tracks, building, and drainages and analyzed for VOCs (Figure 4-32). The four samples were collected at the depth at which probe refusal was encountered. Probe refusal was encountered at 2.5 feet bgs in three attempts at sampling location C41-SV04 and no sample was collected. The analytical results for the soil vapor samples are summarized on Table 4-17 and below.

Very Shallow Soil Vapor Samples

- VOCs detected in the soil vapor samples, and their maximum detected concentrations, included benzene (0.08 mg/m^3); toluene (0.19 mg/m^3); ethylbenzene (0.05 mg/m^3); xylenes (0.22 mg/m^3); 1,2,4-trimethylbenzene (0.09 mg/m^3), 1,3,5-trimethylbenzene (0.03 mg/m^3); 1,3-butadiene (0.25 mg/m^3), hexane (0.16 mg/m^3), heptane (0.11 mg/m^3), methy ethyl ketone (0.13 mg/m^3), 4-ethyltoluene (0.11 mg/m^3) and ethanol (0.09 mg/m^3).
- The concentrations of 1,3-butadiene detected in the four soil vapor samples are above the SVSL of 0.01 mg/m^3 (Table 4-17).

4.11.1.2 *Recent Volatile Organic Compound Investigations*

An evaluation of the previous data for Site C41 and proposed additional data collection activities were presented in the *Revised Remedial Investigation/Feasibility Study Field Sampling Plan – Area 39 and Site C41* (CVEI, 2004). Proposed data collection activities included the collection of soil vapor samples at ten locations around the concrete slab and railcar loading area. The samples would be collected at the depth at which refusal is encountered, but at a minimum depth of 3 feet bgs. Additionally, one soil vapor sample would be collected from the space below the concrete apron east of the railcar loading platform.

As discussed in Section 3.3.1.2, 1,3-butadiene detections in soil vapor samples can not be reproduced and therefore the proposed additional soil vapor sampling at Site C41 for that compound was not performed.

4.11.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site C41*

The scope and results of investigations for non-VOCs conducted at Site C41 are summarized below.

4.11.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the site assessment of Site C41 in 1999, surface soil samples were collected at five locations along the railroad tracks, building, and drainages and analyzed for SVOCs, metals, perchlorate, and TPH-D (Figure 4-32). With the exception of TPH-D, the analytical results are summarized on Tables 4-8, 4-18, and 4-19, respectively, and below.

- No SVOCs or TPH-diesel above their respective PQLs were identified in the five surface soil samples.
- No metals at concentrations exceeding their respective residential or commercial SSLs were detected in the samples (Table 4-18).
- No metals were detected in the five soil samples at concentrations above background and their respective residential and commercial SSLs.
- Perchlorate at 0.083 mg/kg was detected in one (C41-SS04) of the five surface soil samples collected at Site C41 (Table 4-19).

4.11.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data for Site C41 presented in the *Revised Remedial Investigation/Feasibility Study Field Sampling Plan – Area 39 and Site C41* (CVEI, 2004) concluded the following:

- No SVOCs or TPH-D were detected in the surface soil samples collected at Site C41. Therefore, no sampling for those chemicals is needed to complete the RI/FS.
- No metals above their respective residential SSLs were detected in the surface soil samples collected at Site C41. Therefore, no additional metals data are needed to complete the RI/FS.

- Additional data is needed to further evaluate the presence of perchlorate around the railcar loading and unloading platform at Site C41; and
- The dense lithologic material underlying the site is not conducive to the occurrence of perched groundwater. Therefore, no perched groundwater investigation is needed to complete the RI/FS.

Data collection activities were performed at Site C41 in September and October 2005 and in January and June 2006. The investigations included the following activities:

- Collection of surface and/or near-surface (up to 2 feet bgs) soil samples at 23 locations (C41-SS04 through C41-SS17 and C41-SB01 through C41-SB09);
- Collection of subsurface soil samples at 5 feet bgs at four locations (C41-SS13 through C41-SS16) around the former railcar loading platform;
- Collection of subsurface soil samples at 5 and 10 feet bgs at two locations (C41-SS08 and C41-SS09) around the former railcar loading platform where perchlorate had been detected in previous samples; and
- Collection of subsurface soil samples at 5 foot intervals to first groundwater at 10 locations (C41-SS07 and C41-SB01 through C41-SB09) to evaluate the lateral and vertical extent of perchlorate in the vadose zone.

Sampling locations are shown in Figure 4-32. A comparison of proposed and actual soil sampling activities at Site C41 and a summary of sample identifications and depths are provided on Table 4-4. The perchlorate analytical results for the samples are included in Appendix F and summarized below.

Perchlorate

- No perchlorate at concentrations above the residential SSL of 7.8 mg/kg (7,800 µg/kg) was detected in any of the surface, near surface, and subsurface soil samples collected at Site C41.
- The maximum concentration of perchlorate of 1,900 µg/kg was collected at surface soil location C41-SS08 and in the subsurface soil sample collected at 10 feet bgs at location C41-SS07.

- Perchlorate above the screening level of 0.06 mg/kg (60 µg/kg) for the protection of groundwater was detected in 12 of the surface and near surface soil samples (depth of 5 feet or less). Sampling locations and concentrations greater than 60 µg/kg are shown in Figure 4-33.
- Perchlorate above the screening level of 60 µg/kg for the protection of groundwater was detected in 40 subsurface soil samples collected at five foot intervals between 5 feet bgs and first encountered groundwater (55 feet bgs).
- Perchlorate at concentrations greater than 60 µg/kg were detected in soil samples from surface to groundwater. Sampling locations and the estimated extent of perchlorate in soil above the screening level of 60 µg/kg are shown in Figures 4-34 through 4-38.
- No perchlorate above the laboratory reporting limit of 0.02 mg/kg was detected in the surface soil sample collected from a drainage south of the former loading area at Site C41 (C41-SS17).

4.11.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site C41*

No perched groundwater was encountered during the previous and recent investigations at Site C41.

Screening-level groundwater samples were collected from three borings (C41-SB01, C41-SB03, and C41-SS07) at a depth of 60 feet bgs. Perchlorate concentrations in the screening-level samples ranged from 76 to 310 µg/L, which are above the California public health goal (PHG) of 6 µg/L (Table 4-20).

Samples collected from wells 3041 and 3042 southeast of the site also contained perchlorate concentrations above the PHG at 92 and 54 µg/L, respectively.

4.11.4 *Discussion of Investigation Results – Site C41*

The following sections summarize the results of investigations conducted to date.

4.11.4.1 *Soil*

Volatile Organic Compounds

- No VOCs at concentrations above their respective SVSLs were detected in the four soil vapor samples collected at Site C41.

Semivolatile Organic Compounds and Total Petroleum Hydrocarbons

- No SVOCs or TPH-D above their respective laboratory reporting limits were detected in surface soil samples collected at Site C41.

Metals

- No metals above background and their respective residential or commercial SSLs were detected in the soil samples collected at Site C41.

Perchlorate

- No perchlorate at concentrations above the residential SSL of 7.8 mg/kg was detected in surface, near surface, and subsurface soil samples collected at Site C41.
- Perchlorate at concentrations greater than the screening level of 0.06 mg/kg for the protection of groundwater are present in the vadose zone at Site C41.
- The presence of perchlorate in the unconfined groundwater beneath Site C41 suggests that the site is a source of perchlorate to groundwater. However, the presence of perchlorate in groundwater upgradient of Site C41 also indicates that a source of perchlorate may also be present within the Central Disposal Area (CDA).

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site C41 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

4.11.4.2 *Perched Groundwater*

No perched groundwater was encountered during the investigations at Site C41. Perchlorate was detected in screening level groundwater samples collected from three borings (C41-SB01, C41-SB03, and C41-SS07) drilled at Site C41 (Figure 4-39).

Perchlorate concentrations detected in the screening level groundwater samples ranged from 76 to 310 µg/L. Additionally, perchlorate was detected in groundwater samples collected from monitoring wells south, and upgradient, of Site C41, suggesting that a source of perchlorate may be present in the CDA.

4.12 *SECTOR D GROUNDWATER TREATMENT (GET D) FACILITY*

The GET D facility is in the northwest corner of Area 20 and was constructed in 1981 to treat VOCs in extracted groundwater (Figure 4-1). VOCs are removed from groundwater using an air-stripper, and the treated groundwater is recharged back into the groundwater aquifers. Perchlorate is removed from the groundwater using ion exchange resin beds. The GET D facility is included in this PGOU RI/FS because it is likely the treatment conducted at the facility will be moved to ARGET.

Mr. Craig Fegan, Manager of Engineering for Aerojet Environmental Operations, has been involved in the operation of the GET D facility since 1982. In an interview on 3 August 2002, Mr. Fegan indicated that to his knowledge, no hazardous or toxic materials have ever been stored, handled, or used at the GET D facility.

During flow testing of the system during startup in 1981, untreated groundwater that potentially contained low concentrations of VOCs was discharged to a low-lying area west of the GET D facility. Additionally, untreated groundwater containing chemicals used in the rehabilitation of extraction wells, and any materials (algae, silt, mineral deposits) removed from the wells during rehabilitation, are occasionally discharged to the low-lying area. Groundwater containing chemicals and materials resulting from well rehabilitation is not processed through the treatment system because of problems with fouling.

4.12.1 *Summary and Results of Previous and Recent Investigations – GET D Facility*

The scope and results of investigations conducted at the GET D facility are summarized below.

4.12.1.1 *Previous Investigations*

No previous investigations have been conducted at the GET D facility.

4.12.1.2 *Recent Investigations*

During a meeting with the agencies on 22 September 2005, Aerojet agreed to collect soil vapor samples at 10 feet bgs at four locations within the low-lying area west of the GET D facility. On 20 October 2005, three primary and one duplicate soil vapor samples were collected at 10 feet bgs at three locations (GET D-SV02, GET D-SV03, and GET D-SV04) within the low-lying area west of the GET facility and analyzed for VOCs. A fourth soil vapor sampling location could not be accessed and no sample was collected.

The analytical results for the soil vapor samples are included in Appendix F and are summarized on Table 4-17 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 4-17 and below. Soil vapor sampling locations and VOCs detected in the soil vapor samples are shown in Figure 4-11.

Shallow Soil Vapor Samples

- VOCs detected in the soil vapor samples, and their maximum detected concentrations, included PCE (0.024 mg/m^3); Freon 113 (0.009 mg/m^3); benzene (0.007 mg/m^3); toluene (0.05 mg/m^3); ethylbenzene (0.01 mg/m^3); xylenes (0.04 mg/m^3); 1,2,4-trimethylbenzene (0.01 mg/m^3), hexane (0.009 mg/m^3), heptane (0.005 mg/m^3), acetone (0.09 mg/m^3); carbon disulfide (0.02 mg/m^3); 2-propanol (0.04 mg/m^3); methy ethyl ketone (0.02 mg/m^3), and 4-ethyltoluene (0.012 mg/m^3).
- No VOCs were detected in soil vapor samples concentrations above their respective SVSLs.

4.12.2 *Discussion of Investigation Results – GET D Facility*

Evaluation of the information concerning the GET D facility indicates that no additional data are needed to evaluate potential human and ecological risks.

4.13 *UNCONFINED GROUNDWATER - AREAS 20 AND 21*

The first unconfined groundwater beneath Areas 20 and 21 is present in hydrostratigraphic Layers B and C. The following text describes the geology and hydrogeology of Layers B and C, summarizes the scope and results of previous and recent unconfined groundwater sampling

conducted as part of individual source site investigations, and summarizes information regarding the presence and distribution of chemicals in Layers B and C. The information presented in this section summarizes data previously presented in the draft PGOU RI Report for groundwater and the BOU RI/FS Report (ERM, 2008).

4.13.1 *Geology and Hydrogeology of Layers B and C*

Layer B generally consists of sand, gravel, silty sand, and partially consolidated sand interbedded with low permeability units such as silts and clays. The thickness of Layer B ranges from 10 to 130 feet with up to two-thirds of that thickness being composed of low permeability units. Layer B generally dips to the west-southwest and during the RI/FS was typically encountered at depths ranging from 23 to 52 feet bgs. Layer C generally consists of two groups of permeable sediments composed of loose and partially consolidated sand with some gravel interbedded with fine-grained sand, silt, and clay mixtures. The top of Layer C is present at depths as shallow as 65 feet bgs.

The direction of groundwater flow and hydraulic gradients in Layers B and C are relatively similar. In general, groundwater flow direction in Layers B and C is toward the northwest but is locally influenced by the removal of groundwater from the GET D extraction wells. Currently, 10 extraction wells are screened in Layer B and 10 extraction wells are screened in Layers B and C. Groundwater levels in Layers B and C typically fluctuate between 5 and 12 feet during the year, but the hydraulic gradients remain relatively unchanged. Historical groundwater monitoring data indicate that water levels in Layers B and C have decreased 5 to 13 feet between 1983 and 2003.

4.13.2 *Summary and Results of Previous and Recent Unconfined Groundwater Investigations – Areas 20 and 21*

The scope and results of unconfined groundwater investigations related to potential source sites are summarized below.

4.13.2.1 *Previous Unconfined Groundwater Investigations*

Two groundwater monitoring wells (Wells 42 and 507) completed in a perched groundwater zone are located at the west end of the Site 7D ditch (Figure 4-13). During the Stage 1 RI, perched groundwater samples were collected from Well 42 in March 1992 and in January and April 1993. Well 507 was dry.

The samples collected from Well 42 in March 1992 and January 1993 were analyzed for VOCs, SVOCs, metals, hexavalent chromium, perchlorate, TPH, chloride, nitrate, nitrite, and sulfate. The sample collected in April 1993 was analyzed for VOCs, metals, hexavalent chromium, and PCBs. The analytical results for the samples collected from Well 42 are summarized below.

- No VOCs, SVOCs, perchlorate, TPH, nitrite, or PCBs above their respective laboratory reporting limits were detected in the groundwater samples collected from Well 42.
- Metals detected in the groundwater samples collected from Well 42 included aluminum (up to 0.92 mg/L), barium (up to 0.03 mg/L), copper (up to 0.17 mg/L), manganese (up to 0.04 mg/L), and zinc (up to 1.64 mg/L). The concentrations for all metals were below their respective MCLs.
- Nitrate up to 13 mg/L and sulfate up to 11 mg/L were detected in the samples collected in March 1992 and January 1993. The concentrations of nitrate detected in the samples were above the MCL of 10 mg/L.

A total of 25 groundwater monitoring wells in Area 20 were monitored for the presence of groundwater during the Stage 2 RI of Site 10D in 1997. The groundwater monitoring wells included 12 wells completed in hydrostratigraphic Layer C. Samples were collected from 9 of the 12 wells in Layer C and analyzed for VOCs, metals, perchlorate, and TPH-D. The analytical results for those samples are summarized on Table 4-21 and below. Well locations are shown in Figure 4-32.

Volatile Organic Compounds

- VOCs detected in groundwater samples collected from the nine wells in Layer C included TCE (nondetect to 57 µg/L); PCE (nondetect to 270 µg/L); 1,1-dichloroethane (1,1-DCA) (nondetect to 20 µg/L); cis-1,2-DCE (nondetect to 620 µg/L); 1,2-DCA (nondetect to 28 µg/L); Freon 113 (nondetect to 150 µg/L); acetone (nondetect to 270 µg/L); and vinyl chloride (nondetect to 270 µg/L).

Non-Volatile Organic Compounds

- No perchlorate was detected above the laboratory reporting limit of 0.1 mg/L in the groundwater samples collected from Layer C.
- Low, but fairly uniform, concentrations of TPH-D up to 0.2 mg/L were detected in the unconfined groundwater samples.

- No metals were detected at concentrations above federal or state MCLs in the groundwater samples collected from Layer C.

4.13.2.2 *Recent Unconfined Groundwater Investigations*

In accordance with the approved Workplan, the recent investigation of potential source sites in Area 20 included the following:

- Groundwater samples from two vapor extraction wells (FCS-SVE1 and FCS-SVE2) completed in hydrostratigraphic Layer B at the location of the FCS were analyzed for VOCs and SVOCs to assess potential impacts from chemicals present in soil at that location.
- Groundwater samples from one well (38) completed in Layer B and five wells (279, 3086, 3093, 3096, and 3109) completed in Layer C were analyzed for metals to evaluate the potential for metals in the ditches at Sites 5D, 10D, and 11D to leach into and impact groundwater. Additionally, a groundwater sample from one well (108) completed in Layer F was analyzed for metals.
- Wells 42 and 507 completed in Layer B near Sites 5D and 7D were monitored for the presence of groundwater. Well 42 was dry. A sample was collected from Well 507 and analyzed for nitrate.

The results of the VOC, SVOC, and metals analysis of the samples are summarized on Tables 4-22, 4-23, and 4-24, respectively, and below. Laboratory analytical reports are included in Appendix F.

Analytical results for the unconfined groundwater samples collected from FCS-SVE1 and FCS-SVE2 are summarized below and shown in Figure 4-40. The results of the nitrate analysis of the sample collected from Well 507 are also summarized below The results of the metals analysis of the groundwater samples are shown in Figure 4-41.

<u>*Volatile Organic Compounds*</u>

- VOCs detected in the groundwater samples collected from vapor extraction wells FCS-SVE1 and FCS-SVE2 were Freon 113 up to 33 µg/L, PCE up to 4.9 µg/L, TCE up to 1.1 µg/L, and chloroform up to 5.9 µg/L (Figure 4-40).

Semivolatile Organic Compounds

- No SVOCs were reported at concentrations above their respective laboratory reporting limits in the groundwater samples collected from vapor extraction wells FCS-SVE1 and FCS-SVE2.
- No TICs were reported in the SVOC analysis of the groundwater samples from vapor extraction wells FCS-SVE1 and FCS-SVE2.

Metals

Layer B

- Metals detected in the groundwater samples collected from Well 38 completed in Layer B were barium at 0.05 mg/L, calcium at 24 mg/L, magnesium at 21 mg/L, manganese at 0.03 mg/L, and sodium at 15 mg/L.
- Metal concentrations detected in the sample from Well 38 were below their respective MCLs.

Layer C

- Metals detected in the groundwater samples collected from the five wells (279, 3086, 3093, 3096, and 3109) completed in Layer C were barium (0.02 and 0.25 mg/L), boron (nondetect to 0.08 mg/L), calcium (22 to 46 mg/L), iron (nondetect to 3.7 mg/L), magnesium (3.2 to 17 mg/L), manganese (0.05 and 4.2 mg/L), potassium (nondetect to 5.6 mg/L), sodium (4.9 to 18 mg/L), and zinc (nondetect to 13 mg/L).
- Metals detected at concentrations above their respective MCLs were iron in four wells (279, 3093, 3096, and 3109), manganese in all five wells, and zinc in one well (3096).

Layer F

- Metals detected in the groundwater samples collected from Well 108 completed in Layer F were barium at 0.06 mg/L, boron at 0.05 mg/L, calcium at 21 mg/L, iron at 0.34 mg/L, magnesium at 5.7 mg/L, manganese at 0.09 mg/L, potassium at 6.6 mg/L, and sodium at 21 mg/L).
- Iron and manganese concentrations detected in Well 108 were above their respective MCLs.

Nitrate

Layer B

- Nitrate (as NO_3) was detected in the sample collected from Well 507 at 0.74 mg/L, well below the MCL of 45 mg/L.

An evaluation of the potential for metals in the ditches at Sites 5D, 10D, and 11D to leach into and impact groundwater and surface water using the above data is presented in Section 6 of this report.

4.13.3 *Summary of Perimeter Groundwater Remedial Investigation – Areas 20 and 21*

The following is a summary of data previously presented in the draft PGOU RI Report (CVEI, 2003) and the Draft BOU RI/FS Report (ERM, 2008) for groundwater regarding the presence and distribution of chemicals in Layers B and C and the FWBZ in Areas 20 and 21.

Chlorinated solvents and perchlorate are the most commonly detected and widely distributed compounds in Layers B and C. TCE is the most prevalent VOC, but Freon 113 and 1,2-DCE are also common. VOCs detected in Layers B and C near potential source sites in Area 20 and upgradient potential source sites in the CDA at concentrations above their respective MCLs include 1,1,1-TCA; 1,1-DCA; 1,2-DCA; benzene; carbon tetrachloride; chloroform; PCE; TCE; and potential TCE degradation products 1,1-DCE, cis/trans-1,2-DCE, and vinyl chloride.

4.13.3.1 *Distribution of Chemicals in Layer B*

A review of figures presented in the PGOU RI Report and Draft BOU RI/FS Report indicates that 10 monitoring wells (65, 66, 71, 72, 3055, 3085, 3093, 3094, 3096, and 3526) screened within Layer B are present in Area 20. During the sampling period of the PGOU RI (January 2000 through April 2003), only two (3055 and 3094) of the wells were sampled. The analytical results are summarized below.

Volatile Organic Compounds

- TCE at 5.1 µg/L, dibromochloromethane at 5.5 µg/L, cis/trans-1,2-DCE at 44 µg/L, and 1,1-DCA at 3.2 µg/L were detected in the groundwater sample collected from Well 3055 in October 2002.

- Benzene at 1.5 µg/L was detected in a groundwater sample collected from Well 3094 in October 2002.

Semivolatile Organic Compounds and Perchlorate

- No perchlorate above the quantitation limit of 4 µg/L was detected in a sample collected from Well 3055 in January 2002.
- No perchlorate, SVOCs, or dioxane above their respective practical quantitation limits were detected in the groundwater sample collected from Well 3094 in October 2002.

Metals

During the PGOU RI, a primary and duplicate sample was collected from the GET D influent to assess the presence of those metals detected in soils during the Stage 1 RI in the groundwater. Hexavalent chromium was detected at concentration slightly above the MCL of 0.0002 mg/L in the primary sample, but was not detected in the duplicate sample. Concentrations for all other metals were below their respective MCLs (CVEI, 2003).

4.13.3.2 *Distribution of Chemicals in Layer C*

A review of figures presented in the draft PGOU RI Report for groundwater indicates that approximately 39 wells screened within Layer C are present in Area 20. During the sampling period of the PGOU RI (January 2000 through April 2003), approximately 15 of the wells were sampled. A review of TCE and perchlorate isoconcentration contours for Layer C presented in the draft PGOU RI Report for groundwater indicated the following:

Trichloroethene

TCE ranging from nondetect (less than 5 µg/L) to 520 µg/L was detected in groundwater samples collected from Layer C beneath Area 20. No TCE at concentrations greater than the quantitation limit is present in Layer C beneath Area 21.

TCE concentrations in Layer C beneath Area 20 are generally less than 10 µg/L. However, TCE at concentrations greater than 50 µg/L has been detected in Layer C and/or FWBZ beneath Area 20 at three locations. TCE at concentrations greater than 500 µg/L is present in Layer C/FWBZ in the western and southwestern portion of Area 20. The TCE isoconcentration

contours presented in the PGOU and BOU RI/FS Report for groundwater indicate that the concentrations of TCE most likely originate from potential source sites in the CDA upgradient of Area 20. TCE at concentrations greater than 50 µg/L was also detected in groundwater in the area of a GET D extraction well (4001) north of the FCS and at one well location (3675) west of Area 20. Based on the configuration of the TCE isoconcentration contours, TCE detected in Layer C/FWBZ in the area of GET D extraction well 4001 could have potentially originated from potential sources in Area 20. The origin of TCE at concentrations greater than 50 µg/L in groundwater in Well 3675 west of Area 20 has not been ascertained.

Perchlorate

Perchlorate concentrations detected in Layer C beneath Area 20 ranged from nondetect (less than 4 µg/L) to greater than 4,000 µg/L. No perchlorate at concentrations greater than the quantitation limit was detected in Layer C beneath Area 21.

Review of the perchlorate isoconcentration contours for Layer C presented in the PGOU RI Report indicates that perchlorate concentrations in groundwater under much of Area 20 are generally less than 5 µg/L. However, perchlorate at concentrations greater than 4,000 µg/L is present in Layer C in the western and southwestern portion of Area 20. The perchlorate isoconcentration contours indicate that the perchlorate concentrations are commingled with the TCE concentrations described above and likely originate from potential source sites in the CDA, upgradient of Area 20.

4.13.4 *Discussion of Unconfined Groundwater – Areas 20 and 21*

The results of previous and recent investigations and sampling conducted during the period of the PGOU RI indicate that VOCs, primarily TCE, and perchlorate are present in unconfined groundwater Layers B and C beneath Area 20. Although TCE and perchlorate concentrations in Layers B and C are generally less than 10 µg/L and 5 µg/L, respectively, both chemicals are present at concentrations greater than 50 µg/L in unconfined groundwater beneath the western and southwestern portion of Area 20. Additionally, TCE at concentrations greater than 50 µg/L also appears to be present in unconfined groundwater in the north-central portion of Area 20 in the vicinity of GET D extraction well 4001. The concentrations of TCE and perchlorate in unconfined groundwater in the western and southwestern portion of Area 20 appear to originate from

upgradient potential source sites in the CDA. The concentrations of TCE detected in unconfined groundwater in the north-central portion of Area 20 could potentially be associated with potential source sites in Area 20.

The nature and extent of chemicals in groundwater downgradient of Area 20, and any necessary remedial action, are being addressed by the PGOU RI/FS for groundwater.

5.0 *SUMMARY AND RESULTS OF REMEDIAL INVESTIGATIONS FOR SITES IN AREA 49 AND WESTERN PORTION OF THE AEROJET SITE*

Area 49 is located along the northern property boundary of the Aerojet site, directly west of Hazel Avenue (Figure 5-1). Historical operations conducted in Area 49 included shipping and receiving, processing of inert solid rocket motor chambers, and the storage and testing of incoming chemicals. Historical industrial activities conducted in this area included rocket chamber degreasing, sandblasting, the installation of insulation, the application of liner material, and assembly of component parts. Sites within Area 49 and west of Area 49 addressed in this report are:

- All potential source sites (32D through 39D) in Area 49 and the septic systems associated with various buildings; and
- Carve-out assessment sites C4, C10, C14, and C15.

The locations of the 12 sites are shown in Figure 5-1. The potential source sites and drainages in Area 49 are shown in Figure 5-2. As shown on the figures, the 12 sites transect, border, or are surrounded by lands removed from the boundary of the Aerojet Superfund site under the modified PCD (April 2002). The figures for Area 49 presented in this report were generated using a 2002 aerial photograph as a base map.

This section describes Area 49 (including geology and hydrogeology); summarizes investigation results related to the evaluation of transformers, asbestos, and lead-based paint in Area 49; discusses the presence and distribution of chemicals in the first unconfined groundwater layer; and presents the following information for each of the 12 sites:

- A summary of background information including historical operations and activities;
- A summary of the scope and results of previous (prior to 2003) investigations for VOCs, metals, and other non-VOCs in soil and, if present, perched groundwater;
- A summary of the scope and results of recent (2003) investigations for VOCs, metals, and other non-VOCs in soil and, if present, perched groundwater; and
- A discussion of the investigation results.

5.1 PHYSICAL DESCRIPTION OF AREA 49

The physical characteristics of Area 49, including topography and surface water drainage, local geology, and local hydrogeology are described below.

5.1.1 Topography and Surface Water Drainage

Area 49 is relatively flat with a slight slope towards the west and south. The majority of Area 49 has been graded and paved. Surface water runoff in Area 49 is channeled into a series of man-made ditches that ultimately discharge to low areas west and south of Area 49 or to a drainage ditch along the northern boundary of the site. The flow of surface water in drainage ditches in Area 49 is shown in Figure 5-2.

5.1.2 Local Geology

The surface and near-surface lithologies in Area 49 are composed of Quaternary-aged fluvial deposits of cobbles, sand, silt, and clay that have been extensively dredged for gold. The dredge deposits consist primarily of gray and brown silty-sand gravel with subrounded to rounded gravel and cobble-sized clasts to a depth of 28 to 30 feet bgs. The dredge deposits are underlain by a dense to very dense, brown silty sand to sandy silt that extends to approximately 80 feet bgs. Cemented, hard silty-sandy gravel underlies the silty sand to sandy silt to a depth of at least 88 feet (Aerojet, 1997b).

5.1.3 Local Hydrogeology

Perched groundwater was encountered throughout much of Area 49 during investigations conducted in the early 1980s, and 10 auger wells were installed to monitor the perched groundwater (Figure 5-2). Differentiation between perched and shallow unconfined groundwater during the early 1980s was primarily based on the depth at which groundwater was encountered. Between 1985 and 1988, the depth to perched groundwater in the 10 wells ranged from 13 to 26 feet bgs. In 1988, 5 of the 10 perched groundwater wells went dry, and during the Stage 1 RI (1991 through 1993) only 1 of the 10 perched groundwater wells consistently contained water. The data indicate that the extent of perched groundwater in Area 49 has diminished considerably since the early 1980s and has become more discontinuous. The diminished extent of perched groundwater in Area 49 was attributed to drought conditions and the extraction of groundwater from deeper units for treatment.

The presence of perched groundwater in the vicinity of Buildings 49018 and 49014 in Area 49 was evaluated in September 1996 as part of a low-flow SVE pilot study (Aerojet, 1997b). Differentiation between perched and shallow unconfined groundwater during the evaluation was based on the total depth of the well, depth to groundwater, and chemical data. The evaluation indicated that perched groundwater was present, but discontinuous, in dredge tailings between 14 and 28 feet bgs in the vicinity of the two buildings. Monitoring of three wells installed in the perched groundwater in the vicinity of Building 49018 over 4 months indicated that while the perched groundwater received recharge during rain events, the majority of recharge was the result of a leaking industrial water line (Aerojet, 1997b). The level of perched groundwater in the three wells declined after repair of the industrial water line.

The first unconfined groundwater units (Layers B and C) beneath Area 49 are encountered between 35 to 45 feet bgs. The geology and hydrogeology of Layers B and C was presented in Section 4.12. The presence and distribution of chemicals in groundwater Layers B and C beneath Area 49 is summarized in Section 5.13 of this report.

5.2 *SUMMARY AND RESULTS OF INVESTIGATIONS RELATED TO TRANSFORMERS, ASBESTOS, AND LEAD-BASED PAINT IN AREA 49*

In 2000, Aerojet developed an approach for evaluating PCBs related to transformers, asbestos, and lead-based paint in areas designated as Operable Units in accordance with the modified PCD (2002) in response to an Agency demand. The agency-approved approach is outlined below.

- The previous and current locations of all 3,000-kilovolt-ampere (KVA) transformers throughout the Aerojet Superfund site would be identified and inspected to determine the potential for discharges of PCBs to the environment.
- The potential presence of asbestos-containing material (ACM) in soil surrounding former and existing structures would be evaluated by collecting samples, as appropriate, at locations selected by Aerojet and the agencies during a site tour of each Operable Unit.
- The potential presence of lead in soil around former and existing structures resulting from the historical use of lead-based paint would be evaluated by collecting samples at locations proposed in the workplan for each Operable Unit.

The investigation activities conducted in Area 49 related to transformers, asbestos, and lead-based paint in accordance with the approved Workplan and the results of those investigations are summarized below. A comparison between proposed and actual soil sampling activities is provided on Table 5-1.

5.2.1 *Transformer Investigation*

ERM contacted the Aerojet Facilities Maintenance Supervisor to obtain drawings and other data regarding the previous and current locations of all 3,000-KVA transformers in Area 49. According to the Aerojet Maintenance Supervisor, no 3,000-KVA transformers have been, or are currently, present in Area 49. Because the historical and current activities (shipping and receiving, processing of inert solid rocket motor chambers, and the storage and testing of incoming chemicals) performed in Area 49 did not have significant electrical demands, the use of transformers rated at or above 3,000 KVA was unnecessary. Based on the non-existence of 3,000-KVA transformers in Area 49, no additional remedial investigation work was conducted.

5.2.2 *Asbestos Investigation*

Alex McDonald of the RWQCB and Bruce Lewis of ERM conducted a tour of Area 49 on 28 July 2003 to identify sampling locations to assess the presence of ACM in soil. Based on observations made during the tour, surface soil samples were collected at two locations (ASB01 and ASB02) directly north of Buildings 49015 and 49016 and analyzed for asbestos (Figure 5-3). The analytical results are included in Appendix F and summarized below.

No asbestos (chrysotile, amosite, crocodolite, anthophyllite, tremolite, actinolite) or fibrous material was identified in the samples.

5.2.3 *Lead-Based Paint Investigation*

Soil samples were collected at 0, 6, and 12 inches bgs at 14 locations around the buildings and structures in Area 49 and analyzed for lead (Figure 5-3). The proposed sampling locations and sample collection depths were approved by Alex McDonald of the RWQCB during a tour of Area 49 on 28 July 2003. The analytical results for the samples are included in Appendix F and are summarized on Table 5-2 and below. Concentrations of lead detected in the samples are shown in Figure 5-3.

Total lead concentrations detected in the soil samples collected at the 14 locations in Area 49 ranged from 5.1 to 36 mg/kg. The detected concentrations of lead are below the residential SSL of 150 mg/kg and commercial SSL of 800 mg/kg.

5.2.4 *Discussion of Investigation Results – Transformers, Asbestos, and Lead-Based Paint*

The results of the investigations related to transformers, asbestos, and lead-based paints are discussed below.

- No 3,000-KVA transformers have been, or are currently, present in Area 49.
- No asbestos or other fibrous material was detected in the samples collected in Area 49.
- No lead was detected in the samples at concentrations above its residential or commercial SSLs.

Based on the above results, Area 49 has been sufficiently characterized for PCBs, ACM, and lead to allow the evaluation of potential human health and environmental risks.

5.3 *POTENTIAL SOURCE SITES 32D, 34D, 35D, AND 38D*

Potential Source Sites 32D, 34D, 35D, and 38D are in the north-central portion of Area 49 (Figure 5-2). Background information for Sites 32D, 34D, 35D, and 38D is presented separately, but due to the sites' proximity to each other and because the results of the Stage 1 RI indicate that VOCs in soil vapor from the four sites are commingled, the VOC results for soil vapor samples collected at these sites are discussed together as Central Area 49. Additionally, because the VOC results for three soil vapor samples collected during the investigation of Site 36D appear to represent the southern edge of the VOC soil vapor plume from Sites 32D, 34D, 35D, and 38D, the results for those samples are included in the discussion.

Sites 32D, 34D, and 38D are ditches in the Area 49 central ditch system and the analytical results for all compounds other than VOCs (non-VOCs) for these sites are discussed together. Because Site 35D is not part of the ditch system, the non-VOC results for that site are discussed separately.

Background Information – Site 32D

Potential Source Site 32D is a section of unlined ditch about 40 feet west of the former location of Buildings 49005, 49008, and 49009 (Figure 5-2). Drainage from the buildings was discharged to the ditch via a metal pipe. Buildings 49005, 49008, and 49009 were demolished in 1991 and the area in which the buildings were located is currently an open field. Building 49005 was formerly a restriction preparation facility and warehouse. Building 49008 was formerly a fuel preparation and non-destructive testing facility. Building 49009 was formerly a fired chamber rehabilitation and soakout facility where dichloromethane (methylene chloride) soakout operations and steam cleaning were performed.

In addition to the ditch, other features at Site 32D included two sumps and a UST associated with Building 49008, as well as a storage tank area formerly located north of Buildings 49005, 49008, and 49009 (Figure 5-2). Information regarding those features is presented below.

- The two sumps were reportedly abandoned in place sometime prior to demolition of Buildings 49005, 49008, and 49009 in 1991. Documents in Aerojet's UST records reviewed during preparation of this Workplan indicated that the abandoned sumps were still present in 1995.
- The UST at Building 49008 has been removed, but information presented in the Stage 1 RI Report and documents in Aerojet's UST files regarding removal of the UST is inconsistent. The Stage 1 RI Report indicated that a tank located east of Building 49008, between Buildings 49008 and 49005, was removed in July 1991 and that samples collected from the bottom of the excavation contained benzene at 600 mg/kg, TCE at 17 µg/kg, and PCE at 6 µg/kg. Documents in Aerojet's UST files indicated that a 650-gallon UST was removed from the eastern side of former Building 49008 in March 1995 under the oversight of the County of Sacramento. No VOCs (including benzene, toluene, ethylbenzene, and xylenes [BTEX]), TPH, or oil and grease above the reporting limits or metals above regulatory levels were detected in the samples collected from the excavation. The County closed the tank site.
- The storage tank farm formerly located north of Buildings 49005, 49008, and 49009 consisted of four structures identified as Buildings 49019, 49090, 49091, and 49092. Presented below is information regarding the structures obtained from a review of Aerojet Building and Structure Manuals dated 1967, 1970, 1985, and 1988.

- Building 49092 consisted of three acid storage tanks with a combined capacity of 15,000 gallons. Building 49019 was identified as a shelter for the three tanks. The presence of a shelter indicates that the three storage tanks were likely above ground.
- Building 49090 was identified as two storage tanks having a combined storage capacity of 4,000 gallons and Building 49091 was identified as four storage tanks having a combined storage capacity of 80,000 gallons. A plot plan of Area 49 that was included in the 1988 Aerojet Building and Structure Manual indicates that the six tanks were located above ground and were encompassed by a berm or wall.
- All the tanks and the tank shelter were removed sometime between 1970 and 1983.

No information regarding the type(s) of acid formerly contained in the three acid holding tanks (Building 49092) or the types of chemicals formerly stored in the tanks identified as Buildings 49090 and 49091 could be located. The location of the tank farm adjacent to a former rail spur suggests that the tanks were used for the temporary storage of chemicals received by rail prior to undergoing quality assurance checks at facilities in Area 49. A terracotta drainpipe is present along the unlined ditch just west of the former location of the tank farm. The Stage 1 RI report included mention of the terracotta drainpipe in the discussion of Site 35D, but indicated that the origin of the drainpipe was unknown. The location and angle of the terracotta drainpipe suggests a possible historical association with the former storage tank area.

Background Information – Site 34D

Potential Source Site 34D consists of the northern section of an unlined ditch that formerly drained into a culvert under Folsom Boulevard and the septic tank for Building 49011 (Figure 5-2). That section of the ditch may have received drainage from Building 49011. Building 49011, a chemical storage and receiving facility, is located approximately 300 feet southwest of the ditch.

Background Information – Site 38D

Potential Source Site 38D is a section of unlined ditch southwest of the former location of Building 49018 (Figure 5-2). Building 49018 was formerly a degreaser and steam-cleaning facility, as well as a fuel restriction and preparation facility. Steam-cleaning and chlorinated

solvents were used to remove residuals from equipment. Fuel restriction and preparation operations combined dry chemicals and polymers.

In addition to the ditch, other features associated with Building 49018 included a sump on the southern side of the building and a UST on the western side of the building (Figure 5-2). The sump was abandoned in place sometime before 1991 and was removed during the demolition of Building 49018 in September and October 2001. The Aerojet facility engineer, responsible for oversight of demolition and removal activities, indicated that no staining, odors, or other indications of environmental impacts were observed during removal of the sump and Building 49018.

The UST at Building 49018 was removed sometime between July 1991 and March 1995. The Stage 1 RI Report and documents in Aerojet's UST files are inconsistent on the date of removal. However, both references indicated that a tank along the western side of Building 49018 was removed. No VOCs (including BTEX), TPH, or oil and grease were detected above the reporting limits and no metals were detected above regulatory levels in the samples collected from the excavation. The County closed the site.

Background Information - Site 35D

Potential Source Site 35D consists of two sumps and a septic tank at former Building 49014 and the area surrounding Building 49014 (Figure 5-2). Building 49014 was formerly an inert chamber processing facility. Information in the *Stage 1 Report* (ICFKE, 1993) indicated that a TCE sump was located in the center of Building 49014, and a large degreaser sump that reportedly contained 1,1,1-TCA was located at the western end of the building. Aerojet Document X (Aerojet, 1983) indicated that the degreaser might have been in hydraulic connection with shallow groundwater. Water that had seeped into the degreaser was reportedly discharged to the ground at the eastern end of the building. Waste and surface water runoff from Building 49014 potentially reached the central Area 49 ditch. The area directly west of Building 49014 is drained by a culvert that directs runoff towards the north.

Buildings 49014 and 49006, two sumps in Building 49014, and two septic tanks associated with the buildings were demolished and removed in September and October 2001. The following information was obtained in an interview with the Aerojet facility engineer responsible for oversight of demolition and removal activities:

- The large degreaser sump that reportedly contained 1,1,1-TCA was observed at the western end of the building. A second sump containing a large cyclonic dust collector was observed in the northwestern corner of the building. With the exception of the western end of Building 49014, the concrete foundation slab for Buildings 49014 and 49006 was of uniform thickness and relatively flat. No sumps or pits extending below the level of the slab were observed in the center of Building 49014.
- No stained or discolored soils, odors, or other indications of environmental impacts were observed during the removal of the sumps and septic tanks and no groundwater was encountered during the removals.

5.3.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations - Sites 32D, 34D, 35D, and 38D

The scope and results of the RI for VOCs conducted at Potential Source Sites 32D, 34D, 35D, and 38D are summarized below.

5.3.1.1 Previous Volatile Organic Compound Investigations

During the Stage 1 RI in 1992, 47 soil vapor samples were collected from the shallow soil layer (6 to 11 feet bgs) at 39 locations and 16 were collected from the intermediate soil layer (12 to 20 feet bgs) at 16 locations in the central portion of Area 49 (Figures 5-4 and 5-5). Subsurface soil conditions and shallow perched groundwater hindered the collection of soil vapor samples from the intermediate layer. The analytical results for the shallow and intermediate soil vapor samples collected during the Stage 1 RI are summarized below.

