NAVFACCO

Naval Facilities Engineering Service Center
Port Hueneme, California

Contract No. 47408-04-C-7526

Draft
Record of Decision / Remedial Action Plan (ROD/RAP)
Installation Restoration Program
Site 70
Naval Weapons Station Seal Beach
Seal Beach, California

March 2006

Volume I of I

Prepared by:

GeoSyntec Consultants

2100 Main Street, Suite 150
Huntington Beach, California 92648-2648
www.GeoSyntec.com
(714) 969-0800

DECLARATION

DECLARATION

SITE NAME AND LOCATION

Operable Unit 8, Installation Restoration (IR) Site 70, Research, Testing, and Evaluation Area (RT&E Area)
Naval Weapons Station (NAVWPNSTA) Seal Beach
800 Seal Beach Boulevard, Seal Beach, Orange County, California 90740
United States Environmental Protection Agency Identification Number: CA0170024491

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD)/Remedial Action Plan (RAP) presents the selected remedial action for groundwater at IR Site 70 at NAVWPNSTA Seal Beach. Soil at the site is recommended for no further action.

This document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, 42 *United States Code* Section (§) 9602 et seq., and in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 *Code of Federal Regulations (CFR)* Part 300, et seq. This decision is based on the administrative record file for this site. A site-specific administrative record index is included as Attachment A.

The state of California (through the California Environmental Protection Agency [Cal-EPA] Department of Toxic Substances Control [DTSC] and the Regional Water Quality Control Board [RWQCB] Santa Ana Region) concurs on the selected remedy. Attachment B includes the transcript from the public meeting.

REMEDIAL ACTION PLAN

This ROD/RAP satisfies DTSC requirements for a RAP for hazardous substance release sites pursuant to *California Health and Safety Code* § 25356.1. The RAP requirements are summarized in Attachment C.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from groundwater at IR Site 70, if not addressed by implementing the remedial action selected in this ROD/RAP, may present a current or potential threat to public health and welfare or to the environment.

DESCRIPTION OF THE REMEDY

The shallow groundwater underlying IR Site 70 is contaminated with volatile organic compounds (VOCs). This groundwater contamination appears to have occurred when chlorinated solvents were spilled on the ground surface of the site and migrated through the subsurface soils into the shallow aquifer beneath the site. According to historical documents, the site was constructed and operated by North American Aviation (which later became Rockwell International) under a contract with National Aeronautics and

Space Administration (NASA) for the design and manufacture of the second stage of the Saturn V launch vehicle for the Apollo Program.

A risk assessment was conducted during an extended removal site evaluation to assess the potential cancer and noncancer risks to human health from exposure to contaminants in site soils and groundwater (BNI 1999a). The human-health risk screening for soils estimated an incremental cancer risk (i.e., the risk due to site-specific chemicals of potential concern [COPCs]) above the NCP-defined departure point but within the generally allowable risk management range. Noncancer risks (as measured by the hazard index) were driven by the presence of naturally occurring (background) metals. Both cancer and noncancer risks for soil were evaluated and determined to be acceptable.

A fate and transport evaluation was also performed during the extended removal site evaluation (BNI 1999a). The results indicated that the potential for COPCs in soil to further leach to groundwater and be transported within groundwater was negligible. The potential for adverse impacts to ecological receptors from soil at IR Site 70 was also evaluated and found to be negligible. Accordingly, soil at IR Site 70 is recommended for no further action.

The human-health risk screening for groundwater at IR Site 70 estimated a total cancer risk in excess of the NCP-defined generally allowable range (BNI, 1999a). Estimates of noncancer risk indicate a significant potential for systemic toxicity. No complete exposure pathway exists between contaminants in groundwater and ecological receptors. Thus, contaminants reported in groundwater were not evaluated further for ecological risk. However, since the groundwater at IR Site 70 poses an unacceptable risk to human health, groundwater was recommended for further action (BNI, 2002).

There are two areas of VOC contamination in groundwater at IR Site 70: a highly contaminated source area presumed to contain dense nonaqueous-phase liquid (DNAPL) and a surrounding larger area of lower contamination dissolved in the groundwater. The selected remedy for groundwater at IR Site 70 combines an aggressive biostimulation/bioaugmentation *in situ* treatment option for the suspected source area with a passive *in situ* biobarrier treatment of the dissolved-phase contamination. Within the source area, suitable electron donors will be injected into the groundwater zone where contamination is present. Within the source area the injection of electron donor (and halorespiring bacteria if needed) will be applied through a grid of injection wells over the high concentration plume. These electron donors stimulate indigenous halorespiring microorganisms to completely dechlorinate, through reductive dechlorination, the site COCs to ethene. Where the requisite bacteria are absent or too poorly distributed to allow bioremediation, bioaugmentation with stable halorespiring culture will be required.

Within the more highly contaminated areas of the dissolved plume, biobarriers will be used to segment the groundwater plume into treatment zones. Treated groundwater emanating from a biobarrier will sweep contaminated groundwater into the next downgradient biobarrier.

Bioaugmentation of the source area and biobarriers will likely be required and is recommended to overcome uncertainties regarding the potential of indigenous microorganisms to meet remedial goals within desired timeframes. For both the source area and dissolved plume areas, monitored natural attenuation will be used to complete the remediation.

The selected remedy for groundwater includes:

- *in situ* biobarriers to intercept and treat the dissolved plume as it migrates under natural groundwater flow conditions;
- *in situ* treatment of groundwater in the source area (potential DNAPL area) using a biostimulation/bioaugmentation process;
- hydraulic containment of the dissolved plume using biobarriers;
- use of monitored natural attenuation as a secondary treatment to address residual VOC contamination in the source area and dissolved plume;
- performance monitoring throughout the remedial action; and
- institutional controls to prevent use of or exposure to contaminated groundwater; protect the integrity of the remedial action; and allow access for sampling, installing, operating, and maintaining monitoring wells or remediation equipment, and implementing any remedial measures needed in the future.

In situ groundwater remediation addresses the risk posed by VOC contamination (which can be characterized as the primary threat at this site) by degrading VOCs to harmless by-products, thus permanently destroying the contaminants and significantly reducing the toxicity, mobility, and volume of hazardous substances in groundwater.

Institutional controls are necessary to prevent exposure under future land uses, to protect existing monitoring wells, and to grant access for sampling, installing new monitoring wells, and implementing any additional remedial measures needed in the future. Institutional controls are also necessary to prevent use of contaminated groundwater until remediation is complete. Since NAVWPNSTA Seal Beach is an active station, institutional controls addressing the on-station portion of the groundwater plume would be implemented through the Station Project Review Process. Although off-base migration is unlikely, the United States Department of the Navy (DON), Orange County Health Care Agency (OCHCA), Orange County Water District (OCWD), and city of Seal Beach will determine institutional controls addressing the off-station portion of the groundwater plume to assure that any conditions necessary for adequate protection of public health (e.g., treatment to comply with federal and state drinking water standards) will be included in any permits they issue for construction of wells. The DON will also assist OCHCA, OCWD, and the city of Seal Beach in this process by monitoring wells annually with updated copies of figures delineating the off-station groundwater plume.

The DON will provide necessary information to appropriate local and county agencies to identify off-Base areas impacted by groundwater contamination. The DON will support these agencies with technical information required in order to implement restrictions on construction and use of wells in the affected areas.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. The remedy uses permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable and satisfies the statutory preference for remedies employing treatment that reduces toxicity, mobility, or volume as a principal element.

The effectiveness of the remedial action selected in this ROD/RAP will be reviewed at 5-year intervals at a minimum to assure that the remedy continues to adequately protect human health and the environment and is achieving cleanup goals. Once cleanup goals have been achieved, the 5-year review will no longer apply to this action because hazardous substances will not remain above health-based levels.

ROD/RAP DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary:

- chemicals of concern and their respective concentrations (Section 5)
- risk represented by the chemicals of concern (Section 7)
- cleanup levels established for chemicals of concern and the basis for these levels (Section 8)
- how source materials constituting principal threats are addressed (Section 8)
- assumptions in the risk assessment for current and reasonably anticipated future land use and current and potential future beneficial groundwater use (Sections 6 and 7)
- potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 10)
- estimated capital, annual operation and maintenance, and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (Section 10)
- key factors that led to selecting the remedy (Sections 8, 9, and 10)

Additional information can be found in the administrative record file for this site.

For the United States Department of the Navy, Naval Weapons Station Seal Beach, Seal Beach, California

Signature: ______________________________ Date:__________

R.W. Fowler
Captain, U.S. Navy
Commanding Officer

For the State of California Environmental Protection Agency

Signature: ______________________________ Date:__________

Mr. John E. Scandura, Chief
Southern California Operations
Office of Military Facilities
Department of Toxic Substances Control

Signature: ______________________________ Date:__________

Mr. Gerard Thibeault
Executive Officer
Regional Water Quality Control Board Santa Ana Region

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TABLE OF CONTENTS

Section Page

Section Page

13 REFERENCES

RESPONSIVENESS SUMMARY

Page

ATTACHMENTS

Attachment

FIGURES

Figure

TABLES

ACRONYMS/ABBREVIATIONS

AOC	area of concern
API	American Petroleum Industry
ARAR	applicable or relevant and appropriate requirement
BEI	Bechtel Environmental, Inc.
bgs	below ground surface
BNI	Bechtel National, Inc.
CAH	chlorinated aliphatic hydrocarbon
Cal. Code Regs.	*California Code of Regulations*
Cal/EPA	California Environmental Protection Agency
Cal. Fish & Game Code	*California Fish and Game Code*
Cal. Health & Safety Code	*California Health and Safety Code*
Cal-Modified	California Environmental Protection Agency modified
Cal. Pub. Res. Code	*California Public Resources Code*
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	*Code of Federal Regulations*
ch.	chapter
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CTR	California Toxics Rule
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DCE	dichloroethene
div.	division
DNAPL	dense nonaqueous-phase liquid
DON	(United States) Department of the Navy
DOT	(United States) Department of Transportation
DTSC	(Cal/EPA) Department of Toxic Substances Control
DWR	(California) Department of Water Resources
ERSE	extended removal site evaluation
ESA	Endangered Species Act
ESQD	explosives safety quantity-distance
EVO	emulsified vegetable oil
°F	degrees Fahrenheit
Fed. Reg.	*Federal Register*
FFSRA	Federal Facility Site Remediation Agreement
Freon TF	trichlorotrifluorethane
FS	feasibility study

GAC	granular activated carbon
gpd	gallons per day
gpm	gallons per minute
HERD	(DTSC) Human and Ecological Risk Division
HHRA	human-health risk assessment
HI	hazard index
HQ	hazard quotient
IAS	initial assessment study
IR	Installation Restoration (Program)
JEG	Jacobs Engineering Group Inc.
KB-1™	Commercially available microbial consortia
LGAC	liquid-phase granular activated carbon
μg/dL	micrograms per deciliter
μg/L	micrograms per liter
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
NAPL	nonaqueous-phase liquid
NASA	National Aeronautics and Space Administration
NAVWPNSTA	Naval Weapons Station
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NHPA	National Historic Preservation Act
NOAEL	no observed adverse effects level
NPDES	National Pollutant Discharge Elimination System
NWR	National Wildlife Refuge
OCHCA	Orange County Health Care Agency
OCWD	Orange County Water District
O&M	operation and maintenance
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PA	preliminary assessment
PCB	polychlorinated biphenyl

PCE	tetrachloroethene
ppb	parts per billion
ppm	parts per million
PRG	preliminary remediation goal
RAB	Restoration Advisory Board
RAO	remedial action objective
RAP	remedial action plan
RCRA	Resource Conservation and Recovery Act
Res.	resolution
RFS	revised feasibility study
RI	remedial investigation
ROD	record of decision
RRSEM	Relative Risk Site Evaluation Model
RSE	removal site evaluation
RT&E	research, testing, and evaluation
RWQCB	(California) Regional Water Quality Control Board
§	section
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SVOC	semivolatile organic compound
SWDIV	Southwest Division Naval Facilities Engineering Command
SWMU	solid waste management unit
SWRCB	(California) State Water Resources Control Board
TBC	to be considered
TCE	trichloroethene
TDS	total dissolved solids
tit.	title
TRV	toxicity reference value
UCL	upper confidence limit
U.S.C.	*United States Code*
U.S. EPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
WESTDIV	Western Division, Naval Facilities Engineering Command
WQCP	water quality control plan

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Section 1
SITE NAME, LOCATION, AND DESCRIPTION

This Record of Decision (ROD)/Remedial Action Plan (RAP) presents the selected remedial action for soil and groundwater at Installation Restoration (IR) Program Site 70 at Naval Weapons Station (NAVWPNSTA) Seal Beach in Orange County, California. The United States Environmental Protection Agency (U.S. EPA) Identification Number for this station is CA0170024491. This ROD/RAP satisfies the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC) requirements for a RAP for hazardous substance release sites pursuant to *California Health and Safety Code* (Cal. Health & Safety Code) Section (§) 25356.1.

This document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The decision for this site is based on information contained in the administrative record. A copy of the site-specific administrative record index for IR Site 70 is presented in Attachment A.

1.1 SITE NAME

This decision document addresses soil and groundwater at one site at NAVWPNSTA Seal Beach: Operable Unit (OU)-8, IR Site 70, Research, Testing, and Evaluation (RT&E) Area.

1.2 SITE LOCATION

NAVWPNSTA Seal Beach consists of approximately 5,000 acres located in the City of Seal Beach and county of Orange, approximately 26 miles south of downtown Los Angeles (Figure 1-1). IR Site 70 is located on the west side of the station, east of Seal Beach Boulevard and south of Westminster Avenue (Figure 1-2).

1.3 LEAD AND SUPPORT AGENCIES

NAVWPNSTA Seal Beach is an active federal facility that is being remediated under the IR Program. The station is not on the National Priorities List. The lead agency for remedial investigation (RI) and remedial action at this station is the Department of the Navy (DON). Regulatory agencies providing support and oversight include DTSC and the Regional Water Quality Control Board (RWQCB) Santa Ana Region.

1.4 SITE DESCRIPTION

IR Site 70 consists of multistory office and production buildings, asphalt-paved parking areas, a number of aboveground tanks and attendant above- and belowground piping distribution systems, several concrete-lined sumps, and underground storage tanks (USTs). From 1962 to 1973, the area was used for the design and manufacture of the second stage of the Saturn V launch vehicle for the Apollo Program. From 1980 to 1985,

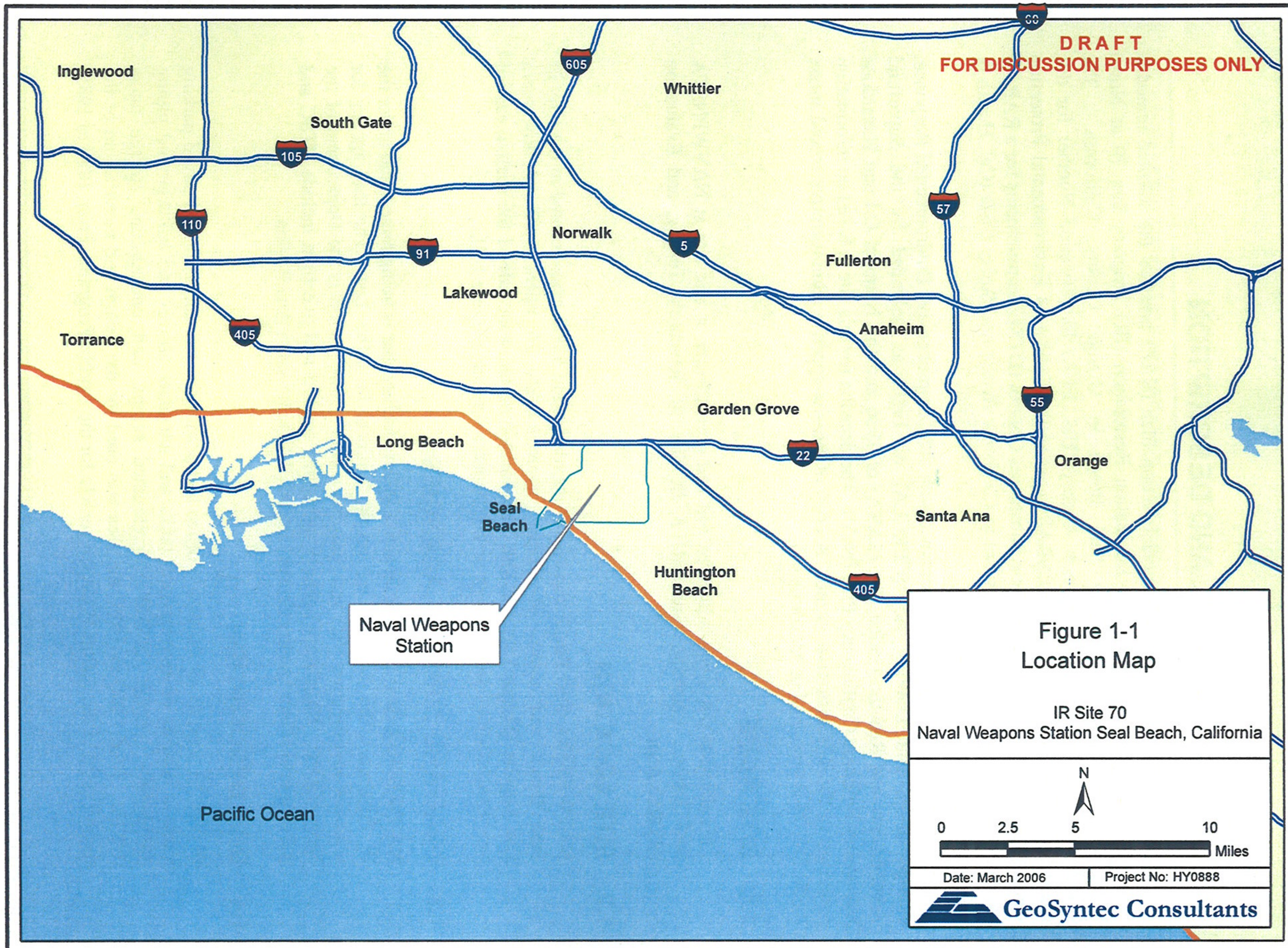

Figure 1-1
Location Map

IR Site 70
Naval Weapons Station Seal Beach, California

Date: March 2006 | Project No: HY0888

GeoSyntec Consultants

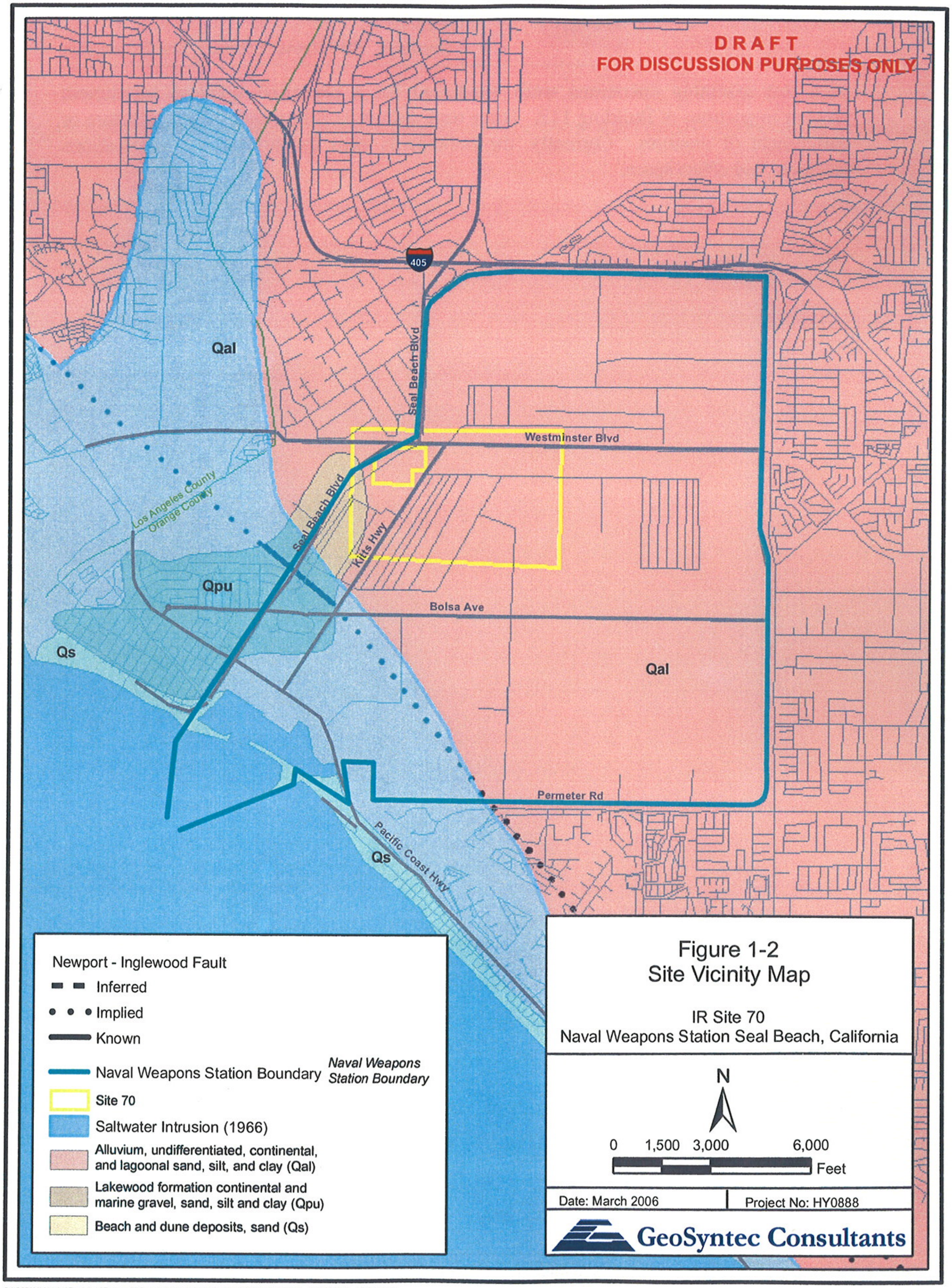

Figure 1-2
Site Vicinity Map

IR Site 70
Naval Weapons Station Seal Beach, California

S:\GIS\HY0888\Projects\RecordOfDecision\Figure1-2_LocalGeology.mxd PRG/SAB 20051013 pilot test assembly operations were conducted for a classified uranium enrichment process in portions of Building 112. These tests did not include either the manufacture or enrichment of uranium. Currently, the building is used for storage, communications research, and office space.

Section 2
SITE HISTORY AND INVESTIGATION ACTIVITIES

This section provides an overview of the history of NAVWPNSTA Seal Beach and summarizes the investigation activities that have taken place at the station.

2.1 SITE HISTORY

NAVWPNSTA Seal Beach is located in Orange County and is bordered by the City of Seal Beach on the north, west, and southwest; the city of Westminster on the northeast; the city of Huntington Beach on the southeast and south; and county land on the south between Edinger and Warner Avenues. The Pacific Ocean borders the station to the south (Figures 1-1 and 1-2).

NAVWPNSTA Seal Beach provides deployment-ready ordnance to ships and analyzes the performance of weapons. The station includes the headquarters, central administrative and support departments, and docking, storage, production, and test facilities. IR Site 70 is located in the western portion of the station. The site consists of multistory office and production buildings, asphalt-paved parking areas, aboveground tanks and attendant above- and belowground piping distribution systems, several concrete-lined sumps, and USTs. Past disposal and waste handling practices resulted in a volatile organic compound (VOC)-contaminated groundwater plume at IR Site 70 that is addressed in this ROD/RAP.

Base supply wells have been used to supply water to the facility and agricultural operations at the base. The current migration of the groundwater plume to a maximum depth of 195 feet below ground surface and over 4,000 feet down gradient from the source threatens multiple aquifers.

2.2 INVESTIGATION ACTIVITIES

There are no enforcement activities related to IR Site 70. Environmental investigation and remediation activities associated with the site are implemented under the stationwide IR Program. The purpose of this program is to identify, investigate, assess, characterize, and clean up or control releases of hazardous substances, as well as to cost-effectively reduce the risk to human health and the environment from past waste disposal operations and hazardous material spills at Navy/Marine Corps stations. The program is administered in accordance with:

- CERCLA, as amended by SARA, and the Community Environmental Response Facilitation Act;
- Resource Conservation and Recovery Act (RCRA); and
- National Environmental Policy Act..

CERCLA is generally applied to inactive sites where a hazardous substance is known to exist or is suspected to have been stored, placed, disposed of, or deposited. RCRA is generally applied to active areas involving solid and hazardous waste management. IR Site 70 is being investigated under CERCLA. The following subsections describe investigations, studies, and removal actions at NAVWPNSTA Seal Beach, including IR Site 70.

2.2.1 General Facility Investigations

In 1985, the DON conducted an initial assessment study (IAS) to investigate potentially contaminated sites at NAVWPNSTA Seal Beach (NEESA, 1985). The IAS was conducted under the Navy Assessment and Control of Installation Pollutants Program, which was the DON version of the Department of Defense IR Program at that time. Twenty-five potentially impacted sites at NAVWPNSTA Seal Beach (IR Sites 1 through 25) were identified based on record searches, aerial photographs, field inspections, and interviews with facility personnel. The study did not identify IR Site 70, because historically it had been the site of non-Navy activities.

In response to DTSC comments on the IAS Report, Naval Energy and Environmental Support Activity (NEESA) completed a preliminary assessment (PA) as an addendum to the 1985 IAS Report (NEESA 1990). This PA reevaluated 16 sites recommended for no further action in the IAS Report, recommended all 16 sites for further study, and identified 17 new sites (IR Sites 35 through 51).

In 1993, Jacobs Engineering Group Inc. conducted a PA of the RT&E Area and issued a final PA Report in 1995 (JEG 1995a). An evaluation of the entire RT&E facility identified ten areas of concern (AOCs) that were recommended for further evaluation to assess the presence or absence of chemicals of potential concern (COPCs). These ten AOCs were identified based on historical activities, use of chemicals, and the likelihood of a potential threat to human health and the environment. The major COPCs identified during the PA were hexavalent chromium, trichloroethene (TCE), phenolic compounds, trichlorotrifluorethane (Freon TF), and heavy metals.

2.2.2 Removal Site Evaluation

In 1996, a removal site evaluation (RSE) was conducted to collect information and to evaluate the qualitative presence or absence of COPCs identified in the RT&E Area (BNI 1996a). Samples were obtained from structures, process piping, soil, and groundwater. The RSE Report recommended that the process piping system and facilities be decommissioned and that soil and groundwater be investigated further (BNI 1996b). The piping and facilities were decommissioned under a separate program (see Section 5.2.3.2) which was documented in the "*Final Closeout Report Decommissioning of Research, Testing, and Evaluation Area Naval Weapons Station, Seal Beach, California*". Soil investigations were recommended for the presence of hexavalent chromium, vinyl chloride, and heavy metals. Groundwater investigations were recommended to delineate TCE in groundwater, determine a potential vadose zone source, and evaluate the nature and extent of hexavalent chromium, phenolic compounds, and heavy metals.

Subsequent to the RSE, the RT&E Area was designated IR Site 70 and formally added to the IR Program in a revision to the Federal Facilities Site Remediation Agreement (FFSRA). IR Site 70 is the only site in Operable Unit 8 (OU-8).

2.2.3 Relative Risk Site Evaluation Model

In 1996, additional soil and groundwater samples were collected in the RT&E Area to obtain analytical data necessary to populate a Relative Risk Site Evaluation Model (RRSEM) (BNI 1996b). This model was used to assist in the prioritization of funding for sites in the IR Program. The RRSEM used data collected at NAVWPNSTA Seal Beach and 14 other bases. The samples collected from the RT&E Area and included in the model indicated the presence of VOCs, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, and metals. The RRSEM confirmed the presence of these contaminants in soil and groundwater. Based on these findings the DON made recommendations to delineate the TCE plume in groundwater and to determine the potential source for the COCs. The DON evaluated the presence of these compounds in subsequent investigations such as the Extended Removal Site Evaluation which served as the Remedial Investigation. The RRSEM was used to justify additional funds for evaluating site conditions at NAVWPNSTA Seal Beach.

2.2.4 Extended Removal Site Evaluation

In 1998, an extended removal site evaluation (ERSE) was conducted to supplement data from the previous investigations at IR Sites 40 and 70 (BNI 1999a). The ERSE included groundwater sampling throughout IR Site 70 and soil sampling at the following four AOCs:

- AOC 2 – Former Stormwater Drainage Channel
- AOC 3 – Salt Marsh Discharge Point
- AOC 4 – Perimeter Drainage Channel
- AOC 11 – Area North of Building 112 (this AOC was added during the ERSE to incorporate the area north of Building 112 where VOCs, SVOCs, PCBs, pesticides, and heavy metals were reported in samples collected during the RRSEM)

The ERSE findings enabled the DON to support a decision of no further action, removal action, or further evaluation by:

- refining the nature and extent of soil and groundwater contamination,
- refining existing geological and hydrogeological site models,
- evaluating the fate and transport of COPCs from soil to groundwater and within groundwater, and
- evaluating soil and groundwater to assess the potential threat to human health and the environment through screening risk assessments.

The vertical and lateral extent of contaminants in groundwater at IR Site 70 were delineated during the ERSE. The contaminants consisted of chlorinated VOCs, primarily TCE and associated degradation products, within a plume with two distinct areas: a source area of higher VOC concentrations suspected of containing dense nonaqueous-phase liquid (DNAPL) and a surrounding larger area of lower VOC concentrations dissolved in the groundwater.

Although results of the screening risk assessment indicated that there was no immediate threat to human health or the environment from groundwater (because groundwater is not currently used for domestic purposes), the ERSE Report recommended further action to address groundwater at IR Site 70, because the cumulative potential human-health risk exceeded the generally acceptable range as defined by the NCP (BNI 1999a). Soil was recommended for no further action (BNI 1999a, 2000a).

The DON determined that the ERSE (BNI 1999a) for IR Site 70 substantially complied with the requirements of an RI under CERCLA and that it was appropriate to proceed directly to a feasibility study (FS) for groundwater. DTSC and RWQCB concurred with this determination.

2.2.5 Aquifer Testing at IR Site 70

Aquifer testing (BNI 1999b) was performed from August to September 1998 to further characterize the saturated zone within the suspected source area and provide data to support evaluation of remedial alternatives in the FS. From November 1998 to February 1999, and from April to June 1999, an extended shallow groundwater aquifer/pilot test was also conducted within the suspected DNAPL area (BNI 1999c, 2000b). The purpose of the test was to confirm the aquifer parameters and determine the effectiveness of low-flow pumping and treating in removing contaminant mass from the shallow groundwater intervals.

Aquifer testing of the deeper water-bearing intervals within the larger dissolved-phase portion of the plume, downgradient of the suspected source area , was conducted between February and May 2002 (BEI 2002a). Data obtained from the aquifer test was used to refine the mathematical groundwater models and support remedial design.

2.2.6 Feasibility Study

A Groundwater FS Report for IR Sites 40 and 70 was finalized in June 2002. The FS evaluated five alternatives based on their ability to contain and/or treat the dissolved plume and suspected source area at IR Site 70 (BNI 2002). *In situ* treatment using chemical oxidation for the suspected source area with a pump and treat component for mass removal of dissolved-phase contamination ranked highest overall using U.S. EPA's selection criteria. Based on these results, the DON decided to perform a pilot test to evaluate the effectiveness of chemical oxidation to convert VOCs in the suspected source area to innocuous by-products.

2.2.7 Pilot Test Program

The chemical oxidation pilot test was conducted from June to September 2001 using a Geo-Cleanse® technology that was selected as a representative process option (BEI 2002b). This technology uses Fenton's chemistry by injecting acids, hydrogen peroxide, and trace quantities of metallic salts (typically ferrous sulfate) into the contaminated media (groundwater in this case). The hydroxyl radicals oxidize organic contaminants to create harmless by-products: water, chlorides, and carbon dioxide. Aquifer quality testing was conducted before, during, and after chemical injection. Results of the pilot test are discussed in futher detail in Section 5 of this ROD/RAP.

2.2.8 Groundwater Monitoring Program

As a result of the groundwater contamination present at the site, IR Site 70 was recommended for inclusion in a 5-year groundwater monitoring program to monitor VOCs, primarily from chlorinated solvents. In 2000, the final Work Plan for Long-Term Groundwater Monitoring at IR Sites 40 and 70 was issued and field activities began that same month (BEI 2000). Seventeen wells located in and around the groundwater plume at IR Site 70 were monitored quarterly for VOCs and semiannually for natural attenuation parameters during the first year of the groundwater monitoring program. Based on analytical results from that year, a reduction in sampling and water-level measurement frequency was recommended and approved by the DTSC and RWQCB (BEI 2002c). During the second year of monitoring, four additional wells were added to the groundwater monitoring program at IR Site 70 to further delineate and monitor the southern extent of the dissolved-phase plume and to monitor changes in the suspected source area following pilot testing (BEI 2002d). During the third year of monitoring, twenty one wells were sampled for VOCs, and a selected subset of these wells were sampled for natural attenuation parameters and 1,4-dioxane. Sampling was performed once for the entire year in the third year. Ten existing and four new wells were added to the single groundwater monitoring event conducted in the fourth year. An additional six wells were installed and added to the monitoring program in the fifth year of monitoring. These six wells were installed to facilitate remedial design/remedial action and to address specific concerns raised by DTSC and RWQCB during their review of previous groundwater monitoring data. This groundwater monitoring program is documented in the annual reports (BNI, 2005).

2.2.9 Revised Feasibility Study

A Revised Feasibility Study was developed for the DON in response to a DON headquarters directive for optimizing remedial actions. Based on advancements in bioremediation of dense non-aqueous phase liquids (DNAPL) and dissolved phase volatile organic compounds, the Revised Feasibility Study evaluated the use of *in situ* bioremediation alternatives for remediating the site. *In situ* biobarriers to treat the dissolved plume and *in situ* bioremediation of the source area rated highest overall among the five balancing criteria. Based on these results, the DON decided to proceed with the enhanced *in situ* bioremediation (EISB) alternative in order to remediate the site.

Section 3
HIGHLIGHTS OF COMMUNITY PARTICIPATION

A Community Relations Plan was developed to document concerns identified during community interviews and to provide a detailed description of community relations activities planned in response to information received from the community (CH2M Hill 2001). The initial plan was prepared in 1993 and revised in 1998 and again in 2001 to update community issues and concerns and to identify information needs related to the ongoing environmental investigation and cleanup efforts at NAVWPNSTA Seal Beach.

The community relations program includes specific activities for obtaining community input and keeping the community informed. These activities include conducting interviews, holding public meetings, issuing fact sheets to provide updates on current cleanup activities, maintaining an information repository where the public can access technical documents and program information, disseminating information to local and regional media, and making presentations to local groups.

3.1 RESTORATION ADVISORY BOARD

A Restoration Advisory Board (RAB) was formed in February 1995 to review and discuss current and projected environmental investigation activities at NAVWPNSTA Seal Beach. Meetings of the RAB include updates on field activities, funding issues, and other technical and administrative matters. RAB meetings are open to the public and are attended by NAVWPNSTA Seal Beach staff, DTSC and RWQCB personnel, city and county health and environmental officials, and interested members of the community.

By sharing information during regularly scheduled meetings with the groups they represent, RAB members help increase awareness and progress of the IR Program process. In addition, members of the public can contact RAB members to obtain information or express concerns to be discussed at subsequent meetings. The RAB meets as needed to discuss project progress, review reports, and comment on investigation and cleanup activities. The RAB also reviews and provides comments on documents involving IR sites, such as SI reports, focused SI reports, RSE reports, RI/FS reports, risk assessments, work plans, engineering evaluation/cost analyses, decision documents, and site closure reports.

Currently, the RAB meets on the second Tuesday of every other month, between 6:00 and 8:00 p.m. at the City of Seal Beach Council Chambers located at 211 8th Street, Seal Beach, California. Copies of the RAB meeting minutes as well as technical reports and other information about the investigation and cleanup of NAVWPNSTA Seal Beach are available at the NAVWPNSTA Seal Beach Information Repository, located at the Seal Beach Public Library, Mary Wilson Branch, 707 Electric Avenue, Seal Beach, California 90740 and at NAVWPNSTA Seal Beach, Environmental Office, Building 110, Seal Beach, California 90740-5000. RAB meeting minutes are also located on the Navy's Southwest Division Naval Facilities Engineering Command (SWDIV) environmental webpage, which can be found at:

http://www.sbeach.navy.mil/Programs/Environmental/IR/IR.htm

3.2 PUBLIC MAILINGS

Public mailings, including information updates, fact sheets, and proposed plans/draft RAPs, have been used to broaden the dissemination of information within the local community. NAVSPNSTA Seal Beach has compiled a mailing list of approximately 300 recipients including local residents; local, state, and federal regulatory agencies; government offices; news media; homeowner's associations; neighborhood watches; newsletters of environmental organizations; city mayors and council members; and other interested parties. Those on the mailing list receive publications, which include information concerning the status of the site investigations, the upcoming remedy selection process, ways the public can participate in the investigation and cleanup, and the availability of the NAVWPNSTA Seal Beach administrative record. Methods used to create and maintain the mailing list include documentation of telephone inquiries, meeting sign-in sheets, and annual updating of the list of elected officials. The mailing list will continue to be updated to support NAVWPNSTA Seal Beach's effectiveness in reaching interested and concerned parties.

3.3 COMMUNITY PARTICIPATION FOR IR SITE 70

The findings, conclusions and recommendations from the ERSE conducted at IR Site 70 were reviewed with the community during the January 1999 RAB meeting. The final ERSE Report for this site was issued in October 1999 (BNI 1999a). Results of the IR Site 70 groundwater FS were presented to the public during the November 1999 RAB meeting. The final Groundwater FS Report for this site was issued in June 2000 (BNI 2002). The final Revised Groundwater FS Report (RFS) for this site was issued in August 2005 (GeoSyntec 2005) and presented to the RAB at the December 2005 meeting. The ERSE, FS, and RFS Reports were made available to the public at the information repository maintained at the Seal Beach Public Library, Seal Beach, California. A Proposed Plan/draft RAP for IR Site 70 was issued to the public on 30 March 2006. A public notice announcing the availability of the ERSE Report, FS Report, and Proposed Plan/draft RAP was published in the *Orange County Register* and the *Seal Beach Sun* on 30 March 2006, approximately two weeks before the start of the public comment period. The public notice also announced the availability of the administrative record file for review. The purpose of the public notice was to invite the interested community members to review these documents and provide comments or questions. A public meeting was held on 18 April 2006 to discuss the Navy's proposed remedy for IR Site 70. A public notice announcing the meeting was published on 30 March 2006 in the *Orange County* Register and the *Seal Beach Sun*. Comments received during the public comment period and the public meeting will be addressed in the Responsiveness Summary portion of the Final ROD/RAP.

Complete administrative record files for NAVWPNSTA Seal Beach are available at Southwest Division, Naval Facilities Engineering Command, 1220 Pacific Highway, San Diego, California 92132-5190. A partial record file is available for review at the NAVWPNSTA Seal Beach, Environmental Office, Building 110, Seal Beach, California 90740-5000, as well as the Seal Beach Public Library, Mary Wilson Branch, 707 Electric Avenue, Seal Beach, California 90740-6196.

Section 4
SCOPE AND ROLE OF OPERABLE UNIT

There are currently eight OUs at NAVWPNSTA Seal Beach: OU-1 through -8. The sites in each OU have been or will be addressed in one or more ROD/RAPs. IR Site 70, the only site in OU-8, is addressed in this ROD/RAP.

OU-1 comprises IR Site 1, Wastewater Settling Pond. A non-time-critical soil removal action was completed in 1999, and the site was subsequently addressed in a No Action ROD that was finalized in April 2002 (SWDIV 2002a).

OU-2 comprises IR Sites 7 (Station Landfill) and 19 (Building 241 Disposal Pit). A non-time-critical removal action was completed at IR Site 7 in 2004 to reduce the potential for exposure to landfill wastes and potentially contaminated soil. A post-closure inspection and maintenance program is currently being implemented at the site. A non-time-critical soil removal action was completed at IR Site 19 in 1998, and the site was subsequently addressed in a No Action ROD that was finalized in April 2002 (SWDIV 2002a).

OU-3 comprises IR Site 22, Oil Island. This site is being evaluated under the IR Program because of potential contamination from disposal of drilling muds, oily wastes, and drill cuttings. A site management plan to reduce the frequency of wildlife receptors visiting the island is being prepared at the site by the Oil Island tenant (Breitburn Energy Corporation).

OU-4 comprises 16 IR sites. Of those 16, IR Sites 2, 3, 6, 13, 21, 23, 25, 35, 36, 37, 38, and 46 were investigated and found not to pose an unacceptable level of risk to human health or the environment. No further response actions are planned at these 12 sites. Non-time-critical soil removal actions have been completed at IR Sites 5 (Clean Fill Disposal Area), 9 (Sandblast Grit Disposal Area), and 20 (Building 68 Mercury Spill). Confirmatory groundwater monitoring is being conducted at IR Site 5 (Explosives Burning Ground). IR Site 40, Concrete Pit Gravel Area, is addressed in a ROD that was issued as a draft in 2004 (SWDIV 2004).

