INTERIM RECORD OF DECISION for GROUNDWATER

and

FINAL RECORD OF DECISION for SOIL

for the

Perimeter Groundwater Operable Unit

OU-5

AEROJET GENERAL CORPORATION SUPERFUND SITE,
RANCHO CORDOVA, CALIFORNIA

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

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PART 1: THE DECLARATION

1.1 Site Name and Location

Aerojet General Corporation Superfund Site ("Site"), Sacramento County California, Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Identification Number CAD980358832.

1.2 Statement of Basis and Purpose

This decision document presents the United States Environmental Protection Agency's (USEPA) Selected Remedy for the Perimeter Groundwater Operable Unit (OU-5) at the Aerojet General Corporation (Aerojet) Site in Sacramento County, California, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the USEPA's Administrative Record file.

This action is an interim remedy for the groundwater areas in OU-5 since the groundwater remedy is dependent on control of source areas in other OUs still in the Remedial Investigation/ Feasibility Study (RI/FS) phase. This action is the final remedy for cleanup of contaminated soil areas which were included in OU-5 as established by the 2001 Stipulation and Order Modifying Partial Consent Decree, (entered in 2002 and hereafter described as the 2002 Modifications of the 1989 Partial Consent Decree (PCD)).

The State of California concurs with the Selected Remedy for the groundwater, although the Regional Water Quality Control Board expressed a preference for lower containment levels and final aquifer cleanup goals for some contaminants based on California Public Health Goals and State water policies. The State of California concurs with the Selected Remedy for cleanup of the soil areas.

1.3 Assessment of Site

The response actions selected in this Interim Record of Decision (ROD) for Groundwater and Final ROD for Soil are necessary to protect the public health or welfare or the environment from actual or threatened releases into the environment of hazardous substances and pollutants or contaminants from this Site which may present an imminent and substantial endangerment to public health or welfare.

1.4 Description of Selected Remedy

The Site is divided into operable units (OUs) because of the overall size of the remediation effort and to expedite the remediation. The scope and definition of the current Aerojet OUs were developed in the 2002 Modification of the PCD. Due to the impact of contaminated groundwater on public drinking water supplies, the site cleanup strategy gives priority to containing and remediating the contaminated groundwater extending from the Aerojet Site, followed by remediation of on-property contaminated soil and groundwater. The containment and remediation of contaminated groundwater surrounding the Aerojet Site is divided into two OUs. The ROD for Western Groundwater Operable Unit (OU-3) was signed on July 20, 2001 to address the loss of drinking water supplies in some of the most populated areas. The remaining contaminated groundwater beyond and near the boundary of the Aerojet Site is addressed in this ROD. The scope of the on-property soil and groundwater remediation effort will require at least four additional OUs.

The remedial action for OU-5 groundwater addresses contaminated groundwater on the north and south sides of the Site and addresses contamination in surface and subsurface soil in one section of the Aerojet property. Implementation of the remedial action for OU-5, in conjunction with the existing remedy for the Western Groundwater Operable Unit (OU-3) to the west and other state enforcement actions to the south will complete the containment of groundwater contamination around the boundary of the Site. The containment provided by Groundwater Extraction and Treatment Systems (GETs) will prevent the loss of additional drinking water supplies in a populated area dependent on groundwater supplies. This action is an interim remedy for the containment of contaminated groundwater areas in OU-5, and does not set numeric cleanup goals for the groundwater in the aquifer at this time. Groundwater restoration in OU-5 is dependent on control of source areas in other OUs still in the Remedial Investigation/ Feasibility Study (RI/FS) phase.

The OU-5 Contaminated Soil Areas were selected from potential source and contaminated soil sites that transect, border, or are surrounded by lands removed from the boundary of the Aerojet Superfund Site by the PCD modification ("carve-out lands"). Several potential source areas on the Aerojet property formerly used for administration and liquid fuel rocket manufacturing have been identified within the contaminated soil areas of OU-5 and are addressed in this ROD. Primary source areas for the groundwater contamination and potential Non-Aqueous Phase Liquids (NAPLs) are located upgradient of OU-5 and principal threat waste from those sources will be addressed in subsequent OUs. Several areas with VOCs and perchlorate include relatively minor amounts of contaminants that do not constitute principal threats due to the lack of mobility of these contaminants and the provisions for containment of more mobile contaminants. Contaminated surface and subsurface soil areas will be treated or removed to protective levels. This action is the final remedy for cleanup of contaminated soil areas in OU-5.

1.4.1 The groundwater portion of the OU-5 remedy includes the following actions:

- Contain contaminated groundwater off-property within OU-5 with groundwater extraction and treatment in all contaminated layers of the aquifer to prevent further contamination of the aquifer;

- Remove additional contaminant mass from the contaminated groundwater on-property which is migrating off-property into OU-5 groundwater Zones, through groundwater extraction and treatment at or near the Aerojet property boundary in all contaminated layers of the aquifer;

- Treat extracted groundwater using reliable, proven treatment methods including biological treatment or resin adsorption for perchlorate, ultraviolet oxidation for NDMA, and carbon filtration or air stripping for residual Volatile Organic Compounds (VOCs), and oxidative destruction for VOCs and 1,4-Dioxane;

  The treated groundwater will be used for non-potable purposes such as industrial cooling or discharged to surface water or land. Aerojet may also provide the extracted water to drinking water providers for treatment for potable or non-potable uses. Water providers are subject to federal drinking water standards as well as California Department of Public Health, Division of Drinking Water and Environmental Management requirements[1];

- Coordinate water replacement contingency planning and implementation with the contingency plans for OU-3;

- Implement Institutional Controls (ICs). These controls will include Sacramento County review of new well drilling permits and prohibitions on access to groundwater on the land overlaying the contaminated groundwater to restrict use of untreated groundwater within the contaminated portions of the aquifer until the final water quality objectives have been attained;

- Monitor groundwater at monitoring wells, drinking water wells, irrigation wells, and up-gradient sentinel wells to verify and evaluate plume control and effectiveness of the remedy; and

- Manage groundwater within the hydraulic influence of the OU-5 groundwater remedy to maintain optimum water levels, to prevent adverse impact on the remedy and to mitigate impacts on downgradient beneficial uses.

[1] Under CERCLA, performance standards for treatment of water to be discharged to on-site surface water shall comply with the substantive requirements of a National Pollution Discharge Elimination System (NPDES) permit as listed in Table 2.16. Discharge of treated water to off-site surface water or use as non-potable water shall comply with applicable federal and State water standards in effect at the time of discharge. On-site discharge of treated groundwater to land shall comply with the substantive requirements of Waste Discharge Requirements developed by the Central Valley Regional Water Quality Control Board.

1.4.2 The contaminated soil areas of the OU-5 remedy incorporate active measures to eliminate or reduce contaminants and control contaminated soil in the eleven areas exceeding risk-based limits and include the following actions:

- Excavate contaminated surface soils and related drainage ditch sediments in areas 10D and 11D to allow for unrestricted use of the land based on residential risk;

- Excavate surface soil contaminated above the cleanup levels that allow for unrestricted use based on residential use in areas C4 and C41 laterally and to a minimum ten foot depth unless the cleanup levels are reached at a shallower depth. The contaminated soil shall be excavated and treated to remove the contaminants or, if justified and approved during remedial design, the soil may be excavated and transported to an approved landfill. The excavated area shall be refilled with soil that meets the residential soil criteria. If waste is left in place deeper than ten feet, land use controls will be necessary to protect against exposure resulting from excavation to depths greater than ten feet;

- Install and operate a soil vapor extraction system in soil areas 32D, 34D, 35D and 38D, covering a total of approximately 11 acres in close proximity to each other to remove VOCs from unsaturated subsurface soil. A temporary asphalt cap or equivalent shall be constructed over the surface to improve capture of the VOCs. Contaminants in the vapors shall be captured and treated by granulated carbon, or destroyed using a catalytic oxidation system with air monitoring. Until the cleanup attains unrestricted use levels for exposure from vapor intrusion, the land shall be restricted to commercial or industrial use with a land use covenant;

- Control the risks from elevated VOCs measured in the vadose zone in soil areas 7D, 33D and the Former Company Store location (FCS) by vapor mitigation systems to prevent movement of contaminant vapors into buildings constructed at these locations. The RI concluded that neither soil excavation nor soil vapor extraction would be protective for these areas until levels of VOCs in the groundwater are reduced by controlling sources of migration onto OU-5. Vapor mitigation systems typically include vapor barriers and venting of vapors from beneath the structure. Appropriate monitoring and land use covenants are required for either residential or commercial use of these locations until the potential threat of vapor intrusion is removed;

Review the monitoring results of the solid waste landfill closure in Zone 4 to ensure both soil and groundwater protectiveness from this potential source of contamination. The landfill in Zone 4 is not included in the actions for OU-5 selected in this ROD. EPA expects that all potential risks from this landfill will be satisfactorily addressed by State and County approval and oversight of the landfill closure process. If potential risks from the landfill are not adequately addressed, EPA will evaluate alternatives in an Explanation of Significant Differences or an amendment to the ROD.

1.5 Statutory Determinations

The Selected Remedy attains the mandates of CERCLA Section 121 and, to the extent practicable, the NCP. Specifically, the remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions to the maximum extent practicable.

This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants**,** or contaminants as a principal element through treatment) for the final contaminated soil area actions. Although the groundwater interim action is not intended to fully address the statutory mandate for permanence and treatment "to the maximum extent practicable," the remedy does utilize treatment and thus supports the statutory mandate. Because the groundwater action does not constitute the final remedy for the Site, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed in this remedy, will be addressed by the final response action. Subsequent actions are planned to fully address the threats posed by conditions at this Site.

Because this interim groundwater remedy will result in hazardous substances, pollutants, or contaminants remaining within OU-5 above levels that allow for unlimited use and unrestricted exposure, a statutory review for the entire OU-5 will be conducted within five years after initiation of the remedial action, and every five years thereafter, to ensure that the remedy is, or will be, protective of human health and the environment.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary Section of this ROD (Additional information can be found in the Administrative Record file for this Site):

- Chemicals of Concern (COC) and their respective health-based concentrations – Section 2.7.1, Page 26 and following;
- Baseline risk represented by the COC – Sections 2.7.5, Page 28 and following;
- Cleanup or containment levels established for the COCs and the basis for these levels – Tables 2.7, page 34, Table 2.11, page 38, and Table 2.12, Page 39;
- How source materials constituting principal threats are addressed – Section 2.11, Page 53;
- Current and reasonable anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD – Section 2.6, Page 20;

- Potential groundwater use that will be available at the Site as a result of the Selected Remedy – Section 2.12.5, Page 57;

- Estimated capital, operation and maintenance (O&M), and total present value costs, discount rate, and the number of years over which the remedy cost estimates are projected – Tables 2.13 and 2.14 a.-c., Pages 44-47 and Appendices C and D; and

- Key factors that led to selecting the remedy – Section 2.12, Pages 53 and 54.

1.7 Authorizing Signature

Kathleen Salyer
Assistant Director, Superfund Division
California Site Cleanup Branch
U.S. Environmental Protection Agency Region IX

2/15/11
Date

PART 2: THE DECISION SUMMARY

2.1 Site Name, Location, and Description

The Aerojet General Corporation Superfund Site is located near Rancho Cordova, California, approximately 15 miles east of Sacramento, CA. (See Figure 2-1). It is bounded on the west and north by the cities of Rancho Cordova, Carmichael, Fair Oaks, Folsom and unincorporated Gold River.

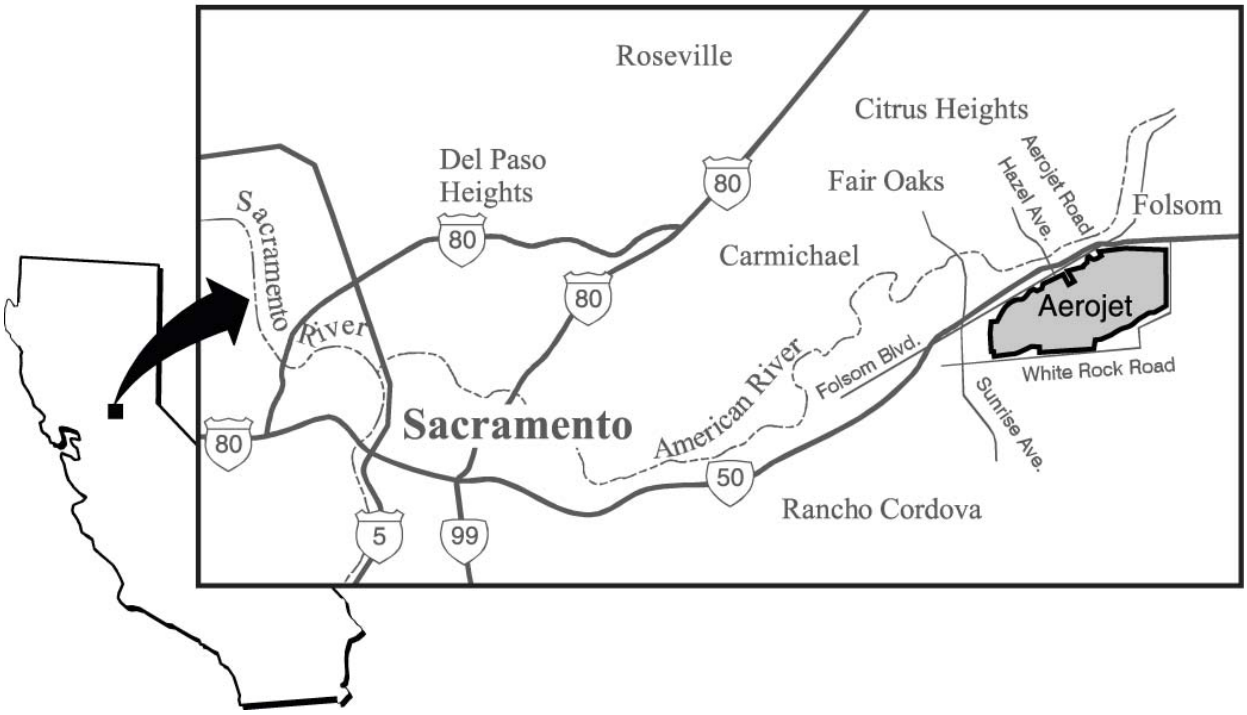

Figure 2-1 Aerojet Superfund Site Map - Location

The CERCLIS Identification Number is CAD980358832.

The lead agency is the USEPA, supported by California EPA Regional Water Quality Control Board -Central Valley Region (RWQCB) and Department of Toxic Substances Control (DTSC).

The major sources of the groundwater contamination are from Aerojet's facilities up-gradient of OU-5. There are areas of contaminated soil within OU-5 that will be remediated by the OU-5 response actions.

OU-5 consists of four Zones of contaminated groundwater (Zones 1 through 4, see Figure 2-2) comprising less than five square miles of the twenty-seven square mile Site. A small portion of the Aerojet industrial facility (Figure 2-3) with known or suspected areas of surface or

subsurface soil contamination is included in OU-5. This area of soil contamination is on the Aerojet property south of the groundwater Zones 1 and 4. The potentially contaminated areas of soil investigated in OU-5 are surrounded by land that had no indication of contamination and which had been "carved out" of the CERCLA cleanup in a negotiated 2002 modification of the 1989 Partial Consent Decree. OU-5 is not known to include major soil or vadose zone sources or areas of NAPL. The Western Groundwater Operable Unit (OU-3) is the groundwater area to the west of the Aerojet property. To the south of Zone 2 is the cleanup project at Inactive Rancho Cordova Test Site (IRCTS) which is overseen by the State of California. Further to the south and west is the closed United States Air Force Mather Field, a Federal National Priority List (NPL) site. (See Figure 2-4)

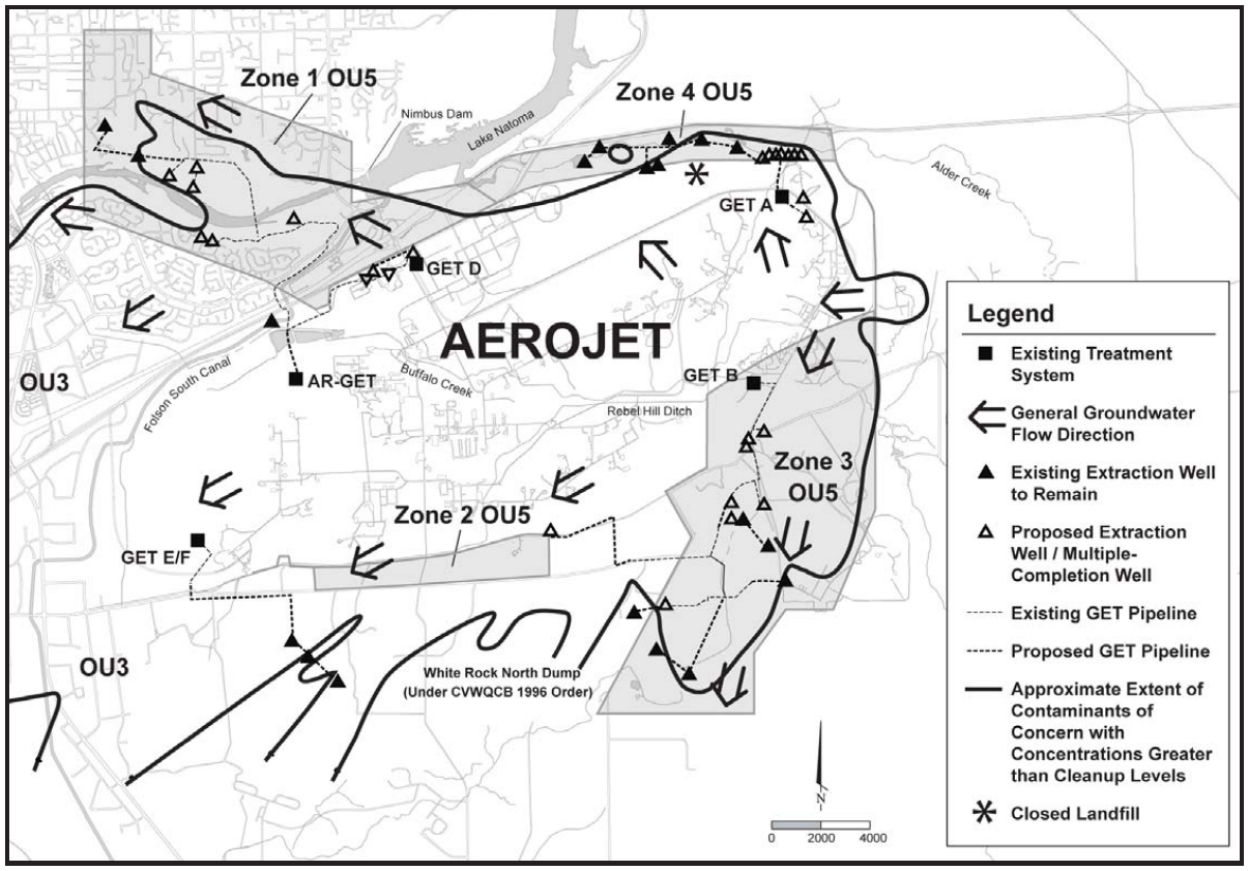

Figure 2-2 Aerojet Perimeter Groundwater Operable Unit (OU-5), Groundwater Zones 1-4. Groundwater flow direction and extraction well and treatment system locations are shown.

