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November 7, 2001

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Mr. Harry M. Schueller
Chief, Water Rights Division
State Water Resources Control Board
1001 I Street, 14th Floor
Sacramento, CA 95812

Re: Petition for a Limited Revision of the Declaration of Fully Appropriated Stream Status of the Lower American River

Dear Mr. Schueller:

Enclosed with this cover letter please find a Petition for a Limited Revision of the Declaration of Fully Appropriated Stream Status of the Lower American River. This Petition is filed on behalf of the Southern California Water Company ("SCWC") in order to allow the State Water Resources Control Board ("SWRCB") to process and grant an Application to Appropriate Water to be filed by SCWC.

The Southern California Water Company, operating as Arden Cordova Water Service, supplies water to the Rancho Cordova area in Sacramento County. Several of SCWC's water supply wells have been rendered unusable by contamination released into the groundwater by the Aerojet-General Corporation and its subsidiaries. At the same time, Aerojet is pumping contaminated groundwater, treating it and then discharging it into the Lower American River. This discharged water is developed water which is available for appropriation.

The water that is the subject of this Petition is non-native water that was not a part of the SWRCB's consideration when it declared the Lower American River to be fully appropriated. The water will be diverted using existing diversion facilities, and the diversions will be limited to the same amount of water as is discharged by Aerojet. In this way there will be minimal, if any, impacts upon the resources of the Lower American River.

Southern California Water Company is responsible for the domestic water supply for many thousands of residents of Sacramento County. This water supply has been put in jeopardy.

Under these circumstances the most equitable course of action is to allow SCWC to file an Application to Appropriate the water discharged by Aerojet.

We thank you for your attention to this matter.

Sincerely,

Scott S. Slater
Michael T. Fife
For HATCH AND PARENT

MXF:bct
Enclosure

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Attorneys for
SOUTHERN CALIFORNIA WATER COMPANY

STATE WATER RESOURCE CONTROL BOARD

OF THE STATE OF CALIFORNIA

In the Matter of the Petition of SOUTHERN CALIFORNIA WATER COMPANY For an Order Revising the Declaration of Full Appropriation of the Lower American River	PETITION FOR LIMITED REVISION OF THE DECLARATION OF FULL APPROPRIATION OF THE LOWER AMERICAN RIVER

HATCH AND PARENT
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Petitioner, SOUTHERN CALIFORNIA WATER COMPANY ("SCWC"), hereby petitions the State Water Resource Control Board ("SWRCB") for a limited revision of its declaration of fully appropriated stream status for the Lower American River ("River") to the extent necessary to enable the SWRCB to process and grant an Application to Appropriate Water ("Application") to be filed by SCWC.

I.

INTRODUCTION

The Lower American River has been placed on the list of fully appropriated steams during the months of July through October. (*See* SWRCB Decisions 1211 and 1108.) The most recent update of the SWRCB list of fully appropriated streams (SWRCB Order WR 98-08, Appendix A) also lists the Lower American River as unavailable for new appropriations year-round due to its

inclusion on the California list of Wild and Scenic Rivers. (*See* California Public Resources Code §§ 5093 et seq.)

As discussed more fully in Part II below, under Cleanup and Abatement Orders and subsequent National Pollutant Discharge Elimination System ("NPDES") Permits from the California Regional Water Quality Control Board ("RWQCB"), Central Valley Region, Aerojet-General Corporation is currently pumping and treating contaminated groundwater and discharging it in to the American River. Under its most recent NPDES Permit, a copy of which is attached to this Petition as Exhibit "A," Aerojet is authorized to discharge as much as 3500 gpm into the River.

The SWRCB has the authority to revise a declaration that a stream is fully appropriated. (Water Code § 1205(c); 23 C.C.R. § 871(c).) Such a revision is appropriate where it can be shown that changed circumstances have resulted in more water being available from the stream system than when the stream was placed on the list of fully appropriated streams. (23 C.C.R. § 871(b).) The water discharged by Aerojet is newly developed water that was not considered in SWRCB Decisions 1211 and 1108. SCWC, operating as Arden Cordova Water Service, has lost the use of many of its wells in this area due to the contamination from Aerojet's historical activities. SCWC wishes to augment a portion of its supply, used for domestic retail service, by diverting the water that Aerojet discharges to the River.

In addition, construction of facilities to divert water from Wild and Scenic rivers is appropriate where the water is needed to supply domestic water to residents of the county through which the river segment flows, and where the facility will not affect the free-flowing condition and natural character of the river segment. (Public Resources Code § 5093.55(a).) Since the Application that will be filed by SCWC pursuant to this Petition is anticipated to utilize existing diversion facilities to divert non-native water, there will be minimal, if any, effect on the natural character of the River.

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II.

BASIS OF PETITION

A. Background of Aerojet's Discharges of Developed Water to the Lower American River

Since 1953, Aerojet-General Corporation and its subsidiaries have manufactured liquid and solid propellant rocket engines for military and commercial applications and have formulated a number of chemicals, including rocket propellant agents, agricultural, pharmaceutical, and other industrial chemicals. The Aerojet site covers 8,500 acres near Rancho Cordova, fifteen miles east of Sacramento as shown on the location map attached to this Petition as Exhibit "B." The northeastern edge of the site is about one half mile from the American River. Historically, Aerojet disposed of unknown quantities of hazardous waste chemicals, including trichloroethylene ("TCE") and other chemicals associated with rocket propellants, as well as various chemical processing wastes at this site. Some wastes were disposed of in surface impoundments, landfills, deep injection wells, leachate fields, and some were disposed of by open burning. (Record of Decision for the Western Groundwater Operable Unit OU-3, Aerojet Sacramento Site, U.S. EPA, July 20, 2001 ("ROD"), § 2.2.1, attached to this Petition as Exhibit "C.")

In 1979, volatile organic compounds ("VOCs") were found off-site in private wells. VOC's were found in the American River in 1983. Perchlorate, a component of solid rocket fuel, was found in drinking water wells off-site above the provisional reference dose range in January, 1997. (ROD § 2.2.1.) Groundwater is used extensively throughout the Rancho Cordova area to supply municipal, domestic, industrial and some irrigation water. SCWC, operating as Arden Cordova Water Service, supplies the Rancho Cordova area with water. SCWC's water supply wells have been contaminated and to date nine wells have been closed as a result. SCWC anticipates that it will lose additional wells in the future.

In 1995, the RWQCB issued Cleanup and Abatement Order No. 95-715 which required Aerojet to submit a plan designed to minimize the spread of contaminated groundwater. The initial plan submitted by Aerojet under this Order proposed to pump and treat 500 gpm of groundwater from three existing groundwater extraction wells. The RWQCB subsequently adopted Order No.

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96-006 which authorized the discharge of this treated water into a pond located at the nearby Sailor Bar Park. On September 20, 1996, the RWQCB modified Order No. 95-715 with the adoption of Cleanup and Abatement Order No. 96-230. This modification directed Aerojet to submit a plan to contain and cleanup the plume of contaminated groundwater. Pursuant to that Order, Aerojet proposed the construction of a treatment facility capable of treating 3500 gpm of contaminated groundwater. In Order No. 98-113, the RWQCB approved this plan and authorized Aerojet to discharge up to 3500 gpm of treated groundwater into Buffalo Creek, with the intention that this water would discharge into the River. Aerojet is currently discharging water into the River pursuant to this Order. The water is discharged into Buffalo Creek and flows into the American River just upstream of the Sunrise Bridge crossing located in Section 13, R6E, T9N, MDB&M as shown on the map attached to this Petition as Exhibit "D."

B. Aerojet's Discharges Constitute a Change of Circumstances that Warrants a Limited Revision of the Declaration of Fully Appropriated Stream Status

The SWRCB has the authority to revise a declaration of a stream system as fully appropriated upon receipt of a petition for revision from any person. (Water Code § 1205(c); 23 C.C.R. § 871(c).) Title 23, section 871(b) of the California Code of Regulations describes the standard under which such a revision may occur. It provides that revocation or revision of a declaration of fully appropriated stream status:

> ". . . may be based upon any relevant factor, including but not limited to a change in circumstances from those considered in a previous water right decision determining that no water remains available for appropriation, or upon reasonable cause derived from hydrologic data, water usage data, or other relevant information . . . ."

As described above, Aerojet is now discharging significant quantities of developed water into the Lower American River. These discharges are recent in origin and thus were not considered in the previous decisions of the SWRCB concerning the fully appropriated stream status of the River, the most recent of which is from 1965. (*See* SWRCB Decision No. 1211.) Furthermore, the groundwater that is treated and discharged by Aerojet would not otherwise reach the River under natural

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conditions. (ROD § 2.5.1.) Thus, this water was not included in the SWRCB's determination that there was no water available for appropriation from the River.

For this reason, Aerojet's discharge of treated groundwater constitutes a change of circumstance that warrants a revision of the declaration of fully appropriated stream status of the Lower American River for the limited purpose of processing SCWC's Application to Appropriate the discharged water.

SCWC's Application for Appropriation will request a right to appropriate only those flows discharged by Aerojet. That is, the amount of SCWC's appropriation will be tied directly to the amount of water discharged by Aerojet. While Aerojet is currently authorized to discharge as much as 3500 gpm, this quantity may be increased in the future, and such additional discharges would also be subject to appropriation by SCWC.

All water obtained will be non-native flows, will be recaptured close to its point of entry into the river (thus minimizing evaporation and other losses) and will be diverted using existing diversion facilities. Thus, recapture by SCWC, the party most injured by Aerojet's contamination, will not affect the natural flow of the river.

III.

CONCLUSION

WHEREFORE, SCWC respectfully requests that the SWRCB revise the Declaration of Full Appropriation for the Lower American River to the limited extent necessary to accept and grant SCWC's Application.

November 7, 2001

HATCH and PARENT

By:_____
SCOTT S. SLATER
MICHAEL T. FIFE
Attorneys for
SOUTHERN CALIFORNIA WATER COMPANY

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EXHIBIT A

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. 98-113

NPDES NO. CA0083861

WASTE DISCHARGE REQUIREMENTS FOR AEROJET-GENERAL CORPORATION INTERIM GROUNDWATER EXTRACTION AND TREATMENT SYSTEM AMERICAN RIVER STUDY AREA SACRAMENTO COUNTY

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that:

1. Aerojet-General Corporation (hereafter Discharger) submitted a Report of Waste Discharge, dated 30 September 1997 and supplemental information dated 31 January 1998 and 25 February 1998 , and applied for authorization to discharge waste under the National Pollutant Discharge Elimination System (NPDES) from the American River Study Area Groundwater Extraction and Treatment System.

2. The Discharger operates a rocket-testing and chemical manufacturing facility in eastern Sacramento County near Rancho Cordova and Folsom. Past discharge practices have caused the release of contaminants into the vadose zone and groundwater at the facility.

3. Concentrations of contaminants in the groundwater northwest of the Discharger's property in the vicinity of Sailor Bar Park and the Nimbus Fish Hatchery, north and south of the American River and west of Hazel Avenue (American River Study Area), respectively, include up to 4000 micrograms per liter (µg/l) trichloroethylene (MCL of 5 µg/l), 220 µg/l cis-1,2-dichloroethylene (MCL of 6.0 µg/l), 110 µg/l 1,1-dichloroethylene (MCL of 5.0 µg/l), and 36 µg/l tetrachloroethylene (MCL of 5 µg/l). Concentrations of trichloroethylene in the plume of contaminated groundwater have been detected north of Sailor Bar Park exceeding 100 µg/l.

4. The current plume of contaminated groundwater off the Discharger's property and to the north of the American River creates or threatens to create a condition of pollution or nuisance. In response, the Executive Officer issued Cleanup and Abatement Order No. 95-715 requiring the Discharger to submit a plan designed to minimize the flux of contaminated groundwater past the northern boundary of Sailor Bar Park while an evaluation and construction of a system for containment, extraction, and treatment of the entire plume in the American River Study Area was being made.

   To comply with the Cleanup and Abatement Order, the Discharger submitted a plan proposing to initially extract approximately 500 gpm of groundwater from three existing groundwater extraction wells, treat the water using granular activated carbon (GAC), and discharge the treated groundwater under a permit into the Sacramento Regional County Sanitation District's collection system. However, the costs for discharge to the sewer were significant prompting the Discharger to request to

discharge the treated groundwater under an NPDES permit to an existing pond in Sailor Bar Park. The pond was being fed by storm and urban runoff from a small upstream watershed and by a groundwater supply well near the pond. The Board adopted an NPDES permit, Order No. 96-066, for the discharge from the interim treatment plant to the pond in Sailor Bar Park. Water quality of the discharge was no worse, and was generally better due to treatment, than the other discharges into the pond. Overflow from the pond is to an unnamed tributary to the American River. Given the very coarse soils in the drainage channel, and the numerous road crossings blocking flow, and ponding areas, a direct discharge from the pond does not reach the American River. See Attachment A, a part of this Order.

5. The interim groundwater treatment system consisted of twenty-four GAC absorber vessels each containing 2000 pounds of carbon and operated in twelve sets of two vessels in series. The plant was designed to treat 500 gpm of extracted ground water to concentrations below that which can be detected. Prior to entering the GAC vessels, the water will passed through bag filters to remove suspended particles larger than 5 microns. The discharge was in substantial compliance with the effluent and receiving water limitations found in Order No. 96-066 during its period of operation, which ceased in October 1997 to allow construction of the current system. The new system is to treat extracted groundwater from all the extraction wells in the American River Study Area (discussed further below). This Order revises the requirements of Order No. 96-066 to reflect the changes due to the proposed discharges.

6. The Board modified Order No. 95-715 with the adoption of Cleanup and Abatement Order No. 96-230 on 20 September 1996. Order No. 96-230 directs the Discharger to complete design, construction, and operation of a groundwater extraction system in the American River Study Area to contain and cleanup the plume of contaminated groundwater. The Discharger is complying with that Order by completing construction of a treatment facility on the Discharger's property capable of treating 3500 gpm. Flow from nine extraction wells in Sailor Bar Park will be pumped under the American River, combined with flows from six extraction wells on the south side of the river, and piped back to the treatment facility. The pipeline has been completed and it is anticipated that the treatment plant will be operational by the end of April 1998.

   The treatment plant utilizes ultraviolet/peroxide oxidation and air stripping to remove the volatile organic contaminants (described in Finding No. 3, above).

7. Sacramento County Department of Parks and Recreation has requested the Discharger to continue the discharge of groundwater to Sailor Bar Park pond (in Section 17, R6E, T9N, MDB&M). It was found that the continuous discharge of freshwater to the pond from the interim system, enhanced the quality of the pond. If the current park well was utilized to provide the flow for the pond, a treatment system would be required for the well since samples of water from the well have found up to 50 µg/l trichloroethylene (TCE). The Discharger will be utilizing a shallow groundwater extraction well for the purpose of filling the pond. The well has shown to have no detectable concentrations of VOCs

during the 18 months of operation of the interim groundwater extraction and treatment system. Monitoring of the extraction well providing flow to the pond will be more intensive than the other extraction wells. The 250 gpm flow from the extraction well will be intermittent, and will have a maximum flow of 0.18 million gallons per day (mgd).

8. The discharges from the system will consist of the main flow from the groundwater treatment plant to Buffalo Creek on the Discharger's property and the flow to the pond as described in Finding No. 7, above. Buffalo Creek discharges to the American River just upstream of the Sunrise Bridge crossing in Section 13, R6E, T9N, MDB&M. See Attachment A.

9. The Report of Waste Discharge, including data from sampling of the Sailor Bar park system and nearby groundwater wells, describes the discharge as follows:

Monthly Average Flow:	5.0 mgd
Daily Peak Flow:	5.0 mgd
Design Flow:	5.0 mgd
Average Temperature:	70°F summer; 59°F winter
pH	7.2 - 8.5

Constituent	mg/l
COD	<3
Total Suspended Solids	<6
Chlorides	40
Sulfate	12
Manganese	0.07
Aluminum	<0.16
Zinc	0.034
Arsenic	<0.002
Lead	<0.005
Hardness (as $CaCO_3$)	110
Barium	0.07
Copper	<0.0015
Chromium	<0.002
Nickel	<0.005
All Volatile Organic Contaminants	<0.0005

10. Sampling for perchlorate in groundwater monitor wells in the American River Study Area was recently conducted. Concentrations ranged from non-detect (<0.004 mg/l) to 0.150 mg/l. The average concentration was 0.007 mg/l with a median of non-detect (<0.004 mg/l). None of the

groundwater extraction wells were found to contain perchlorate at detectable concentrations. The highest concentrations of perchlorate were found in the monitor wells closest to Aerojet and all wells with detections, except one, were found on the south side of the American River. Using values from monitor wells closest to the extraction wells, it is calculated that the influent to the treatment system could reach a value of 0.005 mg/l. This is well below the current regulatory level of concern of 0.018 mg/l. The effluent standard found in this Order is 0.018 mg/l.

11. One other contaminant of concern, other than those discussed above, which was deemed necessary for evaluation is 1,4-dioxane. This contaminant is found in some of the groundwater monitor wells south of the American River in the American River Study Area, with a maximum concentration of 0.029 mg/l (detection level of 0.010 mg/l). Estimated worst-case effluent concentrations for 1,4-dioxane are below the detection limit, at 0.006 mg/l. The Proposition 65 value for 1,4-dioxane is 0.015 mg/l. The effluent limitation is set at the detection limit. It should be noted that there will be a minimum 30-fold dilution in the American River (flow at 250 cubic feet per second) at the maximum discharge rate of 3450 gpm.

12. Another contaminant of concern is N-Nitrosodimethylamine (NDMA) which has been found in groundwater on the eastern side of Aerojet and a few wells on the western edge of Aerojet. There are no known source areas for NDMA in the vicinity or upgradient of the American River Study Area. In addition, NDMA has not been detected in monitor wells in the American River Study Area. This permit requires monitoring for NDMA in the treatment facility and in the American River upstream and downstream of the confluence with Buffalo Creek.

13. The Discharger submitted a Final Revised Engineering Evaluation and Cost Analysis for the American River Study Area dated 13 September 1996, a draft Quality Assurance Project Plan dated 31 January 1998, a draft revised Sampling and Analysis Plan dated 31 January 1998, and a draft Groundwater Extraction and Treatment System Effectiveness Evaluation Work Plan dated 31 January 1998. These documents were utilized in formulating this Order.

14. The Final Revised Engineering Evaluation and Cost Analysis (EE/CA) of the American River Study Area evaluated several discharge options for the treated groundwater, including providing the water for municipal and industrial use. The method of discharge covered in this permit as an interim solution, and options considered in the EE/CA may be utilized by the Discharger in the future. This permit would be modified as necessary."

15. The U.S. Environmental Protection Agency (EPA) and the Board have classified this discharge as a minor discharge.

16. The Board adopted a Water Quality Control Plan, Third Edition, for the Sacramento River Basin and the San Joaquin River Basin (hereafter Basin Plan) which contains water quality objectives for all waters of the Basin. These requirements implement the Basin Plan.

17. The beneficial uses of the American River downstream of the discharge are municipal and domestic, industrial, and agricultural supply; water contact and noncontact recreation; groundwater recharge, fresh water replenishment; and preservation and enhancement of fish, wildlife and other aquatic resources.

18. The beneficial uses of the underlying groundwater are municipal and domestic, industrial, and agricultural supply.

19. The Effluent Limitations for metals established in the table under Effluent Limitation B.1 are based on a limited number of samples from the ground water monitor wells, effluent from the interim treatement system in Sailor Bar Park (and a hardness of 100 mg/l as $CaCO_3$ for groundwater) and the American River. Additional monitoring is required in the Monitoring and Reporting Program for this discharge and the data gathered in that program will be used to reevaluate the effluent limitations for metals. This permit may be reopened and the effluent limits adjusted as allowed in Provision E.1.

20. The permitted discharge is consistent with the antidegradation provisions of 40 CFR 131.12 and State Water Resources Control Board Resolution 68-16. The impact on water quality will be insignificant.

21. Effluent limitations, and toxic and pretreatment effluent standards established pursuant to Sections 301, 302, 304, and 307 of the Clean Water Act (CWA) and amendments thereto are applicable to the discharge.

22. The action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of the California Environmental Quality Act (CEQA) (Public Resources Code Section 21100, et seq.), in accordance with Section 13389 of the California Water Code.

23. The Department of Toxic Substances Control has certified a final Negative Declaration and Initial Study in accordance with the CEQA (Public Resources Code Section 21000, et seq.), and the State CEQA Guidelines. The Board has reviewed the Negative Declaration and these waste discharge requirements will mitigate or avoid any significant impacts on water quality.
24. The Board has notified the Discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for this discharge and has provided them with an opportunity for a public hearing and an opportunity to submit their written views and recommendations.

25. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

26. This Order shall serve as an NPDES permit pursuant to Section 402 of the CWA, and amendments thereto, and shall take effect upon the date of hearing, provided EPA has no objections.

IT IS HEREBY ORDERED that Order No. 96-066 is rescinded and Aerojet-General Corporation, its agents, successors and assigns, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act and regulations and guidelines adopted thereunder, shall comply with the following:

A. Discharge Prohibitions:

1. Discharge of treated wastewater at a location or in a manner different from that described in Finding No. 8 is prohibited.

2. The by-pass or overflow of wastes to surface waters is prohibited, except as allowed by the attached Standard Provisions and Reporting Requirements A.13.

B. Effluent Limitations:

1. Effluent shall not exceed the following limits:

Constituents	Units	Daily Maximum	Monthly Average
Total Copper	µg/l	17	11
Total Lead	µg/l	15	2.5
Total Zinc	µg/l	110	100
Volatile Organics[1]	µg/l	0.5[1]	
Perchlorate	µg/l	18	18
1,4-dioxane	µg/l	15	10

[1] All volatile organic constituents listed in EPA Methods 8010 and 8020. The concentration of each constituent shall not exceed 0.5 µg/l.

Note: Effluent Limitations for metals may be modified in the future based on results of subsequent sampling as allowed in Provision E.1.

2. The discharge shall not have a pH less than 6.5 nor greater than 8.5.

3. The 30-day average daily discharge flow shall not exceed 5.04 mgd.

4. Survival of aquatic organism in 96-hour bioassays of undiluted waste shall be no less than:
Minimum for any one bioassay - - - - - - - - - 70%
Median for any three or more consecutive bioassays - - - - 90%

C. Sludge Disposal:

1. Collected screenings, sludges, and other solids removed from liquid wastes shall be disposed of in a manner that is consistent with Chapter 15, Division 3, Title 23, of the CCR and approved by the Executive Officer.

2. Any proposed change in sludge use or disposal practice shall be reported to the Executive Officer and EPA Regional Administrator at least **90 days** in advance of the change.

D. Receiving Water Limitations:

Receiving Water Limitations are site specific interpretations of water quality objectives from applicable water quality control plans. As such they are a required part of this permit. However, a receiving water condition not in conformance with the limitation is not necessarily a violation of this Order. The Board may require an investigation to determine the cause and culpability prior to asserting that a violation has occurred.