OU-5 comprises IR Sites 8, 12, 16, 39, 42, 43, and 45 and Solid Waste Management Units (SWMUs) 41, 42, and 43. IR Sites 12 and 16 and SWMUs 41, 42, and 43 were investigated and found not to pose an unacceptable level of risk to human health or the environment. No further response actions are planned at these sites/SWMUs. IR Site 39 (Waste Missile Fuel Tanks) was initially included in OU-5 but was removed from the IR Program and placed under the UST program. A non-time-critical soil removal action was completed in 1998 at IR Site 8, Battery Shop Drainage from Building 235. Non-time-critical removal actions are also planned for IR Site 42 (Auto Shop Sump/Waste Oil Tank) and IR Site 45 (Building 88 Floor Drain Outlet) to reduce the risks from exposure to contaminated sediments.

OU-6 comprises ten IR sites. Of those ten, IR Sites 10, 11, 15, 17, 18, and 24 were investigated and found not to pose an unacceptable level of risk to human health or the environment. No further response actions are planned at these six sites. IR Site 41 (Waste Otto Fuel Tank) was initially included in OU-6 but was removed from the IR Program and placed in the UST program. A non-time-critical removal action is planned at IR Site 44 (Former Waste Otto Fuel Drum Storage) to mitigate potential risks from exposure to contaminated ditch sediments. Groundwater monitoring of a petroleum hydrocarbon plume is being conducted at IR Site 14

(Abandoned USTs). At IR Site 4 (Perimeter Road), a non-time-critical removal action for lead in soil at two isolated areas and confirmatory groundwater monitoring were completed in 2004 and 2005, respectively. No further action is planned for Site 4.

OU-7 comprises 2 IR sites (47 and 48), 21 SWMUs, and 2 AOCs (6 and 7). All IR sites, SWMUs, and AOCs included in OU-7 have been investigated and, with the exception of SWMUs 24 and 57, have been found not to pose an unacceptable risk to human health or the environment. No further response action is planned for these IR Sites, SWMUs, and AOCs. A non-time-critical soil removal action was completed at SWMU 24, Stationary Demilitarization Furnace in 2003. A non-time-critical soil removal action is planned at SWMU 57, Paint Locker Area, to mitigate human-health and ecological risks from exposure to contaminants in soil.

OU-8 comprises IR Site 70 (RT&E Area). Remedial action is planned at this site to remediate chlorinated solvents present in groundwater. This ROD/RAP addresses the remedy selection for this site.

In addition to the sites included within the eight OUs, IR Sites 73 and 74 are not included in a designated OU. A non-time-critical removal action was completed at IR Site 73 (Water Tower Area) in 2003, and a non-time-critical removal action is planned at Site 74 (Old Skeet Range) to mitigate potential human-health and/or ecological risks from exposure to lead in soil and sediment.

Section 5
SITE CHARACTERISTICS

This section describes the regional characteristics of NAVWPNSTA Seal Beach, provides a brief history of the sources of contamination at IR Site 70, and summarizes results of sampling performed at this site. This section also discusses potential, past, present, and future migration of the COPCs identified at this site and presents estimates of the mass of TCE present in groundwater. A complete discussion of sampling locations and methodologies, compounds reported at the site, and the nature and extent of contamination appears in the ERSE Report (BNI 1999a).

Interpretations of the nature and extent of contamination at IR Site 70 are based on ERSE data. The ERSE was conducted to supplement data from previous investigations at IR Site 70 and included soil and groundwater sampling. With concurrence of the Navy and regulatory agencies, the ERSE fulfilled the requirements of the RI report in the CERCLA process. Results of the ERSE were used to support the FS.

5.1 REGIONAL CHARACTERISTICS

NAVWPNSTA Seal Beach is situated at latitude 33°45′27″ and longitude 118°04′22″. The station is located within the Los Angeles-Orange County coastal plain. This northwest-trending structural basin is approximately 50 miles long and 20 miles wide with deposits as much as 20,000 feet thick. Basin morphology was developed through the mechanisms of folding, faulting, erosion, and fluctuating sea levels (JEG 1995a).

Most of the station lies on predominantly flat alluvial deposits in the southeastern portion of the Los Angeles Basin. The Los Angeles Basin is bounded on the north by the Santa Monica Mountains; on the northeast by the Repetto and Puente Hills; on the east and southeast by the Santa Ana Mountains and the San Joaquin Hills; and on the south, southwest, and west by the Palos Verdes Hills and the Pacific Ocean.

The land at NAVWPNSTA Seal Beach slopes evenly from approximately 20 feet above sea level in the northwestern part of the station to sea level in the tidal flats of the Seal Beach National Wildlife Refuge (NWR) in the southeast (Figure 5-1). The most pronounced topographic feature at the station is part of Landing Hill along the southwest boundary. Landing Hill reaches a maximum elevation of about 50 feet above mean sea level
(JEG 1995a).

The area climate is classified as a marine-influenced southern California coastal region with mild winters that average 52 degrees Fahrenheit (°F) and summers that average 68 °F. Temperatures range from winter lows in the 30s °F to summer highs in the 90s °F. Annual precipitation averages 12.5 inches with approximately 90 percent occurring between the months of November and April. Although precipitation is low, a high humidity level is sustained due to the proximity of the Pacific Ocean (JEG 1995a). Prevailing winds average 3.8 miles per hour from the west. Occasional strong, dry winds from the northeast, known as the "Santa Anas," occur in the fall, winter, and early spring (JEG 1995a).

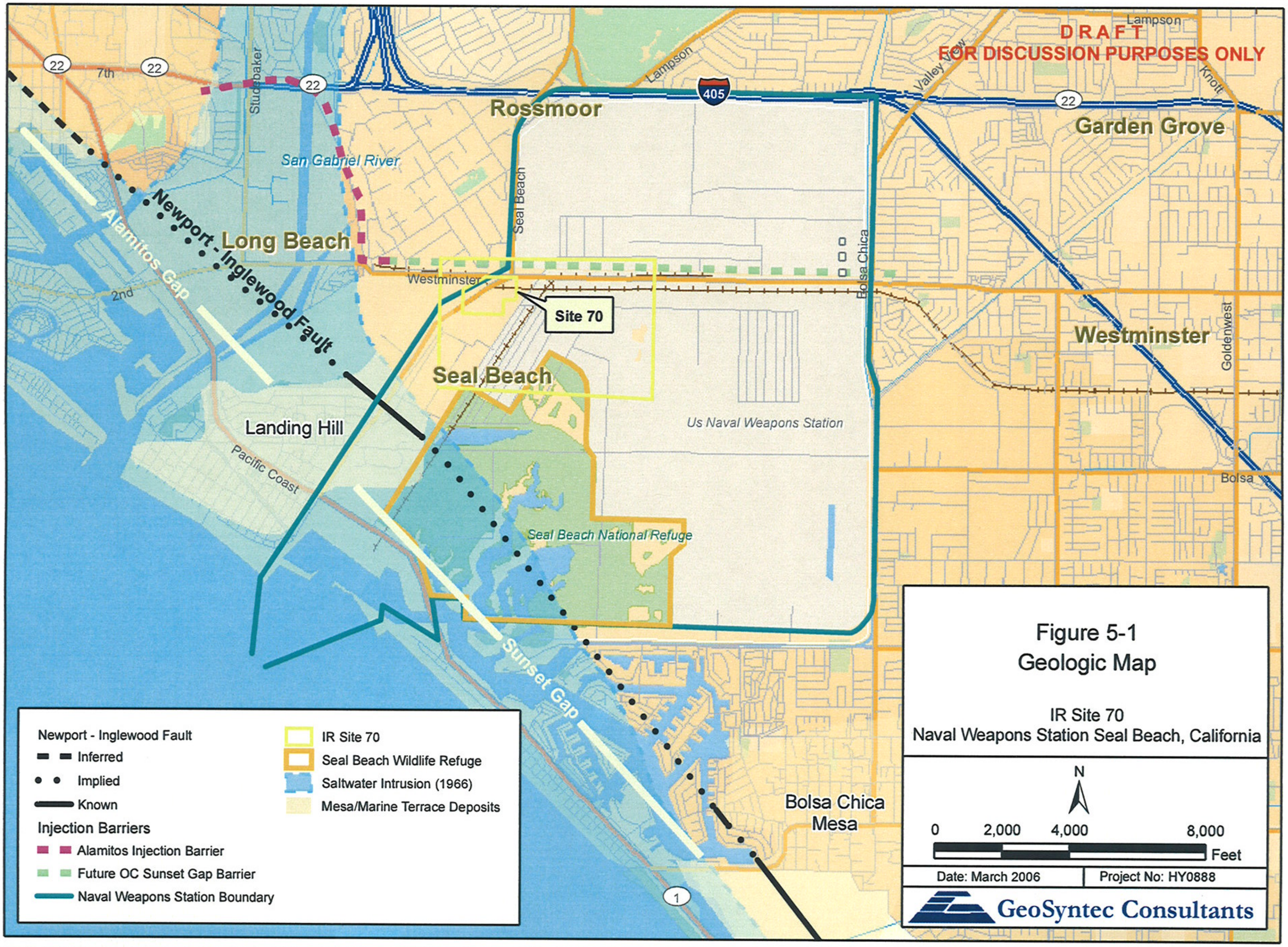

Figure 5-1
Geologic Map

IR Site 70
Naval Weapons Station Seal Beach, California

Date: March 2006 | Project No: HY0888

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Periodically, the region is subjected to a phenomenon called "El Niño," which brings unusually high precipitation, flooding, high winds, and temperatures outside the expected range. The station was subjected to this El Niño weather pattern in 1997–98. This pattern resulted in extremely high winds, higher than normal tidal cycles, a rise in groundwater level, flooding, and ponding in otherwise dry areas.

5.1.1 Geology and Hydrogeology

Two faults, the Seal Beach Fault and the Los Alamitos Fault, traverse portions of the station (Figure 5-1). They are part of the Newport-Inglewood Fault zone.

The Seal Beach Fault is located in the southern portion of the Newport-Inglewood Fault zone. It is a right lateral oblique fault with the south side displaced upward relative to the north side. Vertical displacement is approximately 5 feet in the upper Pleistocene units (Ebersold 1997). Movement along the fault since or during Recent alluvium deposition has not displaced Recent sediments. On the station, the Seal Beach Fault has uplifted Upper Pleistocene deposits at Landing Hill and Hog Island, cutting diagonally across the station and parallel to the coast (JEG 1995a). Apparent movement is nearly vertical with the south side displaced upward relative to the north side. There is also evidence of apparent right lateral motion (Ebersold 1997).

The Los Alamitos Fault lies parallel to the Seal Beach Fault and about 2.25 miles northeast of the Alamitos Gap. The Los Alamitos Fault has little effect on the movement and quality of groundwater in the Lower Pleistocene San Pedro Formation and is older than the active Seal Beach Fault (JEG 1995a).

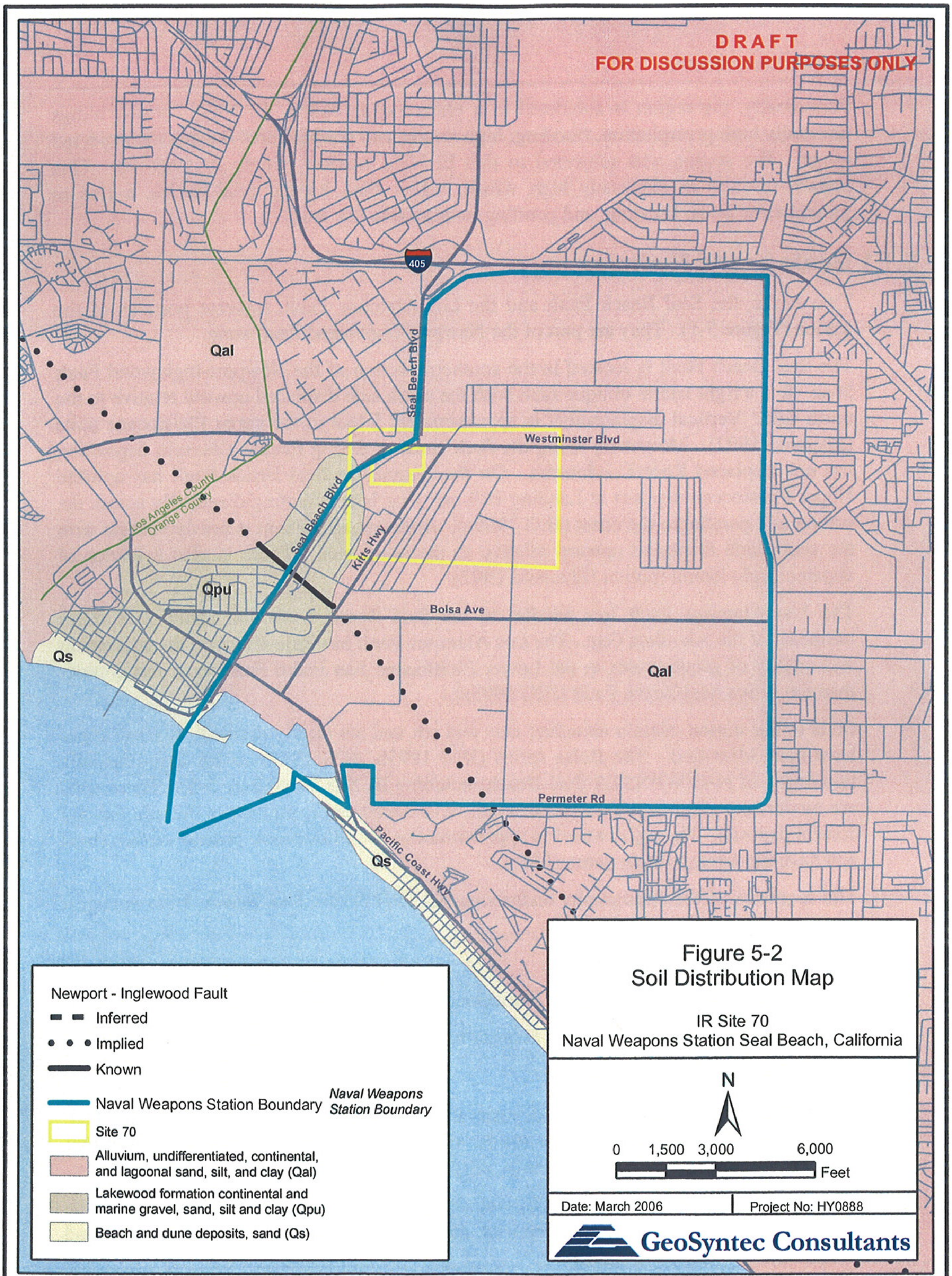
Soils at the station contain abundant clay and silt and are poorly drained. Six soil types have been identified. The Bolsa series (JEG 1995b, SCS 1978) covers approximately two-thirds of NAVWPNSTA Seal Beach including IR Site 70 (Figure 5-2). These soils are moderately alkaline and calcareous and have developed from largely flat alluvial and coastal deposits. The soils extend to approximately 49 inches below ground surface (bgs) and have moderate to slow permeability.

The sequence of the stratigraphy underlying NAVWPNSTA Seal Beach, from youngest to oldest, is:

- Recent alluvium,
- Upper Pleistocene Lakewood Formation,
- Lower Pleistocene San Pedro Formation, and
- Pliocene Pico Formation.

The maximum thickness of Recent deposits in the region is approximately 80 to 100 feet. The upper 50 feet consists of fine sands, silty clays, and clays, while the lower unit consists of sands and gravels, silty sands, silty clays, and clays.

Transitional, shallow marine, and fluvial deposits of great variability are part of the Upper Pleistocene sand and clay deposits, starting at approximately 80 to 100 feet and



S:\GIS\HY0888\Projects\RecordOfDecision\Figure5-2_SoilDistribution.mxd PRG/SAB 20051013 continuing to depths beyond the scope of investigations at IR Site 70. Units are discontinuous and contain zones of high and low permeability. The maximum thickness of the Lakewood Formation is approximately 350 feet in the city of Lakewood (DWR 1961).

NAVWPNSTA Seal Beach is located at the southwestern corner of the Orange County Basin. The Orange County Basin contains the Artesia, Gage, Hollydale, Jefferson, Lynwood, and Silverado aquifers. The Lynwood and Silverado aquifers are merged across most of the station (JEG 1995a). There are four general aquifer zones at the station (JEG 1995a):

- a semiperched, unconfined zone within the upper Recent alluvial deposits
- a confined fresh groundwater zone contained in lower Recent alluvial deposits
- Late and Early Pleistocene deposits of the Lakewood and San Pedro Formations, respectively, and in some parts, deposits of the Late Pliocene Pico Formation
- a confined zone of saline water underlying the freshwater zone

Shallow groundwater underlying the station (upper Recent alluvial deposits) is within the Lower Santa Ana River Groundwater Basin (Orange County Management Zone) (RWQCB 1995). Beneficial uses of groundwater within the Orange County Management Zone include municipal and domestic supply, agriculture, industrial service supply, and industrial process supply. Shallow groundwater underlying IR Site 70 currently does not serve as a water source for any of the beneficial uses designated in the Water Quality Control Plan, Santa Ana River Basin (Basin Plan with addendums) (RWQCB 1995).

The principal freshwater body (lower Recent alluvial deposits and Upper Pleistocene Lakewood Formation) is a large confined aquifer occupying two zones. The first zone is approximately 75 to 200 feet deep and saline. The second zone is approximately 250 to 1,000 feet deep and primarily freshwater. This aquifer is the primary water supply source for neighboring cities. Groundwater levels in the principal freshwater zone fluctuate from year to year due to variations in pumping, infiltration, and recharge. Recharge to this aquifer is primarily from unconfined areas upgradient and from unlined rivers that are hydraulically connected to the aquifer. Seasonal variations occur with highs in the wet winter months and lows in the dry summer months when large quantities of water are used for irrigation (JEG 1995a).

5.1.2 Surface Water Hydrology

Surface water at the station drains through ditches and tidal sloughs in flat-lying clay deposits. Ditch stream flow is intermittent and depends on rainfall and excess irrigation runoff. Ditches at the tidal flat margins also receive saltwater during high tides. Drainage from the station flows predominantly into Anaheim Bay with minor amounts discharged into the Bolsa Chica Flood Control Channel (JEG 1995a). Seawater from Anaheim Bay flushes the salt marsh twice a day by flowing beneath the

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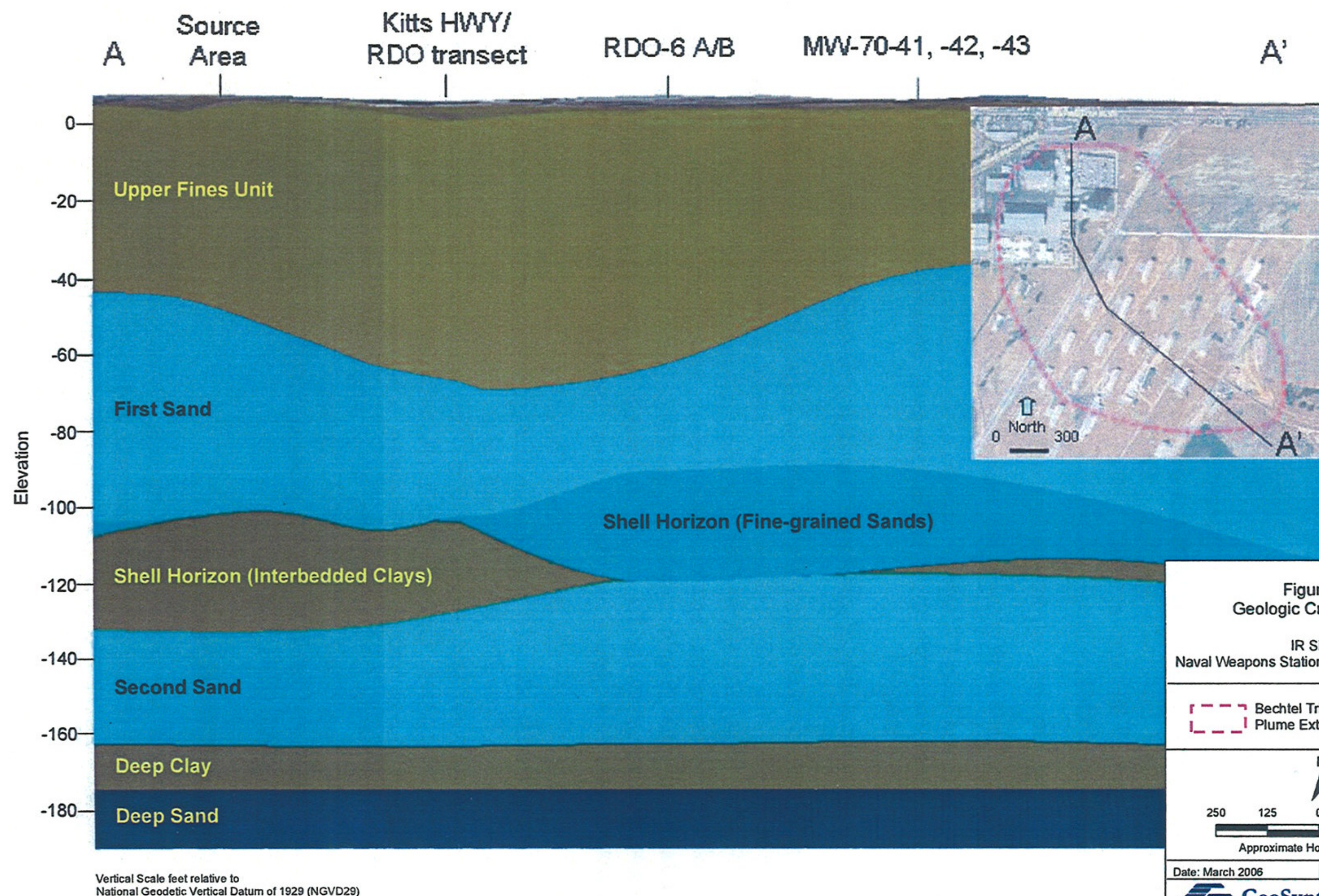

Figure 5-3
Geologic Cross Section

IR Site 70
Naval Weapons Station Seal Beach, California

Bechtel Trichloroethene Plume Extent

N

250 125 0 250 Feet

Approximate Horizontal Scale

Date: March 2006 | Project No: HY0888

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Pacific Coast Highway and into the tidal flats. Raised roadbeds serve as barriers to control tidal flooding.

Flooding brought about by a tsunami of the 100-year recurrence interval would affect only a small area along the beach because of the presence of seawalls and high street profiles. Only low-lying areas of NAVWPNSTA Seal Beach would be inundated in the event of a 500-year flood resulting from the Santa Ana River overflowing. The river lies approximately 12 miles east of the station (JEG 1995a).

5.2 SITE CHARACTERISTICS/CONCEPTUAL MODEL

IR Site 70 is located in the western portion of NAVWPNSTA Seal Beach (Figure 1-2). The site is approximately 40 acres in size and is mostly paved. The site consists of multistory buildings, parking areas, aboveground and underground storage tanks, and piping systems.

5.2.1 Geology and Hydrogeology

Sediments present at IR Site 70 span a wide range of lithologies and grain sizes (Figures 5-3 and 5-4). The geologic units observed at IR Site 70 are as follows (BNI 2002).

- Surficial Soils – Fill materials, including sandy clay and predominantly fine-grained clayey sand to silty sand up to about 7 feet thick. Off-site to the southeast, surficial soils consist of approximately 2 to 17 feet of native sand, silty sand, clayey sand, and sandy clay, occasionally including thin lenses of silt, silty clay, and clay.
- Shallow Clay Unit – A typically 15- to 25-foot-thick interval consisting of clay to silty clay, which grades locally to sandy clay, clayey silt, or silt. Shallow groundwater has been typically encountered within the coarser-grained surficial materials in the underlying clay or just beneath the clay, depending on the location and time since the last rainfall.
- Interbedded Unit – Interbedded clays, sandy clays, clayey sands, silts, and silty sands. This unit is typically thickest in the northwest, where it extends to approximately 54 feet, thinning southeastwardly to a 3- to 10-foot-thick sandy silt to silty sand interval.
- First Sand Unit – Fine- to medium-grained sand, with coarse-grained sand to gravel, grading to silty sand in some areas. The unit also seems to contain several discontinuous silt, silty clay, or clay interbeds. The total unit thickness typically varies from approximately 40 to 80 feet, thickening to the southeast. The top of the unit varies from 22 to 54 feet bgs (and is deeper to the north); its base occurs at 87 to 115 feet bgs.
- Shell Horizon – Sand and shells. The sand is typically fine- to coarse-grained, although it is locally fine-grained or fine- to medium-grained. Depth to the top of the shell unit ranges from 87 to 115 feet bgs. The unit typically extends to 96 to 130 feet bgs.

- Second Sand Unit – The shell horizon is underlain by another unit consisting mainly of sand. The sand is typically fine- to coarse-grained, although it locally contains gravel, which grades to silty sand in some areas. The unit also contains apparently discontinuous silt, silty clay, or clay interbeds in some areas. The top of the unit varies from 96 to 130 feet bgs; its base occurs at 164 to 176 feet bgs. The total unit thickness varies from 34 to 78 feet but pinches out to the southeast.
- Deep Clay Unit – An apparently continuous unit consisting mainly of clay to silty clay is encountered at depths between 164 to 176 feet bgs. The unit grades to clayey silt, silt, sandy silt, or sandy clay in some areas. It is 3 to 20 feet thick, extending to between 175 and 188 feet bgs. The unit is underlain by up to 6 feet of silty sand and sand to the maximum depth of the ERSE borings of 191 feet bgs.

Groundwater first appears at IR Site 70 at approximately 12 to 16 feet bgs in the shallow zone. Groundwater flow direction varies seasonally, ranging from the northwest to the southeast. Occasionally, groundwater flows to the southwest, possibly caused by a trough that is present in the shallow groundwater potentiometric surface in the general area of well EW-70-01 (Figure 5-5). This trough appears to be caused by an old stream drainage system that flowed through the current location of IR Site 70 (BEI 2002c). There is negligible tidal influence upon groundwater at this site.

Groundwater flow patterns within the deeper zones are less complex than that of the shallow zone (Figures 5-6 through 5-8). Groundwater within the deeper zones flows generally toward the southeast.

A consistently downward gradient was measured between the shallow- and intermediate-zone wells screened at depths less than or equal to 40 feet bgs and 50 to 60 feet bgs, respectively. A smaller but also downward gradient was measured between the deeper zone wells screened between 95 and 110 feet and between 160 and 170 feet (BEI, 2002c).

The shallow clay unit may locally act as a confining layer; however, there is no evidence of significant hydraulic pressure buildup beneath the clay. Therefore, it is concluded that the shallow aquifer in the vicinity of IR Site 70 may be semiconfined. During the ERSE, shallow groundwater was typically encountered within the coarser grained surficial materials, in the underlying clay or just beneath the clay, depending on the location and time since the last rainfall (BNI 1999a).

Water-level data indicate that seasonal influences affect the groundwater level in all aquifer zones measured. The magnitude of fluctuation during the 5-year period beginning June 2000 and ending in June 2005 was approximately 10 feet on average (BNI 2005). The highest levels were generally measured in March and April, and the lowest levels were measured in October and November.

Based on the ERSE, general groundwater chemistry data indicate the following (BNI 1999a).

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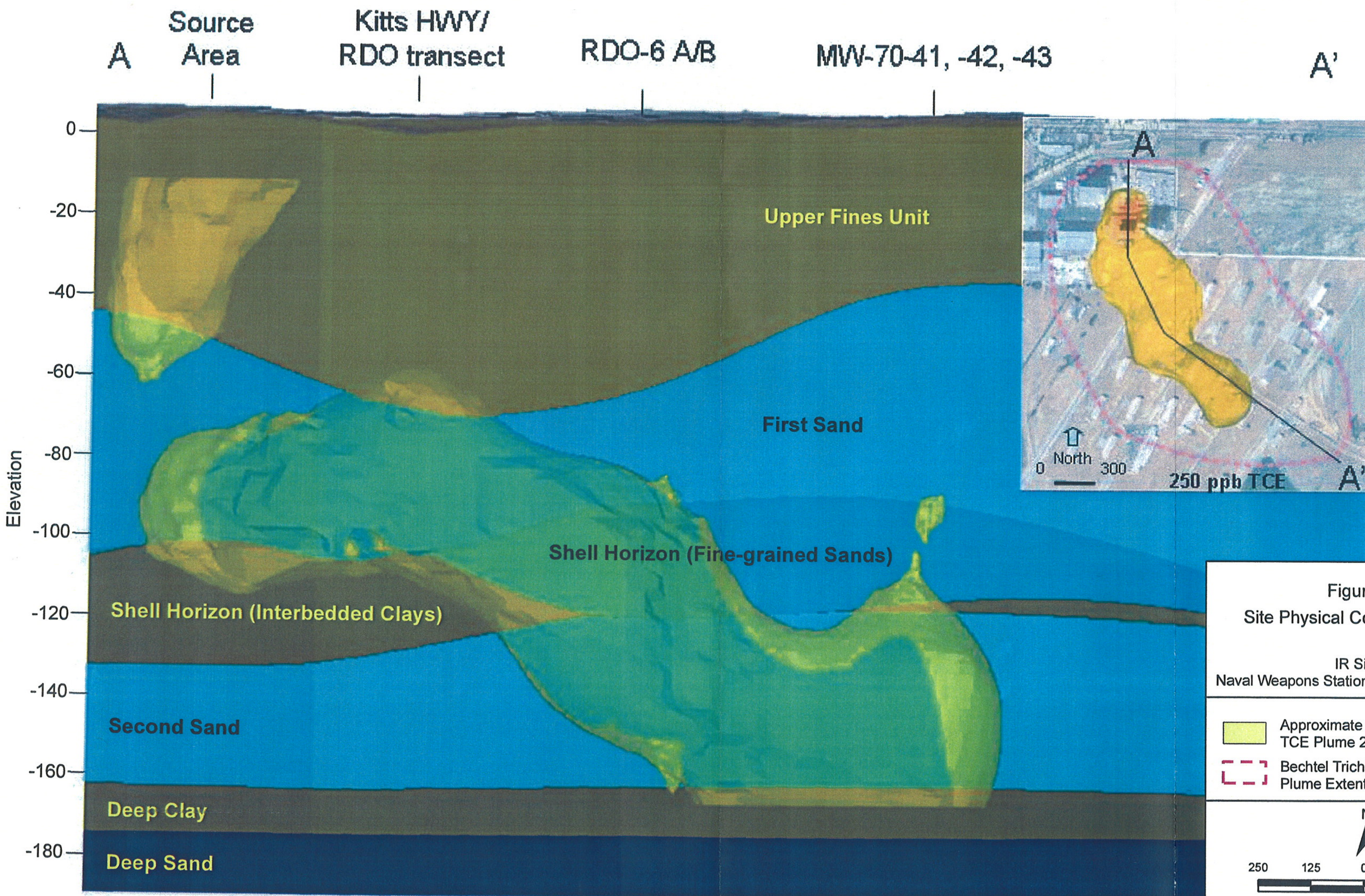

Vertical Scale feet relative to
National Geodetic Vertical Datum of 1929 (NGVD29)
ppb = parts per billion

Figure 5-4
Site Physical Conceptual Model

IR Site 70
Naval Weapons Station Seal Beach, California

Approximate Extent of IR Site 70 TCE Plume 250 ppb January 2006

Bechtel Trichloroethene (TCE) Plume Extent

N

250 125 0 250 Feet

Approximate Horizontal Scale

Date: March 2006 | Project No: HY0888

GeoSyntec Consultants

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Figures 5-5 to 5-8

These detailed station maps have been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

- Total dissolved solids (TDS) indicate that groundwater quality at IR Site 70 ranges from fresh to saline, depending on location and depth interval.
- Chloride is the major anion present in groundwater beneath IR Site 70.
- Major cations include calcium, magnesium, sodium, and potassium.
- Dissolved gases (methane, ethane, and ethene) are locally present.
- Dissolved iron and manganese are locally present.
- Total organic carbon is locally present; the highest concentrations are reported in samples from center-of-plume wells within the defined boundary of the VOC plume.
- Specific conductance and salinity values indicate that shallow groundwater underlying IR Site 70 ranges from fresh to brackish to slightly saline.
- pH values suggest that the groundwater is slightly basic.
- Dissolved oxygen concentrations and oxidation-reduction potential (ORP) values indicate the groundwater environment beneath the area is moderately reducing to reducing. ORP values were positive within the shallow-water interval and negative within the intermediate and deeper water intervals.
- Ferrous iron is present locally.

5.2.2 Site History

IR Site 70 was used from 1962 to 1973 for the design and manufacture of the second stage of the Saturn V launch vehicle for the Apollo Program. According to historical documents, the site was constructed and operated by North American Aviation (which later became Rockwell International) under a contract with NASA. Subsequent to NASA leaving the area, United States Department of Energy and Garrett Engineering (Allied Signal) conducted pilot test assembly operations for a classified uranium enrichment process in portions of Building 112 (Figure 5-9). These tests were conducted from 1980 to 1985. They included neither the manufacture nor enrichment of uranium. Currently, Building 112 is used for storage, communications, research, and office space.

The RSE Report (BNI 1996a) for the IR Site 70 area addressed potential waste sources from the following facilities:

- Bulkhead Fabrication Building 128
- Vertical Assembly and Hydrotest Building 112
- Pneumatic Test, Paint, and Packaging Building 110
- Tool and Maintenance Building 130
- Structural Test Tower
- Water Conditioning Plant

Operations at these facilities were reported to have involved the use of dilute acids, chlorinated solvents, phenolic compounds, petroleum oils, sodium dichromate, detergents, paint waste, VOCs, and lubricating oil. Discharged wastewater was reported to contain high TDS, sodium, and chloride concentrations, and high or low pH.

5.2.3 Site Investigations

Following is a summary of previous investigations conducted at IR Site 70.

5.2.3.1 PRELIMINARY ASSESSMENT

In 1993, Jacobs Engineering Group Inc. conducted a PA of IR Site 70 (JEG 1995a). The PA identified ten AOCs and recommended them for further evaluation to assess the potential presence of COPCs. AOCs were identified for further consideration based on historical activities, use of chemicals, and the likelihood of a potential threat to human health and the environment. Major COPCs identified were hexavalent chromium, TCE, phenolic compounds, Freon TF, and heavy metals. No samples were collected as part of the PA.

5.2.3.2 REMOVAL SITE EVALUATION

In 1996, an RSE was performed to collect information and evaluate the qualitative presence or absence of the COPCs that were identified in the PA Report. Ten AOCs were investigated during the RSE field activities (BNI 1996a). AOCs 2, 3, and 4 are shown on Figure 5-9. Descriptions of the AOCs follow:

- AOC 1, Industrial Waste Discharge Line – the underground industrial waste discharge pipeline originating from Buildings 128, 112, and a tanker truck connection in the RT&E Area that discharges to the San Gabriel River/Westminster Avenue bridge
- AOC 2, Former Stormwater Drainage Channel – the former location of a stormwater drainage channel that was adjacent to the water conditioning plant and Building 110
- AOC 3, Salt Marsh Discharge Point – the location of a previous discharge point for the stormwater drainage channels to the salt marshes south of the RT&E Area
- AOC 4, Perimeter Drainage Channel – the existing cement-lined stormwater drainage channel, notably in the areas north of Building 112, southeast of Building 122, and near the location of the former structural test tower
- AOC 5, Processing Pit, Etchant Spray Booth, and Cleaning Areas in Building 128 – process sumps, floor areas, and any remaining product piping not in service in the processing pit, etchant spray booth, and cleaning pit areas
- AOC 6, UST South of Building 128 – the UST for hydrotest water located south of Building 128

Figure 5-9

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

- AOC 7, Piping and Equipment Associated With TCE and Hydrotest Systems in Building 112 – all abandoned piping, storage tanks, pumps, and equipment associated with the TCE and hydrotest water systems in the basement level of Building 112
- AOC 8, Boom Pit, TCE Sump, and Basement Floor in Building 112 – the boom pit, TCE sump, and basement floor of the hydrotest area
- AOC 9, Sumps and Containment Areas – the concrete sumps and containment areas that drained to the stormwater channels at the water conditioning plant
- AOC 10, TCE and Hydrotest Supply and Return Lines – the TCE and hydrotest water supply and return lines from the water conditioning plant to Building 128, Building 112, and the location of the former structural test tower

Thirty-two soil borings were drilled and soil samples were analyzed to evaluate the presence of COPCs in soil at AOCs 2, 3, and 4. All samples collected were analyzed for VOCs and metals; selected samples from each AOC were also analyzed for hexavalent chromium. Sampling results showed that TCE, methyl ethyl ketone, and Freon TF were below the screening criteria (residential soil preliminary remediation goals [PRGs]) for each analyte in all soil samples. TCE breakdown products (1,1-DCE, trans-1,2-DCE, and cis-1,2-DCE) and vinyl chloride (with the exception of three samples) were reported below the respective residential soil PRG value. Further investigation of TCE and its daughter products was recommended to determine whether soil may be a potential source of continued groundwater contamination.

Hexavalent chromium was not reported above the detection limit in any soil samples collected from AOCs 3 and 4, but a soil sample at AOC 2 had reported hexavalent chromium exceeding the California Environmental Protection Agency modified (Cal-Modified) PRG. The RSE recommended that additional work be conducted to assess the impact of hexavalent chromium in soil at AOC 2 and that a human-health and ecological risk screening of hexavalent chromium in soil be performed.

Eight heavy metals were reported at concentrations above the NAVWPNSTA Seal Beach background screening criteria. The RSE recommended a human-health and ecological risk screening be performed for these eight metals. On the basis of the above results, the RSE recommended further investigation, geochemical evaluation, and both human-health and ecological risk screening, as appropriate for soils.

Fifteen temporary well-point groundwater samples were also collected throughout IR Site 70 to obtain preliminary water quality data for shallow groundwater. All groundwater samples were analyzed for VOCs. Select samples were also analyzed for hexavalent chromium, metals, and phenols. Sampling results indicated that TCE was present in several groundwater samples at concentrations exceeding the maximum contaminant level (MCL), and a TCE plume was present in the vicinity of the tank farm. The RSE recommended that further investigation be conducted to delineate the lateral and vertical extent of the TCE plume and to identify and delineate potential vadose zone contaminant sources. Human-health and ecological risk screening for TCE and breakdown products in groundwater was also recommended.

Hexavalent chromium was reported in four samples at concentrations at or slightly above the method detection limit of 6 micrograms per liter (µg/L). Phenolic compounds were generally reported in very low concentrations with one exception. Because the locations where the phenolic compound was reported coincide with the location of the TCE plume, the RSE recommended further investigation for phenolic compounds, including a human-health and ecological risk screening.

Since four metals (antimony, arsenic, manganese, and nickel) were reported in groundwater at concentrations exceeding the screening criteria, the RSE recommended that further investigation of these metals be conducted, including a human-health and ecological risk screening.

Additionally, structures and piping systems in AOCs 1 and 5 through 10 were inspected to determine their contents, identify COPCs, and determine their structural integrity. Based on the subsequent findings, the RSE recommended that:

- AOC 1, including the industrial waste discharge line, be decommissioned and that a soil investigation be conducted to assess the environmental impact of a rupture in the industrial waste discharge line that occurred off-site;
- no further action be required for AOC 5;
- the UST and associated piping be decommissioned at AOC 6 due to the presence of hexavalent chromium;
- the piping and equipment at AOC 7 be decommissioned due to the presence of hexavalent chromium and TCE;
- AOC 8 be decommissioned and that TCE and other VOCs reported during the investigation be removed from the boom pit shaft and basement floor during decommissioning activities;
- no further action be required for AOC 9 after the removal of hexavalent chromium contaminated solids from the sumps; and
- the piping and equipment at AOC 10 containing chromated water and TCE be decommissioned and that asbestos found during the investigation be removed during the decommissioning.

The Battelle/Foster Wheeler Environmental Corporation team conducted the decommissioning of the RT&E Facility under Navy Remedial Action Contract No. N47408-95-D-0730. This decommissioning work included work in four areas; Building 112 (AOC 7, 8, 9, and 10) , the Tank Farm (AOC 7), the underground storage tank (UST) area (AOC 6), and the industrial waste line (AOC 1). The scope of work involved draining, flushing, cleaning, and leak-testing of the identified pipelines and storage tanks associated with each area. The work also included the removal of TCE-containing groundwater from the basement of Building 112. All excavations created during the decommissioning were backfilled, compacted, and restored to the original surface and grade. This work is documented in the "*Final Closeout Report Decommissioning of Research, Testing, and Evaluation Area Naval Weapons Station Seal Beach, California* prepared by Battelle 17 February 1998.

5.2.3.3 RELATIVE RISK SITE EVALUATION MODEL

In 1996, additional soil and groundwater samples were collected in the RT&E Area to obtain analytical data necessary to populate an RRSEM (BNI 1996b). The RRSEM used data collected at NAVWPNSTA Seal Beach and 14 other bases. The samples collected from the RT&E Area and included in the model indicated the presence of VOCs, SVOCs, PCBs, pesticides, and metals in the area north of Building 112. This area was designated AOC 11 during the ERSE (Figure 5-9). The RRSEM was used to prioritize funding for ongoing work at various IR program sites within the 14 bases.