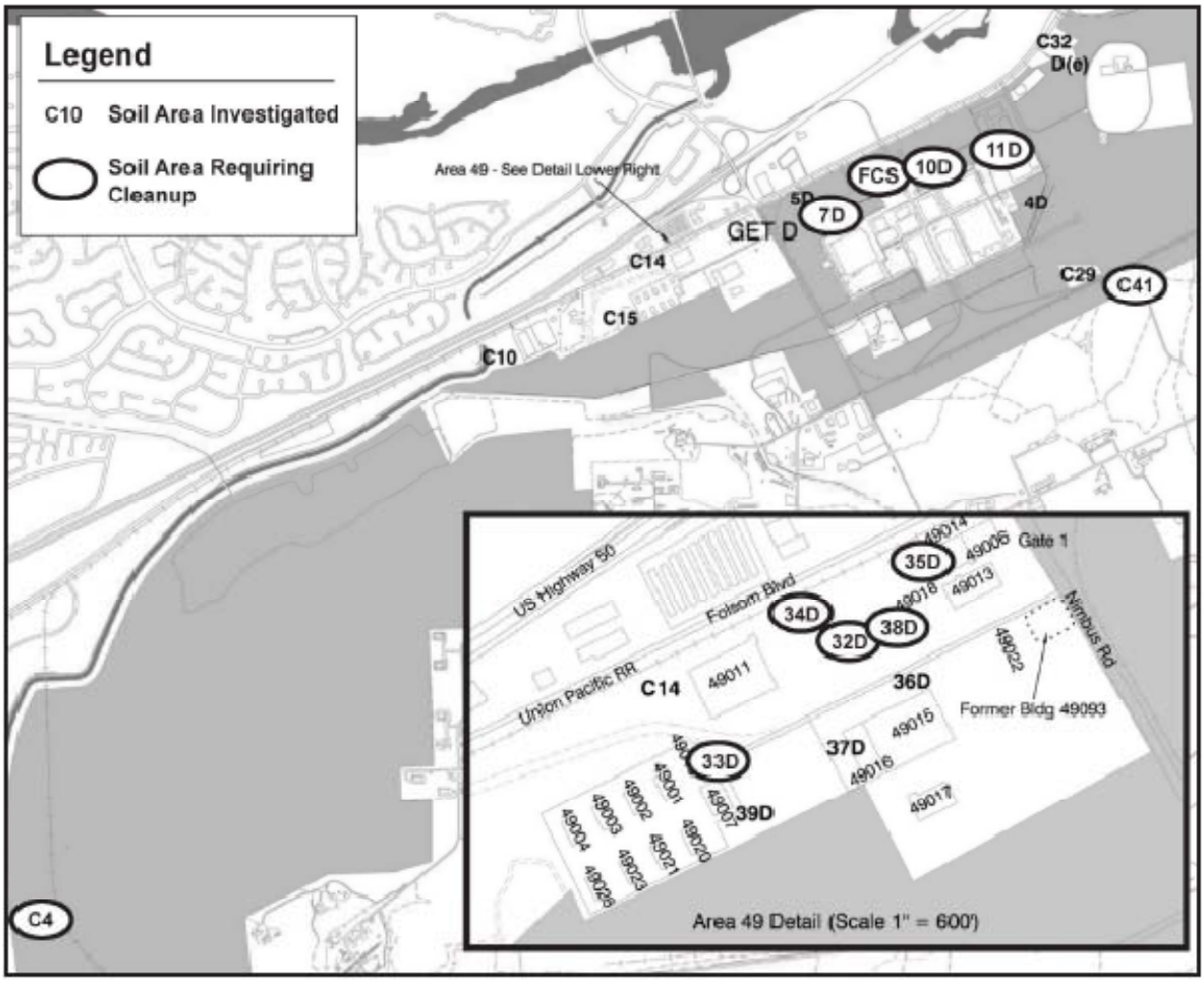

Figure 2-3. Aerojet OU-5 Contaminated Soil Areas. Areas included in remedy are circled.

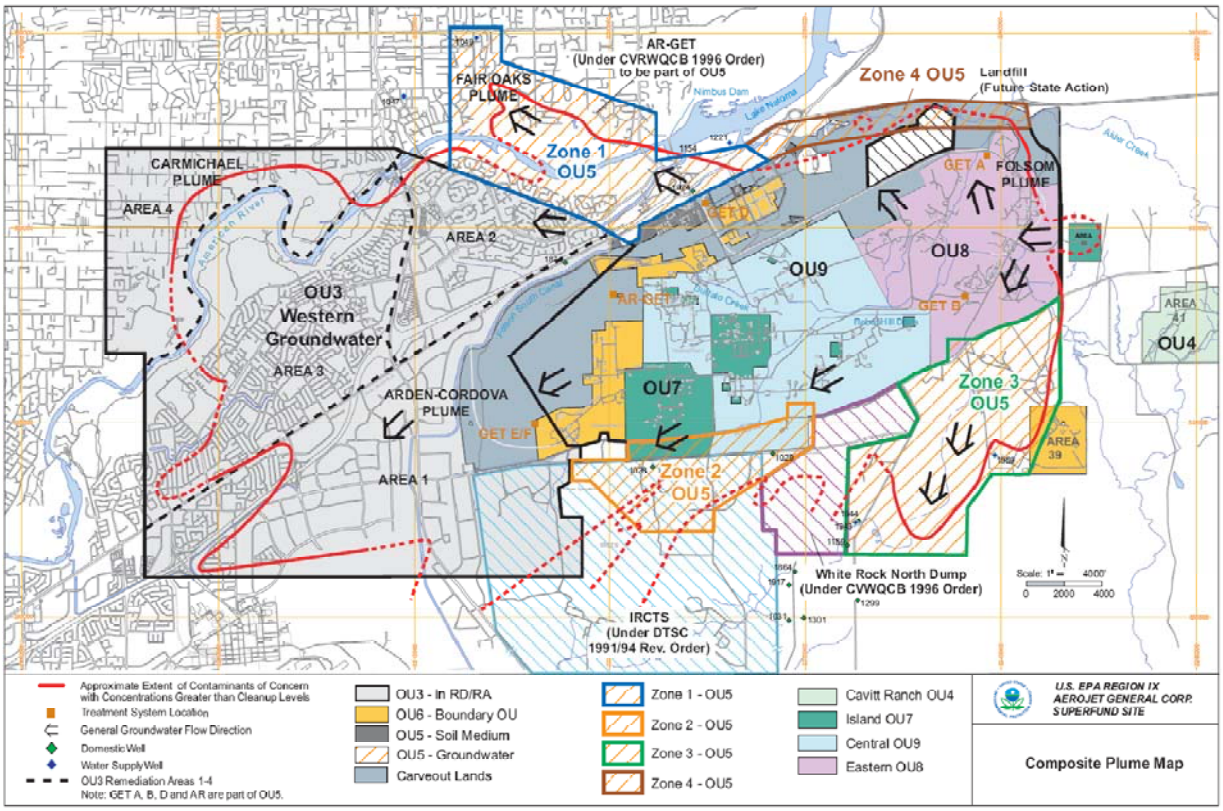

Figure 2-4. Aerojet Site - Relationship with all Operable Units and Groundwater Plume Extent.

2.2 Site History and Enforcement Activities

Aerojet is a wholly owned subsidiary of GenCorp. Aerojet has operated at this location since 1953. Operations included manufacturing liquid and solid propellants for rocket engines for military and commercial applications and formulating a number of chemicals, including rocket propellant agents, agricultural pesticides, pharmaceuticals, and other industrial chemicals. The Cordova Chemical Company operated chemical manufacturing facilities on the Aerojet complex from 1974 to 1979. Some wastes were disposed of on-property in surface impoundments, landfills, deep injection wells, leachate fields, and open burn areas. In 1979, volatile organic chemicals (VOCs) were found in private wells off-property. The most prevalent contaminants in groundwater are Trichloroethene (TCE), perchlorate, and NDMA. In 1997, the practical quantitation limit (PQL) for perchlorate was improved from 400 parts per billion (ppb) to four ppb and has been reduced even further since 2001. The NDMA PQL has also been improved from 150 ppb to 5 parts per trillion (ppt) and current analytic methods are under review by USEPA's Quality Assurance Office that will reduce the PQL to below 2 ppt. As a result of these improved detection methods it has been determined that perchlorate and NDMA contamination of groundwater off-property is extensive. Public drinking water wells on the west side of Aerojet have been removed from service and additional wells are threatened due to groundwater contamination.

The Aerojet Site was placed on the NPL on August 8, 1983. Portions of the state lead IRCTS are considered part of the Aerojet NPL site where hazardous substances originally on the Aerojet facility migrated to or otherwise came to be located on the IRCTS. On their own initiative, Aerojet installed, between 1983 and 1987, five groundwater extraction and treatment (GET) facilities as a perimeter barrier system, primarily to prevent further off-property movement of VOC contaminants. These systems have not been fully effective. Existing GETs E and F which are part of the remedy for OU-3 were initially designed only to treat for VOCs, resulting in perchlorate and NDMA reinjection into the aquifer. On June 23, 1989, a Partial Consent Decree (PCD) was entered by the United States District Court for the Eastern District of California. The PCD obligates Aerojet to complete a Remedial Investigation/ Feasibility Study (RI/FS) for the 8,500 acre main facility, 3,820 acre IRCTS area, and three other smaller parcels (Areas 39, 40 and 41) near the main Aerojet facility, where open burning was conducted. The parties to the PCD are Aerojet General Corporation, the Department of Toxic Substances Control (DTSC), the Regional Water Quality Control Board (RWQCB) and the USEPA. Requirements for the operation, maintenance and effectiveness evaluation of GETs A, B, D, E, and F were incorporated in the PCD. The PCD was modified in July 29, 1998 to add the contaminant perchlorate and to reduce the NDMA discharge limit. In December 1998 Aerojet installed a biological treatment system for perchlorate at GET F, which achieved full scale operation in December 1999. This treatment system treats perchlorate to less than 4 ppb. In July 1999, GETs E and F were combined to provide for treatment of perchlorate at GET E extraction wells and to add ultraviolet oxidation (UV/OX) treatment capability to destroy NDMA to below 2 ppt. The PCD was further modified in 2002 to expedite the cleanup by dividing the Site into OUs, beginning with OU-3, instead of waiting to complete a single Sitewide RI/FS before starting remediation. Completion of the RI/FS for OU-3 proceeded ahead of the 2002 Modifications of the PCD. The PCD Modification also removed certain uncontaminated portions of the Aerojet property from the CERCLIS Site ("Carve-Out Lands", see Figure 2-4).

In 1995 DTSC issued an order to Aerojet requiring soil and groundwater cleanup at the IRCTS property. In 1997 the RWQCB issued order 97-093 to Aerojet and McDonnell-Douglas Corporation, requiring groundwater control and remediation of perchlorate. To address contamination on the north of Aerojet, in 1996 the RWQCB issued order 96-230 for groundwater control and remediation of groundwater contamination not remediated by GET D. In 2000, the RWQCB issued order 500-718 for containment and control of perchlorate at GET D. In addition, in 1996, the RWQCB issued order 96-259 to add perchlorate treatment to the GET E and GET F treatment systems and to evaluate containment of perchlorate contamination not currently captured by the existing GET facilities.

USEPA signed the ROD for OU-3 on July 20, 2001 and issued a Unilateral Administrative Order on August 9, 2002 requiring Aerojet to implement the remedy. The groundwater portions of OU-5 extend the pump and treat system required for OU-3 to the remainder of the groundwater plume at and beyond the Aerojet property. As of 2010, nearly all the required extraction and treatment systems for OU-5 have been constructed and are in operation as part of the work required under the PCD including the 1998 and 2002 modifications of the PCD. As the completion of the final OU-3 GET approaches, USEPA, the State and Aerojet have begun initial activities to evaluate the effectiveness of the outer barrier and inner barrier containment systems in OU-3.

2.3 Community Participation

The RI/FS Report and Proposed Plan for OU-5 were made available to the public on July 31, 2009. These documents can be found in the Administrative Record file of the information repositories maintained at the USEPA Region 9 Superfund Records Center at 95 Hawthorne St. in San Francisco and at the California State University Sacramento Library Reference Desk, 2000 State University Drive East Sacramento, CA. The notice of availability of the RI/FS, proposed plan, date and location for the public meeting and public comment period (August 3, 2009 through September 1, 2009, which was later extended to October 1, 2009 on request from community members) was published the week prior to the start of the public comment period in the Sacramento Bee newspaper and sent to the Aerojet mailing list. The public meeting was held August 11, 2009. Transcripts of the public meeting are part of the administrative file at the repositories and USEPA's response to comments received at the public meeting and written comments are part of this ROD.

An overview of the proposed plan was presented by USEPA at the public meeting and questions were taken prior to acceptance of formal public comments. An Aerojet Community Advisory Group (CAG) formed subsequent to the OU-3 Proposed Plan has been active in discussions with USEPA throughout the development of the OU-5 RI/FS and Proposed Plan.

USEPA spent considerable effort interviewing and meeting with land use planning officials from Sacramento County, Rancho Cordova and Folsom. A great deal of planning has already been approved by local jurisdictions for the development of the Aerojet property near and including parts of OU-5. A report and presentation on the land use plans and the planning process were drafted and provided to the local officials and to the community for review. The information, current as of March 2010, is summarized in Figures 2-6 through 2-9.

2.4 Scope and Role of the Operable Unit or Response Action

The Aerojet Site is a large facility with groundwater contamination that has migrated off the Aerojet property. The USEPA and the State have negotiated with Aerojet to organize the Site into OUs through a modification to the PCD. The USEPA anticipates the OU-5 remedial actions will be implemented by Aerojet as they have implemented the OU-3 remedy. The interim action for groundwater containment will neither be inconsistent with, nor preclude, implementation of the final Sitewide remedy. This action is an interim containment remedy. Therefore EPA is not setting numeric cleanup goals for the groundwater in the aquifer at this time (i.e., "*in situ*" cleanup goals).

Operable Unit 1: Is reserved for the Sitewide final ROD integration remedial actions for all the OUs.

Operable Unit 2: OU-2 has been merged into OU-5. OU-2 was initiated in 1995 pursuant to a Unilateral Administrative Order (UAO) for control of off-property VOC groundwater contaminated on the north side of the Aerojet Site. OU-2 is also referred to as the American River OU. The UAO was withdrawn and work for this part of the Site was

accomplished under RWQCB Order 96-230 and Order 500-718 (for perchlorate treatment in Zone 1). In July 1998 the American River GET became operational as an interim groundwater action to contain VOCs not captured on the north side of the Aerojet Site by the existing GET D.

Operable Unit 3: OU-3 contains and remediates groundwater contamination on the western side of the Aerojet Site. A number of water supply wells have been lost to groundwater contamination and it had been projected that approximately 20 public water supply wells could be lost over the next 25 years without a successful OU-3 remedial action. Although all public water supplies around the Aerojet Site have been replaced with uncontaminated water, ingestion of untreated groundwater extracted from the aquifer would pose a current and potential risk to human health which exceeds the USEPA's acceptable risk range. Construction of remedial actions selected in the 2001 ROD for OU-3 is nearly complete.

Operable Unit 4: OU-4 will address remediation of soil and groundwater in Area 41 caused by Aerojet's burning of industrial wastes on 500 acres of property leased from others. Area 41 has VOC and perchlorate contamination in groundwater, and metals and perchlorate contamination in soil.

Operable Unit 5: **Perimeter Groundwater Operable Unit (OU-5) is the action covered by this ROD.** Perimeter Groundwater OU (OU-5) will contain and remediate groundwater around the remaining three sides of Aerojet (north, east and south) not addressed by OU-3. OU-5 includes Aerojet's GETs A, B, D, the American River GET and groundwater for Areas 39 and 40. USEPA and the State of California have a long history of collaboration in addressing the Aerojet Site, and this cooperation is particularly evident in groundwater contamination portions of OU-5. The work performed under interim RWQCB orders 96-230, 96-259, and 500-718 will be incorporated in OU-5 actions. Order 96-259 was rescinded on 25 January 2008 with the issuance of Order No. R5-2008-0025. Aerojet demonstrated to the RWQCB that they had complied with the order. Certain contaminated soil areas were also included in OU-5 as a result of terms included in the 2002 Modification of the PCD.

Operable Units 6-9: OUs 6-9 will address remediation of soil and groundwater contamination on-property. As part of the 2002 PCD RI/FS modification for OUs, Aerojet will assess the number of OUs and priority for remediating the over 300 source locations identified in the four hydrologic groundwater zones on-property. Dense non-aqueous phase liquids (DNAPLs) are known to exist in the areas to be covered by these OUs.

2.5 Site Characteristics

The land to the north of Aerojet's property has multiple uses including residential, recreational, office, commercial and industrial. The land to the south of Aerojet's property is used for recreation, ranching, agriculture and mining and is also undergoing planning for a mixed use development. Section 2.6 below discusses plans for future land use of the Aerojet property.

Groundwater in the area is designated for municipal use as a drinking water source in accordance with the Central Valley Regional Water Quality Control Board Basin Plan for the Sacramento and San Joaquin River Basins. Public water supply wells around the Aerojet Site are closely monitored, and public water supplies are obtained from uncontaminated sources. None of the monitoring and extraction wells on Aerojet's property are used for potable water. The general groundwater flow direction varies at the Aerojet Site and is grouped into four main zones based on flow direction: Zone 1 to the northwest; Zone 2 to the west and southwest; Zone 3 to the south; and Zone 4 to the north-northwest (see Figure 2-2). The groundwater aquifer is separated into multiple Layers A through F (from shallowest to deepest below ground). These layers consist of permeable materials which readily allow water to flow horizontally and are generally separated by less permeable layers which restrict vertical flow between layers. Groundwater flow within individual layers may differ from the general groundwater flow in that particular zone of OU-5. Surface water bodies in the area of OU-5 include Rebel Hill Ditch, Buffalo Creek and Alder Creek. Any water flowing in Rebel Hill Ditch drains back into the aquifer through the porous soil and does not flow off of Aerojet property. Buffalo Creek flows to the American River north of Aerojet. Buffalo Creek receives storm water discharge and industrial process water flows (primarily cooling water) from Aerojet under a RWQCB National Pollution Discharge Elimination System (NPDES) permit. Alder Creek flows into Lake Natoma from the northeast side of Aerojet and receives rainfall and some groundwater seepage. The remedial investigation found no groundwater contamination entering Alder Creek.

2.5.1 Groundwater Conceptual Site Model.

The Conceptual Site Model (CSM) for the risk assessment and response action was based on: 1) contact with contaminated groundwater in the future through use of private or domestic water supply wells; 2) calculation of hypothetical risks assuming present residential exposure to untreated groundwater from wells; and 3) thorough measurement and calculation of exposure to vapor intrusion into potential residential and commercial structures. Residential exposure through untreated water from drinking water wells would include ingestion, inhalation and dermal contact. The health-based concentrations used in the risk assessment are those that represent the current state of the plumes as well as maximum detected concentrations over the recent years of sampling. The major sources of the groundwater contamination are from Aerojet's facilities up-gradient of OU-5 which will be addressed in OUs that are still in the RI/FS phase. The Aerojet groundwater contamination in OU-5 is deep underground, generally as shallow as 50 feet below ground surface (bgs) near the eastern boundary of the Aerojet property and sloping downward to the west with distance from the property. (See Figure 2-5) The groundwater does not seep up to the surface or impact the nearby American River. As a result, there are no known receptors for an ecological assessment. Drinking water wells are monitored

and removed from service once contaminated, based on California Department of Public Health regulations. Water on-property is supplied from an up-gradient, off-property supply that is not contaminated.