Shallow Soil Vapor Samples

- Total VOC concentrations detected in the soil vapor samples collected from the shallow layer (6 to 11 feet bgs) during the Stage 1 RI are shown in Figure 5-4. The highest total VOC concentrations were detected in soil vapor samples collected adjacent to the abandoned sump and former location of the waste tank adjacent to Building 49018 (Site 38D) and from soil vapor samples collected around the former locations of Buildings 49005, 49008, and 49009 (Site 32D).
- The maximum total VOC concentration of 47,300 mg/m^3 was detected in the shallow layer (6 to 11 feet bgs) adjacent to the abandoned sump on the southern side of Building 49018 (Site 38D).

- VOCs detected in the soil vapor samples collected at Site 38D, and their maximum concentrations, were TCE (26,700 mg/m^3), 1,2-DCE (10,600 mg/m^3), vinyl chloride (9,680 mg/m^3), 1,1-dichloroethene (1,1-DCE) (186 mg/m^3), PCE (126 mg/m^3), 1,1,1-TCA (61.1 mg/m^3), toluene (2.9 mg/m^3), and Freon 113 (2.44 mg/m^3).
- The concentrations of TCE and 1,2-DCE detected in the soil vapor samples collected from the vadose zone near the sump exceeded one percent of their respective vapor saturation levels, indicating the potential for dense nonaqueous-phase liquid.

Intermediate Soil Vapor Samples

- In general, the highest total VOC concentrations in the intermediate layer corresponded to those in the shallow layer (Figure 5-5). Total VOC concentrations greater than 1,000 mg/m^3 were detected in the intermediate layer at four locations in the central portion of Area 49.
- VOCs detected in soil vapor samples collected from the intermediate layer, and their maximum concentrations, included TCE (4,470 mg/m^3), PCE (224 mg/m^3), 1,2-DCE (44.1 mg/m^3), 1,1,1-TCA (100 mg/m^3), 1,1-DCE (14.8 mg/m^3), and Freon 113 (4.45 mg/m^3).

Soil Vapor Extraction Well Samples

In 1996 and 1997, Aerojet drilled several exploratory borings and installed six groundwater/SVE wells at Sites 35D and 38D (Aerojet, 1997b). The borings and wells were drilled in preparation of a pilot study to evaluate the use of low flow SVE to remediate VOCs in the vadose zone at those sites. Due to issues related to the potential discharge of VOCs to the atmosphere, the pilot study was not implemented. The locations of the groundwater/SVE wells are shown in Figure 5-2. The analytical results for vapor samples collected from the six wells are summarized below.

- Total VOC concentrations in the vapor samples collected from the six wells ranged from 67 to 19,419 mg/m^3, with the highest concentration detected in vapor extraction well SVE-2.
- TCE was the predominant VOC detected in the vapor samples collected from the six wells.
- VOCs detected in the vapor sample having the highest total concentration (19,419 mg/m^3) included TCE (12,000 mg/m^3); cis-1,2-DCE (6,200 mg/m^3); vinyl chloride (870 mg/m^3); PCE (210 mg/m^3); 1,1,1-TCA (70 mg/m^3); 1,1-DCE (55 mg/m^3); and trans-1,2-DCE, 1,1-

DCA, toluene, and xylenes at concentrations less than 5 mg/m^3 (Aerojet, 1997b).

5.3.1.2 *Recent Volatile Organic Compound Investigations*

In accordance with the approved Workplan, 52 soil vapor samples (excluding QA/QC samples) were collected at 28 locations to complete the characterization of VOCs in the vadose zone in the central portion of Area 49 (Figures 5-6 and 5-7). Six soil vapor samples were collected from the very shallow layer (1 to 5 feet bgs), 25 were collected from the shallow layer (6 to 11 feet bgs), and 21 were collected from the intermediate layer (12 to 20 feet bgs). A comparison of proposed and actual soil vapor sampling activities for the central portion of Area 49 and a summary of sample identifications and depths is provided on Table 5-3.

The analytical results for the soil vapor samples are included in Appendix F and are summarized on Table 5-4 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 5-4 and below. VOCs detected in the very shallow, shallow, and intermediate layers in the central portion of Area 49 above their respective SVSLs are shown in Figures 5-8, 5-9, and 5-10, respectively.

Very Shallow Soil Vapor Samples

- Total VOC concentrations detected in the soil vapor samples collected from the very shallow layer (1 to 5 feet bgs) ranged from 0.17 mg/m^3 to 16.3 mg/m^3. The maximum total VOC concentrations in the very shallow layer were detected in a soil vapor sample (34D-SP08) in the southwestern portion of the parking lot east of Building 49011.
- Fourteen VOCs were detected in the five soil vapor samples collected from the very shallow layer. The 14 VOCs detected, and their maximum concentrations, were cis-1,2-DCE (0.05 mg/m^3), chloroform (0.08 mg/m^3), 1,1,1-TCA (0.08 mg/m^3), TCE (12 mg/m^3), PCE (4.4 mg/m^3), benzene (0.03 mg/m^3), toluene (0.02 mg/m^3), ethylbenzene (0.03 mg/m^3), xylenes (0.18 mg/m^3), 1,2,4-TMB (0.04 mg/m^3), hexane (0.04 mg/m^3), acetone (0.20 mg/m^3), and MEK (0.06 mg/m^3).
- Five (toluene, ethylbenzene, 1,2,4-TMB, hexane, and MEK) of the fourteen VOCs were detected in only one (38D-SP25) of the five soil vapor samples.
- TCE, PCE, 1,1,1-TCA, and acetone were the most common VOCs detected in the very shallow layer in the central portion of Area 49.

- TCE and PCE above their respective SVSLs were detected in at least one of the five very shallow soil vapor samples (Figure 5-8).

Shallow Soil Vapor Samples

- Total VOC concentrations detected in the soil vapor samples collected from the shallow layer (6 to 11 feet bgs) in the central portion of Area 49 ranged from 0.14 mg/m^3 to 22.24 mg/m^3 (Figure 5-6).
- Twenty-six VOCs were detected in the soil vapor samples collected from the shallow layer in the central portion of Area 49. The 26 VOCs detected, and their maximum concentrations, were 1,1-DCA (0.08 mg/m^3), 1,1-DCE (0.21 mg/m^3), cis-1,2-DCE (1.5 mg/m^3), chloroform (0.22 mg/m^3), 1,1,1-TCA (0.52 mg/m^3), TCE (17 mg/m^3), PCE (estimated at 8.4 mg/m^3), benzene (0.15 mg/m^3), toluene (0.21 mg/m^3), ethylbenzene (0.08 mg/m^3), xylenes (0.35 mg/m^3), 1,3,5-TMB (0.03 mg/m^3), 1,2,4-TMB (0.16 mg/m^3), 1,2-dichlorobenzene (0.04 mg/m^3), hexane (0.1 mg/m^3), cyclohexane (0.04 mg/m^3), heptane (0.16 mg/m^3), propylbenzene (0.04 mg/m^3), acetone (1.2 mg/m^3), carbon disulfide (2.0 mg/m^3), MEK (0.55 mg/m^3), tetrahydrofuran (1.2 mg/m^3), 2-hexanone (estimated at 0.06 mg/m^3), 4-ethyltoluene (0.19 mg/m^3), and ethanol (0.06 mg/m^3).
- Six (1,1-DCA, 1,3,5-TMB, propylbenzene, tetrahydrofuran, 2-hexanone, and 4-ethyltoluene) of the VOCs detected were in only one soil vapor sample.
- TCE and PCE were the only VOCs detected at concentrations above their respective SVSLs in the shallow soil vapor samples collected from the central portion of Area 49 (Figure 5-9).

Intermediate Soil Vapor Samples

- Total VOC concentrations detected in the soil vapor samples collected from the intermediate layer (12 to 20 feet bgs) ranged from 0.11 mg/m^3 to 175 mg/m^3 (Figure 5-7).
- As with the previous VOC data, the highest total VOC concentrations in the intermediate layer (Figure 5-7) generally correspond to those in the shallow layer (Figure 5-6).
- Twenty-three VOCs were detected in the soil vapor samples collected from the intermediate layer in the central portion of Area 49. The 23 VOCs detected, and their maximum concentrations, were dichloromethane (0.02 mg/m^3), 1,1-DCE (0.51 mg/m^3), cis-1,2-DCE (7.1 mg/m^3), chloroform (1 mg/m^3), 1,1,1-TCA (0.4 mg/m^3), TCE

(160 mg/m^3), PCE (10 mg/m^3), benzene (0.05 mg/m^3), toluene (0.16 mg/m^3), ethylbenzene (0.07 mg/m^3), xylenes (0.32 mg/m^3), 1,3,5-TMB (0.03 mg/m^3), 1,2,4-TMB (0.12 mg/m^3), hexane (0.07 mg/m^3), cyclohexane (0.18 mg/m^3), heptane (0.09 mg/m^3), propylbenzene (0.03 mg/m^3), acetone (0.77 mg/m^3), carbon disulfide (0.53 mg/m^3), MEK (0.16 mg/m^3), 4-ethyltoluene (0.16 mg/m^3), and ethanol (0.11 mg/m^3).

- TCE, PCE, benzene, and chloroform were the only VOCs detected in the intermediate soil vapor samples at concentrations above their respective SVSLs (Figure 5-10).

Soil Vapor Extraction Well Samples

In accordance with the approved Workplan, soil vapor samples were collected from the five groundwater/SVE wells at Sites 35D and 38D. The analytical results for the vapor samples collected from the five wells are included in Appendix F and summarized on Table 5-4 and below.

- Total VOC concentrations in the vapor samples collected from the five wells ranged from 3.71 to 511 mg/m^3, with the highest concentration detected in vapor extraction well SVE-1.
- Eleven VOCs were detected in the soil vapor samples collected from the five SVE wells. The VOCs detected, and their maximum concentrations, were dichloromethane (0.01 mg/m^3), 1,1-DCE (1.8 mg/m^3), cis-1,2-DCE (25 mg/m^3), 1,1,1-TCA (2.4 mg/m^3), TCE (500 mg/m^3), PCE (40 mg/m^3), toluene (0.02 mg/m^3), cyclohexane (0.01 mg/m^3), acetone (0.02 mg/m^3), 2-propanol (0.09 mg/m^3), and vinyl chloride (0.004 mg/m^3).
- TCE, PCE, and cis-1,2-DCE were the most predominant VOCs detected in the vapor samples collected from the six wells. TCE and PCE were the only VOCs detected in the five wells at concentrations above their respective SVSLs.

5.3.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations - Sites 32D and 34D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Sites 32D and 34D are summarized below.

5.3.2.1 *Previous Non-Volatile Organic Compound Investigations*

Prior to 1990, soil samples collected in the central portion of Area 49 were analyzed for oil and grease. Oil and grease was detected at 22 mg/kg in a sample collected at 6.5 feet bgs from boring 810 drilled adjacent to former Building 49011 (Figure 5-11).

During the Stage 1 RI, efforts to collect subsurface soil samples at two locations (32D-AH02 and 34D-AH14) in or adjacent to the ditches in Area 49 were unsuccessful due to the presence of cobbles in the subsurface and perched groundwater. Each boring was drilled a minimum of three times in an attempt to collect the samples.

5.3.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Sites 32D and 34D presented in the approved Workplan indicated that the following data were needed to complete the RI/FS:

- Data were needed to evaluate the potential historical release of chemicals to soil at the former location of the acid holding tanks (former Buildings 49019 and 49092) and the storage tank farm area (former Buildings 49090 and 49091) at Site 32D.
- Data were needed to confirm the absence of chemicals in soil at the former location of the UST east of former Building 49008 (Site 32D).

In accordance with the approved Workplan, subsurface soil samples were collected at Site 32D at the following locations:

- One boring (32D-SB05) at the former location of the acid holding tanks (former Buildings 49019 and 49092);
- One boring (32D-SB06) at the storage tank farm area (former Buildings 49090 and 49091) at Site 32D; and
- One boring (32D-SB07) at the former UST location east of former Building 49008.

The location of borings 32D-SB05, 32D-SB06, and 32D-SB07 are shown in Figures 5-11 through 5-13. With only a few exceptions, samples were collected from borings 32D-SB05 and 32D-SB06 at 2.5 feet bgs and at 5-foot intervals to first groundwater (45 to 48 feet bgs) and analyzed for SVOCs, metals, TPH, and pH. With only two exceptions, samples were collected from boring 32D-SB07 at 2.5 feet bgs and at 5-foot intervals to first

groundwater (47 feet bgs) and analyzed for SVOCs, metals, and TPH. Due to the presence of cobbles, two attempts to collect samples at 20 and 25 feet bgs from boring 32D-SB07 were unsuccessful. A comparison of proposed and actual subsurface soil sampling activities at Site 32D and a summary of sample identifications and sampling depths is provided on Table 5-5. The analytical results for the subsurface soil samples are included in Appendix F and summarized below.

Semivolatile Organic Compounds

The results of the SVOC and SVOC TIC analysis of the subsurface soil samples collected from borings 32D-SB05, 32D-SB06, and 32D-SB07 are summarized on Tables 5-6 and 5-7, respectively, and below. The location of borings sampled for SVOCs are shown in Figure 5-12.

Former Location of Acid Holding Tanks and Tank Farm Area

- Two common contaminants (bis[2-ethylhexyl]phthalate and diethyl phthalate) introduced during sampling and analysis were the only SVOCs detected in samples collected from borings 32D-SB05 and 32D-SB06. Bis(2-ethylhexyl)phthalate was detected at an estimated concentration of 45 µg/kg in the sample collected at 40 feet bgs in boring 32D-SB05. No bis(2-ethylhexyl)phthalate was detected above the laboratory reporting limit of 9.3 µg/kg in the duplicate sample collected at 40 feet bgs. Diethyl phthalate was detected at an estimated concentration of 47 µg/kg in the soil sample collected at 7 feet bgs from boring 32D-SB05. Diethyl phthalate was detected at estimated concentrations of 46 µg/kg and 51 µg/kg in the soil samples collected from boring 32D-SB06 at 15 and 45 feet bgs, respectively.
- With the exception of sulfur, no TICs were detected at concentrations above 300 µg/kg in any of the soil samples collected from borings 32D-SB05 and 32D-SB06. Sulfur was detected at 800 µg/kg in the soil sample collected from boring 32D-SB06 at 2.5 feet bgs.

Former Location of UST at Former Building 49008

- Benzoic acid was detected at an estimated concentration of 68 µg/kg in the soil sample collected from boring 32D-SB07 at 40 feet bgs. The common laboratory and field sampling contaminant bis(2-ethylhexyl)-phthalate was detected in five of the nine soil samples collected from boring 32D-SB07 at estimated concentrations ranging from 33 to 170 µg/kg. The detected concentrations of benzoic acid and

bis(2-ethylhexyl)phthalate are well below their respective commercial and residential SSLs.

- No TICs were detected in any of the soil samples collected from boring 32D-SB07.

Metals

The results of the metals analysis of the subsurface soil samples collected from borings 32D-SB05, 32D-SB06, and 32D-SB07 are summarized on Table 5-8 and below.

Former Location of Acid Holding Tanks and Tank Farm Area

No metals were detected at concentrations above background and their respective residential or commercial SSLs in the 17 subsurface soil samples collected from borings 32D-SB05 and 32D-SB06 at the former location of the acid holding tanks and tank farm area.

Former Location of UST at Former Building 49008

No metals were detected at concentrations above background and their respective residential or commercial SSLs in the eight subsurface soil samples collected from borings 32D-SB07 at the former location of the UST at former Building 49008.

Total Petroleum Hydrocarbons

The results of the TPH analysis of the subsurface soil samples collected from borings 32D-SB05, 32D-SB06, and 32D-SB07 are summarized on Table 5-9 and below. Hydrocarbons detected in the subsurface soil samples are shown in Figure 5-11.

Former Location of Acid Holding Tanks and Tank Farm Area

- TPH-D was detected in only 4 of the 20 samples collected from borings 32D-SB05 and 32D-SB06 at the former location of the acid holding tanks and tank farm area. TPH-D was detected at 6.7 mg/kg and 26 mg/kg in samples collected from boring 32D-SB05 at 10 and 30 feet bgs, respectively. TPH-D was detected at 6 mg/kg and 18 mg/kg in samples collected from boring 32D-SB06 at 2.5 and 30 feet bgs, respectively. TPH-D was detected at only 8.4 mg/kg in a duplicate sample collected from boring 32D-SB06 at 30 feet bgs.

- The detected concentrations of TPH-D are well below the screening level of 100 mg/kg for extractable TPH.

Former Location of UST at Former Building 49008

- TPH-D was detected in only four of the nine soil samples collected from boring 32D-SB07 at the former location of the UST at former Building 49008. TPH-D was detected at estimated concentrations of 14, 5.2, 16, and 30 mg/kg in samples collected at 2.5, 30, 35, and 40 feet bgs, respectively. Although TPH-D was detected at 16 mg/kg in the primary soil sample collected at 35 feet bgs, no TPH-D was detected above 5 mg/kg in the duplicate sample collected at that depth.
- The detected concentrations of TPH-D are well below the screening level of 100 mg/kg for extractable TPH.
- pH.

The results of the pH analysis of the subsurface soil samples collected from borings 32D-SB05 and 32D-SB06 at the former location of the acid holding tanks and tank farm area are summarized on Table 5-10 and below.

- The pH values for the 20 soil samples collected from borings 32D-SB05 and 32D-SB06 ranged from 6.18 to 7.52.
- The pH values for the samples are within the range of the background pH units (5.2 to 7.8) for the Aerojet site.

5.3.3 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 38D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site 38D are summarized below.

5.3.3.1 *Previous Non-Volatile Organic Compound Investigations*

Prior to 1990, soil samples collected in the central portion of Area 49 were analyzed for oil and grease. Oil and grease was detected at concentrations ranging from 27 to 170 mg/kg in samples collected between 23 and 28.5 feet bgs from boring 806 on the southern side of Building 49018 (Figure 5-11).

During the Stage 1 RI, soil samples were successfully collected from only one boring at Site 38D. Boring 38D-AH1B1 was drilled between the sump and former location of the UST at Building 49018, the area where oil and

grease was previously detected (boring 806) (Figure 5-11). Soil samples were collected from boring 38D-AH1B1 at 5, 10, and 15 feet bgs and analyzed for SVOCs, oil and grease, and perchlorate. Shallow groundwater was encountered at 15 feet bgs. The analytical results for the subsurface soil samples collected from boring 38D-AH1B1 are summarized below.

Semivolatile Organic Compounds

- Di-n-butyl phthalate, a compound identified during the Stage 1 RI as a laboratory contaminant, was detected in the samples at concentrations up to 1.73 mg/kg.
- TICs reported as part of the SVOC analysis of the subsurface soil samples included hexadecanoic acid up to 4 mg/kg, unknown compounds up to 5 mg/kg, and unknown phthalates up to 2 mg/kg.

Total Petroleum Hydrocarbons

- No oil and grease or perchlorate were detected above their respective laboratory reporting limits in the samples.

5.3.3.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 38D presented in the approved Workplan indicated that data were needed to confirm the presence of TICs detected in the SVOC analysis of the subsurface soil samples collected from boring 38D-AH1B1.

In accordance with the approved Workplan, subsurface soil samples were collected from one boring 38D-SB08 at the approximate former location of Stage 1 RI boring 38D-AH1B1 to assess the presence of SVOCs and TICs in soil (Figure 5-12). First groundwater was encountered during the drilling of 38D-SB08 at 44 feet bgs. Soil samples were collected from boring 38D-SB08 at 2.5, 20, 25, 30, 35, and 40 feet bgs and analyzed for SVOCs. Due to the presence of cobbles, two attempts to collect samples at 5, 10, and 15 feet bgs from boring 38D-SB08 were unsuccessful. A comparison of proposed and actual subsurface soil sampling activities at Site 38D and a summary of sample identifications and sampling depths are provided on Table 5-5.

The results of the SVOC and SVOC TIC analysis of the samples collected from boring 38D-SB08 are included in Appendix F and are summarized on Tables 5-6 and 5-7, respectively, and below.

Semivolatile Organic Compounds

- The common field and laboratory contaminant, diethyl phthalate, was detected in only one of the six soil samples collected from boring 38D-SB08. Diethyl phthalate was detected at 330 µg/kg in the sample collected at 30 feet bgs. The detected concentration is well below its residential and commercial SSL.
- TICs were detected at concentrations greater than 300 µg/kg in only one of the six soil samples collected from 38D-SB08. An unknown compound was detected at an estimated concentration of 5,000 µg/kg in the soil sample collected at 2.5 feet bgs.

5.3.4 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 35D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site 35D are summarized below.

5.3.4.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, surface and near-surface soil samples were collected at five locations (35D-AH1B, 35D-AH02, 35D-AH04, 35D-MV01, and 35D-SNS15), and subsurface soil samples were collected at two of those locations (35D-AH1B and 35D-MV01). Efforts to collect subsurface soil samples at one additional boring location (35D-AH11) were unsuccessful due to the presence of cobbles. Sampling locations are shown in Figure 5-13. The analyses performed on the surface, near-surface, and subsurface soil samples collected at those locations are summarized on Table 5-11 and below.

Surface and Near-Surface Soil

All surface and near-surface soil samples collected at the five locations, with the exception of the surface soil sample from location 35D-AH1B, were analyzed for metals. The surface soil sample collected from 35D-AH1B was analyzed only for oil and grease. In addition to metals, the near-surface soil sample collected from 35D-AH1B, the surface and near-surface soil samples collected from 35D-AH02, and the surface soil sample collected from 35D-AH04 were also analyzed for oil and grease. Additionally, the surface soil sample collected at location 35D-MV01 and the near-surface soil sample (3 feet bgs) collected at location 35D-AH1B were analyzed for SVOCs. The analytical results for the surface and near-surface soil samples are summarized below. The analytical results for

metals, and their respective SSLs, are summarized on Table 5-12. Non-VOCs and metals detected in the samples above background and their respective SSLs are shown in Figures 5-11 through 5-13.

Semivolatile Organic Compounds

- No SVOCs were detected above laboratory reporting limits in the surface soil sample collected at location 35D-MV01. TICs reported as part of the SVOC analysis of the surface soil sample included unknown compounds at 0.46 mg/kg and unknown alkanes at 0.66 mg/kg.
- No SVOCs above laboratory reporting limits or SVOC TICs were detected in the soil sample collected at 3 feet bgs at location 35D-AH1B.

Metals

No metals at concentrations statistically above background and their respective residential or commercial SSLs were detected in the surface and near-surface soil samples collected at Site 35D.

Total Petroleum Hydrocarbons

- No oil and grease was detected above the laboratory reporting limit in the soil samples collected from boring 35D-AH1B at surface and 3 feet bgs.
- Oil and grease was detected at 44 mg/kg in the soil sample collected at 1 foot bgs at location 35D-AH02, but no oil and grease was detected in the soil sample collected at 3.5 feet bgs (Figure 5-11).
- Oil and grease was detected at 370 mg/kg in the near-surface soil sample collected at 1.5 feet bgs at location 35D-AH04 (Figure 5-11).

Subsurface Soil

Boring 35D-AH1B was drilled near the 1,1,1-TCA sump in Building 49014 (Figure 5-2) and subsurface soil samples were collected at 5, 10, and 15 feet bgs. The sample collected at 5 feet bgs was analyzed for oil and grease and the samples collected at 10 and 15 feet bgs were analyzed for SVOCs. The analytical results for the samples are summarized below. The analytical results for SVOCs, and their respective residential SSLs, are summarized on Table 5-13. Boring locations are shown in Figure 5-11.

Semivolatile Organic Compounds

- No SVOCs other than the laboratory contaminant di-n-butyl phthalate (up to 2.07 mg/kg) were detected in the samples collected at 10 and 15 feet bgs.
- TICs reported in the SVOC analysis of the soil samples collected at 10 and 15 feet bgs included hexadecanoic acid up to 4 mg/kg, unknown compounds up to 5.7 mg/kg, and unknown phthalates up to 3 mg/kg.

Total Petroleum Hydrocarbons

- No oil and grease was detected above the laboratory reporting limit in the soil sample collected from boring 35D-AH1B at 5 feet bgs.

Boring 35D-MV01 was drilled in the open field west of Building 49014 (Figure 5-2) and subsurface soil samples were collected at 5, 10, and 15 feet bgs. All soil samples were analyzed for SVOCs. Additionally, the soil samples collected at 5 and 15 feet bgs were analyzed for oil and grease. The analytical results for the samples are summarized below. The analytical results for SVOCs, and their respective residential SSLs, are summarized on Table 5-13.

Semivolatile Organic Compounds

- No SVOCs, other than the common laboratory contaminant bis(2-ethylhexyl)phthalate up to 0.17 mg/kg, were detected in the samples.
- TICs reported in the SVOC analysis of the subsurface soil samples collected from boring 35D-MV01 included unknown alkanes at 0.14 mg/kg in the 5-foot sample and hexadecanoic acid at 0.23 mg/kg in the 15-foot sample.

Total Petroleum Hydrocarbons

- No oil and grease was detected above the reporting limit of 50 mg/kg in the soil sample collected at 5 feet bgs. Oil and grease was detected at 120 mg/kg in the soil sample collected at 15 feet bgs (Figure 5-11).

5.3.4.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 35D presented in the approved Workplan indicated that additional data were needed to confirm the presence of TICs identified in the SVOC analysis of surface and/or subsurface soil samples collected from borings 35D-AH1B and 35D-MV01.

The recent investigation conducted at Site 35D in accordance with the approved Workplan to obtain the data needed to complete the RI/FS is summarized below.

Subsurface soil samples were collected from two borings (35D-SB25 and 35D-SB26) at the former location of Stage 1 RI borings 35D-AH1B and 35D-MV01 (Figure 5-12). Soil samples were collected from boring 35D-SB25 at 2.5, 10, 35, 40, and 45 feet bgs and analyzed for SVOCs. Due to the presence of cobbles, two attempts to collect samples at 5, 15, 20, and 30 feet bgs from boring 35D-SB25 proved unsuccessful. Soil samples were collected from boring 35D-SB26 at 2.5 feet bgs and at 5-foot intervals to first groundwater (47 feet bgs) and analyzed for SVOCs. A comparison of proposed and actual subsurface soil sampling activities at Site 35D and a summary of sample identifications and sampling depths is provided on Table 5-5.

The results of the SVOC and SVOC TIC analysis of the samples collected from borings 35D-SB25 and 35D-SB26 are included in Appendix F and are summarized on Tables 5-13 and 5-7, respectively, and below.

Semivolatile Organic Compounds

- SVOCs were detected in only two of the five soil samples collected from boring 35D-SB25. Chrysene was detected at an estimated concentration of 45 µg/kg and two common field and laboratory contaminants (bis[2-ethylhexyl]phthalate and diethyl phthalate) were detected at estimated concentrations of 60 and 58 µg/kg in the sample collected at 2.5 feet bgs. Bis(2-ethylhexyl)phthalate was detected at an estimated concentration of 48 µg/kg in the sample collected at 35 feet bgs.
- TICs were detected at concentrations greater than 10 µg/kg in only one of the five soil samples collected from 35D-SB25. TICs identified in the SVOC analysis of the soil sample collected at 2.5 feet bgs included four unknown compounds at estimated concentrations up to 2,000 µg/kg, unknown alkanes at an estimated concentration of 300 µg/kg, unknown cycloalkanes at an estimated concentration of 2,800 µg/kg, and unknown cholesterol at an estimated concentration of 1,000 µg/kg.
- The common field and laboratory contaminant bis(2-ethylhexyl)-phthalate was detected in 3 of the 11 soil samples collected from boring 35D-SB26 at estimated concentrations ranging from 38 to 65 µg/kg.

- TICs were detected at concentrations greater than 10 µg/kg in only 2 of the 11 soil samples collected from 35D-SB26. Unknown alkanes were reported at an estimated concentration of 300 µg/kg in the samples collected at 2.5 and 30 feet bgs.

5.3.5 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Sites 32D, 34D, 35D, and 38D*

The scope and results of the RIs for perched groundwater conducted at Sites 32D, 34D, 35D, and 38D are summarized below.

5.3.5.1 *Previous Perched Groundwater Investigations*

Four groundwater monitoring wells (802, 805, 808, and 855) were installed at Sites 32D, 34D, 35D, and 38D in 1985 (Figure 5-2). During the Stage 1 RI, groundwater samples were collected from Wells 802, 808, and 855 and analyzed for VOCs and SVOCs. Well 805 was dry and not sampled. In addition, a screening-level perched groundwater sample (38D-HP01) was collected at a depth of 18 feet adjacent to the sump at Building 49018 (Figure 5-2) during the Stage 1 RI and analyzed for VOCs. The analytical results for the monitoring well and screening-level groundwater samples are summarized below.

- Well 802 contained PCE at 29 µg/L; bis(2-ethylhexyl)phthalate at 800 µg/L; and the hydrocarbon-related compounds alpha,alpha-dimethyl benzene at 12 µg/L and 1-phenyl-ethanone at 5 µg/L.
- Well 808 contained TCE at 380 µg/L; PCE at 7 µg/L; 1,1,1-TCA at 5 µg/L; bis(2-ethylhexyl)phthalate at 1,200 µg/L; and the hydrocarbon-related compounds alpha,alpha-dimethyl benzene at 31 µg/L and 1-phenyl-ethanone at 14 µg/L.
- Well 855 contained TCE at 96 µg/L and cis/trans-1,2-DCE at 9 µg/L.
- Screening-level groundwater sample 38D-HP01 contained TCE at 1,500 µg/L; cis/trans-1,2-DCE at 340 µg/L; PCE at 40 µg/L; 1,1,1-TCA at 20 µg/L; and 1,1-DCE at 10 µg/L.

5.3.5.2 *Recent Perched Groundwater Investigations*

Evaluation of the existing data for Site 35D presented in the approved Workplan indicated that additional data were needed to determine if groundwater is present in the four groundwater wells (802, 805, 808, and 855) and three SVE wells (4485, 4490, and 4495) in the central portion of

Area 49. Additional data were also needed to assess the presence of chemicals in the perched groundwater in that area.

In accordance with the approved Workplan, the four groundwater wells (802, 805, 808, and 855) in the central portion of Area 49 were monitored for the presence of groundwater (Figure 5-14). Well 805 could not be located and Well 855 did not contain a sufficient volume of water to collect a sample. Groundwater was present in Well 808 at a depth of 26.5 feet, but the well did not recharge after being purged and was not sampled. Depth to groundwater in Well 802 was measured at 19.6 feet bgs and a sample was collected from the well and analyzed for VOCs, SVOCs, perchlorate, nitrate, and nitrite. Proposed and actual groundwater sampling activities, and water level and well depth data for the wells, are summarized on Table 5-14.

Review of well construction and groundwater data indicates that Well 802 could potentially be completed within a perched groundwater layer, the first unconfined groundwater, or possibly both. The measured depth to groundwater suggests that Well 802 is likely completed within a perched groundwater layer. However, the total depth of the well is relatively the same as the three SVE wells (4485, 4490, and 4495) completed in the first unconfined groundwater unit (Layer B). The results of the VOC and SVOC analysis of the groundwater sample from Well 802 are summarized on Tables 5-15 and 5-16, respectively, and below. The results of the perchlorate, nitrate, and nitrite analysis of the groundwater sample are included in Appendix F and summarized on Table 5-17 and below. Chemical constituents detected in the well are shown in Figure 5-14.

Volatile Organic Compounds

- TCE at 25 µg/L, PCE at 34 µg/L, and cis/trans-1,2-DCE at 7.4 µg/L were detected in the groundwater sample collected from Well 802.

Semivolatile Organic Compounds

- No SVOCs were detected above their respective laboratory reporting limits in the groundwater sample collected from Well 802.
- With the exception of presumptive evidence of PCE at 10 µg/L, no TICs were reported in the SVOC analysis of the groundwater from Well 802.

Perchlorate, Nitrate, and Nitrite

- Perchlorate at 15 µg/L, nitrate (as NO_3) at 17 mg/L, and nitrite (as nitrogen) at 0.06 mg/L were detected in the groundwater sample collected from Well 802.
- The detected concentrations of nitrate and nitrite are below their respective MCLs of 45 mg/L and 1 mg/L.

In accordance with the approved Workplan, the three SVE wells (4485, 4490, and 4495) in the central portion of Area 49 were monitored for the presence of perched groundwater; however, SVE Well 4490 was damaged and could not be monitored. Depth to groundwater in SVE Wells 4485 and 4495 was measured at 30 and 28 feet, respectively. Proposed and actual groundwater sampling activities, and water level and well depth data for the SVE wells, are summarized on Table 5-14.

Based on a review of the well construction and groundwater data, the two SVE wells are completed within the first unconfined groundwater layer beneath Area 49. The results of the VOC and SVOC analysis of the groundwater samples collected from SVE Wells 4485 and 4495 are presented in Section 5.13 of this report.

5.3.6 *Discussion of Investigation Results – Sites 32D, 34D, 35D, and 38D*

The cumulative results of the investigations associated with Sites 32D, 34D, 35D, and 38D are discussed below.

5.3.6.1 *Soil - Central Area 49 (Sites 32D, 34D, 35D, and 38D)*

Volatile Organic Compounds

The results of the previous VOC investigations conducted in the central portion of Area 49 are discussed below.

- Total VOC concentrations up to 47,300 mg/m^3 were present in the vadose zone in the central portion of Area 49, with the highest concentrations in the shallow (6 to 11 feet bgs) layer near the abandoned sump and former location of the waste tank adjacent to former Building 49018 (Site 38D) and around the former locations of Buildings 49005, 49008, and 49009 (Site 32D).
- VOCs detected in the previous soil vapor samples collected in the central portion of Area 49, and their maximum concentrations, were TCE (26,700 mg/m^3), 1,2-DCE (10,600 mg/m^3), vinyl chloride

(9,680 mg/m^3), 1,1-DCE (186 mg/m^3), PCE (224 mg/m^3), 1,1,1-TCA (100 mg/m^3), Freon 113 (4.45 mg/m^3), and toluene (2.9 mg/m^3).

- TCE and 1,2-DCE could potentially be present as dense nonaqueous-phase liquid in the vadose zone near the sump.

The recent VOC investigation conducted in the central portion of Area 49 was designed to augment the results of the previous investigation and focused on characterizing the lateral extent of the identified VOC plume. The results of the recent VOC investigation are discussed below.

- Total VOC concentrations in the recent soil vapor samples ranged from 0.11 to 175 mg/m^3.
- VOCs detected in the recent soil vapor samples, and their maximum concentrations, were TCE (160 mg/m^3), PCE (10 mg/m^3), cis-1,2-DCE (7.1 mg/m^3), 1,1-DCE (0.51 mg/m^3), carbon disulfide (2.0 mg/m^3), tetrahydrofuran (1.2 mg/m^3), chloroform (1 mg/m^3), 1,1,1-TCA (0.52 mg/m^3), toluene (0.21 mg/m^3), benzene (0.15 mg/m^3), 1,1-DCA (0.08 mg/m^3), ethylbenzene (0.08 mg/m^3), xylenes (0.35 mg/m^3), 1,3,5-TMB (0.03 mg/m^3), 1,2,4-TMB (0.16 mg/m^3), 1,2-dichlorobenzene (0.04 mg/m^3), hexane (0.1 mg/m^3), cyclohexane (0.18 mg/m^3), heptane (0.16 mg/m^3), propylbenzene (0.04 mg/m^3), acetone (1.2 mg/m^3), MEK (0.55 mg/m^3), 2-hexanone (estimated at 0.06 mg/m^3), 4-ethyltoluene (0.19 mg/m^3), dichloromethane (0.02 mg/m^3), and ethanol (0.11 mg/m^3).
- TCE, PCE, and acetone were the most common VOCs detected in the recent very shallow (5 feet bgs), shallow (6 to 11 feet bgs), and intermediate (12 to 20 feet bgs) soil vapor samples.
- The highest total VOC concentrations in the shallow soil vapor samples generally correspond to those detected in the intermediate soil vapor samples.
- Figures 5-9 and 5-10 show that with two exceptions, the lateral extent of TCE and PCE in the shallow and intermediate layers above their respective SVSLs of 1.92 and 0.64 mg/m^3 has been completely characterized.

Review of the cumulative data indicates that the presence, concentrations, and extent of VOCs in the central portion of Area 49 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.3.6.2 *Soil - Sites 32D and 34D*

Semivolatile Organic Compounds

Former Location of Acid Holding Tanks and Tank Farm Area

- The two common sampling and analytical contaminants bis(2-ethylhexyl)phthalate and diethyl phthalate were the only SVOCs detected in subsurface soil samples collected at the former location of the acid holding tanks and tank farm area. The detected concentrations for both compounds were below their respective residential SSLs.
- Sulfur was the only TIC reported in the SVOC analysis of the subsurface soil samples.

Former Location of UST at Former Building 49008

- Benzoic acid and the common laboratory and field sampling contaminant bis(2-ethylhexyl)phthalate were the only SVOCs detected in near-surface and subsurface soil samples collected at the former location of the UST at Building 49008. The detected concentrations of both compounds were well below their respective residential SSLs.
- No TICs were reported in the samples.

Metals

Former Location of Acid Holding Tanks and Tank Farm Area

- No metals were detected above background and their respective residential and commercial SSLs in the near-surface and subsurface soil samples collected at the former location of the acid holding tanks and tank farm area.

Former Location of UST at Former Building 49008

- No metals were detected above background and their respective residential and commercial SSLs in the near-surface and subsurface soil samples collected at the former location of the UST at Building 49008.

Total Petroleum Hydrocarbons

Former Location of Acid Holding Tanks and Tank Farm Area

- Previous investigations indicated the presence of oil and grease up to 370 mg/kg in soil near the eastern edge of the former storage tank farm area (former Buildings 49090 and 49091).
- TPH-D ranging from 6 to 26 mg/kg was sporadically detected in samples collected at 2.5, 10, and 30 feet bgs during the recent investigation at the former location of the acid holding tanks and tank farm area. The detected concentrations of TPH-D are well below the SSL of 100 mg/kg for extractable TPH.

Former Location of UST at Former Building 49008

- TPH-D ranging from 5.2 to 30 mg/kg was detected in samples collected at 2.5, 30, 35, and 40 feet bgs during the recent investigation at the former location of the UST at Building 49008. The detected concentrations of TPH-D are well below the SSL of 100 mg/kg for extractable TPH.
- pH.

Former Location of Acid Holding Tanks and Tank Farm Area

- pH values for the 20 soil samples collected during the recent investigation at the former location of the acid holding tanks and tank farm area ranged from 6.18 to 7.52. The values are within the normal range (5 to 9) for mineral soils (Brady, 1974).

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at the former location of the acid holding tanks and tank farm area and the former location of the UST at Building 49008 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.3.6.3 *Soil - Site 38D*

Semivolatile Organic Compounds

- The laboratory contaminant di-n-butyl phthalate was detected in soil samples collected near the sump at Building 49018 during the Stage 1 RI. TICs reported in the samples were hexadecanoic acid, unknown compounds, and unknown phthalates.

- The common field and laboratory contaminant diethyl phthalate was detected in one of six near-surface and subsurface soil samples collected at the former location of the sump at Building 49018 during the recent investigation. The detected concentration was well below the residential SSL. TICs (unknown compounds) were reported only in the sample collected at 2.5 feet bgs.

Perchlorate

- No perchlorate was detected in soil samples collected near the sump at Building 49018 during the Stage 1 RI and no sampling for perchlorate was proposed in the approved Workplan.

Total Petroleum Hydrocarbons

- No oil and grease was detected in soil samples collected near the sump at Building 49018 during the Stage 1 RI and no sampling for TPH was proposed in the approved Workplan.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site 38D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.3.6.4 *Soil - Site 35D*

Semivolatile Organic Compounds

- No SVOCs were detected in surface soil samples collected at Site 35D during the previous investigations. TICs reported in one surface soil sample were unknown compounds and unknown alkanes.
- The sampling and laboratory contaminants di-n-butyl phthalate and bis(2-ethylhexyl)phthalate were the only SVOCs detected in subsurface soil samples collected at Site 35D during the previous investigations. TICs reported in the subsurface soil samples were hexadecanoic acid, unknown compounds, unknown phthalates, and unknown alkanes.
- Chrysene, bis(2-ethylhexyl)phthalate, and diethyl phthalate were detected at concentrations below their respective residential SSLs in one near-surface soil sample (2.5 feet bgs) collected at Site 35D during the recent investigation. TICs reported in the sample were unknown compounds, unknown alkanes, unknown cycloalkanes, and unknown cholesterol.

- The common field and laboratory contaminant bis(2-ethylhexyl)-phthalate was the only SVOC detected in subsurface soil samples collected at Site 35D during the recent investigation. Unknown alkanes were the only TIC reported in 1 of 14 subsurface soil samples.

Metals

- No metals were detected at concentrations above background and their respective residential and commercial SSLs in the surface and near-surface soil samples collected during previous investigations at Site 35D. Subsurface soil samples collected during previous investigations were not analyzed for metals.