The discharge shall not cause the following in the receiving water:

1. Concentrations of dissolved oxygen to fall below 7.0 mg/l.

2. Oils, greases, waxes, or other materials to form a visible film or coating on the water surface or on the stream bottom.

3. Oils, greases, waxes, floating material (liquids, solids, foams, and scums) or suspended material to create a nuisance or adversely affect beneficial uses.

4. Aesthetically undesirable discoloration.

5. Fungi, slimes, or other objectionable growths.

6. Turbidity to increase more than 20 percent over background levels.

7. The normal ambient pH to fall below 6.5, exceed 8.5.

8. Deposition of material that causes nuisance or adversely affects beneficial uses.

9. The normal ambient temperature to be increased more than 5°F.

10. Taste or odor-producing substances to impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin or to cause nuisance or adversely affect beneficial uses.

11. Radionuclides to be present in concentrations that exceed maximum contaminant levels specified in the California Code of Regulations, Title 22; that harm human, plant, animal or aquatic life; or that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.

12. Aquatic communities and populations, including vertebrate, invertebrate, and plant species, to be degraded.

13. Toxic pollutants to be present in the water column, sediments, or biota in concentrations that adversely affect beneficial uses; that produce detrimental response in human, plant, animal, or aquatic life; or that bioaccumulate in aquatic resources at levels which are harmful to human health.

14. Violation of any applicable water quality standard for receiving waters adopted by the Board or the State Water Resources Control Board pursuant to the CWA and regulations adopted thereunder.

E. Provisions:

1. The Effluent Limitations for metals found in Effluent Limitation B.1 were conservatively developed, but with only a minimal amount of data. The Discharger shall be collecting additional information during required monitoring that will be used to evaluate the limits. If necessary, this permit may be reopened and the effluent limitations for metals revised based on the new data.

2. The Discharger shall comply with the Operation, Maintenance, and Monitoring Plan, Ground Water Extraction and Treatment System, American River Study Area dated **31 January 1998**.

3. The Discharger shall conduct the chronic toxicity testing specified in the Monitoring and Reporting Program. If the testing indicates that the discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above the water quality objective for toxicity, the Discharge shall submit a work plan to conduct a Toxicity Reduction Evaluation (TRE) and upon approval conduct the TRE, and this Order will be reopened and a chronic toxicity limitation included and/or a limitation for the specific toxicant identified in the TRE included. Additionally, if a chronic toxicity water quality objective is adopted by the State

Water Resources Control Board, this Order may be reopened and a limitation based on that objective included.

4. The Discharger shall use the best practicable cost-effective control technique currently available to limit mineralization to no more than a reasonable increment.

5. The Discharger shall comply with all the items of the "Standard Provisions and Reporting Requirements for Waste Discharge Requirements (NPDES)", dated 1 March 1991, which are part of this Order. This attachment and its individual paragraphs are referred to as "Standard Provision(s)."

6. The Discharger shall comply with the attached Monitoring and Reporting Program No. 98-113 which is part of this Order, and any revisions thereto, as ordered by the Executive Officer.

7. Under Monitoring and Reporting Program No. 98-113, the Discharger shall report trace concentrations of constituents found during the analysis of samples. Trace values are estimates of concentrations detected between the detection level and the practical quantitation level. Trace values are not always reliable as there is a potential for interferences below the practical quantitation level. As effluent limitations specified in this permit are at or above the practical quantitation level, reporting trace values shall not be a violation of an effluent limitation. Trace values are to be used to help operate the treatment facility and to provide information to minimize violations of effluent limits."

8. This Order expires on **1 April 2003** and the Discharger must file a Report of Waste Discharge in accordance with Title 23, CCR, not later than 180 days in advance of such date in application for renewal of waste discharge requirements if it wishes to continue the discharge.

9. Prior to making any change in the discharge point, place of use, or purpose of use of the wastewater, the Discharger shall obtain approval of or clearance from the State Water Resources Control Board (Division of Water Rights).

10. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the Discharger, the Discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be immediately forwarded to this office.

    To assume operation under this Order, the succeeding owner or operator must apply in writing to the Executive Officer requesting transfer of the Order. The request must contain the requesting entity's full legal name, the State of incorporation if a corporation, the name, address, and telephone number of the persons responsible for contact with the Board, and a statement.

The statement shall comply with the signatory paragraph of Standard Provision D.6 and state that the new owner or operator assumes full responsibility for compliance with this Order. Failure to submit the request shall be considered a discharge without requirements, a violation of the California Water Code. Transfer shall be approved or disapproved in writing by the Executive Officer.

I, GARY M. CARLTON, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 17 April 1998.

GARY M. CARLTON, Executive Officer

3/2/98:AMM

EXHIBIT B

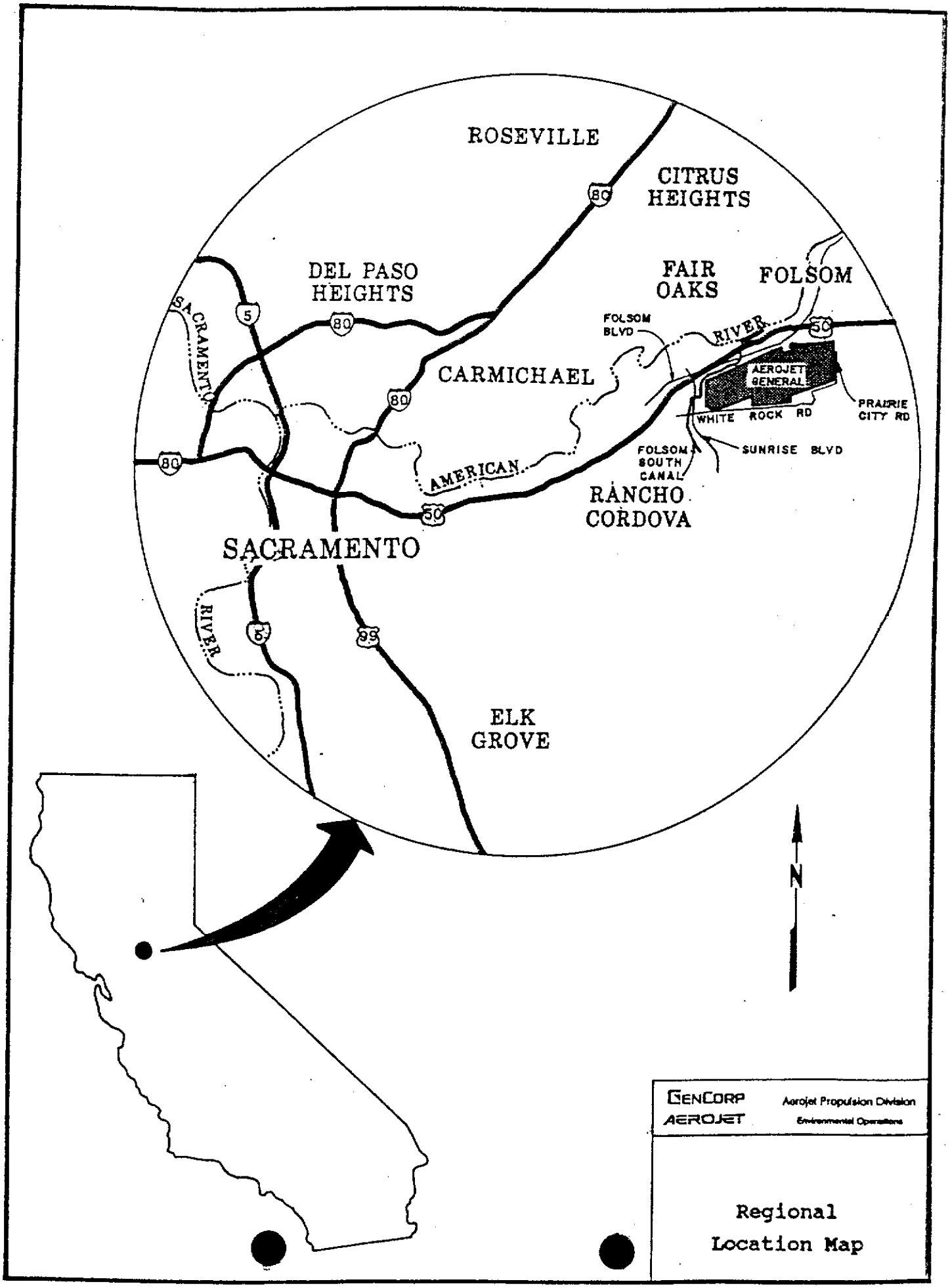
ROSEVILLE
CITRUS HEIGHTS
DEL PASO HEIGHTS
FAIR OAKS
FOLSOM
SACRAMENTO
CARMICHAEL
FOLSOM BLVD
RIVER
AEROJET GENERAL
PRAIRIE CITY RD
WHITE ROCK RD
SUNRISE BLVD
FOLSOM SOUTH CANAL
AMERICAN
RANCHO CORDOVA
SACRAMENTO
RIVER
ELK GROVE
5
80
50
99
N
GENCORP
AEROJET
Aerojet Propulsion Division
Environmental Operations
Regional
Location Map

EXHIBIT C

RECORD OF DECISION

for the

WESTERN GROUNDWATER OPERABLE UNIT
OU-3

AEROJET SACRAMENTO SITE,
RANCHO CORDOVA, CALIFORNIA

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

July 20, 2001

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PART 1: THE DECLARATION

1.1 Site Name and Location - Aerojet-General Corporation, Sacramento County California Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Identification Number CAD980358832.

1.2 Statement of Basis and Purpose

1.2.1 This decision document presents the United States Environmental Protection Agency's (USEPA's) Selected Remedy for the Western Groundwater Operable Unit 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 by the Superfund Amendments and Reauthorization Act (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the USEPA's Administrative Record file.

1.2.2 The State of California concurs with the Selected Remedy.

1.3 Assessment of Site - The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment; 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

1.4.1 This remedial action for Western Groundwater Operable Unit (OU-3), addresses contaminated groundwater by containing and remediating the contaminated groundwater on the western side of the Aerojet Superfund Site with a groundwater Pump and Treat System (P&T) to mitigate the loss of additional drinking water supplies in a populated area.

1.4.2 The site is being divided into operable units (OUs) because of the overall size of the remediation effort and to expedite the remediation. Due to the impact of contaminated groundwater on public drinking water supplies, the site cleanup strategy is to give 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 being divided into two OUs, the first of which is the Western Groundwater OU to stop the loss of drinking water supplies in the most populated areas. The remaining contaminated groundwater near the boundary of the Aerojet Site will be addressed in the Perimeter Groundwater OU with a ROD anticipated in 2004. The scope of the on-property soil and groundwater remediation effort is still being determined but it is anticipated that the size of

the effort will require at least four OUs.

1.4.3 There are no known source areas or Non-Aqueous Phase Liquids (NAPLs) in OU-3 and as a result principal threat waste was not considered for OU-3.

1.4.4 The OU-3 remedy includes the following actions:

1.4.4.1 Contain contaminated groundwater off-property within OU-3 with P&T in all contaminated layers of the aquifer to prevent further contamination of the aquifer;

1.4.4.2 Contain the contaminated groundwater on-property which is feeding the off-property groundwater contamination at the Aerojet's property boundary through P&T in all contaminated layers of the aquifer;

1.4.4.3 Restore all layers of the aquifer between the on- and off-property extraction systems to their beneficial use as a drinking water aquifer;

1.4.4.4 Treat extracted groundwater using biological treatment for Perchlorate, ultraviolet oxidation for N-Nitrosodimethylamine, and air stripping for residual Volatile Organic Compounds (VOCs);

1.4.4.5 The Treated groundwater shall be discharged directly to the drinking water system or discharged to surface water. Any discharge to a drinking water system shall comply with Federal Drinking water standards as well as California Department of Health Services, Division of Drinking Water and Environmental Management requirements.

1.4.4.6 Water replacement contingency planning and implementation shall provide for the following:

- Develop, implement and augment as required a short-term water replacement contingency plan to replace on a temporary basis private and public drinking water and irrigation well water supplies lost to Aerojet contamination within OU-3;

- Develop and implement a long-term water replacement contingency plan for timely permanent replacement of existing private and public drinking water and irrigation well water supplies lost to Aerojet contamination within OU-3;

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

1.4.4.8 Create a groundwater management zone within OU-3 to maintain water levels and to prevent adverse impact on the remedy;

1.4.4.9 Implement Institutional Controls (ICs) with this remedy including Sacramento County review of new well drilling permits; prohibitions on access to groundwater and environmental restrictions on the land overlaying the contaminated groundwater; and notification to drinking water suppliers if treated discharge to a drinking water supply exceeds Californica Department of Health Services drinking water action levels.

1.4.4.10 Provide an evaluation of *in-situ* bioremediation as a possible revised groundwater remedy to augment P&T to allow USEPA to assess if *in-situ* bioremediation can economically and effectively reduce the time for remedy completion. Such a remedy revision would be accomplished by an Explanation of Significant Differences

1.5 Statutory Determinations

1.5.1 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 (unless justified by a waiver), is cost-effective, and utilizes permanent solutions to the maximum extent possible.

1.5.2 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).

1.5.3 Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining within OU-3 above levels that allow for unlimited use and unrestricted exposure, but it will take more than five years to attain remedial action objectives and cleanup levels, a policy review will be conducted within five years of completion of the physical construction of the OU-3 remedy 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):

1.6.1 Chemicals of Concern (COC) and their respective health-based concentrations - Page 21;

1.6.2 Baseline risk represented by the COC - Page 20;

1.6.3 Cleanup levels established for the COC and the basis for these levels - Page 59;

1.6.4 How source materials constituting principal threats are addressed - Page 48;

1.6.5 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 - Page 19;

1.6.6 Potential groundwater use that will be available at the site as a result of the Selected Remedy - Page 38;

1.6.7 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 - Page 47; and

1.6.8 Key factors that led to selecting the remedy - Page 49.

1.7 Authorizing Signature

_____ _____

Date

Keith Takata
Director, Superfund Division

PART 2 THE DECISION SUMMARY

2.1 Site Name, Location, and Description:

2.1.1 Aerojet-General Corporation, Rancho Cordova, California (Approximately 15 miles east of Sacramento, CA See Figure 2-1). It is bounded on the west by the unincorporated city of Rancho Cordova and on the east by the city of Folsom.

2.1.2 The CERCLIS Identification Number is CAD980358832.

2.1.3 The lead agency is the USEPA.

2.1.4 The expected source of cleanup monies is enforcement settlement with the Potentially Responsible Party (PRP).

2.1.5 The major sources of the groundwater contamination are from Aerojet's facilities up-gradient of OU-3. There are some small Volatile Organic Chemicals (VOCs) sources off-property which are and will be remediated by separate State actions.

2.1.6 OU-3 is approximately 14 square miles in area and includes a small portion of both the Aerojet industrial facility and the adjacent Inactive Rancho Cordova Test Site (IRCTS) as well as approximately 10 square miles of commercial and residential developed areas in the unincorporated community of Rancho Cordova (see Figure 2-2). OU-3 is not known to include soil or vadose zone source sites or NAPL. OU-3 is just north of the closed United States Air Force Mather Field, a Federal National Priority List (NPL) site.

2.2 Site History and Enforcement Activities:

2.2.1 Aerojet is a wholly owned subsidiary of GenCorp. Aerojet has operated the Superfund Site since 1953, prior to the Resource Conservation and Recovery Act (RCRA) of 1980. 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 N-Nitrosodimethelamine (NDMA). In 1997, the practical quantitation limit (PQL) for perchlorate was improved from 400 parts per billion (ppb) to four ppb, the health-based concentration associated with standard exposure assumptions made using the low end of the provisional reference dose (RfD) range of 0.0001 mg/kg-day. The NDMA PQL has also been improved from 150 ppb to 5 parts per trillion (ppt) which

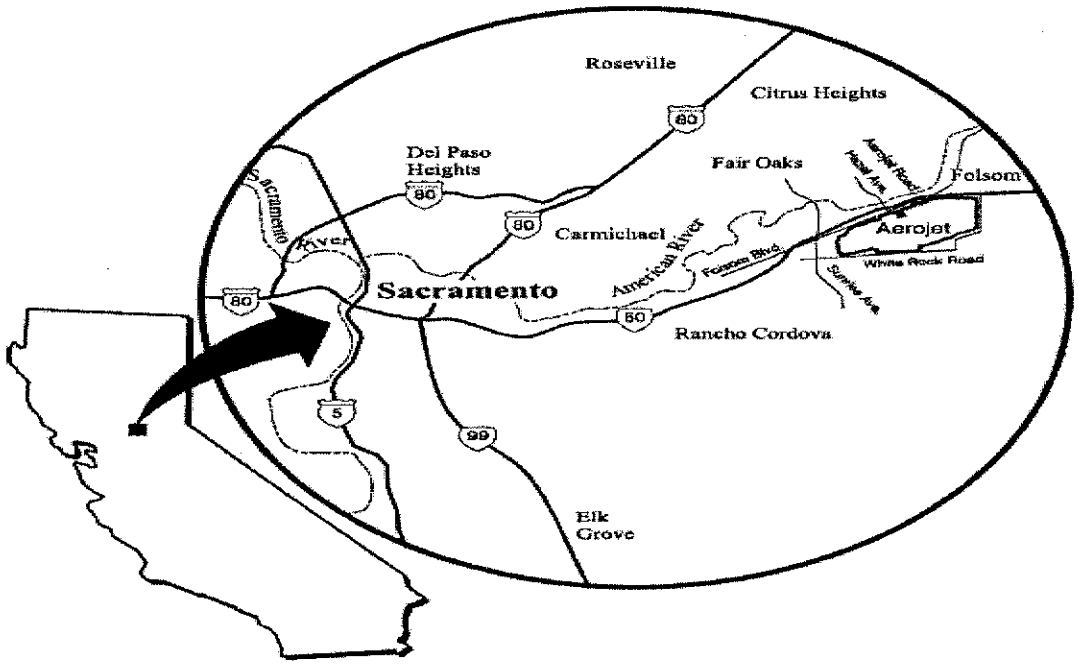
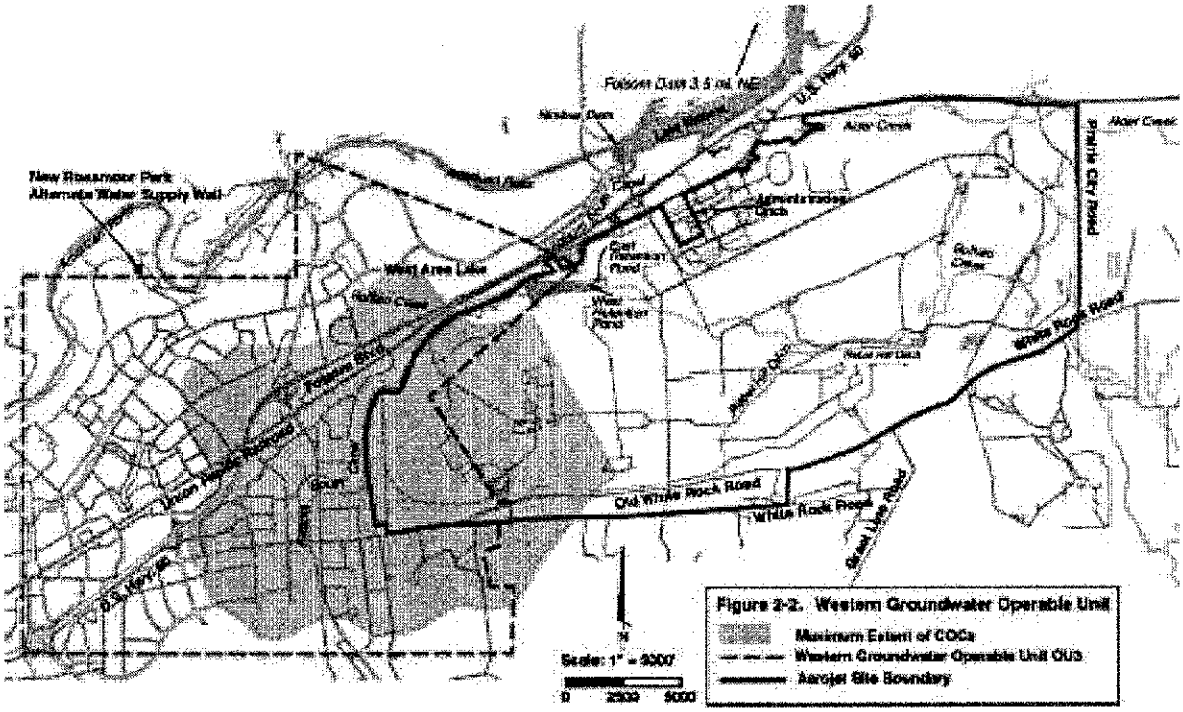


Figure 2-1. Aerojet Superfund Site Map



is still above the Preliminary Remediation Goal (PRG) of 1.3 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.

2.2.2 The Aerojet Site was placed on the NPL August 8, 1983. Portions of the IRCTS are considered part of the NPL 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 will become part of 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 with the United States Eastern District Court 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. 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 first of its kind 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, the current PQL. 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 2 ppt.

2.2.3 At the IRCTS property, in 1995 DTSC issued an order to Aerojet requiring soil and groundwater cleanup. 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 for abatement and remediation of perchlorate off Aerojet's property.

2.2.4 The USEPA and State are negotiating with Aerojet to modify the 1989 PCD to expedite the cleanup by dividing the site into OUs, beginning with OU-3, instead of waiting to complete a single site-wide RI/FS before starting remediation. Completion of the RI/FS for OU-3 has proceeded ahead of the PCD modification.

2.2.5 American States Water Co. has filed a lawsuit in State court against DTSC and the RWQCB and a separate lawsuit against Aerojet for the reinjection of perchlorate at GETs E and F. Three toxic tort suits are also pending against Aerojet related to it's Sacramento site.

2.3 Community Participation: The RI/FS Report and Proposed Plan for OU-3 for the Aerojet Superfund Site in Sacramento, CA, were made available to the public in November 2000. These documents can be found in the Administrative Record file of the information repositories maintained at the USEPA Region 9 Record Center at 95 Hawthorne St. in San Francisco and at the California State University Sacramento Library. The notice of availability of the RI/FS, proposed plan, date and location for the first public meeting and public comment period (December 1, 2000 through January 30, 2000) were published November 30 in the Sacramento Bee and Grapevine Independent new papers. The first public meeting was held December 7, 2000 during which time a second public meeting was requested to insure all comments could be included. The Second public meeting was held January 17, 2001. Transcripts of both public meetings are part of the administrative file at the repositories and USEPA's response to comments received at the two public meetings and written comments are part of this ROD's Responsiveness Summary. An overview of the proposed plan was presented by USEPA at both public meetings and questions were taken by a panel comprised of USEPA, DTSC, RWQCB and, at the second meeting, California Department of Health Services (CADHS). A separate community meeting (not on the proposed plan for this remedy) was held March 22, 2001 which resulted in the forming of a Community Advisory Group (CAG).