5.2.3.4 EXTENDED REMOVAL SITE EVALUATION

In 1998, an ERSE was conducted to supplement data from the RSE. Soil and groundwater sampling and analyses were conducted at AOCs 2, 3, 4, and 11 (BNI 1999a). The soil sampling and analysis were designed to:

- determine the presence of VOCs, SVOCs, hexavalent chromium, heavy metals, pesticides, and PCBs in the vadose zone soils and (if present) delineate the vertical and lateral extent and potential for impact to groundwater; and
- delineate the vertical and lateral extent of chlorinated solvents (TCE, tetrachloroethene [PCE], and degradation products) within vadose zone soils and assess the potential to serve as an ongoing source of VOC contamination to groundwater.

IR Site 70 groundwater sampling and analyses focused on delineating the vertical and lateral extents of VOCs, SVOCs (including phenol), hexavalent chromium, and heavy metals within the water-bearing zones underlying the site. The methodology and results of the ERSE are summarized by AOC in the following sections.

AOC 2 – Former Stormwater Drainage Channel

Twenty soil borings were advanced at AOC 2 during the summer of 1997. Soil samples were collected at depth intervals ranging from surface to 12 feet bgs and analyzed for VOCs, metals, SVOCs, and hexavalent chromium.

VOCs reported in soil at AOC 2 included PCE, TCE, cis-1,2-dichloroethene (DCE), trans-1,2-DCE, 1,1-DCE, vinyl chloride, chloroform, and acetone, indicating a potential source area east of the TCE storage tanks (Figure 5-9). At the source area, the analytical results indicated that VOC concentrations within the vadose zone soils generally increase with depth. All SVOCs were reported at concentrations below detection limits. bis(2-ethylhexyl)phthalate, which had been reported during a previous investigation, was not reported during the ERSE. Aluminum, arsenic, chromium, copper, manganese, and nickel were reported above statistical background levels at levels equal to or below the geochemical upper limit value, indicating that they are naturally occurring.

AOC 3 – Salt Marsh Discharge Point

Five soil borings were advanced using a direct-push drill rig at AOC 3 in June and July 1997. Soil samples were collected at depth intervals ranging from 0.5 foot to 10 feet bgs in each soil boring and analyzed for metals, pH, and total organic carbon.

The RSE investigation had reported elevated metal concentrations in AOC 3 soils. These concentrations were believed to have been caused by the high organic content in the AOC 3 soils. Additional soil samples were collected during the ERSE to confirm this hypothesis and to aid in the human-health and ecological risk screening evaluations. With the exception of lead at one sample location, all reported metals concentrations equal to or greater than statistical background were also reported at concentrations at or below the geochemical upper limit value, indicating that these metals are naturally occurring.

AOC 4 – Perimeter Drainage Channel

Four soil borings were advanced with a direct-push drill at AOC 4 in July 1997. Soil samples were collected at depth intervals ranging from 1 foot to 10 feet bgs in each soil boring. Soil sampling and analyses focused on delineating the vertical and lateral extents of arsenic and manganese within the vadose zone soils, and assessing the potential of metals in these areas to serve as an ongoing source of contamination to groundwater. All samples were analyzed for metals; three samples were also analyzed for pH and total organic carbon.

Cobalt, arsenic, manganese, and nickel were reported in excess of both the statistical background and geochemical upper limit values at four sample locations.

AOC 11 – Area North of Building 112

Soil samples were collected from four soil borings depth intervals ranging from 1 foot to 10 feet bgs in each soil boring. All samples were analyzed for VOCs, SVOCs, metals, hexavalent chromium, and pesticides; four samples were also analyzed for pH and total organic carbon. Soil sampling and analyses focused on determining the presence of VOCs, SVOCs, pesticides, PCBs, and heavy metals in the vadose zone soils and, if present, delineating the vertical and lateral extent and potential for impact to groundwater.

Low levels of TCE, acetone, chloroform, and methylene chloride were reported in soil samples collected at AOC 11. Reported concentrations of aluminum, manganese, silver, and vanadium were considered naturally occurring at AOC 11. Most of the arsenic, chromium, copper, and nickel concentrations reported above statistical background have also been shown to be naturally occurring. Arsenic, chromium, copper, and nickel were reported above both statistical background and geochemical upper limit values.

Groundwater Investigation

As part of the groundwater investigation at IR Site 70, samples were collected from 16 monitoring wells and 47 temporary well-point locations. All samples were analyzed for VOCs. In addition, selected samples were analyzed for metals, SVOCs, and hexavalent chromium.

PCE, TCE, and daughter products were the primary VOCs reported in groundwater at IR Site 70. Maximum concentrations of TCE up to 163,000 μg/L were reported, with concentrations highest in the shallow aquifer and decreasing with depth. The TCE concentrations define a chlorinated solvent plume that extends vertically to a depth of approximately 170 feet bgs. Laterally, the TCE plume achieves a maximum northwest-southeast dimension of approximately 2,800 feet and northeast-southwest direction of approximately 2,000 feet (Figures 5-10 through 5-12). The exception is the deep interval of 150 to 170 feet bgs, where the plume dimensions are approximately 2,400 feet in a northwest-southeast direction and 1,000 feet from northeast to southwest.

Figures 5-10 to 5-12

These detailed station maps have been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

SVOCs reported in IR Site 70 groundwater samples included 2,4-dinitrotoluene and bis(2-ethylhexyl)phthalate. The highest concentrations of metals reported above statistical background levels were generally reported at depths less than 50 feet bgs. The presumed sources of metals above background were in the vicinity of Buildings 112 and 128 and the tank farm, the heavy use areas of the RT&E facility. Naturally occurring metals, such as copper, iron, manganese, and arsenic, are ubiquitous, and their range of concentrations was largely attributed to various organic and inorganic adsorption mechanisms.

Evaluation of Potential Dense Nonaqueous-Phase Liquid Plume

In accordance with U.S. EPA (1992) guidelines, historical site-use information and analytical results from the ERSE site characterization were used to evaluate the potential presence of a DNAPL plume at IR Site 70. The ERSE Report established that historical site-use information indicated the potential presence of DNAPL. The high TCE concentrations and soil organic vapor are inferential evidence for the existence of DNAPL in groundwater at IR Site 70. The suspected DNAPL area is assumed to extend approximately 10 to 50 feet bgs, with a corresponding area at the surface of approximately 23,000 square feet, and a total volume (all media) of approximately 920,000 cubic feet (34,000 cubic yards). The footprint of the suspected DNAPL area corresponds to the 10,000 μg/L isocontour of TCE at the less-than-35-feet-bgs depth interval (GSC 2005 and Bechtel 2005) (Figure 5-13).

5.2.3.5 GROUNDWATER MONITORING

Subsequent to delineation of the extent of contamination in groundwater at IR Site 70, the DON implemented a long-term groundwater monitoring program (BEI 2000) to measure chemical concentrations within and around the chlorinated solvent plume over time. Chemicals of concern (COCs) are being monitored to further establish contaminant concentration trends, evaluate downgradient plume migration, and assess the effectiveness of proposed remedial actions. Other indicator parameters are being monitored for evidence of natural attenuation. In addition, hexavalent chromium and mercury were further delineated to close two data gaps at IR Site 70 (BEI 2002c).

During the first year of monitoring (June 2000 to March 2001), groundwater samples from 17 selected monitoring wells at IR Site 70 were analyzed for VOCs, metals, and selected natural attenuation parameters. The monitoring wells were screened within the shallow, intermediate, and deeper depth intervals.

Results of the first year of groundwater monitoring indicated conditions were not changing significantly over time. However, because the lateral extent of the plume was slightly larger to the southwest than estimated during previous investigations, the southern extent of the plume was further delineated in April 2002. Geochemical indicators for natural attenuation showed that reductive dechlorination from PCE to TCE and cis-1,2-DCE was occurring in the center of the plume at IR Site 70 and that vinyl chloride and ethene were being produced. No observable seasonal variations in groundwater flow direction were noted. Mercury and hexavalent chromium were reported as not detected, indicating that these metals were adequately delineated at IR Site 70 and that the human-health risk screening, prepared as part of the ERSE and summarized in Section 7 of this ROD/RAP, remains valid (BEI 2002c).

Results of the second year of groundwater monitoring indicated conditions were not changing significantly over time. The location, vertical extent, and chemical makeup of the groundwater plume had not significantly changed. However, 1,1-DCE, TCE, and cis-1,2-DCE were reported during all three sampling events in MW-70-18 (80 to 100 feet bgs), indicating that the plume continued to extend farther southwest than originally estimated during the ERSE. TCE concentrations were reported above screening criteria, and the trend analysis indicated increasing-to-stable concentrations of TCE and increasing concentrations of cis-1,2-DCE. This suggested that the southwest plume boundary may be migrating to the south or southwest (BEI 2002d).

Concentration trends at the plume boundaries indicate that the plume does not pose an immediate threat to potential receptors. Therefore, installation of additional wells was not recommended at that time (BEI 2002d).

Analytical results from the fifth year of groundwater monitoring indicated the continued presence of VOC-contaminated water previously identified in the shallow, intermediate, and deep water-bearing intervals. The location, vertical extent, and chemical makeup of the groundwater plume did not significantly change from the previous four years of groundwater monitoring (BEI 2005).

Ongoing groundwater monitoring data indicate the dissolved phase plume continues to extend to the southeast over 4,000 feet from the source area. Concentrations within the dissolved phase plume exceed regulatory standards by several orders of magnitude. Concentrations of TCE within the second sand exceed 1,000 ppb at depths of 170 feet below ground surface (BEI, 2005).

5.2.3.6 PILOT TEST STUDY

A pilot test study for *in situ* chemical oxidation was performed to support the groundwater FS (BNI, 2002). The test involved direct injection of Fenton's reagents (to oxidize organic compounds) into the interbedded zone underlying the upper clay layer. This upper clay layer is the zone with the second lowest hydraulic conductivity. It was assumed that successful treatment of this zone would be indicative of the ability of *in situ* chemical oxidation to successfully treat deeper horizons within the DNAPL area.

Approximately 2,023 gallons of 50 percent hydrogen peroxide and 5,644 gallons of catalyst solution were injected under pressure. The solution was diluted with catalyst during injection, and the maximum peroxide concentration injected did not exceed 20 percent. Surface eruptions were noted during the pilot test injection phase. These eruptions were due to pressure generated by the chemical reaction and resulted in release of vapor to the surface, often accompanied by liquid and solid material. Previous boreholes in the test area acted as conduits for eruptions, and injection was suspended so that the boreholes could be sealed. Injection resumed at a lower rate than planned, but surface eruptions continued through other pathways, including utility trenches.

Pretest and posttest soil and groundwater samples were collected and analyzed to evaluate contaminant mass reduction. The soil results were inconclusive because contaminant concentrations were lower than expected. A general observation was that concentrations decreased in the treatment zone depth interval and increased at shallow depths above the treatment zone.

Sampling results indicated the average TCE concentration in groundwater in the pilot test cell was reduced from approximately 123,000 to 3,800 μg/L, a dramatic reduction within

Figure 5-13

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

the pilot test area. Contaminant mass balance calculations indicated greater than 80 percent removal efficiency. Results of rebound samples collected 1 month after injection indicated residual contamination within the test area was not significant. Increased concentrations in perimeter and deep wells indicated contaminants may have mobilized and migrated outward, but the overall effect appeared to be significant mass destruction.

5.3 CONTAMINANT FATE AND TRANSPORT

The DON investigated soil contamination at IR Site 70 during the ERSE (BNI 1999a) and concluded that the potential for continued leaching of soil COPCs to groundwater is low to negligible. As discussed in the ERSE, releases of chlorinated solvents migrated through the soil in the past, resulting in a groundwater plume containing primarily TCE, along with lesser concentrations of DCE, vinyl chloride, and chloroform. However, concentrations of these VOCs currently present in the vadose soil indicate most of the original releases have already leached to groundwater or volatilized to the atmosphere. The potential for transport of soil COPCs through runoff is also considered low to negligible.

The ERSE also addressed groundwater contamination at IR Site 70 (BNI 1999a) and concluded that the potential for VOCs to have migrated deeper than the depth of the deepest temporary wellpoint (191 feet bgs) is low because the concentrations of TCE attenuated so rapidly at this depth. The plume of chlorinated VOCs appears to have negligible potential for continued migration beyond Navy property within the next several decades. Analytical results indicate that significant biodegradation of the TCE plume has occurred in shallow groundwater, and conditions are conducive to continued degradation. However, the ERSE concluded that suspected DNAPL, unless contained or otherwise treated, could continue to be a source of dissolved-phase contamination indefinitely (BNI 1999a).

The fate and transport of suspected DNAPL at IR Site 70 is an important element of the conceptual model. DNAPL quantities in the subsurface are typically expressed in terms of "saturation," which is simply the ratio of the volume occupied by DNAPL to the pore volume available to be occupied. Two general cases are in the spectrum of saturation. The first is mobile or continuous-phase DNAPL and occurs when the saturation is high enough for gravity and the viscous forces created by hydraulic traction (flowing groundwater) to overcome the capillary forces in the pore and create a flowing DNAPL phase. For example, in a two-phase system (DNAPL and water below the water table), when there is enough DNAPL in the pore for gravity to overcome the capillary pressure created by the interfacial tension between the DNAPL and the water and the aquifer substrate, then the DNAPL can be mobile. The other case is called "residual saturation." This is the saturation at which the capillary forces in the pore trap the DNAPL, and gravity and hydraulic traction cannot overcome the capillary force. When the pore space drains off the mobile DNAPL, the amount of DNAPL left is at residual saturation, and it is trapped. Typically, this is 5 to 15 percent, but residual saturation of some DNAPLs with low interfacial nonaqueous-phase liquid (NAPL) water tensions can be as low as

1 percent. Most DNAPL sites in the United States have their sources predominantly trapped at residual saturation, which makes it difficult to locate and remove the DNAPL.

When the suspected release of liquid chemical waste was occurring at IR Site 70, the waste DNAPL was likely mobile. However, pools of DNAPL have never been located in the subsurface at IR Site 70 and, currently, the suspected DNAPL is assumed to be at residual saturation levels in the form of dispersed droplets and/or ganglia beneath the suspected source area at depths not exceeding 50 feet bgs.

5.4 EXPOSURE PATHWAYS

Pathways for exposure of humans to COPCs in soil include ingestion, inhalation of soil particles, inhalation of chemical vapors released to the atmosphere from soil, and contact of soil with the skin. Pathways for exposure of ecological receptors include direct ingestion, indirect ingestion of plant and animal tissues associated with COPC uptake from soil with subsequent transfer through the food chain, and direct contact with COPCs in soil by plant roots and soil macroinvertebrates. Inhalation exposures to COPCs in dust by mammalian and avian receptors were considered low when compared to direct ingestion of soil and plant and animal food items.

The ERSE recommended no further action and the DTSC and RWQCB agreed, for soil at three of the four AOCs (AOC 2, AOC 3, and AOC 11)[BNI, 1999a]. After a re-evaluation of the AOC 4 data, the DTSC and RWQCB concurred with a no further action for soil at this site (BNI, 2000a). The cancer risk for soil at all four AOCs is estimated to be within the NCP-defined generally acceptable ranges for human health cancer risk. The hazard index does not exceed 1.0 for any of the AOCs under the industrial use scenario. The cumulative non-cancer risk hazard index for all four areas does not exceed 1.0 under the industrial use scenario, therefore no further action has been agreed to for Site 70 soil (BNI, 1999A, 2000a).

Currently, no human or ecological receptor is exposed to VOC-affected groundwater (i.e., there is no complete exposure pathway for contaminants). Shallow groundwater underlying IR Site 70 does not serve as a water source for any of the beneficial uses designated in the Basin Plan (RWQCB 1995), including domestic water supply. All the privately owned wells near the station are completed within the deeper regional aquifer, which has not been impacted by site-related contamination. The shallow aquifer at the station is also not expected to be used as a source of water in the future due to its high salinity and hardness. Should groundwater be used in the future, pathways for human exposure to COCs in groundwater may include ingestion, inhalation of vapor, and direct contact. Ecological exposure to groundwater was not considered because there is no complete exposure pathway between IR Site 70 plumes and potential ecological receptors.

5.5 MASS OF TCE

The total mass of dissolved contamination at IR Site 70 is estimated to be approximately 3,300 pounds, and an unknown quantity of DNAPL is suspected to be near the presumed contaminant source area (BNI 2002) (Table 5-1). DNAPL is suspected because TCE concentrations up to 837,000 μg/L were reported during the pumping for the pilot test (BNI 1999c).

Table 5-1
Estimated IR Site 70 TCE Mass

Depth Interval (feet bgs)	Stratigraphic Unit[a]	TCE Mass[b] (pounds)
2.5–19.5	Shallow clay	501
19.5–34.5	Interbedded unit – upper	475
34.5–39.5	Interbedded unit – lower	358
39.5–61.5	First sand unit – upper	140
61.5–81.5	First sand unit – middle	75
81.5–100	First sand unit – lower	819
100–113	Shell horizon	621
113–142.5	Second sand unit – upper	153
142.5–172	Second sand unit – lower	153
	Total	**3,295**

Notes:
[a] see Figure 5-4 for site physical conceptual model
[b] this is the mass of dissolved TCE; an unknown amount of DNAPL may also be present

Acronyms/Abbreviations:
bgs – below ground surface
DNAPL – dense nonaqueous-phase liquid
IR – Installation Restoration (Program)
TCE – trichloroethene

Section 6
CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

This section discusses the current and reasonably anticipated future land, groundwater, and surface water uses at NAVWPNSTA Seal Beach. This information can aid in identifying, enumerating, and characterizing human populations potentially exposed to site COPCs and in planning the most appropriate remedy for the site.

6.1 LAND USES

NAVWPNSTA Seal Beach encompasses about 5,000 acres. Explosives safety quantity-distance (ESQD) arcs that restrict development to specific permitted uses cover approximately 75 percent of the 5,000 acres. Two agricultural outleases totaling approximately 2,000 acres are used for farming (irrigated and dry farming) and maintenance. Approximately 100 acres of land is currently being leased for oil production (including Oil Island). In addition to the outleased land, the Seal Beach NWR, a major biological resource, encompasses approximately 911 acres. The areas covered by the ESQD arcs overlap the agricultural outlease areas and portions of the Seal Beach NWR.

Other land uses at NAVWPNSTA Seal Beach include residential, ordnance transfer operations, weapons evaluation, quality assurance, storage (inert and explosive), and administration/community support.

Land to the south, southwest, northwest, north, and northeast of NAVWPNSTA Seal Beach is used for residential purposes. Boeing Space and Communications Group is the only major commercial/industrial use bordering the station on the west. The City of Seal Beach Police Department and J.H. McGaugh Elementary School also borders the station on the west. The Bolsa Chica Flood Control Channel borders NAVWPNSTA Seal Beach to the south and east. This channel is fenced in and discharges directly to Anaheim Bay. The Sunset Aquatic Park borders the station to the south and is situated on a 63-acre parcel in an unincorporated portion of Orange County. The park is a commercial development consisting of 260 boat slips, park facilities, a marine repair yard, a boat launch, harbor patrol office, and public picnic areas. Future land uses for the adjacent cities include commercial/industrial, limited residential, and open land uses.

NAVWPNSTA Seal Beach is an active station. Land use is expected to remain the same in the foreseeable future. Access to NAVWPNSTA Seal Beach is restricted; therefore, off-station populations would not likely be directly exposed to on-station COPCs.

6.2 GROUNDWATER USES

Groundwater in the area surrounding NAVWPNSTA Seal Beach is used for drinking water, recreation, and agriculture. Numerous wells are present in and around the station boundaries. To the west of NAVWPNSTA Seal Beach, production water is used to maintain a seawater intrusion barrier as part of the Alamitos Barrier Project. Thirty-two municipal wells are located within a 4-mile radius of the station, and 23 domestic, commercial, and community wells have been identified within this region (BNI 2002). Production wells located within a 1.5-mile radius of the center of the station are shown on Figure 6-1.

The groundwater underlying the station is within the Lower Santa Ana River Groundwater Basin (Orange County Management Zone) (RWQCB, 1995, 2004). Beneficial groundwater uses within the Orange County Management Zone include municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply.

The city of Seal Beach supplies water to the station (JEG 1995a). One of the city wells, State Well No. 5S/11W-7C02 (Well SB-7), is located on the station and is screened in the Lynwood/Silverado aquifer at approximately 625 to 1,000 feet bgs. This well was abandoned in 2005.

The principal freshwater body tapped by the city to supply NAVWPNSTA Seal Beach is a large confined aquifer approximately 250 to 1,000 feet deep. This deeper zone is the primary water supply source to both the station and neighboring cities (BNI 2002). Nonpotable water used for agricultural purposes is supplied by on-station agricultural wells with screened intervals between 140 to 600 feet bgs.

Three wells owned by the DON (former Navy Well 2 and Navy Wells 3 and 6) were also screened in the Lynwood/Silverado aquifer. Due to degraded water quality and findings of Facilities Engineering and others (BNI 2002) that these wells were in hydraulic continuity with an aquifer potentially degraded by saltwater intrusion, Wells 2 and 3 were rendered inactive in 1991. Well 2 was subsequently destroyed in May 2000. Well 6 is located at the northern boundary of IR Site 70 at Westminster Avenue and is currently inactive. Three pumping wells leased to outside agricultural users are located north, due east, and southeast of IR Site 70 within less than a mile. These wells range in depth from 680 to 802 feet bgs. Water-quality information for the years 1990 through 1992 indicates that groundwater in the vicinity of the station met the drinking water standards for the compounds analyzed (BNI 1999a). The production wells within 1.5 mile radius of the center of the Station include RUIZ-6F1 (agricultural), Navy Well No. 6 (inactive), Navy Well No. 3 (inactive), SEA-SB (water supply), W4746 (water supply), and KAY-SB (to be abandoned in 2006).

Shallow groundwater underlying IR Site 70 presently does not serve as a water source for any of the beneficial uses designated in the Basin Plan (RWQCB 1995) nor is it anticipated to be used for these purposes in the future due to its high brackish-to-saline quality and hardness (BNI 1999a).

Potential plans for the reactivation of Navy Well #3 for agricultural irrigation may potentially exacerbate the southeast migration of the deepest dissolved phase plume. The discontinuities observed within the clay layers underlying the site may allow continued downward migration of the dissolved phase plume, ultimately impacting the major drinking water supply aquifers in the area.

6.3 SURFACE WATER USES

Surface water at the station drains through ditches and tidal sloughs in flat-lying clay deposits. Ditch stream flow is intermittent and depends on rainfall and excess irrigation runoff. Ditches at the tidal flat margins also receive saltwater during high tides. Drainage from the station flows predominantly to Anaheim Bay with minor amounts discharged into the Bolsa Chica Flood Control Channel (JEG 1995a). Surface waters from IR Site 70 are not expected to adversely impact local on- or off-station populations.

Seawater from Anaheim Bay flushes the salt marsh twice a day by flowing beneath the Pacific Coast Highway and into the tidal flats. Raised roadbeds serve as barriers to control tidal flooding.

Because of the presence of sea walls and high street profiles, flooding brought about by a tsunami of the 100-year recurrence interval would affect only a small area along the beach. Only low-lying areas of NAVWPNSTA Seal Beach would be inundated in the event of a 500-year flood, the result of the Santa Ana River overflowing. The river lies approximately 12 miles east of the station (JEG 1995a).

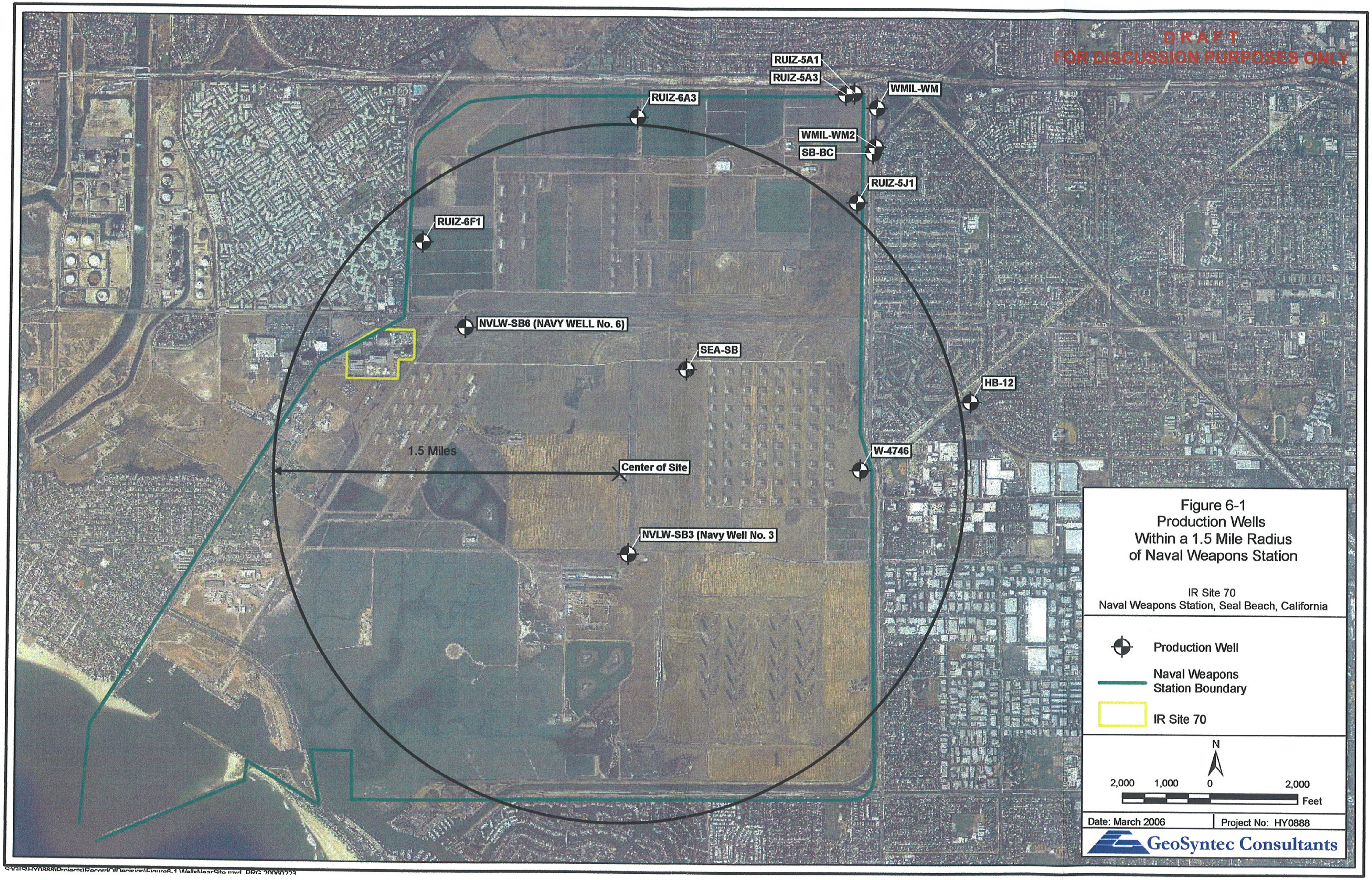

Figure 6-1
Production Wells
Within a 1.5 Mile Radius
of Naval Weapons Station

IR Site 70
Naval Weapons Station, Seal Beach, California

Section 7
SUMMARY OF SCREENING HUMAN-HEALTH AND ECOLOGICAL RISK ASSESSMENTS

Risk assessments provide an evaluation of the potential threat to human health and the environment in the absence of any remedial action. They also provide the basis for determining whether remedial action is necessary and the justification for performing remedial actions (U.S. EPA 1988a, 1991). Screening human-health risk assessments (HHRAs) for groundwater and soil and an ecological risk assessment for soil were conducted at AOCs 3 and 4 during the ERSE (BNI 1999a). Subsequent to the ERSE, a supplemental screening HHRA for soil at AOC 4 was performed using refined exposure conditions (BNI 2000a). Locations of AOCs 3 and 4 are shown on Figure 5-9. The screening HHRA and ecological risk assessment methodologies are described in Appendix P, Volume VII, of the final ERSE Report (BNI 1999a) and Section 1 of Technical Memorandum No. 6 (BNI 2000a). The screening HHRA results presented in this section support the need for remedial action of VOC-contaminated groundwater at IR Site 70. Soil was evaluated and found to require no further action with the concurrence of DTSC and RWQCB.

7.1 SCREENING HUMAN-HEALTH RISK ASSESSMENT

The screening HHRA for IR Site 70 addressed the constituents in groundwater and soil within the investigation area and assessed potential human-health risks from exposure to these media if no actions are taken to reduce the risk. The following assumptions were made.

- No remedial actions are undertaken.
- Untreated groundwater is used for domestic purposes.
- Chemical concentrations remain constant over the assumed exposure period.

At IR Site 70, potential human-health risks from exposure to groundwater and soil were calculated by taking the maximum reported concentration for each COPC and comparing it with the screening criteria. Groundwater COPCs were compared to tap water PRGs and soil was compared to the U.S. EPA Region 9 residential and industrial PRGs (U.S. EPA 1996). The specific screening procedure used was recommended by U.S. EPA Region 9 (U.S. EPA 1995) and is described below.

- The COPCs were matched to the respective PRG values (tap water for groundwater, and residential and industrial for soil) and were evaluated in groups based on the properties of the chemical. The first group was composed of those COPCs with cancer-based PRG values; the second was composed of COPCs with noncancer hazard-based PRG values; and the third (applicable to soil only) was composed of COPCs with PRGs based on saturation or ceiling limits in soil (U.S. EPA 1996).
- The ratio of the maximum reported chemical concentrations and the cancer, noncancer, or saturation-based PRG (for soil only) was calculated for each COPC.

- The ratio of each carcinogen was multiplied by 1×10^{-6} to obtain a cancer risk estimate.
- The cancer risk estimates were summed to obtain an estimate of total cancer risk.
- The ratios for the noncarcinogens were summed to obtain an estimate of total chronic toxicity. The summed total of these ratios is called a hazard index (HI).

A lead screening assessment was also conducted as part of the ERSE. The assessment involved a two-step process. First, the maximum concentration of lead in soil at each site was compared to the Cal/EPA residential PRG of 130 milligrams per kilogram (mg/kg) and the U.S. EPA industrial PRG of 1,000 mg/kg. In the second step, the Cal/EPA pharmacokinetic model was used for IR Site 70 to estimate the blood lead concentration for a resident child and adult where the concentration of lead exceeded either of the PRGs.

Data used for the risk screening were obtained from several reports, including the RSE (BNI 1996a) and ERSE (BNI 1999a).

Potential carcinogenic health risks were analyzed by estimating the excess lifetime cancer risk. Excess lifetime cancer risk is the incremental increase in the probability of developing cancer during one's lifetime over the background probability of developing cancer if no exposure occurs. For example, an excess lifetime cancer risk of 2×10^{-6} means that for every 1 million people exposed to the carcinogen throughout their lifetimes, the average incidence of cancer may be increased by two additional cases.

To manage carcinogenic risk and protect human health, U.S. EPA has established the following protective risk ranges: the probability of greater than one additional cancer case in a population of 10,000 (10^{-4}) or less is unacceptable; the range of probability from one additional cancer case in a population of 10^{-4} to 1,000,000 (10^{-6}) is generally allowable; and less than one cancer case in a population of greater than 10^{-6} is allowable (U.S. EPA 1991). Excess cancer risks are only a prediction of a potential increase in cancer incidence and do not represent exact numbers. Because of the health protection methods followed in estimating cancer potency factors, the excess lifetime cancer risks estimated in the screening HHRA should be regarded as upper bounds on the potential cancer risks.

7.1.1 Groundwater

The following subsections describe the screening HHRA conducted for groundwater at IR Site 70.

7.1.1.1 CHEMICALS OF POTENTIAL CONCERN

COPCs in groundwater were identified based on data from monitoring well and *in situ* samples. For IR Site 70, COPCs included 17 inorganics and 40 organics as shown in Table 7-1. Essential nutrients (e.g., calcium, iron, magnesium, potassium, and sodium) were eliminated from the assessment.

Table 7-1
Human-Health Risk Screening Results for Groundwater at IR Site 70

Analyte	Maximum Reported Concentration (µg/L)	Cancer PRG Value Tap Water (µg/L)	Cancer Cal-Modified PRG Value Tap Water (µg/L)	Tap Water Carcinogenic Risk	Tap Water Cal-Modified Carcinogenic Risk	Noncancer PRG Value Tap Water	Tap Water Hazard Index
Metals							
Aluminum	1,490	—[a]	—	NA	NA	3.65E+04	4.08E-02
Antimony	52.2	—	—	NA	NA	1.46E+01	3.58E+00
Arsenic	59.5	4.48E-02	4.48E-02	1.33E-03	1.33E-03	1.10E+01	5.43E+00
Barium	398	—	—	NA	NA	2.56E+03	1.56E-01
Cadmium	235	—	—	NA	NA	1.83E+01	1.29E+01
Chromium, total	8.5	—	—	NA	NA	—	NA
Chromium VI	13	—	1.60E-01	NA	8.13E-05	1.83E+02	7.12E-02
Cobalt	9.7	—	—	NA	NA	2.19E+03	4.43E-03
Copper	12.5	—	—	NA	NA	1.36E+03	9.22E-03
Lead	41.5	—	—	NA	NA	4.00E+00	1.04E+01
Manganese	10,100	—	—	NA	NA	1.70E+03	5.93E+00
Mercury	3.5	—	—	NA	NA	1.10E+01	3.20E-01
Nickel	218	—	—	NA	NA	7.30E+02	2.99E-01
Selenium	2.3	—	—	NA	NA	1.83E+02	1.26E-02
Thallium	8	—	—	NA	NA	2.92E+00[b]	2.74E+00
Vanadium	21.8	—	—	NA	NA	2.56E+02	8.53E-02
Zinc	150	—	—	NA	NA	1.10E+04	1.37E-02
Class sum				**1.33E-03**	**1.41E-03**		**4.19E+01**
Organics							
1,1,2-Trichloroethane	2.05	2.00E-01	2.00E-01	1.03E-05	1.03E-05	2.43E+01	8.42E-02
1,1-Dichloroethane	159	—	—	NA	NA	8.11E+02	1.96E-01

(table continues)

Table 7-1 (continued)

Analyte	Maximum Reported Concentration (µg/L)	Cancer PRG Value Tap Water (µg/L)	Cancer Cal-Modified PRG Value Tap Water (µg/L)	Tap Water Carcinogenic Risk	Tap Water Cal-Modified Carcinogenic Risk	Noncancer PRG Value Tap Water	Tap Water Hazard Index
1,1-Dichloroethene	299	4.56E-02	4.56E-02	6.56E-03	6.56E-03	5.48E+01	5.46E+00
1,2-Dichloroethane	11.1	1.23E-01	1.23E-01	9.01E-05	9.01E-05	1.74E+01	6.38E-01
1,2-Dichloroethylene	88	—	—	NA	NA	5.48E+01	1.61E+00
2,4-Dinitrophenol	0.8	—	—	NA	NA	7.30E+01	1.10E-02
2,4-Dinitrotoluene	15	—	—	NA	NA	7.30E+01	2.05E-01
2-Butanone	25	—	—	NA	NA	1.90E+03	1.31E-02
2-Methyl-4,6-dinitrophenol	4	—	—	NA	NA	3.40E+00[b]	1.18E+00
2-Nitrophenol	2	—	—	NA	NA	3.40E+00[b]	5.88E-01
4-Chloro-3-methylphenol	2	—	—	NA	NA	3.40E+00[b]	5.88E-01
4-Nitrophenol	2	—	—	NA	NA	3.40E+00[b]	5.88E-01
Acetone	861	—	—	NA	NA	6.08E+02	1.42E+00
Benzene	3	3.86E-01	3.86E-01	7.76E-06	7.76E-06	1.04E+01	2.88E-01
bis(2-ethylhexyl)phthalate	580	4.80E+00	4.80E+00	1.21E-04	1.21E-04	7.30E+02	7.95E-01
Bromodichloromethane	6	1.81E-01	1.81E-01	3.32E-05	3.32E-05	1.22E+02	4.93E-02
Bromoform	1	8.51E+00	8.51E+00	1.18E-07	1.18E-07	7.30E+02	1.37E-03
Carbon disulfide	44	—	—	NA	NA	2.07E+01	2.12E+00
Carbon tetrachloride	0.957	1.71E-01	1.71E-01	5.59E-06	5.59E-06	3.58E+00	2.67E-01
Chlorobenzene	5	—	—	NA	NA	3.95E+01	1.27E-01
Chloroethane	18.3	—	—	NA	NA	7.05E+02	2.59E-02
Chloroform	440	1.65E-01	1.65E-01	2.67E-03	2.67E-03	6.08E+01	7.23E+00
cis-1,2-dichloroethene	1,000	—	—	NA	NA	6.08E+01	1.64E+01
di-n-butyl phthalate	11.6	—	—	NA	NA	3.65E+03	3.18E-03
Dibromochloromethane	5	1.01E+00	1.01E+00	4.93E-06	4.93E-06	7.30E+02	6.85E-03
Diethyl phthalate	7.15	—	—	NA	NA	2.92E+04	2.45E-04
Dimethyl phthalate	5.29	—	—	NA	NA	3.65E+05	1.45E-05

(table continues)

Table 7-1 (continued)

Analyte	Maximum Reported Concentration (µg/L)	Cancer PRG Value Tap Water (µg/L)	Cancer Cal-Modified PRG Value Tap Water (µg/L)	Tap Water Carcinogenic Risk	Tap Water Cal-Modified Carcinogenic Risk	Noncancer PRG Value Tap Water	Tap Water Hazard Index
Ethane	6.54	—	—	NA	NA	3.50E+02[b]	1.87E-02
Methylene chloride	171	4.28E+00	4.28E+00	4.00E-05	4.00E-05	1.62E+03	1.05E-01
Nitrobenzene	3.83	—	—	NA	NA	3.40E+00	1.13E+00
Pentachlorophenol	2	5.60E-01	5.60E-01	3.57E-06	3.57E-06	1.10E+03	1.83E-03
Phenol	1	—	—	NA	NA	2.19E+04	4.57E-05
Tetrachloroethene	43	1.08E+00	1.08E+00	3.97E-05	3.97E-05	6.08E+01	7.07E-01
Toluene	2	—	—	NA	NA	7.23E+02	2.76E-03
Total xylenes	9.55	—	—	NA	NA	1.43E+03	6.67E-03
trans-1,2-dichloroethene	94	—	—	NA	NA	1.22E+02	7.73E-01
Trichloroethene	163,000	1.64E+00	1.64E+00	9.94E-02	9.94E-02	3.65E+01	4.47E+03
Trichlorofluoromethane	27	—	—	NA	NA	1.29E+03	2.10E-02
Trichlorotrifluoroethane	1	—	—	NA	NA	5.92E+04	1.69E-05
Vinyl chloride	137	1.98E-02	1.98E-02	6.93E-03	6.93E-03	5.48E+01[b]	2.50E+00
Class sum				**1.16E-01**	**1.16E-01**		**4.51E+03**
Total Cancer Risk and Hazard				**1.17E-01**	**1.17E-01**		**4.55E+03**

Notes:
[a] dash indicates no PRG for analyte
[b] value based on surrogate PRG

Acronyms/Abbreviations:
Cal-Modified – California (Environmental Protection Agency) modified
IR – Installation Restoration (Program)
µg/L – micrograms per liter
NA – not applicable (cancer risk or hazard quotient cannot be calculated because PRG is not available and no surrogate compound has been identified)
PRG – preliminary remediation goal

7.1.1.2 EXPOSURE ASSESSMENT

The screening risk assessment for groundwater assumed a residential exposure scenario. The likely exposure pathways evaluated are consistent with the typical pathways assumed by U.S. EPA and Cal/EPA in establishing the soil and tap water PRGs used in the screening risk assessment. For groundwater, the likely exposure pathways include ingestion (drinking) and inhalation of volatiles. Dermal absorption from bathing was not considered a significant pathway since the groundwater COPCs consist mainly of volatiles, and the ability of the body to absorb volatiles through the lungs, via the inhalation pathway, is much more efficient than absorption through the skin.

The screening risk assessment was performed for a hypothetical exposure scenario and is designed to be conservative. There are currently no human populations exposed to VOC-affected groundwater in the shallow aquifer at NAVWPNSTA Seal Beach. All the government and privately owned wells near the station are completed within the deeper regional aquifer, which has not been impacted by site-related contamination. In addition, the shallow aquifer at the station is not expected to be used as a source of water in the future due to its high salinity and hardness. Surface water surrounding NAVWPNSTA Seal Beach is not currently affected by the VOCs in shallow groundwater, and there are no completed exposure pathways between the IR Site 70 plume and potential ecological receptors.

7.1.1.3 RESULTS

The total cancer risk associated with the groundwater at IR Site 70 was estimated at 1.2×10^{-1} by use of U.S. EPA tap water and Cal-Modified PRGs (Table 7-1). TCE was identified as the principal risk driver, contributing 85 percent of the total cancer risk. As discussed in Section 7.1, risks are based on the highest reported concentration; the maximum reported concentration for TCE (163,000 μg/L) was collected at a depth of 24 to 27 feet bgs. Since the cancer risk drivers are overwhelmingly chlorinated VOCs and the background for VOCs is zero, no background risk or incremental risk estimates were made.