Total Petroleum Hydrocarbons

- Oil and grease was detected up to 370 mg/kg in two near-surface soil samples and up to 120 mg/kg in one subsurface soil sample collected during previous investigations at Site 35D. The detected concentrations are well below the SSL of 100 mg/kg for extractable TPH.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site 35D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.3.6.5 *Perched Groundwater*

During the Stage 1 RI in 1992, groundwater samples were collected from three of four wells (802, 805, 808, and 855) in the central portion of Area 49. Additionally, a screening-level groundwater sample was collected at Site 38D. Chemical constituents detected in the samples, and their maximum concentrations, were TCE at 1,500 µg/L, PCE at 40 µg/L, 1,1,1-TCA at 20 µg/L, 1,1-DCE at 10 µg/L, cis/trans-1,2-DCE at 340 µg/L, bis(2-ethylhexyl)phthalate at 800 µg/L, and hydrocarbon-related compounds at 5 µg/L.

During the recent investigation, one (802) of the four wells contained water and was sampled. Chemical constituents detected in the sample were TCE at 25 µg/L, PCE at 34 µg/L, cis/trans-1,2-DCE at 7.4 µg/L, perchlorate at 15 µg/L, nitrate (as NO_3) at 17 mg/L, and nitrite (as nitrogen) at 0.06 mg/L. No SVOCs or TICs were detected in the sample.

Review of the well construction and groundwater data indicates that Well 802 could potentially be completed within a perched groundwater layer, the unconfined groundwater unit, or both. The presence of perchlorate in the groundwater sample, however, indicates that the well is likely completed in the unconfined groundwater unit.

Review of the cumulative data indicates that the occurrence of perched groundwater and the presence of chemical constituents in the perched groundwater in the central portion of Area 49 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks.

5.4 POTENTIAL SOURCE SITE 33D

Potential Source Site 33D is a small sump at the northeastern corner of Building 49010 (Figure 5-2). Building 49010 was formerly a chemical sampling facility used for the temporary storage and quality assurance sampling of incoming chemicals. Fluids generated during the cleaning of sampling equipment were discharged to the sump.

5.4.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 33D

The scope and results of the RIs for VOCs conducted at Potential Source Site 33D are summarized below.

5.4.1.1 Previous Volatile Organic Compound Investigations

During the Stage 1 RI, four soil vapor samples were collected from the shallow layer (6 to 11 feet bgs) adjacent to the chemical sump at Site 33D (Figure 5-4). Due to probe refusal and saturated conditions at 20 feet bgs, no samples were collected from below the intermediate layer (12 to 20 feet bgs).

Shallow Soil Vapor Samples

- Total VOC concentrations detected in the four soil vapor samples ranged from 2.34 to 28 µg/L, with the highest concentration detected in the soil vapor sample (33D-SP01) collected on the eastern side of the building (Figure 5-4). TCE was the only VOC detected in three of the four shallow soil vapor samples.

- The soil vapor sample (33D-SP01) with the highest total VOC concentration of 28 mg/m^3 contained TCE at 20.3 mg/m^3, 1,1,1-TCA at 6.04 mg/m^3, and 1,1-DCE at mg/m^3.

5.4.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 33D presented in the approved Workplan indicated that additional soil vapor sampling was needed to evaluate the extent and concentrations of TCE and 1,1-DCE in the vadose zone to complete the RI/FS.

In accordance with the approved Workplan, nine soil vapor samples (excluding QA/QC samples) were collected at six locations (33D-SP05 through 33D-SP10) at Site 33D to assess the extent and concentrations of TCE and 1,1-DCE previously detected in Stage 1 RI soil vapor samples. Two soil vapor samples were collected from the very shallow layer (1 to 5 feet bgs), six were collected from the shallow layer (6 to 11 feet bgs), and four were collected from the intermediate layer (12 to 20 feet bgs). In addition to the soil vapor samples, surface emission flux chamber samples were collected at two locations at Site 33D. A comparison of proposed and actual soil vapor sampling activities at Site 33D and a summary of sample identifications and depths are provided on Table 5-18.

The analytical results for the soil vapor samples are included in Appendix F and summarized on Table 5-19 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 5-19 and below. Total VOC concentrations detected in the shallow and intermediate layers at Site 33D are shown in Figures 5-6 and 5-7, respectively. VOCs detected in the very shallow, shallow, and intermediate layers at Site 33D at concentrations above their respective SVSLs are shown in Figures 5-8, 5-9, and 5-10, respectively. The analytical results for the surface emission flux chamber samples are presented in Appendix N. Flux chamber sampling locations are shown in Figure 5-8.

The recent soil vapor samples were collected at approximately the same locations as those collected during the Stage 1 RI; therefore, comparisons can be made on how conditions have changed over time.

Very Shallow Soil Vapor Samples

- Three VOCs were detected in the two soil vapor samples collected from the very shallow layer (1 to 5 feet bgs) at one location (33D-SP05) at Site 33D.

- The three VOCs and their maximum detected concentrations were chloroform at 0.24 mg/m^3, TCE at 2.8 mg/m^3, and acetone at 0.1 mg/m^3 (Table 5-19 and Figure 5-8). The TCE concentrations detected in the two soil vapor samples were above its SVSL of 1.98 mg/m^3.

Shallow Soil Vapor Samples

- Nine VOCs were detected in the six soil vapor samples collected from the shallow layer (6 to 11 feet bgs) at six locations (33D-SP05 through 33D-SP10) at Site 33D.
- The nine VOCs and their maximum detected concentrations were chloroform (6 mg/m^3), TCE (4.1 mg/m^3), PCE (0.07 mg/m^3), benzene (0.02 mg/m^3), toluene (0.02 mg/m^3), hexane (0.02 mg/m^3), acetone (0.62 mg/m^3), MEK (0.06 mg/m^3), and ethanol (0.03 mg/m^3).
- TCE and chloroform were each detected in only one of the six soil vapor samples at concentrations above their respective SVSLs (Table 5-19 and Figure 5-9). TCE at 4.1 mg/m^3, above the SVSL of 1.98 mg/m^3, was detected in shallow soil vapor sample 33D-SP05. Chloroform at 6 mg/m^3, above the SVSL of 0.7 mg/m^3, was detected in shallow soil vapor sample 33D-SP09.

Intermediate Soil Vapor Samples

- Eighteen VOCs were detected in the four soil vapor samples collected from the intermediate layer (12 to 20 feet bgs) at four locations (33D-SP05, 33D-SP07, 33D-SP08, and 33D-SP09).
- The 18 VOCs and their maximum detected concentrations were dichloromethane (0.03 mg/m^3), chloroethane (estimated concentration of 0.3 mg/m^3), chloroform (6 mg/m^3), TCE (3.6 mg/m^3), benzene (0.29 mg/m^3), toluene (1.9 mg/m^3), ethylbenzene (0.35 mg/m^3), xylenes (1.63 mg/m^3), 1,3,5-TMB (0.11 mg/m^3), 1,2,4-TMB (0.23 mg/m^3), cyclohexane (0.03 mg/m^3), heptane (0.02 mg/m^3), chloromethane (estimated concentration of 0.05 mg/m^3), acetone (0.42 mg/m^3), carbon disulfide (0.08 mg/m^3), 2-propanol (0.07 mg/m^3), MEK (0.14 mg/m^3), and ethanol (0.14 mg/m^3).
- TCE and chloroform were the only VOCs detected in the intermediate soil vapor samples at concentrations above their SVSLs of 1.98 mg/m^3 and 0.7 mg/m^3, respectively (Table 5-19 and Figure 5-10). TCE at 3.6 mg/m^3 was detected in intermediate soil vapor sample 33D-SP05. TCE at 1.6 mg/m^3 and chloroform at 6 mg/m^3 were detected in intermediate soil vapor sample 33D-SP09.

- Ten VOCs detected in the intermediate soil vapor samples but not in the shallow or very shallow soil vapor samples were dichloromethane, ethylbenzene, xylenes, 1,2,4-TMB, 1,3,5-TMB, cyclohexane, heptane, chloromethane, carbon disulfide, and 2-propanol.

5.4.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 33D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site 33D are summarized below.

5.4.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, soil samples were collected at the surface and at 6 and 10 feet bgs from one location (33D-AH01) adjacent to the chemical sump (Figure 5-13). No sample was recovered at 15 feet bgs, and auger refusal was encountered at 17 feet bgs. The soil samples collected at the surface and 6 feet bgs were analyzed for perchlorate, SVOCs, and metals. Due to poor sample recovery, the sample collected at 10 feet bgs was only analyzed for SVOCs and metals. The analytical results for the samples are summarized below. The analytical results for metals, and their respective residential SSLs, are summarized on Table 5-20.

Semivolatile Organic Compounds

- Two SVOCs were detected in the samples collected from boring 33D-AH01. Di-n-butyl phthalate, a compound identified during the Stage 1 RI as a laboratory contaminant, was detected in the samples at concentrations up to 2.01 mg/kg. 1,1,2,2-Tetrachloroethane was detected at 0.9 mg/kg in the surface soil sample. The detected concentration of 1,1,2,2-tetrachloroethane is above the residential SSL of 0.41 mg/kg, but below the commercial SSL of 0.93 mg/kg.
- TICs reported as part of the SVOC analysis of the soil samples included hexadecanoic acid up to 6 mg/kg, unknown compounds up to 10 mg/kg, unknown oxygenated compounds up to 2 mg/kg, and unknown phthalates up to 2 mg/kg.

Metals

- Cadmium was the only metal detected in the Stage 1 RI soil samples collected at Site 33D at concentrations above background and its current residential and/or commercial SSL (Table 5-20 and Figure 5-13). It should be noted that the detected concentration of

cadmium (9.1 mg/kg) is below the USEPA residential PRG of 37 mg/kg used as the screening level in 2004.

Perchlorate

- No perchlorate was detected above the reporting limit of 4 mg/kg in the samples collected at 1 and 6 feet bgs.

5.4.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 33D presented in the approved Workplan indicated that additional data were need to confirm the presence of 1,1,2,2-tetrachloroethane and TICs in soil at the former location of Stage 1 RI boring 33D-AH01.

In accordance with the approved Workplan, subsurface soil samples were collected from one boring (33D-SB01) near the approximate former location of Stage 1 RI boring 33D-AH01 to assess the presence of SVOCs and TICs in soil (Figure 5-12). With one exception, soil samples were collected from boring 33D-SB01 at 1 foot bgs and at 5-foot intervals to first groundwater (40.5 feet bgs) and analyzed for SVOCs. Due to the presence of cobbles, no sample was collected from boring 33D-SB01 at 25 feet bgs. A comparison of proposed and actual subsurface soil sampling activities at Site 33D and a summary of sample identifications and sampling depths are provided on Table 5-5.

The results of the SVOC and SVOC TIC analysis of the samples collected from boring 33D-SB01 are included in Appendix F and summarized on Tables 5-21 and 5-7, respectively, and below.

Semivolatile Organic Compounds

- The common laboratory and sampling contaminants bis(2-ethylhexyl)-phthalate and diethyl phthalate were the only SVOCs detected in samples collected from boring 33D-SB01. Bis(2-ethylhexyl)phthalate was detected at an estimated concentration of 45 µg/kg in the sample collected at 10 feet bgs. Diethyl phthalate was detected at estimated concentrations ranging from 48 to 200 µg/kg in soil samples collected at 10, 15, 20, and 30 feet bgs. Although diethyl phthalate was detected at an estimated concentration of 200 µg/kg in the duplicate sample collected at 30 feet bgs, no diethyl phthalate was detected above the reporting limit of 14 µg/kg in the primary samples collected at that depth.

- No TICs were detected in the soil samples collected from 33D-SB01.

5.4.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 33D*

The scope and results of the RI for perched groundwater conducted at Site 33D are summarized below.

5.4.3.1 *Previous Perched Groundwater Investigations*

During the Stage 1 RI, a screening-level groundwater sample was collected from a boring approximately 100 feet downgradient of the chemical sump. Acetone, a common laboratory contaminant, was detected in the sample at a concentration of 30 µg/L.

5.4.3.2 *Recent Perched Groundwater Investigations*

No perched groundwater was encountered during the drilling of soil boring 33D-SB01 during the recent investigation. Unconfined groundwater was encountered in soil boring 33D-SB01 at 40.5 feet bgs.

5.4.4 *Discussion of Investigation Results – Site 33D*

The cumulative results of the investigations conducted at Site 33D are discussed below.

5.4.4.1 *Soil*

<u>*Volatile Organic Compounds*</u>

- The results of the recent soil vapor sampling conducted at Site 33D represent the most current site conditions.
- TCE and chloroform were the only VOCs detected in soil vapor samples collected at Site 33D at concentrations above their respective SVSLs. As shown in Figures 5-8, 5-9, and 5-10, the extent of TCE in soil vapor at concentrations above the SVSL of 0.64 mg/m^3 appears to be limited to within 50 feet of soil vapor sampling location 33D-SP05 directly east of Building 49010. The extent of chloroform above the SVSL is limited to the shallow and intermediate layer at one location (33D-SP09).

Semivolatile Organic Compounds

- The common laboratory and sampling contaminant di-n-butyl phthalate was detected in subsurface soil samples, and 1,1,2,2-tetrachloroethane was detected in a surface soil sample collected during the Stage 1 RI. TICs detected in the subsurface soil samples were hexadecanoic acid, unknown compounds, unknown oxygenated compounds, and unknown phthalates.
- The common laboratory and sampling contaminants bis(2-ethylhexyl)-phthalate and diethyl phthalate were the only SVOCs detected in soil samples collected during the recent investigation. No TICs were reported in the SVOC analysis.
- The results of the recent investigation indicate that the detection of 1,1,2,2-tetrachloroethane and TICs in soil at Site 33D during Stage 1 were not repeatable and therefore are not indicative of contamination.

Metals

- No metals were detected in the Stage 1 RI soil samples at concentrations above their respective residential and commercial soil PRGs being used in 2004. Cadmium at 9.1 mg/kg, above the 2005 residential and commercial CHHSLs was detected in one subsurface soil sample collected at a depth of 6 feet bgs from boring 33D-AH01. However, because the cadmium concentration was below the SSL proposed in the approved Workplan, no additional sampling for metals was conducted during the recent investigation.

Perchlorate

- No perchlorate was detected above 4 mg/kg in the samples collected at 1 and 6 feet bgs during the Stage 1 RI and accordingly, no sampling for perchlorate was proposed in the approved Workplan.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site 33D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.4.4.2 *Perched Groundwater*

No perched groundwater is present at Site 33D.

5.5 POTENTIAL SOURCE SITE 36D

Potential Source Site 36D consists of an abandoned underground chemical waste tank approximately 40 feet north of Building 49015 and a degreaser sump located within Building 49015 (Figure 5-2). Building 49015 was formerly a tactical process facility and an inert chamber processing and storage facility. Small motor liners also may have been handled at the building, and chlorinated solvents were used to clean equipment. The waste tank was installed in about 1962 and the building was used for 20 to 25 years for Minuteman processing. One drain line discharged to the tank.

5.5.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 36D

The scope and results of the RIs for VOCs conducted at Potential Source Site 36D are summarized below.

5.5.1.1 *Previous Volatile Organic Compound Investigations*

During the Stage 1 RI, 13 shallow (6 to 11 feet bgs), one intermediate (12 to 20 feet bgs), and one deep (30 feet bgs) soil vapor samples were collected at Site 36D. The soil vapor samples were collected around the abandoned chemical waste tank, the parking area north of the degreaser sump, and near the septic tank and leach lines (Figures 5-4 and 5-5). The analytical results for the soil vapor samples are summarized below.

Shallow Soil Vapor Samples

- Total VOC concentrations in the shallow layer ranged from nondetect to 49 mg/m^3, with the highest concentration detected in the shallow layer approximately 40 feet north of the degreaser sump. A lower total VOC concentration (13.1 mg/m^3) was, however, detected in a sample collected about 15 feet north of the degreaser sump. Evaluation of the data during preparation of the Workplan indicated that the total VOC concentration of 49 mg/m^3 likely represented the southern extent of the VOC plume associated with Site 38D.
- The maximum total VOC concentration detected in the sample collected around the former chemical waste tank was 6.02 mg/m^3. TCE was the primary VOC detected in the shallow soil vapor samples.
- VOCs detected in the shallow soil vapor samples and their maximum concentrations included TCE up to 46.9 mg/m^3, 1,1,1-TCA up to

4.93 mg/m^3, PCE up to 2.06 mg/m^3, light hydrocarbons up to 9.56 mg/m^3, and dichloromethane up to 3.46 mg/m^3.

Intermediate and Deep Soil Vapor Samples

Intermediate (12 to 20 feet bgs) and deep (30 feet bgs) soil vapor samples were collected at the location where the highest total VOC concentration (49 mg/m^3) was detected in the shallow layer. TCE was detected at 64.2 mg/m^3 in the intermediate layer and at 23 mg/m^3 in the deep layer (Figure 5-5).

5.5.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 36D presented in the approved Workplan indicated that additional soil vapor sampling was needed to evaluate the extent and concentrations of TCE in the vadose zone, particularly in the vicinity of the abandoned chemical waste tank, and complete the RI/FS.

In accordance with the approved Workplan, 12 soil vapor samples (excluding QA/QC samples) were collected at 7 locations (36D-SP15 through 36D-SP21) during the recent VOC investigation at Site 36D. Additionally, surface emission isolation flux chamber samples were collected at two locations at Site 36D. A comparison of proposed and actual soil vapor sampling activities at Site 36D and a summary of sample identifications and depths is provided on Table 5-18. The recent soil vapor samples were collected at approximately the same locations as those collected during the Stage 1 RI. The analytical results for the recent soil vapor samples therefore represent current site conditions and supersede the results of the Stage 1 RI.

Because the analytical results for recent soil vapor samples at three locations (36D-SP18, 36D-SP20, and 36D-SP21) north of Building 49015 were determined to be more representative of VOCs in soil vapor originating from Site 38D than from Site 36D, the results for those samples were included in the VOC discussion for Sites 32D, 34D, 35D, and 38D (Central Area 49). The analytical results for the soil vapor samples collected around the abandoned underground chemical waste tank and the former degreaser during the recent investigation are included in Appendix F and summarized below. The analytical results for the surface emission flux chamber samples are presented in Appendix N. Flux chamber sampling locations at Site 36D are shown in Figure 5-8.

Abandoned Underground Chemical Waste Tank

Soil vapor samples were collected at two locations (36D-SP15 and 36D-SP16) near the abandoned chemical waste tank (Figures 5-6 and 5-7). The analytical results of the recent soil vapor samples collected around the abandoned underground chemical waste tank are summarized on Table 5-22 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 5-22 and below. Total VOC concentrations detected in the shallow and intermediate layers are shown in Figures 5-6 and 5-7, respectively. VOCs detected in the very shallow, shallow, and intermediate layers at concentrations above their respective SVSLs are shown in Figures 5-8, 5-9, and 5-10, respectively.

Shallow Soil Vapor Samples

- Three VOCs were detected in the shallow (6 to 11 feet bgs) soil vapor sample (36D-SP16) collected adjacent to the abandoned chemical waste tank.
- The three VOCs and their maximum detected concentrations were Freon 11 at 0.28 mg/m^3, TCE at 0.98 mg/m^3, and PCE at 0.65 mg/m^3. The detected concentration of PCE is slightly above its SVSL of 0.64 mg/m^3.

Intermediate Soil Vapor Samples

- Four VOCs were detected in the two intermediate (12 to 20 feet bgs) soil vapor samples (36D-SP15 and 36D-SP16) collected adjacent to and east of the abandoned chemical waste tank. The four VOCs and their maximum detected concentrations were TCE at 0.05 mg/m^3, toluene at 0.06 mg/m^3, xylenes at 0.04 mg/m^3, and acetone at 0.23 mg/m^3.
- The concentrations of TCE, toluene, and xylenes detected in the intermediate soil vapor samples are below their respective SVSLs.

Former Degreaser Sump

Soil vapor samples were collected at one location (36D-SP17) near the former degreaser sump and one location (36D-SP19) north of Buildings 49015 and 49016 (Figure 5-6). The analytical results for the recent soil vapor samples are summarized on Table 5-22 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 5-22 and below. Total VOC concentrations detected in the shallow and intermediate layers are shown in Figures 5-6 and 5-7, respectively. VOCs detected in the very shallow, shallow, and intermediate layers at

concentrations above their respective SVSLs are shown in Figures 5-8, 5-9, and 5-10, respectively.

Very Shallow Soil Vapor Samples

- Three VOCs were detected in the very shallow (1 to 5 feet bgs) soil vapor sample (36D-SP17) collected north of Building 49015 and close to the former degreaser sump (Figure 5-8). The three VOCs and their maximum detected concentrations were TCE at 0.38 mg/m^3, benzene at 0.13 mg/m^3, and xylenes at 0.12 mg/m^3.
- The concentrations of TCE, benzene, and xylenes detected in the very shallow soil vapor sample are below their respective SVSLs.

Shallow Soil Vapor Samples

- Five VOCs were detected in the shallow (6 to 11 feet bgs) soil vapor sample (36D-SP17) collected close to the former degreaser sump (Figure 5-9). The five VOCs and their maximum detected concentrations were TCE at 3.2 mg/m^3, PCE at 0.2 mg/m^3, toluene at 0.18 mg/m^3, xylenes at 0.19 mg/m^3, and 1,2,4-TMB at 0.12 mg/m^3.
- The concentration of TCE at 3.2 mg/m^3 detected in the shallow soil vapor sample is above the SVSL of 1.98 mg/m^3.

Intermediate Soil Vapor Samples

- No VOCs were detected above their respective laboratory reporting limits in the intermediate (12 to 20 feet bgs) soil vapor sample (36D-SP17) collected close to the former degreaser sump (Figure 5-10).
- Nine VOCs were detected in the intermediate (12 to 20 feet bgs) soil vapor sample (36D-SP19) collected north of Buildings 49015 and 49016. The nine VOCs and their maximum detected concentrations were chloroform at 2.5 mg/m^3, TCE at 0.7 mg/m^3, PCE at 0.56 mg/m^3, benzene at 0.02 mg/m^3, toluene at 0.02 mg/m^3, hexane at 0.03 mg/m^3, bromodichloromethane at 0.04 mg/m^3, and acetone at 0.07 mg/m^3.
- The concentration of chloroform (2.5 mg/m^3) detected in the intermediate soil vapor sample is above its SVSL of 0.7 mg/m^3.

5.5.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 36D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site 36D are summarized below.

5.5.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, surface and near-surface soil samples were collected adjacent to the degreaser sump (36D-SNS01), and subsurface soil samples were collected at 1, 5, and 15 feet bgs from a boring (36D-AH1B) adjacent to the abandoned chemical waste tank (Figures 5-12 and 5-13). Groundwater was encountered in the boring at 20 feet bgs. The surface and near-surface samples were analyzed for metals and SVOCs. Samples from the boring were analyzed for SVOCs, metals, and oil and grease. The analytical results for the samples are summarized below. The analytical results for metals, and their respective residential SSLs, are summarized on Table 5-20.

Abandoned Underground Chemical Waste Tank

Semivolatile Organic Compounds

- Di-n-butyl phthalate, a compound identified during the Stage 1 RI as a laboratory contaminant, was detected in all but one of the surface, near-surface, and subsurface soil samples at concentrations ranging up to 1.91 mg/kg.
- TICs reported as part of the SVOC analysis of the subsurface soil samples collected from the boring (36D-AH1B) adjacent to the abandoned chemical waste tank included hexadecanoic acid up to 4 mg/kg, unknown compounds up to 6.8 mg/kg, and unknown phthalates up to 2 mg/kg.

Metals

No metals were detected above background and their respective residential or commercial SSLs in the previous subsurface soil samples collected adjacent to the abandoned chemical waste tanks (Figure 5-13).

Total Petroleum Hydrocarbons

No oil and grease was detected above the laboratory reporting limit of 50 mg/kg in previous soil samples collected from the boring adjacent to the chemical waste tank (Figure 5-11).

Former Degreaser Sump

Semivolatile Organic Compounds

- Di-n-butyl phthalate, a compound identified during the Stage 1 RI as a laboratory contaminant, was detected in all but one of the surface, near-surface, and subsurface soil samples at concentrations ranging up to 1.91 mg/kg.
- TICs reported as part of the SVOC analysis of the surface and near-surface soil samples collected adjacent to the degreaser sump (36D-SNS01) included hexadecanoic acid up to 10 mg/kg, unknown compounds up to 4.8 mg/kg, and unknown phthalates up to 2 mg/kg.

Metals

Thallium was the only metal detected above its 2002 residential or commercial SSL in the surface and near-surface soil samples collected at location 36D-SNS01 adjacent to the degreaser sump. Thallium was detected at 5.55 mg/kg, slightly above the 2002 residential SSL of 5.2 mg/kg, in the near-surface (3 feet bgs) soil sample collected at location 36D-SNS01 adjacent to the degreaser sump (Table 5-20 and Figure 5-13).

5.5.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 36D presented in the approved Workplan indicated that the following data were needed to complete the RI/FS:

- Confirm the presence of TICs in soil; and
- Confirm the presence of thallium in near-surface soil at Stage 1 RI sample location 36D-SNS01 adjacent to the degreaser sump.

Recent soil sampling conducted near the abandoned chemical waste tank and the former degreaser is summarized below. A comparison of proposed and actual subsurface soil sampling activities at Site 36D and a summary of sample identifications and sampling depths are provided on Table 5-5.

Abandoned Underground Chemical Waste Tank

In accordance with the approved Workplan, soil samples were collected from one boring (36D-SB01) adjacent to the abandoned chemical waste tank at 2.5 feet bgs and at 5-foot intervals to first groundwater and

analyzed for SVOCs. Unconfined groundwater was encountered at 41 feet bgs. The results of the SVOC and SVOC TIC analysis of the samples collected from boring 36D-SB01 are included in Appendix F and summarized on Tables 5-23 and 5-7, respectively, and below.

Semivolatile Organic Compounds

- SVOCs were detected at concentrations less than their respective residential SSLs in 3 of the 10 soil samples collected from boring 36D-SB01.
- Chrysene estimated at 150 µg/kg, fluoranthene estimated at 160 µg/kg, pyrene estimated at 180 µg/kg, bis(2-ethylhexyl)phthalate estimated at 180 µg/kg, and diethyl phthalate estimated at 260 µg/kg were detected in the soil sample collected at 2.5 feet bgs.
- Benzoic acid estimated at 52 µg/kg was detected in the soil sample collected at 5 feet bgs.
- Benzoic acid and bis(2-ethylhexyl)phthalate estimated at 86 and 85 µg/kg, respectively, were detected in the primary sample collected at 40 feet bgs. However, those compounds were not detected in the duplicate soil sample collected at 40 feet bgs.
- SVOC TICs were detected in only 1 of the 10 soil samples collected from 36D-SB01. Unknown alkanes were detected at an estimated concentration of 2,000 µg/kg in the soil sample collected at 2.5 feet bgs.

Former Degreaser Sump

In accordance with the approved Workplan, soil samples were collected at 1, 3, and 6 feet bgs and at 5-foot intervals to first groundwater from one boring (36D-SB02) near the former degreaser sump. Groundwater was encountered at 43 feet bgs. All soil samples were analyzed for SVOCs and the samples collected at 0, 3, and 6 feet bgs were analyzed for thallium.

The results of the SVOC, SVOC TIC, and thallium analyses of the samples collected from boring 36D-SB02 are included in Appendix F and summarized on Tables 5-23, 5-7, and 5-20, respectively, and below.

Semivolatile Organic Compounds

- SVOCs were detected in only 2 of the 11 soil samples collected from boring 36D-SB02 at concentrations below their respective residential SSLs.

- Bis(2-ethylhexyl)phthalate was detected at an estimated concentration of 35 µg/kg in the soil sample collected at 6 feet bgs.
- Benzoic acid and bis(2-ethylhexyl)phthalate estimated at 100 µg/kg and 150 µg/kg, respectively, were detected in the soil sample collected at 40 feet bgs. However, those two compounds were not detected in the duplicate soil sample collected at 40 feet bgs.
- With the exception of sulfur, no TICs were detected in any of the soil samples collected from boring 36D-SB02. Sulfur was detected at an estimated concentration of 500 µg/kg in the soil sample collected from boring 36D-SB02 at 3 feet bgs.

Thallium

- Thallium was detected at 0.14 mg/kg in the surface soil sample collected from boring 36D-SB02. No thallium was detected above the reporting limit in the samples collected at 3 and 6 feet bgs. The detected concentration of thallium in the surface soil sample is well below the residential SSL of 0.52 mg/kg and commercial SSL of 63 mg/kg.
- As discussed in Section 3.3.2.2, statistical comparison of the metals data for sites within the PGOU with the 2007 Background dataset indicated that thallium concentrations in the soil are not statistically different than background.

5.5.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 36D*

The scope and results of the RIs for perched groundwater conducted at Site 36D are summarized below.

5.5.3.1 *Previous Perched Groundwater Investigations*

One perched groundwater well (858) and one unconfined groundwater well (804) exist at Site 36D. Perched groundwater Well 858 is adjacent to the abandoned chemical waste tank and unconfined groundwater Well 804 is adjacent to the degreaser sump (Figure 5-2).

During the Stage 1 RI, perched groundwater Well 858 was dry in 1991 and 1992, but was sampled in 1993 and analyzed for VOCs. Unconfined groundwater Well 804 was dry, but a screening-level groundwater sample (36D-HP01) was collected from the unconfined groundwater beneath the degreaser sump and analyzed for VOCs. No perched groundwater was

encountered in the boring drilled to collect the screening-level groundwater sample. The analytical results for the groundwater samples are summarized below.

- TCE at 96 µg/L and cis/trans-1,2-DCE at 9 µg/L were detected in the perched groundwater sample collected from Well 858.

5.5.3.2 Recent Perched Groundwater Investigations

Evaluation of the existing data for Site 36D presented in the approved Workplan indicated that data were needed to assess the presence of perched groundwater and the presence of VOCs and SVOC TICs in perched groundwater.

In accordance with the approved Workplan, Well 804 was monitored for the presence of perched groundwater. Well 804 was dry at a total depth of 30.8 feet. No perched groundwater was encountered during the drilling of borings 36D-SB01 and 36D-SB02; therefore, no screening-level groundwater samples were collected.

5.5.4 Discussion of Investigation Results – Site 36D

The cumulative results of the investigations conducted at Site 36D are discussed below.

5.5.4.1 Soil – Abandoned Underground Chemical Waste Tank

<u>*Volatile Organic Compounds*</u>

- The results of the recent soil vapor sampling conducted at Site 36D represent the most current site conditions and therefore supersede the results of the Stage 1 RI.
- VOCs detected in soil vapor samples collected adjacent to the abandoned chemical waste tank, and their maximum concentrations, were TCE (0.98 mg/m^3), PCE (0.65 mg/m^3), Freon 11 (0.28 mg/m^3), toluene (0.06 mg/m^3), xylenes (0.04 mg/m^3), and acetone (0.23 mg/m^3).
- PCE at a concentration of 0.65 mg/m^3, slightly above its SVSL of 0.64 mg/m^3, was detected in the soil vapor sample (36D-SP16) collected from the shallow layer. As shown in Figures 5-9 and 5-10, PCE above its SVSL was not detected in soil vapor samples (36D-SP17 and 38D-SP28) collected from the shallow layer within 100 feet of

location 36D-SP16 nor in the soil vapor samples collected from the intermediate layer at those locations.

Semivolatile Organic Compounds

- The laboratory contaminant di-n-butyl phthalate was detected in surface, near-surface, and subsurface soil samples collected adjacent to the abandoned chemical waste tank at Site 36D during the Stage 1 RI. TICs reported in the samples included hexadecanoic acid, unknown compounds, and unknown phthalates.
- SVOCs and TICs detected in subsurface soil samples collected adjacent to the abandoned chemical waste tank during the recent investigation were as follows:
  - Chrysene, fluoranthene, pyrene, bis(2-ethylhexyl)phthalate, and diethyl phthalate were detected at concentrations less than their respective residential SSLs in the soil sample collected at 2.5 feet bgs. TICs reported in the analysis of that same soil sample were unknown alkanes.
  - Benzoic acid was detected at a concentration less than its residential SSL in the soil sample collected at 5 feet bgs.
  - Benzoic acid and bis(2-ethylhexyl)phthalate were detected in the primary soil sample collected at 40 feet bgs, but not in the duplicate sample.

Metals

- No metals were detected above their respective residential or commercial SSLs in subsurface soil samples collected adjacent to the abandoned chemical waste tank during the previous (Stage 1 RI) investigation. Therefore, no sampling for metals was proposed in the approved Workplan.

Total Petroleum Hydrocarbons

- No oil and grease was detected in subsurface soil samples collected adjacent to the abandoned chemical waste tank during the previous (Stage 1 RI) investigation. Therefore, no sampling for TPH was proposed in the approved Workplan.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at the abandoned chemical waste tanks at Site 36D have been sufficiently characterized to allow the

evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.5.4.2 *Soil – Former Degreaser Sump*

Volatile Organic Compounds

- The results of the recent soil vapor sampling conducted at Site 36D represent the most current site conditions and therefore supersede the results of the Stage 1 RI.
- VOCs detected in soil vapor samples collected near the former degreaser sump and a location north of Building 49015, and their maximum concentrations, were TCE (3.2 mg/m^3), PCE (0.56 mg/m^3), benzene (0.13 mg/m^3), toluene (0.1 mg/m^3), xylenes (0.19 mg/m^3), chloroform (2.5 mg/m^3), hexane (0.03 mg/m^3), bromodichloromethane (0.04 mg/m^3), and acetone (0.07 mg/m^3).
- TCE at 3.2 mg/m^3 detected in the soil vapor sample (36D-SP17) collected from the shallow layer near the former degreaser sump is above its SVSL of 1.98 mg/m^3. As shown in Figures 5-8 and 5-10, no TCE was detected in the intermediate soil vapor sample collected at location 36D-SP17, and the concentration of TCE detected in the very shallow soil vapor sample at location 36D-SP17 was well below the SVSL. As shown in Figure 5-9, no TCE at concentrations above its SVSL was detected in the soil vapor sample (36D-SP16) collected from the shallow layer 100 feet west of 36D-SP17.

Semivolatile Organic Compounds

- The laboratory contaminant di-n-butyl phthalate was detected in surface and near-surface soil samples collected adjacent to the degreaser sump at Site 36D during the Stage 1 RI. TICs reported in samples included hexadecanoic acid, unknown compounds, and unknown phthalates.
- SVOCs and TICs detected in near-surface and subsurface soil samples collected adjacent to the former degreaser sump during the recent investigation were as follows:
  - Bis(2-ethylhexyl)phthalate was detected in the soil sample collected at 6 feet bgs.
  - Benzoic acid and bis(2-ethylhexyl)phthalate were detected in a primary soil sample collected at 40 feet bgs, but not in the duplicate sample.

- Sulfur was the only TIC reported in the SVOC analysis of the soil samples collected close to the former degreaser sumps. Sulfur was reported in the sample collected at 3 feet bgs.

<u>Metals</u>

- Thallium was detected slightly above the 2002 residential SSL of 5.2 mg/kg in a near-surface soil sample collected near the former degreaser sump during the Stage 1 RI.
- Thallium was detected in only one of the three recent soil samples collected at 0, 3, and 6 feet bgs. The concentration of thallium (0.14 mg/kg) detected in the sample collected at 3 feet bgs is well below the residential and commercial SSLs of 5.2 mg/kg and 63 mg/kg, respectively. Additionally, as discussed in Section 3.3.2.2, concentrations of thallium in soil within the PGOU are not statistically different than background.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil near the former degreaser sump at Site 36D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.5.4.3 Perched Groundwater

No perched groundwater is present at Site 36D.

5.6 POTENTIAL SOURCE SITE 37D

Potential Source Site 37D consists of an inactive waste tank, sump, and septic tank at the western end of Building 49016 (Figure 5-2). Building 49016 served as a receiving, inspection, calibration, and repair lab; and a receiving, inspection, and non-destructive testing facility. The waste tank may have received solvents, oils, emulsifier, and other chemical wastes. TCE, Zyglo 22A, emulsifier, oil, and WD-40 also may have been used.

5.6.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 37D

The scope and results of the RIs for VOCs conducted at Potential Source Site 37D are summarized below.

5.6.1.1 *Previous Volatile Organic Compound Investigations*

During the Stage 1 RI, six soil vapor samples were collected from the shallow layer (6 to 11 feet bgs) around the abandoned chemical waste tank, sump, and septic tank. Attempts to collect soil vapor samples below 10 feet bgs were unsuccessful because of probe refusal and wet clay between 15 and 16.5 feet bgs. The analytical results for the shallow soil vapor samples are summarized below.

Shallow Soil Vapor Samples

- No VOCs were detected above laboratory reporting limits in shallow soil vapor samples collected next to the inactive waste tank and septic tank.
- A trace of TCE (less than 1 mg/m^3) was detected in two shallow soil vapor samples collected adjacent to the sump.

5.6.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 37D indicated that additional soil vapor sampling was needed to assess the potential presence of VOCs at concentrations below the laboratory reporting limits used during the Stage 1 RI.

In accordance with the approved Workplan, eight soil vapor samples were collected at six locations (37D-SP08 through 37D-SP13) at Site 37D. One soil vapor sample was collected from the very shallow layer (1 to 5 feet bgs), six were collected from the shallow layer (6 to 11 feet bgs), and one was collected from the intermediate layer (12 to 20 feet bgs). Additionally, surface emission isolation flux chamber samples were collected at two locations at Site 37D. A comparison of proposed and actual soil vapor sampling activities at Site 37D and a summary of sample identifications and depths are provided on Table 5-18. The recent soil vapor samples were collected at approximately the same locations as those collected during the Stage 1 RI. The analytical results for the recent soil vapor samples represent current site conditions and can be used to evaluate how site conditions have changed over time.

The analytical results for the recent soil vapor samples are included in Appendix F and summarized on Table 5-22 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 5-22 and below. Total VOC concentrations detected in the recent shallow and intermediate soil vapor samples collected at Site 37D in 2003 are shown in Figures 5-6

and 5-7, respectively. VOCs detected in the recent very shallow, shallow, and intermediate soil vapor samples collected at Site 37D at concentrations above their respective SVSLs are shown in Figures 5-8, 5-9, and 5-10, respectively. The analytical results for the flux chamber samples collected at Site 37D are presented in Appendix N. Flux chamber sampling locations are shown in Figure 5-8.

Very Shallow Layer

- 1,1,1-TCA at 0.36 mg/m^3 and TCE at 0.11 mg/m^3 were the only VOCs detected in the soil vapor sample (37D-SP08) collected from the very shallow layer (Figure 5-8).
- The concentrations for 1,1,1-TCA and TCE detected in the very shallow soil vapor sample are below their SVSLs of 4,600 mg/m^3 and 1.98 mg/m^3, respectively.

Shallow Layer

- Sixteen VOCs were detected in the six soil vapor samples collected from the shallow (6 to 11 feet bgs) layer at Site 37D.
- Thirteen of the sixteen VOCs were detected in only one (37D-SP08) of the six shallow soil vapor samples. The 13 VOCs detected only in soil vapor sample 37D-SP08 and their maximum detected concentrations were 1,1-DCA (0.85 mg/m^3), 1,1-DCE (0.06 mg/m^3), cis-1,2-DCE (0.44 mg/m^3), chloroform (0.11 mg/m^3), 1,1,1-TCA (2.4 mg/m^3), benzene (0.07 mg/m^3), toluene (0.05 mg/m^3), styrene (estimated concentration of 0.05 mg/m^3), hexane (0.03 mg/m^3), heptane (0.03 mg/m^3), carbon disulfide (0.17 mg/m^3), methyl ethyl ketone (0.12 mg/m^3), and ethanol (0.05 mg/m^3).
- The two VOCs detected in the shallow soil vapor samples at locations other than 37D-SP08, and their maximum detected concentrations were TCE (0.59 mg/m^3) and acetone (0.55 mg/m^3).
- Concentrations of all VOCs detected in the shallow soil vapor samples collected at Site 37D were below their respective SVSLs (Figure 5-9).

Intermediate Layer

- Seven VOCs were detected in the intermediate soil vapor sample (37D-SP08) collected at Site 37D at a total concentration of 2.25 mg/m^3 (Figure 5-7).
- The seven VOCs and their maximum detected concentrations were 1,1,1-TCA (0.17 mg/m^3), TCE (0.14 mg/m^3), benzene (0.14 mg/m^3),

toluene (0.8 mg/m^3), ethylbenzene (0.15 mg/m^3), xylenes (0.73 mg/m^3), and 1,2,4-TMB (0.12 mg/m^3).

- The detected concentrations for all VOCs were below their respective SVSLs (Figure 5-10).

5.6.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 37D*

The scope and results of the RI for non-VOCs conducted at Potential Source Site 37D are summarized below.

5.6.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, one boring was drilled next to the sump west of Building 49016 (Figures 5-11 through 5-14). Analytical soil samples were collected at 10, 15, 25, 30, 35, and 40 feet bgs. Groundwater was encountered at 45 feet bgs. Due to the presence of cobbles, no analytical samples were collected at depths less than 10 feet bgs or at 20 feet bgs. With the exception of the samples collected at 10 and 15 feet bgs, all samples were analyzed for SVOCs, metals (including mercury), and oil and grease. Due to poor sample recovery, samples collected at 10 and 15 feet bgs were not analyzed for SVOCs. The analytical results for the samples are summarized below.