2.4 Scope and Role of the Operable Unit or Response Action:

2.4.1 Aerojet is a large site with groundwater contamination that has migrated off the Aerojet property. The USEPA and the State have been negotiating with Aerojet to organize the site into OUs through a modification to the PCD. The USEPA anticipates the OU remedial actions will be implemented by Aerojet.

2.4.1.1 Operable Unit 1: Is reserved for the sitewide ROD upon completion of all the OUs. Until the PCD is modified, OU-1 is the vehicle for all RI/FS for the site.

2.4.1.2 Operable Unit 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. 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. It is anticipated that OU-2 will be merged into OU-5 in the future.

2.4.1.3 Operable Unit 3: **Western Groundwater Operable Unit (OU-3) is the action covered by this ROD.** The purpose of OU-3 is to contain and remediate groundwater

contamination on the western side of the Aerojet Site. Nine water supply wells have been lost to groundwater contamination and it is projected that an estimated 13 additional public water supply wells could be lost over the next 25 years. Ingestion of groundwater extracted from the aquifer poses a current and potential risk to human health which is outside the USEPA's acceptable risk range.

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

2.4.1.5 Operable Unit 5: Perimeter Groundwater OU (OU-5) will contain and remediate groundwater around the remaining three sides of Aerojet (north, east and south) not covered by OU-3. OU-5 will include Aerojet's GETs A, B, D, the American River GET and groundwater for Areas 39 and 40. Interim RWQCB orders 96-230, 96-259, and 500-718 will be incorporated in OU-5.

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

2.5 Site Characteristics:

2.5.1 *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 and 2) calculating hypothetical risks assuming present residential exposure to water purveyor supply wells. Residential exposure through water from drinking water wells would include ingestion, inhalation and dermal contact. The health-based concentration used in the risk assessment are those that represent the current state of the plumes as well as maximum detected concentrations over the past 2 years of sampling. The major sources of the groundwater contamination are from Aerojet's facilities up-gradient of OU-3 which will be addressed in future OUs. The Aerojet groundwater contamination is deep underground at least 60 ft at the eastern end of OU-3 and slopes downward to the west. 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 Health Service regulations. Water on-property is supplied from an up-gradient off-property supply that is not contaminated.

2.5.2 *Overview of Site*:

2.5.2.1 Size: OU-3 is approximate 14 square miles in size and characterized by a relatively flat topographic surface that slopes gently downward 140 ft. to the west. The depth to shallow groundwater varies from 40 to 60 ft. in the east to 100 ft. below ground surface in the west. The depth to groundwater in the deepest layer of concern, Layer E, varies from 350 to 400 ft.

2.5.2.2 Geographical and Topographical Information: The American River meanders in a generally southwesterly direction through the northwest part of OU-3. The Folsom South Canal originates at the southwest end of Lake Natoma which is created by Nimbus Dam, 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 various municipal and agricultural water users. Other surface water features include the Administration Ditch, Buffalo Creek and the West Area Lake (see Figure 2-2). Storm water runoff from the northern and northeastern part of Aerojet (beyond the OU-3 boundaries) flows through the Administration Ditch or Buffalo Creek into West Area Lake, which is located in the northeastern corner of OU-3. Water from West Area Lake is discharged to Buffalo Creek and ultimately to the American River under a National Pollution Discharge Elimination System (NPDES) permit.

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 GET-B, located east of OU-3, is discharged to the Rebel Hill Ditch, where it infiltrates into the ground along the southern boundary of the Aerojet Site (see Figure 2-2). There are also a number of lakes, ponds, vernal pools and wetlands located throughout the Aerojet Site that generally contain water only during the rainy season.

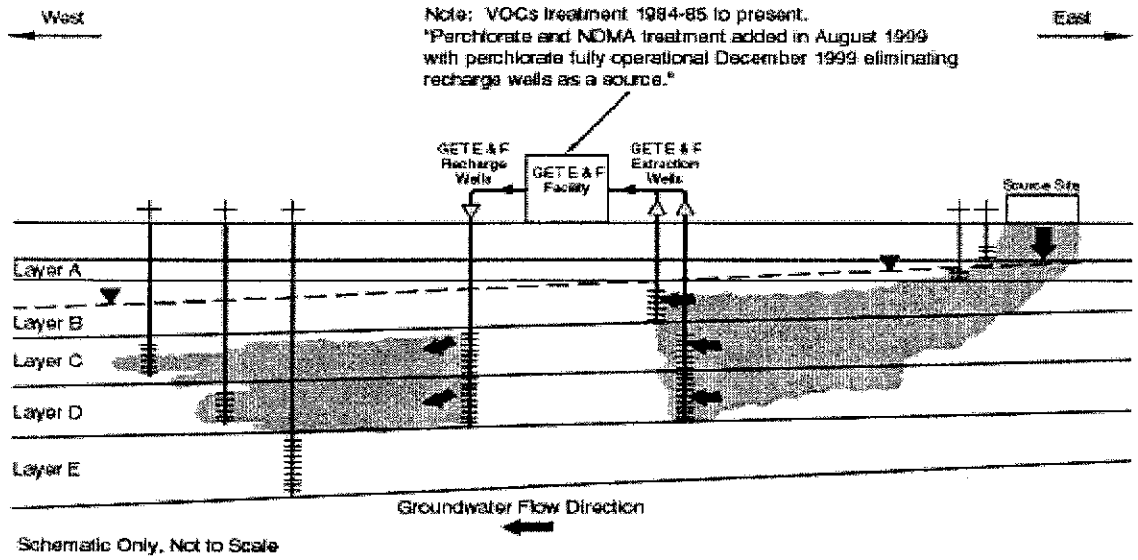
2.5.3 *Surface and Subsurface Features*: The eastern part of OU-3 contains structures built as part of the GETs E and F groundwater extraction and treatment facilities and a few other structures associated with Aerojet operations. Most of OU-3 is located in Rancho Cordova and has been fully developed with residences, commercial buildings and light industry. The area was part of the 1800's gold rush. However, there are no known areas of archaeological or historical features.

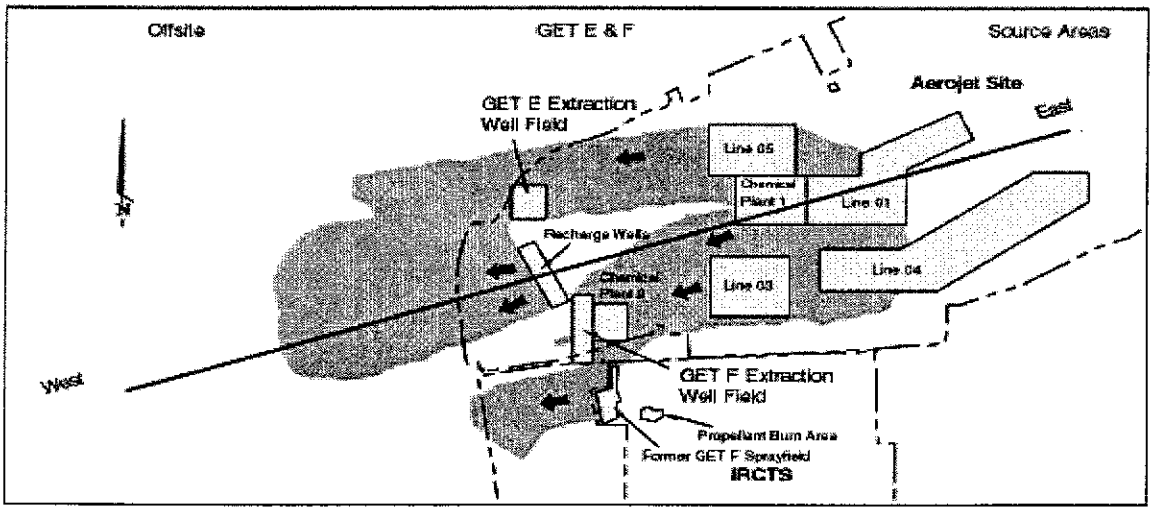
2.5.4 *Sampling Strategy*: Aerojet began installing monitor wells in OU-3 area in 1979. The first wells were installed at or near potential source sites east of OU-3 to evaluate whether chemicals had reached groundwater. From 1980 to 1991, after confirmation of groundwater contamination, Aerojet installed a series of monitor wells down-gradient of the source areas and along its property boundaries. In the mid to late 1980s, Aerojet constructed GETs E and F near its northwestern and southwestern property boundaries. Monitor wells were installed to measure GET effectiveness and for groundwater characterization and monitoring during the remedial investigation.

In 1997, using an improved perchlorate detection method, perchlorate was detected in several public water supply wells. Aerojet collected samples from 36 public water supply wells and nine private wells. Aerojet installed a series of monitor wells to characterize the vertical and lateral extent of perchlorate west of the Aerojet Site. These wells were also used to evaluate the extent of NDMA when NDMA was discovered in GET E in 1998, and subsequently, the GET E recharge wells. GETs E and F were combined in 1999 to facilitate perchlorate and NDMA treatment.

2.5.5 *Known and Suspected Sources of Groundwater Contamination*: Since the early 1950s, the Aerojet Sacramento site 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. Aerojet operating facilities on the western side of Aerojet include Chemical Plants 1 and 2, Manufacturing lines 1, 3, 4, and 5. GETs E and F were constructed in the mid 80's to contain and treat VOC contamination on the western side of Aerojet. GETs E and F used reinjection fields as a component of the systems. As a result, perchlorate was reinjected back into the aquifer at GETs E and F; and NDMA was reinjected at GET E. On the IRCTS property, a spray field was operated from December 1984 to February 1990 and in August 1990, to treat groundwater extracted from GET F extraction Wells 4007 and 4060 (formerly GET F South) for VOCs. The sprayfield did not treat for perchlorate. The suspected sources for groundwater contaminants are shown on Figure 2-3.

2.5.6 *Types of Contamination and Affected Media:* Operations at the Aerojet Site have resulted in the discharge of COC 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. Perchlorate was combined with a cation (generally ammonium or potassium) and utilized as an oxidizer in solid rocket propellants. 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. Other chemicals of concern include breakdown products and contaminants of TCE, Freon, chloroform, nitrate and nitrite as indicated on the Table 2.1.





Approximate Area of Schematic
(Scale: 1" = 6,000')

EXPLANATION

Dissolved phase contaminants. Shown for illustration purposes only, does not depict contaminant type, concentration, depth, or exact location.

Conceptual Water Table

FIGURE 2-3

Sources of Contamination to OU3 Groundwater

Table 2.1
Types and Characteristics of Contaminants of Concern (COCs)

Contaminant/Abbreviation/Category	Source	Mobility	Carcinogenic
Trichloroethlene TCE/ VOC	Solvent	High	yes*
Tetrachloroethene/PCE/ VOC	Solvent	High	yes*
1,2-Dichloroethene/1,2-DCE/ VOC	Solvent/VOC degra-dation product	Very High	no+
1,1-Dichloroethene/1,1-DCE/ VOC	VOC degra-dation product	High	yes*
Vinyl Chloride/VC/ VOC	VOC degradation product	Very High	yes
1,1,2-Trichloroethane/1,1-2-TCA/ VOC	Solvent	Very High	yes*
1,2,-Dichloroethane/1,2-DCA/VOC	Solvent/VOC degra-dation product	Very High	yes*
1,1-Dichloroethane/1,1-DCA/VOC	Solvent	Very High	yes Calif.+
1,1,2-Trichloro-1,2,2-trifluoroethane /Freon 113/VOC	Refrigerant	High	no+
Chloroform/CHCl3/VOC	Solvent	Very High	yes
Carbon Tetrachloride/CCl4/VOC	Solvent	Moderate	yes*
Perchlorate/ClO4/Inorganic Anion	Oxidizer solid rocket fuel	Very High	yes @ high dose+
N-Nitrosodimethylamine/NDMA/ Semi-Volatile Organic	Impurity/combustion of liquid rocket fuel	Moderate	yes
Nitrate/NO3/Inorganic	Degradation product rocket fuel	Very High	no+
Nitrite/NO/Inorganic	Degradation product rocket fuel	Very High	no+

Key: * = also has non-cancer risks; + = has non-cancer risks; Calif. = considered carcinogen by State of California

The affected media in OU-3 is groundwater. The aquifer has six layers A through F. Layers C, D and E have been contaminated, with Layer C having approximately sixty percent of the contamination, Layer D thirty-one percent and Layer E nine percent. Layers A and B, which appear to be present primarily in the eastern portions of OU-3, are distinct in only limited areas of the western off-property area. Layer F has not been contaminated. OU-3 is located near the eastern edge of the Sacramento Valley close to

the point of contact between the Sierra Nevada metamorphic basement rocks and the valley sediments. This area is characterized by shallow-dipping (generally less than 1 degree) Cretaceous-, Tertiary-, and Quaternary-age marine and fluvial sediments overlying steeply dipping Jurassic crystalline basement rocks. The erosional surface of the basement rock dips to the west beneath OU-3 at approximately 4 degrees.

Groundwater flow directions and gradients have been studied for many years on the Aerojet Site and on the IRCTS. During the past several years, monitor wells installed in the western off-property areas have provided additional data to interpret groundwater flow in the off-property areas. Potentiometric contour maps dating from April 1991 through March 1998 were reviewed to assess temporal and seasonal trends in the groundwater flow directions. Groundwater flow in each layer is generally to the west-southwest. The potentiometric surface maps for Layer C do not show many changes in the groundwater flow directions and gradients from 1991 through 1998. Groundwater elevations in Layer C decrease from approximately 75 to -10 ft. mean sea level (msl) from east to west across the OU-3 area. The groundwater flow direction is generally west-southwest with deviations in the groundwater flow direction evident in the vicinity of the GETs E and F extraction, which are screened primarily within Layer C and to a lesser extent in Layer D. The average hydraulic gradient across OU-3 area is approximately 0.004 foot per foot (20 ft. per mile). In general, the horizontal gradient is steepest in the east and flattens to the west. The average hydraulic conductivity in the GET E area ranges from 63.5 to 145.6 ft/day, with a transmissivity of 49,000 to 156,000 gallons per day/ft. The hydraulic conductivity and transmissivity in the GET F are slightly lower because the sediments are finer.

Data collected from numerous aquifer tests in the vicinity of GETs E and F were used to confirm and refine the hydrogeologic model on the Aerojet Site. Very few aquifer tests have been conducted in the western off-property areas, and correlation between the on- and off-property hydrostratigraphic layers were based primarily on relative depths, stratigraphy, water levels, and chemical concentrations. Hydrostratigraphic Layers A and B, which appear to be present primarily in the eastern portions of OU-3, are distinct in only limited areas of the western off-property area. Layers C, D and E appear to be regional features and are more easily correlated between the on- and off-property areas. The cross-section of OU-3 has interbedded sands and clay/silt that result in some discontinuous water bearing layers. With 60% of the contamination, Layer C is the first hydrostratigraphic layer that is continuous across OU-3. Layer C is composed predominantly of sand, sandstone, and minor gravel with varying degrees of cementation. Thin (1 to 10 ft.) interbeds of brown siltstone and clay are common. The depth to Layer C ranges from approximately 80 ft. in eastern part of OU-3, to approximately 180 ft. in the west. Layer C ranges in thickness from 50 to 125 ft., with an average thickness of approximately 80 ft. and a southwesterly dip of approximately 1 degree. It is saturated and continuous throughout the OU-3 area. It is separated from Layer B by an aquitard that ranges from tens of feet to over 100 ft. in thickness and from Layer D by a 10 to 45

foot thick clay and siltstone layer.

2.5.7 *Location of Contamination and Potential Routes of Migration:* Monitor wells in OU-3 were screened in the most permeable portions of the aquifer on the premise that the permeable units would act as preferential groundwater and contaminant pathways. These wells have provided the data necessary to construct a reasonably accurate assessment of the lateral and vertical extent of COC.

Over 40 public and domestic water supply wells (PWSWs) are located within the OU-3 west of Aerojet and IRCTS (see Figure 2-4). Aerojet collects water quality samples from 36 public water supply wells and nine private wells pursuant to the provisions in Exhibit IV of the PCD. Water quality data collected from the PWSWs were posted on the chemical isoconcentration maps for informational purposes and were not used for contouring because these wells are screened over several water-bearing layers.

The distribution of COC in the OU-3 area are strongly influenced by the locations of the source areas, the direction of groundwater flow, and the operations of GETs E and F. Figure 2-4 presents a conceptual model depicting the migration of COC from the Aerojet Site to the western off-property groundwater in Layers C, D and E. Dissolved COC have generally migrated from source areas located east of OU-3 area toward GETs E and F and have also been reinjected through incomplete treatment at GETs E and F. Perchlorate and NDMA are now treated at the combined GET E/F thereby eliminating the GET facility as a source for the contamination. Perchlorate is the predominant contaminant in OU-3 and has been detected in Layer C up to 9,000 ft. west of the western Aerojet perimeter.

Because the extent of contamination is greatest in Layer C (sixty percent), this layer has been selected as a representative layer for the extent of contamination. VOCs were analyzed in groundwater samples collected from over 150 monitor wells screened in Layer C from January 1996 through December 1998. Four VOCs (TCE, 1,1-DCE, 1,2-DCA and chloroform) were most recently detected above USEPA and CADHS primary Maximum Contaminant Levels (MCLs) and two VOCs (1,2-DCE and carbon tetrachloride) exceeded the CADHS primary MCL.

2.5.8.1 *Layer C - Distribution of TCE:* Previous investigations reported TCE concentrations up to 5,000 ug/L in the eastern portion of OU-3 area near source areas (i.e., Lines 03, 05, and Chemical Plant 1) located on the Aerojet Site (Aerojet/Hydro-Search, 1996). Most of the wells located in the source areas were not sampled within the sampling period. TCE was detected up to 1,000 ug/L in the vicinity of the GET E extraction wells. TCE concentrations in the vicinity of the GET F extraction wells are higher, generally ranging from 1,000 to 6,000 ug/L.

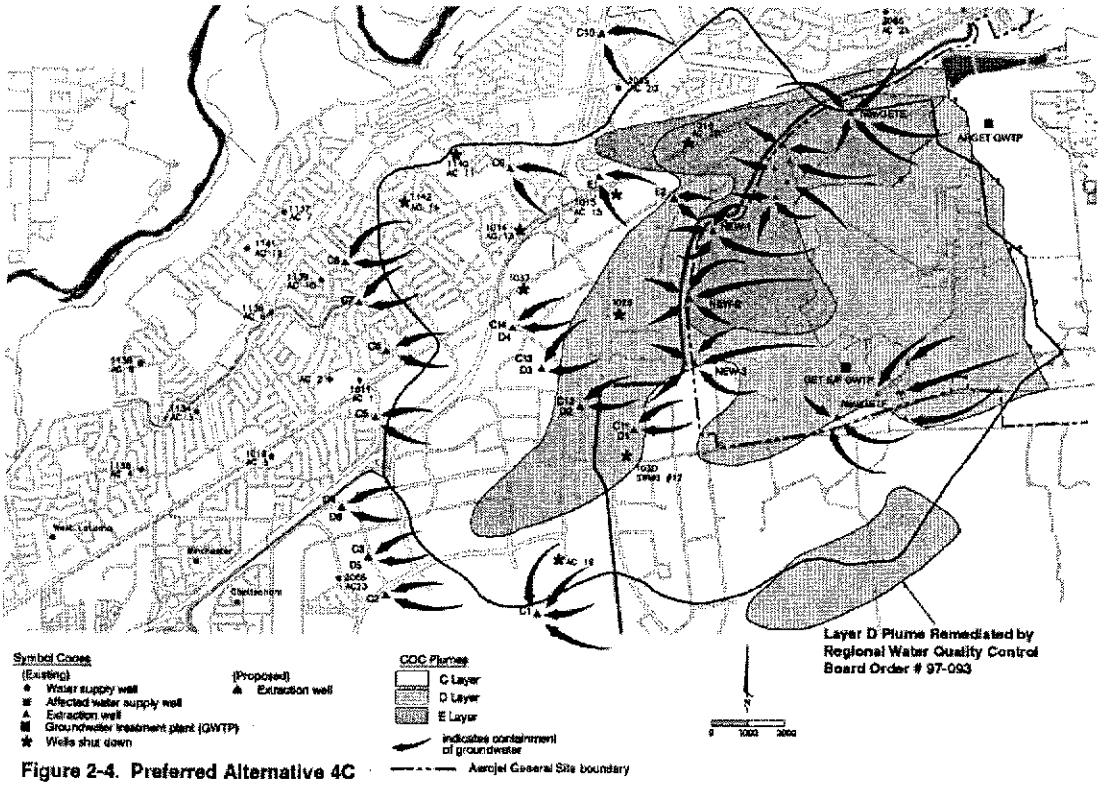


Figure 2-4. Preferred Alternative 4C

TCE concentrations off-property and down-gradient of GETs E and F are substantially lower than those observed on the Aerojet Site. TCE is present off-property to the north of GET E and extends southwest to Zinfandel Drive. In this area, TCE was detected in four public water supply wells at concentrations ranging from 1.2 to 97 ug/L.

TCE was detected above the MCL in 11 monitor wells at eight locations down-gradient of the extraction wells near the western Aerojet boundary and south of the northwestern edge of the IRCTS. The majority of TCE in this area is generally confined to the Aerojet Site and IRCTS, although some TCE may have migrated just beyond the western IRCTS boundary. Potential sources of TCE for this area are outside OU-3 and include the joint propellant burn area and upgradient sources located on Aerojet.

TCE was detected at relatively low concentrations (up to 13 ug/L) southwest of GET E/F recharge wells. The TCE in this area appears to be limited in aerial and vertical extent.

In addition to TCE, four VOCs were detected above their respective MCLs in monitor wells located on the Aerojet Site. Chloroform and 1,2-DCA were detected down-gradient of Line 05/Chemical Plant 1 as far southwest as Chemical Plant 2. Both compounds were used in these areas and their detections are consistent with the identification of source sites in these areas up-gradient of OU-3. 1,2-DCE and 1,1-DCE, both potential breakdown products of TCE, were also detected down-gradient of Chemical Plant 1/Line 05 as far southwest as Chemical Plant 2. These compounds are probably the result of the biological breakdown of TCE in groundwater in this area.

2.5.8.2 *Layer C - Distribution of Perchlorate:* Perchlorate analyses were conducted on groundwater samples collected from over 150 monitor wells screened in Layer C from January 1996 through April 1999. The perchlorate detected in Layer C has the most widespread distribution of any chemical detected in any of the hydrostratigraphic layers. The mass of perchlorate in Layer C is estimated to be $1.5x10^8$ pounds.

On the eastern side of OU-3 area, perchlorate in Layer C has "stair-stepped" down from east to west through overlying Layers A and B. Perchlorate concentrations range up to 1,500 and 8,200 ug/L in the vicinity of GETs E and F, respectively. Groundwater with perchlorate was extracted from GET E and F (three extraction wells in Layer C and five in Layers C and D). Prior to 1999, the extracted groundwater was treated for VOCs only, then recharged still containing perchlorate through the seven GET E and F recharge wells into Layer C and to some extent Layer D, forming the majority of the plume observed west of the Aerojet Site. The irregular shape of the perchlorate plume in the northwestern portion of OU-3 area suggests some influence from regional groundwater pumping. The maximum lateral extent of the perchlorate down-gradient of the recharge well field extends west to approximately Zinfandel Drive.