For groundwater, the HI at IR Site 70 was estimated at 4,600, indicating a potential for systemic toxicity (Table 7-1). TCE was the primary contributor to the HI.

In reviewing the site conceptual model and the plume morphology it is evident that the shallow high concentration plume feeds the deeper, laterally migrating groundwater plumes in the first and second sands. The high concentrations of TCE (163,000 ppb) within the source area provide a continual source to the vertical and lateral migration of the chlorinated plume. The elevated TCE concentration within the shallow groundwater continues to provide a source for the mass flux of chlorinated solvents to the groundwater. A remedy for this source of groundwater contamination will provide a significant reduction to the groundwater impacts in the future.

7.1.2 Soil

The following subsections describe the screening HHRA conducted for soil at IR Site 70 AOCs 2, 3, 4, and 11 (See Figure 5-9).

7.1.2.1 CHEMICALS OF POTENTIAL CONCERN

COPCs used in the soil screening HHRA were identified by AOC and are shown on the tables referenced in the subsections that follow. Essential nutrients (e.g., calcium, iron, magnesium, potassium, and sodium) were eliminated from the assessment.

7.1.2.2 EXPOSURE ASSESSMENT

For soil, the likely exposure pathways at IR Site 70 include ingestion, inhalation of particulates and volatiles, and dermal absorption. Exposure to indoor air from soil gas was not considered a significant pathway due to the presence of a surficial clay layer at the site which, based on soil gas sampling, does not readily release trapped gases to the atmosphere. Exposure to groundwater contaminated by soil leachate is not applicable at the subject site since the static groundwater level is approximately 12 to 16 feet bgs. Ingestion via plant, meat, or dairy products is also not applicable since the subject site is not currently used or expected to be used in the future for subsistence farming (i.e., where the population being assessed is subsisting on the plant, meat, or dairy products grown or raised in the exposure area).

7.1.2.3 RESULTS

Although IR Site 70 was screened in the ERSE for both an industrial and a residential scenario, it should be noted that land use within NAVWPNSTA Seal Beach is generally characterized as heavy industrial use. The current and planned future use for the site is as an RT&E facility. Under this planned future use, personnel would occupy the area but would not reside at the site.

AOC 2 – Residential Land Use

Under the residential scenario, the total cancer risk associated with the soil at AOC 2 was estimated at 9.6×10^{-5} and 1.0×10^{-4} by use of U.S. EPA and Cal-Modified PRGs, respectively (Table 7-2). Arsenic, vinyl chloride, and beryllium are identified as the principal risk drivers, contributing 65, 14, and 11 percent, respectively, of the U.S. EPA derived total cancer risk. These chemicals contribute 61, 13, and 10 percent, respectively, of the total cancer risk estimated by use of Cal-Modified PRGs. As discussed in Section 7.1, risks are based on the highest reported concentration. The maximum reported concentrations for arsenic, vinyl chloride, and beryllium are shown in Table 7-2.

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic and beryllium) identified as COPCs (Table 7-3). Incremental carcinogenic risk was calculated for AOC 2 by subtracting background risk for the naturally occurring metals from their corresponding total lifetime risk. The incremental cancer risk values for the carcinogenic metals were combined with the total cancer risk values for the organic carcinogens to obtain the overall incremental risk estimate for IR Site 70, AOC 2. The cancer risk due to background was calculated at 5.6×10^{-5}. Incremental cancer risk from exposure to the soil was quantified at 4.4×10^{-5} and 4.9×10^{-5} by use of U.S. EPA PRGs and Cal-Modified PRGs, respectively.

Under residential conditions, the HI was estimated at 4.0 (Table 7-2), indicating a potential for systemic toxicity under the residential scenario. Arsenic, TCE, aluminum, manganese, and antimony are the primary contributors to the HI. The maximum concentrations for these analytes are shown in Table 7-2.

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the residential scenario (Table 7-3). These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 2.4.

Since the maximum reported lead concentration at IR Site 70, AOC 2 was 22.8 mg/kg (below the PRG of 130 mg/kg), the Cal/EPA pharmacokinetic model was not used to estimate the blood lead concentration for a resident child or adult.

AOC 2 – Industrial Land Use

Under the industrial scenario, the total cancer risk associated with the soil at IR Site 70, AOC 2 was estimated at 2.2×10^{-5} by use of U.S. EPA PRGs (Table 7-2). Arsenic, vinyl chloride, and TCE are identified as the principal risk drivers, contributing 45, 28, and 11 percent, respectively, of the U.S. EPA-derived total cancer risk. The maximum reported concentrations for arsenic, vinyl chloride, and TCE are shown on Table 7-2.

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic) identified as COPCs (Table 7-3). The cancer risk due to background was calculated at 8.5×10^{-6}. Incremental cancer risk from exposure to the soil under the industrial land-use scenario was quantified at 1.4×10^{-5}.

Under industrial conditions, the HI at AOC 2 was estimated at 0.41, indicating a low potential for systemic toxicity under the industrial scenario.

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the industrial scenario. These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 0.1.

AOC 2 – Basis for Risk Management Decision

The ERSE recommended soil at AOC 2 for no further action. Since the incremental cancer risk was within the NCP-defined generally acceptable range of 10^{-4} to 10^{-6} under both the residential and industrial scenarios, the excess cancer risk at AOC 2 was determined to be acceptable. The noncancer risk was evaluated and was also found to be acceptable based on the following considerations.

- Use of the maximum reported concentrations of contaminants is conservative and leads to an overestimation of risk.
- Consideration was not given to target organs; had such consideration been given, the risk to a given organ would likely have been lower.
- Because the total HI is driven largely (53 percent) by naturally occurring concentrations of aluminum, arsenic, and manganese, it was concluded that the COPCs present in the AOC 2 soils do not pose a significant potential for systemic toxicity.

Table 7-2
Human-Health Risk Screening Results for Soil at IR Site 70, AOC 2

		RESIDENTIAL SOIL						INDUSTRIAL SOIL			
Analyte	Maximum Reported Concentration (mg/kg)	Cancer PRG Value Residential Soil (mg/kg)	Cancer Cal-Modified PRG Value Residential Soil (mg/kg)	Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Noncancer PRG Value Residential Soil (mg/kg)	Residential Hazard Index	Cancer PRG Value Industrial Soil (mg/kg)	Industrial Carcinogenic Risk	Noncancer PRG Value Industrial Soil (mg/kg)	Industrial Hazard Index
Metals											
Aluminum	43,200	—[a]	—	NA	NA	7.67E+04	5.63E-01	—	NA	—	NA
Antimony	13.6	—	—	NA	NA	3.07E+01	4.43E-01	—	NA	6.81E+02	2.00E-02
Arsenic	23.3	3.77E-01	3.77E-01	6.18E-05	6.18E-05	2.21E+01	1.05E+00	2.38E+00	9.79E-06	3.83E+02	6.08E-02
Barium	352	—	—	NA	NA	5.27E+03	6.68E-02	—	NA	—	NA
Beryllium	1.5	1.43E-01	1.43E-01	1.05E-05	1.05E-05	3.83E+02	3.91E-03	1.11E+00	1.35E-06	8.52E+03	1.76E-04
Cadmium	1.1	1.40E+03	9.00E+00	7.83E-10	1.22E-07	3.83E+01	2.87E-02	2.99E+03	3.68E-10	8.50E+02	1.29E-03
Chromium, total	50.9	2.11E+02	2.11E+02	2.42E-07	2.42E-07	—	NA	4.48E+02	1.14E-07	—	NA
Chromium VI	1.06	3.01E+01	2.00E-01	3.52E-08	5.30E-06	3.83E+02	2.76E-03	6.40E+01	1.66E-08	8.52E+03	1.24E-04
Cobalt	19.4	—	—	NA	NA	4.57E+03	4.25E-03	—	NA	9.70E+04	2.00E-04
Copper	64.4	—	—	NA	NA	2.85E+03	2.26E-02	—	NA	6.33E+04	1.02E-03
Lead	22.8	—	—	NA	NA	—	NA	—	NA	—	NA
Manganese	1,680	—	—	NA	NA	3.18E+03	5.28E-01	—	NA	4.31E+04	3.90E-02
Nickel	34.4	—	1.50E+02	NA	2.29E-07	1.53E+03	2.24E-02	—	NA	3.41E+04	1.01E-03
Silver	8.6	—	—	NA	NA	3.83E+02	2.24E-02	—	NA	8.52E+03	1.01E-03
Thallium	0.49	—	—	NA	NA	6.13E+00[b]	7.99E-02	—	NA	1.36E+02[b]	3.60E-03
Vanadium	125	—	—	NA	NA	5.37E+02	2.33E-01	—	NA	1.19E+04	1.05E-02
Zinc	156	—	—	NA	NA	2.30E+04	6.78E-03	—	NA	—	NA
Class sum				**7.26E-05**	**7.83E-05**		**3.08E+00**		**1.13E-05**		**1.39E-01**
Organics											
1,1-Dichloroethane	0.002	—	—	NA	NA	5.01E+02	3.99E-06	—	NA	1.73E+03	1.16E-06
1,1-Dichloroethene	0.035	3.67E-02	3.67E-02	9.55E-07	9.55E-07	1.38E+01	2.54E-03	8.00E-02	4.37E-07	4.58E+01	7.64E-04
1,3-Dichlorobenzene	0.001	—	—	NA	NA	5.04E+02	1.98E-06	—	NA	—	NA
1,4-Dichlorobenzene	0.001	3.60E+00	3.60E+00	2.78E-10	2.78E-10		NA	8.49E+00	1.18E-10	—	NA
2-Butanone	0.052	—	—	NA	NA	7.10E+03	7.32E-06	—	NA	2.65E+04	1.96E-06
Acetone	22.6	—	—	NA	NA	2.09E+03	1.08E-02	—	NA	8.75E+03	2.58E-03
Benzene	0.001	6.32E-01	6.32E-01	1.58E-09	1.58E-09	7.12E+00	1.40E-04	1.37E+00	7.28E-10	2.43E+01	4.11E-05
Bromodichloromethane	0.034	6.33E-01	6.33E-01	5.37E-08	5.37E-08	1.74E+02	1.96E-04	1.41E+00	2.41E-08	6.24E+02	5.45E-05
Bromoform	0.001	5.62E+01	5.62E+01	1.78E-11	1.78E-11	1.30E+03	7.67E-07	2.41E+02	4.14E-12	1.36E+04	7.34E-08
Carbon disulfide	0.0033	—	—	NA	NA	7.48E+00	4.41E-04	—	NA	2.45E+01	1.35E-04
Chloroform	0.83	2.48E-01	2.48E-01	3.34E-06	3.34E-06	4.35E+01	1.91E-02	5.29E-01	1.57E-06	1.49E+02	5.57E-03
cis-1,2-dichloroethene	7.8	—	—	NA	NA	3.09E+01	2.52E-01	—	NA	1.04E+02	7.47E-02
Dibromochloromethane	0.008	5.29E+00	5.29E+00	1.51E-09	1.51E-09	1.30E+03	6.14E-06	2.27E+01	3.52E-10	1.36E+04	5.87E-07

(table continues)

Table 7-2 (continued)

Analyte	Maximum Reported Concentration (mg/kg)	RESIDENTIAL SOIL						INDUSTRIAL SOIL			
		Cancer PRG Value Residential Soil (mg/kg)	Cancer Cal-Modified PRG Value Residential Soil (mg/kg)	Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Noncancer PRG Value Residential Soil (mg/kg)	Residential Hazard Index	Cancer PRG Value Industrial Soil (mg/kg)	Industrial Carcinogenic Risk	Noncancer PRG Value Industrial Soil (mg/kg)	Industrial Hazard Index
Organics (continued)											
Methylene chloride	0.02	7.81E+00	7.81E+00	2.56E-09	2.56E-09	1.68E+03	1.19E-05	1.78E+01	1.12E-09	—	NA
Tetrachloroethene	0.1	5.36E+00	5.36E+00	1.87E-08	1.87E-08	6.15E+01	1.63E-03	1.67E+01	5.99E-09	2.15E+02	4.65E-04
Toluene	0.013	—	—	NA	NA	7.93E+02	1.64E-05	—	NA	—	NA
trans-1,2-dichloroethene	1.2	—	—	NA	NA	7.84E+01	1.53E-02	—	NA	2.67E+02	4.49E-03
Trichloroethene	17	3.16E+00	3.16E+00	5.37E-06	5.37E-06	2.68E+01	6.35E-01	7.01E+00	2.43E-06	9.18E+01	1.85E-01
Vinyl chloride	0.21	1.58E-02	1.58E-02	1.33E-05	1.33E-05	3.54E+01[b]	5.93E-03	3.47E-02	6.05E-06	1.21E+02[b]	1.74E-03
Class sum				**2.31E-05**	**2.31E-05**		**9.43E-01**		**1.05E-05**		**2.76E-01**
Total Cancer Risk and Hazard				**9.57E-05**	**1.01E-04**		**4.02E+00**		**2.18E-05**		**4.14E-01**

Table 7-2 (supplement)

Analyte	Maximum Reported Concentration (mg/kg)	Soil Saturation Concentration PRG Value (mg/kg)	Environmental Concentration Greater Than Soil Saturation Nonrisk PRG?	Soil Maximum Concentration PRG Value (mg/kg)	Environmental Concentration Greater Than Soil Maximum Nonrisk PRG?
Aluminum	43,200	NA	NA	100,000	No
Barium	352	NA	NA	100,000	No
Zinc	156	NA	NA	100,000	No
1,2-Dichlorobenzene	0.001	700	No	NA	NA
1,3-Dichlorobenzene	0.001	862	No	NA	NA
1,4-Dichlorobenzene	0.001	565	No	NA	NA
Ethylbenzene	0.001	225	No	NA	NA
Methylene chloride	0.02	2,279	No	NA	NA
Toluene	0.013	880	No	NA	NA
Total xylenes	0.006	316	No	NA	NA
Trichlorotrifluoroethane	0.037	5,552	No	NA	NA

Notes:
[a] dash indicates no PRG for analyte
[b] value based on surrogate PRG

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
IR – Installation Restoration (Program)
mg/kg – milligrams per kilogram
NA – not applicable (cancer risk or hazard quotient cannot be calculated because PRG is not available and no surrogate compound has been identified)
PRG – preliminary remediation goal

Table 7-3
Incremental Risk, Human-Health Risk Screening Results for Soil at IR Site 70, AOC 2

Analyte	Maximum Reported Concentration (mg/kg)	Seal Beach Statistical Background Concentration (mg/kg)	Residential Carcinogenic Risk	Seal Beach Background Residential Carcinogenic Risk	Incremental Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Seal Beach Background Residential Cal-Modified Carcinogenic Risk	Incremental Residential Cal-Modified Carcinogenic Risk	Residential Hazard Index	Residential Hazard Index From Background Metals	Industrial Carcinogenic Risk	Seal Beach Background Industrial Carcinogenic Risk	Incremental Industrial Carcinogenic Risk	Industrial Hazard Index	Industrial Hazard Index From Background Metals
Metals															
Aluminum	43,200	36,271.00	NA	NA	NA	NA	NA	NA	5.63E-01	4.73E-01	NA	NA	NA	NA	NA
Antimony	13.6	12.40	NA	NA	NA	NA	NA	NA	4.43E-01	4.04E-01	NA	NA	NA	2.00E-02	1.83E-02
Arsenic	23.3	15.38	6.18E-05	4.08E-05	2.10E-05	6.18E-05	4.08E-05	2.10E-05	1.05E+00	6.95E-01	9.79E-06	6.46E-06	3.33E-06	6.08E-02	4.01E-02
Barium	352	412.16	NA	NA	NA	NA	NA	NA	6.68E-02	7.82E-02	NA	NA	NA	NA	NA
Beryllium	1.5	2.11	1.05E-05	1.48E-05	0.00E+00	1.05E-05	1.48E-05	0.00E+00	3.91E-03	5.50E-03	1.35E-06	1.90E-06	NA	1.76E-04	2.48E-04
Cadmium	1.1	2.22	7.83E-10	1.58E-09	0.00E+00	1.22E-07	2.47E-07	0.00E+00	2.87E-02	5.79E-02	3.68E-10	7.43E-10	NA	1.29E-03	2.61E-03
Chromium, total	50.9	46.24	2.42E-07	2.19E-07	2.21E-08	2.42E-07	2.19E-07	2.21E-08	NA	NA	1.14E-07	1.03E-07	1.04E-08	NA	NA
Chromium VI	1.06	NA	3.52E-08	NA	3.52E-08	5.30E-06	NA	5.30E-06	2.76E-03	NA	1.66E-08	NA	NA	1.24E-04	NA
Cobalt	19.4	19.42	NA	NA	NA	NA	NA	NA	4.25E-03	4.25E-03	NA	NA	NA	2.00E-04	2.00E-04
Copper	64.4	39.04	NA	NA	NA	NA	NA	NA	2.26E-02	1.37E-02	NA	NA	NA	1.02E-03	6.17E-04
Lead	22.8	35.70	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	1,680	1,103.00	NA	NA	NA	NA	NA	NA	5.28E-01	3.47E-01	NA	NA	NA	3.90E-02	2.56E-02
Nickel	34.4	32.49	NA	NA	NA	2.29E-07	2.17E-07	1.27E-08	2.24E-02	2.12E-02	NA	NA	NA	1.01E-03	9.54E-04
Silver	8.6	10.11	NA	NA	NA	NA	NA	NA	2.24E-02	2.64E-02	NA	NA	NA	1.01E-03	1.19E-03
Thallium	0.49	0.49	NA		NA	NA	NA	NA	7.99E-02	7.99E-02	NA	NA	NA	3.60E-03	3.60E-03
Vanadium	125	85.95	NA	NA	NA	NA	NA	NA	2.33E-01	1.60E-01	NA	NA	NA	1.05E-02	7.21E-03
Zinc	156	177.17	NA	NA	NA	NA	NA	NA	6.78E-03	7.70E-03	NA	NA	NA	NA	NA
Class Sum			**7.26E-05**	**5.58E-05**	**2.11E-05**	**7.83E-05**	**5.63E-05**	**2.64E-05**	**3.081**	**2.373**	**1.13E-05**	**8.47E-06**	**3.34E-06**	**0.139**	**0.101**
Organics															
1,1-Dichloroethane	0.002	NA	NA	NA	NA	NA	NA	NA	3.99E-06	NA	NA	NA	NA	1.16E-06	NA
1,1-Dichloroethene	0.035	NA	9.55E-07	NA	9.55E-07	9.55E-07	NA	9.55E-07	2.54E-03	NA	4.37E-07	NA	4.37E-07	7.64E-04	NA
1,3-Dichlorobenzene	0.001	NA	NA	NA	NA	NA	NA	NA	1.98E-06	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	0.001	NA	2.78E-10	NA	2.78E-10	2.78E-10	NA	2.78E-10	NA	NA	1.18E-10	NA	1.18E-10	NA	NA
2-Butanone	0.052	NA	NA	NA	NA	NA	NA	NA	7.32E-06	NA	NA	NA	NA	1.96E-06	NA
Acetone	22.6	NA	NA	NA	NA	NA	NA	NA	1.08E-02	NA	NA	NA	NA	2.58E-03	NA
Benzene	0.001	NA	1.58E-09	NA	1.58E-09	1.58E-09	NA	1.58E-09	1.40E-04	NA	7.28E-10	NA	7.28E-10	4.11E-05	NA
Bromodichloromethane	0.034	NA	5.37E-08	NA	5.37E-08	5.37E-08	NA	5.37E-08	1.96E-04	NA	2.41E-08	NA	2.41E-08	5.45E-05	NA
Bromoform	0.001	NA	1.78E-11	NA	1.78E-11	1.78E-11	NA	1.78E-11	7.67E-07	NA	4.14E-12	NA	4.14E-12	7.34E-08	NA
Carbon disulfide	0.0033	NA	NA	NA	NA	NA	NA	NA	4.41E-04	NA	NA	NA	NA	1.35E-04	NA
Chloroform	0.83	NA	3.34E-06	NA	3.34E-06	3.34E-06	NA	3.34E-06	1.91E-02	NA	1.57E-06	NA	1.57E-06	5.57E-03	NA
cis-1,2-dichloroethene	7.8	NA	NA	NA	NA	NA	NA	NA	2.52E-01	NA	NA	NA	NA	7.47E-02	NA
Dibromochloromethane	0.008	NA	1.51E-09	NA	1.51E-09	1.51E-09	NA	1.51E-09	6.14E-06	NA	3.52E-10	NA	3.52E-10	5.87E-07	NA
Methylene chloride	0.02	NA	2.56E-09	NA	2.56E-09	2.56E-09	NA	2.56E-09	1.19E-05	NA	1.12E-09	NA	1.12E-09	NA	NA

(table continues)

Table 7-3 (continued)

Analyte	Maximum Reported Concentration (mg/kg)	Seal Beach Statistical Background Concentration (mg/kg)	Residential Carcinogenic Risk	Seal Beach Background Residential Carcinogenic Risk	Incremental Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Seal Beach Background Residential Cal-Modified Carcinogenic Risk	Incremental Residential Cal-Modified Carcinogenic Risk	Residential Hazard Index	Residential Hazard Index From Background Metals	Industrial Carcinogenic Risk	Seal Beach Background Industrial Carcinogenic Risk	Incremental Industrial Carcinogenic Risk	Industrial Hazard Index	Industrial Hazard Index From Background Metals
Organics (continued)															
Tetrachloroethene	0.1	NA	1.87E-08	NA	1.87E-08	1.87E-08	NA	1.87E-08	1.63E-03	NA	5.99E-09	NA	5.99E-09	4.65E-04	NA
Toluene	0.013	NA	NA	NA	NA	NA	NA	NA	1.64E-05	NA	NA	NA	NA	NA	NA
trans-1,2-dichloroethene	1.2	NA	NA	NA	NA	NA	NA	NA	1.53E-02	NA	NA	NA	NA	4.49E-03	NA
Trichloroethene	17	NA	5.37E-06	NA	5.37E-06	5.37E-06	NA	5.37E-06	6.35E-01	NA	2.43E-06	NA	2.43E-06	1.85E-01	NA
Vinyl chloride	0.21	NA	1.33E-05	NA	1.33E-05	1.33E-05	NA	1.33E-05	5.93E-03	NA	6.05E-06	NA	6.05E-06	1.74E-03	NA
Class sum			**2.31E-05**	**0.00E+00**	**2.31E-05**	**2.31E-05**	**0.00E+00**	**2.31E-05**	**0.943**	**0.000**	**1.05E-05**	**0.00E+00**	**1.05E-05**	**0.276**	**0.000**
Total Cancer Risk and Hazard			**9.57E-05**	**5.58E-05**	**4.42E-05**	**1.01E-04**	**5.63E-05**	**4.94E-05**	**4.024**	**2.373**	**2.18E-05**	**8.47E-06**	**1.39E-05**	**0.414**	**0.101**

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
IR – Installation Restoration (Program)
mg/kg – milligrams per kilogram
NA – not applicable (cancer risk or hazard quotient cannot be calculated because preliminary remediation goal is not available and no surrogate compound has been identified)

AOC 3 – Residential Land Use

Under the residential scenario, the total cancer risk associated with the soil at AOC 3 was estimated at 5.8×10^{-5} by use of U.S. EPA and Cal-Modified PRGs (Table 7-4). Arsenic and beryllium are identified as the principal risk drivers, contributing 84 and 16 percent, respectively, of the U.S. EPA-derived total cancer risk. These chemicals contribute 83 and 16 percent, respectively, of the total cancer risk estimated by use of Cal-Modified PRGs. The maximum reported concentrations of these chemicals are shown in Table 7-4.

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic and beryllium) identified as COPCs (Table 7-5). Incremental carcinogenic risk was calculated for AOC 3 by subtracting background risk for the naturally occurring metals from their corresponding total lifetime risk. The incremental cancer risk values for the carcinogenic metals were combined with the total cancer risk values for the organic carcinogens to obtain the overall incremental risk estimate for IR Site 70, AOC 3. The cancer risk due to background was calculated at 5.6×10^{-5}. Incremental cancer risk from exposure to the soil was quantified at 7.6×10^{-6} by use of U.S. EPA PRGs and Cal-Modified PRGs.

Under residential conditions, the HI at AOC 3 was estimated at 2.5, indicating a potential for systemic toxicity under the residential scenario. Arsenic, manganese, and aluminum are the primary contributors to the HI. Table 7-4 tabulates the individual contribution of each COPC to the AOC 3 HI. The highest reported values for arsenic, manganese, and aluminum are also shown on Table 7-4.

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the residential scenario (Table 7-5). These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 2.4.

Since the maximum reported lead concentration at AOC 3 was 117 mg/kg (below the PRG of 130 mg/kg), the Cal/EPA pharmacokinetic model was not used to estimate the blood lead concentration for a resident child or adult.

AOC 3 – Industrial Land Use

Under the industrial scenario, the total cancer risk associated with the soil at AOC 3 was estimated at 9.0×10^{-6} by use of U.S. EPA PRGs (Table 7-4). Arsenic and beryllium are identified as the principal risk drivers, contributing 85 and 13 percent, respectively, of the U.S. EPA-derived total cancer risk. The maximum reported concentrations for arsenic and beryllium are shown in Table 7-4.

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic and beryllium) identified as COPCs (Table 7-5). The cancer risk due to background was calculated at 8.5×10^{-6}. Incremental cancer risk from exposure to the soil under the industrial land-use scenario was quantified at 1.2×10^{-6}.

Under industrial conditions, the HI at AOC 3 was estimated at 0.12, indicating a very low potential for systemic toxicity under the industrial scenario.

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the industrial scenario (Table 7-5). These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 0.1.

AOC 3 – Basis for Risk Management Decision

The ERSE recommended soil at AOC 3 for no further action. Since the incremental cancer risk was within the NCP-defined generally allowable range of 10^{-4} to 10^{-6} under both the residential and industrial scenarios, the excess cancer risk at AOC 3 was determined to be allowable. The noncancer risk was evaluated and was also found to be allowable because the HI associated with AOC 3 soils under the residential land-use scenario (2.5) is approximately equivalent to the HI due to background metals under the residential land-use scenario (2.4). The HI under the industrial land-use scenario was estimated to be 0.12, indicating a very low potential for systemic toxicity.

AOC 4 – Residential Land Use

Under the residential scenario, the total cancer risk associated with soil at AOC 4 was estimated at 1.7×10^{-4} by use of U.S. EPA and Cal-Modified PRGs (Table 7-6). Arsenic and beryllium were identified as the principal risk drivers, contributing 92 and 7.6 percent, respectively, of the U.S. EPA-derived total cancer risk as well as the total cancer risk estimated by use of Cal-Modified PRGs. The maximum reported concentrations of arsenic and beryllium are shown on Table 7-6.

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic and beryllium) identified as COPCs (Table 7-7). Incremental carcinogenic risk was calculated by subtracting background risk for the naturally occurring metals from their corresponding total lifetime risk. The incremental cancer risk values for the carcinogenic metals were combined with the total cancer risk values for the organic carcinogens to obtain the overall incremental risk estimate. The cancer risk due to background was calculated at 5.6×10^{-5}. Incremental cancer risk from exposure to the soil was quantified at 1.1×10^{-4} by use of U.S. EPA PRGs and Cal-Modified PRGs.

Under residential conditions, the HI at AOC 4 was estimated at 11.8, indicating a potential for systemic toxicity under the residential scenario. Arsenic and manganese are the primary contributors to the HI. Table 7-6 tabulates the individual contribution of each COPC to the AOC 4 HI. The maximum concentrations of arsenic and manganese are shown on this table.

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the residential scenario (Table 7-7). These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 2.4.

Table 7-4
Human-Health Risk Screening Results for Soil at IR Site 70, AOC 3

		RESIDENTIAL SOIL						INDUSTRIAL SOIL			
Analyte	Maximum Reported Concentration (mg/kg)	Cancer PRG Value Residential Soil (mg/kg)	Cancer Cal-Modified PRG Value Residential Soil (mg/kg)	Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Noncancer PRG Value Residential Soil	Residential Hazard Index	Cancer PRG Value Industrial Soil	Industrial Carcinogenic Risk	Noncancer PRG Value Industrial Soil	Industrial Hazard Index
Metals											
Aluminum	33,100	—[a]	—	NA	NA	7.67E+04	4.32E-01	—	NA	—	NA
Antimony	6	—	—	NA	NA	3.07E+01	1.96E-01	—	NA	6.81E+02	8.81E-03
Arsenic	18.2	3.77E-01	3.77E-01	4.83E-05	4.83E-05	2.21E+01	8.22E-01	2.38E+00	7.65E-06	3.83E+02	4.75E-02
Barium	283	—	—	NA	NA	5.27E+03	5.37E-02	—	NA	—	NA
Beryllium	1.3	1.43E-01	1.43E-01	9.12E-06	9.12E-06	3.83E+02	3.39E-03	1.11E+00	1.17E-06	8.52E+03	1.53E-04
Cadmium	2.1	1.40E+03	9.00E+00	1.50E-09	2.33E-07	3.83E+01	5.48E-02	2.99E+03	7.03E-10	8.50E+02	2.47E-03
Chromium, total	66.1	2.11E+02	2.11E+02	3.14E-07	3.14E-07	—	NA	4.48E+02	1.47E-07	—	NA
Cobalt	19.2	—	—	NA	NA	4.57E+03	4.21E-03	—	NA	9.70E+04	1.98E-04
Copper	74	—	—	NA	NA	2.85E+03	2.60E-02	—	NA	6.33E+04	1.17E-03
Lead	117	—	—	NA	NA	—	NA	—	NA	—	NA
Manganese	1,990	—	—	NA	NA	3.18E+03	6.25E-01	—	NA	4.31E+04	4.62E-02
Mercury	0.18	—	—	NA	NA	2.30E+01	7.82E-03	—	NA	5.11E+02	3.52E-04
Nickel	33.8	—	1.50E+02	NA	2.25E-07	1.53E+03	2.20E-02	—	NA	3.41E+04	9.92E-04
Silver	10.1	—	—	NA	NA	3.83E+02	2.63E-02	—	NA	8.52E+03	1.19E-03
Thallium	0.4	—	—	NA	NA	6.13E+00[b]	6.52E-02	—	NA	1.36E+02[b]	2.94E-03
Vanadium	90.2	—	—	NA	NA	5.37E+02	1.68E-01	—	NA	1.19E+04	7.57E-03
Zinc	799	—	—	NA	NA	2.30E+04	3.47E-02	—	NA	—	NA
Class sum				**5.77E-05**	**5.82E-05**		**2.54E+00**		**8.97E-06**		**1.19E-01**
Organics											
Methylene chloride	0.017	7.81E+00	7.81E+00	2.18E-09	2.18E-09	1.68E+03	1.01E-05	1.78E+01	9.55E-10	—	NA
Acetone	0.054	—	—	NA	NA	2.09E+03	2.58E-05	—	NA	8.75E+03	6.17E-06
Toluene	0.012	—	—	NA	NA	7.93E+02	1.51E-05	—	NA	—	NA
Trichloroethene	0.007	3.16E+00	3.16E+00	2.21E-09	2.21E-09	2.68E+01	2.61E-04	7.01E+00	9.99E-10	9.18E+01	7.62E-05
Class sum				**4.39E-09**	**4.39E-09**		**3.12E-04**		**1.95E-09**		**8.24E-05**
Total Cancer Risk and Hazard				**5.77E-05**	**5.82E-05**		**2.54E+00**		**8.97E-06**		**1.20E-01**

(table continues)

Table 7-4 (Supplement)

Analyte	Maximum Reported Concentration (mg/kg)	Soil Saturation Concentration PRG Value (mg/kg)	Environmental Concentration Greater Than Soil Saturation Nonrisk PRG?	Soil Maximum Concentration PRG Value (mg/kg)	Environmental Concentration Greater Than Soil Maximum Nonrisk PRG?
Aluminum	33,100	NA	NA	100,000	No
Barium	283	NA	NA	100,000	No
Zinc	799	NA	NA	100,000	No
Ethylbenzene	0.001	225	No	NA	NA
Methylene chloride	0.017	2,279	No	NA	NA
Toluene	0.012	880	No	NA	NA
Total xylenes	0.003	316	No	NA	NA

Notes:
[a] dash indicates no PRG for analyte
[b] value based on surrogate PRG

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
IR – Installation Restoration (Program)
mg/kg – milligrams per kilogram
NA – not applicable (cancer risk or hazard quotient cannot be calculated because PRG is not available and no surrogate compound has been identified)
PRG – preliminary remediation goal

Table 7-5
Incremental Risk, Human-Health Risk Screening Results for Soil at IR Site 70, AOC 3

Analyte	Maximum Reported Concentration (mg/kg)	Seal Beach Statistical Background Concentration (mg/kg)	Residential Carcinogenic Risk	Seal Beach Background Residential Carcinogenic Risk	Incremental Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Seal Beach Background Residential Cal-Modified Carcinogenic Risk	Incremental Residential Cal-Modified Carcinogenic Risk	Residential Hazard Index	Residential Hazard Index From Background Metals	Industrial Carcinogenic Risk	Seal Beach Background Industrial Carcinogenic Risk	Incremental Industrial Carcinogenic Risk	Industrial Hazard Index	Industrial Hazard Index From Background Metals
Metals															
Aluminum	33,100	36,271.00	NA	NA	NA	NA	NA	NA	4.32E-01	4.73E-01	NA	NA	NA	NA	NA
Antimony	6	12.40	NA	NA	NA	NA	NA	NA	1.96E-01	4.04E-01	NA	NA	NA	8.81E-03	1.82E-02
Arsenic	18.2	15.38	4.83E-05	4.08E-05	7.48E-06	4.83E-05	4.08E-05	7.48E-06	8.22E-01	6.95E-01	7.65E-06	6.46E-06	1.18E-06	4.75E-02	4.01E-02
Barium	283	412.16	NA	NA	NA	NA	NA	NA	5.37E-02	7.82E-02	NA	NA	NA	NA	NA
Beryllium	1.3	2.11	9.12E-06	1.48E-05	0.00E+00	9.12E-06	1.48E-05	0.00E+00	3.39E-03	5.50E-03	1.17E-06	1.90E-06	0.00E+00	1.53E-04	2.48E-04
Cadmium	2.1	2.22	1.50E-09	1.58E-09	0.00E+00	2.33E-07	2.47E-07	0.00E+00	5.48E-02	5.79E-02	7.03E-10	7.43E-10	0.00E+00	2.47E-03	2.61E-03
Chromium, total	66.1	46.24	3.14E-07	2.19E-07	9.43E-08	3.14E-07	2.19E-07	9.43E-08	NA	NA	1.47E-07	1.03E-07	4.43E-08	NA	NA
Cobalt	19.2	19.42	NA	NA	NA	NA	NA	NA	4.21E-03	4.25E-03	NA	NA	NA	1.98E-04	2.00E-04
Copper	74	39.04	NA	NA	NA	NA	NA	NA	2.60E-02	1.37E-02	NA	NA	NA	1.17E-03	6.17E-04
Lead	117	35.70	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	1,990	1,103.00	NA	NA	NA	NA	NA	NA	6.25E-01	3.47E-01	NA	NA	NA	4.62E-02	2.56E-02
Mercury	0.18	0.30	NA	NA	NA	NA	NA	NA	7.82E-03	1.30E-02	NA	NA	NA	3.52E-04	5.87E-04
Nickel	33.8	32.49	NA	NA	NA	2.25E-07	2.17E-07	8.73E-09	2.20E-02	2.12E-02	NA	NA	NA	9.92E-04	9.54E-04
Silver	10.1	10.11	NA	NA	NA	NA	NA	NA	2.63E-02	2.64E-02	NA	NA	NA	1.19E-03	1.19E-03
Thallium	0.4	0.49	NA	NA	NA	NA	NA	NA	6.52E-02	7.99E-02	NA	NA	NA	2.94E-03	3.60E-03
Vanadium	90.2	85.95	NA	NA	NA	NA	NA	NA	1.68E-01	1.60E-01	NA	NA	NA	7.57E-03	7.21E-03
Zinc	799	177.17	NA	NA	NA	NA	NA	NA	3.47E-02	7.70E-03	NA	NA	NA	NA	NA
Class Sum			**5.77E-05**	**5.58E-05**	**7.58E-06**	**5.82E-05**	**5.63E-05**	**7.59E-06**	**2.541**	**2.387**	**8.97E-06**	**8.47E-06**	**1.23E-06**	**0.119**	**0.101**
Organics															
Methylene chloride	0.017	NA	2.18E-09	NA	2.18E-09	2.18E-09	NA	2.18E-09	1.01E-05	NA	9.55E-10	NA	9.55E-10	NA	NA
Acetone	0.054	NA	NA	NA	NA	NA	NA	NA	2.58E-05	NA	NA	NA	NA	6.17E-06	NA
Toluene	0.012	NA	NA	NA	NA	NA	NA	NA	1.51E-05	NA	NA	NA	NA	NA	NA
Trichloroethene	0.007	NA	2.21E-09	NA	2.21E-09	2.21E-09	NA	2.21E-09	2.61E-04	NA	9.99E-10	NA	9.99E-10	7.62E-05	NA
Class Sum			**4.39E-09**	**0.00E+0**	**4.39E-09**	**4.39E-09**	**0.00E+00**	**4.39E-09**	**0.0003**	**0.000**	**1.95E-09**	**0.00E+00**	**1.95E-09**	**0.00008**	**0.000**
Total Cancer Risk and Hazard			**5.77E-05**	**5.58E-05**	**7.58E-06**	**5.82E-05**	**5.63E-05**	**7.59E-06**	**2.541**	**2.387**	**8.97E-06**	**8.47E-06**	**1.23E-06**	**0.120**	**0.101**

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
IR – Installation Restoration (Program)
mg/kg – milligrams per kilogram
NA – not applicable (cancer risk or hazard quotient cannot be calculated because preliminary remediation goal is not available and no surrogate compound has been identified)

Table 7-6
Human-Health Risk Screening Results for Soil at IR Site 70, AOC 4

Analyte	Maximum Reported Concentration (mg/kg)	RESIDENTIAL SOIL: Cancer PRG Value Residential Soil (mg/kg)	RESIDENTIAL SOIL: Cancer Cal-Modified PRG Value Residential Soil (mg/kg)	RESIDENTIAL SOIL: Residential Carcinogenic Risk	RESIDENTIAL SOIL: Residential Cal-Modified Carcinogenic Risk	RESIDENTIAL SOIL: Noncancer PRG Value Residential Soil	RESIDENTIAL SOIL: Residential Hazard Index	INDUSTRIAL SOIL: Cancer PRG Value Industrial Soil	INDUSTRIAL SOIL: Industrial Carcinogenic Risk	INDUSTRIAL SOIL: Noncancer PRG Value Industrial Soil	INDUSTRIAL SOIL: Industrial Hazard Index
Metals											
Aluminum	4.02E+04	—[a]	—	NA	NA	7.67E+04	5.24E-01	—	NA	—	NA
Antimony	9.60E+00	—	—	NA	NA	3.07E+01	3.13E-01	—	NA	6.81E+02	1.41E-02
Arsenic	5.75E+01	3.77E-01	3.77E-01	1.53E-04	1.53E-04	2.21E+01	2.60E+00	2.38E+00	2.42E-05	3.83E+02	1.50E-01
Barium	1.47E+03	—	—	NA	NA	5.27E+03	2.79E-01	—	NA	—	NA
Beryllium	1.80E+00	1.43E-01	1.43E-01	1.26E-05	1.26E-05	3.83E+02	4.69E-03	1.11E+00	1.62E-06	8.52E+03	2.11E-04
Cadmium	6.50E-01	1.40E+03	9.00E+00	4.63E-10	7.22E-08	3.83E+01	1.70E-02	2.99E+03	2.17E-10	8.50E+02	7.65E-04
Chromium, total	4.98E+01	2.11E+02	2.11E+02	2.36E-07	2.36E-07	—	NA	4.48E+02	1.11E-07	—	NA
Cobalt	2.68E+01	—	—	NA	NA	4.57E+03	5.87E-03	—	NA	9.70E+04	2.76E-04
Copper	5.90E+01	—	—	NA	NA	2.85E+03	2.07E-02	—	NA	6.33E+04	9.33E-04
Lead	2.09E+01	—	—	NA	NA	—	NA	—	NA	—	NA
Manganese	2.39E+04	—	—	NA	NA	3.18E+03	7.51E+00	—	NA	4.31E+04	5.55E-01
Mercury	1.10E+00	—	—	NA	NA	2.30E+01	4.78E-02	—	NA	5.11E+02	2.15E-03
Nickel	4.61E+01	—	1.50E+02	NA	3.07E-07	1.53E+03	3.01E-02	—	NA	3.41E+04	1.35E-03
Silver	8.80E+00	—	—	NA	NA	3.83E+02	2.30E-02	—	NA	8.52E+03	1.03E-03
Thallium	1.30E+00	—	—	NA	NA	6.13E+00[b]	2.12E-01	—	NA	1.36E+02[b]	9.54E-03
Vanadium	1.01E+02	—	—	NA	NA	5.37E+02	1.88E-01	—	NA	1.19E+04	8.47E-03
Zinc	1.18E+02	—	—	NA	NA	2.30E+04	5.13E-03	—	NA	—	NA
Class sum				**1.65E-04**	**1.66E-04**		**1.18E+01**		**2.59E-05**		**7.43E-01**
Organics											
2-Butanone	1.50E-02	—	—	NA	NA	7.10E+03	2.11E-06	—	NA	2.65E+04	5.66E-07
Acetone	1.10E-01	—	—	NA	NA	2.09E+03	5.27E-05	—	NA	8.75E+03	1.26E-05
cis-1,2-dichloroethene	3.00E-03	—	—	NA	NA	3.09E+01	9.71E-05	—	NA	1.04E+02	2.87E-05
Methylene chloride	1.10E-02	7.81E+00	7.81E+00	1.41E-09	1.41E-09	1.68E+03	6.54E-06	1.78E+01	6.18E-10	—	NA
Toluene	9.00E-03	—	—	NA	NA	7.93E+02	1.14E-05	—	NA	—	NA
trans-1,2-dichloroethene	1.00E-03	—	—	NA	NA	7.84E+01	1.28E-05	—	NA	2.67E+02	3.74E-06
Trichloroethene	5.20E-02	3.16E+00	3.16E+00	1.64E-08	1.64E-08	2.68E+01	1.94E-03	7.01E+00	7.42E-09	9.18E+01	5.66E-04
Vinyl chloride	2.00E-03	1.58E-02	1.58E-02	1.27E-07	1.27E-07	3.54E+01[b]	5.65E-05	3.47E-02	5.76E-08	1.21E+02[b]	1.65E-05
Class sum				**1.45E-07**	**1.45E-07**		**2.18E-03**		**6.57E-08**		**6.29E-04**
Total cancer risk and hazard				**1.66E-04**	**1.66E-04**		**11.78**		**2.60E-05**		**0.74**