Semivolatile Organic Compounds

- No SVOCs other than the laboratory contaminant di-n-butyl phthalate (up to 1.85 mg/kg) were detected in the subsurface soil samples.
- TICs reported as part of the SVOC analysis of the subsurface soil samples included hexadecanoic acid up to 5 mg/kg, unknown compounds up to 7 mg/kg, and unknown phthalates up to 2 mg/kg.

Metals

- No metals were detected above background and their respective residential and commercial SSLs in the subsurface soil samples (Table 5-20).

Total Petroleum Hydrocarbons

- No oil and grease was detected above the laboratory reporting limit in the subsurface soil samples.

5.6.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 37D presented in the approved Workplan indicated that the following data were needed to complete the RI/FS:

- Assess the presence of hydrocarbons in soil; and
- Confirm the presence of TICs identified in the SVOC analysis of soil samples from Stage 1 RI boring 37D-AH01.

In accordance with the approved Workplan, subsurface soil samples were collected from one boring (37D-SB01) at the approximate former location of Stage 1 RI boring 37D-AH01 to assess the presence of TPH and SVOCs (Figures 5-11 and 5-12). Soil samples were collected at 2.5 and 6 feet bgs and at 5-foot intervals to first groundwater (42.5 feet bgs). With the exception of the sample collected at 2.5 feet bgs, all soil samples were analyzed for SVOCs and TPH-D. The sample collected at 2.5 feet bgs was analyzed only for TPH-D. A comparison of proposed and actual subsurface soil sampling activities at Site 37D and a summary of sample identifications and sampling depths is provided on Table 5-5.

The results of the SVOC, SVOC TIC, and TPH-D analysis of the samples collected from boring 37D-SB01 are included in Appendix F and are summarized on Tables 5-23, 5-7, and 5-24, respectively, and below.

Semivolatile Organic Compounds

- Two common analytical and sampling contaminants, bis(2-ethylhexyl)-phthalate and diethyl phthalate, were the only SVOCs detected in the soil samples collected from boring 37D-SB01. Bis(2-ethylhexyl)-phthalate and diethyl phthalate were detected at estimated concentrations of 47 and 66 µg/kg, respectively, in the duplicate soil sample collected at 6 feet bgs. However, no bis(2-ethylhexyl)phthalate or diethyl phthalate were detected in the primary soil sample collected at that depth.
- No TICs were detected in any of the soil samples collected from boring 37D-SB01.

Total Petroleum Hydrocarbons

- TPH-D was detected in only 4 of the 10 soil samples collected from boring 37D-SB01. TPH-D was detected at 24 mg/kg, 6.2 mg/kg, 5.7 mg/kg, and 18 mg/kg in the soil samples collected at 2.5, 6, 15, and

20 feet bgs, respectively (Figure 5-11). The detected concentrations are well below the SSL of 100 mg/kg for extractable TPH.

5.6.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 37D*

The scope and results of the RIs for perched groundwater conducted at Site 37D are summarized below.

5.6.3.1 *Previous Perched Groundwater Investigations*

No perched groundwater wells exist at Site 37D and no perched groundwater was encountered in the boring (37D-AH01) drilled during the Stage 1 RI.

5.6.3.2 *Recent Perched Groundwater Investigations*

In accordance with the approved Workplan, Well 803 was monitored for the presence of perched groundwater. Well 803, with a total depth of 30 feet bgs, was dry.

5.6.4 *Discussion of Investigation Results – Site 37D*

The cumulative results of the investigations conducted at Site 37D are discussed below.

5.6.4.1 *Soils*

<u>*Volatile Organic Compounds*</u>

- The results of the recent soil vapor sampling conducted at Site 37D represent the most current site conditions and therefore supersede the results of the Stage 1 RI.
- VOCs detected in the recent soil vapor samples collected at Site 37D, and their maximum concentrations, were TCE (0.59 mg/m^3), 1,1-DCA (0.85 mg/m^3), 1,1-DCE (0.06 mg/m^3), cis-1,2-DCE (0.44 mg/m^3), chloroform (0.11 mg/m^3), 1,1,1-TCA (2.4 mg/m^3), benzene (0.14 mg/m^3), toluene (0.8 mg/m^3), ethylbenzene (0.15 mg/m^3), xylenes (0.73 mg/m^3), 1,2,4-TMB (0.12 mg/m^3), styrene (estimated at 0.05 mg/m^3), hexane (0.03 mg/m^3), heptane (0.03 mg/m^3), carbon disulfide (0.17 mg/m^3), MEK (0.12 mg/m^3), acetone (0.55 mg/m^3), and ethanol (0.05 mg/m^3).

- Concentrations of all VOCs detected in the soil vapor samples collected at Site 37D are below their respective SVSLs.

Semivolatile Organic Compounds

- The common laboratory contaminant di-n-butyl phthalate was detected in subsurface soil samples collected during the Stage 1 RI. TICs reported in the samples were hexadecanoic acid, unknown compounds, and unknown phthalates.
- The common analytical and sampling contaminants bis(2-ethylhexyl)-phthalate and diethyl phthalate were detected in a recent primary sample collected at 6 feet bgs, but not in the duplicate sample.
- No TICs were reported in the SVOC analysis of the samples.

Metals

- No metals were detected at concentrations above background and their respective residential or commercial SSLs in the subsurface soil samples collected at Site 37D during the previous (Stage 1 RI) investigation. Therefore, no sampling for metals was proposed in the approved Workplan.

Total Petroleum Hydrocarbons

- No oil and grease was detected in subsurface soil samples collected during previous investigations.
- TPH-D ranging from 5.7 to 24 mg/kg was detected in recent soil samples collected at 2.5, 6, 15, and 20 feet bgs. The detected concentrations are well below the SSL of 100 mg/kg for extractable TPH.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site 37D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.6.4.2 *Perched Groundwater*

No perched groundwater is present at Site 37D.

5.7 POTENTIAL SOURCE SITE 39D

Potential Source Site 39D is a former drum storage area south of Building 49007 (Figure 5-2). The storage area is currently an approximately 30-by-40-foot asphalt pad surrounded by a fence. A drainage swale exists between the storage area and the asphalt surfaces to the north and west. Building 49007, located directly north of the storage area, is a warehouse historically used for the storage of bulk chemicals, possibly including propellant and liner materials. Operations included the temporary storage of incoming drums of chemicals and the segregation of incompatible compounds.

5.7.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site 39D

The scope and results of the RI for VOCs conducted at Potential Source Site 39D are summarized below.

5.7.1.1 *Previous Volatile Organic Compound Investigations*

During the Stage 1 RI, two soil vapor samples were collected from the shallow layer (6 to 11 feet bgs) beneath the drainage ditch along the perimeter of the former drum storage area and one was collected adjacent to the septic tank (Figure 5-4). Additionally, one soil vapor sample was collected from the intermediate layer (12 to 20 feet bgs) and deep layer (30 feet bgs) beneath the drainage ditch (Figure 5-5). Soil vapor samples were not collected from within the fenced area due to vehicle access restrictions. The results of the soil vapor sampling at Site 39D are summarized below.

Shallow Soil Vapor Samples

- TCE was detected at 0.81 and 0.96 mg/m^3 in the shallow layer beneath the drainage ditch (Figure 5-4).
- No VOCs were detected in the shallow layer adjacent to the septic tank.

Intermediate Soil Vapor Samples

- Freon 113 at 6.8 mg/m^3 and PCE at 5.5 mg/m^3 were detected in the intermediate layer and toluene at 0.5 mg/m^3 was detected in the deep layer (Figure 5-5).

5.7.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 39D presented in the approved Workplan indicated that additional soil vapor sampling was needed to evaluate the extent and concentrations of PCE in the vadose zone at Site 39D and complete the RI/FS.

In accordance with the approved Workplan, five soil vapor samples (excluding QA/QC samples) were collected at four locations (39D-SP03, 39D-SP04, 39D-SP05, and 49ST07-SP02) around the former drum storage area and septic tank and leach field east of Building 49007. One soil vapor sample (39D-SP05) was collected from the very shallow layer (1 to 5 feet bgs), one (49ST07-SP02) from the shallow layer (6 to 11 feet bgs), and three (39D-SP03, 39D-SP04, and 39D-SP05) from the intermediate layer (12 to 20 feet bgs). Additionally, surface emission isolation flux chamber samples were collected at two locations at Site 39D. A comparison of proposed and actual soil vapor sampling activities at Site 39D and a summary of sample identifications and depths is provided on Table 5-18.

The analytical results for the soil vapor samples are included in Appendix F and are summarized on Table 5-25 and below. A comparison of the soil vapor results to SVSLs is also provided on Table 5-25 and below. Total VOC concentrations detected in the recent shallow and intermediate soil vapor samples collected at Site 39D are shown in Figures 5-6 and 5-7, respectively. VOCs detected in the recent very shallow, shallow, and intermediate soil vapor samples collected at Site 39D at concentrations above their respective SVSLs are shown in Figures 5-8, 5-9, and 5-10, respectively.

The analytical results for the flux chamber samples collected at Site 39D are presented in Appendix N. Flux chamber sampling locations are shown in Figure 5-8.

<u>*Very Shallow Layer*</u>

- Acetone at 0.13 mg/m^3 was the only VOC detected in the soil vapor sample (39D-SP05) collected from the very shallow layer.
- The detected concentration of acetone is below its SVSL of 6,600 mg/m^3.

Shallow Layer

- Seven VOCs were detected in the shallow soil vapor sample (49ST07-SP02) collected adjacent to the septic tank east of Building 49007.
- The seven VOCs and their maximum detected concentrations were chloroform (0.61 mg/m^3), TCE (0.04 mg/m^3), benzene (0.02 mg/m^3), hexane (0.02 mg/m^3), heptane (0.02 mg/m^3), acetone (0.09 mg/m^3), and tetrahydrofuran (0.06 mg/m^3).
- The concentrations of all VOCs detected in the shallow soil vapor sample are below their respective SVSLs (Table 5-25).

Intermediate Layer

- Nine VOCs were detected in the three soil vapor samples (39D-SP03, 39D-SP04, and 39D-SP05) collected from the intermediate layer at Site 39D.
- The nine VOCs and their maximum detected concentrations were dichloromethane (0.05 mg/m^3), chloroform (0.08 mg/m^3), TCE (0.04 mg/m^3), toluene (0.07 mg/m^3), hexane (0.02 mg/m^3), cyclohexane (0.05 mg/m^3), acetone (4.1 mg/m^3), MEK (0.06 mg/m^3), and ethanol (0.04 mg/m^3). Acetone was the only VOC detected in more than one of the three intermediate soil vapor samples.
- The concentrations of all VOCs detected in the three intermediate soil vapor samples are below their respective SVSLs (Table 5-25).

5.7.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site 39D*

The scope and results of the RIs for non-VOCs conducted at Potential Source Site 39D are summarized below.

5.7.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the Stage 1 RI, soil samples were collected at 0, 8, 11, 15, 20, 25, 32, and 35 feet bgs from a boring (39D-AH01) drilled adjacent to the former drum storage area and analyzed for SVOCs and metals (Figures 5-12 and 5-13). The analytical results are summarized below.

Semivolatile Organic Compounds

- No SVOCs, except for the laboratory contaminant di-n-butyl phthalate (up to 1.62 mg/kg), were detected in the soil samples above their respective laboratory reporting limits.
- TICs reported as part of the SVOC analysis of the subsurface soil samples included hexadecanoic acid up to 12 mg/kg, octadecanoic acid up to 2 mg/kg, unknown compounds up to 10 mg/kg, unknown oxygenated compounds up to 3 mg/kg, unknown hydrocarbons up to 2 mg/kg, and unknown phthalates up to 2 mg/kg.

Metals

- Except for arsenic, no metals above commercial or residential SSLs were detected in the surface and subsurface soil samples collected from the boring (Table 5-20). As discussed in Section 3.3.2.2, arsenic concentrations in soil at sites within the PGOU exceed SSLs, but are not elevated in comparison to background.

5.7.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the existing data for Site 39D presented in the approved Workplan indicated that data were needed to confirm the presence of TICs detected in the SVOC analysis of soil samples from Stage 1 RI boring 39D-AH01.

In accordance with the approved Workplan, subsurface soil samples were collected from one boring (39D-SB01) at the approximate former location of Stage 1 RI boring 39D-AH01 to assess the presence of SVOCs in soil (Figure 5-12). Soil samples were collected at 2.5- and at 5-foot intervals to first groundwater (42 feet bgs) and analyzed for SVOCs. Perched groundwater was not encountered during drilling; therefore, a screening-level groundwater sample was not collected. A comparison of proposed and actual subsurface soil sampling activities at Site 39D and a summary of sample identifications and sampling depths are provided on Table 5-5.

The results of the SVOC and SVOC TIC analysis of the samples collected from boring 39D-SB01 are included in Appendix F and are summarized on Tables 5-26 and 5-7, respectively, and below.

Semivolatile Organic Compounds

- Two common analytical and sampling contaminants, bis(2-ethylhexyl)-phthalate and diethyl phthalate, were the only SVOCs detected in the

soil samples collected from boring 39D-SB01. Bis(2-ethylhexyl)-phthalate was detected at estimated concentrations of 100, 68, 84, and 75 µg/kg in soil samples collected at 2.5, 5, 10, and 30 feet bgs, respectively. Diethyl phthalate was detected at estimated concentrations of 41 and 46 µg/kg in the soil samples collected at 25 and 30 feet bgs, respectively. However, no diethyl phthalate was detected in the duplicate soil sample collected at 25 feet bgs.

- No TICs were detected in any of the soil samples collected from boring 39D-SB01.

5.7.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site 39D*

The scope and results of the RIs for perched groundwater conducted at Site 39D are summarized below.

5.7.3.1 *Previous Perched Groundwater Investigations*

One perched groundwater monitoring well (Well 801) is present at Site 39D. The well, installed in 1985, was dry during the Stage 1 RI and not sampled. No perched groundwater was encountered in the boring (39D-AH01) drilled adjacent to the drum storage area during the Stage 1 RI. Unconfined groundwater was encountered in the boring at 37 feet bgs.

5.7.3.2 *Recent Perched Groundwater Investigations*

Evaluation of the existing data for Site 39D presented in the approved Workplan indicated that although historically present, perched groundwater may not currently exist beneath the site. To complete the RI/FS, additional data are needed to confirm the absence of perched groundwater at Site 39D.

In accordance with the approved Workplan, Well 801 was monitored for the presence of perched groundwater. Well 801, with a total depth of 25 feet bgs, was dry. Additionally, perched groundwater was not encountered during the drilling of boring 39D-SB01.

5.7.4 *Discussion of Investigation Results – Site 39D*

The cumulative results of the investigations conducted at Site 39D are discussed below.

5.7.4.1 *Soils*

Volatile Organic Compounds

- The results of the recent soil vapor sampling conducted at Site 39D represent the most current site conditions and therefore supersede the results of the Stage 1 RI.
- No VOCs at concentrations above their respective SVSLs were detected in the recent soil vapor samples collected at Site 39D.

Semivolatile Organic Compounds

- The laboratory contaminant di-n-butyl phthalate was the only SVOC detected in previous soil samples collected at Site 39D. TICs reported in the samples were hexadecanoic acid, octadecanoic acid, unknown compounds, unknown oxygenated compounds, unknown hydrocarbons, and unknown phthalates.
- Two common analytical and sampling contaminants, bis(2-ethylhexyl)-phthalate and diethyl phthalate, were the only SVOCs detected in the recent soil samples collected at Site 39D. No TICs were detected in any of the recent soil samples.

Metals

- No metals were detected at concentrations above background and their respective residential and commercial SSLs in the surface and subsurface soil samples collected at Site 39D during the previous (Stage 1 RI) investigation. Therefore, no sampling for metals was proposed in the approved Workplan.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site 39D have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.7.4.2 *Perched Groundwater*

Perched groundwater is not present at Site 39D.

5.8 AREA 49 SEPTIC TANKS

Seven septic tanks in Area 49 were investigated during the Stage 1 RI. Due to their proximity to existing potential source sites, the results of the soil vapor sampling conducted around five of the seven septic tanks were included in the discussions for Site 34D (Building 49011), Site 35D (Buildings 49006 and 49014), Site 37D (Building 49015), and Site 39D (Building 49007). The results of the Stage 1 RI for the two remaining septic tanks are discussed below.

5.8.1 Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Area 49 Septic Tanks

The scope and results of the RIs for VOCs conducted at the septic tanks in Area 49 are summarized below.

5.8.1.1 Previous Volatile Organic Compound Investigations

During the Stage 1 RI, shallow soil vapor samples were also collected close to a septic tank and leach field south of Buildings 49015 and 49022 (Figure 5-4). The analytical results for the shallow soil vapor samples are summarized below.

Shallow Soil Vapor Samples

- 1,1,1-TCA at 4.93 mg/m^3 and TCE at 3.5 mg/m^3 were detected in the soil vapor sample close to the septic tank and leach field south of Building 49015.
- TCE was detected at 1.07 mg/m^3 in the soil vapor sample collected close to the septic tank and leach field south of Building 49022.

5.8.1.2 Recent Volatile Organic Compound Investigations

Evaluation of the existing data for the septic tanks in Area 49 indicated that soil vapor sampling was needed around the septic tanks and leach fields south of Buildings 49015 and 49022 to assess the potential presence of VOCs at concentrations below the reporting limits used during the Stage 1 RI.

In accordance with the approved Workplan, seven soil vapor samples (excluding QA/QC samples) were collected near the septic tank and leach fields south of Buildings 49015 and 49022 during the recent investigation. A comparison of proposed and actual soil vapor sampling activities is

provided on Table 5-18. The recent soil vapor samples were collected at approximately the same locations as those collected during the Stage 1 RI. The analytical results for the recent soil vapor samples therefore represent current site conditions and supersede the results of the Stage 1 RI.

The analytical results for the soil vapor samples are included in Appendix F and are summarized on Table 5-27 and below. Total VOC concentrations detected in the shallow and intermediate soil vapor samples are shown in Figures 5-6 and 5-7, respectively. TCE concentrations detected in shallow and intermediate soil vapor samples are shown in Figures 5-9 and 5-10, respectively.

Septic Tank and Leach Field South of Building 49015

Soil vapor samples were collected from the shallow layer at two locations (49ST15-SP05 and 49ST15-SP06) around the septic tank and leach field south of Building 49015. The analytical results are summarized below.

Shallow Soil Vapor Samples

- Acetone at 0.22 mg/m^3 and MEK at 0.06 mg/m^3 were detected in the shallow soil vapor sample (49ST15-SP05) close to the septic tank.
- Acetone was detected at 0.12 mg/m^3 in the shallow soil vapor sample (49ST15-SP06) collected within the leach field.
- The detected concentrations of acetone and MEK in the shallow soil vapor samples collected around the septic tank and leach field south of Building 49015 are below their respective SVSLs.

Septic Tank and Leach Field South of Building 49022

Soil vapor samples were collected from the shallow layer at four locations (49ST22-SP02 through 49ST22-SP05) and from the intermediate layer at one location (49ST22-SP02) around the septic tank and leach field south of Building 49022. The analytical results are summarized below.

Shallow Soil Vapor Samples

- Nine VOCs were detected in the four soil vapor samples (49ST22-SP02 through 49ST22-SP05) collected from the shallow layer around the septic tank and leach field south of Building 49022. Total VOC concentrations detected in the four samples ranged from nondetect to 5.1 mg/m^3 (Figure 5-6).

- The nine VOCs and their maximum detected concentrations were TCE (0.61 mg/m^3), benzene (0.42 mg/m^3), toluene (2.3 mg/m^3), ethylbenzene (0.3 mg/m^3), xylenes (1.31 mg/m^3), chloroform (0.04 mg/m^3), 1,2,4-TMB (0.11 mg/m^3), and acetone (0.06 mg/m^3).
- The concentrations of all VOCs detected in the shallow soil vapor samples around the septic tank and leach field south of Building 49022 are below their respective SVSLs.

Intermediate Soil Vapor Samples

- TCE at 0.41 mg/m^3 was the only VOC detected in the intermediate soil vapor sample (49ST22-SP02) collected adjacent to the septic tank at Building 49022 (Figure 5-9). The detected concentration of TCE is well below its SVSL of 1.98 mg/m^3.

5.8.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Area 49 Septic Tanks*

No investigations for non-VOCs were previously conducted for the septic tanks and leach fields south of Buildings 49015 and 49022 and no sampling for non-VOCs was proposed in the approved Workplan.

5.8.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Area 49 Septic Tanks*

No investigations of perched groundwater were previously conducted around the septic tanks and leach fields south of Buildings 49015 and 49022 and no perched groundwater investigation was proposed in the approved Workplan. However, no perched groundwater was encountered during the recent soil vapor sampling activities.

5.8.4 *Discussion of Investigation Results – Area 49 Septic Tanks*

The cumulative results of the investigations conducted at the septic tanks and leach fields at Buildings 49015 and 49022 are discussed below.

5.8.4.1 *Soils – Septic Tank and Leach Field South of Building 49015*

Volatile Organic Compounds

- The results of the recent soil vapor sampling conducted around the septic tanks and leach field at Building 49015 represent the most

current site conditions and therefore supersede the results of the Stage 1 RI.

- VOCs detected in the recent soil vapor samples collected around the septic tank and leach field south of Building 49015, and their maximum concentrations, were acetone (0.22 mg/m^3) and MEK (0.06 mg/m^3).
- The concentrations of acetone and MEK are well below their SVSLs of 6,600 mg/m^3 and 10,200 mg/m^3, respectively.

Review of the cumulative data indicates that the presence, concentrations, and extent of VOCs in soil around the septic tank and leach field south of Building 49015 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.8.4.2 *Soils – Septic Tank and Leach Field South of Building 49022*

Volatile Organic Compounds

- The results of the recent soil vapor sampling conducted around the septic tanks and leach field south of Building 49022 represent the most current site conditions and therefore supersede the results of the Stage 1 RI.
- VOCs detected in the recent soil vapor samples collected around the septic tank and leach field south of Building 49022, and their maximum concentrations, were TCE (0.61 mg/m^3), benzene (0.42 mg/m^3), toluene (2.3 mg/m^3), ethylbenzene (0.025 mg/m^3), xylenes (1.31 mg/m^3), chloroform (0.04 mg/m^3), 1,2,4-TMB (0.11 mg/m^3), and acetone (0.06 mg/m^3).
- Concentrations for all detected VOCs in the samples are below their respective SVSLs (Table 5-27).

Review of the cumulative data indicates that the presence, concentrations, and extent of VOCs in soil around the septic tank and leach field south of Building 49022 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.8.4.3 *Perched Groundwater*

No perched groundwater was encountered during the recent soil vapor sampling.

5.9 *SITE C10*

Carve-out assessment Site C10 is a section of a concrete-lined ditch west of Schnitzer Steel and Beck's Furniture (Figures 5-1 and 5-15). A review of historical aerial photographs indicated that the ditch was constructed prior to 1953 and prior to Aerojet's ownership of the property. The ditch appears to have been used to transfer water from Alder Creek to areas west of Aerojet for irrigation or dredging operations. The site was designated for sampling during the carve-out site assessment because surface water from the Aerojet site and Schnitzer Steel could have potentially entered the ditch.

5.9.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site C10*

The scope and results of investigations for VOCs conducted at Site C10 are summarized below.

5.9.1.1 *Previous Volatile Organic Compound Investigations*

During the site assessment activities in 1999, soil vapor samples were collected from the shallow layer (6 to 11 feet bgs) at five locations (C10-SV01 through C10-SV05) along the ditch (Figure 5-15). The analytical results for the samples are summarized on Table 5-28 and below. VOCs detected in the soil vapor samples are shown in Figure 5-15.

Shallow Soil Vapor Samples

- Low concentrations of hydrocarbon constituents (lower than 3 mg/m^3) were detected in only two (C10-SV01 and C10-SV04) of the five soil vapor samples collected at Site C10 (Figure 5-15).
- VOCs detected in the two soil vapor samples, and their maximum concentrations, included benzene (0.96 mg/m^3), toluene (0.62 mg/m^3), ethylbenzene (0.19 mg/m^3), xylenes (0.15 mg/m^3), MTBE (0.2 mg/m^3), 1,2,4-TMB (0.07 mg/m^3), 4-ethyltoluene (0.16 mg/m^3), and ethanol (0.11 mg/m^3).

5.9.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the previous data for Site C10 presented in the approved Workplan indicated that additional soil vapor sampling was needed to evaluate the extent of benzene in the vadose zone.

In accordance with the approved Workplan, four soil vapor samples (excluding QA/QC samples) were collected at three locations (C10-SV04, C10-SV06, and C10-SV07) at Site C10. Soil vapor samples were collected from the shallow layer (6 to 11 feet bgs) at two locations (C10-SV06 and C10-SV07) sited east and west of previous sampling location C10-SV04 (Figure 5-15). Two soil vapor samples were collected from the intermediate (12 to 20 feet bgs) layer at the approximate location of previous soil vapor sampling point C10-SV04 (Figure 5-15). A comparison of proposed and actual soil vapor sampling activities at Site C10 and a summary of sample identifications and sampling depths are provided on Table 5-29. The analytical results are included in Appendix F and summarized on Table 5-28 and below. VOCs detected in the soil vapor samples are shown in Figure 5-15.

Shallow Soil Vapor Samples

- VOCs detected in the two shallow soil vapor samples, and their maximum detected concentrations, were heptane at 0.018 mg/m^3, acetone at 0.45 mg/m^3, MEK at 0.12 mg/m^3, and ethanol at 0.28 mg/m^3.
- The concentrations of heptane, acetone, MEK, and ethanol detected in the shallow soil vapor samples are below their respective SVSLs.

Intermediate Soil Vapor Samples

- Soil vapor samples were collected at location C10-SV04 at 17 and 20 feet bgs (Figure 5-15).
- VOCs detected in the soil vapor samples, and their maximum detected concentrations, were PCE at 0.17 mg/m^3, hexane at 0.06 mg/m^3, acetone at 1.5 mg/m^3, MEK at 0.4 mg/m^3, and ethanol at 0.24 mg/m^3.
- Concentrations of all VOCs detected in the intermediate soil vapor samples are below their respective SVSLs.

5.9.2 *Summary and Results of Previous Non-Volatile Organic Compound Investigations – Site C10*

The scope and results of investigations for non-VOCs conducted at Site C10 are summarized below.

5.9.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the site assessment activities in 1999, surface soil samples were collected from the bottom of the ditch at five locations (C10-SS01 through C10-SS05) and analyzed for SVOCs, metals, perchlorate, and TPH-D (Figure 5-16). The analytical results for all compounds are summarized below. Additionally, metals data are summarized on Table 5-30.

Semivolatile Organic Compounds

- No SVOCs were detected at concentrations above their respective laboratory reporting limits in the five surface soil samples.

Metals

- No metals were detected at concentrations above background and their respective residential or commercial SSLs in the five surface soil samples.

Perchlorate

- Perchlorate was not detected above the laboratory reporting limits in the five surface soil samples.

Total Petroleum Hydrocarbons as Diesel

- TPH-D was not detected above the laboratory reporting limits in the five surface soil samples.

5.9.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data for Site C10 presented in the approved Workplan indicated that no additional non-VOC data were needed to complete the RI/FS.

5.9.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site C10*

No perched groundwater investigations have previously been performed at carve-out assessment Site C10.

Evaluation of the previous data for Site C10 presented in the approved Workplan indicated that constituents detected at the site did not represent a likely threat to groundwater. Therefore, no perched groundwater investigation was proposed for Site C10.

5.9.4 *Discussion of Investigation Results – Site C10*

The cumulative results of the investigations conducted at Site C10 are discussed below.

5.9.4.1 *Soil*

Volatile Organic Compounds

- VOCs detected in soil vapor samples collected at Site C10, and their maximum concentrations, were benzene (0.96 mg/m^3), toluene (0.62 mg/m^3), ethylbenzene (0.19 mg/m^3), xylenes (0.15 mg/m^3), MTBE (0.2 mg/m^3), PCE (0.17 mg/m^3), 1,2,4-TMB (0.07 mg/m^3), 4-ethyltoluene (0.16 mg/m^3), hexane (0.06 mg/m^3), heptane (0.02 mg/m^3), acetone (1.5 mg/m^3), MEK (0.4 mg/m^3), and ethanol (0.28 mg/m^3).
- Concentrations of all VOCs detected in the soil vapor samples collected at Site C10 are below their respective SVSLs.

Semivolatile Organic Compounds, Perchlorate, and Total Petroleum Hydrocarbons as Diesel

- No SVOCs, perchlorate, or TPH-D were detected in the five surface soil samples collected at Site C10.

Metals

- No metals were detected at concentrations above background or their respective residential or commercial SSLs in the five surface soil samples.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site C10 have been

sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.9.4.2 *Perched Groundwater*

No perched groundwater investigations have been previously performed at Site C10. Evaluation of the previous data presented in the approved Workplan indicated that no perched groundwater investigation was needed.

5.10 *SITE C14*

Carve-out assessment Site C14 is an east-west trending ditch along the northern border of the Aerojet property, north of Building 49001, and west of Building 49011 (Figures 5-1 and 5-15). The ditch appears to be a remnant of historical dredging operations and not associated with Aerojet activities. The site was designated for sampling during the carve-out site assessment because potentially impacted surface water from the 4900 area could have entered the ditch.

5.10.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site C14*

The scope and results of the investigations for VOCs at Site C14 are summarized below.

5.10.1.1 *Previous Volatile Organic Compound Investigations*

During the site assessment activities at Site C14 in 1999, soil vapor samples were collected between 10 and 15 feet bgs at four locations (C14-SV01 through C14-SV04) adjacent to the ditch (Figure 5-15).

Low concentrations of VOCs were detected in the soil vapor samples collected at three (C14-SV01, C14-SV02, and C14-SV03) of the four locations. VOCs detected in the soil vapor samples included TCE at 0.11 mg/m^3 and acetone at 0.1 mg/m^3.

5.10.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the existing data for Site C14 presented in the approved Workplan indicated that additional soil vapor sampling was needed to

evaluate the presence of 1,3-butadiene detected in previous soil vapor sample C14-SV03.

In accordance with the approved Workplan, three soil vapor samples were collected at three locations (C14-SV03, C14-SV05, and C14-SV06) along the ditch at Site C14 (Figure 5-15). Soil vapor samples were collected from the shallow layer (6 to 11 feet bgs) at two locations (C14-SV05 and C14-SV06) sited southeast and southwest of previous sampling location C14-SV03 (Figure 5-15). One soil vapor sample was collected from the intermediate layer (12 to 20 feet bgs) at the approximate location of previous sampling location C14-SV03. In addition to the soil vapor samples, surface emission isolation flux chamber samples were collected at two locations at Site C14. A comparison of proposed and actual soil vapor sampling activities at Site C14 and a summary of sample identifications and sampling depths is provided on Table 5-29.

The analytical results for the soil vapor samples are included in Appendix F and are summarized on Table 5-28 and below. The analytical results for the flux chamber samples are presented in Appendix N. VOCs detected in the soil vapor samples and flux chamber sampling locations are shown in Figure 5-15.

Shallow Soil Vapor Samples

- Acetone at 0.18 mg/m^3 and MEK at 0.06 mg/m^3 were the only VOCs detected in the shallow soil vapor samples collected at Site C14 (Figure 5-15).
- The detected concentrations of acetone and MEK are below their respective SVSLs (Table 5-28).

Intermediate Soil Vapor Samples

- Acetone at 0.09 mg/m^3 was the only VOC detected in the soil vapor sample C14-SV03 collected at 20 feet bgs (Figure 5-15). The detected concentration of acetone is well below its SVSL.

5.10.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site C14*

The scope and results of investigations for non-VOCs conducted at Site C14 are summarized below.

5.10.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the site assessment activities conducted at Site C14 in 1999, surface soil samples were collected from the bottom of the ditch at four locations (C14-SS01 through C14-SS04) and analyzed for SVOCs, metals, perchlorate, and TPH-D (Figures 5-8 and 5-16). The analytical results for all compounds are summarized below.

Semivolatile Organic Compounds

- No SVOCs were detected at concentrations above their respective laboratory reporting limits in the four surface soil samples.

Metals

- No metals were detected in the samples at concentrations statistically greater than background and above their respective residential or commercial SSLs (Table 5-30).

Perchlorate

- Perchlorate was not detected above the laboratory reporting limits in the four surface soil samples.

Total Petroleum Hydrocarbons as Diesel

- TPH-D was not detected above the laboratory reporting limits in the four surface soil samples.

5.10.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data for Site C14 presented in the approved Workplan indicated that no additional investigations for non-VOCs were needed to complete the RI/FS.

5.10.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site C14*

No perched groundwater investigations have been previously performed at Site C14.

Evaluation of the previous data for Site C14 presented in the approved Workplan indicated that constituents detected at the site did not represent a likely threat to groundwater. Therefore, no perched groundwater investigation was proposed for Site C14.

5.10.4 *Discussion of Investigation Results – Site C14*

The cumulative results of the investigations conducted at Site C14 are discussed below.

5.10.4.1 *Soil*

Volatile Organic Compounds

- No VOCs at concentrations above their respective SVSLs were detected in the soil vapor samples collected at Site C14.

Semivolatile Organic Compounds, Perchlorate, and Total Petroleum Hydrocarbons as Diesel

- No SVOCs, perchlorate, or TPH-D were detected in surface soil samples collected from the bottom of the ditch at Site C14.

Metals

- No metals were detected in the surface soil samples from the bottom of the ditch at Site C14 at concentrations statistically greater than background and above their respective residential or commercial SSLs.

Review of the cumulative data indicates that the presence, concentrations, and extent of all chemical constituents in soil at Site C14 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.10.4.2 *Perched Groundwater*

No perched groundwater investigations have previously been performed at Site C14. Evaluation of the data presented in the approved Workplan indicated that no perched groundwater investigation was needed.

5.11 *SITE C15*

Carve-out assessment Site C15 initially consisted of an east-west drainage swale or shallow drainage ditch that received surface water runoff from warehouses at the west end of Area 49 (Figures 5-1 and 5-15). Following a site reconnaissance by the USEPA, DTSC, and RWQCB in October 1999, Site C15 was expanded to include a low-lying area that received surface water runoff via the drainage swale and from land adjacent to Schnitzer

Steel (Figures 5-1 and 5-15). The land adjacent to Schnitzer Steel was formerly identified as carve-out assessment Site C12.

5.11.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site C15*

The scope and results of investigations for VOCs conducted at Site C15 are summarized below.

5.11.1.1 *Previous Volatile Organic Compound Investigations*

During the assessment of Site C15 in 1999, soil vapor samples were collected from the shallow layer (6 to 11 feet bgs) at four regularly spaced locations (C15-SV01 through C15-SV04) along the drainage swale (Figure 5-15). The analytical results for the soil vapor samples are summarized on Table 5-28 and below. VOCs detected in the soil vapor samples are shown in Figure 5-15.

Shallow Soil Vapor Samples

- Low concentrations of chloroform at 0.2 mg/m^3, acetone up to 0.15 mg/m^3, and ethanol at 0.1 mg/m^3 were detected in three (C15-SV01, C15-SV03, and C15-SV04) of the four soil vapor samples.

5.11.1.2 *Recent Volatile Organic Compound Investigations*

Evaluation of the previous data for Site C15 presented in the approved Workplan indicated that the agencies requested additional soil vapor sampling for VOCs in the low-lying area not addressed during the site assessment activities conducted in 1999.

In accordance with the approved Workplan, four soil vapor samples (excluding QA/QC samples) were collected from the shallow layer (6 to 11 feet bgs) at four locations (C15-SV05 through C15-SV08) within the low-lying area (Figure 5-15). A comparison of proposed and actual soil vapor sampling activities at Site C15 and a summary of sample identifications and sampling depths are provided on Table 5-29.

The analytical results for the soil vapor samples are included in Appendix F and summarized on Table 5-28 and below. Additionally, VOCs detected in the soil vapor samples are shown in Figure 5-15.

Shallow Soil Vapor Samples

- Acetone at 0.20 mg/m^3 and ethanol at an estimated concentration of 0.04 mg/m^3 were the only VOCs detected in the four shallow soil vapor samples collected at Site C15.
- The concentrations of acetone and ethanol are below their respective SVSLs.

5.11.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site C15*

The scope and results of investigations for non-VOCs conducted at Site C15 are summarized below.

5.11.2.1 *Previous Non-Volatile Organic Compound Investigations*

During the site assessment of Site C15 in 1999, four soil samples (C15-SS01 through C15-SS04) were collected from the bottom of the drainage swale at regularly spaced intervals and analyzed for SVOCs, metals, perchlorate, and TPH-D (Figures 5-8 and 5-16). The analytical results are summarized below.

Semivolatile Organic Compounds

- No SVOCs were detected above their respective laboratory reporting limits in the four soil samples.

Metals

- No metals were detected at concentrations above background and their respective residential and commercial SSLs in the soil samples (Table 5-31).

Perchlorate

- No perchlorate was detected above the laboratory reporting limit in the four soil samples.

Total Petroleum Hydrocarbons

- No TPH-D was detected above the laboratory reporting limit in the four soil samples.

5.11.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous information for Site C15 presented in the approved Workplan indicated that the agencies requested additional data to evaluate metals in surface soil in the low-lying area not addressed during the site assessment activities in 1999.

In accordance with the approved Workplan, surface soil samples were collected at four locations (C15-SS05 through C15-SS08) in the low-lying area in July 2003 and analyzed for metals. Following a review of the analytical results for those samples, surface soil samples were collected at three additional locations in November 2004 and analyzed for chromium. A comparison of proposed and actual soil sampling activities at Site C15 and a summary of sample identifications and sampling depths is provided on Table 5-1. The analytical results are included in Appendix F and summarized on Table 5-31 and below.

<u>*Metals*</u>

- No metals were detected in the soil samples at concentrations above background and their respective residential and commercial SSLs. However, Chromium at 880 mg/kg, above the residential and commercial SSLs, was detected in one soil sample (C15-SS06). Chromium was not, however, detected in soil samples collected at three locations (C15-SS09, C15-SS10, and C15-SS11) surrounding location C15-SS06.

In response to agency comments on the Draft PGOU RI, surface soil samples were collected at 15 additional locations within and surrounding Site C15 in January 2006 and analyzed for metals. The additional sampling was performed to support a supplemental screening level ecological risk assessment for Site C15. The analytical results are included in Appendix F and summarized on Table 5-31 and below. An evaluation of the analytical results and the potential for ecological impacts at Site C15 is presented in Attachment G of the PGOU Lands Risk Assessment.

No metals were detected in the additional 15 soil samples collected at Site C15 at concentrations above background and their respective residential and commercial SSLs.

5.11.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site C15*

No perched groundwater investigations have previously been performed at Site C15.

Evaluation of the previous data for Site C15 presented in the approved Workplan indicated that constituents detected at the site did not represent a likely threat to groundwater. Therefore, no perched groundwater investigation was proposed for Site C15.

5.11.4 *Discussion of Investigation Results – Site C15*

The cumulative results of the investigations conducted at Site C15 are discussed below.

5.11.4.1 *Soil*

Volatile Organic Compounds

- No VOCs at concentrations above their respective SVSLs were detected in soil vapor samples collected at Site C15.

Semivolatile Organic Compounds, Perchlorate, and Total Petroleum Hydrocarbons as Diesel

- No SVOCs, perchlorate, or TPH-D were detected in soil samples collected at Site C15.

Metals

- No metals detected in soil at Site C15 were determined to be statistically elevated above background. Chromium, however, was detected at a concentration above its residential and commercial SSL.
- Chromium above its residential and commercial SSLs was detected in only 1 (C15-SS06) of 11 soil samples collected at Site C15. Chromium in three soil samples (C15-SS09, C15-SS10, and C15-SS11) collected around location C15-SS06 was significantly less than the residential and commercial SSLs.
- The results of the investigations indicate that the elevated concentration of chromium detected in sample C15-SS06 is anomalous or that the distribution of chromium in soil at Site C15 is highly variable.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site C15 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.11.4.2 *Perched Groundwater*

No perched groundwater investigations have been previously performed at Site C15. Evaluation of the previous data presented in the approved Workplan indicated that no perched groundwater investigation was needed.

5.12 *SITE C4*

Carve-out assessment Site C4 is a former debris site in the southwestern portion of the Aerojet facility, just west of the junction of a primary dirt road and the railroad tracks (Figures 5-1 and 5-17). The site was initially identified in the *Dump Site Reconsolidation Report* (Minshew Engineering, 1998) as Site 4, consisting of approximately 200 cubic yards of inert debris including tires, wheels, and trash deposited on the ground surface. The *Dump Site Reconsolidation Report*, also referred to as the Minshew Report, documented debris sites throughout the facility that were identified and inspected by Minshew Engineering under contract with Aerojet. According to Aerojet documents, the debris was removed and placed in Waste Management Unit (WMU) Areas 1 and 2 of the Aerojet Landfill. Due to the inert nature of the materials present, no sampling was performed during removal of the debris.

5.12.1 *Summary and Results of Previous and Recent Volatile Organic Compound Investigations – Site C4*

No investigations for VOCs were previously performed at Site C4 and no VOC investigations were proposed in the approved Workplan.

5.12.2 *Summary and Results of Previous and Recent Non-Volatile Organic Compound Investigations – Site C4*

The scope and results of investigations for non-VOCs at Site C4 are summarized below.