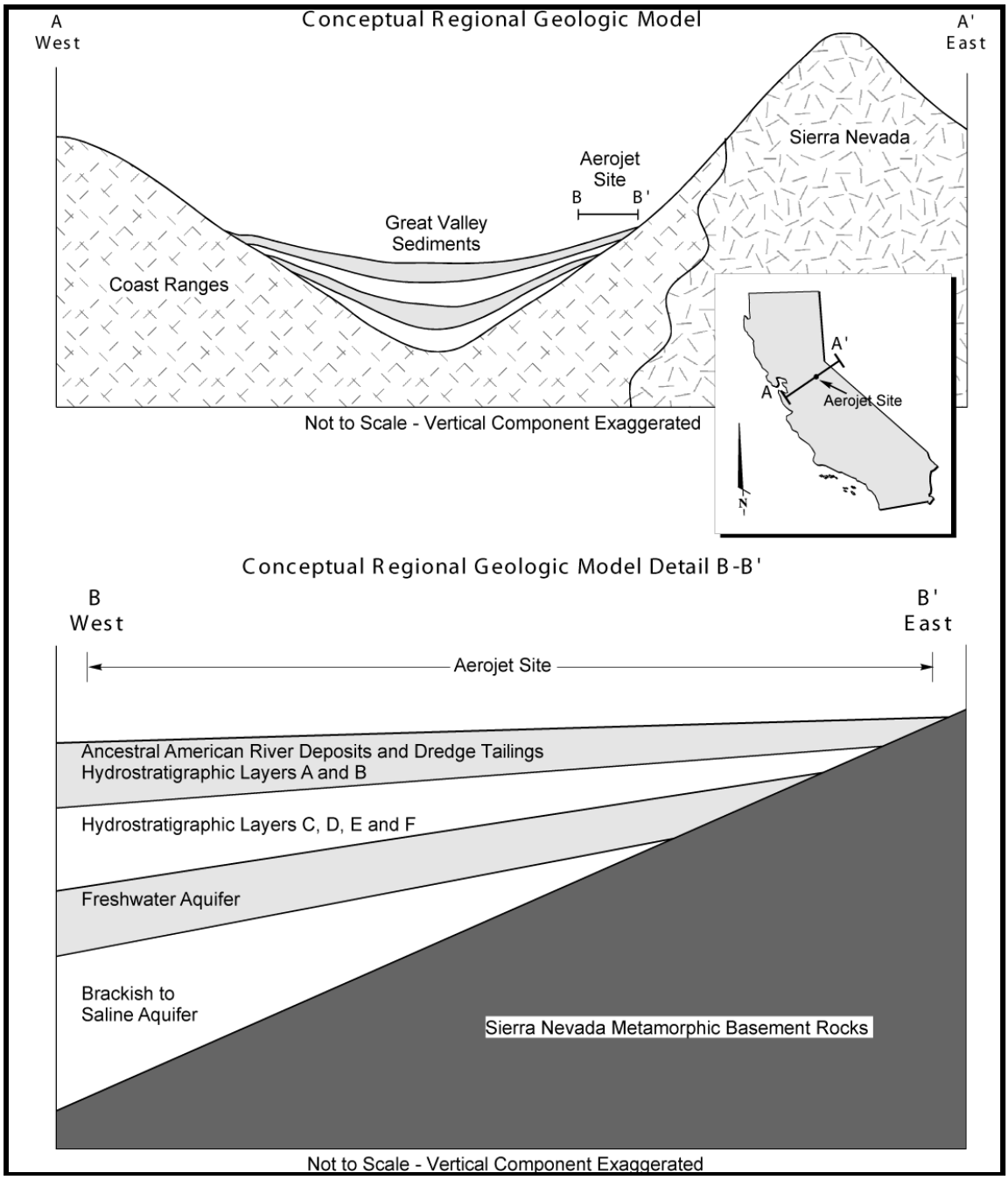

Figure 2-5. Conceptual Model of Groundwater Structure

2.5.2 Contaminated Soil Areas Conceptual Site Model.

A limited area of Aerojet land formerly used for administration and liquid fuel rocket manufacturing is on property surrounded by or adjacent to uncontaminated "carve-out" land. The potential exists for development of these contaminated soil areas for various residential, commercial or industrial uses in the future. The CSM for the risk assessment was based on contact and inhalation - including potential vapor intrusion into structures – and various potential ingestion pathways in residential scenarios including uptake into garden vegetables.

2.5.3 Overview of OU-5

- Size: The estimated area of the approximate extent of contaminated groundwater in the four zones of OU-5 is about 9 square miles, with the contaminated soil areas of OU-5 adding less than 20 acres. The depth to shallow groundwater varies from tens of feet in the east to about 100 ft. below ground surface in the west. The depth to groundwater in the deepest layer of concern, Layer F, is typically greater than 300 ft. below the ground surface.

- Topography: The Aerojet Site and the OU-5 areas are characterized by a relatively flat topographic surface sloping less than 1 degree to the west. Some areas in the eastern portion of the Site, south of GET B, dip to the south and east. The surface elevations range from approximately 200 feet above mean sea level (msl) in the east to approximately 60 feet above msl in the west. Most of the topography on the Aerojet facility is dominated by rows of dredge tailings remaining from gold mining operations that began in the early 1900's. The tailings consist of alternating rows of loose cobble mounds and intervening low areas comprised of silt and clay ("slickens"). Much of the area surrounding Aerojet, including Gold River, portions of the IRCTS, and areas south of GET B, was also dredged, although development has obscured most of the tailings. The dredging apparently disturbed the sediments to depths ranging from 20 to 80 feet below ground surface. Other topographic features include two ancestral American River terrace scarps that generally trend northeast-southwest across the Site. Alder Creek trends east-west through an incised channel cut through the sediments just south of the northern Site perimeter. To the north, a ridge of 30- to 60-foot high bluffs runs parallel to the north side of the American River.

- Surface and Subsurface Water: The American River meanders in a generally southwesterly direction through Zone 1 and the northwest part of OU-5. The Folsom South Canal originates at the southwest end of Lake Natoma. Lake Natoma is formed by Nimbus Dam, which is located one-quarter to one-half mile north of the Aerojet property boundary. In general, the canal parallels the Aerojet boundary. This concrete-lined canal was intended to provide water for a nuclear power plant that is currently being decommissioned, as well as for various municipal and agricultural water users. Other surface water features include the Administration Ditch, Buffalo Creek and the Westlake Stormwater Retention Basins. Most stormwater runoff originating in the northern (Administration Area) portions of Aerojet is diverted to the Westlake basins via the Area

20 Administration Ditches and Buffalo Creek. Stormwater runoff from the northeastern portions of the Site flows through Buffalo Creek to the Westlake storm-water retention cells. Analytical sampling of the storm-water runoff is conducted prior to discharging the water to Buffalo Creek and ultimately the American River. Storm-water discharges to Buffalo Creek/American River are regulated through the National Pollution Discharge Elimination System (NPDES). Aerojet also discharges treated groundwater from ARGET and GET E/F to Buffalo Creek under a separate NPDES permit. Most stormwater runoff generated in the southwestern portions of the Aerojet Site infiltrates locally and does not leave the Aerojet property. The Rebel Hill Ditch traverses the Aerojet Site from northeast to southwest and was constructed to provide water for gold dredging activities. Treated groundwater from GETs A and B, located in Zone 3, is discharged to the Rebel Hill Ditch, where it infiltrates into the ground along the southern boundary of the Aerojet Site

The Site is located near the eastern edge of the Sacramento Valley, near the contact between the Sierra Nevada metamorphic basement rocks and the Great Valley Sedimentary Sequence. The general structure of the subsurface is formed of fairly continuous layers of sediment as shown in cross-section in Figure 2-5. Each layer of permeable sediments is separated by relatively lower permeability sediments. Layer A is defined as the first encountered groundwater that is often, but not always, present or is unsaturated in many areas of the Site. Layer B is relatively thin and is also dry or absent in some areas of the Site. Layers C, D, E, and F are located within the deeper geologic formations and are generally continuous across the western and southern portions of the Site, but are not present in the northern and eastern portions of the Site due to the eastward thinning of the sediment.

Groundwater flow is radial from the interior of the Aerojet Site towards the various Aerojet property boundaries. (See Figure 2-2) Groundwater flows from the Aerojet Site in essentially all directions except east. As a result, multiple interim remedial action GET facilities were necessary to provide hydraulic containment at the property boundaries.

- Groundwater monitoring and contaminant analyses: Aerojet has installed over 2,000 monitoring wells throughout the Site in addition to installing and operating arrays of extraction wells for contaminant containment in some parts of OU-5. Numerous production wells have provided information on the physical and chemical characteristics of the aquifer and the flow of groundwater and chemicals in the water.

  The development of the analytical sampling program for OU-5 was complicated by the large number of chemicals handled at the Site. A systematic process of chemical identification, screening, and assessment was conducted during the Stage 1 RI and subsequent groundwater monitoring efforts. This process followed CERCLA guidance and has resulted in the development and refinement of analytical methods for identifying unique or specialty chemicals, the formation of Target Analyte Lists (TALs) for the groundwater, and an approach for managing tentatively identified chemicals.

- Known and Suspected Sources of Groundwater Contamination: Since the early 1950s, the

Aerojet Sacramento facility has been devoted to the development of rocket propulsion systems to support national defense, space exploration, and satellite deployment activities. Industrial activities at the Aerojet Site have included solid rocket motor manufacturing and testing, liquid rocket engine manufacturing and testing, and chemical manufacturing. Chemicals used in the manufacturing and testing areas on the Aerojet Site have included chlorinated solvents, propellants, metals, oxidizers, and a variety of chemicals produced in the chemical operations areas.

- Types of Contamination and Affected Media in Groundwater Portion of OU-5: Operations at the Aerojet Site have resulted in the discharge of COCs to the vadose zone and the underlying groundwater. Although numerous types of chemicals have been used historically on the Aerojet Site, TCE, perchlorate and NDMA comprise the chemicals that are the most prevalent and of main concern in this operable unit. TCE was utilized on the Aerojet Site for cleaning and degreasing purposes. In OU-5, the TCE concentration varies from below the 5 ppb drinking water standard at the leading edge of the plumes to over 600 ppb in the upgradient OU-5 groundwater near the property boundary. Detailed plume maps for TCE, perchlorate and NDMA in groundwater layers A and C, the most heavily contaminated groundwater layers, are presented in Appendix B. Perchlorate salts were utilized as an oxidizer in solid rocket propellants, with manufacturing, testing and disposal operations leading to the releases throughout the Aerojet facility. Perchlorate concentration in some parts of OU-5 exceeds 100 ppb, well above the California drinking water standard of 6 ppb. NDMA is a semi-volatile organic compound (SVOC) that was either an impurity in hydrazine-based liquid rocket fuels or was formed as a combustion product of these fuels. The maximum concentration of NDMA reported in OU-5 groundwater is 96,000 ppt, over 30,000 times the risk level and California Public Health Goal. The groundwater COCs are listed in Table 2.1.

- Known and Suspected Sources of Soil Contamination: Relatively minor discharges of various COCs occurred in the contaminated soil areas of OU-5, compared to the major manufacturing and testing operations that occurred in other OUs on the Aerojet property. In several soils areas, the pattern of groundwater contamination in the shallower layer of the aquifer indicated that the source of VOCs measured in the vadose zone was from upgradient activities to be addressed in other OUs. This limits the remedial actions in these areas to preventing unacceptable exposure from the soil vapor. The COCs in soil and soil vapor in OU-5 are listed in Table 2.2.

- Types of Contamination and Affected Media in Contaminated Soil Areas of OU-5: Contaminants at various soil areas include VOCs, PCBs, perchlorate and various metals. The relatively immobile metals and PCBs tend to be present in soil near the surface which can be excavated with reasonable effort. Perchlorate at area C41 has been measured throughout the 70 foot depth of the unsaturated soil. The mass of perchlorate totals several kilograms with potential to dissolve in water percolating through the soil and to be transported to groundwater. VOCs in the soil and underlying shallow groundwater can be present as soil vapor capable of movement to the ground surface and into structures.

Table 2.1 Chemicals of Concern in Groundwater

Non-Metal Anion
Perchlorate
SVOCs
N-Nitrosodimethylamine (NDMA)
VOCs
Trichloroethene (TCE)
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethene
1,2-Dichloroethane
cis-1,2-Dichloroethene
trans- 1,2-Dichloroethene
1,4-Dioxane
Bromodichloromethane
Carbon tetrachloride
Chloroform
Dibromochloromethane
Methylene chloride
Tetrachloroethene
Vinyl chloride

Table 2.2 Chemicals of Concern in Soil and Soil Vapor

Soil
2,3,7,8-TCDD (Dioxin)
Antimony
Bis(2-Ethylhexyl)phthalate
Cadmium
Diethyl phthalate
Di-n-butyl phthalate
Hexavalent chromium
Lead
Mercury
Perchlorate
PCB-1254
PCB-1260
Silver
Zinc
Soil Vapor
Benzene
Chloroform
cis-1,2 Dichloroethene
1,1,1 Trichloroethane
Trichloroethene
Tetrachloroethene

2.6 Current and Potential Future Land and Resources Uses

The Aerojet Superfund Site is designated as a Special Planning Zone (SPZ) with multiple uses from propulsion systems testing to office use. The SPZ has a provision for future development under the Sacramento County Land Use Master Plan which would allow for residential use. The contaminated soil areas of OU-5 including the carve-out property free of soil contamination, but underlain by contaminated groundwater, is proposed for development as mixed residential and commercial. The land immediately adjacent to the Site is entirely zoned as heavy and light industrial. The area further to the west and south of the El Dorado Freeway (Highway 50) is designated as an industrial-office park zone. The area north of Highway 50, south of the American River and west of Sunrise Boulevard is zoned approximately 90 percent residential and 10 percent commercial. The area to the east of Sunrise Boulevard, south of the American River and north of Highway 50 is approximately 40 percent industrial and 60 residential. The American River Flood Plain and the edges of the adjacent bluffs are designated as recreational zones. The cities of Rancho Cordova, Carmichael, Fair Oaks, Folsom and unincorporated Gold River are generally fully developed with residential, commercial and industrial properties.

The regional aquifer is extremely large and extends beyond the city of Sacramento, over 15 miles to the west. Much of the aquifer in OU-5 off Aerojet property is currently used for drinking water (Federal Groundwater Classification IIA) and demand on the aquifer is growing. The need for water around the Site is expected to increase over the next 20 years as it is developed. The contamination, if not contained, will continue to flow off the property degrading more of the drinking water aquifer.

Based on a review and analysis of GenCorp's proposed land use plans and municipal development approvals, EPA has identified planned future land uses that affect portions of the Aerojet Site within OU-5. The anticipated future uses and remedial considerations for OU-5 are outlined below.

2.6.1 Sacramento County

- GenCorp's proposed Easton Place and Glenborough at Easton Developments are located in Sacramento County and fall within the Aerojet Special Planning District. The OU-5 soils remedy will require cleanup to unrestricted future use levels, or include targeted use restrictions (e.g., deed restrictions, development standards, construction methods or engineering controls) in order to support the County-approved land uses for Easton Place and Glenborough at Easton.

- The Sacramento County Board of Supervisors approved the General Plan and Zoning Amendments, and Tentative Large and Small Lot Subdivision Maps for Easton Place and Glenborough at Easton in January 2009. (County of Sacramento Zoning Code. *Aerojet Special Planning Area.* Title V, Chapter 8, Article 3)

- County approvals for Easton Place allow for the development of a 183-acre transit-oriented community featuring high-density residential, retail and commercial office uses. High-density residential uses are approved for a portion of the Aerojet Site currently impacted by contaminated soils within OU-5.

- County approvals for Glenborough at Easton allow for a 1,200-acre mixed-use development including residential uses, a new regional town center, village centers, parks and open space, a high school and commercial uses.

2.6.2 City of Rancho Cordova

- GenCorp has submitted an application to the City of Rancho Cordova for the development of the Westborough at Easton Specific Plan (Westborough Plan).

- The proposed Westborough Plan envisions the phased development of a 1,695-acre mixed-use community with low and medium density residential uses, retail and commercial office uses, and natural preserve areas. The Westborough Plan area is primarily located within the City of Rancho Cordova's Aerojet Special Planning District; a small portion of the Westborough Plan is located in an area of Sacramento County proposed for annexation by the City of Rancho Cordova.

- The City of Rancho Cordova is in the process of completing an Environmental Impact Report for the Westborough Plan and has not yet approved the proposed land uses.

- GenCorp's Westborough Plan proposes residential and commercial uses for areas of the Aerojet Site currently impacted by OU-5 contaminated soil, specifically area C4. The OU-5 soils remedy will allow for unrestricted future use, or require targeted use restrictions (e.g., deed restrictions, development standards, construction methods or engineering controls) in order to support GenCorp's proposed Westborough Plan.

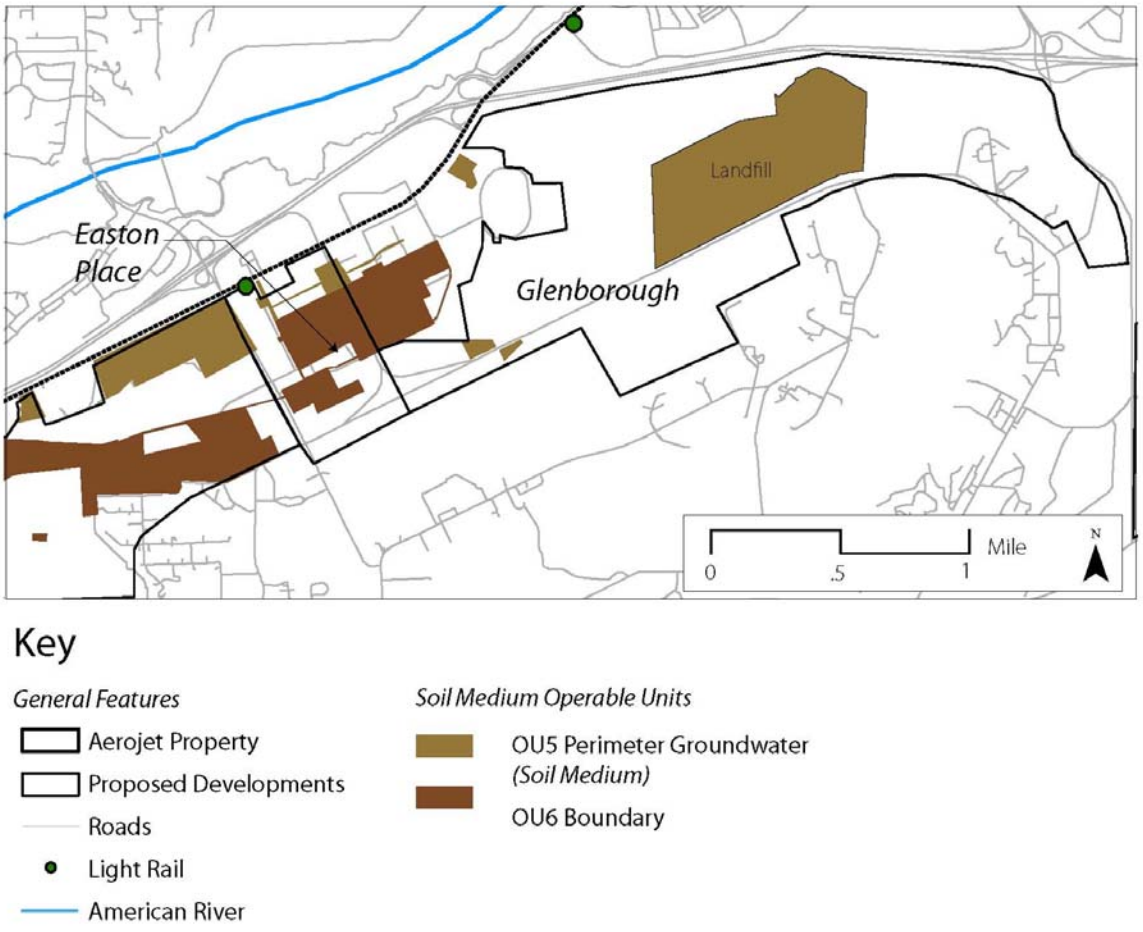

Figure 2-6 Aerojet OU-5 Land Development Plans

Key

General Features

Aerojet Boundary

Light Rail

Operable Units

OU5 Perimeter Groundwater *(Soil Medium)*

OU6 Boundary

Note: All boundaries are approximate.