(table continues)

Table 7-6 (Supplement)

Analyte	Maximum Reported Concentration (mg/kg)	Soil Saturation Concentration PRG Value (mg/kg)	Environmental Concentration Greater than Soil Saturation Nonrisk PRG?	Soil Maximum Concentration PRG Value (mg/kg)	Environmental Concentration Greater Than Soil Maximum Nonrisk PRG?
Aluminum	40,200.00	NA	NA	100,000.00	No
Barium	1,470.00	NA	NA	100,000.00	No
Zinc	118.00	NA	NA	100,000.00	No
Methylene chloride	0.011	2,279.00	No	NA	NA
Toluene	0.009	880.00	No	NA	NA
Total xylenes	0.001	316.00	No	NA	NA

Notes:
[a] dash indicates no PRG for analyte
[b] value based on surrogate PRG

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
PRG – preliminary remediation goal
mg/kg – milligrams per kilogram
NA – not applicable; cancer risk or hazard quotient cannot be calculated because PRG is not available and no surrogate compound has been identified

Table 7-7
Incremental Risk, Human-Health Risk Screening Results for Soil at IR Site 70, AOC 4

Analyte	Maximum Reported Concentration (mg/kg)	Seal Beach Statistical Background Concentration (mg/kg)	Residential Carcinogenic Risk	Seal Beach Background Residential Carcinogenic Risk	Incremental Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Seal Beach Background Residential Cal-Modified Carcinogenic Risk	Incremental Residential Cal-Modified Carcinogenic Risk	Residential Hazard Index	Residential Hazard Index From Background Metals	Industrial Carcinogenic Risk	Seal Beach Background Industrial Carcinogenic Risk	Incremental Industrial Carcinogenic Risk	Industrial Hazard Index	Industrial Hazard Index From Background Metals
Metals															
Aluminum	4.02E+04	3.63E+04	NA	NA	NA	NA	NA	NA	5.24E-01	4.73E-01	NA	NA	NA	NA	NA
Antimony	9.60E+00	1.24E+01	NA	NA	NA	NA	NA	NA	3.13E-01	4.04E-01	NA	NA	NA	1.41E-02	1.82E-02
Arsenic	5.75E+01	1.54E+01	1.53E-04	4.08E-05	1.12E-04	1.53E-04	4.08E-05	1.12E-04	2.60E+00	6.95E-01	2.42E-05	6.46E-06	1.77E-05	1.50E-01	4.01E-02
Barium	1.47E+03	4.12E+02	NA	NA	NA	NA	NA	NA	2.79E-01	7.82E-02	NA	NA	NA	NA	NA
Beryllium	1.80E+00	2.11E+00	1.26E-05	1.48E-05	0.00E+00	1.26E-05	1.48E-05	0.00E+00	4.69E-03	5.50E-03	1.62E-06	1.90E-06	0.00E+00	2.11E-04	2.48E-04
Cadmium	6.50E-01	2.22E+00	4.63E-10	1.58E-09	0.00E+00	7.22E-08	2.47E-07	0.00E+00	1.70E-02	5.79E-02	2.17E-10	7.43E-10	0.00E+00	7.65E-04	2.61E-03
Chromium, total	4.98E+01	4.62E+01	2.36E-07	2.19E-07	1.69E-08	2.36E-07	2.19E-07	1.69E-08	NA	NA	1.11E-07	1.03E-07	7.94E-09	NA	NA
Cobalt	2.68E+01	1.94E+01	NA	NA	NA	NA	NA	NA	5.87E-03	4.25E-03	NA	NA	NA	2.76E-04	2.00E-04
Lead	2.09E+01	3.57E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	5.90E+01	3.90E+01	NA	NA	NA	NA	NA	NA	2.07E-02	1.37E-02	NA	NA	NA	9.33E-04	6.17E-04
Manganese	2.39E+04	1.10E+03	NA	NA	NA	NA	NA	NA	7.51E+00	3.47E-01	NA	NA	NA	5.55E-01	2.56E-02
Mercury	1.10E+00	3.00E-01	NA	NA	NA	NA	NA	NA	4.78E-02	1.30E-02	NA	NA	NA	2.15E-03	5.87E-04
Nickel	4.61E+01	3.25E+01	NA	NA	NA	3.07E-07	2.17E-07	9.07E-08	3.01E-02	2.12E-02	NA	NA	NA	1.35E-03	9.54E-04
Silver	8.80E+00	1.01E+01	NA	NA	NA	NA	NA	NA	2.30E-02	2.64E-02	NA	NA	NA	1.03E-03	1.19E-03
Thallium	1.30E+00	4.90E-01	NA	NA	NA	NA	NA	NA	2.12E-01	7.99E-02	NA	NA	NA	9.54E-03	3.60E-03
Vanadium	1.01E+02	8.60E+01	NA	NA	NA	NA	NA	NA	1.88E-01	1.60E-01	NA	NA	NA	8.47E-03	7.21E-03
Zinc	1.18E+02	1.77E+02	NA	NA	NA	NA	NA	NA	5.13E-03	7.70E-03	NA	NA	NA	NA	NA
Class Sum			**1.65E-04**	**5.58E-05**	**1.12E-04**	**1.66E-04**	**5.63E-05**	**1.12E-04**	**11.78**	**2.39**	**2.59E-05**	**8.47E-06**	**1.77E-05**	**7.43E-01**	**1.01E-01**
Organics															
2-Butanone	1.50E-02		NA	NA	NA	NA	NA	NA	2.11E-06	0.00E+00	NA	NA	NA	5.66E-07	0.00E+00
Acetone	1.10E-01		NA	NA	NA	NA	NA	A	5.27E-05	0.00E+00	NA	NA	NA	1.26E-05	0.00E+00
cis-1,2-dichloroethene	3.00E-03		NA	NA	NA	NA	NA	A	9.71E-05	0.00E+00	NA	NA	NA	2.87E-05	0.00E+00
Methylene chloride	1.10E-02		1.41E-09	0.00E+00	1.41E-09	1.41E-09	0.00E+00	1.41E-09	6.54E-06	0.00E+00	6.18E-10	0.00E+00	6.18E-10	NA	NA
Toluene	9.00E-03		NA	NA	NA	NA	NA	NA	1.14E-05	0.00E+00	NA	NA	NA	NA	NA
trans-1,2-dichloroethene	1.00E-03		NA	NA	NA	NA	NA	NA	1.28E-05	0.00E+00	NA	NA	NA	3.74E-06	0.00E+00
Trichloroethene	5.20E-02		1.64E-08	0.00E+00	1.64E-08	1.64E-08	0.00E+00	1.64E-08	1.94E-03	0.00E+00	7.42E-09	0.00E+00	7.42E-09	5.66E-04	0.00E+00
Vinyl chloride	2.00E-03		1.27E-07	0.00E+00	1.27E-07	1.27E-07	0.00E+00	1.27E-07	5.65E-05	0.00E+00	5.76E-08	0.00E+00	5.76E-08	1.65E-05	0.00E+00
Class Sum			**1.45E-07**	**0.00E+00**	**1.45E-07**	**1.45E-07**	**0.00E+00**	**1.45E-07**	**2.18E-03**	**0.00**	**6.57E-08**	**0.00E+00**	**6.57E-08**	**6.29E-04**	**0.00E+00**
Total Cancer Risk and Hazard			**1.66E-04**	**5.58E-05**	**1.12E-04**	**1.66E-04**	**5.63E-05**	**1.12E-04**	**11.78**	**2.39**	**2.60E-05**	**8.47E-06**	**1.78E-05**	**7.44E-01**	**1.01E-01**

Acronyms/Abbreviations:
- AOC – area of concern
- Cal-Modified – California (Environmental Protection Agency) modified
- IR – Installation Restoration (Program)
- mg/kg – milligrams per kilogram
- NA – not applicable (cancer risk or hazard quotient cannot be calculated because preliminary remediation goal is not available and no surrogate compound has been identified)

Since the maximum reported lead concentration at IR Site 70, AOC 4 was 20.9 mg/kg (below the PRG of 130 mg/kg), the Cal/EPA pharmacokinetic model was not used to estimate the blood lead concentration for a resident child or adult.

AOC 4 – Industrial Land Use

Under the industrial scenario, the total cancer risk associated with the soil at AOC 4 was estimated at 2.6×10^{-5} by use of U.S. EPA PRGs (Table 7-6). Arsenic and beryllium are identified as the principal risk drivers, contributing 93 and 6.2 percent, respectively, of the U.S. EPA derived total cancer risk. The maximum reported concentrations for arsenic and beryllium are shown on Table 7-6.

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic and beryllium) identified as COPCs (Table 7-7). The cancer risk due to background was calculated at 8.5×10^{-6}. Incremental cancer risk from exposure to the soil under the industrial land-use scenario was quantified at 1.8×10^{-5}.

Under industrial conditions, the HI at AOC 4 was estimated at 0.74, indicating low potential for systemic toxicity under the industrial scenario.

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the industrial scenario (Table 7-7). These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 0.1.

AOC 4 – Basis for Risk Management Decision

The ERSE recommended soil at AOC 4 for further evaluation because the incremental cancer risk for the residential scenario (1.1×10^{-4}) was greater than the NCP-defined generally allowable range (10^{-4} to 10^{-6}), and the HI was greater than 1.0. As discussed in Section 7.1, exposure conditions used in the human-health risk screening were chosen to represent a maximum possible exposure in order to deliberately overestimate risk. These exposure conditions include the use of maximum reported concentrations for all chemicals within a particular AOC and/or medium for which an estimate of risk is desired. Since concentrations of a particular chemical will typically vary across the study area from not detected to some maximum value, the degree to which the risk is overestimated using the screening method will be largely dependent on the magnitude of the maximum concentration in relation to the other analytical results.

For AOC 4 soils, the risk screening results presented in the ERSE Report are driven almost exclusively by two sample results: the maximum concentrations of arsenic (57.5 mg/kg) and manganese (23,900 mg/kg), which were reported at one sample location. Arsenic was reported at a concentration of 57.5 mg/kg, which is approximately 4 times the stationwide statistical background value and 2.5 times the geochemical upper limit value. Manganese was reported at a concentration of 23,900 mg/kg, which is approximately 22 times the stationwide statistical background value and 10 times the geochemical upper limit value. However, a comparison of these maximum concentrations with the analytic results from the remaining 53 arsenic samples (from not detected to 25.9 mg/kg) and manganese samples (from 83.3 to 2,230 mg/kg) collected across AOC 4 suggest the risk screening significantly overestimated the risk at AOC 4.

AOC 4 – Supplemental Risk Assessment Screening Evaluation

Subsequent to the ERSE, a supplemental risk screening evaluation was performed to refine the risk at AOC 4. As agreed upon with DTSC, this supplemental risk screening used the 95 percent upper confidence level (95% UCL) rather than the highest maximum concentration, where appropriate, to evaluate risk. The analysis was performed using the same COPCs previously identified in the ERSE and the 1999 U.S. EPA Region 9 PRGs.

Using the 95% UCL of the reported concentrations, the total cancer risk under the residential scenario was estimated at 4.4×10^{-5} (Table 7-8). The incremental cancer risk was estimated at 1.9×10^{-5}. Under the industrial scenario, the total and incremental risks were estimated at 6.8×10^{-6} and 3.1×10^{-6}, respectively. The residential noncancer HI was estimated at 1.7, indicating a potential for systemic toxicity, with a background HI of 1.19, also indicating a potential for systemic toxicity. The industrial noncancer HI was 0.08, with a background HI of 0.05. Arsenic and beryllium were the largest contributors to the cancer risk under both the residential and industrial scenarios. Arsenic was also the largest contributor to the noncancer risk.

Since the cancer and noncancer risks exceeded 1×10^{-6} and 1.0, respectively, they were subjected to a risk management evaluation. This evaluation concluded the following.

- Since the incremental cancer risk of 1.9×10^{-5} is within the NCP-defined generally allowable range (10^{-4} to 10^{-6}) and is slightly lower than that posed by naturally occurring (background) metals (2.6×10^{-5}), no further action is warranted for human-health cancer risk considerations.
- Given the conservative approach used in assessing the HI (assuming that all chemicals detected in soils are COPCs, with no consideration given to specific target organs), and because the majority of the total HI (1.72) is attributable to naturally occurring (background) metals (1.18), it can be concluded that the COPCs present in the AOC 4 soils do not pose a significant potential for systemic toxicity. Accordingly, no further action is required for human-health considerations.

From the above evaluation, IR Site 70 soils were recommended for no further action.

AOC 11 – Residential Land Use

Under the residential scenario, the total cancer risk associated with the soil at AOC 11 was estimated at 9.1×10^{-5} by use of U.S. EPA and Cal-Modified PRGs (Table 7-9). Arsenic and beryllium are identified as the principal risk drivers, contributing 90 and 10 percent, respectively, of the U.S. EPA-derived total cancer risk and of the total cancer risk estimated by use of Cal-Modified PRGs. The maximum reported concentrations for arsenic and beryllium are shown on Table 7-9.

Table 7-8
Revised Estimates of Cancer Risk and Hazard Index for COPCs in Soil at IR Site 70, AOC 4

	Residential		Industrial
	U.S. EPA Cancer Risk[a]	Cal-Modified Cancer Risk[a]	Cancer Risk[a]
Total Cancer Risk	4.4E-05	4.4E-05	6.8E-06
Background Cancer Risk	2.6E-05	2.6E-05	3.9E-06
Incremental Cancer Risk[b]	1.9E-05	1.9E-05	3.1E-06
Cancer Risk Drivers, Cancer Risk Values, Percentages of Cancer Risk			
ARSENIC	3.6E-05	3.6E-05	5.6E-06
	81%	81%	83%
BERYLLIUM	7.9E-06	7.9E-06	1.0E-06
	18.1%	18.0%	15.0%

	Residential	Industrial
Hazard Index[c]	**1.7**	**0.08**
Background Index	**1.19**	**0.05**
Hazard Drivers, Hazard Indices, Percentage of Hazard Index		
Manganese	0.24	0.02
	14%	22%
Arsenic	0.61	0.04
	35%	44%
Aluminum	0.32	NA
	19%	
Antimony	0.22	NA
	13%	

Notes:
[a] risk estimates are based on carcinogenic residential and industrial PRG values
[b] incremental cancer risk was calculated by subtracting the background cancer risk from the total cancer risk for each individual COPC
[c] hazard indices are based on noncancer residential and industrial PRG values

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
COPC – chemical of potential concern
IR – Installation Restoration (Program)
NA – not applicable (COPC is not identified as a hazard driver; i.e., hazard is estimated below 1.0)
PRG – preliminary remediation goal
U.S. EPA – United States Environmental Protection Agency

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic and beryllium) identified as COPCs (Table 7-10). Incremental carcinogenic risk was calculated for the site by subtracting background risk for the naturally occurring metals from their corresponding total lifetime risk. The incremental cancer risk values for the carcinogenic metals were combined with the total cancer risk values for the organic carcinogens to obtain the overall incremental risk estimate for AOC 11. The cancer risk due to background was calculated at 5.6×10^{-5}. Incremental cancer risk from exposure to the soil was quantified at 4.1×10^{-5} by use of U.S. EPA PRGs and Cal-Modified PRGs.

Under residential conditions, the HI at AOC 11 was estimated at 3.1, indicating a potential for systemic toxicity under the residential scenario. Arsenic and manganese are the primary contributors to the HI. The maximum concentrations for arsenic and manganese are shown on Table 7-9.

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the residential scenario. These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 2.4 (Table 7-10).

Since the maximum reported lead concentration was 228 mg/kg (above the Cal/EPA PRG of 130 mg/kg), the Cal/EPA LeadSpread model was used to estimate the blood lead concentration for a resident child and adult (Table 7-12). At AOC 11 the estimated upper-bound concentrations of lead in the blood of the resident child and resident adult (7.6 and 3.0 micrograms per deciliter [µg/dL], respectively, at the 99th percentile) fell below the benchmark of 10 µg/dL. Therefore, it was concluded that the lead concentrations at this site are unlikely to result in potential adverse health effects for residents.

AOC 11 – Industrial Land Use

Under the industrial scenario, the total cancer risk associated with the soil at AOC 11 was estimated at 1.4×10^{-5} by use of U.S. EPA PRGs (Table 7-9). Arsenic and beryllium are identified as the principal risk drivers, contributing 91 and 8 percent, respectively, of the U.S. EPA-derived total cancer risk. The maximum reported concentrations for arsenic and beryllium are shown in Table 7-9.

For perspective, a background risk was estimated for the naturally occurring metals (e.g., arsenic and beryllium) identified as COPCs (Table 7-10). The cancer risk due to background was calculated at 8.5×10^{-6}. Incremental cancer risk from exposure to the soil under the industrial land-use scenario was quantified at 6.5×10^{-6}.

Under industrial conditions, the HI at AOC 11 was estimated at 0.15, indicating very low potential for systemic toxicity under the industrial scenario. Table 7-8 presents the contribution of each chemical to the total cancer risk and HI.

Table 7-9
Human-Health Risk Screening Results for Soil at IR Site 70, AOC 11

		RESIDENTIAL SOIL						INDUSTRIAL SOIL			
Analyte	Maximum Reported Concentration (mg/kg)	Cancer PRG Value Residential Soil (mg/kg)	Cancer Cal-Modified PRG Value Residential Soil (mg/kg)	Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Noncancer PRG Value Residential Soil (mg/kg)	Residential Hazard Index	Cancer PRG Value Industrial Soil (mg/kg)	Industrial Carcinogenic Risk	Noncancer PRG Value Industrial Soil (mg/kg)	Industrial Hazard Index
Metals											
Aluminum	41,400	—*	—	NA	NA	7.67E+04	5.40E-01	—	NA	—	NA
Arsenic	30.6	3.77E-01	3.77E-01	8.12E-05	8.12E-05	2.21E+01	1.38E+00	2.38E+00	1.29E-05	3.83E+02	7.98E-02
Barium	253	—	—	NA	NA	5.27E+03	4.80E-02	—	NA	—	NA
Beryllium	1.3	1.43E-01	1.43E-01	9.12E-06	9.12E-06	3.83E+02	3.39E-03	1.11E+00	1.17E-06	8.52E+03	1.53E-04
Cadmium	1.1	1.40E+03	9.00E+00	7.83E-10	1.22E-07	3.83E+01	2.87E-02	2.99E+03	3.68E-10	8.50E+02	1.29E-03
Chromium, total	51.6	2.11E+02	2.11E+02	2.45E-07	2.45E-07	—	NA	4.48E+02	1.15E-07	—	NA
Cobalt	19.2	—	—	NA	NA	4.57E+03	4.21E-03	—	NA	9.70E+04	1.98E-04
Copper	46.9	—	—	NA	NA	2.85E+03	1.65E-02	—	NA	6.33E+04	7.41E-04
Lead	17.7	—	—	NA	NA	—	NA	—	NA	—	NA
Manganese	2,490	—	—	NA	NA	3.18E+03	7.82E-01	—	NA	4.31E+04	5.78E-02
Nickel	35.6	—	1.50E+02	NA	2.37E-07	1.53E+03	2.32E-02	—	NA	3.41E+04	1.05E-03
Silver	10.6	—	—	NA	NA	3.83E+02	2.76E-02	—	NA	8.52E+03	1.24E-03
Vanadium	104	—	—	NA	NA	5.37E+02	1.94E-01	—	NA	1.19E+04	8.72E-03
Zinc	138	—	—	NA	NA	2.30E+04	6.00E-03	—	NA	—	NA
Class sum				**9.06E-05**	**9.09E-05**		**3.06E+00**		**1.41E-05**		**1.51E-01**
Organics											
Acetone	2.25	—	—	NA	NA	2.09E+03	1.08E-03	—	NA	8.75E+03	2.57E-04
Chloroform	0.0268	2.48E-01	2.48E-01	1.08E-07	1.08E-07	4.35E+01	6.15E-04	5.29E-01	5.06E-08	1.49E+02	1.80E-04
Methylene chloride	0.0371	7.81E+00	7.81E+00	4.75E-09	4.75E-09	1.68E+03	2.21E-05	1.78E+01	2.08E-09	—	NA
Class sum				**1.13E-07**	**1.13E-07**		**1.71E-03**		**5.27E-08**		**4.37E-04**
Total Cancer Risk and Hazard				**9.07E-05**	**9.11E-05**		**3.06E+00**		**1.42E-05**		**1.51E-01**

Table 7-9 (Supplement)

Analyte	Maximum Reported Concentration (mg/kg)	Soil Saturation Concentration PRG Value (mg/kg)	Environmental Concentration Greater Than Soil Saturation Nonrisk PRG?	Soil Maximum Concentration PRG Value (mg/kg)	Environmental Concentration Greater Than Soil Maximum Nonrisk PRG?
Aluminum	41,400	NA	NA	100,000	No
Barium	253	NA	NA	100,000	No
Zinc	138	NA	NA	100,000	No
Methylene chloride	0.0371	2,279	No	NA	NA

Note:
* dash indicates no PRG for analyte

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
IR – Installation Restoration (Program)
mg/kg – milligrams per kilogram
NA – not applicable (cancer risk or hazard quotient cannot be calculated because PRG is not available and no surrogate compound has been identified)
PRG – preliminary remediation goal

Table 7-10
Incremental Risk, Human-Health Risk Screening Results for Soil at IR Site 70, AOC 11

Analyte	Maximum Reported Concentration (mg/kg)	Seal Beach Statistical Background Concentration (mg/kg)	Residential Carcinogenic Risk	Seal Beach Background Residential Carcinogenic Risk	Incremental Residential Carcinogenic Risk	Residential Cal-Modified Carcinogenic Risk	Seal Beach Background Residential Cal-Modified Carcinogenic Risk	Incremental Residential Cal-Modified Carcinogenic Risk	Residential Hazard Index	Residential Hazard Index From Background Metals	Industrial Carcinogenic Risk	Seal Beach Background Industrial Carcinogenic Risk	Incremental Industrial Carcinogenic Risk	Industrial Hazard Index	Industrial Hazard Index From Background Metals
Metals															
Aluminum	41,400	36,271.00	NA	NA	NA	NA	NA	NA	5.40E-01	4.73E-01	NA	NA	NA	NA	NA
Arsenic	30.6	15.38	8.12E-05	4.08E-05	4.04E-05	8.12E-05	4.08E-05	4.04E-05	1.38E+00	6.95E-01	1.29E-05	6.46E-06	6.39E-06	7.98E-02	4.01E-02
Barium	253	412.16	NA	NA	NA	NA	NA	NA	4.80E-02	7.82E-02	NA	NA	NA	NA	NA
Beryllium	1.3	2.11	9.12E-06	1.48E-05	0.00E+00	9.12E-06	1.48E-05	0.00E+00	3.39E-03	5.50-03	1.17E-06	1.90E-06	NA	1.53E-04	2.48E-04
Cadmium	1.1	2.22	7.83E-10	1.58E-09	0.00E+00	1.22E-07	2.47E-07	0.00E+00	2.87E-02	5.79E-02	3.68E-10	7.43E-10	NA	1.29E-03	2.61E-03
Chromium, total	51.6	46.24	2.45E-07	2.19E-07	2.54E-08	2.45E-07	2.19E-07	2.54E-08	NA	NA	1.15E-07	1.03E-07	1.20E-08	NA	NA
Cobalt	19.2	19.42	NA	NA	NA	NA	NA	NA	4.21E-03	4.25E-03	NA	NA	NA	1.98E-04	2.00E-04
Copper	46.9	39.04	NA	NA	NA	NA	NA	NA	1.65E-02	1.37E-02	NA	NA	NA	7.41E-04	6.17E-04
Lead	17.7	35.70	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	2,490	1,103.00	NA	NA	NA	NA	NA	NA	7.82E-01	3.47E-01	NA	NA	NA	5.78E-02	2.56E-02
Nickel	35.6	32.49	NA	NA	NA	2.37E-07	2.17E-07	2.07E-08	2.32E-02	2.12E-02	NA	NA	NA	1.05E-03	9.54E-04
Silver	10.6	10.11	NA	NA	NA	NA	NA	NA	2.76E-02	2.64E-02	NA	NA	NA	1.24E-03	1.19E-03
Vanadium	104	85.95	NA	NA	NA	NA	NA	NA	1.94E-01	1.60E-01	NA	NA	NA	8.72E-03	7.21E-03
Zinc	138	177.17	NA	NA	NA	NA	NA	NA	6.00E-03	7.70E-03	NA	NA	NA	NA	NA
Class Sum			**9.06E-05**	**5.58E-05**	**4.04E-05**	**9.09E-05**	**5.63E-05**	**4.04E-05**	**3.056**	**1.889**	**1.41E-05**	**8.47E-06**	**6.41E-06**	**0.151**	**0.079**
Organics															
Acetone	2.25	NA	NA	NA	NA	NA	NA	NA	1.08E-03	NA	NA	NA	NA	2.57E-04	NA
Chloroform	0.0268	NA	1.08E-07	NA	1.08E-07	1.08E-07	NA	1.08E-07	6.15E-04	NA	5.06E-08	NA	5.06E-08	1.80E-04	NA
Methylene chloride	0.0371	NA	4.75E-09	NA	4.75E-09	4.75E-09	NA	4.75E-09	2.21E-05	NA	2.08E-09	NA	2.08E-09	NA	NA
Class Sum			**1.13E-07**	**0.00E+00**	**1.13E-07**	**1.13E-07**	**0.00E+00**	**1.13E-07**	**0.002**	**0.000**	**5.27E-08**	**0.00E+00**	**5.27E-08**	**0.0004**	**0.000**
Total Cancer Risk and Hazard			**9.07E-05**	**5.58E-05**	**4.05E-05**	**9.11E-05**	**5.63E-05**	**4.06E-05**	**3.058**	**1.889**	**1.42E-05**	**8.47E-06**	**6.46E-06**	**0.151**	**0.079**

Acronyms/Abbreviations:
AOC – area of concern
Cal-Modified – California (Environmental Protection Agency) modified
IR – Installation Restoration (Program)
mg/kg – milligrams per kilogram
NA – not applicable (cancer risk or hazard quotient cannot be calculated because preliminary remediation goal is not available and no surrogate compound has been identified)

For reference purposes, a screening hazard evaluation was performed on the background levels of metals for the industrial scenario. These metals concentrations (the 99th percentile of the background concentration distributions) represent a screening HI level of 0.1.

The Cal/EPA pharmacokinetic model was used to estimate the blood lead concentration for an adult industrial worker. At AOC 11 the estimated upper-bound concentrations of lead in the blood of the adult industrial worker (2.8 µg/dL at the 99th percentile) fell below the benchmark of 10 µg/dL; therefore, the lead concentrations at this site are unlikely to result in potential adverse health effects for industrial workers. Table 7-12 presents a summary of blood lead levels calculated using Cal/EPA LeadSpread.

AOC 11 – Basis for Risk Management Decision

The ERSE recommended soil at AOC 11 for no further action. Since the incremental cancer risk was within the NCP-defined generally allowable range of 10^{-4} to 10^{-6} under both the residential and industrial scenarios, the excess cancer risk at AOC 11 was determined to be allowable. The noncancer risk was also evaluated. Because the total HI of 3.1 under the residential land-use scenario was approximately equivalent to the HI due to background metals of 2.4, the ERSE concluded that the COPCs present at the site do not pose a significant potential for systemic toxicity. The HI under the industrial land-use scenario was estimated to be 0.15, indicating a very low potential for systemic toxicity. Estimates of blood lead concentrations for a resident child, resident adult, and industrial adult were also below benchmark values.

Table 7-11
Summary of Estimates of Total Cancer Risk for Each AOC
Using U.S. EPA and Cal-Modified PRGs for Soil

Area of Concern	Residential Soil Risk (Cal Modified)	Industrial Soil Risk (U.S. EPA PRGs)
2	1.0×10^{-4}	2.2×10^{-5}
3	5.8×10^{-5}	9.0×10^{-6}
4	1.7×10^{-4}	2.6×10^{-5}
11	9.1×10^{-5}	1.4×10^{-5}

Acronyms/Abbreviations:
U.S. EPA – United States Environmental Protection Agency
AOC – Area of Concern
PRGs-Preliminary Remediation Goals
Cal Modified – California Environmental Protection Agency modified PRGs

7.2 ECOLOGICAL RISK

Although chemicals were reported in groundwater beneath IR Site 70, the depth to groundwater is too great for complete exposure pathways to exist between chemicals in groundwater and ecological receptors. Furthermore, no groundwater seeps to the surface were identified that would indicate a potential exposure pathway. For those reasons, groundwater was not evaluated further in the screening ecological risk assessment.

IR Site 70 consists of two areas of ecological concern: AOCs 3 and 4. The principal ecological concern at these AOCs is the potential effects to ecological receptors associated with exposures to metal and organic compounds adsorbed to soil particles. Two specific goals of the screening ecological risk assessment performed during the ERSE were to identify maximum reported concentrations of these chemicals in soil and to assess whether ecological receptors potentially using available habitat at AOCs 3 and 4 were at risk. Specifically, the screening ecological risk assessment identified:

- chemicals of potential ecological concern (COPECs) associated with AOCs 3 and 4,
- likelihood of adverse effects to individuals and populations in the environment, and
- species-specific exposure pathways and chemical exposure concentrations.

Table 7-12
Summary of Estimates of Noncarcinogenic Effects of Lead Using Cal/EPA LeadSpread for AOC 11 Soil (in micrograms per deciliter)

	BLOOD LEAD LEVEL OF 99TH PERCENTILE OF POPULATION[a]			
Location	Adult[b]	Child[b]	Pica Child[b,c]	Industrial Adult[b]
Background	2.7	5.8	10	2.6
AOC 11	3.0	7.6	34	2.8

Notes:
[a] estimates are based on pharmacokinetic model for calculating blood lead concentrations in children and adults
[b] a blood lead level greater than the benchmark of 10 μg/dL indicates that a possible effect could occur
[c] Pica Child blood lead levels are calculated for a scenario involving a childhood behavioral syndrome (Pica Child) characterized by unusual levels of soil ingestion

Acronyms/Abbreviations:
AOC – area of concern
Cal/EPA – California Environmental Protection Agency
μg/dL – micrograms per deciliter

An ecological risk assessment differs from a screening HHRA in that assessment endpoints do not necessarily focus on the individual, as with humans, but on populations and communities, with a final goal of evaluating the ecosystem. Thus, a certain degree of impact to individuals and species is considered within the context of impacts at higher ecological organization. The ecological risk screening evaluation was applied to AOCs 3 and 4 using the following steps.

- Maximum concentrations of COPECs at the AOC were used as the chemical concentrations in soil.
- COPEC concentrations in plants, invertebrates, and small mammals (i.e., food sources for other receptors) were estimated using either uptake factors or regression models obtained from the scientific literature.
- Chemical intakes were estimated for mammalian and avian receptors at each site using general intake equations and exposure factors recommended by Cal/EPA (1996) or U.S. EPA (1993a).
- Potential hazards to terrestrial plant and invertebrate receptors were estimated by comparing toxicity reference values (TRVs) with estimated daily doses.
- Hazard quotients (HQs) for each avian and mammalian receptor were summed to obtain an estimate of total chronic toxicity or HI.

The basic tenet of this approach in the screening ecological risk assessment is the characterization of potential hazards to ecological receptors. Current and potential hazards to receptors and ecological components (which may be organisms [i.e., individual receptors], populations, communities, or ecosystems) are estimated. Estimation of potential hazard to ecological receptors is defined as the given concentration or estimated daily dose of a chemical compared to available toxicity information or benchmark values for biological effects. HQs and/or HIs less than 1.0 are reasonably good indicators that adverse effects are unlikely, provided that indicators of toxicity have been underestimated. However, an HQ or HI greater than 1.0 is not necessarily indicative of adverse effects associated with a given COPEC or ecological receptor because of the use of uncertainty factors to derive toxicity criteria and conservative exposure assumptions.

7.2.1 Chemicals of Potential Ecological Concern

COPECs in soil are presented in Appendix P of the ERSE (BNI 1999a). These chemicals were identified using analytical data collected during the RSE (BNI 1996a) and the ERSE (BNI 1999a). The following types of chemicals were selected as COPECs:

- inorganic chemicals reported above detection limits at least once, except for inorganic constituents commonly found in the environment at relatively nontoxic levels (e.g., calcium, iron, magnesium, nitrate, phosphate, potassium, and sodium)
- organic chemicals reported above detection limits at least once and not identified as laboratory contaminants (i.e., concentrations in the samples are less than 10 times the concentrations in corresponding blank samples), or tentatively identified compounds that have been identified beyond the structural level

Because of the conservative nature of a screening ecological risk assessment, COPECs identified in soil samples up to 10 feet bgs were considered for the ecological screening; however, no exposure route for ecological receptors is considered complete at soil depths greater than 2 to 4 feet bgs (Hoffmeister 1986, Linsdale 1946, Miller 1957, Reynolds and Wakkinen 1987).

7.2.2 Assessment Endpoints

Ecological risk assessment guidance specifies two types of ecological endpoints: assessment and measurement (Cal/EPA 1996, U.S. EPA 1997a). Assessment endpoints are defined as the environmental attributes upon which the ecological risk screening focuses. Measurement endpoints are defined as the measurable, observable changes used to estimate effects on the assessment endpoints.

Potential adverse effects on the reproductive success, growth, or survival of receptor species were used as assessment endpoints for this evaluation. Criteria that were used to select assessment endpoints for site investigations include regulatory and social significance, ecological relevance, amenability to measurement or prediction, and susceptibility to contaminants (U.S. EPA 1992a, 1997a).

Numerous characteristics of species, communities, and ecosystems at AOCs 3 and 4 were considered potential assessment endpoints. For example, species of regulatory or social significance (e.g., peregrine falcon) may occur at these sites. These species could be susceptible to COPECs through ingestion of contaminated media or food items. COPECs could affect their growth, survival, or reproduction.

In terms of ecological relevance, functional groups, such as small mammals, were also considered since these are important prey items for higher trophic level organisms. A functional group refers to a group of species that, as a result of their physiologic and taxonomic similarities and/or dependence on the same types of food (energy) sources, are similar in their function within the ecosystem. Small mammals would also be susceptible to COPECs in soils due to their burrowing habits.

Only species or functional groups of species known to be abundant or common at the site were considered for selection as assessment endpoint species. For AOCs 3 and 4, selected species were plants, soil invertebrates, ground squirrels, western harvest mouse, American robin, striped skunk, and red-tailed hawk. These selected receptors were considered representative of others in each functional group, including threatened and endangered species, if present, with regard to potential exposure to COPECs and toxicological effects.

7.2.3 Exposure Pathways of Concern

For an exposure pathway to be complete, a chemical must be able to travel from the source to ecological receptors and be taken up by the receptors via one or more exposure routes. For the screening assessment, complete routes of exposure identified for selected ecological receptors at the site are the following:

- direct ingestion of COPECs in soil

- indirect ingestion of COPECs in plant and animal tissues associated with COPEC uptake from soil with subsequent transfer through the food chain
- direct contact with COPECs in soil by plant roots and soil macroinvertebrates

7.2.4 Ecological Screening With Toxicity Reference Values (TRV)

For the screening ecological risk assessment, receptors representative of functional groups of species at the site were selected for toxicological comparison to assess potential environmental risks associated with COPECs at IR Site 70. No observed adverse effects levels (NOAELs) were used to develop TRVs for selected terrestrial receptors other than plants and invertebrates. NOAEL is a concentration or dose that did not produce any observable toxicity in the test organism.

Several TRVs for avian and mammalian receptors have been developed by the Human and Ecological Risk Division (HERD) of Cal/EPA and were used in this screening ecological risk assessment. However, HERD-developed TRVs were not available for all receptors or for all COPECs at the station. In these cases, other toxicity data presented by researchers at Oak Ridge National Laboratory were used (Sample et al. 1996).

Most of the benchmarks were derived from chronic or subchronic studies in which reproductive and developmental endpoints were evaluated. An uncertainty factor of 0.1 was used to extrapolate from subchronic to chronic NOAELs and/or to extrapolate from lowest observed adverse effects levels to NOAELs.

Toxicity benchmarks were drawn from studies that considered reproductive and developmental effects or other critical effects indicative of overt impacts to individual organisms that may affect population size. Studies incorporating chronic exposure durations, multiple exposure levels, and statistical evaluation of test results were preferred. Each TRV used was based on one toxicological study but extrapolated for each receptor and COPEC using two different methods.

Method 1 entailed the use of the uncertainty factors recommended by CAL-EPA (1996) to extrapolate toxicity data between taxonomically distant species (e.g. different family or order).

Method 2 entailed adjusting the toxicity benchmarks obtained from the studies for body weight to estimate wildlife toxicity for mammalian species. The adjustment was made by multiplying the NOAEL from the study by the ratio of the average weight of the test species used in the study to the average weight of the wildlife species to the ¼ power $(\text{Body Weight}_{test}/\text{Body Weight}_{wildlife})^{1/4}$. This adjustment is based on the finding that in any group of animal species, the remaining major sources of variation in sensitivity to toxic effects of contaminants is varying body size (Sample et. al.1996). In general, smaller organisms are more tolerant of chemical exposures as a result of the higher rate of metabolism and greater detoxification capabilities (BNI, 1999).

7.2.5 Selection of Background Soil Concentrations

Background concentrations for metals were identified from sample results that represent soil conditions not affected by site operations. An ecological risk screening for the naturally occurring background metals that were among the chemicals identified as COPECs was conducted to understand how much of the on-site hazards can be attributed to site-related activities. On-site and background concentrations for these metals were compared to provide additional information for risk managers to use in making site-specific decisions.

7.2.6 Screening Ecological Risk Assessment Results

The total HIs (i.e., sum of the individual HQs) for the selected receptors were all greater than 1.0 at IR Site 70. As shown in Table 7-13, the HIs at AOC 3 ranged from approximately 8 to 2,500 for the selected receptors; the HIs at AOC 4 ranged from approximately 10 to 3,100. By comparison, HIs were also greater than 1.0 for the selected receptors exposed to stationwide background metal concentrations. The HIs for background concentrations ranged from approximately 10 to 2,700 (Table 7-13). Furthermore, total HIs associated with exposures to background metal concentrations are approximately the same or greater than those for AOCs 3 and 4.

Metals associated with HQs greater than 1.0 and contributing the most to the HIs for AOC 3, AOC 4, and background were aluminum, antimony, barium, cadmium, selenium (selenium was not reported at AOC 3 or 4), and vanadium for the ground squirrel, western harvest mouse, and the striped skunk. HQs for the red-tailed hawk associated with exposures to aluminum, antimony, and lead are lower than the HQs associated with background.

Several organic compounds were reported at AOCs 3 and 4. HIs for organics were greater than 1.0 for all receptors at AOC 4. For AOC 4, total organic HIs were approximately 1 for the ground squirrel, striped skunk, and the red-tailed hawk. The primary contributor to the HI for these receptors is exposure to TCE. For the western harvest mouse, exposures to TCE and vinyl chloride resulted in an HI of approximately 6. For the American robin, exposures to TCE, vinyl chloride, and methylene chloride are associated with an HI of approximately 30.

For AOC 3, only the total HI for organic compounds for the American robin exceeded 1.0. The organic HI for the American robin was approximately 2.0 and was largely associated with exposure to TCE.