5.12.2.1 *Previous Non-Volatile Organic Compound Investigations*

A reconnaissance of the site by ERM in December 1998 confirmed that the majority of the 200 cubic yards of debris had been removed. The site currently consists of a graded area covered with vegetation and some domestic trash, including bottles, soup cans, plates, and teacups. No evidence of hazardous materials or indications of environmental impacts, other than some evidence of burning, were observed and no sampling was performed at Site C4 during the assessment activities.

5.12.2.2 *Recent Non-Volatile Organic Compound Investigations*

Evaluation of the previous data for Site C4 presented in the approved Workplan indicated that sampling was needed to assess metals and the potential presence of dioxins and furans due to burning.

In accordance with the approved Workplan, surface soil samples were collected at two locations (C4-SNS01 and C4-SNS02) at Site C4 and analyzed for SVOCs, metals, and dioxins and furans. A comparison of proposed and actual soil sampling activities at Site C4 and a summary of sample identifications and sampling depths is provided on Table 5-1. The results of the SVOC, metals, and dioxin and furan analyses of the two samples are included in Appendix F and summarized below. The analytical results for metals and dioxins and furans are presented on Tables 5-32 and 5-33, respectively.

Semivolatile Organic Compounds

- No SVOCs were detected above their respective laboratory reporting limits in the samples.
- TICs reported in the two soil samples were diethyl phthalate estimated at 300 µg/kg, stigmast-4-en-3-one estimated at 600 µg/kg, egost-5-en-3-ol (3-beta) estimated at 900 µg/kg; sitosterol estimated at 1,000 µg/kg; sulfur estimated at 200 µg/kg; unknown compounds totaling an estimated 2,100 µg/kg; and unknown alkanes estimated at up to 1,300 µg/kg.

Metals

- Lead was the only metal detected at concentrations above background and its residential or commercial SSL. Lead concentrations in both samples (4D-SNS01 and 4D-SNS02) were above the residential SSL of 150 mg/kg, but less than the commercial PRG of 800 mg/kg.

Dioxins and Furans

- As shown in Figure 5-18, the toxic equivalent quotient (TEQ) for the dioxins and furans detected in samples C4-SNS01 and C4-SNS02 was 1.01 and 6.34 picograms per gram (pg/g), respectively.
- The TEQ for dioxins and furans for all samples was below the commercial SSL of 16 pg/g. The TEQ for one sample (C4-SNS02) was above the residential SSL of 3.9 pg/g.

Following a review of the analytical results for the two surface soil samples, additional surface soil samples were collected at eight locations (C4-SNS03 through C4-SNS10) to characterize the lateral extent of lead and at four locations (C4-SNS03 through C4-SNS06) to characterize the lateral extent of dioxins and furans. Additionally, near-surface (2 feet bgs) soil samples were collected at two locations (C4-SNS02 and C4-SNS07) to assess the vertical extent of lead. The results of the lead and dioxins and furans analyses of the samples are summarized on Tables 5-32 and 5-33, respectively, and below.

Lead

- As shown in Figure 5-17, lead concentrations in the eight additional surface soil samples ranged from 3.4 to 320 mg/kg. Lead was detected at 320 mg/kg, above the residential SSL but below the commercial SSL, in only one (C4-SNS07) of the eight samples.
- Lead concentrations at 58 and 11 mg/kg in the near-surface (2 feet bgs) soil samples collected at locations C4-SNS02 and C4-SNS07, respectively, were significantly lower than at the surface and less than the residential SSL of 150 mg/kg.

Dioxins and Furans

- As shown in Figure 5-18, the TEQ for the dioxins and furans detected in the four additional samples ranged from 0.0638 pg/g to 0.49 pg/g.
- The TEQ for dioxins and furans in the four samples were well below the commercial and residential SSLs of 16 and 3.9 pg/g, respectively.

5.12.3 *Summary and Results of Previous and Recent Perched Groundwater Investigations – Site C4*

No perched groundwater investigations have been previously performed at carve-out assessment Site C4.

Evaluation of the previous data for Site C4 presented in the approved Workplan indicated that any constituents detected at the site would be limited to surface soil and unlikely to represent a threat to groundwater. Therefore, no perched or unconfined groundwater investigation was proposed for Site C4.

5.12.4 *Discussion of Investigation Results – Site C4*

The cumulative results of the investigations conducted at Site C4 are discussed below.

5.12.4.1 *Soil*

Volatile Organic Compounds

- Evaluation of the data for Site C4 presented in the approved Workplan indicated that no VOC investigations were warranted at Site C4.

Semivolatile Organic Compounds

- No SVOCs were detected in the samples collected at Site C4. TICs reported in the soil samples were diethyl phthalate, stigmast-4-en-3-one, egost-5-en-3-ol (3-beta), sitosterol, sulfur, unknown compounds, and unknown alkanes.

Metals

- Lead was the only metal detected in soil at Site C4 at concentrations above background and its residential SSL.
- Lead above the residential SSL was detected in only 3 (C4-SNS01, C4-SNS02, and C4-SNS07) of the 10 surface soil samples collected at Site C4. No lead above the commercial SSL was detected in the 10 soil samples. As shown in Figure 5-17, the lateral extent of lead above the residential SSL of 150 mg/kg at Site C4 has been characterized.
- No lead at concentrations above the residential SSL was detected in the near-surface (2 feet bgs) soil samples collected at two locations (C4-SNS02 and C4-SNS07) at Site C4.
- The results of the investigation indicate that lead at concentrations above the residential SSL of 150 mg/kg at Site C4 is limited to the top 2 to 3 inches or less of soil within a narrow north-south band roughly 40 feet by 100 feet along the top of the cobble pile.

Dioxins and Furans

- No TEQ for dioxins and furans above the commercial SSL was detected in the six samples collected at Site C4. A TEQ above the residential SSL was detected in one sample (C4-SNS02).
- As shown in Figure 5-18, the extent of dioxins and furans at concentrations above residential SSLs has been fully characterized and is limited to an area immediately surrounding sample location C4-SNS02.

Review of the cumulative data indicates that the presence, concentrations, and extent of chemical constituents in soil at Site C4 have been sufficiently characterized to allow the evaluation of potential human health and environmental risks and, if necessary, remedial options.

5.12.4.2 *Perched Groundwater*

No perched groundwater investigations have previously been performed at Site C4. Evaluation of the previous data presented in the approved Workplan indicated that no perched or unconfined groundwater investigation was needed.

5.13 *UNCONFINED GROUNDWATER – AREA 49*

The first unconfined groundwater beneath Area 49 is present in hydrostratigraphic Layers B and C. The geology and hydrogeology of Layers B and C were previously described in Section 4.12. The following text summarizes the scope and results of previous and recent unconfined groundwater sampling conducted as part of the individual source site investigations, and summarizes information regarding the presence and distribution of chemicals in Layers B and C previously presented in the draft PGOU RI Report for groundwater.

5.13.1 *Summary and Results of Previous and Recent Unconfined Groundwater Investigations – Area 49*

The scope and results of previous (prior to 2003) and recent (2003) unconfined groundwater investigations related to potential source sites are summarized below.

5.13.1.1 *Previous Unconfined Groundwater Investigations*

During the Stage 1 RI, an unconfined groundwater well (804) adjacent to the degreaser sump at Site 36D was monitored for the presence of groundwater (Figure 5-2). Well 804 was dry, but a screening-level groundwater sample (36D-HP01) was collected from the unconfined groundwater beneath the degreaser sump and analyzed for VOCs. TCE at 220 µg/L and cis/trans-1,2-DCE at 5 µg/L were detected in the screening-level groundwater sample.

In December 1996, groundwater samples were collected from the three vapor extraction wells (4485, 4490, and 4495) installed in the vicinity of Building 49018 as part of the low-flow SVE study and analyzed for VOCs, perchlorate, SVOCs, TPH, and metals (Aerojet, 1997b). The locations of the three wells are shown in Figure 5-2. Based on depth to groundwater, the three vapor extraction wells are completed within the first unconfined groundwater layer (Layer B). The analytical results for the groundwater samples are summarized below.

Volatile Organic Compounds

VOCs detected in the groundwater samples included TCE ranging from 180 to 630 µg/L; PCE ranging from 5.3 to 170 µg/L; 1,2-DCE ranging from 5.1 to 290 µg/L; and 1,1,1-TCA ranging from nondetect (less than 5 µg/L) to 14 µg/L.

Non-Volatile Organic Compounds

- No perchlorate was detected above the laboratory reporting limit of 0.4 mg/L.
- No TPH or SVOCs were detected above their respective laboratory reporting limits.
- All dissolved metals were less than their respective MCLs.

5.13.1.2 *Recent Unconfined Groundwater Investigations*

In accordance with the approved Workplan, monitoring of the three SVE wells (4485, 4490, and 4495) in the central portion of Area 49 for the presence of groundwater was attempted; however, SVE Well 4490 was damaged and could not be monitored. Depth to groundwater in SVE Wells 4485 and 4495 was measured at 30 and 28 feet, respectively, and groundwater samples from these wells were analyzed for VOCs and

SVOCs. Based on depth to groundwater and well construction data, the two SVE wells are completed within the first unconfined groundwater layer (Layer B) beneath Area 49. Proposed and actual groundwater sampling activities, and water level and well depth data for the SVE wells, are summarized on Table 5-14.

The results of the VOC and SVOC analysis of the unconfined groundwater samples collected from SVE Wells 4485 and 4495 are summarized on Tables 5-34 and 5-35, respectively, and below. Chemical constituents detected in the wells are shown in Figure 5-14.

Volatile Organic Compounds

- VOCs detected in SVE Well 4485 were TCE at 130 µg/L, PCE at 40 µg/L, cis/trans-1,2-DCE at 23 µg/L, 1,1,1-TCA at 2 µg/L, chloroform at 1.2 µg/L, and 1,1-DCA at 0.84 µg/L.
- VOCs detected in SVE Well 4495 were TCE at 450 µg/L, PCE at 8.3 µg/L, cis/trans-1,2-DCE at 210 µg/L, and 1,1,1-TCA at 7.5 µg/L.

Semivolatile Organic Compounds

- No SVOCs were detected above their respective reporting limits in the groundwater samples collected from SVE Wells 4485 and 4495.
- TICs reported in the SVOC analysis of the groundwater sample from SVE Well 4485 were cyclohexanone, estimated at 82 µg/L; 4-methypentanoic acid, estimated at 72 µg/L; 2-ethyl-1-hexanol, estimated at 41 µg/L; hexadecanoic acid, estimated at 170 µg/L; 9-hexadecanoic acid, estimated at 45 µg/L; octadecanoic acid, estimated at 340 µg/L; and an unknown compound, estimated at 320 µg/L.
- TICs reported in the SVOC analysis of the groundwater sample from SVE Well 4495 were hexadecanoic acid, estimated at 26 µg/L; 9-hexadecanoic acid, estimated at 27 µg/L; octadecanoic acid, estimated at 63 µg/L; unknown hydrocarbons, estimated at 120.6 µg/L; and unknown compounds, estimated at 78 µg/L.

5.13.2 *Summary of Perimeter Groundwater Remedial Investigation – Area 49*

The following is a summary of data previously presented in the draft PGOU RI Report (CVEI, 2003) for groundwater regarding the presence and distribution of chemicals in Layers B and C in Area 49.

Chlorinated solvents and perchlorate are the most commonly detected and widely distributed compounds in Layers B and C beneath Area 49. TCE is the most prevalent VOC but PCE is also common. VOCs detected in Layers B and C in wells downgradient of potential source sites in Area 49 and the CDA include 1,1-DCA; chloroform; PCE; TCE; and potential TCE degradation products 1,1-DCE and cis/trans-1,2-DCE.

5.13.2.1 *Distribution of Chemicals in Layer B*

A review of figures and tables presented in the PGOU RI Report indicates that approximately 22 monitoring and/or extraction wells are completed within Layer B along the northern boundary of the Aerojet site in Area 49. Approximately 17 of the wells were sampled during the sampling period of the PGOU RI (January 2000 through April 2003). A review of the TCE and perchlorate isoconcentration contours for Layer B presented in the draft PGOU RI Report indicated the following:

Trichloroethene

TCE concentrations detected in groundwater samples collected from Layer B beneath and/or downgradient of Area 49 ranged from 2.7 to 500 µg/L. The TCE concentrations detected in the wells potentially originate from potential source sites in Area 49 and from potential upgradient source sites in the CDA.

Perchlorate

Perchlorate concentrations detected in groundwater samples collected from Layer B beneath and/or downgradient of Area 49 ranged from nondetect to 440 µg/L. Prior to the fall of 2002, perchlorate was not removed by the GET D system and was present for some period in the treated groundwater that was recharged into Layers B and C through recharge wells along the Aerojet property boundary in Area 49. Therefore, it is difficult to distinguish between perchlorate that may have originated from the recharge wells and that which may have originated from upgradient sources.

5.13.2.2 *Distribution of Chemicals in Layer C*

A review of figures presented in the PGOU RI Report for groundwater indicates that approximately 25 monitoring and/or extraction wells are completed within Layer C in Area 49. Nineteen of the wells are located along the northern boundary of the Aerojet site, downgradient of Area 49.

Approximately 11 of the wells were sampled during the sampling period of the PGOU RI (January 2000 through April 2003). A review of TCE and perchlorate isoconcentration contours for Layer C presented in the PGOU RI Report for groundwater indicated the following:

Trichloroethene

TCE concentrations detected in Layer C beneath Area 49 ranged from nondetect (less than 5 µg/L) to 120 µg/L. The TCE isoconcentration contours for Layer C presented in the PGOU RI Report indicate that the TCE concentrations could have originated from potential source sites in Area 49 or in the CDA upgradient of Area 49.

Perchlorate

Perchlorate concentrations detected in Layer C groundwater beneath Area 49 ranged from 16 to 230 µg/L. The perchlorate isoconcentration contours for Layer C presented in the PGOU RI Report for groundwater appear to indicate that much of the perchlorate possibly originated from potential source sites in the CDA upgradient of Area 49. However, as previously discussed, perchlorate was not removed by the GET D system prior to the fall of 2002 and was present for some period in the treated groundwater recharged into Layers B and C through wells along the Aerojet property boundary in Area 49. It is difficult to distinguish between perchlorate that may have originated from the recharge wells and that which may have originated from upgradient sources.

5.13.3 *Discussion of Unconfined Groundwater – Area 49*

The results of previous and recent investigations and sampling conducted during the period of the PGOU RI indicate that VOCs, primarily TCE, and perchlorate are present in unconfined groundwater Layers B and C beneath Area 49. The concentrations of TCE detected in the unconfined groundwater beneath Area 49 appear likely to have originated from potential source sites in Area 49 and from upgradient potential source sites in the CDA. Due to the historical recharge of treated groundwater containing perchlorate into Layers B and C, the origin of the perchlorate concentrations in unconfined groundwater beneath Area 49 cannot be ascertained with any degree of certainty.

The nature and extent of chemicals in groundwater downgradient of Area 49, and any necessary remedial action, are being addressed by the PGOU RI/FS for groundwater.

6.0 CONTAMINANT FATE AND TRANSPORT AND EVALUATION OF POTENTIAL IMPACTS TO GROUNDWATER, SURFACE WATER, AND AMBIENT AND INDOOR AIR

This section discusses the fate of the constituents detected in soil at the sites addressed in this RI/FS, identifies potential routes of transport and migration, and evaluates the potential for those constituents to impact groundwater, surface water, and indoor air.

6.1 CONTAMINANT FATE, TRANSPORT, AND MIGRATION

The results of the RI show that chlorinated solvents are the most common chemicals present in the vadose zone soil at the sites addressed in this RI/FS, and metals and PCBs are the most common compounds detected in surface soil. Additionally, dioxins and furans were identified in surface soil at one site.

The fate and transport properties of the predominant classes of constituents (i.e., VOCs, metals, PCBs, and dioxins and furans) detected in soil and their potential migration pathways are discussed below. The evaluation of fate and transport and migration pathways is necessary to identify media and locations that may be important in terms of constituent movement and subsequent exposure to human and ecological receptors. A site conceptual model (Figure 6-1) was developed to identify the principal transport and migration mechanisms for the chemicals identified in the surface and vadose zone soil.

6.1.1 Volatile Organic Compounds

TCE was the predominant chlorinated solvent detected in the vadose zone. The presence of VOCs in the vadose zone is primarily the result of releases from lined and unlined sumps and USTs. To a lesser extent, VOCs in the vadose zone may have also resulted from surface releases in the form of spills, leaks from equipment, or during the process of transferring liquids.

VOC transformation and degradation occur at many sites due to natural biotic and abiotic processes in the subsurface. These processes transform original VOC compounds to byproducts. Understanding degradation can be important to assessing plume migration and attenuation at sites where

degradation rates are significantly high. In some cases, more harmful substances are created, such as the transformation of 1,2-DCE to vinyl chloride. In other cases, complete destruction occurs and toxic chemicals are reduced to innocuous substances, such as the mineralization of vinyl chloride to carbon dioxide and water.

The most common degradation process that influences chlorinated ethene plumes is reductive dechlorination. This process results in the sequential degradation of more chlorinated compounds to less chlorinated compounds, such as PCE to TCE (AFCEE, 1996). Other processes, such as cometabolism and direct mineralization, can influence chlorinated ethene plumes as well (AFCEE, 1996). If complete reductive dechlorination occurs, the following sequence of products occurs: PCE, TCE, 1,2-DCE, vinyl chloride, ethene, carbon dioxide, and water. Each step leading to vinyl chloride liberates chloride ions. Chlorinated ethene plumes with active degradation display characteristic patterns of compounds. In the case of complete reductive dechlorination, various configurations of the general pattern may be observed. In many cases, the complete degradation sequence does not occur. The infrequent detection of 1,2-DCE and vinyl chloride in soil vapor and vapor extraction well samples at only low concentrations indicate that reductive chlorination is a relatively slow process at the sites addressed in this RI/FS.

VOCs originating from source areas at the Aerojet site may: 1) remain in the soil; 2) migrate vertically through the coarse-grained materials (dredge deposits) and eventually into perched or unconfined groundwater; or 3) migrate upward through the vadose zone in the form of soil vapor and into ambient or indoor air (Figure 6-1). Lateral migration of VOCs may occur if vertical migration is impeded by layers of relatively impermeable materials such as silts and clays and through diffusion in soil vapor. Perched groundwater impacted with VOCs may remain relatively unchanged; seep into underlying, unconfined groundwater units; discharge to surface water; or become dry, potentially leaving VOCs in the soil.

Comparison of the analytical results for soil vapor samples collected during previous investigations and recent investigations indicates that the extent and concentrations of VOCs do attenuate over time. At the FCS, for example (Section 4.7.4), the data show that the extent and concentrations of TCE in the vadose zone have attenuated significantly (from 325 to 0.12 mg/m^3 at one location) over a 10-year time period. Because reduction chlorination at the site is relatively slow, the attenuation of VOCs is likely the result of a combination of upward migration of soil

vapor through the vadose zone into ambient air and downward migration into perched and/or unconfined groundwater rather than from reductive chlorination.

6.1.2 *Metals*

Metals in the ditches and drainages are naturally occurring or are present as the result of direct discharge and/or the receipt of impacted surface water. The fate and migration of metals is highly site-specific and primarily takes place through the physical and chemical interactions with the particulates to which they are attached. Metals typically cannot be biologically degraded, but some metals (arsenic, chromium, and mercury) may change among various oxidation states that may alter their mobility and toxicity. The pH of the soil and the valence state of the metal are important factors that govern whether migration occurs. The partitioning process is governed by complex electrochemical and physical interactions between the affected media and the chemical. These interactions involve the size and charge of the cation and the number of exchange sites on the individual particle surfaces. In general, many metals are bound to clay particles and higher concentrations of these constituents are often associated with the presence of fine silts.

The primary mechanism of transport for metals in ditches and drainages is the entrainment of metal particles or soil with attached metals in surface water flow or in fugitive dust (Figure 6-1). Although most metals are relatively insoluble, some dissolution of metals into surface water can occur and metals may leach into the underlying soil and/or groundwater. Metals are considered non-volatile, such that volatilization from soil is not generally considered a migration pathway.

6.1.3 *Polychlorinated Biphenyls*

PCBs in or along the ditches are primarily due to releases of oil containing PCBs during the transfer of those liquids to and from an aboveground storage tank. Aroclor 1260 was detected in soil samples associated with the man-made ditches at Sites 10D and 11D.

PCBs have high affinities for organic carbon-rich soils and undergo a variety of weathering processes, resulting in a change in composition relative to the commercial Aroclor mixtures. PCBs are considered non-volatile, such that volatilization from soil is not generally considered a migration pathway.

The primary mechanism of transport for PCBs in ditches and drainages is the entrainment of PCB particles or soil with attached PCBs in surface water flow or windblown dust (Figure 6-1).

6.1.4 Dioxins and Furans

Dioxins and furans, as a group, are characterized as largely immobile in soil. They generally degrade slowly, volatilize poorly, and therefore are very persistent in the environment. In general, the primary mechanism for transport for dioxins and furans in soils would be limited to erosion and transport via storm water runoff and/or fugitive dust.

6.1.5 Perchlorate

Perchlorate salts such as ammonium and potassium perchlorate have low volatility, but high solubility which leads to high mobility in groundwater and surface water. The perchlorate ion is kinetically stable and inert which makes it persistent in the environment. The ion absorbs weakly to most soil minerals and the effect of sorption in inhibiting mobility is minimal.

Perchlorate (ClO4-) is the most oxygenated member of a series of four anions made up of chlorine and oxygen. The negative anion forms an acid or a salt in combination with H+ or another cation such as sodium, potassium, or ammonium. Perchlorate salts are ionic and disassociate completely when dissolved in water. (Public Health Goal for Perchlorate in Drinking Water, Draft for Scientific Peer Review, CAL-EPA, 2002).

6.2 EVALUATION OF POTENTIAL IMPACTS TO GROUNDWATER FROM VOLATILE ORGANIC COMPOUNDS IN SOIL VAPOR

The potential for VOCs in soil vapor at the sites addressed in this RI/FS Report to leach into and impact groundwater was evaluated using VLEACH (version 2.2a), which is based on the original version 1.0 developed for the USEPA Region IX in 1990 (VLEACH, A One Dimensional Finite Difference Vadose Zone Leaching Model, Varadhan Ravi and Jeffrey A. Johnson, 1997).

VLEACH is a one-dimensional finite difference vadose zone leaching model that simulates the movement of VOCs within and between three phases: gas in the vapor phase, solute in the aqueous phase, and an adsorbed compound in the solid phase. The processes are conceptualized as occurring in a number of user-defined polygons that are vertically

divided into a series of cells. User-defined variables such as soil properties, recharge rate, contaminant concentration, areal extent of contamination, depth to the water table, length of simulation, and the specified time-step of simulation are specified for each polygon.

VLEACH initially calculates the equilibrium distribution of contaminant mass between the liquid, gas, and sorbed phases according to distribution coefficients defined by the user. Transport processes are then simulated. Liquid advective transport is calculated based on values defined by the user for infiltration and soil water content. The contaminant in the vapor phase migrates into or out of adjacent cells based on the calculated concentration gradients that exist between adjacent cells. After the mass is exchanged between the cells, the total mass in each cell is recalculated and re-equilibrated between the different phases. These steps are conducted for each time step. At the end of the model simulation, the results from each polygon are compiled to determine an overall area-weighted groundwater impact for the modeled area.

It should be noted that the VLEACH model makes the following assumptions in simulating contaminant transport in the vadose zone:

- Linear equilibrium conditions exist between the liquid, vapor, and soil phases.
- The vadose zone is in a steady-state condition with respect to water movement. More specifically, the moisture content profile within the vadose zone is constant. This assumption will rarely occur in the field.
- Liquid-phase dispersion is neglected and contaminant migration is simulated as a plug flow. This causes higher dissolved concentrations and lower travel time predictions than would occur in reality.
- The contaminant is not subjected to in situ production or degradation. Since organic contaminants, especially hydrocarbons, generally undergo some degree of degradation in the vadose zone, this assumption results in conservative concentration values.
- Volatilization from soil boundaries is completely unimpeded or restricted. This assumption may be significant depending upon depth of investigation and the soil type.
- Homogeneous soil conditions are present. This assumption rarely occurs in the field.

The sections below describe modeling of the sites addressed in this report using VLEACH, including the selection and development of input

parameters, description of the scenarios modeled, and discussion of the modeling results.

6.2.1 *Model Parameter Development*

Site-specific input parameters used in the VLEACH model were grouped into site parameters, soil parameters, and chemical contaminant parameters.

6.2.1.1 *Site Parameters*

Site parameters used in the VLEACH model are summarized in the following table and described below.

Parameter	Value
Recharge Rate	1.63 feet/year
Depth to Groundwater	40 feet bgs
Depth to Soil Impacts	Sample depth specific
Contaminant Concentration (recharge water, atmospheric air, and water table)	0.00 mg/L

Recharge Rate. The recharge rate used in the model was calculated based on percentage recharge rates developed by CVEI for Aerojet's Regional Groundwater Flow Model, and the average annual rainfall recorded at Folsom Dam.

Recharge rates developed by CVEI ranged from 65 to 82 percent of the annual rainfall amount for undeveloped areas in the region. The lower values are representative of undredged areas and higher values are representative of dredged areas. For a conservative approach, the higher recharge rate (i.e. for dredged areas) was used in the model. The average annual rainfall amount of 23.92 inches measured at Folsom Dam was obtained from the Western Regional Climate Center and was used to calculate the recharge rate in feet per year for the sites.

Depth to Groundwater. Depth to groundwater at the sites was assumed to be 40 feet bgs based on findings during the RI and previous subsurface investigations conducted at the sites.

Depth to Soil Impacts. The thickness of the vadose zone (i.e., the distance VOCs would need to travel before encountering groundwater) used in the

model varied depending on the depth at which a soil vapor sample was collected. Modeling was performed for each of the selected VOCs at sample depths of 10, 15, 20, and 30 feet bgs. These depths equate to 10, 20, 25, and 30 feet above groundwater.

Contaminant Concentration. The recharge water for the sites is generally from precipitation. Therefore, the contaminant concentration in recharge water was set to zero. Contaminant concentrations in atmospheric air and at the water table of the source areas were also set to zero.

6.2.1.2 *Soil Parameters*

Soil data used in the VLEACH model were taken from a range of site-specific geotechnical data gathered during the Johnson and Ettinger (J&E) Model Calibration Study (*Report on the Calibration of the Johnson and Ettinger Model for use at the Aerojet Sacramento Site*, [Geosyntec, ERM, & Aerojet, 2006]). The 95th percentile for each of the parameters was determined and used in the model. Geotechnical analytical results for the source areas are included on Table 6-1 and the soil parameters specifically used in the model are summarized below.

Parameter	Value
Dry Bulk Density	1.65 g/cm^3
Porosity	0.49 (unitless)
Volumetric Water Content	0.29 (unitless)
Volumetric Air Content	0.20 (unitless)
Fractional Organic Carbon	0.0016 (unitless)

6.2.1.3 *Chemical Parameters*

Select chemical contaminants were used in the model simulations and included 1,1,1-TCA, benzene, Freon 113, PCE, TCE, and vinyl chloride. These chemical compounds were selected based on how commonly they were detected at the sites addressed in this report (represented about 90 percent of the detected chemical compounds), the ratio of the concentrations of those compounds to the total concentration of VOCs detected (represents 90 percent of the total VOC concentration detected), and their toxicity.

The VLEACH model requires four chemical-specific parameters: organic carbon distribution coefficient, Henry's Law Constant, solubility, and free air dilution coefficient. The chemical-specific parameters for the modeled chemicals were the same as those used in the Central Disposal Area Vapor Intrusion Evaluation (Geosyntec, 2008b) as summarized in the table below.

Chemical	Organic Carbon Distribution Coefficient (cm^3/g)	Henry's Law Constant (dimensionless) (19° Celsius)	Aqueous Solubility (mg/L)	Free Air Dilution Coefficient* (m^2/day)
1,1,1-TCA	110	0.55	1,300	0.674
Benzene	59	0.17	1,800	0.76
Freon 113	160	16	1,100	0.25
PCE	160	0.55	200	0.622
TCE	170	0.32	1,100	0.682
Vinyl Chloride	19	0.95	2,800	0.95

* Free air dilution coefficient is also known as the diffusivity in air.

6.2.2 *VLEACH Modeling*

Twenty-four scenarios were modeled, four for each of the selected contaminant chemicals at sample depths of 10, 15, 20, and 30 feet bgs using the site-specific physical conditions and chemical-specific parameters described above.

Each scenario was modeled for a contaminant source area of 1 square foot in size and a simulation period of 30 years, to estimate the maximum soil concentration of the chemical contaminant that can be transported from the vadose zone to groundwater, without the groundwater contaminant levels exceeding the water quality objectives (WQOs). The WQO used for this evaluation was the lowest value of either the State of California PHG or the MCLs. PHGs and MCLs for the selected chemicals are provided in the table below.

Chemical	Public Health Goal (µg/L)	Maximum Contaminant Level (µg/L)
1,1,1-TCA	1,000	200
Benzene	0.15	1.0
Freon 113	4,000	1,200
PCE	0.6	5.0
TCE	1.7	5.0
Vinyl Chloride	0.05	0.5

The modeling was done through an iterative "back calculation" procedure, by adjusting the contaminant concentrations in the model until a maximum concentration was found that did not result in the exceedance of groundwater quality objectives for each respective chemical contaminant.

It is important to note that the VLEACH model does not incorporate groundwater mixing, but rather only evaluates the impact to groundwater directly beneath a source area in terms of contaminant mass per year (grams/year). Dilution due to groundwater flow was conservatively ignored and concentration values reported for each contaminant represent the maximum value that reached the top 1 foot of the saturated zone. To obtain results in terms of contaminant concentration (µg/L) for each year, it was assumed that the contaminant mass flux from the source area to the saturated zone was into a volume of 1 cubic foot of groundwater (28.3 liters) beneath the source area.

Detailed model simulation results are included in Appendix P. The maximum annual chemical contaminant transfer to groundwater that would not result in the exceedance of groundwater quality objectives was identified in each scenario and results are presented in the next section.

6.2.3 *Comparison of VLEACH Model Results with Site Soil Vapor Concentrations*

To make a direct comparison of the maximum allowable soil contaminant concentrations determined using VLEACH with the detected contaminant concentrations in soil vapor samples from the sites included in this RI/FS, the maximum soil concentrations calculated by VLEACH at 10, 15, 20, and 30 feet bgs were converted to equivalent SVSLs using the equation developed by DiGiulio (USEPA, 1992) and the site-specific soil properties used in the VLEACH modeling. Conversion calculations for the VLEACH depth-specific soil concentrations to depth-specific SVSLs are presented on Table 6-2

The soil vapor concentrations for each of the source sites included in this RI/FS were compared to their depth-specific SVSLs developed using VLEACH. This screening is presented on Tables 6-3 through 6-5. The table below summarizes the source areas where comparison of the soil vapor concentration data with the SVSLs indicates that VOCs could potentially result in an exceedance of the groundwater quality objectives.

Chemical	Sites in Areas 20 & 21 With Concentrations Above VLEACH Screening Level	Sites in Area 49 With Concentrations Above VLEACH Screening Level
1,1,1 –TCA	---	---
Benzene	---	33D, 35D, Building 49022 Septic Tank
Freon 113	---	---
PCE	7D & FCS	32D, 34D, 35D, 36D, & 38D
TCE	---	32D, 33D, 34D, 35D, 36D, 37D, & 38D
Vinyl Chloride	---	38D

6.2.4 *Evaluation and Conclusions Regarding Potential Impacts to Groundwater from Volatile Organic Compounds in Soil Vapor*

The screening evaluation presented above indicates that VOCs are not present in soil vapor at the sites in Areas 20 and 21 and Area 49 listed below at concentrations that could migrate into groundwater and result in concentrations above their respective water quality goals (PHGs where available or MCLs). Therefore, remedial action at these sites for the protection of groundwater is not warranted.

- Areas 20 and 21: Sites 4D, 5D, 10D, 11D, GET D, C29, D(e), C32, and C41; and
- Area 49: Sites 39D, C10, C14, and C15 and Septic Tanks associated with Buildings 49007 and 49015.

Concentrations of TCE, PCE, and/or benzene in soil vapor at two sites in Area 20 and eight sites in Area 49 exceeded their respective VLEACH SVSLs. An exceedance of the VLEACH SVSL does not necessarily signify that the chemical has, or will, migrate into groundwater and result in concentrations above their water quality goals. Rather, it indicates that other lines of evidence should be evaluated to determine if the concentrations have historically or are currently contributing to groundwater and assess the potential for contributing to groundwater in the future.

Further evaluation of those sites having VOC concentrations in soil vapor above the VLEACH SVSLs along with conclusions and recommendations based on the evaluation is presented below.

6.2.4.1 *Area 20 – Sites 7D and FCS*

PCE at concentrations above its VLEACH SVSL was detected in soil vapor samples collected at Sites 7D and the FCS. Due to the proximity of these two sites, these sites are discussed together.

PCE concentrations in groundwater during the Stage 1 RI in 1992 and in the FWBZ in 2006 were reviewed to assess PCE concentration trends over time and in groundwater upgradient and downgradient of Sites 7D and the FCS. PCE concentrations detected in groundwater in 1992 and 2006 are shown on Figure 6-2. Groundwater flow within the Administration Area is towards the west-northwest. As shown in Figure 6-2, PCE concentrations greater than 5 µg/L were present in 1992 within a narrow band from the central part of the Administration Area (north end of Building 20004) to the GET D extraction system. The figure also indicates that the maximum PCE concentrations (up to 48 µg/L) were detected in groundwater upgradient of Sites 7D and the FCS and that PCE concentrations attenuate downgradient of those sites. Although the groundwater data does not rule out the possible contribution of PCE from Sites 7D and the FCS, the data does show that the PCE in groundwater within the Administration Area and beneath those sites is primarily due to upgradient sources.

Figure 6-2 shows that the extraction of groundwater by GET D has resulted in a significant decrease in PCE concentrations in groundwater within the Administration Area. PCE concentrations have significantly attenuated over the past 13 years, although high concentrations (up to 1,000 µg/L) remain in groundwater along the west side of Building 20002. PCE concentrations are generally less than 4 µg/L immediately upgradient of Sites 7D and the FCS and attenuate to less than 0.5 µg/L downgradient of those sites. The 2006 groundwater data indicate that current contributions of PCE to groundwater from Sites 7D and the FCS are negligible.

PCE at 4.9 µg/L was detected in a perched groundwater sample collected from monitoring well 868 in 2003. Monitoring well 868 is located adjacent to the drainage ditch immediately northeast of the former location of the FCS. As discussed in Section 4.13.1, unconfined groundwater levels in the Administration Area have decreased between 5 and 24 feet between 1983 and 2003 as result of drought and the extraction of groundwater by GET D . In 1983 and 1984, the FWBZ was present at elevations nearly equal to perched groundwater and perched groundwater technically did not exist. Although the migration of PCE from soil at the FCS into perched

groundwater can not be discounted, the perched groundwater and the PCE in the perched groundwater could possibly be a remnant of the unconfined groundwater. Nonetheless, the 2006 groundwater data indicate that the perched groundwater, and the PCE concentrations in that groundwater, are not currently migrating into the unconfined groundwater enough to produce a marked increase.

The evaluation indicated that PCE at concentrations above its VLEACH SVSL is present in the shallow (10 feet bgs) interval at six (7D-SP-13, 7D-SP15, FCS-SP04, FCS-SP09, FCS-SP10, and FCS-SP14) locations and in the intermediate (20 feet bgs) interval at three (FCS-SP01, FCS-SP06, and FCS-SP10) locations. PCE concentrations above its VLEACH SVSL in the shallow and intermediate intervals at Sites 7D and the FCS are shown in Figures 6-3 and 6-4, respectively. As shown in the figures, the number of soil vapor samples with PCE concentrations above the VLEACH SVSL are relatively few and are generally surrounded by samples having PCE below the VLEACH SVSL. Additionally, at the FCS, PCE above its VLEACH SVSL was detected in the shallow and intermediate interval at only one location (FCS-SP10). The observed distribution suggests that the PCE concentrations are due to the migration of VOCs from the perched groundwater rather than from discharges to the ground.

Based on the information presented above, remedial action for the protection of groundwater does not appear warranted at Sites 7D and the FCS for the following reasons:

- Groundwater data shows that contributions of PCE from soil and perched groundwater, if any, at Sites 7D and the FCS do not currently result in concentrations of PCE in the unconfined groundwater above the PQL of 0.05 µg/L.
- The distribution of the soil vapor samples with PCE above its VLEACH SVSL indicates that the presence of PCE in soil vapor are likely due to the migration of VOCs from the perched groundwater.
- The distribution of the soil vapor samples with PCE above its VLEACH SVSL is not indicative of the presence of a collective mass of PCE in soil that could be effectively remediated using vapor extraction. Additionally, the heterogeneity of the subsurface materials due to historical dredging would significantly reduce the effectiveness of soil vapor extraction and may not result in a significant reduction in the concentrations.
- The extraction of perched groundwater does not seem to be a viable option for several reasons. First, the volume of perched groundwater

that may be extracted is limited and due to the nature of the material, the rate at which the groundwater could be extracted would likely be very low. Second, the extraction of the perched groundwater would likely result in the volatilization of VOCs into the overlying soil, which could eventually migrate into indoor or outdoor air.

6.2.4.2 *Area 49 – Sites 32D, 34D, 35D, 36D, and 38D*

PCE, TCE, and/or vinyl chloride were present in soil vapor at Sites 32D, 34D, 35D, 36D, and 38D in 1992 and/or 2003 at concentrations above their VLEACH SVSLs. The exceedances were observed in soil vapor samples collected in 1992 and 2003. Although PCE, TCE, and/or vinyl chloride concentrations observed in the 1992 soil vapor data have likely attenuated over the past 16 years, it is likely that concentrations of those VOCs above their VLEACH SVSLs remain in the central portion of Area 49. As indicated in Figures A-35 and A-37 presented in Part 1 of the PGOU RI/FS Report, TCE concentrations greater than 50 µg/L are present in groundwater in the northern portion of Area 49. Based on the current information, it is likely that VOCs are present in soil vapor at Sites 32D, 34D, 35D, and 38D at concentrations that could be a continuing contributor to groundwater. Based on that information, the feasibility of implementing remedial action to reduce VOC concentrations in soil vapor at those sites appears to be warranted.

6.2.4.3 *Area 49 – Site 33D*

TCE and benzene at concentrations greater than their VLEACH SVSL were detected in soil vapor samples collected at Site 33D. As shown in Figures 6-5 and 6-6, TCE above its VLEACH SVSL was detected in shallow and intermediate soil vapor samples at one location (33D-SP05) and in an intermediate soil vapor sample at one location (33D-SP09). The two sampling locations are separated and surrounded by sampling locations (33D-SP06, 33D-SP07, 33D-SP08, and 33D-SP10) with detected concentrations of TCE in the shallow and intermediate intervals significantly less than its VLEACH SVSL. The data indicate that the areal extent of TCE in soil vapor at Site 33D at concentrations above its VLEACH SVSL is very limited. Because the detections of TCE above its VLEACH SVLS at Site 33D is limited to only a few locations, the implementation of soil vapor extraction to remediate these areas would not be cost-effective. Additionally, due to the presence of TCE in Layers B and C in the vicinity of Site 33D (Figures A-35 and A-37), soil vapor extraction would probably not result in a significant reduction in the concentrations.

Benzene above its VLEACH SVSL was detected in two soil vapor samples collected from the intermediate layer at two locations (33D-SP07 and 33D-SP08). Benzene above its VLEACH SVSL was not detected in soil vapor samples collected from the shallow interval. As with TCE, the data indicate that benzene is isolated to a few locations and is limited in extent. The implementation of soil vapor extraction to remediate these areas would therefore not be cost-effective.

6.2.4.4 *Area 49 – Site 37D*

TCE at a concentration above its VLEACH SVSL was detected in soil vapor samples collected at only one (37D-SP08) of five locations at Site 37D. Furthermore, TCE above its VLEACH SVSL was detected in only one of seven samples collected at that location. The data does not indicate that TCE is present in soil vapor at Site 37D at concentrations that could pose a significant threat to groundwater. Therefore, remedial efforts at Site 37D do not appear to be warranted.

6.2.4.5 *Area 49 – Building 49022 Septic Tank*

Benzene at a concentration above its VLEACH SVSL was detected in a soil vapor sample collected at only one (49ST22-SP03) of four locations adjacent to the septic tank at Building 49022. The detection of benzene above its VLEACH SVSL in only one sample does not appear to warrant remedial action.

6.3 *EVALUATION OF POTENTIAL IMPACTS TO GROUNDWATER FROM NON-VOLATILE CHEMICALS IN SOIL*

The potential for metals, PCBs, and perchlorate detected in soil at the sites included in the PGOU to leach into groundwater and result in concentrations above their respective WQOs are discussed below.

6.3.1 *Potential Impacts to Groundwater from Metals and Polychlorinated Biphenyls*

The potential for the metals detected in soil in the bottom of the ditches at Sites 5D, 10D, and 11D to leach into and impact groundwater was evaluated using two methods. The first method utilized the approach outlined in the *Draft Water Quality Site Assessment for Soils and Ground Water* (RWQCB, 1992). The second method was to review the soil sample data to determine if metal concentrations increased or attenuated with

depth as an indicator to whether migration had occurred. The approach outlined in the *Draft Water Quality Site Assessment for Soils and Ground Water* (RWQCB, 1992) is summarized below. The assessment approach was also used to assess the potential for PCBs in soil at Site 10D to leach into and impact surface water and groundwater.