In the area north of Folsom Boulevard, perchlorate data from the public water supply wells were evaluated to supplement the perchlorate data from monitor wells. In addition, four nested monitor wells were installed in December 1998/January 1999 to assess potential migration pathways for perchlorate and NDMA in this area. Perchlorate is present in Layers C and D in the vicinity of public water supply wells 1015/AC15 (Note: the first well number is Aerojet's well number designation followed by the Arden Cordova Water Company well number designation) and 1016/AC16. Perchlorate is present in Layer C in the vicinity of public water supply wells 1013/AC9 and 1014/AC13.

On the IRCTS, perchlorate was detected up to 2,400 ug/L in the upper portion of Layer C, within and generally down-gradient of the GET F Sprayfield and the propellant burn area. The lateral extent of perchlorate in this area is relatively well defined by off-property monitoring wells 30089-90, where only low concentrations of perchlorate were detected up to 13 ug/L. The western extent of the southern perchlorate plume in Layer C on IRCTS has not been delineated for OU-3, and is being investigated under a separate State action.

2.5.8.3 *Layer C - Distribution of NDMA:* NDMA was detected on the Aerojet Site near Line 05/Chemical Plant 1, along the northern and northwestern Aerojet Site boundaries, and in one extraction well (4140) located at GET F. NDMA was also detected off-property down-gradient of the GET E extraction and in recharge wells and in two public water supply wells.

The presence of NDMA in Layer C in the area of West Area Lake suggests NDMA has migrated downward from overlying Layers A and B where NDMA was also detected. Some of the NDMA in these layers has migrated to the GET E extraction wells and was recharged through the recharge well field. Portions of the NDMA plume north of GET E was not captured by the extraction wells resulting in the NDMA plume west of GET E.

Characterization of NDMA in the off-property areas is complicated by the very low health-based concentrations (i.e, part per trillion) and the absence of a well-defined source. The majority of NDMA in the off-property wells was detected in Layer C. Detections of NDMA at 0.034 ug/L in Well 30087 and 0.015 ug/L in public water supply well 1140/AC11 shows that NDMA has migrated westward. NDMA was also reported in two of 20 analyses on Well 1142/AC14. Nested monitor Wells 30128-30 and 30131-3 were drilled between Wells 1140/AC11 and 1142/AC14 to evaluate the layer(s) through which NDMA was migrating. NDMA was not detected in any of the six well completions (three in Layer C, one in Layer D and two in Layer E) at this location. The absence of NDMA in these wells and upgradient Well 30122-3, combined with the presence of NDMA in Wells 30137-8, 1204, 1467, suggests the NDMA is present in relatively thin lenses, within Layer C.

2.5.8.4 *Layer D - COC Summary:* Layer D contamination is approximately 4.6 square miles in area and represents approximately 31 percent of the total contamination. The main contaminant is perchlorate, extending in a narrow plume to halfway between Sunrise Boulevard and Zinfandel Avenue, with a maximum concentration off-property detected at 600 ppb. In layer D, both TCE and NDMA extend off-property slightly to the northeast with maximum detected concentrations of 15 ppb and 0.43 ppb respectively.

2.5.8.5 *Layer E - COC Summary:* Layer E contamination is approximately one square mile in area and contains approximately 9 percent of the total contamination. In layer E, only a small portion of perchlorate, TCE, and NDMA contamination extends off-property. NDMA extends the furthest in a narrow plume which does not reach Sunrise Boulevard. The maximum detected off-property concentrations are: perchlorate at 400 ppb, TCE at 220 ppb, and NDMA at 0.08 ppb.

The maximum concentrations of COCs (within the 1996-1998 time frame) in each layer of the aquifer on- and off-property are summarized in Table 2.3.

All OU-3 contaminants are present in the dissolved phase and will continue to migrate with groundwater to the west and southwest through the process of advection. Dispersion, retardation and biological degradation will affect contaminants to some degree. The estimated groundwater velocities range from 45 to 851 ft. per year. Since the groundwater velocities are relatively high, groundwater advection is the dominant process that will affect the migration of perchlorate. Perchlorate has been detected at Zinfandel Drive. Trichloroethylene's flow rate is more retarded than perchlorate but it has also reached Zinfandel Drive, but to a more limited extent than perchlorate. NDMA has not been detected as far off-property as TCE or perchlorate. NDMA extends south of Sunrise Boulevard in the area of Highway 50.

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 provision for future development under the Sacramento County Land Use Master Plan which would allow for residential use. The on-property part of OU-3 (buffer-zone land 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 Rancho Cordova area is fully developed with residential and industrial properties. It is anticipated that the current land uses will continue into the future.

The aquifer, of which OU-3 is a very small part, is extremely large and extends beyond the city of Sacramento, over 15 miles away to the west. The ten square miles of aquifer in OU-3 off Aerojet property is currently used for drinking water (Federal Groundwater Classification IIA) and demand on the aquifer is growing. The on-property portion of OU-3, approximately 4 square miles, is mostly undeveloped at present. The on-property portion of

OU-3 obtains its water from the City of Folsom, an up-gradient source that is not contaminated and presently has a reserve for growth. The need for drinking water for the on-property portion of OU-3 is expected to increase over the next 20 years as it is developed. The Sacramento area is experiencing significant growth. The contamination if not contained will continue to flow to the west contaminating more of the drinking water aquifer. Thirteen PWSW are projected to be lost in the next 25 years.

2.7 Summary of Site Risks: The aquifer, of which OU-3 is a small part, is used as a drinking water source. Present contamination exceeds both USEPA's acceptable cancer risk range and the non-cancer hazard index of one. Table 2.2 summarizes the on-property and off-property risk associated with use of groundwater in five of the six hydrostratigraphic layers. Sampling results indicate Layer F has not been impacted by COC and Layers A and B are distinct in only limited areas off-property. There are no potentially significant completed exposure pathway for ecological receptors. This ROD response action is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment; and pollutants or contaminants from this site which may present an imminent and substantial endangerment to public health or welfare.

2.7.1 *Summary of Human Health Risk Assessment:* The Risk Assessment assesses the human health risks from hypothetical exposure to groundwater by future residential (both adult and child) 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 this site. Exposure pathways include ingestion, dermal contact while showering and inhalation of volatiles. 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 an NPDES Permit.

Table 2.2 - Summaries On- and Off-Property Risk by Groundwater Layer OU-3

Hydrostratigraphic Unit	Maximum On-Property Risk[1]		Maximum Off-Property Risk[1]	
	Cancer	Non-Cancer Hazard Index[2]	Cancer	Non-Cancer Hazard Index[2]
A	$9.4x10^{-3}$	610	NA	NA
B	$9.4x10^{-3}$	1800	NA	NA
C	$1.1x10^{-2}$	2200	$4.1x10^{-4}$	670
D	$5.1x10^{-3}$	1600	$4.3x10^{-4}$	44
E	$1.3x10^{-3}$	46	$2.5x10^{-4}$	36

Key:

NA Not applicable as layers A and B are distinct in only limited areas off-property.

1 Figures represent the maximum risk if water containing the maximum levels of each contaminant present in a layer was used.

2 Expressed as a multiple of the Non-Cancer Hazard Index of 1.00.

2.7.1.1 *Identification of Chemical of Concern:* The maximum level of contaminants of concern in each hydrostratigraphic layer on-property and off-property was used to calculate the maximum potential risk. Table 2.3 provides the list of COC by aquifer layer and the maximum level of groundwater contamination. Figure 2-4 also shows the maximum extent of contamination in each layers and is supported by the RI/FS, Appendix B, Tables B2.1 through B2.10.

Table 2.3
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Current
Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection %	Exposure Point (Pt.) Concentration	Exposure Pt. Concentration Units
		Minimum	Maximum				
On-Property Layer A	1,1,2-TCA	1.3	1.3	ug/L	13	1.3	ug/L
"	1,2- DCA	1.5	950	"	29	950	"
"	1,2-DCE	2	10	"	23	10	"
"	CHC13	2.8	230	"	26	230	"
"	PCE	0.82	0.82	"	3	0.82	"
"	TCE	3	82	"	33	82	"
"	Perchlorate	4.1	75	"	42	75	"
"	NDMA	0.019	0.16	"	24	0.16	"
"	Nitrate	0.26	219	mg/l	100	219	mg/l
"	Nitrite	0.07	22	"	38	22	"
On-Property Layer B	1,1,2-TCA	1.5	1.5	ug/l	0.5	1.5	ug/l
"	1,1- DCA	1.8	1.8	"	0.5	1.8	"
"	1,1-DCE	13	48	"	2	48	"
"	1,2-DCE	1.9	120	"	4.5	120	"
"	CC14	1.4	1.4	"	0.5	1.4	"
"	CHC13	0.78	350	"	21	350	"
"	Freon 113	1.1	1.1	"	0.5	1.1	"
"	PCE	1.2	2.1	"	1	2.1	"
"	TCE	0.51	9400	"	35	9400	"

Table 2.3
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Current
Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection %	Exposure Point (Pt.) Concentration	Exposure Pt. Concentration Units
		Minimum	Maximum				
"	Perchlorate	4.1	11000	"	67	11000	"
"	NDMA	0.041	0.32	"	33	0.32	"
"	Nitrate	0.57	11	mg/l	100	11	mg/l
"	Nitrite	0.56	0.56	"	25	0.56	"
On-Property Layer C	1,1- DCA	0.67	1.3	ug/l	2	1.3	ug/l
"	1,1-DCE	0.56	63	"	7	63	"
"	1,2-DCA	0.94	160	"	3	160	"
"	1,2-DCE	0.71	41	"	12	41	"
"	CC14	0.66	0.66	"	0.2	0.66	"
"	CHC13	0.53	670	"	22	670	"
"	Freon 113	0.34	5.4	"	4	5.4	"
"	PCE	0.51	5.9	"	4	5.9	"
"	TCE	0.52	5300	"	50	5300	"
"	Perchlorate	5.5	8200	"	46	8200	"
"	NDMA	0.024	0.39	"	28	0.39	"
"	Nitrate	0.16	7.8	mg/l	100	7.8	mg/l
"	Nitrite	0.08	0.08	"	7	0.08	"
On-Property Layer D	1,1- DCA	1.1	1.7	ug/l	1	1.7	ug/l
"	1,1-DCE	0.6	14	"	4	14	"
"	1,2-DCA	1.2	4.7	"	4	4.7	"
"	1,2-DCE	1.2	25	"	9	25	"
"	CHC13	0.57	460	"	17	460	"
"	Freon 113	0.32	5.4	"	5	5.4	"
"	PCE	0.6	5	"	5	5	"
"	TCE	1.1	1500	"	27	1500	"

Table 2.3
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Current
Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection %	Exposure Point (Pt.) Concentration	Exposure Pt. Concentration Units
		Minimum	Maximum				
"	Perchlorate	4.7	8700	"	44	8700	"
"	NDMA	0.028	1.3	"	57	1.3	"
"	Nitrate	0.068	6.7	mg/l	67	6.7	mg/l
On-Property Layer E	Chloroform	1.6	1.6	ug/l	0.5	1.6	ug/l
"	Freon 113	1.1	1.3	"	1	1.3	"
"	TCE	0.92	84	"	17	84	"
"	Perchlorate	4.8	610	"	21	610	"
"	NDMA	0.0098	0.38	"	57	0.38	"
"	Nitrate	0.31	6.6	mg/l	10	6.6	mg/l
Off-Property Layer A	1,1-DCE	2.6	9	ug/l	22	9	ug/l
"	1,2-DCE	50	210	"	22	210	"
"	PCE	0.65	4.4	"	25	4.4	"
"	TCE	3	630	"	47	630	"
"	VC	8.4	130	"	22	130	"
"	Perchlorate	6	20	"	14	20	"
"	Nitrate	1.3	6.9	mg/l	100	6.9	mg/l
"	Nitrite	0.23	1.1	"	100	1.1	"
Off-Property Layer B	1,2-DCE	0.59	0.59	"	1	0.59	"
"	PCE	0.51	1	"	5	1	"
"	TCE	0.53	1.2	"	32	1.2	"
"	Perchlorate	4	15	"	5	15	"
"	Nitrate	1.1	28	mg/l	100	28	mg/l
"	Nitrite	1.8	2.4	"	33	2.4	"
Off-Property Layer C	1,1-DCE	1.1	3.9	ug/l	3	3.9	ug/l

Table 2.3
Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

Scenario Timeframe: Current
Medium: Groundwater

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection %	Exposure Point (Pt.) Concentration	Exposure Pt. Concentration Units
		Minimum	Maximum				
"	CHC13	0.66	28	"	7	28	"
"	TCE	0.6	88	"	25	88	"
"	Perchlorate	4	8700	"	51	8700	"
"	NDMA	0.061	0.25	"	25	0.25	"
"	Nitrate	0.89	12	mg/l	100	12	mg/l
"	Nitrite	0	2.6	"	26	2.6	"
Off-Property Layer D	TCE	1	15	"	18	15	"
"	1,2-DCE	23	23	"	1	23	"
"	VC	1.8	1.8	"	1	1.8	"
"	Perchlorate	4.1	600	"	22	600	"
"	NDMA	0.021	0.43	"	20	0.43	"
"	Nitrate	1.3	9.4	mg/l	71	9.4	mg/l
"	Nitrite	0.06	0.12	"	21	0.12	"
Off-Property Layer E	1,1-DCE	2.3	2.3	ug/l	2	2.3	ug/l
"	1,2-DCE	1	7.8	"	6	7.8	"
"	TCE	0.92	220	"	36	220	"
"	Perchlorate	390	400	"	15	400	"
"	NDMA	0.015	0.08	"	15	0.08	"
"	Nitrate	1	7.1	mg/l	29	7.1	mg/l

Key: ug/l = ppb, mg/l=ppm

This table presents the chemicals of concern (COC) and exposure point concentrations for each of the COCs detected in groundwater. The table includes the range of concentration detected for each COC, as well as the frequency of detection in percent. The table shows there are 15 COC of which perchlorate, NDMA and TCE are the predominant COC.

2.7.1.2 *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. Average health-based concentrations were not calculated due to the complexity of the effort and the fact that the calculated risk exceeds the Superfund acceptable range.

For these calculations, it was assumed that child and adult residents may be exposed to on-property and off-property groundwater from ingestion, dermal contact while showering, and inhalation of volatile chemicals during non-ingestion groundwater use (i.e., showering, washing, bathing, cooking). The intake for the child resident scenario was based on exposure as a child for six years. The intake for the adult resident scenario was based on exposure as a child for six years and as an adult for 24 years for a total duration of 30 years. The exposure frequency was assumed to be 350 days/year. Body weights of 15 kg and 70 kg were used for the child and adult, respectively. Specific standard exposure assumptions used for each exposure route are provided below.

- Ingestion Drinking water ingestion rates recommended by USEPA (USEPA, 1991) were used (Ingestion rates of 1 liter/day for a child and 2 liter/day for an adult resident).

- Dermal Contact While Showering A total body surface area of 20,000 cm^2 was used for adult residents (USEPA, 1992). For the child resident, a total body surface area of 6,600 cm^2 was used (USEPA, 1992). An exposure time of 0.2 hours/day was used, assuming 0.2 hours per event and 1 event per day (USEPA, 1989). The dermal permeability coefficients for the organic COC in groundwater were obtained from USEPA's Dermal Exposure Assessment, Interim Guidance (USEPA, 1992).

- Inhalation of Volatiles During Non-ingestion Groundwater Use In accordance with USEPA guidance, a model presented in the Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals (USEPA, 1991) was used to calculate inhalation intakes through non-ingestion water use. It should be noted that the model is meant to be applied to household non-ingestion use in general and not specifically to showering.

In accordance with USEPA guidance, indoor inhalation rates of five m^3/day and 15 m^3/day were used for the child and adult resident scenarios, respectively. These inhalation rates are daily indoor inhalation rates which take into account non-ingestion household water uses (showering, cooking, washing, etc.).

On-property there are no significant current or future potentially completed exposure pathways within OU-3. There are no known source sites in OU-3. The City of Folsom supplies up-gradient potable and non-potable water to Aerojet. The potential pathway is also remote for future hypothetical workers and owners for the portions of the main Aerojet facility that may be sold for development because institutional controls will limit access to contaminated groundwater through land use covenants and Aerojet will retain the water rights for groundwater. Construction workers excavating on-property are not anticipated to contact contaminated groundwater because the shallowest groundwater in the OU-3 area is at depth of 50 ft. bgs, well below the normal expected construction zone of 10 ft. bgs. Soil gas sampling in OU-3 did not detect vapor diffusion risk for indoor air. The potential pathway for industrial workers at GETs E/F is not complete because the treatment plant operates as a "closed system" and there is very limited potential for workers to contact the water.

There are several potentially complete exposure pathways off-property for untreated or incompletely treated contaminated groundwater. Groundwater beneath the OU-3 area is used as a source of potable and non-potable water and the pathway for human and/or ecological receptors is potentially complete if there is no treatment of the contaminated groundwater or monitoring to remove the contaminated drinking water wells from service. Aerojet, the water purveyors, and the CADHS monitor public and private water supply wells to ensure that concentrations of chemicals do not exceed acceptable health-based levels. There are no known large-scale agricultural or other uses of groundwater that could result in a potentially significant completed exposure pathway for ecological receptors. No impacts to indoor air or construction workers are likely since contaminated groundwater is even deeper off-property than on-property. There are no known seeps or artesian groundwater sources of contaminated groundwater for ecological receptors at nearby surface waters.

The treated groundwater may either be discharged directly to a drinking water system or to surface water. Any use of the treated water as drinking water shall comply with Federal Drinking water standards as well as CADHS requirements. If the treated water is discharged to surface water on-site, this discharge shall comply with the substantive requirements of an NPDES Permit (See Table 2.15); or if the discharge is off-site, it will require an NPDES Permit. Thus, under either option, there will be no potential exposure pathways.

2.7.1.3 *Toxicity Assessment:* The toxicity assessment of the COC is contained in the following Tables 2.4A through F and supported by the RI/FS Appendix B, Tables B.5.1 through 18. Due to the volume of data, the Risk Characterization Summary Tables 2.4.C through F for cancer and non-cancer are presented only for the worst layer in the aquifer, Layer C. The USEPA toxicity values, known as non-

carcinogenic reference doses and carcinogenic slope factors, are obtained from USEPA's Integrated Risk Information System (IRIS), Nation Center for Environmental Assessment (NCEA) through August 1999, and Health Effects Assessment Summary Tables (HEAST). If data are available from more than one of these sources the preference is to use IRIS first, followed by NCEA followed by HEAST.

In the case of 1,1-Dichloroethane (1,1-DCA), California EPA has developed a carcinogenic slope factor and 1,1-DCA was evaluated both as non-carcinogen (using USEPA toxicity values) and as a carcinogen (using California EPA toxicity values). The RI concluded that metals in OU-3 groundwater are naturally occurring. The maximum detected concentration of each COC from the past 2 years of groundwater monitoring was used to assess risks for on- and off-property receptors. When calculating risks for current off-site receptors, the COC list from the water supply well with the highest number of COCs was used when detected concentrations were below MCLs. The exposure point health-based concentration was conservatively assumed to be equivalent to the MCL.

Table 2.4A - Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal

Chemicals of Concern	Oral Cancer Slope Factor	Dermal Cancer Slope Factor	Slope Factor Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
Perchlorate	-	-		B_2	NCEA	12/02/92
NDMA	5.1E+01	5.1E+01	day/(mg/kg)	B_2	IRIS	01/31/87
TCE	1.1E-02	1.1E-02	"	B-C	NCEA	06/87
PCE	5.2E-02	5.2E-02	"	B-C	NCEA	06/87
1,2,-DCA	9.1E-02	9.1E-02	"	B_2	IRIS	03/31/87
1,1,2-TCA	5.7E-02	5.7E-02	"	C	IRIS	03/31/87
1,1-DCA	-	-		C	IRIS	10/01/90
1,1-DCE	6.0E-01	6.0E-01	"	C	IRIS	03/31/87
Chloroform	6.1E-03	6.1E-03	"	B_2	IRIS	06/30/88
Vinyl Chloride (child/adult)	1.5E+00	1.5E+00	"	A	IRIS	08/07/00
Carbon Tetrachloride	1.3E-01	1.3E-01	"	B_2	IRIS	01/01/91

Table 2.4A - Sample Cancer Toxicity Data Summary

Chemical of Concern	Unit Risk	Units	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date
Pathway: Inhalation							
Perchlorate	-		-		-	-	-
NDMA	1.4E-02	ug/m3	4.9E+01	day/(mg/kg)	B_2	IRIS	01/31/87
TCE	1.7E-06	"	6.0E-03	"	B-C	NCEA	06/87
PCE	5.7E-07	"	2.0E-03	"	B-C	NCEA	06/87
1,2,-DCA	2.6E-05	"	9.1E-02	"	B_2	IRIS	03/31/87
1,1,2-TCA	1.6E-05	"	5.6E-02	"	B_2	IRIS	02/01/94
1,1-DCA	-		-		C	IRIS	10/01/90
1,1-DCE	5.1E-05	"	1.8E-01	"	C	IRIS	03/31/87
Chloroform	2.3E-05	"	8.1E-02	"	B_2	IRIS	06/30/88
Vinyl Chloride (combined child/adult)	8.8E-06	"	3.1E-02	"	A	IRIS	08/07/00
Carbon Tetrachloride	1.5E-05	"	5.3E-02	"	B_2	IRIS	11/31/87

Key:
- = No information available
IRIS: Integrated Risk Information System, USEPA
NCEA = National Center for Environmental Assessment, USEPA
R9 PRG Table = Region 9 Preliminary Remediation Goals Table (www.epa.gov/region09/waste/sfund/prg/)

USEPA Group:
A - Human carcinogen
B1 - Probable human carcinogen-Indicates that limited human data are available
B2 - Probable human carcinogen - Indicates sufficient evidence in animals & inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of non-carcinogenicity

Summary of Toxicity Assessment

This table provides carcinogenic risk information which is relevant to the contaminants of concern in groundwater. At this time, slope factors are not available for the dermal route of exposure. Thus, the dermal slope factors used in the assessment have been extrapolated from oral values. An adjustment factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50% absorption via the ingestion route. However, adjustment is not necessary for the chemicals evaluated at this site. Therefore, the same values presented above were used as the dermal carcinogenic slope factors for these contaminants.