Table 7-13
Estimation of Hazard Indices for Selected Ecological Receptors[a]

Receptor	Hazard Index Method 1[b]	Hazard Index Method 2[c]
Area of Concern 3		
Ground squirrel	4.9E + 02	2.0E + 02
Western harvest mouse	2.5E + 03	4.3E + 02
American robin	—[d]	3.0E + 02
Striped skunk	1.5E + 03	5.3E + 02
Red-tailed hawk	—	8.4E + 00
Area of Concern 4		
Ground squirrel	6.1E + 02	2.4E + 02
Western harvest mouse	3.1E + 03	5.3E + 02
American robin	—	3.2E + 02
Striped skunk	1.9E + 03	6.5E + 02
Red-tailed hawk	—	9.9E + 00
Background		
Ground squirrel	5.5E + 02	2.2E + 02
Western harvest mouse	2.7E + 03	4.8E + 02
American robin	—	3.4E + 02
Striped skunk	1.7E + 03	5.9E + 02
Red-tailed hawk	—	1.0E + 01

Notes:
[a] see text for a discussion of the primary contributors to hazard indices
[b] results were obtained using toxicity reference value (TRV) derivation (See Section 7.2.4)
[c] results were obtained using weight extrapolation (See Section 7.2.4)
[d] dash indicates not calculated

Although only a few plant and invertebrate toxicity benchmark values exist for organic compounds, the maximum reported levels at AOCs 3 and 4 were significantly lower than the benchmark values available for comparison.

Several plant and invertebrate benchmark values exist for metals. Maximum reported concentrations of aluminum, chromium, manganese, vanadium, and zinc exceeded the microorganism benchmark values at AOCs 3 and 4. Correspondingly, the stationwide background concentrations for these metals were also greater than the benchmark values for soil microorganisms.

Maximum reported concentrations of chromium, copper, mercury, and zinc exceeded the earthworm benchmark values at AOC 3, and concentrations of chromium, copper, and mercury also exceeded the earthworm benchmark values for AOC 4. It should be noted that the stationwide background concentrations for chromium and mercury exceeded their corresponding earthworm benchmark values.

The maximum reported concentrations of aluminum, chromium, manganese, nickel, silver, vanadium, and zinc exceeded the plant benchmark values at AOCs 3 and 4. Additionally, maximum reported concentrations exceeded the plant benchmark values for arsenic and lead at AOC 3 and for antimony, arsenic, barium, cobalt, mercury, and thallium at AOC 4. By comparison, stationwide background values for aluminum, antimony, arsenic, chromium, manganese, nickel, silver, vanadium, and zinc also exceeded their corresponding plant benchmark values.

7.2.7 Ecological Significance

Although the results from food web modeling and comparison of soil data with soil benchmark values indicate potential hazards for the selected receptors associated with chemical exposures at AOCs 3 and 4, several site-specific factors would indicate that potential exposures may be overestimated. These site-specific factors are discussed in the following sections.

7.2.7.1 AREA OF CONCERN 3

Twenty-three chemicals (17 metals and 6 organic chemicals) present in soil were screened for potential ecological impacts at AOC 3. Although exposures to metals and organic compounds resulted in several HQs and HIs greater than 1.0 for the mammalian receptors, few HQs and none of the HIs were greater than those based on stationwide background concentrations. None of the HQs or HIs for the ground squirrel and the striped skunk exceeded the calculated background HQs or HIs. Only HQs for lead, manganese, vanadium, and zinc for the western harvest mouse exceeded the calculated background HQs. These HQs only slightly exceeded the background HQs, by values less than 3.

For avian receptors, results obtained from the food web analysis generally correspond to results obtained for mammalian receptors, except that the HQ for lead is greater for the avian receptors than for the mammalian receptors. Exposure to the maximum reported concentration of lead at AOC 3 is elevated when compared to background for both the American robin and the red-tailed hawk. However, the elevated organic carbon content of soils at AOC 3 (i.e., approximately 3 percent) would reduce the bioavailability of lead in soil. The food web modeling assumed a bioavailability of 100 percent for all metals and organic chemicals. However, Pascoe et al. (1994) reported that the bioavailable fraction for metals (i.e., arsenic, cadmium, copper, lead, and zinc) in organically rich soil and sediment at a site in Montana was approximately 0.1 percent for small mammals. It is likely that the bioavailable fraction for lead at AOC 3 is less than the 100 percent assumed in the risk assessment. Furthermore, lead concentrations reported in AOC 3 range between 6 and 91 mg/kg. The elevated lead concentrations are concentrated in a very small area around two sample locations. Because of the relatively limited area of elevated lead concentrations in soil, it is not likely that exposures to lead would lead to impacts for avian receptors.

Exposures to maximum reported concentrations of organic chemicals at AOC 3 resulted in an HI of approximately 2 for the American robin. All other organic HIs were less than 1.0. For the American robin, none of the individual HQs are greater than 1.0 except for TCE (HQ of 1.0). Because there is a paucity of suitable toxicological data for avian receptors exposed to organic chemicals, the present screening ecological risk assessment applied a conservative uncertainty factor of 10 to the mammalian NOAEL. Because the HQs and resulting HIs are low for all receptors at AOC 3, and due to the conservativeness in the screening ecological risk assessment process, it is unlikely that exposures to the maximum reported concentrations of organic chemicals at AOC 3 would result in adverse impacts to ecological receptors.

Finally, maximum reported concentrations of metals exceeded soil benchmark values for plants, microorganisms, and invertebrates; however, where local background soil concentrations exceed soil benchmark values, the benchmarks represent a poor measure of risk to the plant and invertebrate communities that may be present at the site (Will and Suter 1995; Efroymson et al. 1997a,b).

7.2.7.2 AREA OF CONCERN 4

Twenty-six chemicals (17 metals and 9 organic chemicals) present in soil were screened for potential ecological impacts at AOC 4. Although exposures to metals and organic compounds resulted in a number of HQs and HIs greater than 1.0 for the selected mammalian receptors, the maximum reported concentrations were obtained from samples taken beneath the concrete bottom of the perimeter channel that surrounds IR Site 70. For example, the maximum reported concentrations of arsenic (57.5 mg/kg), barium (1,470 mg/kg), and manganese (23,900 mg/kg) were obtained from one sample location. Soil samples taken within 2 to 4 feet from this sampling location indicate arsenic, barium, and manganese concentrations nearly at or below stationwide background levels within the soil profile (up to 10.5 feet). Other reported concentrations of arsenic, barium, and manganese range from below background levels to slightly above background levels for AOC 4. Arsenic concentrations above the stationwide background value of 15.38 mg/kg were reported from 15.6 to 25.9 mg/kg at a depth of 10.5 feet. Manganese concentrations above the stationwide background value of 1,103 mg/kg were reported from 1,250 to 2,230 mg/kg. These reported concentrations for arsenic and manganese are significantly lower than the maximum reported concentrations. Other than exposures to arsenic, barium, and manganese, all other metal exposures are within or lower than stationwide background values for AOC 4.

For avian receptors, results from the food web analysis generally correspond to results obtained for mammalian receptors except for antimony and lead.

Only the American robin had an organic chemical HI much greater than 1.0 (the HI of approximately 6.0 for the harvest mouse was estimated from toxicity criteria using the more conservative Method 1 TRV derivation; the HI is approximately 1.0 using the Method 2 Body Weight Extrapolation). For the American robin, HQs greater than 1.0 include methylene chloride, TCE, and vinyl chloride. As mentioned previously, a conservative uncertainty factor of 10 was applied to the mammalian NOAEL to derive TRVs for these compounds. Because of the conservativeness in the screening ecological risk assessment process (i.e., 100 percent bioavailability, use of uncertainty factors to derive TRVs, maximum reported concentrations), it is unlikely that exposures to the maximum reported concentrations of organic chemicals at AOC 4 would result in adverse impacts to the American robin.

Complete pathways at AOC 4 appear improbable due to the concrete lining of the perimeter drainage channel. Analytical results used in this ecological risk assessment were reported from soil samples obtained from beneath the concrete-lined bottom of the channel. The assumed pathway investigated was due to organism burrowing from the adjacent grass-covered land beneath the channel. It is unlikely that any animal would burrow approximately 6 feet down and 10 feet across to reach the soil beneath the channel.

Finally, maximum reported concentrations of metals and organic chemicals exceeded soil benchmark values for plants, microorganisms, and invertebrates; however, where local background soil concentrations exceed soil benchmark values, the benchmarks represent a poor measure of risk to the plant and invertebrate communities that may be present at the site (Will and Suter 1995; Efroymson et al. 1997a,b).

7.2.8 Basis for Ecological Risk Management Decision

The basis for the ecological risk management decision for AOC 3 and 4 follows.

7.2.8.1 AOC 3 RISK MANAGEMENT DECISION

Ecological risks for AOC 3 were evaluated in the ERSE and found to be acceptable for the following reasons.

- Although several HQs and HIs were greater than 1.0 for the mammalian receptors, none of the HIs were greater than those based on stationwide background metals concentrations.
- The individual HQs and HIs for the AOC were on the same order of magnitude as those estimated from exposure to stationwide background metals.
- The HI associated with organic chemical exposure (TCE) at AOC 3 was equal to 1.0 for the American robin. For avian receptors exposed to organic chemicals, a conservative uncertainty factor of 10 was applied to the mammalian NOAEL due to lack of suitable toxicological data. Due to this conservativeness and because HQs and HIs are low for all receptors at AOC 3, adverse impacts to these receptors are unlikely.
- Also, although maximum reported concentrations of metals exceed soil benchmark values for plants, microorganisms and invertebrates present at AOC 3, the benchmarks represent a poor measure of risk because local background soil concentrations exceed soil benchmark values.

7.2.8.2 AOC 4 RISK MANAGEMENT DECISION

Ecological risks for AOC 4 were evaluated in the ERSE and found to be acceptable for the following reasons.

- Several HQs and HIs greater than 1.0 for mammalian receptors exist at IR Site 70, AOC 4. Other than exposures to arsenic, barium, and manganese, all metal exposures are within or lower than stationwide background values for AOC 4. Wildlife exposures to arsenic, barium, and manganese in soil are not likely because these soil concentrations were reported from samples collected beneath the concrete-lined channel. Those sample locations are approximately 6 feet below and 10 feet in a horizontal direction from the adjacent fields to the point underneath the concrete-lined channel. It is unlikely that wildlife would burrow these distances to reach the contaminated soil beneath the channel.
- For avian receptors, results obtained from the food web analysis generally correspond to results obtained for mammalian receptors, except for antimony and lead. Only the American robin had an organic chemical HI much greater than 1.0, including methylene chloride, TCE, and vinyl chloride.
- Due to the conservative uncertainty factor of 10 applied to the mammalian NOAEL to derive TRVs for these compounds and the conservativeness in the screening ecological risk assessment process, it is unlikely that exposures to the maximum reported concentrations of organic chemicals at AOC 4 would result in adverse impacts to the American robin.
- Metals exceeded soil benchmark values for plants, microorganisms, and invertebrates; however, benchmarks represent a poor measure of risk to the plant and invertebrate communities that may be present where local background soil concentrations exceed soil benchmark values.

Section 8
DESCRIPTION OF ALTERNATIVES

This section describes six (includes the no action alternative) remedial alternatives selected for detailed analysis in the IR Site 70 FS (BNI 2002) and the Revised FS (GCI, 2005). The alternatives are based on data from the ERSE (BNI 1999a), results of the screening HHRA (BNI 1999a, 2000a), and a review of applicable or relevant and appropriate requirements (ARARs). Each of the remedial alternatives addresses groundwater. Soil at IR Site 70 is recommended for no action based on the results of the human-health and ecological risk assessments.

The following overall remedial action objectives (RAOs) were developed for IR Site 70 to focus the FS and RFS and define the scope of potential groundwater cleanup activities.

- Consistent with U.S. EPA, State Water Resources Control Board, and RWQCB policies and regulations, protect existing beneficial uses of the shallow aquifer underlying NAVWPNSTA Seal Beach to the extent practicable while preventing or minimizing VOC migration beyond the current NAVWPNSTA Seal Beach boundaries at concentrations exceeding site cleanup goals.
- Protect human health by preventing extraction of VOC-impacted shallow groundwater until site cleanup goals are achieved.

Because there are no complete exposure pathways to ecological receptors, the RAOs focus on mitigating potential human exposures to the groundwater (BNI 2002; GeoSyntec, 2005).

8.1 CHEMICALS OF CONCERN AND CLEANUP LEVELS

Chloroform, 1,1-DCE, TCE, and vinyl chloride were identified as COCs at IR Site 70 based on their contribution to the screening-level carcinogenic risk and frequency of occurrence at the site. For each of these VOCs, Table 8-1 presents the tap water carcinogenic risk resulting from the screening risk calculations and the detection frequency (BNI, 2002).

Table 8-1
Chemicals of Concern in IR Site 70 Groundwater
(reported in micrograms per liter)

Chemical of Concern	Screening Level Tap Water Carcinogenic Risk	Percent of Total Tap Water Carcinogenic Risk[a,b]	Number of Samples Analyzed	Number of Detections	Frequency of Detection (percent)
1,1-Dichloroethene	7E-03	5.59	204	27	13.2
Trichloroethene	1E-02	84.7	204	96	47.1
Vinyl chloride	7E-03	5.9	204	18	8.8
Chloroform	3E-03	2.3	204	21	10.3

Notes:
[a] includes all chemicals of concern
[b] column totals 98.5 percent

Acronym/Abbreviation:
IR – Installation Restoration (Program)

Although ERSE sampling results showed metals exceeding background levels (BNI 1999a), metals were ruled out as COCs at IR Site 70 because:

- single occurrences of metals reported above the statistical background were isolated;
- naturally occurring metals, such as copper, iron, manganese, and arsenic, are widespread, and their range of concentrations can largely be attributed to various organic and inorganic adsorption mechanisms; and
- the cancer and noncancer risk drivers at IR Site 70 are overwhelmingly chlorinated VOCs.

Numerical cleanup goals for IR Site 70 groundwater were developed in the FS (BNI 2002) based on an analysis of ARARs. Table 8-2 lists the remediation goals for COCs at IR Site 70. These groundwater cleanup goals support the RAO of restoring the shallow aquifer underlying NAVWPNSTA as a potential drinking water supply to the extent practicable. The values listed in Table 8-2 are federal MCLs promulgated by U.S. EPA or California MCLs established by the Department of Health Services, whichever is lowest for a given chemical.

Subsequent to the ERSE, four additional VOCs, 1,1-dichloroethane, cis-1,2-DCE, trans-1,2-DCE, and PCE, were added as COCs because they were reported at the site at concentrations above MCLs. The maximum concentrations of these VOCs and their target (cleanup) concentrations are also shown in Table 8-2.

The feasibility of cleaning up to background was evaluated in the IR Site 70 RFS Report (GCI, 2005). The RFS Report noted that demonstrations of the enhanced bioremediation of chlorinated DNAPL and dissolved phase plumes have been completed under the U. S. EPA Superfund Innovative Technology Evaluation program. Test results from Launch Complex 34 (LC 34) at Cape Canaveral indicate TCE mass removal in excess of 98.5 percent. SITE results are documented in *Demonstration of Biodegradation of DNAPL Through Bioaugmentation at Launch Complex 34 in Cape Canaveral Air Force Station, Florida* (EPA, 2004). A summary of these results indicate that TCE concentrations in excess of 8,000 mg/kg were reduced to less than 10 mg/kg over a 12 month period. The bioaugmentation results from the LC 34 study indicate that TCE, cis-DCE, and VC are converted to ethene within 3 to 4 months.

Similarly at NAVWPNSTA Seal Beach, under an *in situ* bioremediation scenario, the volume, mobility, and toxicity of VOCs would be reduced through microbial dechlorination to non-toxic end-products. The enhanced bioremediation is expected to destroy the DNAPL and dissolved phase components of the plume. In addition, as the VOCs are dechlorinated to ethenes, the toxicity is significantly reduced. The mobility of the end products may not be significantly altered under this approach; however, the dechlorination process and rates will contain and reduce the apparent mobility of the parent and degradation products. The passive nature of this remedial action, provides adequate and reliable controls over long timeframes without replacing the technical components of the remedy. The *in situ* destruction of the contaminants prevents the need to dispose of and manage the residuals.

Table 8-2
Remediation Goals for IR Site 70 Groundwater
(reported in micrograms per liter)

Chemical of Concern	Federal Maximum Contaminant Level[a]	California Maximum Contaminant Level[b]	Controlling ARAR	Maximum Concentration in Groundwater
Chloroform	100	100	100	460[c]
1,1-Dichloroethane	NE	5	5	159[d,e]
1,1-Dichloroethene	7	6	6	299[c]
cis-1,2-dichloroethene	70	6	6	50,900[c,d]
trans-1,2-dichloroethene	100	10	10	2,600[c,d]
Tetrachloroethene	5	5	5	3,940[d,e]
Trichloroethene	5	5	5	837,000[c]
Vinyl chloride	2	0.5	0.5	960[f]

Notes:
[a] source: U.S. EPA Safe Drinking Water Act, 40 C.F.R. § 141
[b] source: Cal. Code Regs. tit. 22, § 64439, Requirements, and § 64444, MCLs
[c] maximum concentration from pilot test conducted from November 1998 to February 1999 (BNI 1999c)
[d] chemical not identified as a risk driver during the ERSE (BNI 1999a), but added as a chemical of concern because it was reported at the site at concentrations above the MCL
[e] maximum concentration from ERSE (BNI 1999a)
[f] maximum concentration from pilot test conducted from June to September 2001 (BEI 2002b)

Acronyms/Abbreviations:
ARAR – applicable or relevant and appropriate requirement
BEI – Bechtel Environmental, Inc.
BNI – Bechtel National Inc.
Cal. Code Regs. – *California Code of Regulations*
C.F.R. – *Code of Federal Regulations*
ERSE – extended removal site evaluation
IR – Installation Restoration (Program)
MCL – maximum contaminant level
NE – not established
§ – section
tit. – title
U.S. EPA – United States Environmental Protection Agency

8.2 AREA OF ATTAINMENT

U.S. EPA guidance defines the area of attainment for a CERCLA groundwater response action as the location where cleanup levels will be achieved at the time a remedial action is considered complete (U.S. EPA 1988b). According to U.S. EPA guidance, the area of attainment generally coincides with the areal extent of groundwater contamination outside the boundary of waste remaining in place and up to the margin of the contaminant plume at the time restoration begins. The purpose of identifying an area of attainment is to facilitate development and evaluation of remedial alternatives (e.g., to determine where to place extraction wells, hydraulic containment systems, *in situ* treatment wells, or monitoring wells).

The attainment area for this remedial action is the footprint of the TCE plume at IR Site 70 as defined by the area exceeding the MCL of 5 μg/L. The DON does not intend to establish a point of compliance for this remedial action. Because of the levels of contamination encountered, the affected medium (i.e., groundwater) will be addressed as two separate areas within the plume: a suspected source area and a dissolved-phase plume. Cleanup strategies were evaluated accordingly.

According to U.S. EPA (1993a), delineation of the zone of suspected DNAP at a site is critical for remedy design and evaluation of the restoration potential of a site. U.S. EPA acknowledges that delineation of the DNAPL source area may be difficult and may require that it be inferred from geologic information or from interpretation of the aqueous concentration of contaminants derived from DNAPL sources.

Figure 5-13 shows the suspected DNAPL area, which corresponds to the 10,000 μg/L isocontour of TCE at the less-than-35-foot depth interval. This area is assumed to extend to approximately 50 feet bgs. The basis for this conclusion is that the isocontour of 10,000 μg/L corresponds to approximately 1 percent of the solubility limit of TCE. The corresponding area at the surface is approximately 5,700 square feet, and the total volume (all media) is approximately 285,000 cubic feet (10,600 cubic yards). DNAPL is particularly difficult to locate and remove from the subsurface and may be either sorbed onto or lodged within the saturated soils that compose the water-bearing zones. Technical impracticability considerations, therefore, apply to this zone. The area of the dissolved-phase plume is approximately 3,800 by 2,200 feet at its largest footprint.

8.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Remedial alternatives for IR Site 70 were developed to meet the RAOs in accordance with requirements of CERCLA, as amended by SARA, 42 *United States Code* (U.S.C.) § 9602 et. seq., and the NCP. CERCLA Section 121(b) identifies the following statutory preferences for remedial actions.

- Preferred remedial actions are those involving treatment that permanently and significantly reduces the volume, toxicity, or mobility of site-related contaminants.

- The least favorable remedial action is off-site transport and disposal of hazardous substances or contaminated materials without treatment when practical treatment technologies are available.
- Remedial actions using permanent solutions, alternative treatment technologies, or resource recovery technologies should be assessed.

Also considered were the criteria regarding eventual selection of a preferred remedial action (U.S. EPA 1988b). According to U.S. EPA technical guidance, the preferred remedial action for IR Site 70 should:

- protect human health and the environment;
- meet contaminant-specific ARARs and be consistent with location- and action-specific ARARs;
- be cost-effective;
- use permanent solutions and alternative treatment technologies to the maximum extent practicable; and
- satisfy the preference for treatment as a principal element of the remedial action to reduce the toxicity, mobility, or volume of contaminants.

The development of remedial alternatives was also guided by prior U.S. EPA experience at VOC-contaminated sites. Presumptive remedies are technologies presumed to be the most appropriate for addressing contamination at sites affected by chlorinated VOCs in soil and groundwater (U.S. EPA 1993a, 1996, 1997b). U.S. EPA expects presumptive remedies to be used at all appropriate sites, although alternative technologies may be considered when warranted (U.S. EPA 1993b). To that end, U.S. EPA has published several guidance documents, directives, and policy statements, which were followed in developing the remedial alternatives for IR Site 70 (U.S. EPA 1994a; 1997b,c).

The use of U.S. EPA guidance resulted in the development of six alternatives for addressing the dissolved-phase plume and suspected DNAPL area at IR Site 70:

- Alternative 1, no action
- Alternative 6, hydraulic containment (dissolved plume) and *in situ* treatment (DNAPL area)
- Alternative 7, hydraulic containment (dissolved plume) and pump and treat (DNAPL area)
- Alternative 9, pump and treat (dissolved plume) and *in situ* treatment (DNAPL area)
- Alternative 10, pump and treat (dissolved plume) and pump and treat (DNAPL area)
- Alternative 11, *in situ* enhanced bioremediation (DNAPL and dissolved plume areas)

Each of these alternatives (except no action) also includes monitored natural attenuation (MNA) as a support technology, used when active technology is no longer effective, and land use controls to prevent humans from being exposed to contaminated groundwater until cleanup levels are achieved.

8.3.1 Alternative 1 – No Action

Alternative 1 is required by CERCLA to provide a basis for developing and evaluating the other remedial alternatives. Under Alternative 1, no remedial measures or access or land-use controls would be initiated at IR Site 70, and the DON would conduct no groundwater extraction or other forms of remediation. It likewise would have no effect on the physical, biological, or chemical processes controlling the fate and transport of existing contamination.

8.3.2 Alternative 6 – Hydraulic Containment (Dissolved Plume) and *In Situ* Treatment (DNAPL Area)

Alternative 6 includes the following components:

- hydraulic containment (dissolved plume)
- *in situ* chemical oxidation (DNAPL area)
- *ex situ* groundwater treatment (dissolved plume)
- treated groundwater discharge (dissolved plume)
- MNA
- performance monitoring
- land use controls

Each component is discussed in the subsections that follow.

8.3.2.1 HYDRAULIC CONTAINMENT (DISSOLVED PLUME)

Based on groundwater modeling, it is estimated that five shallow-depth wells, two intermediate-depth wells, and one deeper well would be required to provide hydraulic containment of the dissolved plume.

The shallow wells (less than 40 feet bgs) would pump from the sandy portion of the interbedded unit (Figure 5-4) to capture the dissolved plume in the shallow clay and in the interbedded unit. Groundwater would be pumped at 1 gallon per minute (gpm) per well.

Intermediate depth wells (80 to 100 feet bgs) in the lower portion of the first sand unit would pump from the lower portion of the first sand unit and capture the dissolved plume in the first sand unit, the shell horizon, and the second sand unit. Two intermediate depth wells, pumping at 80 gpm each, would achieve containment.

One deeper well location (greater than 120 feet bgs) would pump from the second sand unit, if the plume in the second sand unit is not captured by wells in the first sand unit. This well would be pumped at a rate of 80 gpm.

Hydraulic containment would continue until contaminant mass reaches asymptotic levels and the residual contamination has been reduced to concentrations that will not migrate at unacceptable levels. This is expected to occur after approximately 35 years; hence it is assumed that the hydraulic containment system would operate for 35 years, then MNA would be used to further reduce contaminant levels. Five-year periodic reviews would assess mass removal and effectiveness.

8.3.2.2 *IN SITU* TREATMENT (DNAPL AREA)

U.S. EPA encourages consideration of innovative technologies at DNAPL sites, particularly where DNAPL-zone containment could be enhanced or where such a technology could clean the DNAPL zone (1993a). U.S. EPA also recognizes that *in situ* treatment can significantly reduce contaminant mass at DNAPL sites; however, attainment of remediation goals in the short term may be technically impracticable.

Potentially viable innovative technologies were evaluated in the FS and *in situ* chemical oxidation was identified as a prospective remediation technology for the DNAPL area. *In situ* chemical oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The chemical oxidants most commonly employed to date include peroxide, ozone, and permanganate. These oxidants have been able to cause the rapid and complete chemical destruction of many toxic organic chemicals; other organics are amenable to partial degradation as an aid to subsequent bioremediation. In general, the oxidants have been capable of achieving high treatment efficiencies (e.g., greater than 90 percent) for unsaturated aliphatic (e.g., TCE) and aromatic compounds (e.g., benzene) with very fast reaction rates (90 percent destruction in minutes). Field applications have clearly affirmed that matching the oxidant and *in situ* delivery system to the COCs and the site conditions is the key to successful implementation and achieving performance goals.

The Geo-Cleanse® process was used for FS evaluation purposes. This process involves injecting chemicals such as hydrogen peroxide to oxidize contaminants and render them inert. Since chemical oxidation represents an innovative technology, site-specific bench-scale and pilot tests would be required. The bench test would determine the optimum chemical injection ratio and chemical compounds for subsequent pilot testing and full-scale application. It would also allow refinement of cost-estimating and removal rates. Pilot testing for *in situ* treatment would be performed using one injection well and three monitoring wells for performance monitoring.

For evaluation purposes, it was assumed that the technology could effectively oxidize any DNAPL present and reduce the existing dissolved contaminant mass significantly through two sequential treatment events. MNA would then be employed to further reduce any residual contamination levels to achieve remediation goals.

It was also assumed that treatment would occur over a 31,400-square-foot area. To be effective, a separate scheme is expected to be needed for delivering reagents to the relatively impermeable shallow clay layer and the underlying formation. Assuming a 15-foot radius of influence, the reagent would be introduced through 242 stainless steel injection wells.

The vendor anticipates applying the chemical reagents at six different levels throughout the DNAPL area. Approximately 756,000 gallons of hydrogen peroxide would be applied for full treatment. Reagent would be injected at a rate of 16,000 pounds per day over 2 months. Performance monitoring would continue until cleanup levels are achieved or COC concentrations reach asymptotic levels A pilot test was conducted at the site and is documented in the *Final Technical Memorandum No. 5 and 7; Shallow Groundwater Pilot Test Report* (BNI, 1999c, and 2000b, respectively).

This option requires no pumping within the DNAPL area. Following *in situ* treatment, any remaining dissolved contamination would be hydraulically contained and remediated using MNA.

8.3.2.3 *EX SITU* GROUNDWATER TREATMENT (DISSOLVED PLUME)

The hydraulic containment wells evaluated in the FS were assumed to yield a nominal pumping rate of 245 gpm or 353,000 gallons per day (gpd). Extracted groundwater would be delivered to the treatment system through buried pipelines constructed according to applicable agency codes. For cost-estimating purposes, it was assumed that approximately 3,000 feet of conveyance piping would be needed. It was also assumed that only single-walled conveyance piping would be used to transport the untreated water (although if concentrations are encountered that exceed the RCRA guidelines, double-walled piping would be used in the portions of the system where guidelines are exceeded).

Extracted groundwater would be treated at a groundwater treatment plant located at or near IR Site 70. Remediation would be achieved by pumping the extracted water through a cartridge filtration system followed by two-stage granular activated carbon (GAC) adsorption. For cost-estimating purposes, 35 years of operation was assumed. It was also assumed that the GAC supplier would take spent GAC off-site for regeneration or disposal. Prior to shipment from the site, the spent carbon would be tested to determine its waste classification (nonhazardous, RCRA hazardous, and/or non-RCRA hazardous). This material would be characterized, packaged, and transported in accordance with United States Department of Transportation (DOT), U.S. EPA, and DTSC requirements.

8.3.2.4 TREATED GROUNDWATER DISCHARGE (DISSOLVED PLUME)

Effluent from the groundwater treatment facility would be piped to a nearby storm drain. The location of the storm drain would be determined during remedial design. For cost-estimating purposes, it is assumed that 1,000 feet of single-walled piping would be used to connect the treatment facility at IR Site 70 to the storm drain.

Because the treated groundwater would discharge to a surface water drainage channel, discharge of the treated groundwater would comply with the substantive requirements of a general National Pollutant Discharge Elimination System (NPDES) permit. Numerical discharge limits for the surface discharge of treated groundwater at IR Site 70 are discussed in Section 11 under the Santa Ana RWQCB Basin Plan (Table 11-6.

Other treated groundwater discharge options may also be considered during remedial design. A reason for considering other alternatives is because the groundwater would only be treated to remove VOCs. Concentrations of TDS and other inorganics may be too high to meet waste discharge requirements. In this case, alternative beneficial uses compatible with the TDS and inorganics in the groundwater may be more cost-effective.

8.3.2.5 MONITORED NATURAL ATTENUATION

Groundwater modeling performed during the FS (BNI 2002) indicated that Alternative 6 would achieve the following:

- remove approximately 1,800 pounds of TCE by pumping after 30 years
- remove an additional 400 pounds through natural degradation over 50 years

Assuming that the DNAPL source treatment is effective in removing the dispersed DNAPL and dissolved phase mass in the source area during the initial two *in situ* treatment events, this would result in the following:

- removal of approximately 1,100 pounds of dissolved phase TCE from source treatment activities
- reduction of TCE to 5 μg/L in all layers after 47 years

The time required for complete *in situ* treatment of the DNAPL mass is unknown, as it depends upon heterogeneity (which is significant at this Site) and the amount of DNAPL mass present (unknown). For cost-estimating purposes, it was assumed that the DNAPL would be completely removed during the initial two *in situ* treatment events. Hydraulic containment of the plume would continue for an estimated 35 years (based on the results of the groundwater modeling) until contaminant mass has reached asymptotic levels in the dissolved plume and the residual contamination is below the assimilative capacity of the aquifer. MNA would be required for another 15 years (assuming the rate of natural attenuation is on the order of average attenuation rates presented in the literature) to further reduce contaminant levels within the boundaries of the existing dissolved plume to cleanup goals (U.S. EPA 1999). MNA would also be used to further reduce residual contaminant levels in the DNAPL area once chemical oxidation treatment is complete.

Use of MNA is considered feasible because natural attenuation processes are occurring at IR Site 70 (BNI 1999a) as evidenced by:

- reported concentrations of cis-1,2-DCE and vinyl chloride, both breakdown products of TCE, above the detection limits;
- dissolved oxygen concentrations less than 1,000 μg/L;

- elevated iron (II) concentrations, relative to background levels, within the shallow groundwater plume and within localized areas of the intermediate and deep groundwater plumes;
- elevated methane concentrations, relative to background levels, in the area of highest chlorinated aliphatic hydrocarbon (CAH) concentration;
- reported ethene and ethane concentrations above the detection limits and localized in the vicinity of the highest CAH concentrations, within the shallow groundwater zone;
- elevated chloride concentrations, relative to background levels, within the intermediate and deep groundwater zones; and
- low-to-negative ORP values.

The type, presence, and distribution of halorespiring microorganisms would be assessed through analysis of extracted DNA from groundwater or soil samples and the use of microcosms as appropriate. Long-term monitoring would be used to track the progress of natural attenuation and help verify model predictions. Periodic reviews would be scheduled at least every 5 years. These reviews would consider whether the modeling predictions are accurate and also determine whether the contaminant level/location could impact off-station human and environmental receptors. It was assumed that ten new wells (one upgradient, five crossgradient, and four downgradient) and six current wells (four center and two downgradient) would be used for long-term monitoring. The locations and exact number of wells would be determined during remedial design.

8.3.2.6 PERFORMANCE MONITORING

Performance monitoring, including water-level measurements and sampling and analysis, would be used to verify effectiveness of the *in situ* treatment at the DNAPL area, optimize operation of the extraction system, verify containment of the dissolved plume, and demonstrate successful treatment of the extracted groundwater prior to discharge.

For the DNAPL area, the FS estimated that seven wells would be monitored for chemical and physical parameters to assess contaminant destruction, geochemical effects, and process safety of the *in situ* treatment at the DNAPL area. The exact number and location of the wells would be determined during the remedial design phase. Frequency of monitoring would depend on the number of reagent application events necessary to achieve the contaminant reduction goals. It is assumed that two reagent injection events would occur (an intensive initial treatment and a second polishing stage), and that sampling and analysis would occur before each injection as a baseline and three times thereafter at 2-week intervals.

For the dissolved plume, the FS estimated that nine downgradient and crossgradient monitoring wells would be used to optimize operation of the extraction system and verify containment of the dissolved plume. The actual number and locations of the wells would be determined at the remedial design phase. Process streams within the treatment plant would also be tested. It is also assumed that 16 new piezometers would be installed to verify hydraulic containment (2 new piezometers per extraction well). The piezometers would be screened in the same interval as the respective extraction well(s).

The monitoring frequency to verify containment would vary. During system start-up and equilibration, water levels in the extraction wells would be monitored almost continuously. This initial period of monitoring was assumed in the FS to last no more than 2 weeks, after which water-level monitoring would be conducted daily, weekly, monthly, and then finally quarterly. Sampling for VOC analysis was assumed to occur biannually for 35 years. Effluent lines from the GAC vessels would be monitored to assess the performance of the treatment system and demonstrate compliance with numerical discharge limits of the general NPDES permit.

Actual monitoring parameters and frequency of performance monitoring would be defined during the remedial design phase.

8.3.2.7 LAND USE CONTROLS

Land use controls in the form of land-use restrictions would be used to limit the exposure of future landowner(s) and/or user(s) of the property to hazardous substances and to maintain the integrity of the remedial action until remediation is complete and federal and state cleanup levels have been met. Monitoring and inspections will be conducted to assure that the land-use restrictions are being followed. Land-use control objectives to be achieved through the land-use restrictions include:

- preventing the use of VOC-contaminated groundwater until cleanup objectives have been achieved,
- protecting the groundwater monitoring and extraction wells and associated piping and equipment,
- managing intrusive activities to minimize potential human exposure to contaminated groundwater, and
- managing groundwater injection and extraction activities to assure that hydraulic control of the contaminant plume is not unacceptably compromised.

Land use controls will also be used to provide the DON and regulatory agencies access to the site to assure that construction and monitoring of the final remedy and any further investigation and response action are implemented.

The land use controls required by this alternative would be limited to approximately 50 acres overlying the existing areas of contamination and an associated buffer zone from the outermost point of contamination (see Section 10.7). Land use controls for the on-station portion of the groundwater plume will be described in and implemented through the station's project review process in accordance with NEPA. The DON is currently working with the city of Seal Beach, Orange County Water District (OCWD), and Orange County Health Care Agency (OCHCA) to develop appropriate means to implement land use controls for the off-station portion of the groundwater plume.

The land use controls would remain in effect until monitoring data show that contamination levels have reached remediation goals.

8.3.3 Alternative 7 – Hydraulic Containment (Dissolved Plume) and Pump and Treat (DNAPL Area)

Alternative 7 consists of the following components:

- hydraulic containment (dissolved plume)
- pump and treat (DNAPL area)
- *ex situ* groundwater treatment
- treated groundwater discharge
- MNA
- performance monitoring
- land use controls

Each component is discussed in the subsections that follow.

8.3.3.1 HYDRAULIC CONTAINMENT (DISSOLVED PLUME)

The pumping scheme and estimated pumping rate for hydraulic containment of the dissolved plume are the same as those for Alternative 6 (Section 8.3.2.1). Hydraulic containment of the downgradient leading edge(s) of the dissolved plume would be performed in conjunction with MNA until contaminant levels are reduced enough that unacceptable levels would not migrate. This is expected to occur within 35 years. At that time, MNA would be used to reduce the concentrations of contaminants within the plume to cleanup goals.

8.3.3.2 PUMP AND TREAT (DNAPL AREA)

Alternative 7 would use a pump and treat system to remove VOC mass within the suspected DNAPL area. Continuous operation of this system over the entire project life (50 years) would also prevent lateral and vertical migration of contamination within the DNAPL area. Based on modeling performed during the FS (BNI 2002), it was assumed that the pump and treat system would consist of nine closely spaced shallow wells operating at a pumping rate of 1 gpm or a total pumping rate of 9 gpm. The wells would pump from the sandy portion of the interbedded unit (Figure 5-4) to contain the potential residual DNAPL in the shallow clay and in the interbedded unit. The shallow clay in the source area would be mostly dewatered by aggressively pumping from the interbedded unit; this would vertically contain residual DNAPL in this unit.

8.3.3.3 *EX SITU* GROUNDWATER TREATMENT

The combined flow rate from the extraction and hydraulic containment wells was to be a nominal 254 gpm or 366,000 gpd. The extracted groundwater from the DNAPL area and the dissolved plume would be conveyed to a treatment facility located at or near IR Site 70 where the VOCs would be treated and the treated groundwater would be discharged to a nearby storm drain. For cost-estimating purposes, it was assumed that the groundwater extraction and treatment system would operate for a total of 50 years, 35 years with the full combined flow rate and an additional 15 years thereafter for the 9-gpm DNAPL influent.

Groundwater would be continuously pumped from the extraction wells and delivered to the treatment system through buried pipelines constructed according to applicable agency codes. For cost-estimating purposes, it was assumed that approximately 4,000 feet of conveyance piping is expected to be required by Alternative 7. It was assumed that only single-walled conveyance piping would be used to transport the untreated water. If VOC concentrations exceed RCRA guidelines, double-walled conveyance piping would be used for the portions exceeding the guidelines.

As with Alternative 6 (Section 8.3.2.3), the extracted groundwater would be pumped through a cartridge filtration system followed by two-stage GAC adsorption. Lower levels of contamination from the dissolved plume containment system would be mixed with more contaminated flows from the DNAPL area system prior to treatment.

Regeneration or disposal of the spent carbon would be the responsibility of the GAC supplier under a long-term service contract. It was assumed spent GAC would be taken off-site for regeneration or disposal. Prior to shipment from the site, the spent carbon would be tested to determine its waste classification (nonhazardous, RCRA hazardous, and/or non-RCRA hazardous). This material would be characterized, packaged, and transported in accordance with DOT, U.S. EPA, and DTSC requirements.

8.3.3.4 TREATED GROUNDWATER DISCHARGE

Treated groundwater would be discharged as per Alternative 6 (Section 8.3.2.4).

8.3.3.5 MONITORED NATURAL ATTENUATION

Groundwater modeling performed during the FS (BNI 2002) indicated that Alternative 7 would achieve the following:

- remove approximately 2,300 pounds of TCE by pumping after 30 years
- remove an additional 1,000 pounds of TCE through natural degradation over 50 years

It should be noted that the modeling does not account for the presence of residual DNAPL; if residual DNAPL is present, the amount of mass removed will be underestimated. Assuming that the initial TCE mass present within the plume totals 3,300 pounds and that no mass is contributed from DNAPL, this would result in the following:

- reduction of concentrations of TCE to 5 μg/L in layers below the shallow clay area within 25 to 44 years

- failure to reduce concentrations of TCE to 5 μg/L in the fine-grained material of the interbedded unit within 50 years

MNA is assumed to take place in conjunction with pumping and treating of the DNAPL area and with hydraulic containment at the downgradient edge of the dissolved plume. Pumping and treating of the DNAPL area is assumed to continue throughout the life of the remediation (50 years). Hydraulic containment of the dissolved plume would continue until contaminant concentrations reach asymptotic levels and the residual contamination is below the assimilative capacity of the aquifer. Based on the groundwater modeling, this is expected to require approximately 30 years; however, the presence of DNAPL may result in an extension of this timeframe. Once the hydraulic containment extraction wells for the dissolved plume have been shut off, MNA would be used to reduce contaminant levels throughout the dissolved plume to cleanup goals.

8.3.3.6 PERFORMANCE MONITORING

The monitoring program would be similar to that used for Alternative 6 (Section 8.3.2.6). In addition, water levels from existing wells in the vicinity of the DNAPL area would be monitored to demonstrate reversal of vertical gradients underneath the DNAPL area.

8.3.3.7 LAND USE CONTROLS

Land use controls would be identical to those associated with Alternative 6 (Section 8.3.2.7).

8.3.4 Alternative 9 – Pump and Treat (Dissolved Plume) and *In Situ* Treatment (DNAPL Area)

Alternative 9 includes the following components:

- pump and treat and hydraulic containment (dissolved plume)
- *in situ* chemical oxidation (DNAPL area)
- *ex situ* groundwater treatment (dissolved plume)
- treated groundwater discharge (dissolved plume)
- MNA
- performance monitoring
- land use controls

Each component is discussed in the subsections that follow.