- The mean background soil extract concentrations and standard deviation for each metal or constituent of concern was determined.
- The soil extract concentration for each metal suspected to be a constituent of concern was determined.
- The soil extract concentrations for each site were compared with the corresponding soil extraction concentrations for the background samples.
  - If the constituent concentration in the site soil extract was less than or equal to the concentration in the background soil extract, then the constituent is not leaching from site soil greater than from background and no further action is required.
  - If the constituent concentration in the site soil extract was greater than the concentration in the background soil extract, then that constituent may be leaching from the site soil at greater concentrations than background, and the site soil extract is compared to background groundwater concentrations and applicable water quality limits.
  - For those constituents that were determined to have the potential to leach from site soil at concentrations greater than from background, the following approach was followed.
- The site soil extract concentration was converted to a site soil leachate concentration and the leachate concentration was compared to the background groundwater concentration.
  - If the soil leachate concentration was less than or equal to the background groundwater concentration, the constituent is not impacting groundwater quality.
  - If the site soil leachate concentration is above the background concentration, the constituent may potentially impact groundwater quality. (The degree of attenuation was determined by dividing the site soil leachate concentration by the background groundwater concentration.)
  - If the site soil leachate concentration was above the applicable numerical water quality limit, the soil constituent may potentially

impact water quality to the extent that beneficial uses are impacted. (The degree of attenuation was determined by dividing the site soil leachate concentration by the appropriate numerical water quality limit.)

Presented below is the results of the evaluation for metals in soil in the ditches at Sites 5D, 10D, and 11D and for PCBs in soil at Site 10D to impact groundwater in accordance with the above approach.

6.3.1.1 *Determination of Background Soil Extract Concentrations*

In accordance with the approved Workplan and as discussed in Section 3.3.3, background soil extract samples were collected at four locations in Area 20 (Figure 3-1). The soil samples were collected in an area close to Sites 5D, 10D, and 11D where no industrial activities had occurred and the soil type was similar to that of the sites. The purpose of the sampling was to obtain extract for metals analysis from soils having background metal concentrations representative of the soil type present at Sites 5D, 10D, and 11D. A WET was performed on each sample using deionized water and the sample extract was analyzed for Title 22 metals and general minerals. Because PCBs are not naturally occurring, the samples were not analyzed for PCBs. The results of the metals analysis of the background soil samples and their respective sample extracts are summarized on Tables 6-6 and 6-7, and below.

Soil Samples

- Arsenic and vanadium were the only metals detected in the background soil samples at concentrations above their respective residential soil PRGs.
- Metals detected in at least one of the four background soil samples at concentrations above their respective mean background levels were arsenic up to 9.1 mg/kg, cadmium up to 0.37 mg/kg, copper up to 46 mg/kg, and mercury up to 0.23 mg/kg.

Sample Extracts

- Metals detected in the extracts from the four background soil samples at concentrations above their respective laboratory reporting limits were aluminum up to 37,000 µg/L, barium up to 11,000 µg/L, beryllium up to 7.8 µg/L, chromium up to 98 µg/L, cobalt up to 700 µg/L, copper up to 590 µg/L, manganese up to 35,000 µg/L, nickel up to 420 µg/L, titanium up to 1,000 µg/L, vanadium up to 910 µg/L,

and zinc up to 370 µg/L. The mean concentration for each metal in the background soil extract and the standard deviation is presented on Table 6-7.

6.3.1.2 *Determination of Soil Extract Concentration*

The determination of soil extract concentrations for metals and PCBs is described below.

Metals

Following a review of the metals data for all soil samples collected from the ditches during the recent investigation, a WET using deionized water was performed on seven soil samples collected from the bottom of the ditches at Sites 5D, 10D, and 11D. The seven samples were selected based on the number of metals of potential concern (i.e., detected at concentrations exceeding average background levels) and the degree of the exceedance. As indicated on Table 6-8, metals detected in at least one of the seven soil samples at a concentration above background, and their maximum concentrations, were antimony (1.0 mg/kg), arsenic (12 mg/kg), beryllium (0.83 mg/kg), cadmium (2.2 mg/kg), chromium (130 mg/kg), cobalt (27 mg/kg), copper (110 mg/kg), lead (110 mg/kg), manganese (1,000 mg/kg), mercury (0.75 mg/kg), molybdenum (3.7 mg/kg), silver (40 mg/kg), and zinc (1,900 mg/kg).

Based on a review of the metal concentrations for all previous and recent samples and potentially applicable water quality criteria, the extract from each of the seven soil samples was analyzed for the following metals of potential concern: arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, copper, lead, manganese, mercury, nickel, silver, and zinc. Metals detected in the extract from at least one of the soil samples included barium up to an estimated 290 µg/L, hexavalent chromium up to an estimated 6.8 µg/L, manganese up to 130 µg/L, and zinc up to an estimated 3,600 µg/L (Tables 6-8 and 6-9).

Polychlorinated Biphenyls

Following a review of the PCB data for all soil samples collected from the Site 10D ditch during the recent investigation, a WET was performed on two samples (10D-SNS31 and 10D-SNS34) and the extract was analyzed for PCBs. The two samples selected contained concentrations of Aroclor 1260 and 1254 above their respective residential soil PRGs. The results of the PCB analysis of the two soil samples and their respective

extracts are presented on Table 6-10. No concentrations of Aroclor 1254 and 1260 or other PCBs above the PQL of 4.0 µg/L were detected in the sample extracts. The results indicate that the PCBs in soil along the bottom and banks of the ditch are not soluble and therefore do not have the potential to impact groundwater.

6.3.1.3 *Comparison of Soil and Background Extract Concentrations*

A comparison between metal concentrations in the extract from the soil samples collected at Sites 5D, 10D, and 11D and the mean concentration of metals detected in the extract from the background soil samples is presented on Tables 6-11, 6-12, and 6-13, respectively. The comparison indicates that zinc was the only metal detected in the soil sample extracts above its mean background soil extract concentration and therefore the only metal having the potential to impact groundwater quality. However, in comments on the Draft PGOU RI/FS Report dated 14 April 2005, the RWQCB indicated that due to the elevated reporting limit (380 µg/L) for lead in the extract from both site and background soil resulting from matrix interference, the comparison was insufficient to assess the potential for lead to leach from the soil into groundwater. Further evaluation of the potential for zinc and lead to leach through the vadose and impact groundwater is presented below.

Zinc

The potential impact to groundwater posed by zinc in the soil samples collected from the bottom of the ditches at Sites 5D, 10D, and 11D was further evaluated by comparing the maximum zinc leachate concentration to mean background groundwater concentrations and applicable water quality limits for zinc (Table 6-14). Because the WET procedure includes a 10-fold dilution of the soil sample, the maximum zinc leachate concentration (36,000 µg/L) was determined by multiplying the zinc extract concentration (3,600 µg/L) by a factor of 10. A list of numerical water quality goals for zinc is presented on Table 6-14. Zinc concentrations in background groundwater samples collected during the recent investigation are presented on Table 6-15. The background groundwater data are based on three wells (38, 3093, and 3109) located in Area 20 upgradient of all potential source areas and completed in the first encountered unconfined groundwater layers (Layers B and C).

The comparison presented on Table 6-14 shows that the maximum zinc leachate concentration (36,000 µg/L) for site soils exceed both the mean background groundwater concentration (133 µg/L) and the lowest

applicable beneficial use numerical water quality limit (2,000 µg/L). The attenuation factor was determined by dividing the maximum zinc leachate concentration (36,000 µg/L) by the mean background groundwater concentration (133 µg/L) and the numerical water quality limit (2,000 µg/L), respectively. The attenuation factor accounts for the ability of natural processes in the vadose zone soil to reduce contaminant concentrations.

As indicated on Table 6-14, the attenuation factor to protect groundwater quality and beneficial groundwater use is 271 and 18, respectively. The attenuation factors are well below the attenuation factor of 1,000 that the RWQCB indicated that it typically uses as a benchmark to assess the potential for metals to impact groundwater.

The potential for zinc to leach from site soil into groundwater was also evaluated using metals analytical data for surface and subsurface soil samples collected at three locations (10D-SNS05/10D-SB02, 10D-SNS07/10D-SB07, and 10D-SNS10/10D-SB10) in the bottom of the ditch at Site 10D (Figure 4-8). Surface soil samples collected at locations 10D-SNS05, 10D-SNS07, and 10D-SNS10 contained zinc at 370, 1,600, and 710 mg/kg, respectively. As indicated on Table 6-16, zinc concentrations in the subsurface soil attenuate to less than the 95 percent UCL for mean background within the upper 5 feet at two locations (10D-SB02 and 10D-SB10) and within the upper 10 feet at all three locations. Depth to groundwater in the area of Site 10D is approximately 20 to 25 feet bgs.

Based on the evaluations presented above, zinc is not expected to pose a potential impact to groundwater.

Lead

As discussed previously, the RWQCB indicated that due to an elevated reporting limit for lead, comparison of the lead concentrations in the site soil extract to those in the background soil extract was insufficient to assess the potential for lead to leach from the soil into groundwater. As a result of discussions with the agencies at a meeting on 22 September 2005, the leaching of lead from surface soils into groundwater was further evaluated using data for subsurface soil samples. The soil samples were collected at three locations (10D-SNS05, 10D-SNS07, and 10D-SNS10) where elevated concentrations of lead were detected in surface soil. The data collection activities performed to support the evaluation included the following:

- During the Stage 2 RI of Site 10D in 1997, subsurface soil samples were collected at 2.5, 5, and 7.5 feet bgs from boring 10D-SB02 sited at surface sample location 10D-SNS05. Lead at 40 mg/kg was detected in surface soil sample 10D-SNS05.
- As agreed upon with the agencies on 22 September 2005, soil samples were collected at 2, 5, and 10 feet bgs from two borings (10D-SB07 and 10D-SB10) in the Site 10D ditch. The borings correspond to surface sampling locations 10D-SNS07 and 10D-SNS10. Lead at 130 and 110 mg/kg was detected in surface soil samples 10D-SNS07 and 10D-SNS10, respectively, in 1997.

The metals analytical results for the surface and subsurface soil samples collected at the three locations at Site 10D are summarized on Table 6-16 and discussed below.

As indicated on Table 6-16, lead concentrations in soil attenuate to less than the 95 percent UCL for mean background within the upper 5 feet of soil at two locations (10D-SB02 and 10D-SB10) and within the upper 10 feet at all three locations. Additionally, lead concentrations detected in all soil samples collected between 2 and 10 feet bgs were below the maximum background concentration of 63.5 mg/kg. The same degree of attenuation for lead concentrations with depth was also reflected in the analytical data for zinc.

Based on the analytical data presented above, elevated lead concentrations in surface soil at Site 10D is not expected to pose a potential impact to groundwater.

6.3.1.4 Results of Evaluation for Metals and Polychlorinated Biphenyls

The results of the evaluation show that metals in soil in the ditches at Sites 5D, 10D, and 11D and PCBs in soil at Site 10D will not impact the quality or beneficial uses of groundwater.

6.3.2 Evaluation of Potential Impacts to Groundwater from Perchlorate in Soil

Due to its high solubility, the potential for perchlorate in soil at the former railcar siding (Site C41) to leach into and impact groundwater is likely. Additionally, the detection of perchlorate in screening level groundwater samples collected at the site indicates that perchlorate has impacted first encountered groundwater beneath the site.

6.4 *EVALUATION OF POTENTIAL IMPACTS TO SURFACE WATER FROM CHEMICALS IN SOIL VAPOR AND SOIL*

Evaluation of the potential threat to surface water quality posed by VOCs in soil vapor and non-VOCs in soil at Sites 4D, 5D, 7D, 10D, 11D, and the FCS consisted of a comparison of concentrations of those compounds in surface water samples collected at sampling Station S-2 between 1 January 2000 and 31 December 2004 to the criteria outlined below. Sampling Station S-2 is along the Administration Ditch downstream of the referenced sites (Figure 4-1).

- Dissolved concentration limits cited in the *Revised Waste Discharge Requirements for Aerojet-General Corporation and Aerojet Fine Chemicals* (NPDES Permit No. CA0004111) (RWQCB Order No. R5-1999-0016-R01, revised 2002). The Revised Waste Discharge Requirements establishes limits on concentrations of constituents that may be present in surface water released from the Westlake storm water retention cells to Buffalo Creek, and subsequently, the American River. It should be noted that sampling Station S-2 provides information on the quality of water entering Westlake and is not representative of water discharged to Buffalo Creek. It should also be noted that sampling Station S-2 is located downstream of potential source areas other than those addressed in this PGOU RI/FS and detected constituents may not have originated from PGOU sites.
- The lowest applicable WQO, as presented in the RWQCB document, *A Compilation of Water Quality Goals* (RWQCB, 2008). RWQCB values for the constituents of concern are provided on tables presented in the following sections.

In response to a comment from the agencies in a letter dated 21 January 2009, ERM reviewed specialized limited sampling data for California Toxics Rule constituents collected in 2002 under Aerojet's NPDES permit. The sampling was performed at sampling Station S-1, located along Buffalo Creek on the west side of Line 2 and directly north of Illinois Street. Because this portion of Buffalo Creek does not receive surface water discharges from the ditches in the PGOU, including those in the Administration Area, the analytical data for samples collected at Station S-1 was not applicable to the evaluation of potential surface water impacts from sites within the PGOU.

6.4.1 *Potential Impacts to Surface Water from Volatile Organic Compounds in Soil Vapor*

Surface water samples are collected at Station S-2 at a minimum of one sample per week when there is sufficient flow, and analyzed for selected VOCs in accordance with the NPDES permit. The analytical results for 724 primary surface water samples collected at Station S-2 during a 4-year period between 1 January 2000 and 31 December 2004 are summarized on Table 6-17 and below.

As indicated on Table 6-17, acetone and chloroform were the only VOCs detected in surface water samples collected at Station S-2 during the 4-year period. Acetone at 20 and 100 µg/L was detected in surface water samples collected at Station S-2 on 5 and 21 March 2003, respectively.

Chloroform was sporadically detected in two surface water samples collected in December 2001 and January 2002, and in six samples collected between April and September 2004. Chloroform at 5.2 and 5.3 µg/L was detected in surface water samples collected on 17 December 2001 and 28 January 2002, respectively. Chloroform at concentrations ranging from 6.3 to 16 µg/L was detected in six surface water samples collected between April and September 2004. Chloroform at concentrations above the laboratory reporting limit of 5.0 µg/L was not detected in surface water samples collected at Station S-2 prior to December 2001 or after September 2004.

6.4.2 *Potential Impacts to Surface Water from Semivolatile Organic Compounds in Soil*

Surface water samples are collected at Station S-2 on a quarterly basis, when there is sufficient flow, and analyzed for selected SVOCs and hydrazines in accordance with the NPDES permit. The analytical results for 19 primary surface water samples collected at Station S-2 between 1 January 2000 and 31 December 2004 are summarized on Table 6-18. SVOCs and hydrazines at concentrations above their respective PQLs were not detected in the surface water samples.

6.4.3 *Potential Impacts to Surface Water from Polychlorinated Biphenyls in Soil*

Surface water samples collected at Station S-2 are not analyzed for dissolved concentrations of PCBs. However, as previously discussed, no concentrations of Aroclor 1254 and 1260 or other PCBs were detected

above the PQL of 4.0 µg/L in the extracts from two samples collected at Site 10D having concentrations of those isomers above their respective residential soil PRGs.

6.4.4 *Potential Impacts to Surface Water from Metals in Soil*

Dissolved concentrations of metals detected in surface water samples collected at Station S-2 between 1 January 2001 and 31 December 2004, limits for dissolved metal concentrations cited in the NPDES permit, and water quality objectives are summarized on Table 6-19 and below.

- Dissolved metals detected in at least one surface water samples collected at Station S-2 during the 4-year period were aluminum ranging from less than 0.05 mg/L, barium ranging from 0.022 to 0.93 mg/L, boron ranging from 0.02 to 0.053 mg/L, calcium ranging from 1.2 to 13 mg/L, copper ranging from 0.006 to 0.04 mg/L, iron ranging from nondetect (less than 0.075 mg/L) to 0.64 mg/L, manganese ranging from 0.003 to 0.039 mg/L, magnesium ranging from 1.2 to 3.1 mg/L, molybdenum (one detect at 0.042 mg/L), potassium ranging from 1.1 to 45 mg/L, sodium ranging from 1.1 to 17 mg/L, vanadium ranging from 0.0017 to 0.005 mg/L, and zinc ranging from nondetect (less than 0.025 mg/L) to 0.14 mg/L.
- Dissolved concentration limits for the following metals were established in the NPDES permit: arsenic (0.01 mg/L), barium (0.1 mg/L), copper (0.01 mg/L), iron (0.3 mg/L), manganese (0.05 mg/L), silver (0.01 mg/L), and zinc (0.1 mg/L).

As presented on Table 6-19, dissolved concentrations of barium, copper, iron, molybdenum, and/or zinc above the limits established in the NPDES permit or WQOs were detected in only one or two surface water samples collected at Station S-2 during the 4-year period. As indicated on the table, the exceedances were infrequent and were typically preceded and followed by nondetects or detections less than the permit limits and WQOs. The analytical results for the surface water samples indicate that metals in soil at Sites 5D, 10D, and 11D are unlikely to result in dissolved concentrations of metals in the Westlake storm water retention cells that exceed the limits established in the NPDES permit.

6.4.5 *Potential Impacts to Surface Water from Miscellaneous Compounds in Soil and General Water Quality Parameters*

Surface water samples are collected at Station S-2 at varying frequency in accordance with the NPDES permit when there is sufficient flow and

analyzed for pH, temperature, turbidity, electrical conductivity (EC), total dissolved hardness, dissolved oxygen (DO), chemical oxygen demand (COD), total organic halogen, total suspended solids (TSS), total dissolved solids (TDS), ammonia as nitrogen, chlorine, nitrate, nitrate as nitrogen, total Kjeldhal nitrogen, organic Kjeldhal nitrogen, oil and grease, and perchlorate. The analytical results for the listed parameters for surface water samples collected at Station S-2 between 1 January 2000 and 31 December 2004 are summarized on Tables 6-20 and 6-21.

Review of the data indicates that chlorine was the only constituent detected in surface water samples collected at Station S-2 during the 4-year period at concentrations above the NPDES permit limit. However, chlorine was only detected in 2 of 19 samples collected and at concentrations only slightly above the limit of 0.02 mg/L.

6.4.6 *Results of Surface Water Impact Evaluation*

Based on the analytical results for samples collected at Station S-2, constituents detected in soil vapor and soil at the sites addressed in this RI/FS do not pose a threat to the quality or beneficial uses of surface water.

6.5 *EVALUATION OF POTENTIAL IMPACTS TO AMBIENT AND INDOOR AIR FROM VOLATILE ORGANIC COMPOUNDS IN SOIL VAPOR AND GROUNDWATER*

The potential for VOCs detected in vapor at the soil sites addressed in this RI/FS and VOCs in groundwater beneath the lands within the PGOU to migrate into ambient and indoor air was evaluated in accordance with the approach presented in the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (Draft Subsurface Vapor Intrusion Guidance, USEPA, 2002c) and agreements with the agencies. The evaluation consisted of a comparison of the concentrations of VOCs detected in soil vapor and groundwater to the generic target media-specific concentrations in the guidance and to conservative site-specific screening levels developed based on discussions with USEPA. The comparison indicated that some VOCs in soil vapor at several sites and in groundwater at various locations had the potential to migrate into indoor and ambient air. A site-specific evaluation of the potential for VOCs in soil vapor to migrate into indoor and ambient air is presented in the *PGOU Lands Baseline Risk Assessment* (ERM, 2009) submitted under separate cover. Evaluation of the potential for VOCs present only in

groundwater to migrate into and impact ambient and indoor air is presented in Appendix E of Part 1 of the PGOU RI/FS Report.

7.0 FEASIBILITY STUDY FOR PERIMETER GROUNDWATER OPERABLE UNIT LANDS

This section presents the Feasibility Study (FS) performed to identify and evaluate potential remedial actions to mitigate chemicals detected in soil at concentrations that potentially pose a risk to human and ecological receptors at 24 soil source sites within the PGOU. This FS has been developed in compliance with the USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988c) and the *National Oil and Hazardous Substance Pollution Contingency Plan* (NCP; USEPA, 1990). The scope of work for this FS was outlined in the *Draft Workplan to Complete the Remedial Investigation/ Feasibility Study (RI/FS) for Selected Sites in Areas 20, 21, and 49* (ERM, 2003a).

This FS incorporates the results of the human health and ecological risk assessments conducted for both soil and groundwater within the PGOU and an evaluation of the potential for chemical migration into groundwater and surface water. The results of the human health risk assessment (HHRA) and screening level ecological risk assessment (SLERA) for the lands (soil sites) within the PGOU are presented in the PGOU Lands Risk Assessment, submitted under separate cover at the request of the agencies. A HHRA for the hypothetical use of groundwater for domestic use and the potential migration of volatile organic compounds (VOCs) from groundwater into soil and indoor air is presented in Appendix E to Part 1 of this PGOU RI/FS. Evaluation of the potential for chemicals detected in soil at the sites within the PGOU to migrate into and adversely impact beneficial uses of groundwater and surface water was presented in Section 6 of Part 2 of the PGOU RI/FS.

The FS serves as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. The FS utilizes the information developed during the RI, HHRA, and SLERA to:

- Develop specific remedial action objectives (RAOs) and cleanup goals;
- Identify and screen applicable remedial technologies;
- Develop and screen remedial alternatives;
- Conduct a detailed evaluation and comparative analysis of remedial alternatives; and

- Recommend a specific remedial alternative to mitigate the potential risks posed by the presence of chemicals in the designated exposure zones.

This FS has been developed to evaluate potential environmental remedies for chemicals in soil at the sites addressed in this RI/FS, specifically the HHRA.

7.1 SUMMARY OF REMEDIAL INVESTIGATIONS

7.1.1 Summary of Remedial Investigations – Sites in Areas 20 and 21

The scope and results of previous RI's conducted at the PGOU soil sites within Areas 20 and 21 addressed in this FS are presented in Section 4 of Part 2 of the PGOU RI/FS. Additionally, the scope and results of the RI at each of the potential source areas within Areas 20 and 21 were summarized in Section 3.1 of the PGOU Lands Risk Assessment (ERM, 2008).

7.1.2 Summary of Remedial Investigations – Sites in Area 49 and Western Portion of the Aerojet Site

A summary of the previous investigations at each of the soil sites within Area 49 addressed in this RI/FS is summarized in Section 5 of this document. Additionally, the scope and results of the RI at each of the potential source areas within Area 49 were summarized in Section 3.1 of the PGOU Lands Risk Assessment (ERM, 2008).

7.2 SUMMARY OF HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT RESULTS

The HHRA and SLERA process and the results of those assessments for each of the sites within Areas 20 and 21, Area 49, and the western portion of the Aerojet site within the PGOU are summarized below.

USEPA and Cal EPA have both defined a range of acceptable risk as 1×10^{-6} to 1×10^{-4}, in accordance with the requirements of the *National Oil and Hazardous Substances Pollution Contingency Plan* (USEPA, 1990). This range of acceptable risk is used to assess the significance of the potential cancer risks estimated herein. For sites where the estimated lifetime cancer risk is between 10^{-4} to 10^{-6}, the need for active remediation or risk

management will be evaluated on a site-specific basis (i.e., risks within this range are "potentially acceptable" depending on site-specific considerations).

7.2.1 *Summary of Risk Assessment Results – Sites in Areas 20 and 21*

The HHRA results for each of the sites within Areas 20 and 21 under residential, commercial/industrial worker, and construction worker scenarios, along with the current and planned future land use, are summarized in Table 7-1 and below. Additionally, the results of the SLERA and evaluation of the potential for chemicals to migrate into and adversely affect beneficial uses of groundwater and surface water are also summarized below.

Total estimated ILCRs and adult/child HIs at individual sampling locations within Areas 20 and 21 under a residential, commercial/industrial, and construction worker scenarios are presented in Figures 7-1 through 7-3.

For the human health risk, the regulatory threshold levels (RTLs) used in the following discussion are:

- ILCRs are less than 1×10^{-6};
- HIs are less than 1; and
- Blood lead estimates are less than 10 µg/dL.

7.2.1.1 *Site 4D*

Site 4D is a section of unlined ditch south of Building 20022 and east of Building 20024. Soil, soil vapor, and screening groundwater samples collected during RI evaluated in this RI/FS are labeled with the prefix "04D-". Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 4D are summarized below.

<u>Human Risk</u>

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.1.2 Site 11D

Site 11D consists of unlined ditches north and east of Building 20022, a 170-foot section of ditch north of Building 20B73, and an underground culvert between Sites 11D and 10D. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "11D-." Perched groundwater was not encountered during the collection of soil vapor samples along the sections of ditches; therefore, no screening-level groundwater samples were collected. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 11D are summarized below.

Human Risk

- **Residential:** Risk above RTLs (ILCR and blood lead) due to PCBs and lead in soil and chloroform in soil vapor. However, PCBs (11D-SNS10) and lead (11D-SNS04) above their RTL were detected in only one sample each. Chloroform above its RTL (ILCR) was detected in only one soil vapor sample (11D-SP22 at 10 feet bgs).
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

The underground culvert between Sites 11D and 10D received surface water runoff from the 170-foot section of ditch north of Building 20B73, and a drainage ditch west of Building 20022. The drainage ditch west of Building 20022 was investigated in 2005 and 2006 as part of the BOU RI. Sampling conducted historically and during the BOU RI shows that PCBs are present in surface and near-surface soils within the drainage ditch at

concentrations ranging from 83 to 720,000 µg/kg. PCBs in the ditch could potentially become entrained in surface water and migrate into the sections of the Site 10D and 11D ditches in the PGOU. Therefore, remedial action to remove PCBs from the upstream sections of the Site 11D ditch or alteration of the drainage system to prevent surface water potentially containing PCBs from entering into the culvert and Site 10D ditch is required prior to deletion of Sites 10D and 11D from the Superfund site. The Draft BOU RI/FS (ERM, December 2008) concluded that PCBs in soil within Site 11D upstream of the PGOU sites posed a risk to human health and that excavation and disposal of the PCBs was the most feasible remedial alternative.

7.2.1.3 Site 10D

Site 10D is the principal drainage ditch in Area 20 and parallels Folsom Boulevard. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "10D-." Only one well (Auger Well 675) within 500 feet of the Site 10D ditch (north of the drainage ditch) contained water and was sampled during the RI. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 10D are summarized below.

<u>Human Risk</u>

- **Residential:** Risk above RTLs (HI, ILCR, and blood lead) due to lead, silver, mercury, iron, and PCBs in soil. No risk above RTLs in soil vapor.
- **Commercial:** Risk above RTLs (ILCR) due to PCBs in soil. No risk above RTL in soil vapor.
- **Construction:** Risk above RTLs (ILCR) due to hexavalent chromium in soil. No risk above RTL due to soil vapor.

<u>Ecological Risk</u>

- No significant ecological risk.

<u>Groundwater and Surface Water Risk</u>

- No significant risk to groundwater or surface water.

As discussed in Section 7.2.1.2, PCBs are present in surface and near-surface soils within a drainage ditch (11D) west of Building 20022 that discharges to the Site 10D and 11D ditches. PCBs in that upstream section

of ditch could potentially become entrained in surface water and migrate into the sections of the Site 10D and 11D ditches in the PGOU. The Draft BOU RI/FS (ERM, December 2008) concluded that PCBs in soil within Site 11D upstream of the PGOU sites posed a risk to human health and that excavation and disposal of the PCBs was the most feasible remedial alternative.

7.2.1.4 *Site 7D*

Site 7D is a concrete-lined ditch 400 feet north of Building 20009. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "07D-." No perched groundwater was encountered at Site 7D during the RI. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 7D are summarized below.

Human Risk

- **Residential:** Risk above RTLs (ILCR and blood lead) due to PCE and chloroform in soil vapor and lead in soil. PCE detected in soil vapor along length of ditch. Lead above RTL detected in only one sample at one location (07-CS01 at surface).
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater Risk

- PCE at concentrations above its VLEACH SVSL was detected in soil vapor samples collected at Site 7D. However, the distribution of the soil vapor samples with PCE above its VLEACH SVSL indicates that the presence of PCE in soil vapor is likely due to the migration of VOCs from the perched groundwater and does not currently result in concentrations of PCE in the unconfined groundwater above the PQL of 0.05 µg/L. Although, no perched groundwater was encountered beneath Site 7D during the RI, the data from the surrounding area shows that upgradient sources do have PCE in groundwater.

Surface Water Risk

- No significant risk to surface water.

7.2.1.5 *Site 5D*

Site 5D is an unlined ditch between the northern property line and the confluence with the Site 7D ditch. As presented in the approved Workplan, evaluation of Site 5D indicated that this site is not a source of VOCs, and therefore, no additional sampling for VOCs was conducted. No perched groundwater was identified at Site 5D. Soil samples collected during the RI evaluated in this RI/FS are labeled with the prefix "05D-." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil at Site 5D are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.1.6 *Former Company Store*

A vehicle and refrigeration unit repair and maintenance facility was located on the west side of the FCS. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "FCS-." Locations from which groundwater samples were collected at the FCS include: Well 868 within the perched groundwater zone and vapor extraction wells FCS-SVE1 and FCS-SVE2. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site FCS are summarized below.

Human Risk

- **Residential:** Risk above RTLs (ILCR) due to PCE and chloroform in soil vapor. No risk above RTLs in soil. PCE and chloroform in soil vapor at multiple locations
- **Commercial:** Risk above RTLs (ILCR) due to PCE and chloroform in soil vapor. PCE (FSC-SP07 and FCS-SP10) and chloroform (FSC-SP03

and FCS-SP17) above RTLs detected in only two soil vapor samples each. No risk above RTLs in soil.

- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater Risk

- PCE at concentrations above its VLEACH SVSL was detected in soil vapor samples collected at FCS. However, the distribution of the soil vapor samples with PCE above its VLEACH SVSL indicates that the presence of PCE in soil vapor is likely due to the migration of VOCs from the perched groundwater and does not currently result in concentrations of PCE in the unconfined groundwater above the PQL of 0.05 µg/L.

Surface Water Risk

- No significant risk to surface water.

7.2.1.7 Site C29

Site C29 is an open area of land on the north side of Aerojet Road identified by the USEPA in a 1957 aerial photograph as a possible waste burial site. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "C29-." Evaluation of the site data presented in the approved Workplan indicated that the dense lithologic material underlying Site C29, as evidenced by the probe refusal encountered at 4 to 5 feet bgs during soil vapor sampling, is not conducive to the occurrence of perched groundwater. Therefore, no investigation of perched groundwater was conducted at Site C29.

Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site C29 are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.1.8 Site D(e)

Site D(e) consists of three ponds formerly used to contain backwash water from the filtration plant. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "D(e)-". An attempt to collect a screening-level groundwater sample at Site D(e) during the Stage 1 RI was unsuccessful due to auger refusal at 8 feet bgs. Therefore, no perched groundwater samples were collected at Site D(e). Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site D(e) are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.1.9 Site C32

Site C32 was an area of debris encompassing approximately 1.1 acres along the north side of Aerojet's property. The debris is believed to have originated from a junkyard (referred to as Wim's Acres) adjacent to Aerojet, as well as other dumping not authorized by Aerojet. The debris was removed in September and October 2001. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "C32-." No perched groundwater wells are located at Site C32 and perched groundwater was not encountered during the debris removal

activities at this site. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site C32 are summarized below.

Human Risk

- **Residential:** No risk above the RTL due to chemicals in soil vapor. Risk above the RTL (HI and blood lead) due to iron and lead in soil. Because iron is an essential nutrient and substantial amount of uncertainty is associated with the NCEA provisional iron reference dose, iron in soil at one location (C32-SS02) at this site is unlikely to pose a substantial threat to human health. Lead above RTL (blood lead) was detected in only one sample at one location (C32-SS01).
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.1.10 *GET D Groundwater Treatment Facility*

The GET D Groundwater Treatment Facility was constructed in 1981 to treat VOCs in extracted groundwater (Figures 1-1 and 4-10). Soil vapor samples were collected at 10 feet bgs at the GET D facility during the PGOU RI in October 2005. No soil or potential perched groundwater samples have been collected at the GET D facility. Soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "GET D-." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil vapor at Site GET D are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.1.11 Site C41

Site C41 consists of a former railcar siding south of Aerojet Road. In 1991 and 1992, secondary containment was constructed at the site and perchlorate and water solutions from the Aerojet RCRA facility were transferred from trucks to railcars for shipment to an off-site treatment facility. Soil, soil vapor, and screening-level groundwater samples collected at Site C41 are labeled with the prefix "C41-." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site C41 are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater Risk

As discussed in Section 6, the potential for perchlorate in soil at Site C41 to leach into and impact groundwater is likely. Additionally, the detection of perchlorate in screening level groundwater samples collected at the site indicates that perchlorate has impacted first encountered groundwater beneath the site.

Surface Water Risk

- Perchlorate in shallow soils at Site C41 could migrate into surface water.

7.2.2 *Summary of Risk Assessment – Sites in Area 49 and Western Portion of Aerojet Site*

The HHRA results for each of the PGOU sites within Area 49 and the western portion of the Aerojet property under residential, commercial/industrial worker, construction worker, and maintenance worker scenarios, along with the current and planned future land use, are summarized in Table 7-2 and below. Additionally, the results of the SLERA and evaluation of the potential for chemicals to migrate into and adversely affect beneficial uses of groundwater and surface water are also summarized below.

Total estimated ILCRs and adult/child HIs at individual sampling locations within Area 49 under a residential, commercial/industrial, construction worker, and maintenance worker scenarios are presented in Figures 7-4 through 7-7.

For the human health risk, the RTLs used in the following discussion are:

- ILCRs are less than 1×10^{-6};
- HIs are less than 1; and
- Blood lead estimates are less than 10 µg/dL.

7.2.2.1 *Sites 32D, 34D, 35D, and 38D*

Sites 32D, 34D, and 38D are sections of unlined ditch in the Central Portion of Area 49. Other features associated with former buildings in the area of the unlined ditches included sumps and USTs. Site 35D consists of two sumps and a septic tank at former Building 49014 and the area surrounding Building 49014. Soil and soil vapor samples evaluated in this RI/FS are labeled with the prefixes "32D-", "34D-", "35D-", and "38D-". The data indicated that VOCs detected in some soil vapor samples collected near Site 36D represent the outer fringe of the VOC plume originating from Sites 32D, 34D, 35D, and 38D; therefore, select soil vapor locations from Site 36D are included in the Central Portion of Area 49 (see Section 7.2.2.3 for description). Perched groundwater monitoring wells evaluated in the RI/FS are identified as Wells 802, 805, 808, and 855. Potential risks to human and ecological receptors, ground water, and surface water posed by chemicals in soil and soil vapor at Sites 32D, 34D, 35D, and 38D in the Central Portion of Area 49 are summarized below.

Human Risk

- **Residential:** No risk above RTLs in soil. Risk above RTLs (HI and ILCR) due to the presence of TCE; PCE; chloroform; 1,1-DCA; 1,2-DCA; 1,1-DCE; cis/trans 1,2-DCE; vinyl chloride; and/or benzene in multiple soil vapor samples. Risk posed by soil vapor was calculated using historical data collected in 1992 and 1993 during the Stage 1 RI. VOC concentrations in soil vapor have likely attenuated in the past 16 years.
- **Commercial:** No risk above RTLs in soil. Risk above RTLs (HI and ILCR) due to the presence of TCE; PCE; chloroform; 1,1-DCA; 1,2-DCA; 1,1-DCE; cis/trans 1,2-DCE; vinyl chloride; and/or benzene in multiple soil vapor samples. Risk posed by soil vapor was calculated using historical data collected in 1992 and 1993 during the Stage 1 RI.
- **Construction:** No risk above RTLs in soil. Risk at Site 38D above RTL (HI and ILCR) due to presence of TCE, cis/trans-1,2-DCE, and vinyl chloride in two soil vapor samples. Risk posed by soil vapor is based on historical data collected in 1992 and 1993 during the Stage 1 RI.
- **Maintenance:** No risk above RTLs in soil. Risk above RTLs (HI and ILCR) at Sites 32D, 35D, and 38D due to presence of TCE, PCE, 1,2-DCA, cis/trans-1,2-DCE, chloroform, and/or vinyl chloride in soil vapor samples. Risk posed by soil vapor based on historical data collected in 1992 and 1993.

Ecological Risk

- No significant ecological risk.

Groundwater Risk

- Risk to groundwater posed by the presence of PCE, TCE and/or vinyl chloride in soil vapor at concentrations above their VLEACH SVSLs (Section 6.2.4.2), indicating the potential to migrate into groundwater.

Surface Water Risk

- No significant risk to surface water.

7.2.2.2 *Site 33D*

Site 33D is a small sump at the northeast corner of Building 49010. Soil and soil vapor samples evaluated in the RI/FS are labeled with the prefix "33D." During the Stage 1 RI, a screening-level groundwater sample was

collected from a boring approximately 100 feet downgradient of the chemical sump at Site 33D. No perched groundwater was encountered during the drilling of soil boring 33D-SB01 during the recent investigation at Site 33D. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 33D are summarized below.

Human Risk

- **Residential:** No risk above RTLs in soil. Risk above RTLs (ILCR) due to presence of TCE and/or chloroform in soil vapor. TCE detected in soil vapor at multiple depths at a single location (33D-SP05). Chloroform detected in soil vapor at multiple locations.
- **Commercial:** No risk above RTLs due to soil. Risk above RTL (ILCR) due to presence of chloroform in soil vapor at multiple depths at a single location (33D-SP09).
- **Construction:** No risk above RTLs.
- **Maintenance:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater Risk

- As discussed in Section 6, TCE and benzene at concentrations greater than their respective VLEACH SVSLs were detected in soil vapor samples collected at Site 33D. The data indicates that TCE and benzene are isolated to a few locations and is limited in extent.

Surface Water Risk

- No significant risk to surface water.

7.2.2.3 *Site 36D*

Site 36D consists of an abandoned underground chemical waste tank approximately 40 feet north of Building 49015 and a degreaser sump within Building 49015. Soil and soil vapor samples evaluated in the RI/FS are labeled with the prefix "36D-" and "49ST15-", with the exceptions of soil vapor samples 36D-SP17, 36D-SP18, 36D-SP-19, and 36D-SP20 (TCE, PCE, and chloroform detected in these samples are related to Site 38D).

The risks associated with these samples are therefore included in the summary for Site 38D.

Groundwater wells near Site 36D include perched groundwater well (858) and unconfined groundwater well (804). No perched groundwater was encountered during the recent soil vapor sampling activities. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 36D are summarized below.

Human Risk

- **Residential:** No risk above RTLs
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.
- **Maintenance:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.2.4 Site 37D

Site 37D consists of an inactive waste tank, sump, and septic tank at the western end of Building 49016. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "37D-. " No perched groundwater has been identified at Site 37D. One shallow unconfined groundwater well (Well 803) exists at Site 37D but was dry and therefore not sampled. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 37D are summarized below.

Human Risk

- **Residential:** No risk above RTLs in soil. Risk above RTLs (ILCR) due to TCE in soil vapor at only one depth at one location (37D-SP08). ILCR for TCE in soil vapor sample estimated at 1×10^{-6} with all other detections of VOCs less than 1×10^{-6}.
- **Commercial:** No risk above RTLs.

- **Construction:** No risk above RTLs.
- **Maintenance:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater Risk

- As discussed in Section 6, TCE at a concentration above its VLEACH SVSL was detected in soil vapor samples collected at only one (37D-SP08) of five locations at Site 37D. The data does not indicate that TCE is present in soil vapor at Site 37D at concentrations that could pose a significant threat to groundwater.

Surface Water Risk

- No significant risk to surface water.

7.2.2.5 Site 39D

Potential Source Site 39D is a former drum storage area south of Building 49007. Soil and soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "39D-." No perched groundwater was encountered during the RI sampling. Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site 39D are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.
- **Maintenance:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.2.6 *Area 49 Septic Tanks*

Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil vapor near three septic tanks associated with Buildings 49007, 49011, and 49022 within Area 49 are summarized below. Soil vapor samples collected during the RI are evaluated in this RI/FS are labeled with prefixes "49ST07-", "49ST11-", "49ST22-".

Human Risk

- **Residential:** No risk above RTLs in soil. Risk for septic tanks at Buildings 49007 (49ST07-SP02) above RTLs (ILCR) due to presence of chloroform in soil vapor. Risk for septic tank at Building 49022 above RTLs due to presence of benzene in one sample (49ST22-SP03). ILCR for Chloroform in soil vapor sample collected at Building 49011 (49ST11-SP03) estimated at 1×10^{-6} with all other detections of VOCs less than 1×10^{-6}.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.
- **Maintenance:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater Risk

- As discussed in Section 6, benzene at concentrations greater than its VLEACH SVSL was detected in soil vapor samples collected at the Building 49022 Septic Tank. The data indicates that benzene is isolated to one location and is limited in extent.

Surface Water Risk

- No significant risk to surface water.