Table 2.4B - Non-Cancer Toxicity Data Summary									
Pathway: Ingestion, Dermal									
COC	Chronic/ Sub-chronic	Oral RfD Values	Oral Value Units	Dermal RfD	Dermal RfD units	Primary Target Organ	Combined Uncertain-ty/Modify-ing Factors	Sources of RfD Target Organ	Date of RfD Target Organ
Perchlorate	Chronic	1.0E-04	(mg/kg)/ day	-	(mg/kg) /day	Thyroid	1000	NCEA	12/02/92
1,1-DCA	Chronic	1.0E-01 (a)	"	1.0E-01	"	Kidney	1000	HEAST	07/97
CIS-1,2-DCE	Chronic	1.0E-02	"	1.0E-02	"	Blood	3000	HEAST	07/97
Freon 113	Chronic	3.0E+01	"	3.0E+01	"	Neuro-logical	10	IRIS	06/87
TCE	Chronic	6.0E-03	"	6.0E-03	"	Liver	1000	NCEA	06/85
PCE	Chronic	1.0E-02	"	1.0E-02	"	Liver	1000	IRIS	03/01/88
1,2,-DCA	Chronic	3.0E-02	"	3.0E-02	"	Liver	1000	NCEA	NA
1,1,2-TCA	Chronic	4.0E-03	"	4.0E-03	"	Liver	1000	IRIS	09/26/88
1,1-DCE	Chronic	0.9E-02	"	1.0E-01	"	Liver	1000	IRIS	01/31/87
Chloroform	Chronic	1.0E-02	"	1.0E-02	"	Liver	1000	IRIS	01/31/87
Carbon Tetra-chloride	Chronic	7.0E-04	"	7.0E-04	"	Liver	1000	IRIS	01/31/87
Vinyl Chloride (child/adult)	Chronic	3.0E-03	"	3.0E-03	"	Liver	30	IRIS	08/07/00
NDMA	-	-		-		-	-	-	-
Nitrate	Chronic	1.6E+00	"	-	"	Blood	1	IRIS	05/01/91
Nitrite	Chronic	1.0E-01	"	-	"	Blood	10	IRIS	01/31/87

Table 2.4B - Non-Cancer Toxicity Data Summary

Pathway: Inhalation

COC	Chronic/ Sub-chronic	Inhalation RfC	Inhalation RfC Units	Inhalation RfD	Inhalation RfD units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources RfC:RfD Target Organ	Dates
1,1-DCA	Chronic	5.0E-01	mg/m^3	1.4E-01	(mg/kg) /day	Kidney	1000	HEAST	07/97
CIS-1,2-DCE	Chronic	3.5E-02	"	1.0E-02	"	OV	OV	R9 PRG Table	11/00
Freon 113	Chronic	3.0E+01	"	8.6E+00	"	Whole Body	100	HEAST	07/97
TCE	Chronic	2.1E-02 (a)	"	6.0E-03	"	OV	OV	R9 PRG Table	11/00
PCE	Chronic	3.9E-01	"	1.1E-01	"	Liver	1000	NCEA	08/87
1,2,-DCA	Chronic	4.9E-03	"	1.4E-03	"	Liver	1000	NCEA	08/87
1,1,2-TCA	Chronic	1.4E-02 (a)	"	4.0E-03 (a)	"	OV	OV	R9 PRG Table	11/00
1,1-DCE	Chronic	3.2E-02	"	9.0E-03	"	OV	OV	R9 PRG Table	11/00
NDMA	-	-		-		-	-	-	-
Nitrate	-	-		-		-	-	-	-
Nitrite	-	-		-		-	-	-	-
Chloroform	Chronic	3.0E-04	"	8.6E-05	"	Liver	10	NCEA	12/01/97
Carbon Tetra-chloride	Chronic	2.5E-03 (a)	"	7.0E-04 (a)	"	OV	OV	R9 PRG Table	11/00
Vinyl Chloride	Chronic	1.0E-01	"	2.9E-02	"	Liver	30	IRIS	08/07/00

Key: - = No information available
(a) = Based on route-to-route extrapolation. Oral toxicity criteria was extrapolated to inhalation route based on information provided in EPA
OV= The oral value is used
IRIS = Integrated Risk Information System, USEPA
HEAST = Health Effect Assessment Summary Table
R9 PRG Table = Region Nine Preliminary Remediation Goals Table (www.epa.gov/region09/waste/sfund/prg/)
NCEA = National Center for Environmental Assessment, USEPA

Summary of Toxicity Assessment
This table provides non-carcinogenic risk information which is relevant to the contaminants of concern in groundwater.

Table 2.4C
Risk Characterization Summary -Non-Carcinogens (Layer C Worst Layer On-Property)

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

Medium	Exposure Medium	Exposure Pt.	COC	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground-water (GW)	GW	Tap water	Perchlorate	Thyroid	5.8E+02	-	9.0E-01	5.8E+02
"	"	"	1,1-DCA	Kidney	4.6E-04	1.6E-03	8.0E-06	2.1E-03
"	"	"	1,2-DCE	Liver	1.6E-01	8.0E-01	3.1E-03	9.6E-01
"	"	"	Freon 113	Whole Body	6.3E-06	1.1E-04	2.1E-07	1.2E-04
"	"	"	Nitrate	Blood	1.7E-01	-	-	1.7E-01
"	"	"	Nitrite	Blood	2.8E-02	-	-	2.8E-02
"	"	"	NDMA	Whole Body	-	-	-	-
"	"	"	TCE	Liver	3.1E+01	1.6E+02	9.7E-01	1.9E+02
"	"	"	PCE	Liver	2.1E-02	9.4E-03	1.9E-03	3.2E-02
"	"	"	1,2,-DCA	Liver	1.9E-01	2.0E+01	1.9E-03	2.0E+01
"	"	"	1,1-DCE	Liver	2.5E-01	1.2E+00	7.7E-03	1.5E+00
"	"	"	CHC13	Liver	2.4E+00	1.4E+03	4.1E-02	1.4E+03
"	"	"	CC14	Liver	3.3E-02	1.7E-01	1.4E-03	2.0E-01

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

Liver Hazard Index =	1.6E+03
Blood Hazard Index =	2.0E-01
Thyroid Hazard Index =	5.8E+02

Risk Characterization

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of HQs) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than one indicates the potential for adverse non-cancer effects. The estimated HI of 2.2E+03 indicates that the potential for adverse non-cancer effects could occur from exposure to contaminated groundwater.

Table 2.4D
Risk Characterization Summary -Non-Carcinogens (Layer C Worst Layer Off-Property)

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

Medium	Exposure Medium	Exposure Pt.	COC	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
GW	GW	Tap water	Perchlorate	Thyroid	6.1E+02	-	9.6E-01	6.1E+02
"	"	"	Nitrate	Blood	2.6E-01	-	-	2.6E-01
"	"	"	Nitrite	Blood	9.1E-01	-	-	9.1E-01
"	"	"	TCE	Liver	5.2E-01	2.6E+00	1.6E-02	3.1E+00
"	"	"	1,2,-DCA	Liver	6.6E-04	7.0E-02	6.8E-06	7.0E-02
"	"	"	1,1-DCE	Liver	1.5E-02	7.6E-02	4.8E-04	9.1E-02
"	"	"	CHC13	Liver	9.8E-02	5.7E+01	1.7E-03	5.7E+01
Key: - = Toxicity criteria not available to quantitatively address this route of exposure.							Liver Hazard Index =	6.0E+01
							Blood Hazard Index =	1.2E+00
							Thyroid Hazard Index =	6.1E+02

Risk Characterization
This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of HQs) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than one indicates the potential for adverse non-cancer effects. The estimated HI of 6.7E+02 indicates that the potential for adverse non-cancer effects could occur from exposure to contaminated groundwater.

Table 2.4E
Risk Characterization Summary - Carcinogens (Layer C Worst Layer On-Property)

Scenario Timeframe: Current (if well installed) Receptor Population: Resident Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Pt.	COC	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
GW	GW	Layer C Tap Water	Perchlorate	-	-	-	-
"	"	"	NDMA	3.0E-04	-	4.7E-07	3.0E-04
"	"	"	TCE	8.8E-04	2.4E-03	2.8E-05	3.3E-03
"	"	"	PCE	4.6E-06	8.9E-07	4.3E-07	5.9E-06
"	"	"	1,2,-DCA	2.2E-04	1.1E-03	2.3E-06	1.3E-03
"	"	"	1,1-DCE	5.7E-04	8.5E-04	1.8E-05	1.4E-03
"	"	"	1,1-DCA	1.1E-07	5.6E-07	1.9E-09	6.7E-07

Table 2.4E
Risk Characterization Summary - Carcinogens (Layer C Worst Layer On-Property)

Scenario Timeframe: Current (if well installed) Receptor Population: Resident Receptor Age: Adult + Child

Medium	Exposure Medium	Exposure Pt.	COC	Carcinogenic Risk			
				Ingestion	Inhalation	Dermal	Exposure Routes Total
"	"	"	CHCl3	6.2E-05	4.1E-03	1.1E-06	4.2E-03
"	"	"	CCl4	1.3E-06	2.6E-06	5.6E-08	4.0E-06
Key: - = Toxicity criteria not available to quantitatively address this route of exposure.						Total Risk =	1.1E-02

Risk Characterization
This table provides the risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure. The estimated Total Risk of 1.1E-02 indicates that the potential for cancer effects exceeds the USEPA risk range from exposure to contaminated groundwater.

Table 2.4F
Risk Characterization Summary - Carcinogens (Layer C Worst Layer Off-Property)

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	Layer C Tap Water	Perchlorate	-	-	-	-
"	"	"	NDMA	1.9E-04	-	3.0E-07	1.9E-04
"	"	"	TCE	1.5E-05	6.6E-05	4.6E-07	8.6E-05
"	"	"	1,1-DCE	3.5E-05	5.3E-05	1.1E-06	8.9E-05
"	"	"	CHCl3	2.6E-06	4.0E-05	4.5E-08	4.3E-05
Key - = Toxicity criteria not available to quantitatively address this route of exposure.						Total Risk =	4.1E-04

Risk Characterization
This table provides the risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure. The estimated Total Risk of 4.1E-04 indicates that the potential for cancer effects slightly exceeds the USEPA risk range from exposure to contaminated groundwater.

2.7.1.4 *Risk Characterization Assessment:* Generally, the majority of the risk is due to the presence of five or fewer of the fifteen COC. Compound specific risk are summarized in Tables 2.5.A and B.

Table 2.5A - Summary of On-Property Maximum Compound-Specific Risk OU-3

Hydrostratigraphic Unit	Compound	Concentration (ug/L)	Adult Cancer Risk	Non-Cancer Hazard Index
A	1,1,2-TCA	1.3	$6.6x10^{-6}$	0.068
	1,2-DCA	950	$7.8x10^{-3}$	121
	1,2-DCE	10	NA	0.24
	CHC13	230	$1.4x10^{-3}$	470
	PCE	0.82	$8.2x10^{-7}$	0.045
	TCE	82	$5.1x10^{-5}$	2.9
	Perchlorate	75	NA	5.3
	NDMA	0.16	$1.2x10^{-4}$	NA
	Nitrate	219,000	NA	4.8
	Nitrite	22,000	NA	7.7
		Maximum Total Risk*	$9.4x10^{-3}$	610
B	1,1,2-TCA	1.5	$7.6x10^{-6}$	0.08
	1,1-DCA	1.8	$9.2x10^{-7}$	0.00085
	1,1-DCE	48	$1.1x10^{-3}$	1.1
	1,2-DCE	120	NA	2.8
	CC14	1.4	$8.4x10^{-6}$	0.43
	CHC13	350	$2.1x10^{-3}$	716
	Freon-113	1.1	NA	0.000024
	PCE	2.1	$2.1x10^{-6}$	0.011
	TCE	9,400	$5.8x10^{-3}$	332
	Perchlorate	11,000	NA	775
	NDMA	0.32	$2.5x10^{-4}$	NA
	Nitrate	11,000	NA	0.24
	Nitrite	0.56	NA	0.2
		Maximum Total Risk*	$9.4x10^{-3}$	1800
C	1,1-DCA	1.3	$6.7x10^{-7}$	0.0017
	1,1-DCE	63	$1.4x10^{-3}$	1.4
	1,2-DCA	160	$1.3x10^{-3}$	20
	1,2-DCE	41	NA	0.96
	CC14	0.66	$4.0x10^{-6}$	0.20
	CHC13	670	$4.2x10^{-3}$	1402
	Freon-113	5.4	NA	0.00011
	PCE	5.9	$5.9x10^{-6}$	0.032
	TCE	5,300	$3.3x10^{-3}$	192
	Perchlorate	8,200	NA	581
	NDMA	0.39	$3.0x10^{-4}$	NA
		Maximum Total Risk*	$1.1x10^{-2}$	2200
D	1,1-DCA	1.7	$8.8x10^{-7}$	0.003
	1,1-DCE	14	$3.2x10^{-4}$	0.82
	1,2-DCA	4.7	$3.8x10^{-5}$	0.6
	1,2-DCE	25	NA	0.6
	CHC13	460	$2.8x10^{-3}$	942
	Freon-113	5.4	NA	0.0001
	PCE	5	$5.0x10^{-6}$	0.03
	TCE	1,500	$9.4x10^{-4}$	53
	Perchlorate	8,700	NA	610
	NDMA	1.3	$1.0x10^{-3}$	NA
	Nitrate	6,700	NA	0.15
		Maximum Total Risk*	$5.1x10^{-3}$	1600

Table 2.5A - Summary of On-Property Maximum Compound-Specific Risk OU-3

Hydrostratigraphic Unit	Compound	Concentration (ug/L)	Adult Cancer Risk	Non-Cancer Hazard Index
E	CHC13	1.6	$9.9x10^{-6}$	0.034
	Freon-113	1.3	NA	0.00003
	TCE	84	$2.9x10^{-4}$	3.0
	Perchlorate	610	NA	43
	NDMA	0.38	$1.0x10^{-3}$	NA
	Nitrate	6.6	NA	0.15
		Maximum Total Risk*	$1.3x10^{-3}$	46

*Use of Calif. Office of Environmental Health and Hazard Assessment values for TCE and PCE would provide for a higher calculated risk.

Table 2.5B - Summary of Off-Property Maximum Compound-Specific Risk OU-3

Hydrostratigraphic Unit	Compound	Concentration (ug/L)	Adult Cancer Risk	Non-Cancer Hazard Index
C	1,1-DCE	3.9	$8.9x10^{-5}$	0.022
	1,2-DCE	0.56	NA	0.0071
	CHC13	28	$4.3x10^{-5}$	57
	TCE	88	$8.1x10^{-5}$	3.1
	Perchlorate	8,700	NA	611
	NDMA	0.25	$1.9x10^{-4}$	NA
	Nitrate	12,000	NA	0.26
	Nitrite	2,600	NA	0.91
		Maximum Total Risk*	$4.1x10^{-4}$	670
D	1,2-DCE	23	NA	0.53
	TCE	15	$9.4x10^{-6}$	0.53
	Perchlorate	600	NA	42
	NDMA	0.43	$3.3x10^{-4}$	NA
	VC	1.8	$9.3x10^{-5}$	NA
	Nitrate	9,400	NA	0.21
	Nitrite	120	NA	0.042
		Maximum Total Risk*	$4.3x10^{-4}$	44
E	1,1-DCE	2.3	$5.3x10^{-5}$	0.054
	1,2-DCE	7.8	NA	0.18
	TCE	220	$1.4x10^{-4}$	7.7
	Perchlorate	400	NA	28
	NDMA	0.08	$6.1x10^{-5}$	NA
	Nitrate	7,100	NA	0.16
		Maximum Total Risk*	$2.5x10^{-4}$	36

*Use of Calif. Office of Environmental Health and Hazard Assessment value for TCE would provide for a higher calculated risk.

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:

Risk = CDI x SF

Where: Risk = a unitless probability (e.g., $2x10^{-5}$) 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 life time 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}.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life-time) with a 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

The clean-up levels for the COCs for OU-3 are listed in the Table 2.14 and the rationale for these levels are as follows:

- Perchlorate: The cleanup level selected for perchlorate is 4 ppb. USEPA is in the process of establishing a RfD for perchlorate which is expected late 2001. By letter dated June 18, 1999, USEPA Office of Research and Development (ORD) provided Interim Assessment Guidance for Perchlorate which provides and RfD range of 0.0001 to 0.0005 mg/kg-day. Using standard adult parameters this RfD range translates to 4 to 18 ppb perchlorate in drinking water. The OU-3 perchlorate remediation level of 4 ppb was selected based on the following reasons: 1) the

spatial extent of the perchlorate contamination at 4 ppb vs. 40 ppb are almost equivalent (thus, extraction systems are essentially the same), 2) the biological treatment system is not concentration sensitive (the cost of perchlorate treatment to 4 or 40 ppb is essentially the same), and 3) the current toxicological studies indicate the potential for developmental and neonatal impacts from perchlorate which could result in an action level at the lower end of the no observed adverse effects level (use of infant or child parameters vs. adult parameters).

- NDMA: There is no MCL for NDMA. The CADHS has an interim action level 20 ppt which has temporarily been raised from 2 ppt. The PRG for NDMA is 1.3 ppt. NDMA is very carcinogenic and induces tumors at multiple sites in both rodents and non-rodent mammals. 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 COC. 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.).

- Other COC: The cleanup level for the remaining COC, e.g., 11 VOCs, nitrate and nitrite are based on MCLs. However, it is expected that as a result of the treatment for perchlorate (and to some extent NDMA) the cleanup levels achieved for the remaining 11 COCs will be well below MCLs.

A certain 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 over the past 2 years of monitoring, 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.

2.7.2 *Summary of Ecological Risk Assessment:* A review of potential ecological receptors concluded there were no significant completed pathways of significance. Within OU-3 the contamination is deep below ground and contaminants do not rise to the surface or enter surface waters. The irrigation wells in OU-3 are used for watering turf areas such as stadium lawns. Any discharge of remediated groundwater to surface water on-site will meet the substantive requirements of an NPDES Permit (See Table 2.15) or if discharged off-site, it will require an NPDES Permit which will not pose a threat to ecological receptors.

2.8 Remedial Action Objectives: The Remedial Action Objectives (RAOs) for the OU are 1) Protect human health and the environment from exposure to contaminated groundwater; 2) Achieve full containment of the contaminated groundwater to minimize future migration

of contaminants until cleanup is accomplished;
3) Protect public drinking water wells through short-term and long-term contingency plans for alternative water supplies; and
4) Restore both on-property and off-property western groundwater within OU-3 to beneficial uses.

These RAOs were selected based on the following considerations:
1) The groundwater at the western part of the Aerojet Site is used as a public water supply by two water purveyors serving over 40,000 people;
2) Eight public water supply wells have already been shut down due to groundwater contamination from the Aerojet Site;
3) One private well and 13 public water supply wells are projected to be impacted by the groundwater contamination;
4) The need for the remedial action to contain contaminated groundwater at the Aerojet boundary to prevent further migration of contamination off-property due to up-gradient sources to be remediated in the future if unabated;
5) The need for the remedial action to prevent off-property migration of the groundwater contamination to prevent the further loss of drinking water wells outside OU-3 (prevent impact on a third water purveyor);
6) The need to restore the aquifer between the on- and off-property containment systems for drinking water use;
7) The need to quickly and permanently replace any further water supply wells within OU-3 that may be lost to contamination.

2.9 Description of Alternatives: The alternatives for this remedial action are assembled from screened technologies. The RI/FS presented ten alternatives as follows:

1. No action except groundwater monitoring
2A. Off-property alternate water supply with GET E/F extraction and reinjection wells
2B. Off-property alternate water supply with GET E/F extraction wells only
3A. Off-property wellhead treatment at water supply wells with GET E/F extraction and reinjection wells
3B. Off-property wellhead treatment at water supply wells with GET E/F extraction wells only
4A. New off-property extraction wells with GET E/F extraction and reinjection wells
4B. New off-property extraction wells with GET E/F extraction wells only
4C. New off-property extraction wells with optimal well placement and with GET E/F extraction wells only
5A. New off-property extraction and reinjection wells with GET E/F extraction and reinjection wells
5B. New off-property extraction and reinjection wells with GET E/F extraction wells only

Alternatives (3A through 5B) meet ARARs and have the same numeric designations assigned to them in the FS.

Subsequent to the RI/FS, field pilot studies for *in-situ* biological remediation of both perchlorate and TCE in groundwater were initiated and are currently being implemented. While *in-situ* biological remediation was not evaluated in the alternatives, initial results from Area 20 and at GET D are promising. A pilot study at GET B is pending. Various electron donors (calcium-magnesium-acetate sodium lactate) have been used to promote establishment of anaerobic conditions and to reduce groundwater redox conditions that favor reduction of perchlorate. A proprietary material is used to degrade TCE. Environmentally-acceptable end products are produced in the degradation process (perchlorate to chloride and oxygen - TCE to ethene and chloride). Further electron donors will be evaluated, as well as distribution methods and system costs. The preliminary pilot efforts suggest *in-situ* biological remediation should be further evaluated and the remedy revised in the future if the USEPA determines it is appropriate.

2.9.1 *Description of Remedy Components*:

- Alternative 1, the No-Action Alternative, will not contain the migration of the contaminated groundwater. Water supply wells will continue to be lost. Because the contamination is not contained this alternative is not protective of public health or the environment and does not comply with ARARs. This alternative is not further evaluated.

- Alternatives 2A and 2B replace lost water supplies with new sources but allow the plume to continue to migrate and further contaminate the aquifer. The difference between 2A and 2B is that Alternative 2B provides for replacement of GET E and F's reinjection field with nine extraction wells. [Note this is a consistent difference between all A and B Alternatives] Neither Alternative 2 A or 2B contains the contamination and thus, are not protective of public health or the environment and do not comply with ARARs. These alternatives are not further evaluated.

- Alternatives 3A and 3B provide wellhead treatment to water supply wells as they become contaminated. The difference between 3A and 3B is that Alternative 3B provides for replacement of GET E and F's reinjection field with nine extraction wells. Plume control occurs through the PWSWs which is not optimal since the well locations are not selected to optimize plume control. It is anticipated that to achieve effective plume control additional extraction wells will need to be installed which would make the cost of Alternatives 3A and 3B the most expensive alternatives (Alternative 3B is already the most expensive alternative).

- Alternatives 4A, 4B, and 4C are essentially pump and treat with various extraction well locations and two discharge options for the treated groundwater. The difference between Alternative 4A and the 4B and 4C Alternatives is that both Alternatives 4B and 4C provide for replacement of GET E and F's reinjection field with nine extraction wells. The difference between Alternatives 4B and 4C is that for 4C five additional wells (four

in Layer C and one in Layer E) and five of the 4B outer ring extraction wells (four in the Layer D and one in Layer E) are moved further up-gradient to prevent further contamination of Layers D and E and the extraction wells are installed earlier. Alternatives 4A and B are the least expensive of all alternatives based on 30 year present value cost, however, for 4A and 4B the 30 year present value cost do not reflect the total cost of the remedy because components are added after 30 years (See Table 2.9 Notes for details). Alternative 4C is the least expensive of all alternatives based on total undiscounted cost (cost through life of the remedy). Alternatives 4A, B and C are acceptable to the DTSC and the RWQCB, however, CADHS and the water purveyors have expressed opposition to Alternative 4A because of its retention of the on-property reinjection field.

- Alternatives 4A through 5B contemplate two options for the treated water: discharge directly to the drinking water system, or discharge to surface water. Any direct discharge to a drinking water system will require approval from the CADHS. Discharge to surface water on-site must comply with the substantive provisions of an NPDES Permit (See Table 2.15); discharge to surface water off-site will require an NPDES Permit.