8.3.4.1 PUMP AND TREAT AND HYDRAULIC CONTAINMENT (DISSOLVED PLUME)

Pump and treat operations would be implemented throughout areas of the dissolved plume where TCE concentrations are greater than 1,000 μg/L. Based on groundwater modeling, it was estimated that eight shallow wells, two intermediate wells, four deep wells, and four deeper wells would be used to contain the plume and accelerate cleanup. The assumed pumping rate for Alternative 9 is 446 gpm.

Shallow wells (approximately 40 feet bgs) would pump from the sandy portion of the interbedded unit (Figure 5-4) to capture the dissolved plume in the shallow clay and in the interbedded unit. Intermediate wells (above and below 75 feet bgs) would pump from the lower portion of the first sand unit to capture the dissolved plume in the first sand unit and the shell horizon. Deeper wells (greater than 120 feet bgs) would pump from the second sand unit if needed to capture the dissolved plume in this stratum.

Pumping and treating the dissolved plume would also control plume migration. The pump and treat system would continue to operate until contaminant mass reached asymptotic levels and the residual contamination had been reduced and would no longer migrate at unacceptable levels. This is assumed to occur after approximately 15 years. Hence it is assumed that the pump and treat system would operate for 15 years, then MNA would be used to further reduce contaminant levels. Five-year periodic reviews would assess mass removal and effectiveness.

8.3.4.2 *IN SITU* TREATMENT (DNAPL AREA)

For the DNAPL area, *in situ* chemical oxidation would proceed as described for Alternative 6 (Section 8.3.2.2). As per Alternative 6, it is assumed that two sequential treatment events would effectively lower contaminant concentrations at most locations within the DNAPL area to remediation goals. Pilot testing of the Geo-Cleanse chemical oxidation technology was performed and evaluated prior to implementation of the remedy (See BNI, 1999c and 2000b).

8.3.4.3 *EX SITU* GROUNDWATER TREATMENT (DISSOLVED PLUME)

The extraction wells installed under Alternative 9 were assumed to yield a nominal 642,000 gpd. Extracted groundwater would be delivered to the treatment plant, located at or near IR Site 70, by buried pipelines. For cost-estimating purposes, it is assumed that approximately 4,000 feet of conveyance piping would be required. It is assumed that only single-walled conveyance piping would be used to transport the untreated water. If VOC concentrations exceed RCRA guidelines, double-walled conveyance piping would be used in the portions of the system where guidelines are exceeded.

Extracted water would be pumped through a cartridge filtration system followed by two-stage GAC adsorption. Regeneration or disposal of the spent carbon would be contracted to the GAC supplier under a long-term service contract. It was assumed that spent GAC would be taken off-site for regeneration or disposal. Prior to shipment from the site, the spent carbon would be tested to determine its waste classification (nonhazardous, RCRA hazardous, and/or non-RCRA hazardous). This material would be characterized, packaged, and transported in accordance with DOT, U.S. EPA, and DTSC requirements.

8.3.4.4 TREATED GROUNDWATER DISCHARGE (DISSOLVED PLUME)

Treated groundwater would be discharged as per Alternative 6 (Section 8.3.2.4).

8.3.4.5 MONITORED NATURAL ATTENUATION

Groundwater modeling performed during the FS (BNI 2002) indicated that Alternative 9 would achieve the following:

- remove approximately 1,900 pounds of TCE by pumping after 10 years
- remove an additional 300 pounds of TCE through natural degradation over 50 years

Assuming that the DNAPL source treatment was effective in removing dispersed DNAPL and dissolved phase mass in the source area during the initial two *in situ* treatment events, this would result in the following:

- removal of approximately 1,100 pounds of dissolved phase TCE by *in situ* treatment
- reduction in concentrations of TCE to 5 μg/L in all layers after 46 years
- reduction in concentrations of TCE to 5 μg/L in layers below the interbedded unit in 11 to 18 years

The time required for complete *in situ* treatment of the DNAPL mass is unknown, as it depends upon heterogeneity (which is significant at this Site) and the amount of DNAPL mass present (unknown). For cost-estimating purposes, it was assumed that the DNAPL would be completely removed during the initial two *in situ* treatment events, resulting in an estimated operation time for the groundwater extraction and treatment system of 15 years. The extraction wells would remain active until they achieved significant VOC mass removal, reached asymptotic concentration levels, and reduced the concentrations of contaminants to levels that are below the natural assimilative capacity of the aquifer (for costing purposes estimated to occur at 15 years for the dissolved plume, but actual duration will depend on the effectiveness of the DNAPL treatment). After that time, MNA would be used to reduce concentrations of VOCs to cleanup goals. Ten new wells and six existing wells would be used for long-term monitoring.

8.3.4.6 PERFORMANCE MONITORING

Monitoring would be used to verify the effectiveness of the *in situ* chemical oxidation treatment at the DNAPL area and hydraulic containment/pumping and treating for the dissolved plume. The monitoring program would be the same as for Alternative 6 (Section 8.3.2.6). For the DNAPL area, seven wells would be monitored for chemical and physical parameters to assess contaminant destruction, geochemical effects, and process safety. For the dissolved plume, monitoring would include water-level measurements as well as sampling and analysis from groundwater monitoring wells. Process streams within the treatment plant would also be tested. It is assumed that

26 new piezometers would be installed to verify hydraulic containment for the extraction system.

8.3.4.7 LAND USE CONTROLS

Land use controls would be identical to those in Alternative 6 (Section 8.3.2.7).

8.3.5 Alternative 10 – Pump and Treat (Dissolved Plume) and Pump and Treat (DNAPL Area)

Alternative 10 includes the following components:

- pump and treat (dissolved plume and DNAPL area)
- *ex situ* groundwater treatment
- treated groundwater discharge
- MNA
- performance monitoring
- land use controls

Each component is discussed in the subsections that follow..

8.3.5.1 PUMP AND TREAT (DISSOLVED PLUME AND DNAPL AREA)

Pumping and treating of the DNAPL area would be performed using the same pumping scheme as for Alternative 7 (Section 8.3.3.2) over the entire project life (50 years). The purpose of the pump and treat system within the DNAPL area is to remove contaminant mass and reverse vertical gradients. The pumping rate is assumed to be 1 gpm per well or a total rate of 9 gpm from all nine shallow wells.

Pumping and treating of the dissolved plume area would control migration of the plume and accelerate cleanup. The pumping scheme for Alternative 10 is similar to that of Alternative 9, but with two changes. First, two intermediate wells near the source area in Alternative 9 would be eliminated to assure vertical hydraulic containment of the shallow source area. Second, three wells surrounding the source area in Alternative 9 would be replaced in Alternative 10 by nine wells for pumping and treating of the source area.

The extraction wells in the dissolved plume would operate until VOC concentrations in the shallow aquifer approached asymptotic levels and the residual contamination would no longer migrate at unacceptable levels. This is expected to require approximately 15 years. Following this period, MNA would proceed without further active hydraulic containment or mass removal.

For cost estimating, it was assumed that the groundwater extraction and treatment system would operate for 15 years at a combined flow rate of 434 gpm and, for an additional 35 years thereafter, at a flow rate of 9 gpm.

8.3.5.2 *EX SITU* GROUNDWATER TREATMENT

The extraction wells installed under Alternative 10 were assumed to yield a combined nominal flow of 625,000 gpd. Groundwater would be continuously pumped from the extraction wells and delivered to the treatment system through buried pipelines constructed according to applicable agency codes. For cost estimating, it is assumed that approximately 4,000 feet of conveyance piping would be required by Alternative 10. It is assumed that only single-walled conveyance piping would be used to transport the untreated water. In the event that chlorinated VOC concentrations in effluent are above RCRA guidelines, double-walled conveyance piping would be used in the portions of the system where guidelines are exceeded.

Treatment would be identical to that of Alternative 6 (Section 8.3.2.3). Regeneration or disposal of the spent carbon was assumed to be contracted to the GAC supplier under a long-term service contract. Prior to shipment from the site, the spent carbon would be tested to determine its waste classification (nonhazardous, RCRA hazardous, and/or non-RCRA hazardous). This material would be characterized, packaged, and transported in accordance with DOT, U.S. EPA, and DTSC requirements.

8.3.5.3 TREATED GROUNDWATER DISCHARGE

Treated groundwater would be discharged per Alternative 6 (Section 8.3.2.4).

8.3.5.4 MONITORED NATURAL ATTENUATION

Groundwater modeling performed during the FS (BNI 2002) indicated that Alternative 10 would achieve the following:

- remove approximately 2,400 pounds of TCE by pumping after 10 years
- remove an additional 900 pounds of TCE through natural degradation over 50 years

It should be noted that the modeling does not account for the presence of residual DNAPL; if residual DNAPL is present, the amount of mass removed will be underestimated. Assuming that the initial TCE mass present within the plume totals 3,300 pounds and that no mass is contributed from DNAPL, this would result in the following:

- reduction of TCE to 5 µg/L in layers below the shallow clay within 11 to 34 years
- failure to reduce concentrations of TCE to 5 µg/L in the fine-grained material of the interbedded unit within 50 years

During implementation of this Alternative, the extraction wells would remain active until they achieved significant VOC mass removal, reached asymptotic concentration levels (for costing purposes assumed to occur at 15 years for the dissolved plume, but actual duration will depend on the mass and distribution of DNAPL present), and reduced the concentrations of contaminants to levels that are below the natural assimilative capacity of the aquifer. After that time MNA would be used for another 35 years to reduce concentrations of VOCs throughout the plume to cleanup goals. Ten new wells and six existing wells would be used for long-term monitoring.

8.3.5.5 PERFORMANCE MONITORING

The monitoring program would be the same as for Alternative 6 (Section 8.3.2.6). In addition, two piezometers per well (22 total piezometers) would be installed and monitored for water levels to assure that containment is achieved.

8.3.5.6 LAND USE CONTROLS

Land use controls would be the same as Alternative 6 (Section 8.3.2.7).

8.3.6 Alternative 11 – Enhanced Bioremediation (DNAPL Area and Dissolved Plume)

Alternative 11 includes the following components:

- *in situ* biostimulation/bioaugmentation (source area)
- *in situ* biobarriers using biostimulation and bioaugmentation (dissolved plume)
- MNA
- performance monitoring
- land use controls

Each component is discussed in the subsections that follow.

8.3.6.1 *IN SITU* BIOSTIMULATION/BIOAUGMENTATION (DNAPL AREA)

The enhanced treatment approach for the source area will consist of a grid of injection wells that cover the source area (Figure 5-13). These wells will be constructed so that injections can be made at future dates as needed. Bioaugmentation and subsequent monitoring is the same as for the biobarriers. Monitoring data will be used to determine the need for additional electron donor (emulsified vegetable oil [EVO]) injections, growth and dispersion of *Dehalococcoides*, and groundwater quality. The start up monitoring program will be at a more frequent rate to identify the dechlorination rate and to demonstrate the complete dechlorination to ethenes within the target timeframe.

8.3.6.2 *IN SITU* BIOBARRIERS USING BIOSTIMULATION AND BIOAUGMENTATION (DISSOLVED PLUME)

The conceptual approach to implement the biobarriers within the dissolved plume include the use of multiple well points that will transect the plume at selected locations. Figures illustrating the conceptual model and the system layout are provided in the "Final Groundwater RFS Report" (GCI, 2005). Figure R-5-13 from the Revised FS (GCI, 2005) provides a conceptual model of the biobarriers within the upper sand. Figure R-5-14 from the Revised FS (GCI, 2005) provides a conceptual model of the distribution of biobarriers within the lower sand. A plan view of the system layout is provided in Figure R-5-15 (GCI, 2005) These transects will consist of individual well points that will allow multiple dosing of EVO on an as needed basis. Final spacing of the biobarriers and well points will be determined based on design investigation results. Addition of the EVO will create a reduced environment conducive to microbial growth. Once the appropriate geochemical conditions that support the growth and activity of *Dehalococcoides* are established, the biobarriers will be inoculated with KB-1™ (a *dehalococcoides* containing microbial consortia). Dispersion of the KB-1™ will be monitored along with electron donor and contaminant concentrations (see Table R-5-19 (GCI, 2005)).

8.3.6.3 MONITORED NATURAL ATTENUATION

The results of the analysis in the RFS (GCI 2005) indicated that Alternative 11 would achieve the following:

- remove 99% of the dissolved phase TCE mass *in situ* within the first 16 years through enhanced treatment within biobarriers
- remove the remaining TCE mass through natural degradation over the following 9 years

The time required for complete *in situ* treatment of the DNAPL mass is unknown, as it depends upon heterogeneity (which is significant at this Site) and the amount of DNAPL mass present (unknown). For cost-estimating purposes, it was assumed that the DNAPL would be completely removed after 15 years of active source area treatment. MNA would be implemented when the flux of dissolved chlorinated VOCs emanating from any residual source of DNAPL is less than the assimilative capacity of the aquifer to remove these VOCs to meet RAOs.

8.3.6.4 PERFORMANCE MONITORING

Groundwater monitoring will be conducted to evaluate the effectiveness of the enhanced bioremediation. To accomplish this, monitoring wells will be constructed and subsequently sampled within the biobarrier treatment zone and immediately up and downgradient of the biobarriers. These sample data will be used to verify the effectiveness of the enhanced bioremediation approach. The performance monitoring will evaluate the duration of the active remediation phase, that is the duration of EVO injection to maintain the enhanced bioactivity. The performance monitoring will also provide analytical data to support ending the active treatment phase. Discoontinuing the active treatment phase will terminate when the influent samples to the biobarriers falls below the 250 ppb TCE concentration. Two sample rounds which detect less than 250 ppb influx to the biobarriers will be the basis for discontinuing the next round of EVO injection. A confirmation sampling event will be conducted 3 months after the second sampling round to verify that concentrations continue to be below the threshold 250 ppb.

Monitoring will be performed to track the plume over time and identify that dechlorination is occurring at rates sufficient to attain RAOs. The monitoring program will be documented within the design document. The performance monitoring program will provide the sampling schedules. A long-term remediation monitoring plan (RMP) will document the actual monitoring program and contain a contingency plan triggering actions to manage any future expansion of the plume per U.S. EPA guidance (U.S. EPA 1998, 1999).

Monitoring data would be used for periodic reviews every year to assess plume migration, dechlorination activity, to evaluate the extent of microbial migration, and the adequacy of the remedial action to meet RAOs. Reviews would be documented in a summary report issued to appropriate regulatory agencies. These reports may suggest modifications to the cleanup program as needed.

8.3.6.5 LAND USE CONTROLS

In addition to preventing exposure under future land uses (Section 8.3.2.7), the land use controls would protect existing monitoring wells and grant access for sampling, installing new monitoring wells, and implementing any additional remedial measures needed in the future. Part of these remedial efforts will include the maintenance of land use controls to limit future drilling, construction, and pumping of production groundwater wells within the buffer zone identified in Section 10.6. Restrictions for injection wells within the buffer zone will also be implemented. Restriction of off-base pumping (or injection) within the buffer zone will be coordinated with the OCWD, OCHCA, and the City of Seal Beach. The land use controls would be in effect until monitoring data shows contamination levels below remediation goals.

Section 9
SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents the results of the comparative analysis conducted to evaluate the relative advantages and disadvantages of each remedial alternative in relation to the nine evaluation criteria outlined in CERCLA Section 121(b), as amended. A complete discussion of the evaluation of the alternatives for IR Site 70 is found in the IR Sites 40 and 70 FS Report (BNI 2002) and the Revised FS (GCI, 2005).

CERCLA evaluation criteria are based on requirements promulgated in the NCP. As stated in the NCP (40 *Code of Federal Regulations* [C.F.R.] § 300.430[f]), evaluation criteria are arranged in the following hierarchical manner: threshold criteria, primary balancing criteria, and modifying criteria. Threshold criteria must be satisfied for an alternative to be eligible for selection. Primary balancing criteria are used to weigh major trade-offs among alternatives. Generally, modifying criteria are taken into account after public comments are received on the Proposed Plan/draft RAP.

Threshold criteria are the following:

- overall protection of human health and the environment
- compliance with ARARs

Primary balancing criteria are the following:

- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume
- short-term effectiveness
- implementability
- cost effectiveness

Modifying criteria are the following:

- state acceptance
- community acceptance

Table 9-1 summarizes the comparative analysis of IR Site 70 alternatives with respect to the balancing criteria. Computer modeling supported the comparative analysis by assessing the effect of each alternative on VOC contamination. The modeling was used primarily to evaluate long-term effectiveness, short-term effectiveness (i.e., time to achieve cleanup objectives), and reduction of toxicity, mobility, or volume of contaminants.

Modeling for IR Site 70 was performed by using a groundwater flow and solute transport model SURFER®, VLEACH, MODFLOW, and MT3D computer codes were used with supporting information taken primarily from the ERSE Report (BNI, 1999a). Table 9-2 summarizes the results and compares Alternatives 1, 6, 7, 9, 10, and 11 in terms of simulated time and cost to clean up the principal aquifer. The cleanup time is based on reducing concentrations of TCE throughout the plume to the MCL (5 μg/L).

Table 9-1
Comparative Analysis of Alternatives by Balancing Criteria
IR Site 70

Alternative*	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost-Effectiveness
Summary of Criteria	Impact of a remedial alternative in the long term, defined as the time after RAOs are met. Consider magnitude of residual risk at the completion of remedial activities; type, degree and adequacy of long-term management from contaminants remaining on-site; long-term reliability of engineering/land use controls; potential need to replace components and continuing need for repair/maintenance.	CERCLA preference for technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances. Consider treatment processes used; amount of hazardous material to be treated; degree of expected reduction in toxicity, mobility, or volume; degree to which treatment is irreversible; and type and quantity of treatment residuals.	How an alternative affects human health and the environment from planning until RAOs are achieved. Consider short-term risks to community; potential impacts on workers during construction and O&M; potential environmental impacts of the action; and amount of time required before RAOs are achieved (i.e., the duration of the short term).	Technical and administrative feasibility. Consider technical feasibility, including constructability; operational reliability; ability to take alternative remedial actions in the future; ability to monitor effectiveness. Consider ability to obtain governmental approvals. Consider availability of services and materials, including time needed to develop new or innovative technologies under consideration.	Per the NCP, a remedy is cost-effective if its costs are proportional to its effectiveness. Consider capital cost, including both direct and indirect cost, O&M costs, and net present value of capital and O&M costs.
Alternative 1 – No Action	**Low** Under this alternative, there would be no method of assessing long-term effectiveness and permanence.	**Low** No active treatment is performed and no means are available to monitor natural attenuation processes.	**Low** Natural attenuation processes would not be effective in the short term.	**High** Easy to implement.	**Medium** Low cost, but not effective.
Alternative 6 – Hydraulic Containment (dissolved plume) and *In Situ* Treatment (DNAPL area)	**Moderately High** In situ chemical oxidation (ISCO) is a very aggressive form of treatment and should result in lower residual risks in the DNAPL area. Containment of the dissolved phase is a very slow process with mixed results.	**Medium** Modeling indicates 1,100 lb dissolved/sorbed TCE removed within the first year by *in situ* chemical oxidation treatment and 1,800 lb removed by pumping in 30 years. Potential impacts due to pumping of the aquifer (i.e. TDS, salt water intrusion).	**Medium** Groundwater modeling indicates RAOs may be achievable within 50 years.	**Low** Design of chemical oxidation will require bench- and pilot-scale testing. Buffering capacity and TDS of aquifer may interfere with process. Potential for vigorous chemical reactions exists.	**Moderately Low** Capital costs are high; however, permanent destruction of VOCs in DNAPL area would provide low cost in proportion to effectiveness.
Alternative 7 – Hydraulic Containment (dissolved plume) and Pump and Treat (DNAPL area)	**Low** Pump and treat has not been shown as a viable treatment alternative for DNAPL. Hydraulic containment of the dissolved phase plume requires an extensive time period.	**Low** Modeling indicates 2,300 lb dissolved/sorbed TCE removed by pumping in 30 years. Pump and treat ineffective on DNAPL. Expect significant impacts to aquifer from pumping.	**Low** Groundwater modeling results indicate RAOs are not achieved within 50 years.	**Medium** Demonstrated technology; however, must be carefully designed to minimize disruption to active base operations. Trenching around utilities may be necessary.	**Medium** Low capital costs, but cost in proportion to effectiveness may be questionable.
Alternative 9 – Pump and Treat (dissolved plume) and *In Situ* Treatment (DNAPL area)	**Moderately High** Chemical oxidation is a very aggressive form of treatment and should result in lower residual risks in the DNAPL area. The long term pump and treat of the dissolved phase plume is slow and significantly impacts the aquifer (TDS).	**Moderately High** Modeling indicates 1,100 lb dissolved/sorbed TCE removed within the first year by ISCO treatment and 1,900 lb removed by pumping in 10 years. Expect significant impacts to aquifer from pumping.	**Medium** Groundwater modeling indicates RAOs may be achievable within 50 years. Aggressive pumping of the dissolved plume makes MNA in this portion of the plume viable within 15 years. High risks to site workers and facility with ISCO components.	**Low** Design of chemical oxidation will require bench- and pilot-scale testing. Buffering capacity and TDS of aquifer may interfere with process. Potential for vigorous chemical reactions exists. Large volume of pumped groundwater to handle and pipe.	**Moderately High** Capital costs are high; however, permanent destruction of VOCs in DNAPL area would provide low cost in proportion to effectiveness.
Alternative 10 – Pump and Treat (dissolved plume) and Pump and Treat (DNAPL area)	**Medium** This alternative relies on pump and treat and MNA to complete the remediation of residual contamination in the DNAPL area, which may be in the form of contaminants sorbed to the aquifer substrate.	**Medium** Modeling indicates 2,400 lb dissolved/sorbed TCE removed by pumping in 10 years. Expect significant impact to aquifer from salt water intrusion which will impact treatment costs due to fouling.	**Low** Groundwater modeling results indicate RAOs are not achieved within 50 years in all areas.	**Medium** Demonstrated technology; however, must be carefully designed to minimize disruption to active maintenance operation. Trenching around utilities may be necessary.	**Low** Low capital costs, but cost in proportion to effectiveness may be questionable.

Table 9-1 (continued)
Comparative Analysis of Alternatives by Balancing Criteria
IR Site 70

Alternative*	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost-Effectiveness
Alternative 11 – Biobarriers (dissolved plume) and Biostimulation – Bioaugmentation (DNAPL area)	**High** Enhanced bioremediation is a very aggressive form of treatment that has been shown effective in treating both DNAPL and dissolved phase plumes, while allowing subsequent MNA.	**High** Testing under the EPA SITE program has demonstrated DNAPL destruction of up to 98% of the mass within one year using bioaugmentation with KB-1™. Dissolved phase COC destruction has been shown too.	**High** Groundwater modeling indicates RAOs may be achievable within 15 years. Enhanced bioremediation is immediately compatible with MNA. Site workers exposed to minimal hazards.	**Medium** Innovative technical application will require some treatability studies. Require a large number of injection well points. Possible biofouling and groundwater flow issues may impact the implementation and operation.	**High** Lowest total costs, but high capital costs for injection points. Highest net present value costs reflect implementation costs. Permanent destruction of COC's in both DNAPL and dissolved phase plume a plus. Costs for converting to MNA after pump and treat has not been included in the current costs for pump and treat.
Comments	All the alternatives (except No. 1 and 11) rely on pumping to remove contamination in the dissolved plume which may impact the aquifer (salt water intrusion). All remedial actions rely on MNA to some extent to achieve RAOs, yet ISCO may not be compatible with MNA. At the completion of MNA, there should be little need for ongoing land use controls. When RAOs are achieved, it is anticipated that no further monitoring/maintenance would be needed.	An estimated 3,300 lb of dissolved/sorbed TCE is present, and unknown quantities of DNAPL may also be present. Chemical oxidation of the DNAPL area rates are higher than pump and treat for the DNAPL area, and aggressive pump and treat rates are higher than hydraulic containment for the dissolved plume under this criterion. Enhanced bioremediation has been shown to destroy both sorbed and dissolved phase COC's.	The enhanced bioremediation approach is a low energy but highly effective method to dechlorinate the site that does not pose short term risks to the community, workers, the environment, and the site facilities. None of the alternatives poses short-term risks to the community or differs in terms of environmental impacts. Chemical oxidation poses some short term worker risk but would reduce risks to O&M workers by reducing duration. Pump and treat poses significant risk to the aquifer due to salt water intrusion.	Enhanced bioremediation does not require significant impacts to the site or large above ground treatment systems (piping, containment, etc.) The alternatives which involve pumping for contaminant mass removal and/or hydraulic containment are demonstrated technology (but extremely long duration). Implementability for alternatives with chemical oxidation and bioremediation are rated lower because of the need to conduct bench- and pilot-scale testing. Chemical oxidation also has the potential for chemical interferences and a complicated (and reactive) reagent delivery system.	Alternatives involving pump and treat of the DNAPL area may need to be operated beyond the assumed 50-year project life, increasing O&M costs. Alternatives implementing significant pumping for containment or treatment may also require significant cost growth for a pretreatment phase if salt water intrusion impacts the carbon treatment efficiency.

Note:
* MNA and land use controls are included in all alternatives except Alternative 1 (no action)

Acronyms/Abbreviations:
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
COCs – Constituents of Concern
DNAPL – dense nonaqueous-phase liquid
EPA SITE – United States Environmental Protection Agency Superfund Innovative Technology Evaluation Program
IR – Installation Restoration (Program)
ISCO – In Situ Chemical Oxidation
KB-1™ - Commercially available microbial consortia
lb – pound
MNA – monitored natural attenuation
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
O&M – operation and maintenance
RAO – remedial action objective
TCE – trichloroethene
TDS – total dissolved solids
VOC – volatile organic compound

Table 9-2
Summary of Remediation Time and Costs for IR Site 70 Alternatives

Alternative	Estimated Duration (years)	Total Direct Capital Cost	Total Direct O&M Cost	Total Cost***	Net Present Value
Alternative 1, no action	25-47	$0	$0	$0	$0
Alternative 6, hydraulic containment (dissolved plume) and *in situ* treatment (DNAPL area)	25-47	$3.5 million*	$5.2 million*	$24.2 million*	$11.0 million*
Alternative 7, hydraulic containment (dissolved plume) and pump and treat (DNAPL area)	50	$831,200*	$6.3 million*	$23.9 million*	$6.7 million*
Alternative 9, pump and treat (dissolved plume) and *in situ* treatment (DNAPL area)	46	$7.9 million**	$10.1 million**	$21.6 million**	$12.1 million**
Alternative 10, pump and treat (dissolved plume) and pump and treat (DNAPL area)	50	$1.3 million*	$6.6 million*	$26.8 million*	$8.5 million*
Alternative 11, Biostimulation - bioaugmentation (DNAPL area) and bioaugmented biobarriers (dissolved plume)	25	$4.3 million	$11.4 million	$18.8 million	$14.7 million

Notes:

Highlighted values indicate the lowest cost for that project element and use revised cost estimates based on 2005 dollars

* indicate price with a 3% per year cost increase to reflect current 2004 pricing

** indicate BNI revised estimates from the "White Paper – Alternative Technology Evaluation IR Site 70, NAVWPNSTA Seal Beach" June 2004

*** Includes 20% Contingency

Acronyms/Abbreviations:

IR – Installation Restoration (Program)
DNAPL – dense nonaqueous-phase liquid
O&M – operation and maintenance

9.1 THRESHOLD CRITERIA

Threshold criteria include overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements. An alternative must meet both threshold criteria to be eligible for selection.

9.1.1 Overall Protection of Human Health and the Environment

Assesses whether a cleanup remedy provides adequate public health protection and describes how health risks posed by the site will be eliminated, reduced, or controlled through treatment, engineering controls, or land use and regulatory controls.

Alternative 1 is not considered protective of human health and the environment because contaminant migration would not be prevented or monitored and use of groundwater would not be prohibited. Groundwater at IR Site 70 is not currently used for domestic purposes. However, without land use controls preventing such use, it is possible that groundwater could be used for such purposes in the future. The human-health risk assessment estimated that if groundwater were used for domestic purposes, the excess cancer risk associated with this use would be 1.2×10^{-1} and the noncancer risk would be 4,600. These values are within the range considered unacceptable by U.S. EPA.

Alternatives 6, 7, 9, 10, and 11 are considered protective of human health and the environment because they contain land use controls that would prevent use of groundwater until cleanup levels, represented by MCLs, have been obtained. MCLs are drinking water standards that are considered protective of human health.

9.1.2 Compliance With Applicable or Relevant and Appropriate Requirements

Addresses whether a cleanup remedy will meet all federal, state, and local environmental statutes or requirements.

CERCLA § 121(d)(1) (42 U.S.C. § 9621[d]) specifies that remedial actions must attain a degree of cleanup that assures protection of human health and the environment. Additionally, remedial actions that leave hazardous substances, pollutants, or contaminants on-site must meet standards, requirements, limitations, or criteria that are ARARs. Federal ARARs for any site may include requirements under any federal environmental laws. State ARARs include promulgated requirements under state environmental or facility-siting laws that are more stringent than federal ARARs and that have been identified by the state in a timely manner.

CERCLA § 121 states that, at the completion of a remedial action, a level or standard of control required by an ARAR will be attained for wastes that remain on-site. In addition, the NCP, 40 C.F.R. § 300.435(b)(2), requires compliance with ARARs during the remedial design/remedial action. Because ARARs are triggered only when a remedial action is taken, no discussion of ARARs is needed for Alternative 1.

Alternatives 6, 7, 9, 10, and 11 comply with RCRA hazardous waste management requirements for managing extracted groundwater (as needed) and other potentially hazardous waste such as drill cuttings from well installations (as needed).

The state of California interprets State Water Resources Control Board (SWRCB) Resolution (Res.) 68-16 as prohibiting migration of existing groundwater contamination. The DON has considered this position and has determined that further migration of already contaminated groundwater is not a discharge governed by the language of the resolution. That is, the resolution is intended to apply to new discharges to maintain existing high-quality waters and is not intended to apply to restoration of waters that have already been degraded. Therefore, the DON accepts SWRCB Res. 68-16 as an ARAR for new discharges (e.g., injection, discharge to surface water) only.

Alternatives 6, 7, 9, and 10 involve extraction of groundwater, treatment at a treatment facility to remove VOCs, and discharge to surface water. The act of discharging to surface water will trigger ARARs (e.g., National Toxics Rule, California Toxics Rule, Inland Surface Waters Plan, and California Ocean Plan) depending on the water body receiving the discharge. The DON would use a general NPDES permit to comply with numerical requirements of state and federal ARARs identified for the discharge of groundwater to surface water.

Alternatives 6, 9, and 11 involve injection of chemicals into groundwater for *in situ* treatment. There are no specific federal or state ARARs concerning injection of nutrients/adjuvants and/or chemical reagents into the groundwater.

The intent of Alternatives 6, 7, 9, 10, and 11 is to comply with all ARARs for IR Site 70, meeting the remedial goals for the aquifer and thereby complying with the requirements of the Water Quality Control Plan (WQCP), federal or state MCLs for organic compounds, and RCRA groundwater protection standards. However, over the past 13 years, a number of researchers have reported difficulties in achieving health-based or more stringent cleanup goals with available technologies.

Mackay and Cherry (1989) examined the difficulties of groundwater cleanup and concluded that pump and treat systems are best viewed as an effective option for the containment of contaminant plumes, rather than for aquifer restoration. In 1992, U.S. EPA evaluated 24 sites using pump and treat technology and found that cleanup goals were reached at only one of these sites (U.S. EPA 1992b,c). U.S. EPA concluded that "experience over the past decade has shown that restoration to drinking water quality (or more stringent levels where required) may not always be achievable . . ." (U.S. EPA 1989b). U.S. EPA's conclusions are supported by researchers at the Oak Ridge National Laboratory, who evaluated 12 of the sites reviewed by U.S. EPA and 4 additional sites and found that none of the aquifers had been restored to MCLs (Doty and Travis 1991).

Studies by the American Petroleum Institute (API) and RWQCB have indicated better results but still demonstrate the difficulty of restoring groundwater to cleanup goals. The API study examined 13 sites and found that 5 of the sites had achieved cleanup goals (API 1993). However, it is important to note that these 5 sites were gasoline stations contaminated with benzene, which biodegrades relatively quickly. The RWQCB study indicated that, of the 37 sites evaluated, 2 sites had met health-based cleanup goals for all contaminants and 8 sites had met cleanup goals for some contaminants (Bartow and Davenport 1992). In one of the most comprehensive studies to date, the National Research Council examined 77 sites (most of which had been examined in the previous studies) and concluded that portions of most of these sites were incapable of achieving health-based or more stringent cleanup levels using pump and treat technology (MacDonald and Kavanaugh 1994). This study also concluded that "no existing technology, conventional or innovative, can overcome all the difficulties associated with groundwater cleanup."

The most prevalent reasons for the difficulty in remediating contaminated aquifers are physical heterogeneity, the presence of NAPL, diffusion of contaminants into inaccessible regions, adherence of contaminants to subsurface materials, and difficulties in characterizing the subsurface (National Research Council 1994). In addition, experience has shown that the older the contamination, the more difficult the site is to clean up (MacDonald and Kavanaugh 1994).

Information from the ESRE indicates that many of the conditions discussed above are present at IR Site 70 and that cleanup goals may not be achievable at all locations. Reference is made to U.S. EPA Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration (U.S. EPA 1993a). DNAPL is presumed to exist at IR Site 70, and subsurface contaminant transport is apparently influenced by heterogeneous structural features in the lithology (e.g., bedding planes and low-permeability lenses of silts and clays). DNAPL is likely trapped in porous materials of the subsurface and may be providing a continuous source of dissolved contamination. Although the *in situ* chemical oxidation pilot test indicated promising results in terms of contaminant mass reduction, numerical remediation goals were not achieved. Practical experience with treatment systems, both for IR Site 70 and for other highly complex sites, indicates it may be technically impracticable to remediate groundwater to potential ARAR-based levels at all locations within the plume.

Alternative 11 is expected to meet chemical-specific, location-specific, and action-specific ARARs. The remedial action will monitor the establishment of the halorespiring microorganisms throughout the treatment areas. The timeframe required to attain the RAOs will be evaluated, and treatment modifications will be initiated if they are needed to meet the cleanup schedule. In the interim, land use controls would prevent inadvertent exposure to contaminated groundwater.

Soil cuttings and well development water generated during the installation of monitoring wells for Alternative 11 would be subject to RCRA requirements to determine whether such wastes should be classified as hazardous. This determination would be made at the time the waste is generated. The appropriate management requirements for storing, manifesting, and transporting this material for final disposal would be followed if the soil cuttings or well development water are found to be RCRA or non-RCRA hazardous waste.

The time needed to meet the remedial goals will likely therefore be significant (Table 9-2) and the numerical modeling predictions of cleanup timeframes should be evaluated for comparative purposes only and not as absolute values. In the interim, the remedial alternatives would rely on land use controls to prevent exposure to contamination in groundwater.

9.2 PRIMARY BALANCING CRITERIA

Primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost. These are used to weigh trade-offs among alternatives and identify the most favorable.

9.2.1 Long-Term Effectiveness and Permanence

Refers to the ability of a remedy to continue protecting human health and the environment over time after the cleanup action is completed.

For each alternative, long-term effectiveness and permanence are evaluated on the basis of model-based predictions of groundwater quality. While modeling results presented in the RFS Report (GCI, 2005) suggest that several alternatives could achieve site cleanup goals given sufficient time, Alternative 11 is rated highest for long-term effectiveness and permanence. Alternative 11, which uses *in situ* techniques, is expected to more effectively degrade VOCs in both DNAPL and dissolved-phase areas. Alternatives 6 and 9 also use an in situ component for DNAPL, but rely on other methods for the dissolved plume, so are rated moderately high. Alternatives 7 and 10, which employ extraction wells to treat contamination *ex situ*, are rated low and medium respectively, because DNAPL is difficult to remove from the subsurface. Therefore, residual contamination associated with Alternatives 7 and 10 would be higher than with Alternatives 6, 9, and 11. Alternative 1 is rated low in long-term effectiveness and permanence because effectiveness of natural attenuation processes would not be verified, and plume migration patterns would not be monitored to demonstrate protectiveness.

The residual risk remaining when Alternatives 6, 7, 9, 10, and 11 attain cleanup levels would be represented by MCLs and risk-based concentrations for VOCs, which U.S. EPA has determined are acceptable risk levels.

9.2.2 Reduction of Toxicity, Mobility, or Volume

This criterion assesses the degree to which the alternatives employ recycling or treatment that reduce 1) harmful effects to human health and the environment (toxicity), 2) the contaminant's ability to move (mobility), and 3) the amount of contamination (volume), including how treatment is used to address the primary threats posed by the site.

Alternative 1 is rated lowest in this category because this alternative would provide no treatment or other active approach for the reduction of the toxicity, mobility, or volume of contaminants.

Alternative 11 rates high in reduction of toxicity, mobility, or volume through effective dechlorination using enhanced bioremediation. Through biostimulation and bioaugmentation of the DNAPL (source area), the mass of contaminants will be reduced and the chlorinated compounds will be reduced to ethenes, a non-toxic end product. Thus the quantity and toxicity of the source area and dissolved phase plumes will be reduced through the enhanced bioremediation treatment. The mobility of contaminants may be altered by the biobarriers but the intent of the remedial design is to allow existing groundwater flow to continue and provide the mechanism for moving contaminants through the treatment stages. MNA will continue to reduce the mass and toxicity of residual contaminants left after the enhanced bioremediation period.

Alternatives 6, 7, 9, and 10 all involve an element of active treatment that would provide a significant reduction in toxicity, mobility, and volume over time. Of these alternatives, Alternatives 9 is ranked moderately high in this category. This alternative relies on chemical reactions occurring within the most contaminated DNAPL area to degrade halogenated VOCs, such as PCE and TCE, to nontoxic inert compounds. Because of the nature of the chemical reaction, toxicity, mobility, and volume are simultaneously reduced as the reaction occurs. Modeling indicates that, using Alternative 9, 1,100 pounds of dissolved/sorbed TCE would be destroyed during the first year by *in situ* treatment; an additional 1,900 pounds would be removed within 10 years by pumping.

Alternatives 6 is ranked medium in its use of treatment to reduce toxicity, mobility, and volume of contaminants. Alternative 6, like Alternative 9, uses chemical reactions to reduce VOCs to nontoxic inert compounds and is expected to remove 1,100 pounds of dissolved/sorbed TCE during the first year by *in situ* treatment. However, because it employs less aggressive hydraulic containment (versus pump and treat in the more contaminated areas of the dissolved plume), Alternative 6 requires 30 years to remove 1,800 pounds of TCE by pumping.

Alternatives 7 and 10 actively reduce the volume and mass of VOC contamination through use of a groundwater extraction system and treatment with GAC. Alternative 7 is rated low and is expected to remove 2,300 pounds of dissolved/sorbed TCE by pumping in 30 years; Alternative 10 is rated medium and is expected to remove 2,400 pounds of dissolved/sorbed TCE in 10 years. However, both alternatives are expected to leave TCE contamination in portions of the aquifer at the end of the 50-year span of the model.

9.2.3 Short-Term Effectiveness

The short-term effectiveness criterion assesses how well human health and the environment will be protected from impacts due to construction and implementation of a remedy. Also considered is time to reach cleanup goals.

Alternative 1 would not entail any on-site remedial activities and, therefore, would not impact the surrounding community, workers, or the environment. The time required for Alternative 1 to achieve cleanup levels protective of human health and the environment would be controlled by the rate of natural attenuation processes and is expected to be more than 50 years. However, without monitoring, actual remediation time cannot be verified.

Short-term impacts associated with the implementation of Alternatives 6, 7, 9, and 10 include the increased risk of exposure to workers through the handling of contaminated groundwater. Additional short-term impacts include risks associated with installation of monitoring wells, extraction wells, conveyance pipelines, and the treatment plant. Installation of this equipment and facility is expected to pose relatively minor risks to workers because potential on-site exposures and risks from these activities would be controlled through use of personal protective equipment, monitoring, and compliance with a site-specific safety and health plan. An additional risk posed by Alternatives 6 and 9 is one associated with the risk of vigorous chemical reaction from the materials used for chemical oxidation. These risks would also be controlled by a site-specific safety and health plan that specifically addresses these chemical hazards. The pump and treat portion of these remedies will contribute waste streams including contaminated GAC and filter sediments.

Enhanced in situ bioremediation (Alternative 11) will require the installation of injection wells, monitoring wells, groundwater extraction wells, and temporary pipeline conveyance to the well heads from the mixing and distribution point. The groundwater extraction wells will be used to supply site groundwater for mixing with the EVO. These short term exposure scenarios would pose relatively minor exposure risks to workers and the community with proper application of mitigation measures. The short duration for mixing groundwater with the electron donor and re-injecting is the most significant exposure path for human contact with groundwater. This short-term risk can be mitigated through proper design, site specific health and safety plan, and the remedial action work plan. During the majority of the time for remediation, virtually all exposure paths are limited due to the *in situ* nature of the remedial action

Risks to the surrounding community are expected to be negligible. None of the actions taken in Alternatives 6, 7, 9, 10, and 11 are expected to cause adverse short-term health effects.

Alternatives 6, 7, 9, and 10 are expected to achieve cleanup goals in 47, more than 50, 46, and more than 50 years, respectively (Table 9-2). Alternatives 6 and 9 are expected to remove contaminants more quickly than the other alternatives, removing 1,100 pounds of dissolved sorbed TCE within the first year and an additional 1,800 to 1,900 pounds by pumping and treating within 30 and 10 years, respectively. Actual time to achieve remediation goals is highly dependent on well location and subsurface conditions. Alternative 11 is expected to achieve cleanup goals for TCE within 25 years, based on groundwater modeling.