Proposed Land Uses

CMU

Commercial

Community Resource

High Density Residential

Low Density Residential

Medium Density Residential

Major Road

Office

Open Space

Open Space/Alder Creek

PQP

Park

Parkway

School

Figure 2-7 Easton Development Plan

Key

General Features

- Aerojet Boundary
- Light Rail
- American River
- **Landfill**

Operable Units

- OU5 Perimeter Groundwater *(Soil Medium)*
- OU6 Boundary
- OU8 Eastern

Proposed Land Uses

- CMU
- Commercial
- Community Resource
- High Density Residential
- Low Density Residential
- Medium Density Residential
- Major Road
- **Office**
- Open Space
- Open Space/Alder Creek
- PQP
- Park
- Parkway
- School

Figure 2-8 Glenborough Development Plan

Figure 2-9 Westborough Phase 1 and Phase 2 Development Plans

2.7 Summary of Site Risks

Human health and ecological risk assessments were performed to identify and estimate potential risks to people and the environment from contamination of groundwater and soils, assuming current conditions and unrestricted future use of the contaminated soil areas within OU-5.

The Human Health Risk Assessment (HHA) assesses the human health risks from hypothetical exposure to groundwater, soil and soil vapors by future residential (both adult and child) commercial or industrial receptors if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for the Site.

Potential risks from cancer-causing contaminants (carcinogens) are defined as the probability of a person getting cancer from a long-term exposure to those carcinogens. This probability is expressed as the number of additional cancers that might occur due to exposure to the Site's contamination. EPA's goal is to protect residents, workers and visitors at an NPL site from increased risks of cancer by keeping the risks extremely low. USEPA seeks to manage potential cancer risks so that they fall within or below a risk management range of one in ten thousand (1×10^{-4}) to one in one million (1×10^{-6}) chance of additional cancer that might occur due to exposure to the contamination. USEPA uses the 10^{-6} risk level as the point of departure for determining remediation goals when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants or multiple pathways of exposure. 40 C.F.R. § 300.430(e)(2) (2010). For contaminants that do not cause cancer but may cause other health effects (non-carcinogens), risk is expressed as a Hazard Index (HI). If the HI is less than or equal to 1.0, no adverse health effects are expected. An HI greater than 1.0 indicates an increased risk of health effects. The higher the HI, the more likely that health effects could be experienced, especially by people more sensitive to the chemical's effects.

The ecological health assessment determined there are no ecological risks within OU-5 that require action. Discharge to surface water on-Site will comply with the substantive requirements of an NPDES Permit; discharge to surface water off-Site will require an NPDES Permit.

2.7.1 Identification of Chemicals of Concern

The maximum level of contaminants of concern in any hydrostratigraphic layer on-property and off-property was used to calculate the maximum potential risk. Table 2.1 in Section 2.5.3 above provides the list of COCs for groundwater contamination and Table 2.2 lists all COCs for the soil areas in OU-5. Table 2.3 describes the specific types of COCs found in individual OU-5 soil areas.

Table 2.3 Contaminant Types in OU-5 Contaminated Soil Areas

Contaminated Soil Area	Contaminants Requiring Remedial Action – Residential Land Use	Contaminants Requiring Remedial Action – Commercial Land Use
11D	PCBs and Lead	None
10D	PCBs, Silver, Hexavalent Chromium, Mercury and Lead	PCBs
7D	VOCs	None
Former Company Store (FCS)	VOCs	VOCs
C41	Perchlorate	Perchlorate
32D	VOCs	VOCs
34D	VOCs	VOCs
35D	VOCs	VOCs
38D	VOCs	VOCs
33D	VOCs	None
C4	Dioxins/Furans and Lead	None

2.7.2 Exposure Assessment

Exposure pathways include ingestion, dermal contact while showering, and inhalation of volatiles. It was assumed that maximum contamination levels are contained in overlapping plumes (all contaminants in a layer are summed at the maximum concentration level), which may not occur at any given well. Thus, the maximum risk may be overestimated.

There is no known current use of groundwater for residential water supply from unmonitored or untreated wells either at or beyond the property boundary within OU-5. Additionally, future use of groundwater is restricted by existing institutional controls. However, recognizing the State's designation of the aquifer of OU-5 as a potential drinking water source, the analysis included the hypothetical use of untreated groundwater for residential water supply. This analysis considered hypothetical exposure to groundwater constituents via the following routes: ingestion, dermal contact, and inhalation of VOCs released during household non-ingestion use (i.e., showering, cooking, laundering, and dishwashing). Based on the hydrostratigraphic data and the detection of COPCs, the discharge of groundwater to surface water in Alder Creek and Administration Ditches was examined in the RI/FS as a potentially complete pathway in the Risk Assessment. However, exposures to constituents in Alder Creek and Administration Ditches are expected to be negligible and limited to occasional dermal contact under a recreational scenario which was evaluated in the Risk Assessment.

2.7.3 Data Evaluation

The HHA considered analytical results for all groundwater sampling conducted between January 2000 and June 2004 and supplemental data collected since then. Solvents (e.g., TCE) and rocket fuel components, including perchlorate and NDMA, are the most widely distributed chemicals in groundwater within OU-5. Other detected chemicals include tetrachloroethene (PCE); 1,2-dichloroethene (1,2-DCE); 1,1-DCE; and Freon 113.

2.7.4 Toxicity Assessment

Consistent with USEPA guidance, the noncarcinogenic effects of the COPCs were assessed by comparing the calculated chemical intakes with USEPA reference doses. Evaluation of potential cancer risk utilized slope factors published by USEPA and Cal-EPA's Office of Environmental Health Hazard Assessment. This Risk Assessment evaluated petroleum hydrocarbon mixtures through quantitative evaluation of the risks associated with exposure to petroleum constituents such as benzene, toluene, ethylbenzene, and xylenes (BTEX) and polynuclear aromatic hydrocarbons (PAHs).

2.7.5 Risk Characterization

Based on the risk analysis, the hypothetical use of untreated groundwater for residential water supply could result in unacceptable levels of risk. In addition, the HHA identified potential locations in the contaminated soil areas in which risks associated with the hypothetical or planned use of land for either residential or commercial use could result in risks greater than the 1×10^{-6} due to vapor migration from groundwater. The locations are areas 7D, 32D, 33D, 34D, 35D, 38D and FCS. In considering these findings, two points deserve emphasis: First, there is no current or likely future use of untreated groundwater for residential water supply. Second, this HHA incorporated a number of conservative assumptions to guard against the underestimation of risks. The uncertainties in risk assessment can be grouped into four main categories and include environmental sampling and analysis, fate and transport modeling, assumptions concerning exposure scenarios and toxicity data and dose response extrapolations.

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equations:

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

Where: Risk = a unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor, expressed as (mg/kg-day)-1

The risks are probabilities that usually are expressed in scientific notation (e.g., $1x10^{-6}$). An excess lifetime cancer risk of $1x10^{-6}$ indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an excess lifetime cancer risk because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally accepted risk range for site-related exposures is 10^{-4} to 10^{-6}. USEPA uses the 10^{-6} risk level as the point of departure for determining remediation goals when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants or multiple pathways of exposure. 40 C.F.R. § 300.430(e)(2) (2010).

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life-time) with an RfD derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ less than one indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The hazard Index (HI) is generated by adding HQs for all chemicals of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI less than one indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI greater than one indicates that site-related exposures may present a risk to human health. The HQ is calculated from the following equation:

Non-cancer HQ = CDI/RfD

Where: CDI = Chronic daily intake
RfD = Reference dose

Some uncertainty is inherent in risk assessments. Uncertainty exists in the exposure assessment, toxicity values, and the risk characterization. In the human health risk assessment, exposure and the toxicity assessments are the largest sources of uncertainty and variability. For the exposure assessment, there is uncertainty in risk estimates because of 1) the use of the maximum detected concentrations for all COCs in each hydrostratigraphic layer during the RI/FS, 2) the use of upper-bound values for ingestion, inhalation, and dermal contact rates, and 3) the use of default values for exposure duration that are likely to overestimate exposures.

2.7.5.1 Groundwater

The HHA concluded that contaminated groundwater exceeds drinking water standards within the plume shown on Figure 2-2 (page 8) and the figures in Appendix B. The HHA also concluded that groundwater contamination must be contained to prevent further contamination of the existing drinking water aquifer. The three most prevalent contaminants detected in the

groundwater are perchlorate, NDMA and TCE. (See Table 2.1 for the list of all groundwater contaminants detected.) These were found in all four zones of OU-5, with the exception of NDMA, which is found in all zones except zone 2. The cancer risk for all four zones exceeds EPA's target risk range as shown in Table 2.5. The cancer risks in Zones 1 and 2 exceed 10^{-3} and in Zones 3 and 4 the maximum cancer risks exceed 10^{-2}. The non-cancer HIs exceed 1000 in Zones 1, 2 and 4, and the HI is well over 100 in Zone 4 (See Table 2.6). Remedial action to prevent further contamination and expedite final cleanup of the drinking water aquifer is justified by the potential risks.

Table 2.4 Detailed Groundwater Risk Values for All Zones and Layers

Layer	Property Boundary		Beyond Property Boundary	
	Total Lifetime Cancer Risk	Hazard Index (Child) [1]	Total Lifetime Cancer Risk	Hazard Index (Child) [1]
Zone 1				
B	7×10^{-4}	710	3×10^{-5}	1.1
C	1×10^{-3}	4,300	2×10^{-3}	870
D	9×10^{-3}	2,300	4×10^{-3}	700
E	1×10^{-3}	360	2×10^{-3}	400
F	2×10^{-5}	2	2×10^{-4}	16
Zone 2				
A	4×10^{-4}	430	NA	
B	3×10^{-3}	4,000	NA	
C	5×10^{-3}	47,000	NA	
D	1×10^{-5}	440	NA	
Zone 3				
A			NA	110
B	4×10^{-2}	650	2×10^{-3}	110
C	8×10^{-2}	1,400	1×10^{-1}	1,600
D	5×10^{-2}	820	9×10^{-2}	1,200
E	5×10^{-2}	570	4×10^{-2}	470
F	6×10^{-2}	640	5×10^{-2}	610
Zone 4				
Dredged	6×10^{-5}	17	NA	
A	4×10^{-2}	590	NA	
B	2×10^{-4}	8.3	NA	

[1] HIs have been summed across all target endpoints and are presented for the most sensitive population (children).
NA = Not Applicable

Table 2.5 Risk Characterization Summary - Carcinogens in Groundwater

Scenario Timeframe: Current Receptor Population: Resident Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Pt.	COC	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
GW	GW	Tap Water	Perchlorate	-	-	-	-
GW- Zone 1	GW	Tap Water	NDMA	-	-	-	-
GW- Zone 2				-	-	-	-
GW- Zone 3				2.3E-02	-	4 E-05	2.3E-02
GW- Zone 4				2.4E-03	-	4 E-06	2.4E-03
GW- Zone 1	GW	Tap Water	TCE	4.5E-05	2.1E-04	4.1E-04	2.9E-04
GW- Zone 2				4.5E-05	2.1E-04	4.1E-04	2.9E-04
GW- Zone 3				4.5E-06	2.1E-05	4.1E-06	2.9E-05
GW- Zone 4				4.5E-06	2.1E-05	4.1E-06	2.9E-05
- = Toxicity criteria not available to quantitatively address this route of exposure.					Maximum Total Risk		2.3E-02

Risk Characterization

This table provides the cancer risk estimates for the significant routes of exposure from the primary contaminants on OU-5 groundwater. These risk estimates are based on a reasonable maximum exposure using recent data used for the chemical-specific plume maps in Appendix B and were developed by taking into account various conservative assumptions about the frequency and duration of exposure.

NDMA toxicity from Provisional Peer Reviewed Toxicity Values; TCE toxicity values from California EPA

Table 2.6 Risk Characterization Summary – Non-Carcinogens in Groundwater

Scenario Timeframe: Current Receptor Population: Resident Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Pt.	COC	Non -Carcinogenic Risk – Hazard Quotient			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
GW- Zone 1	GW	Tap Water	Perchlorate (Thyroid)	1.5	-	-	1.5
GW- Zone 2				20	-	-	20
GW- Zone 3				20	-	-	20
GW- Zone 4				2.5	-	-	2.5
GW- Zone 1	GW	Tap Water	NDMA	ND	-	-	ND
GW- Zone 2				ND	-	-	ND
GW- Zone 3				330	-	-	330
GW- Zone 4				34	-	-	34
GW	GW	Tap Water	TCE	-	-	-	-
						Groundwater Hazard Quotient Total	350

- = Toxicity criteria not available to quantitatively address this route of exposure.

ND –Not detected

Risk Characterization

This table provides non-cancer risk estimates for the significant routes of exposure from the primary contaminants on OU-5 groundwater. These risk estimates are based on a reasonable maximum exposure using recent data, and information from the chemical-specific plume maps in Appendix B. The maximum total Hazard Quotient is from Zone 3, although all Zones had HQs greater than the Hazard Index of 1.0.

Perchlorate toxicity from IRIS; NDMA toxicity from Provisional Peer Reviewed Toxicity Values; TCE toxicity values from California EPA

The containment levels for the COCs for OU-5 groundwater and the basis for establishing these containment levels are listed in the Table 2.7 Table 2.8 lists the residual risks for groundwater calculated at the groundwater containment levels. More detailed rationales for these levels are as follows:

- Perchlorate: The containment level selected for perchlorate is 6 ppb (6 µg/L). This is the drinking water standard (MCL) promulgated by the State of California in 2006. In January 2009, USEPA issued an Interim Health Advisory for perchlorate to assist state and local officials in addressing local contamination of perchlorate in drinking water while the Agency evaluates the opportunity to reduce risks through a national primary drinking water standard. The USEPA Interim Drinking Water Health Advisory level was published as 15 µg/L. This advisory level is not a promulgated standard. The California MCL is a promulgated standard and USEPA believes it is relevant and appropriate as the containment level.

- NDMA: The containment level selected for NDMA is 0.003 µg/L or 3 parts per trillion (ppt). There is no California or federal Maximum Contaminant Level (MCL) for NDMA. In 2006, the California Office of Environmental Health Hazard Assessment (OEHHA) developed a Public Health Goal (PHG) of 0.003 µg/L or 3 ppt for NDMA in drinking

water. The PHG is based on an extra cancer risk of 1 in 1 million (10^{-6}) for lifetime exposure to NDMA in drinking water. The California Notification Level (previously known as Action Level) for NDMA is 0.01 µg /L. Notification levels are defined by DHS as "health-based advisory levels established by DHS for chemicals in drinking water that lack maximum contaminant levels (MCLs)." Carcinogenic effects observed in animal studies were judged to be the most sensitive endpoint and are the basis of the PHG for NDMA. NDMA is one of over 100 nitrosamines, many of which have been shown to be carcinogenic by genotoxic mechanisms. There is a high cumulative risk because there are eight other carcinogens in the mix of COCs. In addition there is a relative source contribution to be considered because of the presence of NDMA in our dietary intake (e.g., bacon, beer, etc.). USEPA has published a Regional Screening Level (RSL) of 0.42 ppt. Based on the USEPA IRIS oral carcinogenic slope factor, the cancer risk at 3 ppt would be about 4×10^{-6}. Although the California PHG of 3 ppt is not a promulgated standard, USEPA this PHG is protective and should be used as the containment level.

- TCE and Other COCs: The containment level selected for TCE is the MCL of 5 ppb (5 µg/L). The groundwater containment levels for the remaining COCs such as the VOCs are also based on MCLs. For contaminants with federal or state MCLs, USEPA maintains a general policy of establishing Superfund groundwater cleanup or containment standards at the MCL. USEPA notes that the federal MCL establishes a maximum limit of 80 µg/L for the sum of the concentration of all four major trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, and bromoform). The total limit had not been clear in a table of containment levels included in the Proposed Plan fact sheet. When the maximum total risk at the MCL for trihalomethanes is considered, the cumulative cancer risk would remain within the acceptable risk range in OU-5 if all COCs were at the containment levels. Since TCE, NDMA and perchlorate are the major groundwater contaminants, it is expected that few if any of the other COCs in groundwater will be at the containment level when the primary contaminants reach containment goals. The State and other commenters expressed a preference for considering certain state and local policies that require more stringent non-promulgated standards for use of groundwater for public supply. However, the groundwater remedy for OU-5 is an interim rather than final remedy and USEPA is not setting numeric cleanup goals for the groundwater in the aquifer at this time. Coordination and integration of USEPA's containment and the State's remediation efforts and cleanup objectives for IRCTS and White Rock Road North Dump will be reviewed in the final Sitewide remedy selection. USEPA will evaluate final aquifer cleanup levels during the Sitewide remedy selection process. An evaluation of the effectiveness of the OU-5 groundwater remedy during the five year reviews will need to address these issues.

Table 2.7 Groundwater Chemicals of Concerns with Containment Levels for OU-5

Chemicals of Concern in Groundwater	Containment Level (micrograms per liter or ppb)	
Non-Metal Anion		
Perchlorate	6	CA Drinking Water Standard (MCL)
SVOCs		
N-Nitrosodimethylamine (NDMA)	0.003	CA Public Health Goal
VOCs		
Trichloroethene (TCE)	5	Federal MCL
1,1,2,2-Tetrachloroethane	1	CA MCL
1,1,2-Trichloroethane	5	Federal MCL
1,1-Dichloroethene	6	CA MCL
1,2-Dichloroethane	0.5	CA MCL
cis-1,2-Dichloroethene	6	CA MCL
trans- 1,2-Dichloroethene	10	CA MCL
1,4-Dioxane	1	CA DPH Notification Level
Bromodichloromethane*	80*	Federal MCL
Carbon tetrachloride	0.5	CA MCL
Chloroform*	80*	Federal MCL
Dibromochloromethane*	80*	Federal MCL
Methylene chloride	5	Federal MCL
Tetrachloroethene	5	Federal MCL
Vinyl chloride	0.5	CA MCL

* The federal MCL establishes a limit of 80 µg/L for the sum of the concentration of all four major trihalomethanes: chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

Table 2.8 Risks Associated with Containment Levels for Chemicals of Concern (COC) in Groundwater at Aerojet OU-5

COC	Containment Level	Basis for Containment Level	Risk at Containment Level
Perchlorate	6.0 ppb	MCL California	Non-carcinogenic risk (NCR) Hazard index (HI) = 1
NDMA[1]	.003 ppb[1]	California Public Health Goal	Cancer risk $1x10^{-6}$ (see footnote)
Trichloroethene	5 ppb	Max. Contaminant Level (MCL) USEPA & California	Cancer risk $2.4x10^{-6}$
1,1,2,2-Tetrachloroethane	1 ppb	MCL California	Cancer risk $1x10^{-6}$
1,1,2-Trichloroethane	5 ppb	MCL USEPA & California	Cancer risk $1.8x10^{-5}$
1,1-Dichloroethene	6 ppb	MCL California	NCR, HI= 0.009
1,2,-Dichloroethane	0.5 ppb	MCL California	Cancer risk $2.9x10^{-6}$
cis 1,2-Dichloroethene	6 ppb	MCL California	NCR, HI = 0.3
trans 1,2-Dichloroethene	10 ppb	MCL California	NCR, HI = 0.3
1,4 -Dioxane	1 ppb	California DPH Notification Level	HI = 1
Bromodichloromethane*	80 ppb*	MCL USEPA	Cancer risk $6.7x10^{-4}$
Carbon Tetrachloride	0.5 ppb	MCL California	Cancer risk $2.3x10^{-6}$
Chloroform*	80 ppb*	MCL USEPA	Cancer risk $4.2x10^{-4}$
Dibromochloromethane*	80 ppb*	MCL USEPA	Cancer risk $5.3x10^{-4}$
Methylene Chloride	5 ppb	MCL USEPA	Cancer risk $1x10^{-6}$
Tetrachloroethene	5 ppb	MCL USEPA & California	Cancer risk $4.5x10^{-5}$
Vinyl Chloride	0.5 ppb	MCL California	Cancer risk $2.2x10^{-5}$

Notes: [1] Cancer risk estimated by California OEHHA 2006. The NDMA PQL is being improved. The current enforceable level is greater than 3 ppt. Best available monitoring method technology shall be used until a PQL of 3 ppt or lower is achieved.
* The federal MCL establishes a limit of 80 µg/L for the sum of the concentration of all four major trihalomethanes: chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

Although the national Superfund policy is to establish groundwater cleanup or containment levels at the MCL, the toxicological information for contaminants of concern will continue to be developed over time. The five year review process reviews new information relevant to protection of public health and explicitly considers any new regulations promulgated since the ROD.