- Alternatives 5A and 5B are similar to the "4-series" alternatives except that they both use seven new off-property injection wells along with off-property extraction wells to help hydraulically control the plume. The difference between Alternatives 5A and 5B is that Alternative 5B provides for replacement of GET E and F's reinjection field with nine extraction wells. There is a greater uncertainty in controlling the plume using injection wells and general opposition to injection by the CADHS and the water purveyors. Alternatives 5A and B are more expensive than Alternatives 4A and B based on 30 year present value and more expensive than 4A, B and C using total undiscounted cost. Portions of the 5A and 5B remedy are not installed in the first 30 years of the remedy (See Table 2.9 Notes for details) and are not reflected in the 30 year present value cost.

2.9.2 *Common Elements and Distinguishing features of Each Alternative*: The retained Alternatives 3A through 5B contain the following items:

- The continued operation of the combined existing GETs E and F and the installation of four additional wells to increase the effectiveness of the on-property hydraulic barrier at GET E/F.
- Groundwater treatment using liquid phase granulated carbon or UV/oxidation for VOCs, UV/oxidation for NDMA and biological reduction for perchlorate for all but 3A and 3B which use ion exchange.
- Groundwater monitoring, institutional controls and re-evaluation of containment in 2006.
- Alternatives 4A, 4B, 5A and 5B have components of the remedy installed after 30 years which are not included in the 30 yr. present value cost (See Table 2.9 Notes).

The following Table 2.6 summarizes unique elements of each of the alternatives, followed

by Table 2.7 which provides the general comparison information for each alterative.

Table 2.6 - Summary of Unique Elements of Alternatives

Alternative	Elements
3A	• Continued operation of GET E/F treatment system and extraction and recharge wells. • Existing water supply wells located off Aerojet's property will have wellhead treatment, allowing for use of the treated water as drinking water.
3B	• Shut down of GET E/F recharge wells and replacement with nine additional on-property extraction wells to maintain on-property capture at GET E/F. • Existing water supply wells located off Aerojet's property will have wellhead treatment, allowing for use of the treated water as drinking water.
4A	• Continued operation of GET E/F treatment system and extraction and recharge wells. • Installation of 30 new off-property extraction wells to create off-property hydrologic barrier. • A new groundwater treatment plant will be constructed on and/or off Aerojet's property to treat the contaminated groundwater. The treated water will either be sent directly to the water purveyors facilities or be discharged to surface water.
4B	• Shut down of GET E/F recharge wells and replacement with nine additional on-property extraction wells to maintain on-property capture at GET E/F. • Installation of 17 new off-property extraction wells to create off-property hydrologic barrier. • A new groundwater treatment plant will be constructed on and/or off Aerojet's property to treat the contaminated groundwater. The treated water will either be sent directly to the water purveyors facilities or be discharged to surface water.
4C	• Shut down of GET E/F recharge wells and replacement with nine additional on-property extraction wells to maintain on-property capture at GET E/F. • Installation of 22 new extraction wells, with D and E layer wells installed near current plume boundary. • A new groundwater treatment plant will be constructed on and/or off Aerojet's property to treat the contaminated groundwater. The treated water will either be sent directly to the water purveyors facilities or be discharged to surface water.
5A	• Continued operation of GET E/F treatment system and extraction and recharge wells. • Installation of 24 extraction wells and seven recharge wells to create off-property hydraulic barrier. • A new groundwater treatment plant will be constructed on and/or off Aerojet's property to treat the contaminated groundwater. The treated water will either be sent directly to the water purveyors facilities or be discharged to surface water.
5B	• Shut down of GET E/F recharge wells and replacement with nine additional on-property extraction wells to maintain on-property capture at GET E/F. • Installation of 11 new extraction wells and seven recharge wells to create off-property hydraulic barrier. • A new groundwater treatment plant will be constructed on and/or off Aerojet's property to treat the contaminated groundwater. The treated water will either be sent directly to the water purveyors facilities or be discharged to surface water.

The following Table 2.7 summarizes the cost of each of the alternatives; the additional groundwater flow needed for treatment to replace drinking water lost by 2023; the amount of water reinjected; the estimated time (by layer) to capture one pore volume; and the number of years to achieve RAOs. All cost estimates are based on 30 years using a 7% discount rate.

Table 2.7 - Summary of General Comparison Information for Each Alternative

Alternative	30 yr. Present Value Cost in $M	New Wells	Added Treatment Flow gpm	Replacement Drinking Water by Year 2023	Re-inject gpm	Estimated Time for One Pore Volume by Model Runs			Est. Time to Achieve RAO at 6 Pore Volumes all Layers in Years
						Layer C (60% of Plume Area)	Layer D (31% of Plume Area)	Layer E (9% of Plume Area)	
3A	97.3	4	400 gpm	none - wellhead treatment	3800	47 years	60 years	119 years	330 years
3B	119.8	13	2825 gpm	none - wellhead treatment	none	82 years	81 years	25 years	480 years
4A	94.9 to 96.8	34	9000 gpm	3400 gpm SWTP	3800	28 years	47 years	81 years	234 years
4B	96.3 to 98.2	30	7425 gpm	3400 gpm SWTP	none	48 years	52 years	141 years	348 years
4C	**109.1 to 111**	**35**	**7975 gpm**	**3400 gpm SWTP**	**none**	**44 years**	**33 years**	**31 years**	**240 years**
5A	100.5 to 102.4	35	7600 gpm	3400 gpm SWTP	8000	32 years	46 years	92 years	258 years
5B	107.7 to 109.6	31	5725 gpm	3400 gpm SWTP	2600	54 years	52 years	66 years	348 years

SWTP = Surface Water Treatment Plant | GET = Groundwater Extraction and Treatment | gpm = gallons per minute

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. 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. Alternatives 1, 2A and 2B do not comply with the threshold criteria and are not discussed beyond the threshold criteria (Table 2.8 Comparative Analysis of Alternatives follows the text discussion):

2.10.1 *Overall Protection of Human Health and the Environment:* All the retained alternatives (Alternatives 3A through 5A) are protective of human health and the environment and eliminate, reduce, or control risks posed by the contamination at OU-3 through treatment and institutional controls.

2.10.2 *Compliance with ARARs:* All the retained alternatives comply with ARARs by providing various means of containing the groundwater contamination and restoring the aquifer, and replacing lost water supplies. Alternatives 3A and 3B contain and treat the groundwater contamination by adding wellhead treatment to preserve existing supply

wells as they become contaminated. Alterative 4 and 5 variations contain and treat the groundwater using new extraction wells or extraction wells with reinjection wells. Of the remaining alternatives, Alternative 4A, 4C and 5A are projected to restore the aquifer a minimum of 90 years faster than the other alternatives.

2.10.3 *Long-term Effectiveness and Permanence:* All the retained alternatives (Alternatives 3A through 5B) would permanently remove known chemicals of concern from the groundwater. It is possible, however, that when the treatment systems are turned off that residual amounts of COCs (residual risk) could remain in portions of the groundwater aquifer after RAOs and cleanup standards for these chemicals have been achieved. Some alternatives provide better long-term effectiveness than others. Alternative 4C has the least potential for residual amount of COC to remain in portions of the groundwater aquifer because it provides for the earliest containment of contamination in Layers D and E significantly reducing the extent of contamination in these Layers D and E. By reducing the extent of contamination in Layers D and E the amount of potential residual contamination is smaller. Alternatives 4B and 4C are estimated to have the least long-term risk.

All the evaluated alternatives have the ability to maintain reliable protection of human health and the environment over time. Institutional Controls for OU-3 on-property include environmental restrictions; existing CADHS 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 annually.

2.10.4 *Reduction of Toxicity, Mobility, or Volume Through Treatment:* All the retained alternatives equally reduce the toxicity of the chemicals of concern in the treated groundwater. Alternatives 4B and 4C would most effectively reduce the mobility of groundwater contaminants, because they use only extraction and selective placement of extraction wells for hydraulic control. Alternative 4C would contain the contamination in Layers D and E the fastest by increasing the volume of contamination that is remediated (Allowing Layers D and E contamination to reach the extent of Layer C would increase the volume of contamination that adheres to soil grains which is not economically removable with current technology.).

2.10.5 *Short-term Effectiveness:* None of the alternatives considered are truly short-term remedies. Alternative 4A is estimated to achieve remedial action objectives (RAOs) in the shortest period of time, 234 years. However, 4A as well as 3A have disadvantages under the reduction of mobility criterion, due to the continued reinjection of treated water on-site which will not be as effective as extraction only in containing the contamination. The variations of Alternative 5 have the same drawback, due to off-site reinjection. Of the alternatives that do not include reinjection, Alternative 4C achieves RAOs in 240 years or 3 percent longer than 4A, but faster than 4B by an estimated 108 years or 31 percent.

Potential danger to workers and to the environment during the implementation of Alternative 4 and 5 variations would be higher than for Alternative 3 variations because of the need to install approximately 20 additional extraction wells and additional piping to the central treatment plant. However, the Alternative 3 variations would require maintenance for a significantly longer period. Also, Alternative 3 variations might require construction of additional extraction wells to contain the contamination, since existing drinking water well locations are not optimal for plume control. In this case, short-term effectiveness of Alternative 3 variations would be little better than that of Alternative 4 and 5 variations.

2.10.6 *Implementability:* Under Alternatives 3A and 3B, no additional drinking water wells need to be installed, making these alternatives potentially easier to implement. However, wellhead treatment needs to be installed at the existing wells. There must be sufficient space at the well location to allow installation of the treatment system. This may result in removal and replacement of existing structures. The wellhead treatment for perchlorate would use ion exchange. A similar treatment system was permitted by CADHS in southern California. Since the CADHS permit is site specific, the wellhead treatment system being contemplated under these alternatives for OU-3 would need CADHS approval.

Alternatives 4A through 5B contemplate use of a biological treatment process for perchlorate, either through an on or off-property system, to treat contaminated groundwater. If the treated water will be discharged directly to the water purveyors systems to be used as drinking water, the proposed biological treatment process will need to be approved and a specific application permit obtained from CADHS. Alternative 4C implementation may be more complicated since there is a risk of contaminating Layer D (from Layer C) during implementation of the remedial action.

2.10.7 *Cost:* Tables 2.9 and 10 provides specific cost estimates for each alternative based on 30 Year Costs and the number of years to remedy completion. Costs for the variations of Alternatives 4 and 5 depend partly on whether treated water is reused directly or indirectly. Using a 30-year present-worth method, Alternative 4B ($96.3-98.2M) is the

least expensive alternative, $12.8 M or 13 percent cheaper than Alternative 4C. However, not all the remedy is installed in the first 30 years as indicated at the bottom of Table 2.9 which results in underestimating the remedy cost. Under the total undiscounted cost method, which totals the annual costs of the remedy for the entire duration until the RAOs are met, Alternative 4C is the least expensive remedy at $1,215.7 to $1,219.1M, which is $545.7M or 45 percent cheaper than Alternative 4B.

2.10.8 *State Acceptance:* The State of California's Department of Toxic Substances Control and the Regional Water Quality Control Board support both Alternative 4B and 4C, provided 4C can be implemented to prevent potential migration of Layer C contamination down to Layer D. The State agencies do not accept Alternatives 3A and 3B because they cost more than 4B and do not insure that contaminated groundwater will be contained resulting in further loss of the down-gradient aquifer and water supply wells. The State prefers Alternatives 4B and 4C to the remedies with reinjection (3A, 4A, 5A, and 5B) because of the complexity of the site hydrogeology and the potential for residual contamination.

2.10.9 *Community Acceptance*: The three local water purveyors expressed a preference for a remedy with no reinjection and expressed no preference between Alternatives 4B and C. The acceptance of Alternative 4C or 4B by the community was mixed. The main support from the community for Alternative 4C was based on completing remediation as soon as possible. Portions of the community were willing to delay the remedy completion time in favor of initial reduced traffic congestion and expressed a preference for Alternative 4B (Alternative 4C has 2 miles or 19% more piping off-property to impact roadways, however, Alternative 4C will achieve cleanup goals an estimated 108 years faster than 4B resulting in few pipe line renewals over the life of the remedy).

Table 2.8 - Comparative Analysis of Alternatives							
Criteria	3A	3B	4A	4B	4C	5A	5B
Protective	yes	yes	yes	yes	yes	yes	yes
Meet ARARs	yes	yes	yes	yes	yes	yes	yes
Long-term effective	yes	yes	yes	Potentially better	Potentially better	yes	yes
Reduction in toxicity, mobility, or volume	Reinjection control difficult	Non-optimal well locations	Reinjection control difficult	2nd best	Best	Reinjection control difficult	Reinjection control difficult
Short-term effective-ness	Reinjection control difficult	Not optimal well locations	Reinjection control difficult	2nd best	Best	Reinjection control difficult	Reinjection control difficult
Implementability	CADHS site permit required	CADHS site permit required	Direct reuse site & process permit	Direct reuse site & process permit	Direct reuse site & process permit	Direct reuse site & process permit	Direct reuse site & process permit
Cost 30 yr Present Value*	97.3M	119.8M	94.9 to 96.8M	96.3 to 98.2M	109.1 to 111M	100.5 to 102.4M	107.7 to 109.6M
Cost Total Present Value**	110.2M	133.7M	107.2 to 109.1M	106.6 to 108.5M	118.7 to 120.6M	113.1 to 115M	118.3 to 120.2M
Cost Total undid-counted at remedy complete	2,177.9M	2,994.8M	1,510.2 to 1,513.3M	1,759.7 to 1,764.8M	1,215.7 to 1219.1M	1,868.9 to 1,874M	1,919.7 to 1,923.8M
State OK	No	No	Mixed	Yes	Yes	No	No
Community OK	No	No comment	No	Mixed	Mixed	No	No

* For Alternatives 4A, 4B, 5A and 5B not all costs occur in the first 30 yrs. (See Table 2.9 Notes for details).

** The total present value is provide at remedy completion for information purposes, however, for projects over 30 years it does not adequately represent the cost to fund the remedy to completion.

Tables 2.9 and 2.10 which follow provide the detail for the alternatives by 30 year cost and by cost to remedy completion.

Table 2.9 30 Year Remedy Costs OU-3	Capital ($ million)	30 yr. O&M [b] ($ million)	30 yr. Present Value [a] ($ million)	30 yr. Undiscounted Cost [c] ($ million)	Estimated Duration of Remedy
Alternative 1 - No Action	0	4.8	2.1	4.8	Indefinite
Alternative 3A – GETs E and F Extraction and Recharge Wells with Off-site Wellhead Treatment at Water Supply Wells	64.0	141.7	97.3	205.7	330 years
Alternative 3B – GETs E and B Extraction Wells within Off-site Wellhead Treatment at Water Supply Wells	78.4	160.5	119.8	238.9	480 years
Alternative 4A – GETs E and F Extraction and Recharge Wells with Off-site Extraction wells	54.1[d]	105.4[d]	89.3[d]	159.5[d]	234 years
Direct to water purveyor/Surface water discharge Cost	3.9/6.9	4.0/1.3	5.6/7.5	7.9/8.2	"
Sum Alternative 4A 30 Yr Cost Direct/Surface Water	58/61[d]	109.4/106.7[d]	94.9/96.8[d]	167.4/167.7[d]	"
Alternative 4B – GETs E&F Extraction Wells with Off-site Extraction Wells	48.1[e]	111.4[e]	90.7[e]	159.5[e]	348 years
Direct to water purveyor/Surface water discharge Cost	3.9/6.9	4.0/1.3	5.6/7.5	7.9/8.2	"
Sum Alternative 4B 30 Yr. Cost Direct/Surface Water	52/56[e]	115.4/112.7[e]	96.3/98.2[e]	167.4/167.7[e]	"
Alterative 4C – GETs E and F Extraction Wells with Off-site Extraction Wells Multi-Containment Corridors	54	122.7	103.5	176.7	240 years
Direct to water purveyor/Surface water discharge Cost	3.9/6.9	4.0/1.3	5.6/7.5	7.9/8.2	"
Sum Alternative 4C 30 Yr. Cost Direct/Surface Water	57.9/60.9	126.7/124	109.1/111	184.6/184.9	"
Alternative 5A – GETs E and F Extraction & Recharge Wells with Off-site Extraction and Recharge Wells	53.8[f]	117.4[f]	94.9[f]	171.2[f]	258 years
Direct to water purveyor/Surface water discharge Cost	3.9/6.9	4.0/1.3	5.6/7.5	7.9/8.2	"
Sum Alternative 5A 30 Yr. Cost Direct/Surface Water	57.7/60.7[f]	121.4/118.7[f]	100.5/102.4[f]	179.1/179.4[f]	"
Alternative 5B – GETs E and F Extraction Wells with Off-site Extraction and Recharge Wells	55.5[g]	121[g]	102.1[g]	176.5[g]	348 years
Direct to water purveyor/Surface water discharge Cost	3.9/6.9	4.0/1.3	5.6/7.5	7.9/8.2	"
Sum Alternative 5B 30 Yr. Cost Direct/Surface Water	59.4/62.4[g]	125/122.3[g]	107.7/109.6[g]	184.4/184.7[g]	"

NOTES: All costs estimated with an accuracy of -30% to +50%.

[a] Present-value costs based on a 7% real discount rate.

[b] 30 yr. O&M is the present-value cost of annual & periodic O&M expenditures for 30 yrs (Annual cost varies as portions of remedy are installed. In some alternatives 4A, 4B, 5A &5B have portions of remedy installed after 30 yrs. see notes d thru g).

[c] 30 yr. undiscounted costs are 1999 dollars.

[d] 4A does not reflect total cost of remedy: in 2051, 1D and 1 E layer (700 gpm) and in 2061, 4 E layer (1300 gpm) extraction wells must be installed with monitoring wells and treatment plant upgrades.

[e] 4B does not reflect total cost of remedy; in 2041, 2D and 1 E layer (900 gpm) extraction wells must be installed with monitoring wells and treatment plant upgrades.

[f] 5A does not reflect total cost of remedy: in 2051, 3 E layer (1100 gpm) and in 2061, 2 E layer (600 gpm) extraction wells must be installed with monitoring wells and treatment plant upgrades.

[g] 5B does not reflect total cost of remedy: in 2111, 1 E layer (300 gpm) extraction well must be installed with monitoring wells and treatment plant upgrades.

Table 2.10 Costs at Remedy Completion for OU-3	Capital ($ million)	Total O&M [b] at Completion ($ million)	Total Present Value [a] at Completion ($ million)	Total Undiscounted Cost [c] ($ million)	**Estimated Duration of Remedy**
Alternative 1 - No Action	0	NA	NA	0.160/year	Indefinite
Alternative 3A – GETs E and F Extraction and Recharge Wells with Off-site Wellhead Treatment at Water Supply Wells	117.2	2,060.8	110.2	2,177.9	330 years
Alternative 3B – GETs E and B Extraction Wells within Off-site Wellhead Treatment at Water Supply Wells	261.8	2,733.0	133.7	2,994.8	480 years
Alternative 4A – GETs E and F Extraction and Recharge Wells with Off-site Extraction wells (Excludes Reuse Cost)	209.9	1,248.6	101	1,458.5	234 years
Direct to water purveyor/Surface water discharge $	23.4/41.4	31.8/10.3	6.2/8.1	54.8/51.7	"
Total Alternative 4A Cost Direct/Surface Water	233.3/251.3	1,280.4/ 1,258.9	107.2/109.1	1,513.3/ 1,510.2	"
Alternative 4B – GETs E&F Extraction Wells with Off-site Extraction Wells	225.3	1,457.6	100.4	1,682.9	348 years
Direct to water purveyor/Surface water discharge $	35.2/62.1	46.4/15.3	6.2/8.1	81.5/77.4	"
Total Alternative 4B Cost Direct/Surface Water	260.5/287.4	1,504/1,472.9	106.6/108.5	1,764.8/ 1,759.7	"
Alterative 4C – GETs E and F Extraction Wells with Off-site Extraction Wells in Multiple Containment Corridors	161.4	1,002.4	112.5	1,163.7	240 years
Direct to water purveyor/Surface water discharge $	23.4/41.4	32/10.6	6.2/8.1	55.4/52	"
Total Alternative 4C Cost Direct/Surface	184.8/202.8	1,034.4/1013	118.7/120.6	1,219.1/ 1,215.7	"
Alternative 5A – GETs E and F Extraction and Recharge Wells with Off-site Extraction and Recharge Wells	210.7	1,605.5	106.9	1,816.2	258 years
Direct to water purveyor/Surface water discharge $	23.5/41.4	34.4/11.3	6.2/8.1	57.8/52.7	"
Total Alternative 5A Cost Direct/Surface Water	234.2/252.1	1,639.9/1,616.8	113.1/115	1,874/1,868.9	"
Alternative 5B – GETs E and F Extraction Wells with Off-site Extraction and Recharge Wells	163.5	1,678.8	112.1	1,842.3	348 years
Direct to water purveyor/Surface water discharge $	35.2/62.1	46.4/15.3	6.2/8.1	81.5/77.4	"
Total Alternative 5B Cost Direct/Surface	198.7/225.6	1,725.2/ 1,694.1	118.3/120.2	1,923.8/ 1919.7	"

2.11 Principal Threat Wastes: The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. OU-3 applies only to contaminated groundwater. Contaminated groundwater generally is not considered to be a source material but NAPLs may be viewed as source material. However, there are no known source areas or NAPLs at OU-3 and as a result principal threat waste was not considered.

2.12 Selected Remedy: Preferred Alternative

Based on current information, USEPA prefers Alternative 4C, which requires installation of new off-property extraction wells with optimal well placement and the modification of the on-property GET E/F extraction system to eliminate reinjection wells and improve contaminated groundwater capture.

Alternative 4C provides the earliest containment of the contaminated groundwater in Layers D and E and the earliest treatment of contaminated groundwater. It would restore layers D and E 31 percent faster than the next preferred alternative, Alternative 4B. Alternative 4C would also cost least over the life of the project and has the support of the State agencies.

USEPA believes Alternative 4C meets 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 Remedy:* The principal factors considered in selecting Alternative 4C as the preferred remedy are 1) provides the earliest contamination containment in aquifer Layers D and E off-property, 2) reduces the amount of residual contamination which results in an increase of the overall contamination which can be removed (contamination adhering tightly to soil particle are difficult to remove with present technology), and 3) restores the aquifer an estimated 108 years or 31 percent faster than the next preferred remedy Alternative 4B. The 30 year present value cost for Alternative 4C over 4B is an additional $12.7 million or 13 percent more but not all the remedy components for Alternative 4B are installed within the first 30 years of the remedy and thus, are not included in the estimate. The undiscounted cost, which estimates remedy costs to completion, costs significantly more for Alternative 4B because of the additional time to complete the remedy.

2.12.2 *Description of the Selected Remedy:* The components for the selected remedy Alternative 4C are as follows:

2.12.2.1 Contain and treat the contaminated groundwater off-property with P&T in all contaminated layers of the aquifer within OU-3 to prevent further contamination of the aquifer.