7.2.2.7 *Site C4*

Site C4 is a former debris site in the southwestern portion of the Aerojet facility, just west of the junction of a primary dirt road and the railroad tracks. Evaluation of the soil data for Site C4 presented in the approved Workplan indicated that any constituents detected at the site would be

limited to surface soil and unlikely to represent a threat to groundwater. Therefore, no soil vapor, perched or unconfined groundwater investigation has been performed at Site C4.

Soil samples collected during the RI that are evaluated in this RI/FS are labeled beginning with "C4-." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site C4 are summarized below.

Human Risk

- **Residential:** Risk above RTLs (HI, ILCR, and blood lead) due to presence of lead in two (C4-SNS01 and C4-SNS07) surface soil samples and dioxin and furans and iron in one (C4-SNS02) surface soil sample. No risk above RTLs from soil vapor.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.2.8 Site C10

Site C10 is a section of a concrete-lined ditch west of Schnitzer Steel and Beck's Furniture. Evaluation of the site data for Site C10 indicated that constituents detected at the site did not represent a likely threat to groundwater. Therefore, no perched groundwater investigation has been performed for Site C10.

Soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "C10-." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site C10 are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.

- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.2.9 Site C14

Site C14 is an east-west trending ditch along the northern border of the Aerojet property, north of Building 49-001, and west of Building 49-011. Evaluation of the site data for Site C14 indicated that constituents detected at the site did not represent a likely threat to groundwater. Therefore, no perched groundwater investigation has been performed for Site C14.

Soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "C14-." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site C14 are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.2.10 Sites C15

Site C15 consists of an east-west drainage swale or shallow drainage ditch that received surface water runoff from warehouses at the west end of Area 4900 and a low-lying area that received surface water runoff via the drainage swale and from land adjacent to Schnitzer Steel. Evaluation of the site data for Site C15 indicated that constituents detected at the site did

not represent a likely threat to groundwater. Therefore, no perched groundwater investigation has been performed for Site C15.

Soil vapor samples collected during the RI evaluated in this RI/FS are labeled with the prefix "C15-." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil and soil vapor at Site C15 are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water.

7.2.2.11 *Potential Lead-Based Paint*

Surface and near surface samples were collected adjacent to buildings (49001, 49002, 49003, 49004, 49011, 49017, 49020, 49021, 49023, and 49026) to assess the presence of lead in soil around former and existing structures resulting from the historical use of lead-based paint (Figure 5-3).

Soil samples collected and analyzed for lead-based paint are labeled with the prefix "A49-LBP." Potential risks to human and ecological receptors, groundwater, and surface water posed by chemicals in soil are summarized below.

Human Risk

- **Residential:** No risk above RTLs.
- **Commercial:** No risk above RTLs.
- **Construction:** No risk above RTLs.

Ecological Risk

- No significant ecological risk.

Groundwater and Surface Water Risk

- No significant risk to groundwater or surface water

7.2.3 *Summary of Risk Assessment Results for All Sites within the Perimeter Groundwater Operable Unit*

The table below summarizes the risk for each site under each scenario (residential, commercial/industrial, constructions, and/or maintenance scenarios) as presented in Sections 7.2.1 and 7.2.2. Sites with risks above their respective RTLs are shaded. Sites without shading are those having no risk above RTLs and therefore do not warrant further evaluation or remedial action. Sites with cross-hatching are those that fall into a gray area (i.e., risk due to single detection or risks not significantly above RTLs) where evaluation of other evidence may conclude that the risk does not warrant remedial action. Evaluation of those "gray" sites is presented in the following subsections.

	Residential Risk	**Comm. Worker Risk**	**Const. Worker Risk**	**Maint. Worker Risk**	**Eco Risk**	**GW/ SW Risk**
Areas 20 and 21						
4D						
11D						
10D						
7D						
5D						
FCS						
C29						
D(e)						
C32						
GET D						
C41						
Area 49 and Western Aerojet Site						
32D						
34D						
35D						
38D						
33D						
36D						
37D						
39D						
Bldg 49007 ST						

	Residential Risk	Comm. Worker Risk	Const. Worker Risk	Maint. Worker Risk	Eco Risk	GW/ SW Risk
Bldg 49011 ST						
Bldg 49022 ST						
C4						
C10						
C14						
C15						

Notes:

Comm – Commercial

Const – Construction

Eco – Ecological

GW/SW – Groundwater and surface water

Maint – Maintenance

7.2.3.1 *Residential Risk Cross-Hatching*

Soil

Sites with crossed-hatched areas under residential risk are those where risks above the RTL are: 1) due to the presence of chemicals in only one sample that is bounded by samples with no risk, or 2) due to iron, an essential nutrient. These sites include C32, 37D, Building 49007 Septic Tank, and Building 49022 Septic Tank.

At Site C32, the presence of iron at elevated concentration in one (C32-SS02) sample resulted in an HI greater than 1. As discussed in Section 7.2.1.9, substantial uncertainties surround the potential risk posed by iron, an essential nutrient. The presence of iron at an elevated concentration in only one sample is unlikely to pose a significant threat to human health. In addition, one sample (C32-SS01) had a lead concentration (175 mg/kg) which exceeded the blood lead threshold for a child resident. The blood lead estimates for the adult resident, commercial, and construction worker scenarios are all below regulatory thresholds for C32. In addition, the other samples at C32 had blood lead estimates for a child resident below the regulatory threshold of 10 µg/dL (ranging from 6.5 to 7.4 µg/dL). Based on the evaluations described above, iron and lead at Site C32 are unlikely to pose a substantial threat to human health and therefore were not evaluated in this FS.

One soil sample (7D-CS01) at Site 7D had a lead concentration (139 mg/kg) which exceeded the blood lead threshold for a child resident[1]. The blood lead estimates for the adult resident, commercial, and construction worker scenarios are all below regulatory thresholds for Site 7D. In addition, the other samples at 7D had blood lead estimates for a child resident below the regulatory threshold of 10 µg/dL (ranging from 5.5 to 9.9 µg/dL). Based on the evaluations described above, lead at Site 7D is unlikely to pose a substantial threat to human health and therefore was not evaluated in this FS.

Soil Vapor

The cumulative ILCR from soil vapor under a residential scenario slightly exceeded the *de minimus* risk of 1×10^{-6} in one sample (37D-SP08; 3×10^{-6}) at Site 37D and one sample (49ST11-SP03; 2×10^{-6}) at Building 49011. In each of these samples, no individual compounds were above the *de minimus* risk of 1×10^{-6}.

The cumulative ILCR estimated for Buildings 49007 and 49022 exceeded the *de minimus* risk of 1×10^{-6} in one sample at each location under a residential scenario as described below:

- 49ST07-SP02 – The cumulative ILCR is estimated 4×10^{-6} (migration of VOCs into indoor air). The only individual compound above the *de minimus* risk of 1×10^{-6} is chloroform (4.4×10^{-6}).
- 49ST22-SP03 - The cumulative ILCR is estimated 5×10^{-6} (migration of VOCs into indoor air). The only compound above the *de minimus* risk of 1×10^{-6} is benzene (3.3×10^{-6}) in one sample (33D-SP03). Three of the five samples collected in the surrounding area did not have detections of benzene above the method reporting limit. The estimated ILCR for benzene detected in the one other sample is 1.1×10^{-7} (49ST22-SP02).

The risk estimates for the commercial, construction, and maintenance worker scenarios for Buildings 49011 and 49022 are all below regulatory thresholds.

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[1] Site 7D was not cross-hatched on the table because soil vapor concentrations exceeded RTLs in addition to the one lead result described in this paragraph.

At Site 11D, the cumulative ILCR for one sample (11D-SP22) is estimated at 3×10^{-6} (migration of VOCs into indoor air)[2]. The only compound in the sample above the *de minimus* risk of 1×10^{-6} is chloroform (3.3×10^{-6}). Six of the nine vapor samples collected in Site 11D did not have detections of chloroform above the method reporting limit. The estimated ILCR for the other chloroform detections at Site 11D are 9.3×10^{-7} (11D-SP21) and 1×10^{-6} (11D-SP20).

Based on the evaluations described above, VOCs at Sites 11D, 37D, and the Septic Tanks for buildings 49007, 49011 and 49022 are unlikely to pose a substantial threat to human health and therefore were not evaluated in this FS.

7.2.3.2 *Commercial Risk Cross-Hatching*

The cumulative ILCR from soil vapor under a commercial scenario exceeded the *de minimus* risk of 1×10^{-6} in one sample at multiple depth at Site 33D (33D-SP09 at 10 feet; 1×10^{-5} and 33D-SP09 at 20 feet; 6×10^{-6}). In each of these samples, no individual compounds were above the *de minimus* risk of 1×10^{-6}. The only individual compound above the *de minimus* risk of 1×10^{-6} is both of these samples chloroform (1.0×10^{-5} and 5.5×10^{-6}). Four of the eleven samples collected in the surrounding area did not have detections of benzene above the method reporting limit. The estimated ILCR for chloroform detected in the other seven samples ranged from 6.6×10^{-7} to 2.3×10^{-7}. Based on the evaluations described above, VOCs at Site 33D are unlikely to pose a substantial threat to human health under a commercial land use scenario and therefore were not carried forward for evaluation of remedial action in this FS.

7.2.3.3 *Groundwater and Surface Water Risk Cross-Hatching*

Sites with crossed-hatched areas are those where constituents were detected above the VLEACH SVSL. These sites include 7D, the FCS, 33D, 37D, and Building 49022 Septic Tank. However, as discussed in Section 6, remedial action is not warranted at these locations due to one or more of the following reasons:

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[2] Site 11D was not cross-hatched on the table because soil concentrations exceeded RTLs in addition to the one soil vapor result described in this paragraph.

- Groundwater data shows that constituents from soil and perched groundwater, if any, do not currently result in concentrations in the unconfined groundwater above the PQL.
- The distribution of the soil vapor samples indicates that the presence of constituents in soil vapor is likely due to the migration of VOCs from the current or historical perched groundwater.
- The distribution of the soil vapor samples above the respective VLEACH SVSL is not indicative of the presence of a collective mass in soil that could be effectively remediated using vapor extraction.
- Detections of constituents above respective VLEACH SVSL is limited to only a few locations and is limited in extent; therefore, the implementation of soil vapor extraction to remediate these areas would not be cost-effective.

Based on the evaluations presented in Section 6, VOCs at 7D, FCS, 33D, 37D, and Building 49022 Septic Tank are unlikely to pose a substantial threat to groundwater and surface water and therefore were not carried forward for evaluation of remedial action in this FS.

7.3 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES AND CLEANUP GOALS

The summary of human health and ecological risk assessment results presented in Section 7.2 indicate that in most instances, estimated risks to human health above RTLs under the various land use scenarios are generally due to the presence of only a few chemicals, referred to as risk drivers, in soil and/or soil vapor.

Remedial action objectives (RAOs) are developed to address the potential health risks posed by the chemical risk drivers in soil and soil vapor and to ensure groundwater resources are protected. RAOs consist of chemical-specific and medium-specific goals for protecting human health and the environment (ecological receptors and waters of the state) under current and potential future land use scenarios. These serve as the performance objectives for remediation.

The process for developing RAOs consists of the following steps:

- Identify levels of risk and affected media to protect human health and the environment;

- Identify current and anticipated future beneficial uses of site resources and potential exposure scenarios associated with each use.
- Identify and evaluate laws and regulatory standards that are potential applicable or relevant and appropriate requirements (ARARs).
- Incorporate laws and regulatory standards that are, in fact, ARARs, and that provide medium-specific site remedial requirements.
- Develop cleanup goals (CGs) that incorporate ARARs and are protective of human health and the environment.

This section identifies current and future planned beneficial uses of the lands within the PGOU, presents remedial action objectives (RAOs), and describes the development of CGs to achieve the RAOs. Additionally, applicable or relevant and appropriate requirements (ARARs) used in the development of the RAOs and CGs are also discussed.

7.3.1 Identification of Risk and Affected Media

The HHRA indicated that metals, PCBs, and dioxins and furans were present in soil and VOCs were present in soil vapor above their respective RTLs under one or more of the defined exposure scenarios (residential, commercial, construction, and maintenance). Specifically, the HHRA indicated the following (Tables 7-1 and 7-2):

- Residential Land Use - VOCs detected above RTLs at Sites 7D, 11D, 32D, 33D, 34D, 35D, 37D, 38D, FCS and Septic Tanks at Buildings 49007, 49011, and 49022. PCBs detected above RTLs at Sites 10D and 11D. Metals (mercury, lead, silver, iron, and lead) detected above RTLs at Sites 7D, 10D, 11D, C32, and C4.

- Commercial Land Use - VOCs detected above RTLs at FCS, and Sites 32D, 33D 34D, 35D, and 38D. PCBs detected above RTLs at Site 10D.

- Construction Worker Scenario - VOCs detected above RTLs at Site 38D. Metals (hexavalent chromium) detected above RTLs at Site 10D.

- Maintenance Worker Scenario – VOCs above RTLs at Sites 32D, 35D, and 38D.

In addition, the evaluation presented in Section 6 of this report indicated that perchlorate in soil at Site C41 and VOCs (PCE, TCE, and/or vinyl chloride) in soil vapor at Sites 32D, 34D, 35D, and 38D in Area 49 have the

potential to migrate into groundwater and adversely affect groundwater quality.

As previously discussed, the SLERA concluded that chemicals in soil and soil vapor at the sites within the PGOU did not pose a significant risk to ecological receptors.

7.3.2 *Identification of Beneficial Uses and Exposure Scenarios*

Current and future potential beneficial uses of the soil sites in Areas 20, 21, and 49 within the PGOU and associated potential exposure scenarios are described below.

7.3.2.1 *Current Beneficial Uses*

The Aerojet site is zoned for industrial use, and facilities are grouped into manufacturing areas consisting of multiple buildings. None of the sites addressed in this RI/FS are located within buildings. Many of the sites in Area 49 are associated with historical activities conducted at various buildings and are located adjacent to or in close proximity to existing buildings currently in use by Aerojet.

7.3.2.2 *Anticipated and Planned Future Beneficial Uses*

Aerojet's anticipated redevelopment of the property includes a mixture of residential and commercial land use. Current development plans for the soil sites in Areas 20, 21, and 49 addressed in this RI/FS are site-specific and include both residential and commercial uses. Additionally, the anticipated future land use for some sites (32D, 34D, 35D, and 38D) in Area 49 is a cloverleaf roadway interchange. In addition to Aerojet's planned future use, the Agencies have demanded an evaluation for residential use at each site. Planned future land uses for each of the areas and sites addressed in this RI/FS are specified in Tables 7-1 and 7-2.

7.3.2.3 *Exposure Scenarios*

The anticipated future land uses of the sites within the PGOU include residential and commercial development. In addition to adult/child residents and commercial/industrial workers, construction workers and maintenance workers also have the potential to be exposed to chemicals in soil and soil vapor.

7.3.3 *Applicable or Relevant and Appropriate Requirements*

Site characterization and remediation conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, requires the identification and consideration of Applicable or Relevant and Appropriate Requirements (ARARs). ARARs include standards, criteria, or limitations that have been promulgated under federal or state law.

A requirement may be either applicable or relevant and appropriate, but not both. Applicable requirements are those remedial standards, standards of control, or other environmental protection criteria or limitations that are promulgated under federal or state law that specifically address hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances at the site. Relevant and appropriate requirements are those promulgated federal and state requirements that, while not applicable to the circumstances at the site, address problems or situations sufficiently similar to those encountered at CERCLA sites that their use is well suited to the target site of concern.

In guidance on the identification of ARARs (*CERCLA Compliance with Other Laws Manual,* Interim Final, Part I, August 1988, and Part II, August 1989, Office of Solid Waste and Emergency Response [OSWER] Directives 9234.1-01 and 9234.1-02) (USEPA, 1988b, 1989a), USEPA identifies three categories of ARARs: chemical-specific; action-specific; and location-specific. A description of the three categories is provided below.

- Chemical-specific ARARs are numerical standards set by various regulatory and government agencies that indicate the concentrations of certain compounds permitted in air, soil, groundwater, surface water, and sediments.
- Action-specific requirements generally set performance, design, or other similar action-specific controls or restrictions on site activities related to the management of hazardous substances. Action-specific ARARs will impact all activities that may be performed at the site.
- Location-specific ARARs are restrictions placed on the conduct of activities solely because they are in specific locations. These ARARs may include restrictions such as those imposed on activities conducted in floodplains or in areas that may experience earthquake activity.

In addition to laws, regulations, and policies that are either directly applicable, or relevant and appropriate, certain other items may have some rational reason warranting their consideration as an ARAR. Information "to be considered" (TBC) includes advisories or guidance documents issued by regulatory agencies that are not legally binding. TBCs may influence the selection of a remedy to allow the optimal remedy to be identified. TBCs can also be divided into chemical-specific, action-specific, and location-specific types.

7.3.3.1 *ARAR Selection Considerations*

The following points were considered in selecting ARARs:

- As stated in the federal regulations, "applicable" requirements are those that apply to the release or remedial action contemplated, based on an objective determination of whether the requirement specifically addresses a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at the site [40 CFR 300.400(g)(1)].
- Federal regulations describe "relevant and appropriate" requirements as those that address problems or situations sufficiently similar to the circumstances of the release or remedial action contemplated, and that are well suited to the site (40 CFR 300.400[g][2]).
- Federal regulations identify the following comparisons that should be made when pertinent to determine relevance and appropriateness:
  - The purpose of the requirements and the purpose of the action;
  - The medium regulated or affected by the requirement and the medium contaminated or affected at the site;
  - The substances regulated by the requirement and the substances found at the site;
  - The actions or activities regulated by the requirement and the actions contemplated at the site;
  - Any variances, waivers, or exemptions of the requirements, and their availability for the circumstances at the site;
  - The type of place regulated and the type of place affected by the release or action;
  - The type and size of structure or facility regulated, and the type and size of structure or facility affected by the release; and

- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource at the site (40 CFR 300.400 [g][2]).

Finally, one means of complying with ARARs involves meeting the requirements and conditions associated with a variance or exemption provision (55 Federal Register [FR] 8741 [8 March 1990]). Variances are incorporated because there are specific circumstances where compliance with a requirement may be inappropriate for technical reasons, or unnecessary, to protect human health and the environment (55 FR 8744).

7.3.3.2 *Summary of Applicable, Relevant, or Appropriate Requirements*

The ARARs identification and selection process was conducted as described above. ARARs were identified for all three categories (chemical-specific, action-specific, and location-specific). In addition, TBCs were identified. The identified ARARs and TBCs are summarized below. The individual regulatory citations are provided in Table 7-3.

<u>Chemical-Specific ARARs</u>

Chemical-specific ARARs are numerical standards set by various regulatory and government agencies that indicate the concentrations of certain compounds permitted in air, soil, groundwater, surface water, and sediments. Several chemical-specific ARARs were identified for compounds detected in soil at the site. These ARARs apply to all remedial alternatives developed in this FS.

<u>Action-Specific ARARs</u>

Action-specific requirements generally set performance, design, or other similar action-specific controls or restrictions on site activities related to the management of hazardous substances. Action-specific ARARs will impact all of the activities that may be performed at the sites. The types of activities under consideration include:

- Soil vapor extraction (SVE) and on-site treatment of vapors;
- Soil excavation and disposal;
- Soil excavation and on-site treatment;
- Land use covenants; and
- Construction of commercial facilities.

Various laws and regulations affect these activities. The action-specific ARARs include:

- Air emissions standards promulgated by the Sacramento Metropolitan Air Quality Management District (SMAQMD);
- Worker health and safety regulations promulgated by the California Occupational Safety and Health Administration; and
- Resource Conservation and Recovery Act/California requirements for generation, handling, storage, and transportation of hazardous wastes.

These ARARs are summarized in Table 7-3.

Location-Specific ARARs

Location-specific ARARs are restrictions placed on the conduct of activities solely because they are in specific locations. One location-specific ARAR, concerning seismic standards, has been identified for the site. Because the site is located in an area that may experience earthquake activity, all construction activities need to comply with California seismic design and construction standards (California Uniform Building Code, California Code of Regulations, Title 24 Part V, Chapter 23, Part III – Earthquake Design). These standards apply to temporary or permanent structures only; portable structures and equipment are exempt.

To Be Considered Information

To be considered (TBC) information includes advisories or guidance documents issued by regulatory agencies that are not legally binding. Chemical-specific TBCs were identified as applicable to the site (Table 7-3). These requirements apply mainly to action levels for compound concentrations in groundwater set by federal and state agencies.

7.3.4 *Remedial Action Objectives*

Remedial action objectives (RAOs) developed for the sites in Areas 20, 21, and 49 within the PGOU based on the results of the HHRA and the protection of groundwater evaluation, the exposure pathways identified for the chemicals detected above their RTLs, and current and future beneficial uses for the sites, and ARARs are presented below.

- Prevent exposure to volatile constituents released into indoor and ambient air from soil vapor at concentrations in excess of the health-based levels for the proposed land use;
- Prevent exposure (i.e., incidental ingestion, dermal contact, and inhalation of fugitive dust) to soil having constituent concentrations in excess of the health-based levels for the proposed land use; and
- Prevent the migration of VOCs in soil vapor into groundwater at concentrations that would adversely affect the beneficial uses of that resource.

7.4 DEVELOPMENT OF CLEANUP GOALS

Chemicals (risk drivers) present in soil at the sites within the PGOU resulting in risks above the residential, commercial, and/or construction worker RTLs include hexavalent chromium, iron, lead, silver, PCBs, and dioxins and furans. Chemicals (risk drivers) present in soil vapor at the sites within the PGOU include TCE; PCE; chloroform; 1,1-DCA; 1,2-DCA; 1,1-DCE; cis/trans 1,2-DCE; and/or benzene. Chemicals present in soil at sites within the PGOU that could potentially adversely affect the beneficial uses of groundwater were TCE; 1,2-DCE, and perchlorate. The elimination of those chemicals or a reduction in their concentrations in soil and soil vapor would achieve the RAOs.

Cleanup goals (CGs) were developed for those chemicals of concern (COCs) identified in the HHRA as being present in soil and soil vapor at the PGOU sites at levels that pose an unacceptable risk to human health under the identified exposure scenarios (residential, commercial/industrial, construction, and maintenance). As previously discussed, the SLERA concluded that the chemicals in soil and soil vapor at the sites within the PGOU did not pose a significant threat to ecological receptors. Therefore, CGs were not developed for the protection of ecological receptors. Additionally, other criteria (e.g., ARARs and protection of groundwater) were considered in developing CGs for VOCs in soil vapor and perchlorate in soil for the protection of groundwater. The CG for each chemical represents the concentration in each media (soil, soil vapor) and under each scenario below which it would no longer exceed its RTL and pose an unacceptable risk.

7.4.1 *Health-Based Cleanup Goals*

Health-based CGs were developed based on the risk assessment results and USEPA's acceptable risk range of 10^{-6} to 10^{-4} and noncarcinogenic effects range of 0.1 to 1.0 The following simplistic equation was used to calculate health-based CGs for chemicals in soil and soil vapor:

$$[Media]_t = \frac{[Media]_c \times Risk_t}{Risk_c}$$

Where:

$[Media]_t$	=	Health-based CG for COPC in the media (*e.g.*, mg/kg in soil)
$[Media]_c$	=	Current concentration of COPC in the media (*e.g.*, mg/kg in soil)
$Risk_t$	=	Acceptable carcinogenic or non-carcinogenic risk level (unitless)
$Risk_c$	=	Current carcinogenic or non-carcinogenic risk level (unitless)

Human-based cleanup goals for chemicals in soil and soil vapor were calculated for all COCs identified in the HHRA (Tables 7-4 and 7-5).

7.4.2 *Soil Remedial Goals for the Protection of Groundwater*

As discussed in Section 6, perchlorate was detected at Site C41 at concentrations having the potential to migrate into groundwater above water quality objectives. Therefore, a cleanup goal for the protection of groundwater was estimated for perchlorate (Table 7-4). The cleanup goal for perchlorate of 0.06 mg/kg was developed using the approach outlined in the *Designated Level Methodology for Waste Classification and Cleanup Level Determination* (RWQCB, 1989) where:

Cleanup Goal =
(Water Quality Goal) X (Leachability Factor) X (Attenuation Factor)

Where:

Water Quality Goal = Public Health Goal of 0.006 mg/L;

Leachability Factor = 1; and

Attenuation Factor = 10.

7.4.4 *Soil Vapor Remedial Goals for the Protection of Groundwater*

There are no contaminant-specific ARARs that dictate a numeric remedial goal for soil vapor for the protection of groundwater. Therefore, the VLEACH SVSLs developed in Section 6.2.1 were selected as the cleanup goals (Table 7-5). As discussed in Section 6.2.1, VLEACH SVSLs were developed for 1,1,1-TCA, benzene, Freon 113, PCE, TCE, and vinyl chloride at depths of 10, 15, 20, and 30 feet bgs. Conversion calculations for the VLEACH depth-specific soil concentrations to depth-specific SVSLs are presented in Table 6-2.

7.5 *AREAS AND VOLUMES OF IMPACTED SOIL*

The area and volume of soil at each site in Areas 20 and 21 and Area 49 within the PGOU containing chemicals at concentrations above their exposure scenario specific CGs were estimated following the recommendations presented in the *Measure and Calculations for Volume of Contaminated Medium Addressed with Respect to the Superfund and RCRA Corrective Action Programs* (USEPA, 2003).

An estimate of the area and volume of soil containing chemicals at concentrations above their cleanup goals is required to evaluate the feasibility of various soil treatment and other remedial alternatives. Areas and volumes of impacted soil are estimated for residential and commercial/industrial/construction workers based on exceedance of their health-based and protection of groundwater CGs developed in the previous section. The estimated area and volume of soil and area of soil vapor included all chemicals at concentrations exceeding the CG corresponding to an ILCR of 1×10^{-6} (one in one million) and/or an HI less than or equal to 1.

7.5.1 *Areas and Volumes of Impacted Soil – Sites in Areas 20 and 21*

Estimates of the area and volume of soil containing COCs and the area having VOCs in the vadose zone at the sites in Areas 20 and 21 at concentrations above their exposure-scenario specific CGs are provided in Tables 7-6 and 7-7, respectively. Areas containing COCs in soil and soil

vapor at concentrations above their residential/construction worker[3] and commercial/construction worker CGs are shown in Figures 7-1 and 7-2, respectively.

7.5.2 *Areas and Volumes of Impacted Soil – Sites in Area 49 and Western Portion of Aerojet Site*

Estimates of the area and volume of soil containing COCs and the area having VOCs in the vadose zone at the sites in Area 49 at concentrations above their exposure-scenario specific CGs are provided in Tables 7-6 and 7-7, respectively. Areas containing COCs in soil and soil vapor at concentrations above their residential/construction and commercial/construction/maintenance worker[4] CGs are shown in Figures 7-4 and 7-5, respectively.

7.6 *IDENTIFICATION, DEVELOPMENT, AND SCREENING OF REMEDIAL ALTERNATIVES*

This subsection identifies potential remedial technologies and process options to address impacted soil. The initial step in the identification of remedial technology types and process options is the development of general response actions (GRAs) for remediation of identified volumes and areas of affected media. GRAs must satisfy the site RAOs. Following the development of GRAs, the specific remedial technologies and process options for each GRA are identified and described.

7.6.1 *General Response Actions*

GRAs are broadly defined as general types of actions that can reduce or eliminate the adverse impact of chemicals on human health and the environment. Appropriate GRAs for the soil sites addressed in this FS have been identified as those actions that satisfy the RAOs (except for the No Action alternative). The GRAs developed for the site include:

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[3] Areas of impact identified for the construction worker are included in the residential and commercial estimates.

[4] Areas of impact identified for the construction and maintenance workers at Sites 32D, 34D, 35D, and 38D are included in the commercial estimates.

- No Action;
- Limited Action;
- Containment Action;
- Ex Situ Treatment and Discharge; and
- In Situ Treatment.

Each GRA is described below. Specific technologies applicable to each GRA and each medium are described in the subsequent portions of this section.

7.6.1.1 *No Action*

For the No Action response, no measures would be taken to contain, treat, or remove impacted soils. No steps would be taken to protect workers or the public from potential exposure. The NCP requires that this response action be evaluated.

7.6.1.2 *Limited Action*

The Limited Action response consists of minimal-cost actions that could be rapidly implemented by only administrative actions or with only minor construction and site disturbances. Limited Action responses are divided into two categories: 1) institutional controls, which limit exposure through use of legal or administrative means; and 2) engineering controls, which limit exposure through the use of physical means. The Limited Action responses have been grouped into one GRA because they are generally conducted simultaneously and represent a similar level of effort.

7.6.1.3 *Containment Action*

Containment Action responses are intended to reduce chemical constituent migration and prevent the potential for exposure of human or environmental receptors to impacted soil or soil vapor. The purpose of containment is not to reduce the actual toxicity or volume of impacted soil. Containment of affected material can be accomplished by placing a physical barrier around, beneath, and/or over the site to prevent or minimize the horizontal and/or vertical mobility of chemical constituents in soil. This GRA would include vapor mitigation.

7.6.1.4 *Ex-Situ Treatment and Discharge*

The Ex Situ Treatment and Discharge response action is intended to remove chemical mass from the soil, thereby reducing chemical concentrations in soils. This response action consists of the removal of contaminated material and treatment and/or discharge either on or off site.

7.6.1.5 *In-Situ Treatment*

The In-Situ Treatment response action is also intended to remove chemical mass from the soil and reduce chemical concentrations. However, affected media is treated in place, and removal of chemical mass is accomplished without excavating, transporting, or otherwise disturbing the impacted material.

7.6.2 *Identification of Remedial Technologies for Soil*

Eleven sites within Areas 20, 21, and 49 have soil containing VOCs, metals, PCBs, dioxins and furans, and/or perchlorate at concentrations that could result in an unacceptable risk to human receptors under one of the identified exposure scenarios or migrate into groundwater. VOCs have been identified as COPCs at Sites 7D and the FCS in Area 20 and at Sites 32D, 33D, 34D, 35D, and 38D. Metals and/or PCBs have been identified as COPCs at Sites 10D and 11D in Area 20, and metals and dioxins and furans have been identified as COPCs at Site C4 in the western portion of the site. Additionally, perchlorate has been identified as a COPC at Site C41 due to its potential to migrate into groundwater.

Each of the GRAs can be implemented using a variety of remedial technologies. A variety of sources, including USEPA publications and databases, textbooks, vendor information, and experience, have been used to identify the various technologies applicable for remediation of soil in the exposure areas.

Some of the identified technologies employ different methods of implementation, which are referred to as process options. Table 7-8 lists the remedial technologies and associated process options that were considered to address site soil and soil vapor. The USEPA document *Remediation Technologies Screening Matrix and Reference Guide* (USEPA, 1994b) was referenced to develop Table 7-8.

Technologies determined to be inappropriate based on the initial screening criteria of effectiveness, implementability, and cost were eliminated from further consideration. The rationale for retaining or eliminating particular technologies is also provided in Table 7-8.

As indicated in Table 7-8, a number of technologies were retained for further consideration. Most of the technologies are both effective and implementable. Some of them were eliminated because they are significantly more costly or less effective than others are. Based on the screening evaluation summarized in Table 7-8, the following sections describe the technologies/process options that were retained for the development of remedial alternatives.

7.6.2.1 *No Action*

Under the No Action response, no site modifications would be implemented to reduce or eliminate human health and environmental risks associated with chemicals in soil and soil vapor.

This alternative does not reduce or control potential future risk posed by chemicals in soil or soil vapor in the exposure areas. Because the alternative requires no activity, it is easily implemented. There is no cost associated with this alternative. Consideration of No Action as a technology is required by the NCP for comparison purposes; therefore, this option is retained for further evaluation.

7.6.2.2 *Limited Action*

The Limited Action responses retained include both institutional controls and engineering controls, as described below.

Institutional Controls

Institutional controls are non-engineered instruments such as administrative and/or legal controls that minimize the potential for exposure to contamination by limiting land or resource use. Land-use restrictions as a remedial technology/process involve placing restrictions on the current and future uses of the land. Several process options are available for this purpose, including zoning restrictions, land use covenants, consent decrees, unilateral administrative orders, or deed notifications. Implementing these restrictions protects workers and future residents should sale or redevelopment of the property occur. Land-use restrictions are being retained for further evaluation.

Engineering Controls

Protection of human health may be attained during future site activities through the implementation of engineering controls. These may include appropriate vapor mitigation systems installed in existing buildings or during the construction of new buildings to prevent migration of vapors released from soil into indoor air, or other preventive measures to protect site workers during future construction activities. Vapor mitigation systems may include vapor barriers (i.e., Liquid Boot™), subslab venting, and/or subslab depressurization. Vapor mitigation is being retained for further evaluation.

7.6.2.3 *Containment Action*

Containment Actions are intended to reduce chemical migration to the atmosphere; prevent the potential for exposure of human or environmental receptors to impacted soils and/or vapors; and limit infiltration of surface water, formation of leachate, and potential threat to groundwater. The USEPA has designated containment as the presumptive remedy for low-level-threat waste at metals-in-soil sites (USEPA, 1999c). Soil capping is the only containment option being considered.

Capping involves the installation of an impermeable layer (i.e., high density polyethylene [HDPE] or asphalt) on top of the soil surface overlying the impacted region. The cap prevents soil vapor from migrating to the atmosphere, water from infiltrating into the soil, and human and animal contact with the impacted soils. Capping is being retained for further evaluation.

7.6.2.4 *Ex-Situ Treatment and Disposal*

Ex-situ treatment consists of excavation of contaminated soil, treatment, and discharge. Various ex-situ soil treatment and disposal technologies were evaluated including physical, biological, chemical, and thermal options. Biological and chemical treatment options were not considered for further evaluation because they have limited effectiveness for treating halogenated VOCs, have excessive space requirements, or because they are not as cost-effective as other ex-situ (e.g., excavation and disposal) or in-situ (e.g., SVE) options. Thermal treatment options were also evaluated but removed from further consideration because of ineffective technology or prohibitively high costs. Excavation with either landfill disposal or recycling is retained for further evaluation, as described below.

Landfill Disposal

Excavation and landfill disposal of soil impacted with chemicals above cleanup goals involves the removal and stockpiling of affected soil. Each stockpile will be sampled prior to off-site disposal. Once properly characterized, the soil will be transported off site for disposal at an appropriately licensed waste management facility. No further treatment of soil on site is required. Depending on the nature and extent of soil contamination, excavated soil may be disposed of at a Class I or II landfill. Depending on the landfill requirements, chemical stabilization may be required for metals impacted material.

Excavation, chemical stabilization (as necessary), and off-site disposal is a well-proven and implementable technology. Increased costs can be associated with the distance to the nearest licensed facility, soil characterization, and possible treatment to meet the land disposal restrictions.

Recycling

Another disposal option is the recycling of excavated soils for use as road base material. Soil impacted with COCs at concentrations considered to be nonhazardous can be recycled as fill for road construction or mixed with concrete that can be used for other purposes, such as liner material for ditches.

For use as road fill construction material, the excavated soils containing COCs would be mixed with a binding agent and placed beneath the concrete or asphalt road material. The impacted soil then becomes entombed by the road surface, effectively eliminating the potential for exposure to humans and the environment. There are several factors that may limit the effectiveness and applicability of recycling soil as road base material:

- Impacted soil can only be used in areas where water levels are deep and there is no threat of groundwater contamination;
- The long-term integrity of the binding agent may be limited, with the potential for release of COCs as the material degrades; and
- Land use restrictions could possibly be placed on the roadway or ditch.

7.6.2.5 *In-Situ Treatment*

Several in-situ treatment technologies were evaluated including biological, physical/chemical, and thermal treatment process options. Although not proven effective for remediation of chlorinated solvents, enhanced bioremediation was retained because it may be applicable for the remediation of perchlorate. Due to the potential mobilization of chemicals to groundwater or the relatively high cost, several physical/chemical options the thermal treatment option (soil flushing and thermally enhanced SVE) were eliminated from further evaluation for the remediation of VOCs and metals.

SVE is the USEPA's preferred presumptive remedy for sites where soil is impacted by VOCs, and is the only in-situ technology being considered for remediation of VOCs in unsaturated zone soils. SVE involves the application of a vacuum to the subsurface to remove organic vapors from unsaturated zone soils. Vacuum is typically applied using an aboveground vacuum blower connected to a series of vertical extraction wells or horizontal extraction vents. A variety of treatment options are available to reduce organic vapor concentrations in off-gas to acceptable discharge levels; these include internal combustion engines, thermal or catalytic oxidizers, and granular activated carbon. In addition, surface capping can be combined with SVE to increase the radius of influence (ROI) of extraction wells or vents.

Enhanced bioremediation for perchlorate impacted soils involves the stimulation of naturally occurring microbes by injecting water-based solutions into impacted soils. This process enhances in-situ biological degradation of organic contaminants.

7.7 *SCREENING OF REMEDIAL TECHNOLOGIES*

The remedial technologies and process options to address impacted soils at the sites within the PGOU were identified and preliminarily screened in Section 7.6. In the following subsections, the range of remedial technologies and representative process options identified are further screened for the treatment areas using three screening criteria:

- Effectiveness;
- Implementability; and
- Cost.

Those remedial technologies and process options that best satisfy the three evaluation criteria are used to develop site-specific remedial alternatives in Section 7.8. The technologies and process options that do not satisfy the three criteria are eliminated from further consideration. Table 7-8 presents a summary of this analysis.

7.7.1 *Screening Criteria*

This subsection explains the components of each of the three screening criteria.

7.7.1.1 *Effectiveness*

Each remedial technology/process option was screened with respect to effectiveness in satisfying the RAOs. The effectiveness of a remedial technology/process option is assessed by considering:

- The ability of a remedial technology/process option to achieve the desired remedial goal for each COC;
- The degree of protectiveness to human health and the environment provided by the remedial technology/process option during construction and implementation; and
- How proven and reliable the process is with respect to site conditions.

7.7.1.2 *Implementability*

The implementability criterion evaluates the technical and administrative feasibility of a remedial technology/process option by considering the following factors:

- The institutional aspects of implementation of a remedial technology/process option, including the ability to obtain necessary permits, and public acceptance; and
- The availability of support services and equipment associated with the remedial technology/process option, and the degree to which the technology has been demonstrated at other sites.

7.7.1.3 *Cost*

This criterion is used to compare the relative capital and O&M costs of the remedial technologies/process options. During this initial screening of

remedial technologies/process options, cost is considered a minor screening criterion.

7.7.2 *Screening of Soil Remedial Technologies*

In the subsections that follow, the remedial technologies/process options discussed in Section 7.6 were screened against the three criteria described above for the sites within the PGOU. To aid in the screening process, the sites in Areas 20/21 and 49 were divided into the following FS groups based on similar COCs, affected media, and planned future land use (Table 7-9):

<u>FS Groups in Areas 20 and 21</u>

- FS Group A20-1: Sites with COCs in soil at concentrations above residential CGs (Sites 10D, and 11D). FS Group A20-1 assumes that the planned future land use is commercial.
- FS Group A20-2: Sites with VOCs in soil vapor at concentrations above residential CGs (Sites 7D and FCS). FS Group A20-2 assumes that the planned future land use is residential.
- FS Group A20-3: Sites with COCs (perchlorate) in soil below residential and commercial CGs, but above PGW CGs (Site C41). FS Group A20-3 assumes that the planned future land use is residential.

<u>FS Groups in Area 49</u>

- FS Group A49-1: Sites with VOCs in soil vapor at concentrations above residential, commercial, construction, and maintenance worker CGs and have the potential to migrate into groundwater (Sites 32D, 34D, 35D, and 38D). FS Group A49-1 assumes that the planned future land use is commercial with portions of the area serving as a roadway.
- FS Group A49-2: Sites that have VOCs in soil vapor at concentrations above residential CGs (Site 33D). FS Group A49-2 assumes that the planned future land use is commercial.
- FS Group A49-3: Sites with COCs in soil at concentrations above residential CGs (Sites C4). FS Group A49-3 assumes that the planned future land use is residential.

The remedial technology screening process for soil and soil vapor at the sites in the FS Groups above is presented in Table 7-10 and summarized below.

7.7.2.1 *FS Group A20-1: Sites 10D and 11D*

Three soil remediation technology/process options described in Section 7.6 were screened as they applied to affected soil at the sites (10D and 11D) within FS Group A20-1 considering the planned future land use (commercial). These technology process options include:

- No Action;
- Limited Action - Institutional Controls; and
- Ex-Situ Treatment – Excavation and Landfill Disposal.

No Action

This option is easily implemented and has no associated cost, but does not satisfy the effectiveness screening criteria (i.e., ability to achieve RAOs or protectiveness of human health and environment). In accordance with requirements of the NCP, however, the No Action option is retained for further evaluation.

Limited Action - Institutional Controls/ Land Use Restriction

This option meets the implementability criteria and would allow for the planned future use of the sites. A land use restriction would restrict use of the affected area(s) at both sites to commercial development and would therefore eliminate the potential exposure to residents. A land use restriction would not eliminate potential exposure to commercial workers or to construction workers who may come in contact with affected soils during trenching at Site 11D. Institutional controls may be a feasible and cost-effective option in combination with hot spot removal for the sites in FS Group A20-1; therefore, this option is retained for further evaluation.