2.7.5.2 Surface and Subsurface Soil Contamination

The potential soil sources that were investigated are shown on Figure 2-3 on page 9. The majority of the locations were not contaminated above health based levels for unrestricted use such as residential development. Eleven soil areas were found to be contaminated with one or more chemicals of concern (Tables 2.2 and 2.3). The HHA found that further action is required at these 11 locations to protect residents or workers from exposure through direct contact, ingestion and/or inhalation of COCs. The contaminants found in these areas include lead, zinc, cadmium, polychlorinated biphenyls (PCBs), dioxins, furans, chloroform and TCE. The maximum concentrations of soil contaminants found in each area are listed in Table 2.9. The maximum measured soil vapor levels are listed in Table 2.10, along with the risk levels for that soil vapor level. Table 2.11 shows the cleanup goals and performance standards in soils for each COC based on the lowest cancer or non-cancer risks for potential land uses (residential or commercial). In some cases, cadmium and chromium contamination in the soil could be of concern for construction workers at the Site. The HHA concluded that remedial action for the vadose zone was justified in areas 32D, 34D, 35D and 38D (Figure 2-3) because the contaminants exceeded EPA's target risk range for protection from inhaling VOCs and the HI for the contaminants present were significantly over 1. Table 2.12 shows the vapor performance standards and risk basis for ambient air in the soil areas with VOC vapor levels exceeding the risk range for residential or industrial uses. The HHA identified three areas (7D, 33D and FCS) where VOCs were measured in soil gas exceeding EPA's target risk range.

Table 2.9 – Maximum Chemical Concentrations in Soil by Area, reported in milligrams per kilogram (mg/kg)

	Area 20				Area 49					
Chemical	**7D**	**10D**	**11D**	**C41**	**32D**	**33D**	**34D**	**35D**	**38D**	**C4**
2,3,7,8-TCDD (Dioxin)	--	--	--	--	--	--	--	--	--	3.5 E-7
Antimony	<5	<24	1 J	12 J	<1.2	<5	--	<6	--	1.7
Bis(2-Ethylhexyl)phthalate	--	0.049 J	--	<0.6	0.170 J	0.045 J	--	0.065 J	<0.0093	--
Cadmium	2.56	4.58	3.89	<1	<0.49	9.1	--	1.7	--	4.9
Diethyl phthalate	--	<0.33	--	0.190 J	0.051 J	0.2 J	--	0.058 J	0.33	--
Di-n-butyl phthalate	--	--	--	--	<0.012	<0.012	--	<0.012	<0.012	--
Hexavalent chromium	--	11.7	0.74	--	0.88	--	--	--	--	1.1
Lead	125	130	288	99.2	9.2	10.9	--	8.97	--	530
Mercury	3.07	1.9	0.34	0.061	0.13	<0.1	--	0.2	--	0.043
Perchlorate	--	--	--	1.9	--	--	--	--	--	--
PCB-1254	--	0.5	<0.033	--	--	--	--	--	--	--
PCB-1260	--	1.2	0.15	--	--	--	--	--	--	--
Silver	18.8	29	1.16	0.56	<0.34	<1	--	<1	--	<0.66
Zinc	1150	1700 J	2960	44.5	230	54.8	--	135	--	1000

--: The chemical not analyzed. <: The chemical not detected above the value. Soil vapor only was detected in area

34.

Table 2.10 Risk Characterization Summary – Soil Vapor at Contaminated Soil Areas

Contaminated Soil Area	Chemical of Concern Measured Above Screening Level	Soil Vapor Screening Level* mg/m^3	Maximum Measured Concentration mg/m^3	Estimated Risk for Unrestricted Use
7D	Tetrachloroethene (PCE)	0.64	2.1	3.3E-06 Cancer Risk
FCS	Chloroform (CF)	0.7	0.92	1.3E-06 Cancer Risk
	PCE	0.64	7.6	1.2E-05 Cancer Risk
33D	CF	0.08	6.0	7.5E-05 Cancer Risk
	Trichloroethene (TCE)	0.96	4.1	4.3E-06 Cancer Risk
	Benzene	0.08	0.29	3.6E-06 Cancer Risk
34D	CF	0.08	0.22	2.8E-06 Cancer Risk
	PCE	0.32	5.0	1.6E-05 Cancer Risk
	1,1,1 Trichloroethane	0.12	0.5	HQ=4.2 non-cancer
	TCE	0.96	17	1.8E-05 Cancer Risk
35D	PCE	0.32	2.0	6.3E-06 Cancer Risk
	TCE	0.96	3.2	3.3E-06 Cancer Risk
38D	Cis-1,2 Dichloroethene	3.7	7.1	HQ=1.9 non-cancer
	PCE	0.32	40	1.3E-04 Cancer Risk
	1,1,1 Trichloroethane	0.12	2.4	HQ=20 non-cancer
	TCE	0.96	240	2.5E-04 Cancer Risk
	Benzene	0.08	0.15	1.9E-06 Cancer Risk

*Conservative estimated attenuation factor applied to RSLs to develop soil vapor screening level

Perchlorate in the soil at C41 poses a potential risk for both surface exposure and transport into the groundwater. Excavation of the surface soil to at least ten feet and replacement with clean soil will be protective from surface exposure for unrestricted use. However the highly soluble perchlorate remaining below the excavated depth could potentially flush into the groundwater. USEPA assessed a range of site-specific conditions and determined that the groundwater containment remedy would adequately address the perchlorate potentially transported to the

groundwater. At the most rapid transport rate, with relatively high flushing of water through the soil column, the groundwater concentration would be severely impacted for approximately ten years during which period the groundwater remedy would contain and remediate the perchlorate. At progressively slower rates of flushing, the impact on groundwater is reduced while remaining contained by the groundwater remedy. The groundwater downgradient from C41 will be monitored, and the protectiveness of the groundwater from contaminants remaining at C41 will be evaluated in the final Sitewide remedy selection process.

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Table 2.11 Risk Basis for Performance Standards in OU-5 Surface Soil.

Chemical	Unrestricted Use Level (Residential Use)		Restricted Use (Commercial Use)	
	Soil concentration mg/kg soil	Risk basis	Soil concentration mg/kg soil	Risk basis
2,3,7,8-TCDD (Dioxin)	3.9E-06	Cancer	1.6E-05	Cancer
Antimony	31	Non-cancer	120	Non-cancer (construction worker)
Bis(2-Ethylhexyl)phthalate	35	Cancer	123	Cancer
Cadmium	48	Cancer (construction worker)	48	Cancer (construction worker)
Diethyl phthalate	49,000	Non-cancer	186,000	Non-cancer (construction worker)
Di-n-butyl phthalate	6,110	Non-cancer	23,280	Non-cancer (construction worker)
Hexavalent chromium	1.4	Cancer (construction worker)	1.4	Cancer (construction worker)
Lead	127	Non-cancer	531	Non-cancer (construction worker)
Mercury	23.5	Non-cancer	84	Non-cancer (construction worker)
Perchlorate*	55	Non-cancer	210	Non-cancer (construction worker)
PCB-1254	0.09	Cancer	0.3	Cancer
PCB-1260	0.09	Cancer	0.3	Cancer
Silver	390	Non-cancer	1,500	Non-cancer (construction worker)
Zinc	23,400	Non-cancer	90,000	Non-cancer (construction worker)

*Perchlorate cleanup goal for protection of groundwater quality is 0.06 mg/kg soil.

Table 2.12 Risk Basis for Performance Standards for Ambient Air Vapor Levels of VOC Chemicals of Concern at Aerojet Soil Areas, protective of residential and industrial inhalation risk. Protective soil vapor levels in subsurface soil are decreased by location- and depth-specific attenuation factors.

Chemical	Unrestricted Use Level (Residential Use)		Restricted Use (Industrial Use)	
	Soil Vapor Health-Based Levels µg /m^3 soil	Risk basis	Soil Vapor Health-Based Levels µg /m^3 soil	Risk basis
Benzene	3.1E-01	Cancer 10^{-6} risk level	1.6	Cancer 10^{-6} risk level
Chloroform	1.1E-01	Cancer 10^{-6} risk level	5.3E-01	Cancer 10^{-6} risk level
cis-1,2 Dichloroethene	1.1E02	Non-cancer	2.1E-01	Non-cancer
1,1,1 Trichloroethane	5.2E03	Non-cancer	2.2E04	Non-cancer
Trichloroethene	1.2	Cancer 10^{-6} risk level	6.1	Cancer 10^{-6} risk level
Tetrachloroethene	4.1E-01	Cancer 10^{-6} risk level	2.1	Cancer 10^{-6} risk level

2.7.4 Summary of Ecological Risk Assessment

2.7.4.1 Summary of Ecological Risk Assessment- Groundwater

The results of the OU-5 RI indicated that Alder Creek in Zone 4 is the only surface water feature that supports ecological receptors that could potentially receive discharge from OU-5 groundwater. The analysis of surface water samples collected from Alder Creek as part of the RI detected trace concentrations of acetone, chloromethane, naphthalene, perchlorate, NDMA, and various metals. Screening of these detected constituents against conservative ecological screening levels identified barium, boron, cadmium, manganese, and selenium as COPCs. Further evaluation indicated that the presence of those metals in Alder Creek did not appear to be site related and/or did not pose a potential risk to aquatic receptors.

A bioassessment of Alder Creek was also performed to further evaluate the potential effects on biota from the discharge of impacted groundwater in Zone 4. The bioassessment involved the collection, identification, and comparison of benthic macroinvertebrates (BMI) at three locations along Alder Creek. The bioassessment found that, in general, the BMI communities at the three locations were not substantially different and did not indicate a potential for site related impact. Minor variations in the BMI communities appear due to physical characteristics of the stream such as shading and sediment compaction. The results of the screening and bioassessment identified no specific impacts related to the Site, and therefore, no further sampling or ecological risk assessment was warranted.

Any discharge of remediated groundwater to surface water on-Site will meet the substantive requirements of an NPDES Permit or, if discharged off-Site, will require an NPDES Permit so that the discharge does not pose a threat to ecological receptors.

2.7.4.2 Summary of Ecological Risk Assessment - Contaminated Soil Areas

Using conservative procedures, there is a potential for contaminants in soil even in the largely disturbed areas to pose an adverse risk to ecological receptors under the exposure conditions assumed at several of the contaminated soil areas including FCS. However, the RI indicated a current lack of suitable habitat in impacted areas and exposure of the ecological receptors to elevated background levels of COPCs that are not associated with OU-5 releases. As a result, the ecological risk assessment concluded that no significant future ecological risk is likely.

2.8 Remedial Action Objectives

The Remedial Action Objectives (RAOs) describe what the proposed Site remediation effort is expected to accomplish. The containment levels for groundwater (Table 2.2) are based on Federal EPA Maximum Contaminant Levels (MCLs) for drinking water or on California MCLs, whichever is lower. Neither an MCL nor a Federal Public Health Advisory level has been established for NDMA, so the containment level for NDMA is the California Public Health Goal. Since 1,4-dioxane also has no MCL, the containment level for 1,4-dioxane is set at California Department of Public Health's Notification Level of 1 ppb for drinking water established in November 2010, which takes into account the 2010 federal risk evaluation for 1,4-dioxane. The current RSL corresponding to a 10^{-6} risk is 0.67 ppb. These groundwater containment levels ensure that public health and the environment are protected. For contaminated soil, the action objectives are based on Site-specific potential exposure information as used in the HHA and on current values for the hazards posed by the chemicals of concern. The soil action levels (Tables 2.11 and 2.12) are calculated to reduce human health risks to protective levels for unrestricted future land use.

2.8.1 Interim Groundwater RAOs

The remedial action for OU-5 is an interim remedy for the groundwater areas in OU-5 since the groundwater remedy is dependent on control of source areas in other OUs still in the Remedial Investigation/ Feasibility Study (RI/FS) phase. The OU-5 groundwater remedy does not establish final cleanup levels for restoration of the contaminated aquifer. These will be selected in the final Sitewide ROD. Complete cleanup of the entire Aerojet Superfund Site will require coordination of all seven groundwater and source operable units.

Specifically, the groundwater RAOs for OU-5 are as follows:

- Protect human health and the environment by preventing exposure to contaminated

groundwater through restricting withdrawal of the water within the containment area for purposes other than remediation;

- Achieve containment of the contaminated groundwater that exceeds the groundwater containment standards to prevent future migration of contaminants until cleanup levels are achieved to protect long-term beneficial uses of the groundwater;

- Remove contaminant mass from the aquifer through extraction and treatment of highly contaminated groundwater at or near the upgradient portions of the OU-5 groundwater zones. This action will improve the efficiency and effectiveness of contaminant containment of OU-5 groundwater.

2.8.2 Surface and Subsurface Contaminated Soil RAOs:

This action is the final remedy for cleanup of contaminated soil areas included in OU-5 through the PCD as modified in 2002. The RAOs are as follows:

- Eliminate exposure to concentrations of pollutants in soils and related drainage ditch sediments that pose an unacceptable risk for present and future occupants of the property and ecological receptors on the property;

- Prevent migration of VOCs and perchlorate in the soil that would impact long-term beneficial uses of groundwater;

- Control perchlorate in subsurface soil below the depth that can be removed by excavation, which may migrate to the shallow groundwater, through containment of the OU-5 groundwater;

- Prevent exposure to VOCs in soils or soil vapor exceeding the EPA health-based ambient air screening levels for residential land use. Potential exposure pathways include inhalation (breathing), ingestion and skin contact. Where commercial or industrial cleanup criteria are used, the land will be restricted to commercial or industrial use through a land use covenant.

2.9 Description of Alternatives: Summary of Remedial Alternatives

EPA is required by law to consider a No Action alternative and to evaluate viable cleanup or containment alternatives against nine criteria. The OU-5 soil and groundwater alternatives were compared against all of the nine evaluation criteria including community acceptance, which was solicited during the public comment period. For an alternative to be considered as a possible final remedy, it must meet EPA's two threshold criteria which are (1) to protect human health and the environment and (2) to comply with specific state and federal regulations known as Applicable or Relevant and Appropriate Requirements (ARARs). The No Action alternative for both soil and groundwater for OU-5 is not a viable remedy alternative because it does not meet either of EPA's

threshold criteria. Groundwater Alternatives in Zones 1 through 4 were each evaluated to determine if additional groundwater control was needed. The RI determined that each of the four zones required action to protect public water supplies. The FS assessed a range of possible actions in each zone needed to prevent further spread of groundwater contamination (Groundwater Containment) and additional steps to control elevated concentrations of groundwater contamination in order to improve containment efficiency and to expedite the remedy (Groundwater Containment with Mass Removal).

2.9.1 Description of Groundwater Remedy Components

Interim groundwater containment alternatives were consolidated into three alternatives 1) No Action; 2) Groundwater Containment Alternatives; and 3) Groundwater Containment with Mass Removal (EPA's preferred alternative). Each alternative requires thorough groundwater monitoring and evaluation to ensure that the containment is effective and protective, and institutional controls on groundwater extraction and use. The no action alternative would be neither effective nor protective. Both Groundwater Containment and Containment with Mass Removal alternatives involve the pumping of sufficiently large volumes of contaminated water to prevent the spread of contaminants above the containment levels into uncontaminated areas. It is estimated that either of these alternatives will pump between 10 and 15 million gallons of groundwater each day. The water will be piped to one of several treatment systems (see Figure 2-2) where a series of standard, reliable treatment systems will remove the various contaminants. The treated water may be used for non-potable purposes such as industrial cooling or discharged to surface water or land. Aerojet may provide the extracted water to drinking water providers for treatment for potable or non-potable uses. The water providers are subject to federal drinking water standards as well as California Department of Public Health, Division of Drinking Water and Environmental Management requirements. If treated water will be discharged on-Site, it will comply with the substantive requirements of an NPDES permit for surface water discharge or waste discharge requirement for discharges to land which are the same as the numerical water quality standards of the NPDES (see Table 2.8); off-Site discharge will require an NPDES permit. Treated water used for non-potable purposes must comply with all applicable regulations. Many of the details, such as monitoring design, final well location and pumping rates, will be determined in the design phase of the project. The value and demands for water supply for any of the end use options will change over the duration of the remedy, as will the various technical, logistical and administrative challenges. The selected remedy considers the listed range of uses and discharges to be acceptable. Selection of a particular end use or uses for the treated groundwater may be developed during the design phase of the remedy and may change over time based on the external factors.

USEPA typically uses an estimated 30-year cost to be able to evaluate options with varying capital and operation & maintenance (O&M) costs with a comparison of current net worth. The estimated 30-year cost for the Groundwater Containment alternative is $57 million. The Groundwater Containment with Mass Removal alternative includes additional extraction of more highly contaminated groundwater nearer the source areas to reduce the mass of contaminants more effectively. The estimated 30-year cost for Groundwater Containment with Mass Removal is over $61 million.

2.9.2 Description of Contaminated Soil Areas Remedy Components

More than 25 soil areas of potential concern in OU-5 were investigated (See Figure 2-3 on page 9). Fourteen of the 25 soil areas tested met residential use requirements. Of the 11 contaminated soil areas, some form of remedial action is required to allow the land to be developed. All options require careful and thorough soil sampling and monitoring of VOC vapor extraction and mitigation to ensure effectiveness and protectiveness. The 11 contaminated soil locations have a range of different contaminants that may be addressed effectively by different alternatives. Of the many alternatives considered, the most viable options were:

- Excavation (physical removal) of the contaminated surface soil to a minimum ten foot depth unless the cleanup levels are reached at a shallower depth, with various disposal options: disposal in an approved landfill, treatment and recycling as fill material, solidification/stabilization and biological treatment (for perchlorate). The ten foot minimum excavation requirement is based on the depths to which residential excavation would normally occur, in order to eliminate current and future exposure to surface materials and eliminate restrictions on disposal or use of surface soil excavated during and after land reuse. During the design phase, deeper excavation may prove feasible;

- Containment with an impermeable asphalt or membrane cap;

- Soil vapor extraction to remove VOCs without excavation;

- Vapor mitigation to reduce or prevent VOC intrusion into buildings through vapor barriers (synthetic membrane) and subslab venting systems and/or subslab depressurization systems;

- Institutional Controls such as deed notification to inform future owners of the presence of potentially hazardous substances at the Site and /or deed restriction to restrict future use of Site; and,

- Biological treatment of deeper perchlorate-contaminated soil using a method under development at the Site.

2.9.3 Summary of Remedy Alternatives

The alternatives for this remedial action are assembled from technologies screened in the RI/FS. The alternatives have been evaluated against EPA's nine evaluation criteria, including community acceptance which was evaluated through review of community responses to the proposed plan for OU-5.