–The first priority is to contain the contamination off-property with P&T. The groundwater contamination off-property is primarily in the Layer C although extended fingers of contamination exist in Layers D and E. If contamination is later found in Layer F, it will be included in the remediation.

–The second priority is to modify the existing GET E/F P&T to contain and remediate all groundwater contamination at the Aerojet property boundary in all layers which feed the off-property groundwater contamination and replace the existing reinjection field with extraction wells. Aerojet must demonstrate that extraction for containment in Layers A and B is not required for the on-property boundary containment system. Existing reinjection wells 4014, 5050, 5045, 5100, 5080, 5085, 5090, 5095 will be removed from service and destroyed in accordance with State requirements and replaced with extraction wells.

–The third priority is to expedite remediation of the groundwater and prevent further degradation off-property of Layers D and E. An evaluation of *in-situ* bioremediation or a combination of the P&T and *in-situ* bioremediation shall be conducted to allow the EPA to determine whether these components can be effectively and economically implemented to expedite remediation of the groundwater as a possible revision to the remedy. Unless the remedy is revised, the groundwater remediation shall be expedited through interior P&T wells (Figure 2-4 wells E2, C11 through C14 and D1 through D4).

2.12.2.2 Restore all layers of the drinking water aquifer within the Western Ground Water Operable boundary depicted on Figure 2.2 to the cleanup levels specified in Table 2.14. The RAOs and cleanup levels are not applicable on-property up-gradient of GET E/F extraction wells. The existing GET E/F extraction wells 4315 and 4007 near Chemical Plant 2 are outside the OU-3 boundary and not part of the OU. The RAOs and cleanup levels apply up-gradient of the outermost off-property boundary extraction wells and down gradient of the on-property GET E/F extraction wells within the OU-3 boundary.

2.12.2.3 Treat extracted groundwater using biological treatment for perchlorate, UV/OX for NDMA, and liquid phase granular activated carbon air stripping for residual VOCs to meet the cleanup levels. The treatment system may be located on or off Aerojet's property, subject to USEPA approval. The treated water may either be discharged directly to the drinking water system or to surface water. If the treated water will be discharged directly to the drinking water system the appropriate CADHS approval shall be obtained. If treated water will be discharged on-site it will comply with the substantive requirements of an NPDES Permit (See Table 2.15); off-site discharge will require an NPDES Permit.

2.12.2.4 The treated water may be available as drinking water. Any use of the treated water as drinking water shall comply with Federal drinking water standards as well as CADHS requirements.

2.12.2.5 Develop, implement and augment as appropriate a short-term water replacement contingency plan (SWRCP). The SWRCP shall provide for replacement, within 24 hours, of private and public drinking water and irrigation well water supplies lost within OU-3 to Aerojet contamination on an interim basis. The SWRCP shall provide the interim water replacement until the long-term water replacement contingency plan can provide permanent replacement water. The SWRCP shall replace any extraction reductions caused by implementation of the groundwater management zone. The SWRCP shall include actions to be undertaken, a work schedule and estimated costs for the work. At a minimum, the SWRCP provisions shall provide for the following:

- Replacement of a water supply well upon initial finding of contamination at the COC cleanup level for perchlorate and NDMA or at two-thirds the MCL for the other COC. Confirmation testing will be used to determine if replacement continues.

- The SWRCP shall provide for at least a two year replacement capacity for water supplies lost due to Aerojet contamination of a well or reductions in a well's operating capacity for groundwater contamination control. The two year replacement capacity evaluation shall be the greater of the following unless otherwise agreed to by the EPA:
  - The sum of the capacities of private and public water supply wells that are within 1,000 feet of the contaminated groundwater plume at the time of entry of an enforcement agreement for OU-3;

  - Fifteen percent of the capacity of private and public water supply wells within OU-3 at the time of entry of an enforcement agreement for OU-3; or

  - The sum of the modeled two year replacement capacity for public and private water supply wells, irrigation wells and capacity reductions anticipated for groundwater management zone needs.

- The short-term capacity projection shall include the time needed to bring short and long term replacement capacity on-line. The short-term replacement capacity is to be tied into the affected water purveyors distribution system in a manner acceptable to CADHS to allow for permitting of the modification. Hydraulic modeling of the distribution system shall be provided to meet CADHS requirements. The SWRCP shall provide for telemetry active operation to allow for replacement of the anticipated water supply loss within 24 hours.

- Annual revision of the SWRCP is to be prepared. The revision shall review present capacity and shall model projections for the next two years in order to provide an adequate short-term water supply until any short- and long-term additional capacity can be available for actual use.

- Except within three months of an annual revision of the SWRCP, any time a portion of the capacity is used which exceeds the projected use in the latest SWRCP by twenty percent, the SWRCP shall be updated.

2.12.2.6 Develop and implement a long-term water replacement contingency plan (LWRCP) for the permanent replacement of private and public drinking water and irrigation water supply wells which may continue to be lost due to Aerojet contamination. The LWRCP shall provide for adequate water to permanently replace water supplies that may be lost due to Aerojet contamination for the duration of the implementation of the remedy, including supplies lost due to implementation of the groundwater management zone. The initial LWRCP and subsequent revisions shall include a minimum five year planning projection of anticipated replacement demand for all of OU-3. The LWRCP shall apply to water supply wells in place at the time of a legally enforceable order or decree to implement the remediation for OU-3 and any other replacement water supply wells which become contaminated during implementation of the remedy. Excluded from the LWRCP are permanent accommodations already completed by Aerojet under the provisions of the 1989 Partial Consent Decree (Civil Action No. CIVS-86-0064-EJG) or other subsequent legal settlement agreements with private well owners or water purveyors. The LWRCP shall include actions to be undertaken, a work schedule and estimated costs for the proposed work. The plan shall provide for the following:

- The permanent replacement of a contaminated water supply well with equivalent water supply, within 18 months of confirmation sampling that the water supply well is contaminated by COC from Aerojet.

- The implementation of permanent replacement capacity to meet the LWRCP projections based on a minimum five year planning period.

- The long-term replacement capacity is to be tied into the affected water purveyors distribution system in a manner acceptable CADHS to allow for permitting of the modification. A hydraulically equivalent distribution system shall be provided with computer hydraulic modeling done to meet CADHS requirements.

- Revision of the LWRCP every five years and submission to the USEPA for approval. The revision shall review present available capacity with model

projections for permanent replacement requirements over at least the next five years and make recommendations to provide an adequate replacement water supply, detailed by well with projected date of replacement.

- Except within six months of the next five year revision of the LWRCP, any time the actual permanent water supply replacement exceeds a yearly projected use in the latest LWRCP projection by fifteen percent the LWRCP shall be updated.

2.12.2.7 Monitoring of drinking water wells, irrigation wells, up-gradient sentinel wells, plume control evaluation, and remedy verification shall be conducted as part of the existing "Groundwater Monitoring Plan for the Aerojet Site".

2.12.2.8 Creation of a groundwater management zone (GMZ) within OU-3 to maintain water levels and prevent interference with the remedy. The GMZ shall model and assess by affected aquifer layer any operational restrictions which may be required on existing private and public water supply wells and irrigation wells to prevent any adverse effect on the sphere of influence of the remedy extraction wells. The GMZ shall also establish the areas (by aquifer layer) where new wells shall not be installed to prevent adverse effect on the remedy.

2.12.2.9 Institutional Controls (ICs) that shall be implemented with this remedy which include the following:

- Sacramento County's continued review of new well drilling permit applications.

- Aerojet shall provide an annual notification in local newspapers showing the OU-3 area of groundwater contamination, the requirement for a permit for any well within OU-3 and point of contact for a permit or the equivalent electronic information format for dissemination to the local community approved by the USEPA.

- If treated groundwater discharged directly to water supply systems exceeds CADHS drinking water action levels, Aerojet shall provide written notification on each occurrence to drinking water suppliers.

- Access to groundwater on Aerojet' property within OU-3 shall be restricted. Aerojet shall prevent access to the groundwater by reserving the groundwater estate in any sale of land overlaying the contaminated groundwater. Moreover, any lease or sale of land overlaying contaminated groundwater shall be subject to the following environmental restrictions:
  - No extraction of groundwater;

- No recharge of groundwater unless and until expressly permitted in writing by the RWQCB;
- No injection into the groundwater; and
- No sustained extraction of groundwater encountered during construction without written approval by the RWQCB.

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 USEPA and the RWQCB 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.

2.12.2.10 Conduct an evaluation of *in-situ* bioremediation or a combination of P&T and *in-situ* bioremediation to allow the EPA to determine whether these components can be effectively and economically implemented to expedite remediation of the groundwater as a possible revision to the remedy.

2.12.3 *Summary of the Estimated Remedy Costs:* The estimated cost for the selected remedy Alternative 4C is provided in the following three tables (Cost Estimate Summary, Estimated Cost of Main Remedy Components, and Summary of Present Value Analysis). At the time of the ROD, the option for dispersing of the treated water (directly discharged to the drinking water system or surface water discharge) has not yet been selected. To obtain the total remedy cost, the cost for the selected discharge option must be added to the base remedy cost to provide a total remedy cost.

Table 2.11
Cost Estimate for 30 Years & Remedy Completion Summary for Selected Remedy 4C

Alterative 4C – GETs E/ F Extraction Wells with Off-Property Extraction Wells in Multiple Containment Corridors	Capital ($ million)	Total O&M [b] ($ million)	Total Undiscounted Cost [c] ($ million)	Total Present Value [a] ($ million)
30 yr. present value $ direct/surface water	57.9/60.9	126.7/124	184.6/184.9	109.1/111
Undiscounted $ direct/surface water	184.8/202.8	1034.4/1013	1219.1/1215.7	118.7/120.6

NOTE: All costs estimated with an accuracy of -30% to +50%.

[a] Present-value costs based on a 7% real discount rate and a 240-year period of analysis (e.g., project duration).

[b] Total O&M is the total present-value cost of annual and periodic operations and maintenance expenditures for the 240-year period of analysis.

[c] Total undiscounted costs are 1999 dollars for the 240-year period of analysis.

Table 2.12
Cost Estimate to Remedy Completion Main Remedy Components - GETs E/F Extraction Wells with Off-Property Extraction Wells in Multiple Containment Corridors

Description	Alternative Cost	Direct	Surface Water
CAPITAL COSTS			
Easements and land purchase, surveying	$1,084,000	$5,000	$453,000
Extraction wells, drilling and development	$8,170,000	NA	NA
Pumps, discharge piping, wiring, pump power and control, instrumentation	$2,168,000	NA	NA
Monitor wells	$1,683,000	NA	NA
Untreated groundwater piping	$10,911,000	NA	$1,370,000
Treatment facilities	$10,981,000	$955,000	$2,880,000
Discharge piping	$1,866,000	$1,705,000	NA
Subtotal (Construction)	$36,863,000	$2,665,000	$4,703,000
Contractor markup, mobilization/demobilization, insurance	$3,686,000	$267,000	$470,000
Engineering, permitting, construction management	$5,529,000	$400,000	$705,000
Regulatory oversight	$922,000	$67,000	$118,000
Estimated Project Capital Costs	$47,000,000	$3,399,000	$5,996,000
Contingency (15%)	$7,050,000	$510,000	$899,000
Total Initial Estimated Project Capital Costs	$54,050,000	$3,909,000	$6,895,000
Treatment Plant and Piping Replacement (Total 5 replacements)	$107,365,000	$19,545,000	$34,475,000
TOTAL CAPITAL COSTS	$161,415,000[d]	$23,454,000	$41,370,000
OPERATIONS AND MAINTENANCE COSTS			
Total Undiscounted O&M costs ($ million) [a]	1002.4	32.0	10.6
Total Present Value O&M costs ($ million) [b]	59.7	2.0	0.6
Total Undiscounted Cost in 1999 ($million) [c] - Capital & O&M	1,163.7[d]	55.4	52.0
Total Present Value ($ million) - Capital & O&M	112.5[d]	6.2	8.1

Notes: All costs estimated with an accuracy of -30% to +50%.

[a] Total O&M is the total present-value cost of annual and periodic operations and maintenance expenditures for the 240-year period of analysis.

[b] Present-value costs based on a 7% real discount rate and a 240-year period of analysis (e.g., project duration).

[c] Total undiscounted costs are 1999 dollars for the 240-year period of analysis.

[d] Direct or surface water costs must be added to Alternative 4C.

2.12.3.1 Uncertainty in cost Estimates: The information in these cost estimate summary tables are based on the best available information regarding the anticipated scope of the remedial alternative. For example over the next few years electrical rates may fluctuate. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative, or as new technologies are tested. Major or significant

changes may be documented in the form of a memorandum in the Administrative Record file, an Explanation of Significant Difference, or a ROD Amendment, as appropriate. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.12.3.2 Impact of Discount Rate on Long-Term Projects: Although it appears it is more expensive to perform Alternative 4C ($112.5 million total present value at remedy completion) than Alternative 4B ($100.4 million), this is partially due to the effect of the discount rate on the total percent value cost estimate. Using the total undiscounted cost which excludes the discount rate and sums the annual capital and maintenance costs over the total duration of the remedy the cost comparison is reversed. The total undiscounted costs per Table 2.10 for Alternative 4C ($1,163.7 million in 1999 dollars) is less than the total discounted costs of Alternative 4B ($1,682.9 million in 1999 dollars). The reversal in cost is due to the fact that the treatment plant and piping for Alternative 4B would need to be maintained and periodically replaced for 108 years more than Alternative 4C to complete the remedy.

Table 2.13 - Summary of Present Value Analysis to Remedy Completion

Year	Capital Cost	Annual Cost	Total Cost	Discount Factor	Present Value
0	$46,413,000	$1,999,200	$48,412,000	1.000	$48,400,000
1	0	$3,998,400	$3,998,400	.935	$3,700,000
2	0	$3,998,400	$3,998,400	.873	$3,500,000
3	0	$3,998,400	$3,998,400	.816	$3,300,000
4	0	$3,998,400	$3,998,400	.763	$3,100,000
5	$6,430,000	$3,998,700	$10,428,700	.712	$7,400,000
6	0	$3,998,700	$3,998,700	.666	$2,700,000
7	0	$3,998,700	$3,998,700	.623	$2,500,000
8	0	$3,998,700	$3,998,700	.582	$2,300,000
9	0	$3,998,700	$3,998,700	.544	$2,200,000
10	$573,000	$4,088,700	$4,661,700	.508	$2,400,000
11	0	$4,088,700	$4,088,700	.475	$1,900,000
12	0	$4,088,700	$4,088,700	.444	$1,800,000
13	0	$4,088,700	$4,088,700	.415	$1,700,000
14	0	$4,088,700	$4,088,700	.388	$1,600,000

Table 2.13 - Summary of Present Value Analysis to Remedy Completion					
Year	Capital Cost	Annual Cost	Total Cost	Discount Factor	Present Value
15	0	$4,088,700	$4,088,700	.362	$1,500,000
16	0	$4,088,700	$4,088,700	.339	$1,400,000
17	0	$4,088,700	$4,088,700	.317	$1,300,000
18	0	$4,088,700	$4,088,700	.296	$1,200,000
19	0	$4,088,700	$4,088,700	.277	$1,100,000
20	$573,000	$4,178,700	$4,751,700	.258	$1,200,000
21	0	$4,178,700	$4,178,700	.242	$1,000,000
22	0	$4,178,700	$4,178,700	.226	$900,000
23	0	$4,178,700	$4,178,700	.211	$900,000
24	0	$4,178,700	$4,178,700	.197	$800,000
25	0	$4,178,700	$4,178,700	.184	$800,000
26	0	$4,178,700	$4,178,700	.172	$700,000
27	0	$4,178,700	$4,178,700	.161	$700,000
28	0	$4,178,700	$4,178,700	.150	$600,000
29	0	$4,178,700	$4,178,700	.141	$600,000
30	0	$4,178,700	$4,178,700	.131	$500,000
31	0	$4,178,700	$4,178,700	.123	$500,000
32	0	$4,178,700	$4,178,700	.115	$500,000
33	0	$4,178,700	$4,178,700	.107	$400,000
34	0	$4,178,700	$4,178,700	.100	$400,000
35	0	$4,178,700	$4,178,700	.094	$400,000
36	0	$4,178,700	$4,178,700	.088	$400,000
37	0	$4,178,700	$4,178,700	.082	$300,000
38	0	$4,178,700	$4,178,700	.076	$300,000
39	0	$4,178,700	$4,178,700	.071	$300,000
40	$21,473,000	$4,178,700	$25,651,700	.067	$1,700,000
41	0	$4,178,700	$4,178,700	.062	$300,000
42	0	$4,178,700	$4,178,700	.058	$200,000
43	0	$4,178,700	$4,178,700	.054	$200,000

Table 2.13 - Summary of Present Value Analysis to Remedy Completion

Year	Capital Cost	Annual Cost	Total Cost	Discount Factor	Present Value
44	0	$4,178,700	$4,178,700	.051	$200,000
45	0	$4,178,700	$4,178,700	.048	$200,000
46	0	$4,178,700	$4,178,700	.044	$200,000
47	0	$4,178,700	$4,178,700	.042	$200,000
48	0	$4,178,700	$4,178,700	.039	$200,000
49	0	$4,178,700	$4,178,700	.036	$200,000
50	0	$4,178,700	$4,178,700	.034	$100,000
51 – 65	0	$4,178,700	$4,178,700	.032 – .012	*$100,000
Total Present Value					$112,500,000

*In year 66, present value costs are $0, in year 2081, the present value cost to replace the $21,473,000 treatment plant is $100,000; all other present value costs are zero.

2.12.4 *Expected Outcomes of the Selected Remedy:* The expected outcomes of the Selected Remedy is the restoration of the aquifer to beneficial use (drinking water source) after cleanup levels are achieved in an estimated 240 years. Final cleanup levels for groundwater are provided in Table 2.14.

Table 2.14 Cleanup Levels for Chemicals of Concern (COC)

COC	Cleanup Level	Basis for Cleanup Level	Risk at Cleanup Level
Perchlorate	4.0 ppb[1]	Low end of ORD range	Non-carcinogenic risk (NCR) Hazard index (HI) = 1
NDMA	1.3 ppt[2]	Preliminary Remediation Goal	Cancer risk $1x10^{-6}$
Trichloroethlene	5 ppb*	Max. Contaminant Level (MCL) USEPA & CA	Cancer risk $2.4x10^{-6}$
Tetrachloroethene	5 ppb*	MCL USEPA & CA	Cancer risk $4.7x10^{-6}$
1,1-Dichloroethane	5 ppb*	MCL CA	NCR, HI= 0.009
1,2,-Dichloroethane	0.5 ppb*	MCL CA	Cancer risk $2.9x10^{-6}$
1,1,2-Trichloroethane	5 ppb*	MCL USEPA & CA	Cancer risk $1.8x10^{-5}$
1,1-Dichloroethene	6 ppb*	MCL CA	Cancer risk $1.1x10^{-4}$
1,2-Dichloroethene	6 ppb*	MCL CA	NCR, HI = 0.3
1,1,2-Trichloro-1,2,2-trifluoroethane	1200 ppb*	MCL CA	NCR, HI = 0.03
Chloroform	100 ppb*	MCL CA	Cancer risk $4.1x10^{-4}$
Vinyl Chloride	0.5 ppb*	MCL CA	Cancer risk $2.2x10^{-5}$
Carbon Tetrachloride	0.5 ppb*	MCL CA	Cancer risk $2.3x10^{-6}$
Nitrate	10000ppb	MCL USEPA	NCR, HI = 0.4
Nitrite	1000ppb	MCL USEPA	NCR, HI = 1

Notes: [1] Low end of Office of Research and Development (ORD) guidance letter of 6/18/99
[2] 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 1.3 ppt is achieved.
* VOC are expected to be cleaned up to below MCLs as a result of the perchlorate and NDMA treatment.

The purpose of this response action is to control risks posed by drinking water supplies resulting in exposures from ingestion, inhalation and dermal contact. Perchlorate is the most widely distributed chemical and along with NDMA will drive the cleanup of the VOCs. While the cleanup level for VOCs are being set at the MCL level, it is anticipated that achieving the perchlorate and to some extent the NDMA cleanup levels will result in the aquifer cleanup to 10^{-6} cancer risk. The ORD 6/18/99 "Interim Assessment Guidance for Perchlorate" provides the current range of the provisional reference dose value for perchlorate as 0.0001 mg/kg-day to 0.0005 mg/kg-day issued by the National Center for Environmental Assessment (NCEA) in 1995 using standard adult parameters. The perchlorate reference dose and drinking water equivalents based on standard parameters are developed from "no observed adverse effects levels"and thus, are below the anticipated level that will cause cancer.

Table 2.15 - Effluent Limitations & Receiving Water Limitations*

Effluent Discharge Limitations

Constituents	Daily Maximum in ug/l	Monthly Average in ug/l
Volatile Organics (1	Not applicable	0.50
Perchlorate	8	4
1,4 -Dioxane	10	5
N-Nitrosodimethylamine	0.005	0.0013

(1 All volatile organic constituents listed in USEPA Method 8010 and 8020. The concentration of each constituent shall not exceed 0.5 ug/l.

(2 The discharge shall not have a pH less than 6.5 nor greater than 8.5.

(3 The 30-day average daily discharge flow shall not exceed 5.04 million gallons per day

(4 Survival of aquatic organism in 96-hour bioassays of undiluted waste shall be no less than:
Minimum for any one bioassay - - - - - - - - - 70%
Median for any three or more consecutive bioassays - - - - 90%

Receiving Water Limitations (Discharge shall not cause the following in the receiving water)

(1 Concentrations of dissolved oxygen to fall below 7.0 mg/l.

(2 Oils, greases, waxes, or other materials to form a visible film or coating on the water surface or on the stream bottom.

(3 Oils, greases, waxes, floating material (liquids, solids, foams, and scums) or suspended material to create a nuisance or adversely affect beneficial uses.

(4 Aesthetically undesirable discoloration.

(5 Fungi, slimes, or other objectionable growths.

(6 Turbidity not to increase more than 1 Natural Turbidity Units (NTUs) when natural turbidity is between 0 & 5 NTUs; increase more than 20 % when natural turbidity is between 5 & 50; increase more than 10 NTUs if the natural turbidity is between 50 & 100 NTUs; nor increase more than 10 % when the natural turbidity is greater than 100 NTUs.

(7 The normal ambient pH to fall below 6.5, exceed 8.5, nor cause the normal ambient pH to change by more than 0.5 pH units.

(8 Deposition of material that causes nuisance or adversely affects beneficial uses.

(9 The normal ambient temperature to be increased more than 5°F.

(10 Taste or odor-producing substances to impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin or to cause nuisance or adversely affect beneficial uses.

(11 Radionuclides to be present in concentrations that exceed maximum contaminant levels specified in the California Code of Regulations, Title 22; that harm human, plant, animal or aquatic life; or that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life

(12 Aquatic communities and populations, including vertebrate, invertebrate, and plant species, to be degraded.