Ex-Situ Treatment – Excavation and Landfill Disposal

This option would be effective for protection of human health and the environment and achieving residential cleanup goals for COCs (metals and PCBs) in soil. In addition, this option could be used to remove hot spots with COCs above commercial and construction worker CGs at Site 11D. The excavation of impacted soil combined with disposal at an appropriate landfill would be easy to implement and would permanently eliminate future exposures under all reuse scenarios. Therefore, this option is retained for further evaluation.

7.7.2.2 *FS Group A20-2: Sites 7D and FCS*

Three remediation technology/process options retained as a result of the analysis in Section 7.6 were screened as they applied to affected soil vapor at Sites 7D and the FCS under a residential use scenario. These technology/process options include:

- No Action;
- Limited Action - Institutional Controls and Engineering Controls (Land Use Restrictions and Vapor Mitigation); and
- In-Situ Treatment – Soil Vapor Extraction.

No Action

This option is easily implemented and has no associated costs, but does not satisfy the effectiveness screening criteria (i.e., ability to achieve RAOs or protectiveness of human health and environment). In accordance with requirements of the NCP, however, the No Action option is retained for further evaluation.

Limited Action – Institutional Controls

This option meets the implementability criteria, but institutional controls would not be effective for achieving cleanup goals. Additionally, institutional controls alone would not prevent exposure of human or ecological receptors to VOCs. However, institutional controls could be effective for reducing risks to human and environmental receptors if combined with other process options. Consequently, this option is retained for further evaluation.

Limited Action - Engineering Controls

This option could be implemented if combined with institutional controls to ensure that they are implemented and maintained. Although engineering controls such as vapor mitigation would not be effective for achieving cleanup goals, they would reduce the potential for VOCs to migrate into buildings and inhalation by humans. Based on this consideration, engineering controls are retained for further evaluation.

In-Situ Treatment – SVE

This option satisfies both the implementability and effectiveness criteria. In addition, SVE is the preferred presumptive remedy for sites impacted with VOCs (USEPA, 1993; 1996b). However, current VOC concentrations in soil vapor at Sites 7D and the FCS are just above the cleanup goals and, as discussed in Section 6, are likely due to migration from current or historical groundwater. Therefore, it is unlikely that SVE would result in a significant reduction in concentrations or be effective until VOCs are removed from the groundwater. Therefore, SVE was not retained for further evaluation as a viable option at Sites 7D and the FCS.

7.7.2.3 FS Group A20-3: Site C41

Three remediation technology/process options retained as a result of the analysis in Section 7.6 were screened as they applied to soil containing perchlorate at Site C41. These technology/process options include:

- No Action;
- Ex-Situ Treatment – Excavation and Off-site Disposal; and
- In-Situ Treatment – Enhanced Bioremediation.

No Action

This option is easily implemented and has no associated cost, but does not satisfy the effectiveness screening criteria (i.e., ability to achieve RAOs or protectiveness of human health and environment). In accordance with requirements of the NCP, however, the No Action option is retained for further evaluation.

Ex-Situ Treatment and Disposal – Excavation and Landfill Disposal

This option would be effective in reducing or eliminating the migration of perchlorate into groundwater and achieving the cleanup goals. Given the depth (50 to 55 feet bgs) to which perchlorate has migrated into the vadose zone, complete excavation of all soil containing perchlorate above its PGW CG is impractical and not easily implemented. However, the removal of a partial amount soil containing perchlorate at Site C41 could potentially result in reducing the movement of perchlorate into groundwater. Soil containing perchlorate above its PGW CG would be excavated to a depth of 10 feet and disposed of off-site at an appropriate landfill facility. Perchlorate remaining in the vadose zone would potentially migrate into

groundwater and then be captured downgradient by existing extraction wells in Zone 1 and treated. Excavation and disposal to a landfill is a well-proven and implementable technology and, depending on the amount of soil volume to be removed and the type of disposal facility, is generally cost effective. Therefore, this option was retained for further consideration.

In-Situ Treatment – Enhanced Bioremediation

This technology is most effective (decreased treatment time and reduced potential for substantial leaching of perchlorate to treatment depth) by excavating soils with high concentrations, applying a base layer of electron donor, then replacing the soil while mixing with electron donor. Therefore, this technology has the same limitations as ex-situ treatment and disposal because the depth (50 to 55 feet bgs) to which perchlorate has migrated into the vadose zone.

However, the in-situ treatment of a partial amount soil containing perchlorate at Site C41 could potentially result in reducing the migration of perchlorate into groundwater. Soil containing perchlorate above its PGW CG would be excavated to a depth of 10 feet, treated as described above and then replaced. Following replacement, a water-based electron donor (citric acid) solution would be delivered to the treatment area.

Enhanced bioremediation has been used successfully in California to reduce the concentration of perchlorate in soil and is generally cost effective. Therefore, this option was retained for further consideration.

7.7.2.4 *FS Group A49-1: Sites 32D, 34D, 35D, and 38D*

Five remediation technology/process options retained as a result of the analysis in Section 7.6 were screened as they applied to VOCs above residential and commercial CGs in the vadose zone at Sites 32D, 34D, 35D, and 38D. These technology/process options include:

- No Action;
- Limited Action - Institutional Controls (Land Use Restrictions);
- Containment – Capping;
- Ex-Situ Treatment – Excavation and Landfill Disposal; and
- In-Situ Treatment – Soil Vapor Extraction.

No Action

This option is easily implemented and has no associated cost, but does not satisfy the effectiveness screening criteria (i.e., ability to achieve RAOs or protectiveness of human health and environment). In accordance with requirements of the NCP, however, the No Action option is retained for further evaluation.

Limited Action – Institutional Controls

This option meets the implementability criteria, but institutional controls alone would not prevent exposure of human or ecological receptors to VOCs. For example, land use restrictions would reduce the potential for inhalation of VOCs by human receptors but would not prevent the migration of VOCs in the potential source areas to the underlying unconfined aquifer. In addition, institutional controls would not be effective for achieving cleanup goals. However, institutional controls could be effective for reducing risks to human and environmental receptors if combined with other process options. Consequently, this option is retained for further evaluation.

Containment – Capping

This option could be implemented if combined with institutional controls to ensure implementation and utilized as part of the planned reuse of the sites (roadway or parking area). Although capping would not be effective for achieving cleanup goals, installation of an asphalt/aggregate base cap would reduce the potential for inhalation of VOCs and limit infiltration of surface water and migration of VOCs to the unconfined aquifer. In addition, installation of a cap could increase the effective radius of influence (ROI) of SVE wells or vents. Based on these considerations, capping is retained for further evaluation.

Ex-Situ Treatment – Excavation and Landfill Disposal

Soil impacted with VOCs would be excavated, removed from the site, and disposed of at an appropriate landfill facility. However, because VOCs at the site exist primarily in vapor phase in the pore space of the soil, the excavation of VOCs is unlikely to achieve cleanup goals for residential or commercial reuse. Additionally, the excavation and disposal of soils with VOCs would likely result in releases of those chemicals to ambient air unless engineering controls are implemented to prevent such an occurrence. The excavation and disposal of soil with VOCs to a landfill is

impractical and prohibitively expensive due to the volume of impacted soil and the depth of excavation (>20 feet bgs) that would likely be required to achieve cleanup goals, specifically those for the protection of groundwater. Consequently, this option is eliminated from further consideration.

In-Situ Treatment – SVE

This option satisfies both the implementability and effectiveness criteria. In addition, SVE is the preferred presumptive remedy for sites impacted with VOCs (USEPA, 1993; 1996b). In addition, SVE is the only option that could address DNAPL potentially present in the vadose zone. SVE combined with off-gas treatment would effect removal of VOCs from the subsurface at potential source areas and produce an overall reduction in VOC concentrations in soil and soil vapor. Source removal would be protective of human and ecological receptors and the unconfined aquifer beneath the site. Based on these considerations, SVE is retained for further evaluation.

7.7.2.5 *FS Group A49-2: Sites 33D*

Three remediation technology/process options retained as a result of the analysis in Section 7.6 were screened as they applied to VOCs in the vadose zone Site 33D. These technology/process options include:

- No Action;
- Limited Action - Institutional Controls and Engineering Controls (Land Use Restrictions and Vapor Mitigation); and
- In-Situ Treatment – Soil Vapor Extraction.

No Action

This option is easily implemented and has no associated costs, but does not satisfy the effectiveness screening criteria (i.e., ability to achieve RAOs or protectiveness of human health and environment). In accordance with requirements of the NCP, however, the No Action option is retained for further evaluation.

Limited Action – Institutional Controls

This option meets the implementability criteria, but institutional controls would not be effective for achieving cleanup goals. Additionally,

institutional controls alone would not prevent exposure of human or ecological receptors to VOCs. However, institutional controls could be effective for reducing risks to human and environmental receptors if combined with other process options such as engineering controls. Consequently, this option is retained for further evaluation.

In addition, a land use restriction could restrict use of the affected area(s) at the site to commercial development, thereby eliminating potential exposure to residents. Institutional controls may be a feasible and cost-effective option for the sites in FS Group A49-2 and therefore this option is retained for further evaluation.

Limited Action - Engineering Controls

This option could be implemented if combined with institutional controls to ensure that they are implemented and maintained. Although engineering controls such as vapor mitigation would not be effective for achieving cleanup goals, they would reduce the potential for VOCs to migrate into buildings and inhalation by humans. Based on this consideration, engineering controls are retained for further evaluation.

In-Situ Treatment – SVE

This option satisfies both the implementability and effectiveness criteria. In addition, SVE is the preferred presumptive remedy for sites impacted with VOCs (USEPA, 1993; 1996b). The current VOC concentrations in soil vapor at Site 33D are fairly low; therefore, it is unlikely that SVE would result in a significant reduction in concentrations or achieve residential CGs. In addition, the proposed future land use for Site 33D is commercial. For a commercial worker, only one location (33D-SP09) exceeds the remedial goals for one COC (chloroform). Therefore, SVE was not retained for further evaluation as a feasible option for the sites in FS Group A49-2.

7.7.2.6 *FS Group A49-3: Site C4*

Three soil remediation technology/process options retained as a result of the analysis in Section 7.6 were screened as they applied to surface soil containing metals and/or dioxins and furan under commercial and residential use scenarios. These technology/process options include:

- No Action;
- Limited Action - Institutional Controls (Land Use Restrictions); and

- Ex-Situ Treatment – Excavation and Landfill Disposal.

No Action

This option is easily implemented and has no associated costs, but does not satisfy the effectiveness screening criteria (i.e., ability to achieve RAOs or protectiveness of human health and environment). In accordance with requirements of the NCP, however, the No Action option is retained for further evaluation.

Limited Action - Institutional Controls/Land Use Restriction

This option meets the implementability criteria and would allow for the planned future use of the sites. A land use restriction would restrict use of the affected area(s) at the sites to commercial development, thereby eliminating potential exposure to residents. Institutional controls may be a feasible and cost-effective option for Site C4 and therefore this option is retained for further evaluation.

Ex-Situ Treatment – Excavation and Landfill Disposal

This option would be effective for protection of human health and the environment and achieving residential cleanup goals for COCs (metals and dioxins and furans) in soil. The excavation of impacted soil combined with disposal at an appropriate landfill would be easy to implement and would permanently eliminate future exposures under all reuse scenarios. Therefore, this option is retained for further evaluation.

7.8 DEVELOPMENT OF REMEDIAL ALTERNATIVES

In this subsection, the technologies and process options that were retained through the initial screening are combined into workable systems (alternatives) that address the RAOs and CGs for each FS Group. As presented in Sections 7.6 and 7.7, the number of viable options that both address site conditions and meet RAOs was found to be limited. This in turn has limited the number of the remedial alternatives developed for each treatment area.

The alternatives detailed in subsequent sections were developed through an application of site knowledge, a detailed review of prior remedial efforts at each treatment area, and engineering judgment. The alternative development process was intended to be focused and practical, and for

this reason only the most appropriate and practical technologies were selected for development into remedial alternatives.

7.8.1 *FS Group A20-1: Sites 10D and 11D*

Based on the results of the RI and HHRA, COCs (silver, lead, and/or hexavalent chromium) are present in soil at Sites 10D and 11D at concentrations above CGs for the planned use (commercial) of those sites. The following alternatives were developed for the sites in FS Group 1:

- Alternative A20-1A: No Action.
- Alternative A20-1B: Land Use Restriction and Excavation and Disposal.
- Alternative A20-1C: Excavation and Disposal.

7.8.1.1 *Remedial Alternative A20-1A: No Action*

The inclusion and evaluation of this alternative is required by the NCP to serve as a baseline against which the performance of other alternatives is evaluated. Under this alternative, no action would be taken under this alternative to address COCs in soil and/or soil vapor. The surface at Sites 10D and 11D is currently unpaved open ground. Under this alternative, no further measures would be implemented to limit access to the site or prevent exposure to soils containing metals and PCBs. In addition, no actions would be taken to restrict future site use through institutional controls. There is no cost associated with Alternative A20-1A. This option is retained for further evaluation.

7.8.1.2 *Remedial Alternative A20-1B: Land Use Restriction and Excavation and Disposal*

The COCs at Site 10D are above residential, commercial, and construction worker CGs. The COCs at Site 11D are above residential CGs, but below commercial, and construction worker CGs. With Alternative A20-1B, COCs below commercial worker CGs would be left in place at Sites 10D and 11D and institutional controls would be required to restrict future development of the site to commercial use. These institutional controls would consist of a land use restriction that would be placed in the deed (i.e., become part of the chain of title) to limit redevelopment of the site to commercial/industrial use and a Land Use Covenant to ensure the restriction is not removed without concurrence from the USEPA and DTSC.

In addition, Alternative A20-1B would include hot spot removal of soil containing COCs at concentrations above their commercial and construction worker CGs at Site 10D using conventional excavation equipment (bulldozers, backhoes, etc.). Figure 7-8 shows the excavation limits for Remedial Alternative A20-1B. Confirmation sampling would be performed to verify that COCs were removed to concentrations below the remedial goals. The criteria used to evaluate the effectiveness of the remedial action would be based on the future land use (commercial).

Excavation of soils affected with metals is a quick and effective method of remediation. It is easily implemented and cost effective, as it only requires the use of conventional construction equipment. Excavation is often preferred over other alternatives because it permanently removes impacted soil from the site. This option is retained for further evaluation.

7.8.1.3 *Remedial Alternative A20-1C: Excavation and Disposal*

Alternative A20-1C would involve the removal of soil containing COCs at concentrations above their residential CGs using conventional excavation equipment (bulldozers, backhoes, etc.). Figure 7-9 shows the excavation limits for Remedial Alternative A20-1C. Confirmation sampling would be performed to verify that that COCs were removed to concentrations below their remedial goals. The criteria used to evaluate the effectiveness of the remedial action would be based on the future land use (residential). Option A20-1C would not require additional institutional controls restricting future development to commercial use as COCs would be removed to residential CGs.

Excavation of soils affected with metals is a quick and effective method of remediation. It is easily implemented and cost effective, as it only requires the use of conventional construction equipment. Excavation is often preferred over other alternatives because it permanently removes impacted soil from the site. Therefore, this option is retained for further evaluation.

7.8.2 *FS Group A20-2: Sites 7D and FCS*

The results of the RI and HHRA concluded that PCE and chloroform are present in soil vapor at Sites 7D and the FCS at low concentrations, but above residential CGs. The following alternatives were developed for the sites under a residential use scenario.

- Alternative A20-2A: No Action.

- Alternative A20-2B: Institutional and Engineering Controls.
- Alternative A20-2C: Land Use Restriction and Engineering Controls.

7.8.2.1 Remedial Alternative A20-2A: No Action

The inclusion and evaluation of this alternative is required by the NCP to serve as a baseline against which the performance of other alternatives is evaluated. Under this alternative, no action would be taken under this alternative to address COCs in soil vapor. The surface at Sites 7D and the FCS is currently unpaved open ground. Under this alternative, no further measures would be implemented to limit access to the site or prevent exposure to VOCs in soil vapor. In addition, no actions would be taken to restrict future site use through institutional controls. There is no cost associated with Alternative A20-2A. Therefore, this option is retained for further evaluation.

7.8.2.2 Remedial Alternative A20-2B: Institutional and Engineering Controls

With Alternative A20-2B, no action would be taken to remove VOCs in soil vapor from the vadose zone. Engineering controls (appropriate vapor mitigation) would be installed during construction of residential structures to prevent the migration of VOCs into indoor air and inhalation by humans. Institutional controls would be required to prohibit future residential development without the use of appropriate vapor mitigation. Institutional controls would consist of a land use restriction that would be placed in the deed (i.e., become part of the chain of title) to ensure implementation and maintenance of engineering controls. A Land Use Covenant would be required to ensure these restrictions are not removed without concurrence from the USEPA and DTSC. This option is retained for further evaluation.

7.8.2.2 Remedial Alternative A20-2C: Land Use Restriction and Engineering Controls

With Alternative A20-2B, no action would be taken to remove VOCs in soil vapor from the vadose zone. With Alternative A20-2C, COCs below commercial worker CGs would be left in place at Sites 7D and FCS and institutional controls would be required to restrict future development of the site to commercial use. These institutional controls would consist of a land use restriction that would be placed in the deed (i.e., become part of the chain of title) to limit redevelopment of the site to commercial/industrial use and a Land Use Covenant to ensure the

restriction is not removed without concurrence from the USEPA and DTSC.

In addition, engineering controls (appropriate vapor mitigation) would be installed during construction of commercial structures to prevent the migration of VOCs into indoor air and inhalation by humans. Institutional controls would also be required to prohibit future commercial development without the use of appropriate vapor mitigation. As stated previously, there are several mitigation methods available to prevent vapor intrusion (e.g., vapor barriers, subslab venting, and/or subslab depressurization). Vapor mitigation methodology is an evolving science. As noted above, an appropriate vapor mitigation system would be installed at the time of construction. For the purposes of costing for this Feasibility Study, Aerojet has assumed installation of a vapor barrier combined with subslab venting system.

7.8.3 FS Group A20-3: Site C41

Perchlorate is present in the vadose zone at Site C41 at concentrations below all health-based cleanup goals, but at concentrations that could migrate into groundwater. The following three alternatives were developed for Site C41:

- Alternative A20-3A: No Action.
- Alternative A20-3B: Soil Excavation and Disposal.
- Alternative A20-3C: Enhanced Bioremediation.

7.8.3.1 Remedial Alternative A20-3A: No Action

The inclusion and evaluation of this alternative are required by the NCP to serve as a baseline against which the performance of other alternatives is evaluated. No action would be taken under this alternative to address perchlorate in soil at Site C41. The surface at Site C41 currently consists of paved areas, a concrete slab, and open ground. Under this alternative, no further measures would be implemented to limit access to the site or prevent further migration of perchlorate into groundwater. There is no cost associated with Alternative A20-3A. Therefore, this option is retained for further evaluation.

7.8.3.2 *Remedial Alternative A20-3B: Soil Excavation and Disposal*

As discussed in Section 7.7.2.3, due to the depth to which perchlorate has migrated into the vadose zone, the complete removal of all soil containing perchlorate above its PGW CG is impractical. However, the removal of some soil containing perchlorate may reduce the migration of perchlorate into groundwater. Under this alternative, soil containing perchlorate above its PGW CG would be excavated to a depth of 10 feet and disposed of at an appropriate landfill facility. Figure 7-10 shows the excavation limits for Remedial Alternative A20-3B. Perchlorate that remained in the vadose zone is anticipated to migrate into groundwater and then be captured downgradient by existing extraction wells in Zone 1 and treated. This option is retained for further evaluation.

7.8.3.3 *Remedial Alternative A20-3C: Enhanced Bioremediation*

As discussed in Section 7.7.2.3, due to the depth to which perchlorate has migrated into the vadose zone, the complete removal of all soil containing perchlorate above its PGW CG is impractical. However, in situ treatment of some soil containing perchlorate may reduce the migration of perchlorate into groundwater.

Prior to in situ treatment, grid (every 25 feet) sampling to a depth of 10 feet using direct push drilling techniques will be conducted for site characterization and substrate bench testing. Following sampling, soil containing perchlorate above its PGW CG would be excavated to a depth of 10 feet applying a base layer of electron donor (CMA, vegetable oil, or soybean oil, methyl ester), then replacing the soil mixed with electron donor. Following replacement, a water-based electron donor (citric acid) solution would be delivered to the treatment area using high flow drip tape.

Perchlorate remaining in the vadose zone is anticipated to migrate into groundwater that would then be captured downgradient by existing extraction wells in Zone 1 and treated. This option is retained for further evaluation.

7.8.4 *FS Group A49-1: Sites 32D, 34D, 35D, and 38D*

Volatile organic compounds (TCE; PCE; chloroform; 1,1-DCA; 1,2-DCA; 1,1-DCE; cis/trans 1,2-DCE; and/or benzene) are present in soil vapor at Sites 32D, 34D, 35D, and/or 38D at concentrations above residential and commercial CGs. Additionally, VOCs in soil vapor at Sites 32D, 35D, and

38D are also above construction and/or maintenance worker CGs and present at concentration that could potentially migrate into groundwater. The following alternatives were developed for the sites in FS Group A49 1:

- Alternative A49-1A: No Action.
- Alternative A49-1B: Capping with Institutional Controls.
- Alternative A49-1C: SVE with Capping and Institutional Controls.

7.8.4.1 *Remedial Alternative A49-1A: No Action*

The inclusion and evaluation of this alternative are required by the NCP to serve as a baseline against which the performance of other alternatives is evaluated. No action would be taken under this alternative to address VOCs in soil vapor in the vadose zone at Sites 32D, 34D, 35D, and 38D. The surface at the sites is currently unpaved open ground and some fencing exists to limit general access. Under this alternative, no further measures would be implemented to limit access to the site or prevent exposure to VOC-impacted soil or ambient air. In addition, no actions would be taken to restrict future site use through institutional controls. There is no cost associated with this alternative. Therefore, this option is retained for further evaluation.

7.8.4.2 *Remedial Alternative A49-1B: Capping with Institutional Controls*

Under this alternative, the site would be capped to prevent exposure to all humans, reduce the infiltration of surface water into the vadose zone, thereby reducing the migration of VOCs into groundwater. Institutional controls would be required to prohibit redevelopment of the site for any purpose other than a roadway or a parking lot. Institutional controls would consist of a land use restriction that would be placed in the deed (i.e., become part of the chain of title) to restrict use of the property for roadways, parking lots, or other uses (park or green belt area) compatible with capped land (i.e., will not cause damage to the cap). A Land Use Covenant would be required to ensure these restrictions are not removed without concurrence from the USEPA and DTSC. This option is retained for further evaluation.

7.8.4.3 *Remedial Alternative A49-1C: Soil Vapor Extraction (SVE) with Capping and Institutional Controls*

In this alternative, an asphalt cap would be installed to reduce the potential for exposure to VOCs in vapor and prevent ambient air from

being drawn into the vadose zone by SVE, soil vapor extraction would be implemented to reduce VOCs in soil vapor, and institutional controls would limit future reuse of the site based on the levels achieved through SVE.

SVE

Implementation of SVE as a remedial alternative would involve the installation of SVE wells and/or the use of existing SVE wells, construction of an extraction and off-gas treatment system, and operation of the system to remove COCs above commercial, construction, and maintenance worker CGs. Implementation of SVE would generally involve the following:

- SVE pilot study and confirmation sampling to determine the treatment area.
- Prepare system design.
- Select off-gas treatment unit and obtain authority to construct permits from the SMAQMD.
- Install system conveyance lines, treatment system compound, and off-gas treatment system, as needed.
- Operate and maintain the system until chemical-specific cleanup goals are achieved or until SVE is no longer technically or economically effective. Periodic O&M would include monthly discharge sampling, soil gas sampling, and reporting.
- Remove the treatment system, and properly destroy the SVE wells and vapor monitoring points at the conclusion of the program.

The installation and operation and maintenance of an SVE system at the Sites in FS Group A49-1 would be practical and cost-efficient because VOC concentrations in soil vapor are relatively high (above residential, commercial, construction, maintenance, and/or protection of groundwater CGs) and are present over a fairly extensive area (7.2 acres). A conceptual design of an SVE system at those sites is described below and illustrated on Figure 7-11.

An SVE system would involve the use of SVE wells installed in 1997, installation of new wells in the treatment area, construction of an extraction and off-gas treatment system, and operation of the system to remove VOCs from the vadose zone.

The SVE system would use three SVE wells (4485, 4490, and 4495) and three SVE monitoring wells (SVE-1 through SVE-3) installed in the central portion of Area 49 by Aerojet in 1997. The wells were installed as part of a pilot study to evaluate the removal of VOCs from the vadose zone using low-flow SVE (Aerojet, 1997b). SVE wells 4485, 4490, and 4495 and SVE monitoring well SVE-1 are screened between 5 and 30 feet bgs. SVE monitoring wells SVE-2 and SVE-3 are screened between 10 and 30 feet bgs, respectively. The actual locations and screen intervals of the new wells would be determined based on data obtained during the pilot study and confirmation sampling. To evaluate the remedial alternatives, 34 new wells distributed across the treatment area as shown on Figure 7-11 was assumed.

The conceptual design of the SVE system includes connecting the existing SVE wells and new wells to a 500-standard-cubic-feet-per-minute (scfm) thermal oxidizer. The final design of the SVE well array and selection of off-gas treatment technology would be based on site-specific design parameters obtained from an on-site, initial SVE performance test (pilot test).

Calculations presented in the Stage 1 RI (IFC Kaiser, 1993) estimated the mass of VOCs (TCE, 1,2-DCE, and 1,1-DCE) in soil vapor within the source area unsaturated zone to be approximately 1,216 pounds. However, because that estimate did not account for the presence of DNAPL, it likely underestimates the mass of VOCs. The SVE system would be operated until either the compound-specific cleanup goals are achieved or until system operation reaches a point of diminishing returns (e.g., when the expense of continued operation is not justified by the insignificant additional mass of contaminant removed from the ground). Based on observed TCE soil gas concentrations, planned flow rates, and observed concentration decreases at other sites with similar characteristics, active remediation by SVE from extraction wells that exist in the source area is expected to continue for approximately 5 years. Interim risks to site workers during implementation and installation and O&M of the remedial system would be managed by DTSC through the standard CERCLA regulatory process.

Asphalt Cap

Alternative A49-1C includes installation of an asphalt cap to (1) reduce the potential for exposure to VOCs at the surface (i.e., inhalation of contaminated soil particles or VOCs in ambient air), (2) limit infiltration of rain or surface water and continued leaching of VOCs to groundwater,

and (3) increase the effective ROI of SVE wells and prevent preferential flow of air from the surface (e.g., short-circuiting). Installation of the cap would involve grading and compaction of a minimum 2-inch-thick, crushed aggregate sub-base and placement of a 2-inch-thick asphalt layer over the areas shown on Figure 7-11.

Land Use Restriction

With Alternative A49-1C, VOC concentrations in soil gas that exceed cleanup goals for both residential and commercial use could remain after completion of SVE. Consequently, institutional controls would be required to prohibit redevelopment of the site for residential or commercial use. These institutional controls would consist of a land use restriction that would be placed in the deed (i.e., become part of the chain of title) to limit redevelopment of the site to the installation and maintenance of a roadway and a Land Use Covenant to ensure these restrictions are not removed without concurrence from the USEPA and DTSC.

7.8.5 *FS Group A49-2: Site 33D*

VOCs are present in soil vapor in the vadose zone at Site 33D. However, as noted in Section 7.2.3.2, chloroform at Site 33D is unlikely to pose a substantial threat to human health under a commercial land use scenario and therefore was not carried forward for evaluation of remedial action for this land use. The following alternatives were developed for the site under the future planned use (commercial):

- Alternative A49-2A: No Action.
- Alternative A49-2B: Institutional and Engineering Controls.
- Alternative A49-2C: Land Use Restriction.

7.8.5.1 *Remedial Alternative A49-2A: No Action*

The inclusion and evaluation of this alternative are required by the NCP to serve as a baseline against which the performance of other alternatives is evaluated. No action would be taken under this alternative to address VOCs in soil vapor in the vadose zone at Sites 33D. The surface at the site is currently occupied by an abandoned building surrounded by unpaved open ground. The site is within a fenced area with limited general access. Under this alternative, no further measures would be implemented to limit access to the site or prevent exposure to VOC-impacted soil or

ambient air. In addition, no actions would be taken to restrict future site use through institutional controls. There is no cost associated with this alternative. This option is retained for further evaluation.

7.8.5.2 *Remedial Alternative A49-2B: Institutional and Engineering Controls*

With Alternative A49-2B, no action would be taken to remove VOCs in soil vapor from the vadose zone. Engineering controls (appropriate vapor mitigation) would be installed during construction of residential structures to prevent the migration of VOCs into indoor air and inhalation by humans. Institutional controls would be required to prohibit future residential development without the use of appropriate vapor mitigation. Institutional controls would consist of a land use restriction that would be placed in the deed (i.e., become part of the chain of title) to implementation and maintenance of engineering controls. A Land Use Covenant would be required to ensure these restrictions are not removed without concurrence from the USEPA and DTSC. This option is retained for further evaluation.

7.8.5.3 *Remedial Alternative A49-2C: Land Use Restriction*

With Alternative A49-2C, no action would be taken to remove VOCs in soil vapor from the vadose zone. Institutional controls would be required to restrict the use of the site to commercial development and prohibit future residential development. Institutional controls would consist of a land use restriction that would be placed in the deed (i.e., become part of the chain of title) to restrict use of the site to commercial development. A Land Use Covenant would be required to ensure these restrictions are not removed without concurrence from the USEPA and DTSC. This option is retained for further evaluation.

7.8.6 *FS Group A49-3: Site C4*

Lead and dioxins and furans are present in soil at Site C4 at concentrations above residential, but below commercial CGs. The following alternatives were developed for Site C4 considering a residential use scenario:

- Alternative A49-3A: No Action.
- Alternative A49-3B: Soil Excavation and Disposal.

7.8.6.1 *Remedial Alternative A49-3A: No Action*

The inclusion and evaluation of this alternative are required by the NCP to serve as a baseline against which the performance of other alternatives is evaluated. No action would be taken under Alternative A49-3A to address COCs in soil. The surface at Site C4 is currently unpaved with some trash and other debris on the surface and within the fenced area of Aerojet's property. Under this alternative, no further measures would be implemented to limit access to the site or prevent exposure to COCs in soil. In addition, no actions would be taken to restrict future site use through institutional controls. There is no cost associated with this alternative. This option is retained for further evaluation.

7.8.6.2 *Remedial Alternative A49-3B: Soil Excavation and Disposal*

Alternative A49-3B would involve the removal of soil containing COCs at concentrations above their residential CGs using conventional excavation equipment (bulldozers, backhoes, etc.). Figure 7-12 shows the excavation limits for Remedial Alternative A49-3B. Confirmation sampling would be performed to verify that COCs were removed to concentrations below the remedial goals. The criteria used to evaluate the effectiveness of the remedial action would be based on the future land use (residential).

Excavation of soils affected with metals is a quick and effective method of remediation. It is easily implemented and cost effective, as it only requires the use of conventional construction equipment. Excavation is often preferred over other alternatives because it permanently removes impacted soil from the site. This option is retained for further evaluation.

7.9 *DETAILED AND COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES*

In this section, the remedial alternatives developed in Section 7.8 are subjected to a detailed and comparative analysis. The detailed analysis of each alternative involves:

- An evaluation of each remedial alternative with respect to the nine federal evaluation criteria; and
- An assessment of each remedial alternative with respect to its effectiveness in achieving cleanup goals.

The nine federal evaluation criteria as set forth in the NCP [40 CFR 300.430(e)(9)(iii)] are as follows:

- Overall protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction in toxicity, mobility, or volume of contaminants through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State agency acceptance; and
- Community acceptance.

The comparative analysis of alternatives for each area will be performed by qualitatively comparing the alternatives to one another.

7.9.1 Detailed Evaluation Criteria

The nine federal evaluation criteria are described in the following subsections and are later used in the detailed alternatives analysis.

7.9.1.1 Overall Protection of Human Health and the Environment

This criterion assesses whether each alternative provides adequate protection of human health and the environment. It evaluates through each exposure pathway how site risks posed by COCs are being eliminated, reduced, or controlled through treatment, engineering, or institutional controls. It also evaluates the degree to which the alternative satisfies RAOs. An alternative that is not sufficiently protective of human health and the environment may be eliminated by this criterion.

7.9.1.2 Compliance with Applicable, or Relevant and Appropriate Requirements

This criterion is used to determine whether each alternative will meet ARARs, as presented in Section 7.3. Each alternative will be evaluated to determine compliance with chemical-specific, action-specific, and location-specific ARARs. Additionally, compliance with other applicable criteria, advisories, and guidelines (TBCs) will be considered.

7.9.1.3 *Long-Term Effectiveness and Permanence*

The long-term effectiveness and permanence criterion measures the long-term reliability of the alternative, including any uncertainties that may be associated with the alternative. It also assesses the permanence of the proposed alternative. This criterion includes an evaluation of the magnitude of residual risk posed by the presence of untreated waste or treatment residuals and an assessment of the reliability of the proposed equipment and process. Finally, it evaluates the adequacy of institutional actions or containment measures and assesses the potential need to replace technical components of the alternative.

7.9.1.4 *Reduction in Toxicity, Mobility, or Volume through Treatment*

This criterion measures the degree to which the alternative will achieve a permanent reduction in toxicity, mobility, or volume of the COC through treatment. This criterion also assesses how treatment is used to address the principal threats posed by the site. It evaluates the degree to which the treatment is irreversible and the residual compounds that will remain following treatment. This criterion favors alternatives that utilize treatment to the maximum extent possible and generate little or no residual wastes.

7.9.1.5 *Short-Term Effectiveness*

The short-term effectiveness criterion measures the short-term risks to the community or remediation construction personnel that might occur during implementation of the remediation. It also evaluates the time required to implement the proposed remediation. Finally, this criterion assesses the potential impact on the environment during remediation and the effectiveness of the proposed remedial measures.

7.9.1.6 *Implementability*

The implementability criterion measures the ease or difficulty of conducting the proposed remediation. Included in this criterion are the technical feasibility of the project, the reliability of the technology, the ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remediation. It also measures the administrative feasibility of implementing the proposed alternative, including the time required to obtain proper permits and approvals. Additionally, this criterion assesses the availability of the required equipment, materials, and services, as well as site-specific constraints such as availability of

treatment areas. This criterion favors proven technologies that are widely available and simple to implement or construct and operate.

7.9.1.7 *Cost*

The cost criterion assesses the financial burden associated with implementing the alternative. The factors that are addressed include capital costs, both direct and indirect, and O&M costs. Direct capital costs include construction costs or expenditures for labor, materials, equipment, and subcontractors associated with the remedial action. Due to the uncertainty associated with remedial actions, a 20 percent contingency is applied to the sum of direct and indirect capital costs. Indirect capital costs include costs associated with engineering, permitting, construction management, and other services necessary to carry out the remedial action. O&M costs include operational labor and maintenance materials associated with the extended O&M and reporting for each alternative. Costs are given as present worth costs. A maximum performance period of 30 years is assumed for each alternative. In accordance with OSWER Directive No. 9355.3-20, inflation is not considered in this analysis.

7.9.1.8 *State and Community Acceptance*

The state and community acceptance criteria are addressed together. The state acceptance criterion evaluates the technical and administrative issues and concerns that the state may have regarding each of the alternatives. The community acceptance criterion addresses the community's apparent preferences among or concerns about alternatives. Aerojet has implemented a community relations program that has included fact sheets, public meetings, and a public information archive. The information obtained through this community relations program is considered under this criterion. Final evaluation of this criterion may not be complete until the Record of Decision (ROD).

7.9.2 *Detailed Evaluation of Remedial Alternatives*

As described in the previous sections, remedial alternatives were developed for the six FS Groups developed in Section 7.7.2 considering both planned (commercial) and potential (residential) future use scenarios. A detailed analysis of the remedial alternatives is presented in the following subsections. The areas and volumes of soil with COCs and areas having VOCs in soil vapor addressed by the remedial alternatives are summarized in Section 7.5. Detailed cost estimates for remedial alternatives that involve construction costs are presented in Appendix Q.

7.9.2.1 *FS Group A20-1: Sites 10D and 11D*

Three remedial alternatives are being evaluated for the sites in FS Group A20-1. These alternatives are:

- Alternative A20-1A: No Action.
- Alternative A20-1B: Institutional Controls and Excavation and Disposal.
- Alternative A20-1C: Excavation and Disposal.

A comparative analysis of the three remedial alternatives is provided in Table 7-11. A detailed analysis of each of the remedial alternatives against the nine federal statutory criteria is presented in Table 7-12. A summary of the cost of each remedial alternative and detailed estimates of the cost associated with each individual technology/process option comprising the alternatives are presented in Tables Q-1 and A20-1a through A20-1c in Appendix Q. A summary of the costs associated with the implementation of site-wide and PGOU-specific institutional controls are presented in Tables Q-2 through Q-3 in Appendix Q.

Based on the detailed and comparative analysis of the three remedial alternatives, Alternative A20-1C scored highest for residential land use and Alternative A20-1B scored highest for commercial land use.

7.9.2.2 *FS Group A20-2: Sites 7D and FCS*

Three remedial alternatives are being evaluated for the sites in FS Group A20-2. These alternatives are:

- Alternative A20-2A: No Action.
- Alternative A20-2B: Institutional and Engineering Controls.
- Alternative A20-2C: Land Use Restriction and Engineering Controls

A comparative analysis of the three remedial alternatives is provided in Table 7-11. A detailed analysis of each of the remedial alternatives against the nine federal statutory criteria is presented in Table 7-13. A summary of the cost of each remedial alternative and detailed estimates of the cost associated with each individual technology/process option comprising the alternatives are presented in Tables Q-1, A20-2a, and A20-2b in Appendix Q. A summary of the costs associated with the implementation of site-wide and PGOU-specific institutional controls are presented in Tables Q-2 through Q-3 in Appendix Q.

Based on the detailed and comparative analysis of the three remedial alternatives, Alternative A20-2B (residential land use) and A20-2C (commercial land use) scored the same.

7.9.2.3 *FS Group A20-3: Site C41*

Three remedial alternatives are being evaluated for Site C41. These alternatives are:

- Alternative A20-3A: No Action.
- Alternative A20-3B: Soil Excavation and Disposal.
- Alternative A20-3C: Enhanced Bioremediation

A comparative analysis of the three remedial alternatives is provided in Table 7-11. A detailed analysis of each of the remedial alternatives against the nine federal statutory criteria is presented in Table 7-14. A summary of the cost of each remedial alternative and detailed estimates of the cost associated with each individual technology/process option comprising the alternatives are presented in Table Q-1 and Tables A20-3a through A20-3c in Appendix Q.

Based on the detailed and comparative analysis of the three remedial alternatives, Alternative A20-3B scored highest.

7.9.2.4 *FS Group A49-1: Sites 32D, 34D, 35D, and 38D*

Three remedial alternatives are being evaluated for the sites in FS Group A49-1. These alternatives are:

- Alternative A49-1A: No Action.
- Alternative A49-1B: Capping with Institutional Controls.
- Alternative A49-1C: SVE with Capping and Institutional Controls.

A comparative analysis of the three remedial alternatives is provided in Table 7-11. A detailed analysis of each of the remedial alternatives against the nine federal statutory criteria is presented in Table 7-15. A summary of the cost of each remedial alternative and detailed estimates of the cost associated with each individual technology/process option comprising the alternatives are presented in Table Q-1 and Tables A49-1a through A49-1d in Appendix Q. A summary of the costs associated with the implementation of site-wide and PGOU-specific institutional controls are presented in Tables Q-2 through Q-3 in Appendix Q.

Based on the detailed and comparative analysis of the three remedial alternatives, Alternative A49-1C scored highest.

7.9.2.6 FS Group A49-2: Sites 33D

Three alternatives are being evaluated for the site in FS Group A49-2. These alternatives are:

- Alternative A49-2A: No Action.
- Alternative A49-2B: Institutional and Engineering Controls.
- Alternative A49-2C: Land Use Restriction.

A comparative analysis of the three remedial alternatives is provided in Table 7-11. A detailed analysis of each of the remedial alternatives against the nine federal statutory criteria is presented in Table 7-16. A summary of the cost of each remedial alternative and detailed estimates of the cost associated with each individual technology/process option comprising the alternatives are presented in Tables Q-1 and A49-2a in Appendix Q. A summary of the costs associated with the implementation of site-wide and PGOU-specific institutional controls are presented in Tables Q-2 through Q-3 in Appendix Q.

Based on the detailed and comparative analysis of the three remedial alternatives, Alternative A49-2B (residential land use) and A49-2C (commercial land use) scored equally.

7.9.2.6 FS Group A49-3: Site C4

Two alternatives are being evaluated for Site C4. These alternatives are:

- Alternative A49-3A: No Action.
- Alternative A49-3B: Soil Excavation and Disposal.

A comparative analysis of the two remedial alternatives is provided in Table 7-11. A detailed analysis of each of the remedial alternatives against the nine federal statutory criteria is presented in Table 7-17. A summary of the cost of each remedial alternative and detailed estimates of the cost associated with each individual technology/process option comprising the alternatives are presented in Tables A49-5a and A49-5b in Appendix Q.

Based on the detailed and comparative analysis of the two remedial alternatives, Alternative A49-3B scored highest.

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