2.9.3.1 Groundwater

Federal regulations require that Superfund remedies remain protective of human health and the environment and minimize untreated waste. EPA expects to use treatment to address the principal threats and to use engineering controls such as containment for relatively low long-term threats or where complete treatment is impracticable. Institutional controls, such as restrictions on land or water use, may be used to supplement treatment and engineering controls as appropriate for long-term management but are not substitutes for practicable active response measures. EPA regulations also anticipate prevention of further exposure to contaminants and spread of the contaminant plume as well as returning groundwater to beneficial uses within a timeframe that is reasonable, given the particular circumstances of the site. The OU-5 groundwater action is an interim remedy for containment of contaminated groundwater, with the final aquifer restoration goals to be evaluated in the final Sitewide remedy selection process. The evaluation of OU-5 groundwater remedy alternatives is presented in Table 2.13. Containment with Mass Removal is expected to maintain a more consistent and lower concentration of contamination at the outer containment line, improving the reliability of the hydraulic containment and treatment systems. Extraction of a lower volume of higher concentrations of groundwater contaminants improves the efficiency of removing and treating the water. Additionally, once the sources of contamination are controlled, the Groundwater Containment with Mass Removal alternative significantly reduces the estimated time to achieve groundwater containment goals compared to Containment alone.

Table 2.13 Groundwater Alternative Comparisons

Criteria	Groundwater Containment	Groundwater Containment with Mass Removal
Overall Protectiveness	Meets Criterion	Meets Criterion
Compliance with State and Federal Requirements	Meets Criterion for Interim Remedy	Meets Criterion for Interim Remedy
Long-term Effectiveness	Meets Criterion	Meets Criterion. Better for effectiveness
Reduction in Toxicity, Mobility, or Volume	Meets Criterion	Meets Criterion. Better for efficient removal of mass at high concentration with lower volume
Short-term Effectiveness	Meets Criterion	Meets Criterion
Implementability	Meets Criterion	Meets Criterion
Cost - 30 Year Present Value	$57 Million	$61 Million
State Acceptance	Meets Criterion with Exception for More Stringent State Restoration Objectives	Meets Criterion with Exception for More Stringent State Restoration Objectives
Community Acceptance	Generally Acceptable See Response to Comments, Appendix A	Generally Acceptable. See Response to Comments, Appendix A

2.9.3.2 Soil Areas

The detailed evaluation of soil remedy alternatives for the 11 locations with contaminated soil can be found in the RI/FS report available at the information repositories. A simplified analysis focusing on the preferred alternatives is presented in Table 2.14 a-c, and the alternatives considered are discussed below.

Soil areas 32D, 34D, 35D and 38D are contaminated with VOCs at concentrations above cleanup goals for either residential or commercial use. The only viable technology which has the potential for attaining unrestricted use levels for these areas is soil vapor extraction (SVE). Containing the VOCs in place with an impermeable cap would not meet the RAO for unrestricted use and could pose a risk for groundwater contamination.

The contaminants in areas 10D, 11D, C4 and C41 include lead, PCBs, dioxin and perchlorate. The only viable alternative to meet the criteria for protectiveness is to remove the contaminants by excavation. Three potential alternatives were considered during the screening phase for the contamination within the top 10 feet of soil: treatment of perchlorate in the near-surface soil, institutional controls restricting land use to non-residential, and excavating the contaminated soil. Proven methods for treating perchlorate in the surface soils at area C41 pose the risk of flushing some of the highest concentrations of perchlorate into the groundwater and would not meet EPA's protectiveness criteria. Land use restrictions alone are not protective because current contaminant levels would prevent even commercial or industrial uses in some areas. An option for areas planned for commercial or industrial uses would be to excavate enough contaminated soil to meet the restricted use action levels and limit the land use by institutional controls.

The VOCs at 7D and FCS originate from contaminated groundwater moving laterally from sources outside OU-5. The RI /FS indicated that SVE would not be effective for cleaning up the low concentrations of VOCs measured in soil vapor in areas 7D, FCS and 33D to meet the goals for unrestricted use. The only viable remedy for these areas to achieve residential use is vapor mitigation beneath buildings constructed in the areas to prevent movement of contaminants into the buildings. If any of these areas are to be used for commercial or industrial use only, institutional controls would be required.

Table 2.14 a. Contaminated Soil Areas Alternative Comparison-Areas 32D, 34D, 35D and 38D

Criteria	Capping and Land Use Restriction	Capping, Soil Vapor Extraction and Land Use Restriction
Overall Protectiveness	Partially Meets Criterion	Meets Criterion
Compliance with State and Federal Requirements	Partially Meets Criterion.	Meets Criterion
Long-term Effectiveness	Partially Meets Criterion.	Partially Meets Criterion. Better for active remediation and control of VOCs.
Reduction in Toxicity, Mobility, or Volume	Does not Meet Criterion	Partially Meets Criterion. Better for removal and treatment of VOCs.
Short-term Effectiveness	Meets Criterion	Meets Criterion
Implementability	Meets Criterion	Meets Criterion
Cost - 30 Year Present Value	$0.4 Million	$1.0 Million
State Acceptance	Meets Criterion.	Meets Criterion
Community Acceptance	Generally Acceptable with Comments See Response to Comments, Appendix A	Generally Acceptable with Comments, Generally Preferred More Rapid Cleanup See Response to Comments, Appendix A

Table 2.14 b. Contaminated Soil Areas Alternative Comparisons -Areas C4, C41, 10D and 11D

Criteria	Excavation of Contaminated Surface Soil and Related Ditch Sediment
Overall Protectiveness	Meets Criterion
Compliance with State and Federal Requirements	Meets Criterion
Long-term Effectiveness	Meets Criterion
Reduction in Toxicity, Mobility, or Volume	Meets Criterion. Perchlorate treatment of excavated soil to be examined in Remedial Design.
Short-term Effectiveness	Meets Criterion. Perchlorate treatment of excavated soil to be examined in Remedial Design.
Implementability	Meets Criterion
Cost - 30 Year Present Value	$0.6 Million
State Acceptance	Meets Criterion.
Community Acceptance	Generally Acceptable. See Response to Comments, Appendix A

Table 2.14 c. Contaminated Soil Areas Alternative Comparisons -Areas 7D, 33D and FCS

Criteria	Mitigation of Soil Vapor Intrusion and Land Use Restriction
Overall Protectiveness	Meets Criterion
Compliance with State and Federal Requirements	Meets Criterion
Long-term Effectiveness	Partially Meets Criterion. Neither soil excavation nor soil vapor extraction would be protective for these areas until levels of VOCs in the groundwater are reduced by controlling sources outside OU-5.
Reduction in Toxicity, Mobility, or Volume	Partially Meets Criterion. Mitigation actions have the potential to reduce some mass and limit mobility of VOCs.
Short-term Effectiveness	Meets Criterion. Mitigation actions control exposure.
Implementability	Meets Criterion
Cost - 30 Year Present Value	$0.03 Million
State Acceptance	Meets Criterion.
Community Acceptance	Generally Acceptable. See Response to Comments, Appendix A

2.9.4 Common Elements and Distinguishing Features of Each Groundwater Alternative

Both Groundwater Containment and Containment with Mass Removal alternatives involve the pumping of sufficiently large volumes of contaminated water to prevent the spread of contaminants above the containment levels into uncontaminated areas beyond the current extent of the contaminant plumes. It is estimated that either of the two groundwater alternatives would pump between 10 and 15 million gallons of groundwater each day. The water will be piped to one of several treatment systems (see Figure 2.2) where a series of standard, reliable treatment systems remove the various contaminants.

Both groundwater alternatives would continue the operation and optimization of the existing GETs. Both would require the installation of additional wells to effectively contain the groundwater contamination through a hydraulic barrier. Groundwater treatment using tested reliable treatment methods for NDMA, VOCs and perchlorate would continue and expand as necessary to treat the extracted groundwater to the required end uses. Improvement and optimization of the GETs including the extraction system and treatment methodologies are components of both groundwater alternatives. Both alternatives include end use of the water for non-potable or industrial use, or discharge to surface water at levels consistent with the substantive NPDES requirements in Table 2.16. Any temporary discharge to ground on–Site for either alternative shall also meet substantive requirements contained in Waste Discharge Requirements issued by the RWQCB (also Table 2.16). Both alternatives allow Aerojet to provide the extracted water to drinking water providers for treatment for potable or non-potable uses. In California any treatment system that supplies potable water is required to be operated by a certified water provider. Water providers are subject to all applicable federal drinking water standards as well as California Department of Public Health, Department of Drinking Water and Environmental management requirements. Both alternatives require management of groundwater within the hydraulic influence of the OU-5 groundwater remedy to maintain optimum water levels, to prevent adverse impact on the remedy and to mitigate impacts on downgradient beneficial use.

The difference between the two groundwater alternatives is the use of an extraction system for contaminant mass removal near the Aerojet property boundary and closer to the main contaminant sources of the contamination. This alternative more efficiently removes contaminant mass before it migrates into lower concentration areas of the plume. Assuming the contaminant sources are controlled and that the final cleanup goals are approximated by the containment levels, the Containment with Mass Removal alternative would reduce the estimated time required to restore the aquifer by up to 40 percent, on the order of decades. Both the initial capital cost and annual operational costs would be higher for the Mass Removal alternative. However the long-term costs for Containment with Mass Removal would decrease due to the substantially shorter estimated period of operation of the remedy compared to the alternative with Containment alone.

2.9.5 Common Elements and Distinguishing Features of Contaminated Soil Area Alternatives

For seven of the eleven soil areas (Areas C4, C41, 10D, 11D, 7D, 33D and FCS), only one viable alternative, excavation with treatment or disposal of the excavated soil, was available after considering the many alternatives during the screening phase. Perchlorate in Area C41 was measured in subsurface soil throughout the 70 foot depth to the water table, far below the feasible excavation depth. The groundwater containment remedy for OU-5 will provide protection of the groundwater that could potentially be affected by the perchlorate remaining at C41. For the soil excavated from C41, factors to be analyzed during remedial design will determine whether the perchlorate-contaminated soil will be treated or disposed off-Site.

The two alternatives for Areas 32D, 34D, 35D and 38D are distinguished by soil vapor cleanup objectives. The less expensive method relies on capping with institutional controls to limit exposure to VOC vapors. USEPA's preferred alternative is to remove VOCs more aggressively through active Soil Vapor Extraction. Physical limitations on soil vapor extraction methods will require both alternatives to restrict land use until the soil vapor cleanup goals are attained.

2.10 Summary of Comparative Analysis of Remedy Alternatives

In accordance with the NCP, the alternatives were evaluated by the USEPA using the nine criteria. 40 C.F.R. § 300.430(e)(9). For an alternative to be an acceptable remedy it must pass the USEPA's two threshold criteria: 1) Overall Protective of Human Health and the Environment, and 2) Compliance with ARARs. The No-Action Alternatives for either the groundwater or contaminated soil areas portions of OU-5 do not comply with the threshold criteria and are not discussed beyond the threshold criteria.

Overall Protection of Human Health and the Environment: Both of the retained groundwater alternatives are protective of human health and the environment and eliminate, reduce, or control risks posed by the contamination at OU-5 through treatment and institutional controls. The retained soils alternatives are protective of human health and the environment and eliminate, reduce, or control risks posed by the contamination if future land uses are limited to commercial or industrial uses in some cases. Institutional controls of future land uses would be necessary for cleanup to commercial levels only in areas 32D, 34D, 35D and 38D.

Compliance with ARARs: The groundwater action is an interim remedy, so final cleanup goals for restoration of the aquifer will be addressed in the final Sitewide remedy selection process. Both retained groundwater alternatives comply with ARARs by providing various means of containing the groundwater contamination and replacing lost water supplies. Assuming that the groundwater contaminant sources are contained through actions to be determined in future RODs, the alternative with containment plus mass removal is projected to restore the aquifer up to 40 percent faster than the other alternative with containment alone.

Cleanup actions for the contaminated soil areas of OU-5 are final remedies. All contaminated soil area alternatives will comply with ARARs, as long as institutional controls for areas 32D, 34D, 35D and 38D are effective in limiting future land use to commercial or industrial activities.

Long-term Effectiveness and Permanence: Long-term effectiveness and permanence refers to residual risk, and the ability of a remedy to maintain reliable protection of human health and the environment over time, once the RAOs are met. Residual risk can result from exposure to untreated waste or treatment residuals.

For the interim groundwater containment alternatives, the untreated waste refers to contaminants not removed from the aquifer. Both groundwater alternatives prevent the migration of contaminated groundwater above the containment levels into clean and less-contaminated portions of the aquifer. The Containment with Mass Removal alternative inhibits downgradient migration of contamination into OU-5 from source areas and removes substantial contaminant mass. As a result, this alternative improves the long-term effectiveness of the interim action by reducing the cost and difficulty of operating existing extraction and treatment facilities by preventing highly contaminated groundwater from reaching these systems. Assuming control of contaminant sources, the Mass Removal alternative would reduce the eventual cost, difficulty, and time required for hydraulic control and restoration of the aquifer.

Alternatives considered for the final remedy for contaminated soil areas with immobile contaminants (Areas C4, C41, 10D and 11D) will permanently remove known contaminants from the surface soil to levels that are protective for unrestricted uses. Combined excavation and control of groundwater migration provides protection from perchlorate contamination from Area C41.

Neither soil excavation nor soil vapor extraction for areas 7D, 33D and FCS would achieve permanent removal of residual risk from untreated soil vapor for these areas until levels of VOCs in the groundwater are reduced by controlling sources outside OU-5. However combined mitigation of soil vapor intrusion and land use restriction will effectively protect human health and the environment over time.

Capping of the VOC-contaminated areas 32D, 34D, 35D and 38D does not meet the criterion for long-term effectiveness and permanence as well as the alternative that adds Soil Vapor Extraction (SVE) for active remediation and control of VOCs. Even with SVE, this area poses physical limitations to achieving long-term cleanup in a timely fashion. However, land use restrictions will effectively protect human health and the environment over time.

Reduction of Toxicity, Mobility, or Volume through Treatment: Although the groundwater interim action is not intended to fully address the statutory mandate for permanence and treatment "to the maximum extent practicable," both groundwater alternatives utilize treatment and thus support the statutory mandate. Because the

groundwater action does not constitute the final remedy for the Site, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element, although partially addressed in this remedy, will be addressed by the final response action. Subsequent actions are planned to fully address the threats posed by groundwater conditions at this Site.

Residual amounts of COCs with residual risk within the acceptable risk range are expected to remain in portions of the groundwater aquifer after RAOs and containment standards for these chemicals have been achieved. Assuming the contaminant sources are controlled, the alternative with containment plus mass removal is projected to achieve containment goals throughout the OU-5 aquifer up to 40 percent faster than the other alternative with containment alone.

The final contaminated soil area remedy alternatives for areas C4, C41, 10D and 11D with immobile contaminants will permanently remove known contaminants from the surface soil to levels that are protective for unrestricted use. Alternatives using soil vapor extraction for areas with VOCs will permanently remove most VOCs originating at those locations. Subsurface soil conditions will physically limit the effectiveness of SVE to achieve cleanup levels in a timely fashion. The alternative for the VOC-contaminated soil areas with capping alone would not meet the criterion for permanence and treatment to the maximum extent possible.

All the evaluated alternatives have the ability to maintain reliable protection of human health and the environment over time. Institutional Controls for groundwater and soil areas include environmental and land use restrictions; existing CADPH regulations on operations of potable water suppliers (i.e., monitoring, sampling, shut-down of wells as necessary and approval of new well locations); and county approval of new well use permits. Aerojet will also be required to provide public notice of new well restrictions.

Short-term Effectiveness: Short-term effectiveness addresses adverse impacts that may be posed to workers, the community, and the environment during construction of the remedy.

Both interim groundwater alternatives are assigned a high ranking for short-term effectiveness, although the Containment with Mass Removal alternative is likely to result in longer construction time. Neither alternative poses unmitigable risks to the community during construction, nor do any of the alternatives pose unmitigable risks to workers beyond typical hazards associated with large construction projects. Noise and dust abatement during construction, and on-Site treatment or off-Site disposal of the contaminated drill cuttings and purge water, would protect the community during construction.

Excavation and soil vapor extraction alternatives for contaminated soil area cleanup similarly could involve potential risks to workers during implementation of the remedy. These short-term risks to workers can be readily mitigated through noise and dust abatement during construction, and on-Site treatment or off-Site disposal of the contaminated soil and soil vapors. Soil vapor mitigation is required for construction in

areas where VOCs may pose a short-term inhalation risk. Aerojet controls access at all contaminated soil areas and surrounding areas; noise and dust abatement and management of off-property vehicle traffic will provide effective short-term protection of the community.

Implementability: Clear evidence at the Aerojet Site demonstrates the implementability of the groundwater remedy. Much of the remedial action for the groundwater remediation in OU-5 has been constructed and is currently operating. Also, a similar groundwater remedy is operating successfully at OU-3. All soil remedies are proven remedial technologies. The soil vapor extraction systems are expected to have limitations in achieving final cleanup objectives. Control of sources in future OUs and long-term mitigation in buildings constructed on these areas will be needed.

Cost: Tables 2.13 and 2.14 provide specific cost estimates for each groundwater and contaminated soil area alternative, with detailed costs presented in Appendix C for groundwater and Appendix D for contaminated soil areas.

Using a 30-year present-worth method, the interim groundwater alternative with Containment plus Mass Removal may be less than ten percent more expensive than Containment alone. However, the costs for Containment with Mass Removal becomes less expensive than containment alone considering a more realistic comparison of costs that incorporate the potential duration of the action, assuming control of the contaminant sources.

The cost for adding SVE to areas 32D, 34D, 35D and 38D increases the overall costs of remediation of the soil areas by an estimated $0.67 million, which is about 65 percent more expensive than capping alone. In terms of overall cost of OU-5, an increase of this level is quite small while achieving improvement in several criteria including long-term effectiveness, reduction of mobility through treatment, and state and community acceptance.

State Acceptance: The State of California supports both groundwater and soil alternatives to prevent potential migration of the contaminant plumes. USEPA addressed certain State comments regarding final cleanup standards for groundwater by acknowledging that the groundwater actions are interim remedies with the final cleanup objectives to be addressed in the final Sitewide remedy selection process consistent with national Superfund policy. The State is overseeing implementation of groundwater cleanup remedies at IRCTS and White Rock Road North Dump areas in the southwestern and southeastern corners of the Aerojet Site. Differences in cleanup goals between those projects and OU-5 may produce inconsistencies in current remedies. An evaluation of the effectiveness of the groundwater remedy during the five year reviews will need to address this issue. Coordination and integration of USEPA's cleanup and the State's remediation efforts for IRCTS and White Rock Road North Dump also will be reviewed in the final Sitewide remedy selection.

Community Acceptance: The community including local water providers expressed a preference for a remedy with lower cleanup standards consistent with state policies. The groundwater containment is an interim remedy and USEPA will evaluate groundwater restoration and cleanup levels in the final Sitewide remedy selection. The community supported the Proposed Plan's approach to more rapid migration control and remediation of contaminated groundwater. Community members raised issues regarding the suitability of development of the contaminated soil areas. USEPA rigorously researched the local land use planning process and current planning effort and incorporated these considerations in the remedy. The community generally endorsed cleanup to unrestricted use wherever possible in preference to the use of commercial or industrial future use assumptions.

2.11 Principal Threat Wastes

The principal threat concept is applied to the characterization of source materials at a Superfund site considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. OU-5 applies primarily to contaminated groundwater. Contaminated groundwater generally is not considered to be a source material but NAPLs may be viewed as source material. There are no known source areas or NAPLs in the groundwater portion of OU-5 and as a result principal threat waste was not considered for the groundwater portion of OU-5.

Surface soil containing chemicals of concern that are relatively immobile or readily contained, such as in areas 10D, 11D, and C4, are not considered to be principal threat wastes. The VOCs in the soil and vadose zone in areas 32D, 33D, 34D, 37D, and 38D could be considered mobile. The selected remedy removes the contaminants by extracting the VOCs at those locations where the source is primarily from the soil or vadose zone within OU-5. The selected remedy also addresses the VOCs in areas 7D and FCS, although the source is from water contamination migrating laterally from parts of the Aerojet Site which will be fully addressed in other OUs. The perchlorate contamination in area C41 that is not removed by excavation of the surface soil to ten feet bgs will be readily contained by the groundwater containment and remediation remedy.