(13 Toxic pollutants to be present in the water column, sediments, or biota in concentrations that adversely affect beneficial uses; that produce detrimental response in human, plant, animal, or aquatic life; or that bioaccumulate in aquatic resources at levels which are harmful to human health.

(14 Violation of any applicable water quality standard for receiving waters adopted by the Board or the State Water Resources Control Board pursuant to the CWA and regulations adopted thereunder.

* These effluent discharge limitations may need to be supplemented in the NPDES Permit process, depending on the discharge point (Lake Natoma, Folsom South Canal or Buffalo Creek) and the receiving water (American River, Cosumness River and Mokelumne River).

2.13 Statutory Determinations:

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. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that during the implementation and upon completion of the selected remedial action the action, must comply with applicable or relevant and appropriate environmental standards established under federal and State environmental laws unless a waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The following section discusses how the selected remedy addresses these statutory requirements and preferences.

2.13.1 *Protection of Human Health and the Environment:* Exposure to contaminated groundwater through drinking water supplies is the area of potential risk. The selected remedy will contain the off-property contamination and treat the contamination between the on- and off-property extraction fields to drinking water standards. 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. It is expected that perchlorate and NDMA cleanup levels will drive the cleanup and result in risk levels at the lower end of the USEPA risk range. Water supply wells will be monitored and drinking water wells that will continue to be lost due to Aerojet contamination will be replaced through provision of alternative water supply. Access to contaminated groundwater will be restricted. Any sale or lease of land overlaying contaminated groundwater on Aerojet property will be subject to the following environmental restrictions: No extraction of groundwater; no recharge of groundwater unless and until expressly permitted in writing by the RWQCB; no injection; and no sustained extraction of groundwater encountered during construction expressly permitted in writing by the RWQCB. These restrictions will be implemented through a Declaration of Covenants and Environmental Restrictions, whereby Aerojet covenants to impose these restrictions.

The remedy will not have detrimental cross-media impacts. Treatment systems will comply with air quality requirements. Under direct use, treated groundwater will go directly to the water purveyors closed distribution system. Under surface water discharge on-site, the discharge will comply with the limits specified in Table 2.15; off-site discharge will require an NPDES Permit.

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 or more stringent 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) action-specific requirements; and (3) location-specific requirements. 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.

Chemical-specific ARARs are risk-based cleanup standards or methodologies which, when applied to site-specific conditions, result in the development of cleanup standards for COC.

Location-specific ARARs are restrictions placed on health-based 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.

Table 2.16 - 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 Require-ment	Ground-water (GW)	Federal Safe Drinking Water Maximum Contaminant Levels (MCLs)	Relevant & Appropriate (R&A)	MCLs have been regulated for a number of common organic and inorganic contaminants. These levels regulate the concentrations of contaminants in public drinking water supplies and are considered relevant and appropriate for ground-water aquifers potentially used for drinking water.	The selected remedy will comply with these requirements. The cleanup levels for the VOCs in the aquifer are set at MCLs. Where there are no MCLs for the contaminants, e.g., perchlorate and NDMA, the cleanup levels are based on risk.
State Regulatory Requirement	GW	Title 27, CCR, Section 20410, Title 23, CCR, Section 2550.6	R&A	Groundwater will be monitored according to Title 27/Title 23 regulations	Progress of the remedy will be evaluated by monitoring the water supply wells & established sentinel wells.

Table 2.16 - Description of ARARS for Selected Remedy					
Authority	**Medium**	**Requirements**	**Status**	**Synopsis of Requirements**	**Action to be Taken to Attain Requirements**
State Regulatory Requirement	GW	California Safe Drinking Water Act - Title 22, Division 4, Chapter 15, Articles 4, 5.5, and 8.	R&A	The State has promulgated MCLs for some of the COCs that are more stringent.	The cleanup level for a COC with a state MCL that is more stringent is set at the state MCL.
Federal Regulatory Requirement	GW	National Pollutant Elimination Discharge System (NPDES) Permit	Applicable	A discharge to surface water must comply with effluent and receiving water limitations.	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 an NPDES Permit.
Federal Regulatory Requirement	GW	US EPA Region 9 Preliminary Remediation Goals (PRGs)	Applicable as Performance Standard	USEPA has developed preliminary remediation goals that are risk-based levels that are used to screen sites that may require additional investigation or possible remediation. PRGs may also be considered in setting groundwater cleanup levels in the absence of promulgated MCLs for contaminants.	In the absence of MCLs for perchlorate and NDMA, the cleanup levels for these COCs are based on risk levels. For NDMA, the cleanup level is the PRG. For perchlorate, the cleanup level is the low end of the risk range provided in ORD's 6/18/99 "Interim Assessment Guidance for Perchlorate using standard adult parameters."
Federal Regulatory Requirement	GW	USEPA Drinking Water Health Advisories and NAS Suggested No Adverse Response Levels (SNARLs)	Applicable as Performance Standard	USEPA and the Natural Academy of Sciences (NAS) published risk values for toxicity based factors other than cancer or incremental cancer risk estimates. USEPA and NAS published risk estimates for perchlorate.	The risk values for perchlorate published by USEPA and NAS were considered in establishing the cleanup level for perchlorate at the site.
State Regulatory Requirement	GW	CA Water Code, Division 7, Section 13241, 13243, 13263(a), and 13360 (Porter-Cologne Water Quality Control Act)	Applicable	Authorizes State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board (RWQCB) to establish in water quality control plans water quality standards for the waters of the State/Region (surface and groundwater).	The selected remedy complies with the applicable requirements in the Central Valley Region Basin Plan.
State Regulatory Requirement	GW	Water Quality Control Plan for the Sacramento River and San Joaquin River Basins	Applicable	Those portions of the Central Valley Region Basin Plan which set out the designated uses (i.e., beneficial uses) and the water quality criteria based upon such uses are applicable requirements.	The designated use for the aquifer at the Aerojet Site is municipal and aquatic water supply. The cleanup levels for the contaminated groundwater comply with the water quality criteria based upon such use.

Table 2.16 - Description of ARARS for Selected Remedy

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
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.
State Regulatory Requirement	GW	SWRCB resolution 92-49 (policies and Procedures for Investigation and Cleanup and Abatement of Discharge (Water Code Section 13304 and 13307)	Applicable	Discharges must cleanup and abate the effects of discharges in a manner that promotes the attainment of either background water quality, or the best water quality that is reasonable if background water quality cannot be restored.	Groundwater at OU-3 will be cleaned up to attain best water quality that is reasonable, e.g., 4 ppb for perchlorate and 1.3ppt for NDMA and at a minimum MCLs for VOCs. However, it is expected that as a result of the treatment for perchlorate and NDMA, VOCs will be cleaned up to below MCLs.*
* The Regional Water Quality Control Board, using the requirements established in Resolution No. 92-49 and the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins, would set the cleanup values for cancer causing substances for OU-3 at the incremental $1x10^{-6}$ cancer risk value and not the MCLs. However, cleanup of perchlorate to 4 ug/l and NDMA to 0.0013 ug/l will likely reduce the other COCs to below their respective incremental $1x10^{-6}$ cancer risk values.					
Location-Specific ARARs					
Federal Regulatory Requirement	Within 100-year flood-plain	40 CFR Part 6, Appendix A, Fish and Wildlife coordination Act (16 USC 661 et seq.), and 40 CFR Part 6.302	Potentially Applicable	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 CFR 264.18(b) and 22 CCR 66264.18(b)	Potentially 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	Since the treatment facilities will generate hazardous waste, any facility constructed within a 100 year flood plain shall comply with this requirement.

Table 2.16 - Description of ARARS for Selected Remedy

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Federal Regulatory Requirement	Excavation of terrain which may cause irreparable, harm, loss, or destruction of artifacts	National Archaeological and historical Preservation Act (16 USC Section 469); 36 CFR Part 65	Potentially Applicable	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archaeological data may require actions to recover and preserve artifacts.	The proposed remedial alternatives will not alter or destroy any known prehistoric or historic archeological features west of the Aerojet Site. Areas west of the Aerojet Site are essentially completely developed. However, because there is always a possibility that buried historic or prehistoric remains could be discovered during construction, this regulation would require action to recover and preserve artifacts.
Federal Regulatory Requirement	Critical habitat upon which endangered species or threatened species depend	Substantive portions of the Endangered Species Act of 1973 (16 USC 1531 et seq.); 50 CFR Part 200 and 50 CFR Part 402 Substantive portions of the CA Endangered Species Act Substantive portions of the native Plant Protection Act	Potentially Applicable	Requires action to conserve endangered species or threatened species, including consultation with the Department of Interior, Fish and Wildlife Service.	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 endangered 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 the impact an endangered species shall comply with this requirement.
Federal Regulatory Requirement	Wetlands	40 CFR Part 6 Appendix A	Potentially applicable	Actions must be taken to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.	Could be applicable if treatment facilities are constructed off- site on a wetland. Any construction in wetland would avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.
State Regulatory Requirement	Wetlands	Fish and Game Commission Wetlands Policy (adopted 1987) included in Fish and Game Code Addenda	Could be applicable as a Performance Standard	Actions must be taken to ensure that "no net loss" of wetlands acreage or habitat value occurs. Actions must be taken to restore and enhance California's wetland acreage and habitat value.	Any construction off-site would ensure that no net loss of wetlands or habitat value occurs.
State Regulatory Requirement	Areas affecting stream or river	Fish and Wildlife Coordination Act (16 USC 661 et seq.) And 40 CFR Part 6 Section 302	Potentially Applicable	Restrictions on diversion, channeling or other activity that modifies a stream or river and affects fish or wildlife.	Applicable if treated water will be discharged to surface water. Discharge to surface water shall comply with these restrictions.

Table 2.16 - Description of ARARS for Selected Remedy

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Action-Specific ARARs					
Federal Regulatory Requirement	Generat-ion of waste from construct-ion & operation due remedial action selected	40 CFR Part 261 and 22 CCR Section 66261	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	Generat-ion of waste from construct-ion & operation due remedial action selected	40 CFR Section 262.11 and 22 CCR Section 66262.11	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	Shipment of hazardous wastes for treatment or disposal off-site	40 CFR Section 262.34 and 22 CFR 66262.34	Potentially 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	Discharge to inland surface water	National Toxics Rule, 40 CFR 131.36	Potentially Applicable	Establishes the appropriate aquatic and human health criteria for toxic pollutants in inland surface waters and enclosed bays and estuaries. Included in the National Rule were EPA promulgated specific criteria for certain water bodies in California.	If treated water is discharged to surface water, the discharge shall comply with these requirements.
Federal Regulatory Requirement	Discharge to inland surface water	California Toxics Rule 40 CFR 131.38	Potentially Applicable	Establishes numeric water quality criteria for priority Toxic Pollutants for inland waters in the state of California, the presence or discharge of which could reasonably be expected to interfere with maintaining designated uses.	If treated water is discharged to surface water, the discharge shall comply with these requirements.
State Regulatory Requirement	Discharge to surface water	SWB Resolution Nos. 68-16 and 92-49	Potentially Applicable	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 is potentially applicable if treated water is discharged to surface water.

Table 2.16 - Description of ARARS for Selected Remedy

Authority	Medium	Requirements	Status	Synopsis of Requirements	Action to be Taken to Attain Requirements
Federal Regulatory Requirement	Discharge to surface water	40 CFR Parts 122 and 125 and 23 CCR 2235 et seq.	Potentially 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 an NPDES Permit.
Federal Regulatory Requirement	Storm-water manage-ment	40 CFR Part 122.26 and 23 CCR 2235 et seq.	Potentially 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.
State Regulatory Requirement	Ground-water extraction and treatment	SWB Basin Plan (wastewater reuse policy)	Relevant and Appropriate	Requires evaluation of potential water reuse options and identifies potential reuse options that should be considered prior to disposal of treated groundwater	This policy is a relevant and appropriate in reviewing the options for reuse of the treated water.
State Regulatory Requirement	GW treat-ment waste generat-ion	27 CCR, Division 2, Subdivision 1.	Applicable	Title 27 establishes waste siting classification systems and minimum waste management standards for discharges of waste to land for treatment, storage, and disposal.	Spent GAC will be classified and handled in accordance with Title 27 requirements.
Federal Regulatory Requirement	Organic waste generat-ion into air	Article 27 Air Emission Standards for Process Vents (22 CCR 66265.1030-66265.1035).	Relevant & Appropriate	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.

2.13.3 *Cost-Effectiveness:* In the EPA's judgement, the Selected Remedy is cost-effective and represents a reasonable value. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." [Note: NCP Section 300.430(f)(1)(ii)(D)] This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., the alternatives are both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of remedial Alternative 4C was determined to be proportional to its costs and hence this alternative represents a reasonable value for its

cost.

Long term Alternative 4C has the least residual risk of all the alternatives because it provides for the earliest containment contamination of Layers D and E, thereby significantly reducing the extent of contamination in these layers. By reducing the extent of contamination in Layers D and E, the area for potential residual contamination is smaller. Alternative 4C effectively reduces the mobility of groundwater contaminants, because it uses only extraction and through selective placement of extraction wells for hydraulic control. Because the contamination in Layers D and E is contained, a larger volume of contamination will be remediated. Alternative 4C achieves RAOs in 240 years, 3 percent longer than 4A, but faster than 4B by an estimated 108 years or 31 percent. Using a 30-year net-present-worth method, Alternative 4C is $12.8 M or 13 percent more expensive than the next preferred, Alternative 4B. Under the total undiscounted cost method, which totals the annual costs of the remedy to completion, Alternative 4C is the least expensive remedy at $1,215.7 to $1,219.1M, which is $545.7M or 45 percent cheaper than Alternative 4B.

The selected cleanup level at the low end of ORD's Interim Guidance for Perchlorate (4 ppb vs. the high end of the range18 ppb) is appropriate at this site because there is no appreciable cost difference over the first 30 years of the remedy. The extent of the perchlorate contamination at 4 ppb vs. 40 ppb are almost equivalent, resulting in the same cost for the extraction system at these cleanup levels. The biological treatment system is not concentration sensitive; thus, the treatment cost are approximately the same.

The selected cleanup level for NDMA at 10^{-6} vs. 10^{-5} has an estimated 30-year Present Value impact of $0.9M or less than one percent of the remedy costs. The estimate is based on reducing the volume of NDMA to be treated by UV/OX through segregated piping, electrical rate of $0.78 per kilowatt-hour and interest rate of 7%. UV/OX treatment electrical consumption increases significantly with each order of magnitude reduction in the treatment level. The National Institute of Occupational Safety and Health has categorized NDMA as a potential occupational carcinogen for which no exposure threshold could be identified that would protect 100 percent of the population. The additional cost is appropriate to treat NDMA to 10^{-6} at this site because 1) there is a high cumulative risk with eight other carcinogen in the mix of COC and 2) there is a relative source contribution to be considered because of the presence NDMA in our dietary intake (e.g., bacon, beer, etc.).

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 Alternative 4C provides 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 as outlined as follow:

- Long-term Effectiveness and Permanence: By reducing the extent of contamination in Layers D and E, the area for potential residual contamination is much smaller, thereby reducing the potential for contamination to leach from soil particle.
- Reduction of Toxicity, mobility, or Volume Through Treatment: The mobility of contamination in Layers D and E is restricted in Alternative 4C. More contamination volume is removed because the area of residual contamination is the smallest.
- Short-term Effectiveness: Alternative 4C is projected to achieve remedy completion over 100 years faster than Alternatives 3A, 3B, 4B and 5B. While the time frame is approximately the same for Alternatives 4A and 5A, Alternative 4C restores layers D and E the fastest.
- Implementability: Alternative 4C is not significantly much more complex to implement than other alternatives.
- Costs: Alternative 4C is within 13 percent of the lowest cost protective remedy Alternative 4A and cheapest when evaluated using total undiscounted cost.
- State Acceptance: DTSC and the RWQCB accepts only Alternatives 4B and 4C. The CADHS are opposed to all alternatives with reinjection.
- Community Acceptance: No alternative was clearly favored by the community. However, Alternative 4C was preferred by members of the community interested in the cleanup being implemented as expeditiously as possible.

2.13.5 *Preference for Treatment as A Principal Element:* There are no known source materials or NAPL in OU-3. The largest human health risk is exposure to contaminated groundwater supplies. The selected remedy will treat the contaminated groundwater between the on- and off-property extraction well systems to the cleanup levels. The off-property extraction system will contain the off-property contamination, preventing further contamination of the aquifer. The on-property extraction system will also contain the contaminated groundwater on-property and prevent further contamination moving off-property. The remedy provides the best reduction in volume by containing the Layer D and E contamination the earliest and preventing spreading of contamination over portions of the aquifer which cannot be fully removed.

2.13.6 *Five-Year Review Requirements:* Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining within OU-3 above levels that allow for unlimited use and unrestricted exposure, but it will take more than five years to attain remedial action objectives and cleanup levels, a policy review will be conducted within five years of completion of the physical construction of the OU-3 remedy to ensure that the remedy is, or will be protective of human health and the environment.

2.14 Documentation of Significant Changes: In response to comments from Aerojet received on the National Remedy Review Package, the USEPA added four Layer C (C11, C12,

C13 and C14) extraction wells to the Alternative 4C to prevent contamination from migrating from Layer C to D (See Figure 2-4). The cost estimates were increased accordingly. The proposed plan fact sheet inadvertently omitted these wells but they were appropriately shown on story boards shown to the public at the two public meetings.

The Proposed Plan indicated a range of cleanup levels no higher than MCLs for VOCs with a final cleanup levels to be specified in the ROD. Groundwater at OU-3 will be cleaned up to attain best water quality that is reasonable, e.g., 4 ppb for perchlorate and 1.3 ppt for NDMA and at a minimum MCLs for VOCs although it is expected that as a result of the treatment for perchlorate and NDMA, VOCs will be cleaned up to below MCLs.

PART 3: RESPONSIVENESS SUMMARY

3.1 Stakeholder Issues and USEPA Responses

There was significant community response received at the two public meetings 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. Aerojet expressed a preference for Alternative 4B. The water purveyors provided no alternative preference but oppose any reinjection. The community supported completing the remedy as expeditiously as possible, however, some member of the community expressed a concern over traffic congestion which will be higher for Alternative 4C over 4B in the initial phase of the remedy.

3.2 Technical and Legal Issues

3.2.1 *Technical Issues:*

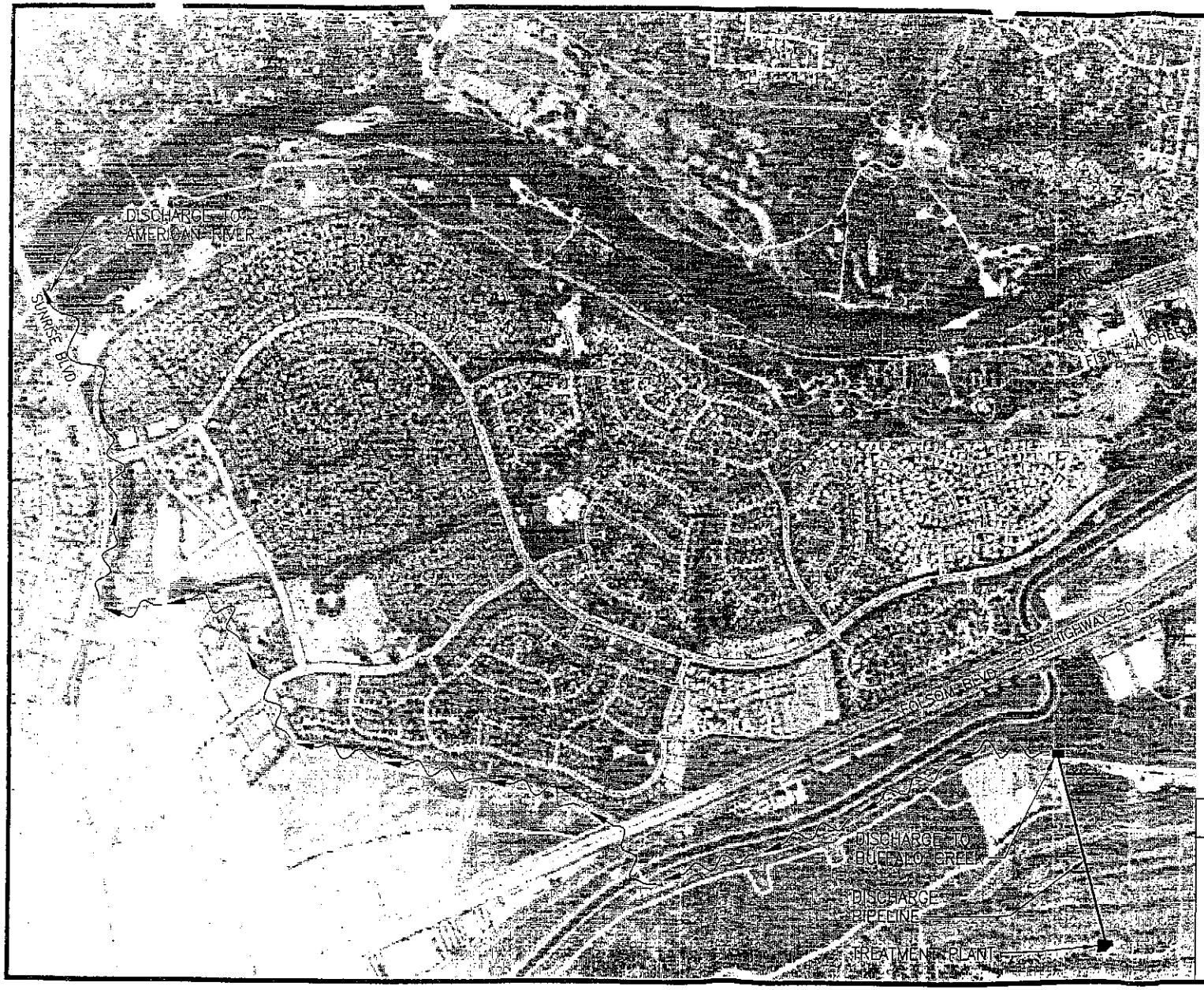
Aerojet has questioned the ability of the Selected Remedy to prevent contamination migration from the more contaminated Layer C to Layer D for the middle row of extraction wells. The USEPA review has indicated the appropriate remedial design can address the concern. Extraction wells C11 through C14 were added to the cost estimate based on particle tracking modeling to address the concern.

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 1.3 ppt is achieved.

3.2.2 *Legal Issues:*

American States Water Co. has filed a lawsuit in State court against DTSC and the RWQCB and a separate lawsuit against Aerojet for the reinjection of perchlorate at GETs E and F. Three toxic torte suits are also pending against Aerojet related to it's Sacramento site.

EXHIBIT D


DISCHARGE TO
AMERICAN RIVER
SUNRISE BLVD
FISH HATCHERY
FOLSOM BLVD
US HIGHWAY 50
DISCHARGE TO
BUFFALO CREEK
DISCHARGE
PIPELINE
TREATMENT PLANT
N
SCALE: 1" = APPROX. 1000'
GenCorp
AEROJET
Aerojet Propulsion Division
Environmental Operations
American River GET
BUFFALO CREEK
DISCHARGE