2.12 Selected Remedy: Preferred Alternative

Based on current information, USEPA is selecting as the remedy for OU-5 Groundwater Containment with Mass Removal, Soil Cleanup to Unrestricted Use, and SVE at contaminated soil areas 32D, 34D, 35D and 38D.

The Groundwater Containment with Mass Removal alternative inhibits downgradient migration of contamination into OU-5 from source areas and removes substantial contaminant mass, improving the long-term effectiveness of the interim action by reducing the cost and difficulty of operating existing extraction and treatment facilities by preventing highly contaminated groundwater from reaching these systems. Assuming control of contaminant sources, the Mass

Removal alternative would reduce the eventual cost, difficulty, and time required for hydraulic control and eventual restoration of the aquifer. The cost difference between alternatives is less than ten percent, which is not significant.

The more rigorous treatment of contaminated soil areas to residential risk levels, including SVE at contaminated soil areas 32D, 34D, 35D and 38D, is warranted by plans for future mixed residential, commercial and industrial land use. The active soil vapor extraction alternative at these areas also better meets the criteria for long-term effectiveness and reduction of toxicity, mobility or volume through treatment. The alternatives selected as final remedies for contaminated soil areas are supported by the State and the community.

USEPA believes these alternatives meet the threshold criteria and provides the best balance of tradeoffs among the alternatives. The USEPA expects the preferred alternative to satisfy the following statutory requirements of CERCLA Section121 (b): (1) to be protective of human health and the environment; (2) to comply with ARARs; (3) to be cost effective; (4) to utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) to satisfy the preference for treatment as a principal element.

2.12.1 Summary of the Rationale for the Selected Interim Groundwater Remedy

The principal factors considered in selecting the preferred groundwater remedy are: 1) Contaminated groundwater is contained within the existing plume, completing the containment of the off-property Aerojet plume; 2) Mass Removal effectively reduces the amount of residual contamination migrating into the OU-5 groundwater area, improving the reliability and long-term effectiveness of the containment by maintaining a more consistent and lower concentration for the extraction and treatment systems at the outer edge of the plumes; and 3) Long-term cleanup goals for aquifer restoration, which will be selected in the Sidewide remedy, can be attained as much as 40 percent faster with Mass Removal than with Containment alone, assuming control of the contaminant sources migrating into OU-5.

2.12.2 Summary of the Rationale for the Selected Contaminated Soil Areas Remedy

The principal factors considered in selecting the preferred contaminated soil area remedies are: 1) Active excavation and Soil Vapor Extraction provides effective permanent long-term remedies that achieve the USEPA preference for treatment to reduce toxicity and mobility of the contaminants, 2) Cleaning to unrestricted use levels provides a greater protectiveness and flexibility for planned and unplanned changes in future land uses ; and, 3) Active SVE provides a more rapid remediation than capping of VOC-contaminated soil alone. The 30 year present value cost for the preferred soil remedies is $0.67 M more expensive than the alternative without active SVE at areas 32D, 34D, 35D and 38D. With the potential for change in future land use, this increased cost is relatively minimal for the flexibility in future land use options.

2.12.3 Description of the Selected Interim Groundwater Remedy

The groundwater portion of the OU-5 remedy includes the following actions:

- Contain contaminated groundwater off-property within OU-5 to the levels set forth in Table 2.7 with groundwater extraction and treatment (GET) in all contaminated layers of the aquifer to prevent further contamination of the aquifer, utilizing existing GET components where effective and practicable;

- Remove additional contaminant mass from the contaminated groundwater on- property using groundwater extraction and treatment in all contaminated layers of the aquifer;

- Treat extracted groundwater using reliable, proven treatment methods including biological treatment or resin adsorption for perchlorate, ultraviolet oxidation for NDMA, and carbon filtration, chemical oxidation or air stripping for residual Volatile Organic Compounds (VOCs) and 1,4-dioxane;

- Use the treated groundwater for non-potable purposes such as industrial cooling, discharge to surface water or discharge to land. Aerojet may provide the extracted water to a drinking water providers for treatment for potable or non-potable uses. The water providers are subject to all applicable federal drinking water standards as well as California Department of Public Health, Division of Drinking Water and Environmental Management requirements. Discharge of treated water to on-Site surface water will comply with the substantive requirements of the current National Pollution Discharge Elimination System (NPDES) permit in effect at the Aerojet site (See Table 2.16). Any temporary discharge to ground on–Site will also meet substantive requirements contained in Waste Discharge Requirements issued by the RWQCB (also Table 2.16). Discharge of treated water to off-Site surface water or off-Site use as non-potable water will comply with applicable federal and State water standards;

- Prepare plans for water replacement contingencies in OU-5 consistent with the requirements for OU-3, and implement the plans as necessary;

- Implement selected Institutional Controls (ICs) including prohibitions on access to groundwater on the land overlying the contaminated groundwater. These restrictions will be implemented through a recorded declaration of Covenants and Environmental restrictions pursuant to California Civil Code Section 1471, whereby Aerojet covenants to impose these restrictions. These covenants and environmental restrictions will be binding to Aerojet's successors and assigns as covenants running with the land. The State of California and USEPA (as a third party beneficiary) will have the right to enforce these restrictions. Any lease or sale of Aerojet property overlying the contaminated groundwater in OU-5 shall be subject to the following restrictions:

    - No recharge of groundwater unless and until expressly permitted in writing by USEPA and the RWQCB;

- No injection into the groundwater unless approved in writing by USEPA and the RWQCB;
- No sustained extraction of groundwater encountered during construction without written approval by USEPA and the RWQCB.

Aerojet shall give written notice of the groundwater contamination to each buyer, lessee, renter and mortgagee of any of these lands and every lease, deed, mortgage or instrument conveying any part of these lands shall expressly provide that it is subject to this Declaration of Covenants and Environmental Restrictions.

- Monitor groundwater at existing and new monitoring wells, drinking water wells, irrigation wells and up-gradient sentinel wells, to verify and evaluate plume control, and effectiveness of the remedy conducted as part of the existing Groundwater Monitoring Plan for the Aerojet Site. Additional monitoring wells may be required as necessary to evaluate the effectiveness of the remedy;

- Manage groundwater within OU-5 in coordination with the OU-3 groundwater management zone to maintain water levels and to prevent adverse impact on the remedy.

2.12.4 Description of the Contaminated Soil Area Remedy

- **Areas 10D and 11D.** Excavate the contaminated surface soils and sediments in areas 10D and 11D to the performance standards listed in Table 2.11 for unrestricted use of the land based on residential risk levels;

- **Areas C4 and C41.** Excavate contaminated surface soil in area C4 and C41 laterally and to a minimum ten foot depth to the performance standards listed in Table 2.11 for unrestricted use of the land based on residential risk levels unless the cleanup levels are reached at a shallower depth. Lateral as well as horizontal surfaces shall be tested to ensure attainment of soil cleanup goals. Treat the excavated soil to remove the contaminants to cleanup levels or transport contaminated soil to an approved landfill. The excavated area shall be refilled with material that meets the residential soil criteria. If waste is left in place deeper than ten feet, land use controls will be necessary to protect against exposure resulting from excavation to depths greater than ten feet;

- **Areas 32D, 34D, 35D and 38D.** Install and operate a vapor extraction system in soil areas 32D, 34D, 35D and 38D to remove VOCs from subsurface soil to the performance standards listed in Table 2.12 for unrestricted use of the land based on residential risk levels. A temporary asphalt cap or equivalent shall be constructed over the surface to improve capture of the VOCs. Contaminants in the vapors shall be captured and treated by granulated carbon or destroyed using a catalytic oxidation system with air monitoring. Land use will be restricted to commercial or industrial use through appropriate land use covenants and employing soil vapor mitigation methods as necessary, until the cleanup

attains unrestricted use levels of VOC COCs based on USEPA Region 9 Soil Vapor Screening Levels (Table 2.12), adjusted with location- and depth-specific attenuation factors approved by USEPA;

- **Areas 7D, 33D and FCS.** Control the risks from elevated VOCs measured in the vadose zone in soil areas (each about 0.1 acres) and the Former Company Store location (FCS, approximately 3.4 acres), using vapor mitigation systems that prevent movement of contaminant vapors into buildings constructed at these locations. The RI concluded that neither soil excavation nor soil vapor extraction would be protective until levels of VOCs in the groundwater are reduced by controlling sources outside OU-5. Vapor mitigation systems may include vapor barriers and venting of vapors from beneath the structure. Appropriate monitoring and land use covenants are required for either residential or commercial use of these locations until the potential threat of vapor intrusion is removed, based on USEPA Region 9 Soil Vapor Screening Levels (Table 2.12), adjusted with location- and depth-specific attenuation factors approved by USEPA;

- **Institutional Controls.** Implement restrictions on the future use of contaminated soil areas that have not attained residential cleanup objectives through a recorded Declaration of Covenants and Environmental Restrictions pursuant to California Civil Code Section 1471, whereby Aerojet covenants to impose these restrictions. These covenants and environmental restrictions will be binding to Aerojet's successors and assigns as covenants running with the land. The USEPA and California EPA will have the right to enforce these restrictions. Aerojet shall give written notice of the groundwater contamination to each buyer, lessee, renter and mortgagee of any of these lands and every lease, deed, mortgage or instrument conveying any part of these lands shall expressly provide that it is subject to this Declaration of Covenants and Environmental Restrictions;

- **Zone 4 Landfill.** The landfill in the northern portion of OU-5 (Zone 4) is not included in the proposed actions for OU-5. EPA will review the monitoring results of the solid waste landfill closure to ensure both soil and groundwater protectiveness from this potential source of contamination. EPA expects that all potential risks from this landfill will be satisfactorily addressed by the approved landfill closure process with State and County oversight. If potential risks from the landfill are not adequately addressed, EPA will evaluate alternatives in an Explanation of Significant Differences or a ROD amendment.

2.12.5 Expected Outcomes of the Selected Remedy

The expected outcomes of the Selected Interim Groundwater Remedy are the containment of groundwater contamination at the current extent of the plumes to protect uncontaminated drinking water sources, reliable long-term operation of the containment through mass removal of highly contaminated groundwater migrating into OU-5, and reducing the time and cost for restoration of the aquifer to beneficial use (drinking water source) once the final Sitewide remedy is selected and assuming control of contaminant sources. Containment levels for groundwater are provided in Table 2.7.

The expected outcomes of the contaminated soil area remedies include the restoration of the contaminated areas to levels protective of expected future land uses. Additionally the remedy will monitor and control remaining contamination.

2.13 Statutory Determinations

This section provides a brief, Site-specific description of how the selected interim groundwater remedy and the final contaminated soil area remedy satisfy the statutory requirements of CERCLA §121 (as required by NCP §300.430(f)(5)(ii)), and explains the five-year review requirements for the selected remedy.

2.13.1 Protection of Human Health and the Environment

Under its legal authorities, USEPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment.

The selected interim groundwater remedy will reduce human health risk by limiting the spread of highly contaminated groundwater into clean and less contaminated portions of the aquifer, reducing the likelihood and magnitude of human exposure to contaminated groundwater. The mass removal aspect of the remedy targets highly contaminated groundwater in the portions of OU-5 nearer the contaminant sources on Aerojet property. Exposure to contaminated groundwater through drinking water supplies is the area of potential risk addressed by the interim groundwater remedy. The selected remedy will contain the off-property contamination in all four OU-5 groundwater Zones and treat the water to discharge standards meeting the substantive requirements of a National Pollution Discharge Elimination System (NPDES) permit (See Table 2.16) or all applicable standards for off-Site reuse or disposal. Exposure levels will be within the acceptable risk range of 10^{-4} to 10^{-6} for carcinogenic risk and below the Hazard Index of 1 for non-carcinogens.

If no action is taken, contaminated groundwater will continue to spread, increasing the likelihood of future increases in contaminant concentrations in downgradient portions of the aquifer, increasing risk by increasing the likelihood of and magnitude of exposure, and increasing the eventual cost, difficulty, and time required for restoration of the aquifer.

The selected interim groundwater remedy includes above-ground water treatment systems to remove the COCs (primarily VOCs, perchlorate, and NDMA) from the extracted groundwater. After treatment, the extracted groundwater will achieve all containment goals identified in this ROD. The remedy also requires compliance with ARARs associated with the disposal of treatment residuals and control of air emissions, if any, to eliminate or minimize short-term risks and cross-media impacts. The remedy includes an extensive monitoring program to evaluate the performance of the remedy.

There is no known exposure pathway in which ecological receptors could be exposed to contaminated groundwater at the Site.

The selected final remedy for contaminated soil areas addressed potential risks to eleven areas on Aerojet property that may be considered for future residential and non-residential uses. The remedy will reduce the potential for human health risk by removing contaminated surface soils to levels protective of residential land use. Areas with VOCs that pose a potential risk for soil vapor intrusion are addressed by active soil vapor extraction and, as necessary, mitigation of vapor intrusion for future structures and Institutional Controls to limit exposure.

If no action is taken on contaminated soil areas, potential exposure for either residents or workers would exceed acceptable risk levels.

The selected final remedies include excavation of surface soils with on-Site treatment (e.g., standard biological treatment for perchlorate) or off-Site disposal at a secure landfill, monitoring to ensure protectiveness of the groundwater through the interim groundwater containment remedy, capping and soil vapor extraction of VOCs and vapor mitigation and institutional controls as necessary to limit exposure.

After the remedies are implemented, the soil areas will achieve all ARARs identified in this ROD. The remedy also requires compliance with ARARs associated with the disposal of treatment residuals and control of air emissions, if any, to eliminate or minimize short-term risks and cross-media impacts. The remedy includes an extensive monitoring program to evaluate the performance of the remedy.

. The ecological health assessment determined there are no ecological risks within OU-5 that require action. The RI indicated a current lack of suitable habitat in impacted areas and exposure of the ecological receptors to elevated background levels of COPCs that are not associated with OU-5 releases.

2.13.2 Compliance with Applicable or Relevant and Appropriate Requirements

Remedial actions selected under CERCLA must comply with all ARARs under federal environmental laws or, where more stringent than the federal requirements, State environmental or facility siting laws. Where a State has delegated authority to enforce a federal statute, such as RCRA, the delegated portions of the statute are considered to be a Federal ARAR unless the State law is broader in scope than the federal law. Applicable or relevant and appropriate requirements are identified on a site-specific basis from information about site-specific chemicals, specific actions that are being considered, and specific features of the site location.

There are three categories of ARARs: (1) chemical-specific requirements; (2) location-specific requirements and (3) action-specific requirements. Chemical-specific ARARs are risk-based cleanup or containment standards or methodologies which, when applied to site-specific conditions, result in the development of standards for COCs. For interim groundwater containment actions, ARARs for the final chemical-specific standards will be addressed and modified as necessary during the final Sitewide remedy selection process.

Location-specific ARARs are restrictions placed on concentrations of hazardous substances or the conduct of activities because of the special locations, which have important geographical, biological or cultural features. Examples of special locations include wetlands, flood plains, sensitive ecosystems and seismic areas.

Action-specific ARARs are technology-based or activity-based requirements or limitations on actions to be taken to handle hazardous wastes. They are triggered by the particular remedial activities selected to accomplish a remedy.

Where no ARARs exist for a given chemical, action or location, USEPA may consider non-promulgated federal or State advisories and guidance as To Be Considered criteria (TBC). Although consideration of a TBC is not required, if standards are selected based on TBC, those standards are legally enforceable as performance standards.

The ARARs are frozen at the time the ROD is signed, but off-Site requirements are not,, including requirements applicable to treated water delivered to the drinking water supply., Offsite requirements in effect at the time the action occurs must be met, even if they differ from those in effect at the time the ROD is signed.

The OU-5 interim groundwater remedy and the final contaminated soil remedy will comply with ARARs as described in Table 2.15, except when additional studies and investigations may be undertaken pursuant to CERCLA section 104(b), 42 U.S.C. § 9604(b), ("CERCLA section 104(b) activities") during remedial design. USEPA expects to fully comply with ARARs during most CERCLA Section 104(b) activities, but there may be activities during which USEPA concludes that it is not practicable to fully comply. Such activities may include discharges of untreated or partially treated groundwater resulting from the development and testing of new groundwater extraction wells, but may also include other temporary high flow, high volume discharges. In such cases, EPA will evaluate the practicability of fully complying with ARARs, and comply with the USEPA policy that removal actions "will comply with ARARs to the extent practicable, considering the exigencies of the circumstances" 55 Fed. Reg. 8666, 8756 (Mar. 8, 1990); *see also* 40 C.F.R. § 300.415(j). Studies and investigations undertaken pursuant to CERCLA section 104(b), such as activities conducted during RI/FS, are considered removal actions." ***Id.***

Table 2.15 provides a complete list of ARARs for OU-5. As an interim ROD for groundwater containment, the remedy is designed to minimize further contaminant migration and reduce the risk of exposure to contaminated groundwater. Because this remedy is an interim action that does not include restoration of the aquifer as an objective, EPA is not, at this time, establishing chemical-specific ARARs as *in situ* cleanup goals for contaminated groundwater at OU-5. *In situ* cleanup goals will be addressed in the final Sitewide decision document. ARARs are frozen at the time the ROD is signed, but offsite requirements are not (e.g., drinking water standards applicable to treated water delivered for potable use).Because MCLs, non-zero MCLGs or more restrictive state ARARs will be considered as *in situ* cleanup standards as part of the final Sitewide cleanup remedy in the future. *See Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration* (Interim Final), U.S. EPA OSWER Directive 9234.2-25 at 5 (Sept. 1993).

Performance Standards for containment of groundwater are the Containment Standards listed in Table 2.7. The Containment Standards for perchlorate, TCE and most of the other VOC COCs are the state and federal MCLs. As of November 2010, no state or federal MCLs have been promulgated for NDMA or 1,4-dioxane. For these emerging chemicals that lack MCLs, EPA is treating the California EPA's Public Health Goal (PHG) for NDMA and the CDPH notification level for 1,4-dioxane (for which there is no PHG), which are health-based advisory levels for drinking water use, as criteria to be considered in setting alternative performance standards for containment of groundwater contamination in OU5. PHGs and Notification Levels are established as precautionary measures for contaminants that may be considered candidates for establishment of MCLs.

Performance standards for treatment of extracted groundwater prior to discharge to on-Site surface water or non-potable uses are the substantive requirements of the current National Pollution Discharge Elimination System (NPDES) permit in effect at the Aerojet Site (See Table 2.16). Any temporary discharge to ground on–Site shall also meet substantive requirements contained in Waste Discharge Requirements issued by the RWQCB (also Table 2.16). Discharge of treated water to off-Site surface water or off-Site use as non-potable water shall comply with applicable federal and State water standards in effect at the time of discharge.

Potable supply is one authorized end use for any treated groundwater. If treated water is placed into a conveyance system on-Site for delivery as potable supply, MCLs are ARARs for treatment of the water on-Site. For the purposes of determining compliance with these performance standards, the point of compliance shall be the effluent from an on-Site treatment facility, just prior to its delivery to a water provider for potable end use. The ARARs are frozen at the time the ROD is signed, but off-Site requirements, including requirements applicable to treated water delivered to the drinking water supply, must be met in order to comply with the end use as potable water regardless of whether those requirements change over time. As a result, if an off-Site drinking water requirement changes, the treatment system must meet whichever standard - the performance standard selected in the ROD or the off-Site requirement - is lower.

Performance standards in the contaminated soil areas for soil contaminants and soil vapor are the risk-based soil concentrations for unrestricted use listed in Tables 2.11 and 2.12. Restrictions on the future use of contaminated soil areas that have not attained residential cleanup objectives will be implemented through a recorded declaration of Covenants and Environmental restrictions pursuant to California Civil Code Section 1471, whereby Aerojet covenants to impose these restrictions.

Table 2.15 - Description of ARARS for Selected Remedy

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Chemical-Specific ARARs					
Federal Regulatory Requirement	Ground-water (GW)	Federal Safe Drinking Water Maximum Contaminant Levels (MCLs); 42 U.S.C. § 300(f), *et seq.;* 40 C.F.R. Part 141 (2010)	Relevant & Appropriate (R&A)	MCLs have been adopted for a number of common organic and inorganic contaminants. These levels regulate the concentrations of contaminants in public drinking water supplies and may be relevant and appropriate for final RODs restoring ground-water aquifers potentially used for drinking water. MCLs are Relevant and Appropriate as performance standards for on-Site treatment of water delivered for potable end use.	MCLs are Relevant and Appropriate Standards for on-Site treatment of water placed into an on-Site conveyance system for potable end use. Where there are no federal MCLs for the contaminants, e.g., NDMA and 1,4-dioxane, the treatment standards are based on State MCLs or values developed by the State of California for drinking water. See Table 2.7.
State Regulatory Requirement	GW	California Safe Drinking Water Act , Cal. Health & Safety Code § 116365; 22 CCR §§ 64431 & 64444	R&A	The State has promulgated MCLs for some of the COCs that are more stringent than federal MCLs.	More stringent State MCLs are Relevant and Appropriate Standards for on-Site treatment of water for potable end use. Where there are no State MCLs for the contaminants, such as NDMA and 1,4-dioxane, the treatment standards are based on CA PHG or Drinking Water Notification Levels. See Table 2.7.
Federal Regulatory Requirement	Soil	US EPA Regional Screening Levels (RSLs) (2010)	To Be Considered (TBC)	USEPA has developed regional screening levels that are risk-based levels that are used to screen sites that may require additional investigation or possible remediation. RSLs may also be considered in setting soil cleanup levels or groundwater cleanup levels in the absence of promulgated MCLs for contaminants.	RSLs are considered in setting soil cleanup levels, including soil vapor levels, to be protective for residential, commercial or industrial land use scenarios. Groundwater cleanup values are based on MCLs, CA PHGs or CA Drinking Water Notification Levels as listed in Table 2.7.
California PHGs, California Environmental Protection Agency, and OEHHA	GW	California Calderon-Sher SDWA of 1996, California Health and Safety Code §116365	TBC	OEHHA has adopted PHGs for chemicals in drinking water. PHGs are levels of drinking water contaminants at or below which adverse health effects are not expected.	In the absence of MCLs for NDMA, the state PHGs adopted by OEHHA have been considered during selection of performance standards for groundwater containment.
CDPH Drinking Water Notification Levels	GW	California Health & Safety Code § 116455	TBC	CDPH has established drinking water notification levels (formerly known as action levels) based on health effects, but in some cases they are based on organoleptic (taste and odor) values for chemicals without MCLs.	In the absence of MCLs for 1,4-Dioxane, the drinking water notification levels established by CDPH have been considered during selection of performance standards for groundwater containment.

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Chemical-Specific ARARs (continued)					
State Regulatory Requirement	GW	Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins (2009 revisions), adopted in accordance with CA Water Code, Division 7, Sections 13240, and 13050 (Porter-Cologne Act); Chaps. II & III	Applicable	Those portions of the Basin Plan which set out the designated uses (i.e., beneficial uses) and the water quality objectives based upon such uses are applicable requirements.	The designated use for the aquifer at the Aerojet Site is municipal and aquatic water supply. The containment levels for the contaminated groundwater and surface water comply with the Basin Plan's water quality objectives based upon such use.
State Regulatory Requirement	GW	SWRCB Resolution No. 88-63 (Sources of Drinking Water Policy)	Applicable	Designates all ground and surface waters of the State as drinking water except where the Total Dissolved Solids (TDS) is greater than 3,000 ppm, the well yield is less than 200 gpd from a single well, the water is a geothermal resource or in a water conveyance facility, or the water cannot reasonably be treated for domestic use using either best management practices or best economically achievable treatment practices.	The aquifers under the Aerojet Site have been identified as sources of drinking water.
Location-Specific ARARs					
Federal Regulatory Requirement	Floodplain and wetland protection	Executive Order Nos. 11990 & 11988	TBC	Require avoidance of adverse effects, minimization of potential harm, and restoration and preservation of natural and beneficial values of floodplains.	Constructing groundwater treatment facilities in a 100 year flood plain will be avoided. If it cannot be avoided, the potential harm to the flood plain shall be minimized.
Federal Regulatory Requirement	Within 100-year flood-plain	40 C.F.R. §264.18(b) (2010) and 22 CCR §66264.18(b)	Applicable	A RCRA facility located in a 100-year flood plain must be designated, constructed, operated and maintained to prevent washout of any hazardous waste by a 100-year flood	Because any new treatment facilities in OU-5 may generate hazardous waste, any such facility constructed within a 100 year flood plain must comply with this requirement.

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Location-Specific ARARs (continued)					
Federal Regulatory Requirement	Sites on or eligible for inclusion on the National Register of Historic Places	National Historic Preservation Act (16 U.S.C. §§ 470, *et seq.*); 36 C.F.R. Part 800 (2010)	Applicable	Provides for protection of sites with historic places and structures. Federal agencies are required to take into account their undertakings on historic properties and afford the State Historic Preservation Office a reasonable time to comment.	Applicable if a federal undertaking (cleanup) could adversely affect historic properties which are included in or eligible for inclusion in the National Register of Historic Places. The proposed remedial alternatives are not expected to not alter or destroy any known prehistoric or historic archeological features in OU-5 of the Aerojet Site. However, because there is always a possibility that buried historic or prehistoric remains could be discovered during such actions, this requirement would require action to address such areas.
Federal Regulatory Requirement	Endangered species or threatened species	Substantive portions of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.); 50 C.F.R. Part 200 and 50 C.F.R. Part 402 (2010)	Applicable	Federal agencies are required under Section 7 of the ESA to insure that their actions do not jeopardize the continued existence of a listed species or result in destruction of adverse modification of its critical habitat (16 U.S.C. § 1536). If the proposed action may affect the listed species or its critical habitat, consultation with the USFWS may be required (50 C.F.R. § 402.14). Additionally, Section 9 of the ESA prohibits the illegal taking of a listed species (16 U.S.C. § 1538(a)(1).	Two endangered floral species are known to occur within Sacramento County: the Sacramento Orcutt grass (Orcuttia Viscinda) and the Boggs Lake hedge hyssop (Gratiola Heterospala). Four listed wildlife species are expected to occur within 25 miles of the Aerojet Site: Bald Eagle, Peregrine Falcon, Giant Garter Snake, and the Valley Elderberry Longhorn Beetle. The Aerojet Site may be a habitat for the Burrowing Owl, a species of concern in CA. Any action that may impact or threaten to impact an endangered species shall comply with this requirement.
State Regulatory Requirement		CA Endangered Species Act, Cal. Fish & Game Code § 2080	Applicable	Prohibits the illegal taking of plant and animal species designated as either threatened or endangered in the state of California	See Federal ESA above.
Federal Regulatory Requirement	Listed migratory birds	Migratory Bird Treaty Act; 16 U.S.C. §§ 703, *et seq.*	Applicable	Prohibits the illegal taking of migratory birds	The Aerojet Site may be a habitat for the Burrowing Owl, a species of concern in CA.
Federal Regulatory Requirement	Areas affecting stream or river	Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) And 40 §302 (2010)	Applicable	Restrictions on diversion, channeling or other activity that modifies a stream or river and affects fish or wildlife.	Applicable if a water body will be controlled or modified by the action.

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Location-Specific ARARs (continued)					
State Regulatory Requirement	Streambed or riverbed alterations	Substantive Requirements of Cal. Fish & Game Code § 1602	Applicable	Prohibits substantial diversion or obstruction of the natural flow of, or a substantial change of the bed or channel of a river, stream or lake. Prohibits the deposit or disposal of debris or waste where it may pass into any river, stream or lake.	Applies to grading and filling activity.
State Regulatory Requirement	Restrictions relating to land and groundwater	Cal. Civ. Code §1471; 22 CCR § 67391.1(a), (d) (2010)	R&A	Substantive requirements for placing an environmental restrictive covenant on contaminated land in the state of California.	Require Aerojet to record environmental restrictive covenants on contaminated land and to name EPA as a third party beneficiary in the covenants.
Action-Specific ARARs					
Federal Regulatory Requirement	Dredge and Fill	33 U.S.C. §§ 1251, *et seq.* and 40 C.F.R. Parts 230 & 231 (2010)	R & A	Regulates discharge of dredged or fill material into waters of the United States, including wetlands.	Substantive portions applicable. Permit is not required for on-Site activities.
Federal Regulatory Requirement	Generation of waste from construction & operation due to remedial action selected	40 C.F.R. Part 261(2010) and 22 CCR § 66261 (2010)	Applicable	Establishes procedures and numeric limits for identification and management of characteristic hazardous wastes, listed hazardous wastes, and State-only (non-RCRA) hazardous wastes.	These requirements are applicable to management of waste materials generated as a result of construction of the selected remedial action or operation of a groundwater treatment plant.
Federal Regulatory Requirement	Generation of waste from construction & operation due to remedial action selected	40 C.F.R. §262.11 (2010) and 22 CCR §66262.11 (2010)	Applicable	Requires waste generators to determine if wastes are hazardous wastes and establishes procedures for such determinations	These requirements are applicable to management of waste materials generated as a result of construction of the selected remedial action or operation of a groundwater treatment plant.
Federal Regulatory Requirement	Storage of hazardous wastes for treatment or disposal off-Site	40 C.F.R. §262.34 and 22 C.C.R. §66262.34 (2010)	Applicable	Specifies maximum amounts and maximum periods for accumulation of hazardous waste on-site under generator status	These requirements are potentially applicable to management of waste materials generated as a result of construction of the remedial action and operation of any groundwater treatment plant if these waste materials are hazardous wastes.
Federal Regulatory Requirement	Shipment of hazardous substances off-Site	42 U.S.C. § 9621(d)(3); 40 C.F.R § 300.440 (2010) ("Offsite Rule")	Applicable	Hazardous substances from a CERCLA response action that must be transferred off-Site for disposal or treatment must be transferred to a facility in compliance with RCRA, TSCA, and other applicable federal and state law.	Applicable to hazardous wastes from treatment facilities and to wastes from remedial actions that must be disposed of off-Site.

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Action-Specific ARARs (continued)					
Federal Regulatory Requirement	Discharge to inland surface water	National Toxics Rule, 40 C.F.R. §§ 131.6 & 131.38 (2010) (CA Toxics Rule)	Applicable	Establishes the appropriate aquatic and human health criteria for priority toxic pollutants in inland surface waters and enclosed bays and estuaries. Included in the National Rule are EPA promulgated specific criteria for certain water bodies in California the presence or discharge of which could reasonably be expected to interfere with maintaining designated uses.	May be applicable for off-Site discharge subject to NPDES permits and for on-Site discharge subject to substantive requirements of an NPDES permit.
State Regulatory Requirement	Discharge to surface water	SectionIV-16 (Policy for Application of Water Quality Objectives) of the Basin Plan for Sacramento River and San Joaquin River Basins (2009 rev.)	TBC	Allows for the use of mixing zones as part of a determination of whether water quality is being maintained in the receiving water.	This requirement may be a performance standard if treated water is discharged to surface water.
Federal Regulatory Requirement	Discharge to surface water	National Pollutant Elimination Discharge System (NPDES) Permit 40 C.F.R. Parts 122 and 125 and 23 CCR 2235 et seq.	Applicable	Establishes treatment and monitoring requirements for discharges to surface water.	Discharge to surface water on-Site will comply with the substantive requirements of an NPDES Permit (See Table 2.15); discharge to surface water off-Site will require a NPDES Permit.
Federal Regulatory Requirement	Storm-water manage-ment	40 C.F.R. Part 122.26 (2010) and 23 CCR §2235 et seq. (2010)	Applicable	Establishes, monitoring, and pollutant control requirements for storm water from industrial activities	The substantive requirements would be applicable if construction activities associated with the remedial action disturb an area of 5 acres or greater.
Federal Regulatory Requirement	Air	Air Emission Standards for Process Vents; 40 C.F.R. §§ 265.1030-1035 (2010);22 CCR §§66265.1030-66265.1035	R&A	Applies to treatment, storage, and disposal facilities with process vents associated with solvent extraction or air or steam stripping operations managing RCRA hazardous wastes with organic concentrations of at least 10 ppm. These operations must reduce total organic emissions below specified device to reduce total organic emissions by 95 percent by weight.	The requirements are relevant and appropriate for groundwater extraction and air-stripping operations for the remedy where organic concentrations are at least 10 ppm.

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Action-Specific ARARs (continued)					
State Regulatory Requirement	Air	Sacramento Metropolitan Air Quality Management District Rules Cal. Health & Safety Code, §§ 39602, 39606, 40001 Rule 402 Nuisance Rule 403 Fugitive Dust Rule 404 Particulate Matter Rule 441 Organic Solvents	Applicable	Limits emissions of dust, particulates and organic solvents to the air.	May apply to remedial actions involving ground disturbing activities and to emissions from treatment facilities.

Table 2.16 – Substantive Requirements in Current (November 2010) NPDES Effluent Limitations at Aerojet Site

Effluent Discharge Limitations		
Constituents	Daily Maximum in µg /l	Monthly Average in µg /l
Volatile Organics 1)	0.7	0.50
Perchlorate	6	4
1,4 -Dioxane	6	3
N-Nitrosodimethylamine	0.010	0.002
1) All volatile organic constituents listed in USEPA Method 8010 and 8020. The monthly average concentration of each constituent shall not exceed 0.5 µg /l.		

2.13.3 Cost-Effectiveness

EPA must select a remedy that is cost effective. The NCP defines a cost-effective remedy as one whose "costs are proportional to its overall effectiveness." More than one remedial alternative can be cost effective, and EPA is not required to select the most cost-effective alternative. Overall effectiveness is determined by evaluating three of the balancing criteria: long-term effectiveness; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness.

In USEPA's judgment, the selected interim groundwater remedy for OU-5 is cost-effective. EPA made this judgment after evaluating the overall effectiveness of the two alternatives that satisfied the threshold criteria and then comparing overall effectiveness to costs. EPA's judgment is based on the high ranking assigned the long-term effectiveness and reduction in toxicity, mobility, and volume through treatment to the Containment with Mass Removal alternative. Estimated costs for the two alternatives were within ten percent, with Containment alone less expensive with a 30-year-present-worth method and Containment with Mass Removal less expensive considering the estimated duration of the remedy.

In USEPA's judgment, the selected remedy is cost-effective for the final remedy for the contaminated soil areas: excavation for Areas C4, C41, 10D and 11D;
for Areas 7D, 33D and FCS; and
Areas 32D, 34D, 35D and 38D. . USEPA made this judgment after evaluating the overall effectiveness of the alternatives that satisfied the threshold criteria and then comparing overall effectiveness to costs. USEPA's selection of the remedy for Areas 32D, 34D, 35D and 38D is also based on the higher ranking assigned to Capping with SVE for long-term effectiveness and reduction in toxicity, mobility, and volume through treatment compared to Capping alone. Although Capping with SVE is $0.67 Million more expensive than Capping, USEPA has concluded that the incremental cost of the remedy provides a significant increase in overall effectiveness in preventing VOC exposure, given the planned future development of the area and surrounding Aerojet property.

EPA judges the No-Action Alternatives as neither protective of human health nor cost-effective.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the maximum Extent Practicable

USEPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Of those alternatives that are protective of human health and the environment and comply with ARARs, USEPA has determined that the selected alternatives provide the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and considering State and community acceptance

2.13.5 Preference for Treatment as a Principal Element

There are no known source materials or NAPL in OU-5. The largest human health risk is exposure to contaminated groundwater. The selected remedy will treat the contaminated groundwater between the on- and off-property extraction well systems to the containment levels, but will require coordination with other OUs to be fully effective. The off-property extraction system will contain the contamination at the leading edge, preventing further spread of contamination above containment levels into clean portions of the regional aquifer. The extraction systems in more highly contaminated parts of the OU-5 groundwater will help contain the contamination moving from the source areas and efficiently remove a significant mass of contaminants. The selected remedy provides the best reduction in volume by containing contamination at the containment levels, thus preventing the spread of contamination into other portions of the aquifer. The remedies for the soil areas are specific to each set of conditions, focusing on cleanup to levels allowing unrestricted future residential land use. The soil and vadose zone contaminated with VOCs will be treated to remove the contamination where possible. Actions to prevent exposure will be required until the sources of VOCs in shallow groundwater originating in upgradient OUs can be remediated. Relatively immobile contaminants in surface soils will be removed (e.g., metals, PCBs and perchlorate) to allow for unrestricted future land use. Deep subsurface soil treatment of percolate in area C41 is not currently available, so the remedy combines surface soil removal and containment of groundwater.

2.13.6 Five-Year Review Requirements

Because the interim groundwater remedy will result in hazardous substances, pollutants, or contaminants remaining within OU-5 above levels that allow for unlimited use and unrestricted exposure, a statutory review for the entire OU-5 will be conducted within five years after initiation of the remedial action, and every five years thereafter, to ensure that the remedy is, or will be, protective of human health and the environment.

2.14 Documentation of Significant Changes

Following many comments regarding attainment of the cleanup standards and the appropriate consideration of final and draft Public Health Goals, USEPA is selecting an interim groundwater containment remedy for OU-5. Aquifer restoration goals are not being selected at this time and will be evaluated in the final Sitewide remedy selection process.

The Proposed Plan fact sheet incorrectly listed the State's cleanup level for perchlorate in soil that is considered generally protective of groundwater. The fact sheet inadvertently omitted the soil vapor concentration that is protective for inhalation exposure at 10^{-6} risk range for VOCs including TCE. These are stated correctly in the ROD. The ROD explicitly states that the federal MCL establishes a limit of 80 µg/L for the sum of the concentrations of all four major trihalomethanes, which had not been clear in a table of cleanup levels included in the Proposed Plan fact sheet.

In November 2010, CDPH revised its notification level for 1,4-dioxane to 1 ppb following USEPA's August 2010 revision of the reference dose for this chemical. The current State notification level replaces the earlier level of 3 ppb, established in 1998 and based on a 1990 USEPA reference dose. USEPA's Regional Screening Level (RSL) was changed to 0.67 ppb to correspond to a 10^{-6} incremental cancer risk level calculated using the 2010 reference dose. The California notification level is slightly greater than the 10^{-6} incremental cancer risk level commonly used by CDPH for notification levels, reflecting difficulty in monitoring 1,4-dioxane at very low concentrations. Based on the above changes, the ROD has selected 1 ppb as the containment level for 1,4-dioxane.

Aerojet may provide the extracted water to drinking water providers for treatment for potable or non-potable uses. Water providers are subject to federal drinking water standards as well as California Department of Public Health, Division of Drinking Water and Environmental Management requirements. Discharge of treated water to on-Site surface water or land shall comply with the substantive requirements of the National Pollution Discharge Elimination System (NPDES) permit currently in effect. Discharge of treated water to off-Site surface water or off-Site use as non-potable water shall comply with applicable federal and State water standards in effect at the time of discharge.

PART 3: RESPONSIVENESS SUMMARY

3.1 Stakeholder Issues and USEPA Responses

There was significant community response received at the public meeting and provided in writing during the comment period. The comments and USEPA responses are included in the Responsiveness Summary as Appendix A of this document. The water providers and the community supported completing the remedy as expeditiously as possible but largely were concerned that the interim groundwater containment standards were not strict enough.

3.2 Technical and Legal Issues

3.2.1 Technical Issues:

The NDMA PQL is being improved. The current enforceable level is 5 ppt. Best available monitoring method technology shall be used until a PQL of less than 3 ppt is achieved.

3.2.2 Legal Issues:

Sacramento County and Aerojet have not completely resolved issues over water replacement.