Considering all the factors listed in the U.S. EPA RI/FS guidance (U.S. EPA 1988a), Alternative 11 rates highest in the short-term effectiveness, because the treatment step is *in situ* and a significant quantity of the VOC mass in the groundwater would be dechlorinated through the enhanced in situ bioremediation. Tests have shown relatively high destruction rates for DNAPL under bioaugmented conditions. Alternative 9 was rated medium in short term effectiveness. Chemical oxidation would render most of VOC mass in groundwater chemically inert in the first year of implementation and remove most of the mass in the dissolved plume within the first 10 years. Alternative 6 was rated medium in short-term effectiveness. Under this alternative, most of the VOC mass in the groundwater is also rendered chemically inert within the first year of implementation; however, an additional 30 years is required to remove most of the VOCs from the dissolved portion of the plume. Alternatives 1, 7, and 10 are rated low because all three alternatives remove mass more slowly and are expected to require more than 50 years to completely remove groundwater contamination.

9.2.4 Implementability

Refers to the technical feasibility (how difficult the remedy is to construct and operate) and the administrative feasibility (coordination with other agencies) of a remedy. Factors such as availability of materials and services needed are considered.

Alternative 1 is the most easily implemented alternative from a technical perspective because it would involve no on-site construction or other remediation activities.

Alternative 11 is technically feasible and is rated medium in difficulty. Alternative 11 will require conventional wells for injection, manifolds for EVO and KB-1™ injection, and monitoring wells for evaluating the treatment. No difficulties are anticipated for shipping, installation, application, and evaluation of the bioaugmentation treatment process. The process uses conventional drilling equipment and components for the treatment system.

Alternatives 6, 7, 9, and 10 all require the construction of monitoring wells, conveyance piping, and treatment facilities. Alternatives 6 and 9 also require bench and pilot testing because of the innovative nature of the chemical oxidation technology. It is possible that the buffering capacity and high TDS levels of the aquifer may interfere with operation of these alternatives. Alternative 11 may require treatability studies to provide design details such as well spacing, biobarrier spacing, and EVO dosing.

Construction and operation of the hydraulic containment and pump and treat components entail standard, proven practices known to be readily implementable. Difficulties regarding feasibility, availability of equipment and services, or schedule are not anticipated. The monitoring program used by these alternatives would provide early warning of changes in contaminant concentrations or groundwater flow that may require modification of extraction rates, well locations, or treatment methods to attain remedial objectives.

The technical feasibility of Alternatives 7 and 10 is considered medium, because both would employ reliable, widely available technologies. Implementation is somewhat complicated by the presence of an active maintenance operation. Each alternative would be installed using conventional equipment and construction methods.

For technical reasons, Alternatives 6 and 9 were rated low in implementability. The chemical oxidation technologies these alternatives employ are considered innovative, and bench and pilot testing would be necessary to verify effectiveness, implementability, and cost. Site conditions at the station, specifically the buffering capacity of the aquifer and TDS and sulfate concentrations of the shallow groundwater, raise concerns about possible chemical interferences that could adversely affect the short-term effectiveness of this technology. The land use controls associated with Alternatives 6, 7, 9, and 10 are not expected to prevent or unnecessarily complicate continued government use of the property. Difficulties are not anticipated with regard to reliability or scheduling.

9.2.5 Cost Effectiveness

This criterion evaluates the estimated capital costs and present worth in today's dollars required for design and construction and long-term operation and maintenance costs in proportion to an alternative's effectiveness.

Table 9-2 shows estimated costs for the six remedial alternatives. The cost estimates for Alternatives 1, 6, 7, and 10 have been escalated from the 1999 prices using a 3 percent increase per year. The cost for Alternative 9 has been revised based on a process optimization analysis provided to the DON in 2004. Costs for Alternative 11 were developed by using 2005 costing data. Costs for Alternative 1 are zero and will not be evaluated further.

Alternative 11 is rated highest because it had the lowest estimated total cost over the life of the treatment system and MNA. The duration of the treatment has a significant impact on the remediation costs. Alternative 9, rated moderately high, had the next lowest total cost based on a 46-year remediation cycle. Alternatives 7, 6, and 10 show increasing total cost as the remediation period increases and passes the 50 year mark, and are rated medium, moderately low, and low respectively.

Irrespective of the differences in net present-worth costs, Alternatives 1, 6, 7, 9, and 10 are all rated below Alternative 11 in terms of cost-effectiveness due to the extended duration (50 years or more). The *in situ* application of enhanced bioremediation without any significant groundwater extraction provides for a cost effective approach to Site 70 remediation strategy. Although *in situ* treatment results in higher capital costs, Alternatives 9 and 11 are considered cost effective because costs are proportional to effectiveness over the duration of the remedial action.

9.3 MODIFYING CRITERIA

Modifying criteria include state and community acceptance. State acceptance is taken into account during development of the Proposed Plan/draft RAP and ROD/RAP. Public acceptance is considered through comments received during the public comment period.

9.3.1 State Acceptance

This criterion reflects whether the state of California's environmental agencies agree with, oppose, or have no objection to or comment on the DON's preferred alternative.

Alternative 1 is rated low in terms of state acceptance. Based on presentation to date to the regulatory agencies, an enhanced bioremediation alternative should be acceptable to the State. Because formal acceptance has not been received, Alternative 11 is rated medium. Each of the other alternatives is rated medium with regard to this criterion. The DON believes each of the alternatives complies with ARARs and is protective of human health and the environment.

9.3.2 Community Acceptance

This criterion evaluates whether community concerns are addressed by the remedy and if the community has a preference for a remedy. Although public comment is an important part of the final decision, the DON is compelled by law to balance community concerns with other criteria.

Alternative 1 is rated low in terms of community acceptance. Each of the other alternatives is rated medium for this criterion. All of the alternatives prevent off-site migration of contamination. There is a potential, but unlikely disruption for the area if groundwater cannot be extracted for consumption. The passive groundwater treatment systems will create less impact to the aquifer than the pumping scenarios and therefore should be potentially less disruptive.

Section 10
SELECTED REMEDY

The DON has selected Alternative 11, enhanced *in situ* bioremediation for both the source area and the dissolved plume, as the remediation method for groundwater at IR Site 70. This decision is based on the results from the ERSE, FS, pilot test, and RFS for IR Site 70; the administrative record for this site; and an evaluation of comments submitted by interested parties during the public comment period. Soil at IR Site 70 does not require action.

The selected remedy for groundwater includes:

- *in situ* treatment of groundwater within the dissolved plume using biobarriers with biostimulation and bioaugmentation;
- *in situ* treatment of groundwater in the soouce (potential DNAPL) area using biostimulation and bioaugmentation;
- use of monitored natural attenuation as a secondary treatment to address residual VOC contamination in the DNAPL area and dissolved plume;
- performance monitoring throughout the remedial action; and
- land use controls to prevent use of or exposure to contaminated groundwater; protect the integrity of the remedial action; and allow access for sampling, installing, operating, and maintaining monitoring wells or remediation equipment, and implementing any remedial measures needed in the future.

In both the DNAPL area and the dissolved plume, MNA will be used to complete the remediation once the primary remedial technology becomes ineffective. The duration of this alternative is assumed to be approximately 25 years, based on groundwater modeling results and the assumed effectiveness of the *in situ* treatment (GCI, 2005).

10.1 *IN SITU* TREATMENT (DISSOLVED PLUME)

Alternative 11 which involves the addition of a dechlorinating bacterial culture (KB-1™) and emulsified vegetable oil (EVO), an electron donor, to establish biobarriers that intercept and treat the dissolved plume as it migrates under natural groundwater flow conditions. The addition of EVO will also enhance the activity of indigenous halorespiring microorganisms (if present) to reductively dechlorinate the COCs to ethene.

The biobarriers will be constructed by creating a continuous and immobile zone of EVO by injecting this donor (EVO) through multiple well points that will intersect the plume at selected locations perpendicular to the groundwater gradient. Final spacing of the well points and biobarriers will be determined based on design investigation results and will be optimized to provide the lowest cost within a reasonable treatment timeframe. EVO will be injected at low concentrations (target of 0.5% oil saturation) to avoid impacting soil permeability and causing avoidance of the biobarrier by the groundwater. Typical reductions in permeability are thought to be on the order of 5 to 40%, depending on the soil type, emulsion droplet size, and pore size. Given that geotechnical samples from the RI/FS indicate very well-sorted sands in the upper and lower treatment zones with minimum 30% porosities, permeability reductions for this soil type are expected to be at the lower end of the estimated range.

The width of the biobarrier will be sufficient to provide the residence time necessary for the COC to be treated to meet RAOs. Additional EVO would be injected as it is consumed (estimated every 3 years). COCs between biobarriers will be treated by their flushing into the next downgradient biobarrier and through natural attenuation processes that will continue to occur between biobarriers. The biobarriers will be located to contain the chlorinated plume, with biobarriers placed in the upper and lower sand unit to treat the extent of the dissolved phase plume.

Bioaugmentation of the groundwater with a stable, naturally-occurring, and pathogen-free culture of halorespiring microorganisms (e.g., KB-1™) would be added shortly after the addition of EVO stimulated anaerobic conditions. The KB-1™ culture contains various strains of *Dehalococcoides*, which is the only microorganism genus capable of further dechlorinating cis-DCE past VC to ethene.

Injection of the KB-1™ culture will not impact the permeability of the aquifer, as only ten liters will be amended at each injection point, which is then distributed throughout a pore volume of 3,000 ft^3 to 6,400 ft^3 (i.e., representing less than 0.01% of the pore volume). Typical full-strength bacterial populations have a population count of 10^{12} microbes per liter of groundwater; with each microbe on the order of 0.5 microns in diameter, this represents only 0.04% of the pore volume.

10.2 *IN SITU* TREATMENT (SOURCE AREA)

For Alternative 11, biostimulation of the intrinsic halorespiring microorganisms with an electron donor (EVO) would address the suspected source area. EVO would be introduced through a grid of wells starting around the perimeter of the source area and gradually applying the electron donor over the source area. EVO would also be injected into a biobarrier aligned along the northern edge of the source area to contain and treat TCE mass discharge from the source area under conditions of groundwater flow reversal. The KB-1™ culture would be added shortly after the addition of EVO stimulated anaerobic conditions.

Additional EVO would be injected as it is consumed (estimated every 2 years). The EVO will be injected at low concentrations (targeting oil saturations of 1%) to avoid adversely impacting soil permeability. Growth and distribution of the indigenous halorespiring microorganisms, and concentration trends of the VOCs and their degradation products, and other parameters (e.g., key inorganic species, dissolved hydrocarbon gases, dissolved oxygen, oxidation-reduction potential), would be monitored. Sampling would occur within and downgradient of the source zone as part of the remediation monitoring program to evaluate the enhanced mass removal rate of the residual DNAPL and effectiveness of biocontainment of the source zone (i.e., reduction in total flux of chlorinated VOCs). The types, presence, and distribution of halorespiring microorganisms would be assessed through analysis of extracted DNA from groundwater or soil samples and the use of microcosms, as appropriate. MNA would be implemented when the flux of dissolved chlorinated VOCs emanating from any residual source of DNAPL is less than the assimilative capacity of the aquifer to remove these VOCs to meet RAOs.

10.3 MONITORED NATURAL ATTENUATION

For Alternative 11, MNA is a secondary mechanism to address VOC contamination in the DNAPL area and dissolved plume. MNA will be used once bioremediation has fulfilled its objectives and is no longer effective. Groundwater modeling and other evaluations performed during the FS predicted that bioremediation could reduce the VOC concentrations in the source area to active cleanup goals, and reduce TCE within the dissolved plume to concentrations that would not migrate at unacceptable levels within six years. Groundwater monitoring and modeling will be used to validate the modeling predictions and to determine when the use of MNA is appropriate. Active remedial actions (represented by continued EVO injections) within the source area and dissolved phase plume will be discontinued when TCE concentrations approach the effective limits of bioremediation (estimated to be 200 ppb TCE).

As discussed in Section 8, evaluations of natural attenuation parameters at IR Site 70 has shown that MNA is likely to be effective in reducing contaminant concentrations to cleanup levels within a reasonable time frame. Long-term monitoring (including 5-year periodic reviews) will be used to verify that MNA is reducing concentrations of contaminants as planned.

10.4 PERFORMANCE MONITORING

Groundwater monitoring will be conducted to evaluate the effectiveness of each step of the enhanced bioremediation. To accomplish this, monitoring wells will be constructed and subsequently sampled within the biobarrier treatment zone and immediately up and downgradient of the biobarriers. These sample data will be used to verify the effectiveness of the enhanced bioremediation approach.

Microcosm studies, which will be completed in the remedial design investigation, will provide data on the removal efficiency under enhanced bioremediation and natural attenuation conditions.

Annual monitoring would involve collecting and analyzing groundwater samples from wells within and along the downgradient migration pathways of the plume (to be presented in the design document). A combination of six existing monitoring wells would be utilized and additional monitoring wells will be installed and used to monitor the performance of each element of the treatment system. The monitoring data will be collected the data presented in Table 10-1. Additional monitoring wells will be added based on the number of biobarriers installed. Groundwater levels would be measured in new and existing wells to confirm groundwater flow patterns and vertical gradients. Monitoring will be performed to track the plume over time and identify that dechlorination is occurring at rates sufficient to attain RAOs and within the timeframe

Table 10-1
Proposed Performance Monitoring Requirements for Alternative 11
IR Site 70

Type of Monitoring Data	Monitoring Locations	Purpose/Use of Data
Water levels	Monitoring wells along downgradient perimeters, within the plume, down gradient of biobarriers, within biobarriers and DNAPL area and in upgradient areas	Prepare potentiometric surface maps. Determine horizontal and vertical hydraulic gradients. Identify potential barriers to flow. Quantify impact of seasonal variations.
Field parameters	Monitoring wells throughout and around the IR Site 70 vicinity plume	Confirm dechlorination and anaerobic conditions.
Volatile fatty acids (lactate, propionate, formate, butyrate, hexanoate)	Monitoring wells throughout and around the IR Site 70 vicinity plume	Confirm continuing presence of oil.
Dissolved metals (iron, manganese, arsenic, etc.)	Select monitoring wells throughout and around the IR Site 70 vicinity plume	Monitor secondary groundwater impacts to groundwater quality.
Anions (sulfate, chloride, nitrate, phosphate, sulfide, nitrite)	Monitoring wells throughout and around the IR Site 70 vicinity plume	Monitor for presence of competing electron acceptors and to confirm dechlorination activity (chloride production).
Dissolved Hydrocarbon Gases (methane, ethane, ethene)	Monitoring wells throughout and around the IR Site 70 vicinity plume	Confirm dechlorination sequence to non-toxic end products and gather data to define mass balance for remedial zones.
Biochemical oxygen demand (BOD) and total organic carbon (TOC)	Monitoring wells throughout and around the IR Site 70 vicinity plume	Confirm continuing presence of oil.
DHE PCR	Select monitoring wells throughout and around the IR Site 70 vicinity plume	Monitor bioremediation culture distribution and continuing viability.
VOC concentrations in the aquifer	Monitoring wells throughout and around the IR Site 70 vicinity plume	Confirm dechlorination sequence, gather data to define mass balance for remedial zones.
VOC concentrations in extracted groundwater	Extraction wells for mixing with EVO and bioaugmentation culture.	Monitor concentrations within treatment zones. Provide water quality data for water discharge requirements (WDR) monitoring requirements.
VOC concentrations in reinjected water-EVO mixture	Effluent lines from mixing unit at each treatment area (source area and biobarrier)	Demonstrate substantive compliance with the WDR.
Flow rates	Extraction wells and injection wells	Confirm that extraction and reinjection rates are compatible, identify potential biofouling issues.
Other operational parameters (e.g., waterline pressures)	Various locations	As needed to assess proper operation or incipient failure of pumps and filters.

Acronyms/Abbreviations:
- IR – Installation Restoration (Program)
- EVO – Emulsified Vegetable Oil
- WDR – Waste Discharge Requirements
- VOC – Volatile Organic Compound

predicted by groundwater modeling. A long-term remediation monitoring plan would document the actual monitoring program and contain a contingency plan triggering actions to manage any future expansion of the plume per U.S. EPA guidance (U.S. EPA 1988, 1999). Additional well installation to track changes in the extent of the plume are included as part of this alternative. The cost of additional wells is incorporated into the long-term monitoring costs.

Monitoring data would be used for periodic reviews every year to assess plume migration, dechlorination activity, to evaluate the extent of microbial migration, and the adequacy of the remedial action to meet RAOs. Reviews would be documented in a summary report issued to appropriate regulatory agencies. These reports may suggest modifications to the cleanup program as needed.

10.5 TERMINATION OF REMEDIAL ACTION

Groundwater remediation will be considered complete when the concentrations of COCs in all monitoring wells reach and remain at cleanup goals for a period of 1 year.

10.6 LAND USE CONTROLS

The objectives of the land use controls are to prevent exposure to VOC-contaminated groundwater, maintain the integrity of the remedial action until cleanup goals are complete, and assure access to the site by the DON and regulatory agencies to maintain the remedy and conduct any further investigation and response action, if required.

The land use controls required by this alternative will be applied to the overlying footprint of the existing areas of contamination, approximately 50 acres, and two associated buffer zones (Figure 10-1) that will extend from and encircle the interpreted limits of the VOC plume. A half-mile-radius buffer zone will be established for groundwater from the surface to a depth of approximately 495 feet bgs and a 250-foot-radius buffer zone for groundwater beneath the deep aquitard at depths greater than 495 feet bgs (Figure 10-1). This dual zone thereby creates a three-dimensional buffer zone by depth.

County of Orange Ordinance 2607 authorizes the Orange County Health Care Agency (OCHA) to regulate the construction and destruction of wells. Section 4-5-14 of the Ordinance States, "It is the purpose of this article to control the construction and reconstruction of wells to the end that the groundwater of this County will not be impaired in quality and that water obtained from such wells will be suitable for the purpose for which used and will not jeopardize the health, safety or welfare of the people of this County..." (OCHA, 2002) (Attachment D).

These land use controls will be implemented by restricting well permits via the Orange County Health Care Agency Environmental Health Department in a manner similar to what exists for the nearby Alamitos Barrier. The permit restrictions will require that OCHA, the DON, and other appropriate stake holders (identified by the DON) review well permit applications prior to the granting said permits within the controlled area to determine compliance with applicable sections of the County of Orange Ordinance 2607

(OCHA, 2002). This restriction will apply to water supply wells and injection wells within the buffer zones.

10.7 PERIODIC REVIEWS

As required by CERCLA § 121(c), when contamination remains in place, periodic reviews will occur at least every 5 years. Five-year reviews of federal facilities are a federal agency function intended to evaluate whether immediate threats have been addressed, whether the remedial action remains protective of public health and the environment, and that necessary O&M is being performed. The review of IR Site 70 is expected to focus on whether the land use controls are in place and are sufficient to assure protection and whether groundwater remediation is reducing contaminant concentrations and preventing migration of VOCs.

The 5-year review will be conducted by the DON. The review will 1) clearly state whether the remedy is expected to be protective, 2) document any deficiencies identified during the review, and 3) recommend specific actions to assure that the remedy will continue to be protective. If necessary, the 5-year review report will include descriptions of follow-up actions needed to achieve or to continue to assure protectiveness along with a timetable for these actions.

10.8 OPERATION AND MAINTENANCE PLAN

An O&M plan will be developed during the remedial design phase for the in-situ biological treatment systems. This plan will establish the exact number and location of injection and monitoring wells. It will also outline sampling and analysis methods, periods and sampling frequency for each well, and major decision points to be made during monitoring (e.g., adding or removing wells, or changing sampling frequency or analytical parameters). The criteria for assessing the effectiveness of the remedial action will also be included in the O&M plan. The O&M plan will specify the criteria for evaluating well performance and determining if maintenance is required for specific wells.

Each injection well will remain in operation until it has been demonstrated that cleanup goals have been achieved or the injection well is no longer effective in contributing to the restoration of the aquifer. Criteria for shutting off the wells and terminating use of bioremediation will be developed during the remedial design phase and incorporated into the O&M plan.

The O&M plan will also include specifications for implementation and monitoring of the chosen technology refinements and/or post-treatment selections based on further bench and pilot testing.

10.9 RATIONALE FOR REMEDY SELECTION

The selected alternative provides the best balance with respect to the NCP evaluation criteria. Based on the information available at this time, the selected alternative offers:

- a high level of performance when assessed against the following NCP evaluation criteria: short-term effectiveness; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; implementability; compliance with ARARs; and overall protection of human health and the environment; and
- a cost-effective means of accomplishing the remedial action objectives for the site.

Table 10-2 summarizes the cost estimate for the selected alternative, including capital and O&M costs assumed to extend for 15 years. The assumed 15-year time frame does not necessarily reflect the duration of the O&M activities at the site; the discontinuation or extension of O&M activities will be determined based on the results of sampling designed to evaluate the effectiveness of remediation. Technology refinements and/or post-treatment activities added to the alternative during the design phase may increase the duration and costs.

Some modifications to the selected remedy (e.g., technology refinements and/or post-treatment maintenance, locations and number of wells) may be necessary as a result of the remedial design and construction process. Detailed design specifications, performance criteria will be incorporated into the design document.

Figure 10-1

This detailed station map has been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.

evaluations, and the schedule will be determined during the remedial design phase.

Table 10-2

Cost Estimate Summary – IR Site 70
Alternative 11 – Bioaugmented Biobarriers (Dissolved Plume) and Biostimulation with Bioaugmentation (DNAPL Area)

Description	Cost
Capital Costs	
Groundwater monitoring wells (installation of 42 wells)	$166,000
Oil amendment injection wells (installation of 212 wells)	$1,097,000
Temporary oil injection equipment	$100,000
Professional labor (includes Proposed Plan, Record of Decision, Remedial Action Plan, workplan, design and startup, well installation oversight)	$2,162,000
Site characterization and laboratory treatability study	$800,000
Total capital costs (based on January 2005 dollars, including profit and overhead)	**$4,325,000**
O&M Costs	
Oil emulsion (15 year supply)	$4,199,000
Oil injection labor (15 years)	$574,000
Monitoring (includes 20% QA/QC, sampling, analysis, mobilization and labor)	$2,003,000
Gene-Trac analysis	$108,000
KB-1™	$602,000
Annual Professional Costs (five year reviews, annual reporting, field program start-up and management)	3,865,000
Total O&M Costs (including 2.5% inflation per annum)	**$11,351,000**
Subtotal	**$15,676,000**
Total (including 20% contingency)	**$18,810,000**
NET PRESENT VALUE (based on January 2005 dollars)	**$14,663,000**

Section 11
STATUTORY DETERMINATIONS

Under CERCLA, the DON's primary responsibility is to undertake remedial actions that achieve adequate protection of human health and the environment. Section 121 of CERCLA establishes several additional statutory requirements and preferences specifying that, when complete, the selected remedial action must comply with ARARs established under federal and state laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and use permanent solutions and alternative treatment technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that, as their principal element, permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste. The following sections discuss how the selected remedy meets these statutory requirements and preferences. Complete discussions are found in the Groundwater FS Report for IR Sites 40 and 70 (BNI 2002) and the Final Groundwater RFS Report for IR Site 70 (GCI, 2005).

11.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

RAOs for IR Site 70 are concerned with limiting future contaminant migration and exposures to contaminated media and restoring the beneficial use of the groundwater. The selected remedy protects human health and the environment by preventing use of contaminated groundwater until remediation is complete. Although groundwater is currently not used for potable purposes, contaminated groundwater is a potential future threat to human health if it is used for domestic purposes. Remediation of groundwater will eliminate this threat in time; in the interim, land use controls will prevent inadvertent exposure to VOCs at concentrations above MCLs by controlling new well drilling. Restrictions will also be used during remediation to prevent disturbance of injection and monitoring wells.

There are no short-term threats associated with the selected remedy that cannot be controlled. In addition, no adverse cross-media impacts are expected from the remedy.

11.2 COMPLIANCE WITH ARARs

The selected remedy will comply with the substantive portions of all ARARs. Section 121(e) of CERCLA, U.S.C. § 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on-site. Therefore, actions conducted entirely on-site must meet only the substantive, not the administrative, requirements of the ARARs. Any action conducted off-site is subject to the full requirements of federal, state, and local regulations. The chemical-, location-, and action-specific ARARs for the selected remedy for IR Site 70 are listed in Tables 11-1, 11-2, 11-3, 11-4, 11-5, and 11-6, respectively, and discussed below.

11.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient

Table 11-1
Federal Chemical-Specific ARARs by Medium [a] for Preferred Remedy

Requirement	Prerequisite	Citation	ARAR Determination	Comments
		GROUNDWATER		
Safe Drinking Water Act, 42 USC 300 [b]				
National primary drinking water standards are health-based standards for public water systems (MCLs)	Public water system.	40 CFR 141.11 - 141.16, excluding 141.11(d)(3); 40 CFR 141.60 - 141.63	Relevant and appropriate	The NCP defines MCLs as relevant and appropriate for groundwater determined to be a current or potential source of drinking water in cases where MCLGs are not ARARs. MCLs are relevant and appropriate for Class II aquifers such as the Groundwater Management Zone-Orange County Basins. The RWQCB has designated the Groundwater Management Zone-Orange County Basins for municipal/domestic use (potential drinking water) in addition to other uses, and these designations also apply to the shallow groundwater system at NAVWPNSTA Seal Beach. Only the primary standards for organic chemicals (40 CFR 141.61), specifically VOCs, are identified as ARARs for this RFS. MCLs are not ARARs for those constituents that NAVWPNSTA Seal Beach has not contributed to the shallow groundwater system (e.g., inorganics such as arsenic and nitrate).
Resource Conservation and Recovery Act [b]				
Groundwater protection standards: Owners/operators or RCRA TSD facilities must comply with conditions designed to assure that hazardous constituents entering groundwater from a regulated unit do not exceed concentration limits for contaminants of concern set forth under 22 CCR 66264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance.	Uppermost aquifer underlying a waste management unit beyond the point of compliance; RCRA hazardous waste treatment, storage, or disposal	22 CCR 66264.94, except 66264.94(a)(2), and 94(b)	Relevant and appropriate	Applicable only for regulated TSD facilities. Based on available data, no RCRA-listed hazardous wastes were disposed of at Site 70 and groundwater contamination did not result from release of RCRA-regulated waste. However, substantive provisions of these requirements are relevant and appropriate to site circumstances. VOC constituents in groundwater are similar to those found in RCRA wastes and may be found at concentrations exhibiting the characteristics of toxicity, making this a chemical-specific ARAR for development of site remedial goals.

Table 11 -1 (continued)
Federal Chemical-Specific ARARs by Medium [a] for Preferred Remedy

Requirement	Prerequisite	Citation	ARAR Determination	Comments
		SOIL		
Resource Conservation and Recovery Act [b] Groundwater protection standards: Owners/operators or RCRA TSD facilities must comply with conditions designed to assure that hazardous constituents entering groundwater from a regulated unit do not exceed concentration limits for contaminants of concern set forth under 22 CCR 66264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance.	Waste generation.	22 CCR 66262.11, 66262.2, 66261.3, 66261.100(a)(1), 66261.21, 66261.23, and 66261.24(a)(1)	Applicable	VOC-affected soil that may be excavated at IR Site 70 is not an RCRA-listed hazardous waste and is unlikely to be an RCRA characteristic hazardous waste. However, waste must still be tested for the RCRA hazardous waste characteristics at the point of generation.
		SURFACE WATER		
Comprehensive Environmental Response, Compensation, and Liability Act [b]				
Alternative Concentration Limits	There are known and projected points of entry of groundwater to surface water, there is no statistically significant increase of hazardous consttituents from groundwater in surface water at point of entry, and there are enforceable institutional controls to preclude human exposure at any point between the facility boundary and the point of entry to surface water.	CERCLA Section 122(d)(2)(B)(ii)	Not an ARAR	Applicable as outlined under prerequisites. Allows a risk-based approach to setting alternative concentration limits based on a surface water discharge pathway.
Surface water discharge under intent of CERCLA.	Surface water discharge.	CERCLA 121(d)(2)(B) I as codified in 40 CFR 131.36, National Toxics Rule (NTR), 57 *Federal Register* 60848.	Applicable	Applicable limiting discharge levels of waste to surface waters that are consistent with health-based standards for human health or ecological health. FAWQC may be applicable to surface water discharges.

Table 11-1 (continued)
Federal Chemical-Specific ARARs by Medium [a] for Preferred Remedy

Notes:

[a] Chemical-specific concentrations used for RFS evaluation may not be ARARs indicated in this table, but may be concentrations based upon other factors. Such factors may include the following:

- Human health risk-based concentrations (40 CFR 300.430[e][2][i][A][1] and [2]).
- Ecological risk-based concentrations (40 CER 300.430[el[2][i][G]
- Practical quantitation limits of contaminants (40 CFR 300.430[e][2][i][A][3])

Many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables

[b] Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the Department of the Navy accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
CCR – *California Code of Regulations*
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
CFR – *Code of Federal Regulations*
FAWOC – federal ambient water quality criteria
RFS – Revised Feasibility Study
IR – Installation Restoration
MCL – maximum contaminant level
MCLG – maximum contaminant level goal
NAVWPNSTA – Naval Weapons Station
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
RCRA – Resource Conservation and Recovery Act
RWQCB – California Regional Water Quality Control Board, Santa Ana Region
SMCL – secondary maximum contaminant level
TSD – treatment, storage, and disposal
USC – *United States Code*
VOC – volatile organic compound

Table 11-2
State Chemical-Specific ARARs by Medium [a] for Preferred Remedy

Requirement	Prerequisite	Citation	ARAR Determination	Comments
		GROUNDWATER		
Cal/EPA Department of Toxic Substances Control National drinking water standards for public water systems (state MCLs).	Public water system.	22 CCR 64431 and 64444	Relevant and appropriate	If more stringent than federal MCLs or nonzero MCLGs, state MCLs are relevant and appropriate for groundwater determined to be a source of drinking water. The Groundwater Management Zone - Orange County Basins is a Class II aquifer designated by the RWQCB for municipal and domestic use in addition to other uses. These use designations also apply to the shallow groundwater system at NAVWPNSTA Seal Beach. Only state primary standards for organic chemicals (22 CCR 64444), specifically VOCs, are chemical-specific ARARs for this RFS. MCLs are not ARARs for constituents that NAVWPNSTA Seal Beach has not contributed to the shallow groundwater system (e.g., inorganics such as As, NO_3^-).
State Water Resources Control Board and California Regional Water Quality Control Board, Santa Ana Region [b]				
Authorizes the state and regional water boards to establish in water quality plans beneficial uses and numerical and narrative standards to protect both surface and groundwater quality. Authorizes regional water boards to issue permits for discharges to land and surface or groundwater that could affect water quality, including NPDES permits, and to take enforcement action to protect water quality.		California Water Code, Division 7, Sections 13241, 13243, 13263(a), 13269, and 13360 (Porter-Cologne Water Quality Control Act)	Applicable	Other provisions of Porter-Cologne Water Quality Act are not considered substantive by the DON.
Describes water basins in Santa Ana Region. Establishes beneficial uses of groundwater and surface water. Establishes water quality objectives, including narrative and numerical standards. Establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies.	Public water system.	Water Quality Control Plan for the Santa Ana Basins (Basin Plan)	Applicable	Substantive provisions in Chapters 2 through 4 of the Basin Plan are ARARs. The beneficial uses for the Groundwater Management Zone - Orange County Basins are municipal/domestic use (potential drinking water), agricultural supply, industrial service supply, and industrial process supply. These uses also apply to the shallow groundwater system at NAVWPNSTA Seal Beach.

Table 11-2 (continued)
State Chemical-Specific ARARs by Medium [a] for Preferred Remedy

Requirement	Prerequisite	Citation	ARAR Determination	Comments
Incorporated into Basin Plan. Designates all ground and surface waters of the state as potential drinking water except where TDS are 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 by using either best management practices or best economically achievable treatment practices.	Public water system.	SWRCB Resolution No. 88-63 (Sources of Drinking Water Policy) and RWQCB Resolution No. 89-42.	Applicable	Substantive provisions are ARARs. However, this requirement is not a controlling ARAR since the Basin plan identifies the Groundwater Management Zone - Orange County Basins and the overlying shallow groundwater at NAVWPNSTA Seal Beach as a source of drinking water.
		SOIL		
California Environmental Protection Agency Department of Toxic Substances Control [b]				
Definition of non-RCRA hazardous waste.	Waste generation.	22 CCR 66262.11, 66261.2, 66261.3, 66261.101(a)(1) and (a)(2), 66261.22(a)(3) and (a)(4), 66261.24(a)(2) through (a)(8)	Relevant and appropriate	VOC-affected soil that may be removed at Site 70 is unlikely to be a non-RCRA hazardous waste. However, these materials must still be characterized at the point of generation.
		SURFACE WATER		
Discharges to surface water bodies of the state are authorized under the auspices of the regional water boards.		California Water Code, Division 7, Section 13241, 13243, 132663(a), and 13360 (Porter-Cologne Water Quality Control act)	Applicable	Water quality criteria may be relevant and appropriate for discharge of treated groundwater to surface water.
Discharge of treated water to surface waters.		Water Quality Control Plan for the Santa Ana Basin (Basin Plan)	Applicable	Portions of Chapters 2 through 4 are ARARs concerning discharges to surface water.
Discharge of treated waters potentially entering the ocean.		Ocean Plan	Applicable	Linked through the Basin Plan for water quality standards affecting human health and aquatic species health.

Table 11-2 (continued)
State Chemical-Specific ARARs by Medium [a] for Preferred Remedy

Requirement	Prerequisite	Citation	ARAR Determination	Comments
		AIR		
Air Resources Control Board (SCAQMD) Air emissions under the National Ambient Air Quality Standards place source-specific emissions limitations for emissions of particulates, organic compounds, and toxic air pollutants.	Emission restrictions.	Clean Air Act 40 USC 7401 et seq. as South Coast Air Quality Management District Rules 212 and 1303 under the State Implementation Plan	Applicable	Establish emission standards for particulates, organic compounds, hazardous air pollutants, and new sources.
Visible air emissions limited to less than value described by Ringlemann No. 1 or 20 percent opacity for 3 minutes in any hour.	Emission restrictions.	South Coast Air Quality Management District Rule 401	Applicable	Potential action-specific ARAR.
New Source Review of Carcinogenic Air Contaminants. Regulation XIV. Establishes allowable limits based on risk levels.	Emission restrictions.	South Coast Air Quality Management District Rule 1401	Applicable	Potential action-specific ARAR for new stationary sources. Requires BACT to limit emissions.
Prohibitions under Regulation IV, prohibiting air emissions creating nuisance; fugitive dust; particulate matter; solid particulate matter; liquid and gaseous air contaminants; circumvention; fuel combustion contaminants; sulfur content of gaseous, liquid, or fossil fuels; and burning equipment oxides of nitrogen.	Emission restrictions.	South Coast Air Quality Management District, Rules 402, 403, 404, 405, 407, 408, 409, 431.1, 431,2, 431.3, and 474		Not ARARs for action, chemical, or location.

Table 11-2 (continued)
State Chemical-Specific ARARs by Medium [a] for Preferred Remedy

Requirement	Prerequisite	Citation	ARAR Determination	Comments

Notes:

[a] Chemical-specific concentrations used for RFS evaluation may not be ARARs indicated in this table, but may be concentrations based upon other factors. Such factors may include the following:

- Human health risk-based concentrations (40 CFR 300.430[e][2][i][A][1] and [2]).
- Ecological risk-based concentrations (40 CER 300.430[el[2][i][G]
- Practical quantitation limits of contaminants (40 CFR 300.430[e][2][i][A][3])

Many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables

[b] Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the Department of the Navy accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
As – arsenic
BACT – best available control technology
CCR – *California Code of Regulations*
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
CFR – *Code of Federal Regulations*
CWA – Clean Water Act
DON – U.S. Department of Navy
RFS – Revised Feasibility Study
gpd – gallon per day
IR – Installation Restoration
NAVWPNSTA – Naval Weapons Station
MCL – maximum contaminant level
MCLG – maximum contaminant level goal
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
NO3- – nitrate
NPDES – National Pollutant Discharge Elimination System
ppm – parts per million

Table 11-2 (continued)
State Chemical-Specific ARARs by Medium [a] for Preferred Remedy

RCRA – Resource Conservation and Recovery Act
RWQCB – California Regional Water Quality Control Board, Santa Ana Region
SMCL – secondary maximum contaminant level
TSD – treatment, storage, and disposal
USC – *United States Code*
UST – underground storage tank
VOC – volatile organic compound

Table 11-3
Federal Location-Specific ARARs for Selected Remedy

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
National Archeological and Historical Preservation Act					
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts.	Construction on previously undisturbed land would require an archeological survey of the area.	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archeological data.	Substantive requirements of 36 CFR 65, 40 CFR 6.301(3), 16 USC Section 469	Applicable	An archeological survey for NAVWPNSTA Seal Beach indicates the presence of 186 out of the 250 structures surveyed as eligible for contributing to a historic district. Buildings at IR Site 70 are listed.
National Historic Preservation Act [Section 106] of 1966, as amended					
Historic property owned or controlled by federal agency.	Action to preserve historic properties; planning of action to minimize harm to properties listed on or eligible for listing on the National Register of Historic Places.	Property included in or eligible for the National Register of Historic Places.	Substantive requirements of 36 CFR 800, 40 CFR 6.301(b), 16 USC, Section 470	Applicable	An archaeological survey of NAVWPNSTA Seal Beach indicates the presence of 186 out of 250 structures that are eligible as elements contributing to a historic district. Buildings at IR Site 70 are included.
Endangered Species Act of 1973					
Critical habitat upon which endangered species or threatened species depend.	Action to conserve endangered species or threatened species, including consultation with the Department of the interior.	Determination of effect upon endangered or threatened species or its habitat.	16 USC 1536(a), 50 CFR 402	Applicable	IR Site 70 remedial activities may affect the Seal Beach NWR, which supports special status species or habitat.
Executive Order 11990, Protection of Wetlands					
Wetland.	Action to minimize the destruction, loss, or degradation of wetlands.	Wetland as defined by EO 11990 Section 7.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Relevant and Applicable	Jurisdictional wetlands at NAVWPNSTA Seal Beach, identified by U.S. Army Corps of Engineers, are in close proximity to the sites. IR Site 70 remedial actions will include measures to prevent or mitigate any expected impacts on wetlands.
National Wildlife Refuge System					
Wildlife	Only actions allowed under the provisions of 16 USC Section 668 dd(c) may be undertaken in areas that are part of the NWR System.	Area designated as part of NWR System.	50 CFR 27; 16 USC, Section 668dd	Applicable	NAVWPNSTA Seal Beach includes the Seal Beach NWR and Bolsa Chica Ecological Reserve. NAVWPNSTA Seal Beach is part of the NWR System.

Table 11-3 (continued)
Federal Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Coastal Zone Management Act					
Within coastal zone.	Conduct activities in a manner consistent with approved state management programs.	Activities affecting the coastal zone, including lands hereunder and adjacent shore land.	Section 307(c) of 16 USC 1456(c); also see 15 CFR 930 and 923.45	Relevant and Appropriate	NAVWPNSTA Seal Beach is within the Coastal Barrier Resource System.
National Recommended Water Quality Criteria - Correction 1999					
Habitat including freshwater and saltwater environments.	Establishes water quality standards for freshwater, saltwater, and human-health criteria.	Discharge potentially affecting water quality.	40 CFR 131 Section 304(a)(1) of the Clean Water Act	Relevant and Appropriate	Establishes water quality standards for freshwater and saltwater that are based on current toxicity information. Where discharges occur to freshwater and saltwater, these criteria provide guidance.
Migratory Bird Treaty Act of 1972					
Migratory bird area.	Protects almost all species of native birds in the U.S. from unregulated "take" that can include poisoning at hazardous waste sites.	Presence of migratory birds.	16 USC Section 703	Relevant and Appropriate	IR Site 70 remedial action addresses contaminated groundwater. Migratory birds are not likely to be exposed to VOC-affected groundwater or affected by remedial activities.
Marine Mammal Protection Act					
Marine mammal area.	Protects any marine mammal in the U.S., except as provided by international treaties from unregulated "take."	Presence of marine mammals.	16 USC 13722	TBC	The project site is in a coastal zone or area that might be habitat for marine mammals.

Table 11-3 (continued)
Federal Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments

Notes:

[a] Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate the DON accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading: only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
CCR –*California Code of Regulations*
CFR – *Code of Federal Regulations*
DON – U.S. Department of the Navy
EO – Executive Order
ERSE – Extended Removal Site Evaluation
FEMA – Federal Emergency Management Agency
IR – Installation Restoration
NAVWPNSTA Seal Beach – Naval Weapons Station Seal Beach
NWR – National Wildlife Refuge
RCRA – Resource Conservation and Recovery Act
TBC – to be considered
USC – *United States Code*

Table 11-4
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous California Endangered Species Act					
Habitat	No person shall import, export, take, possess, or less any endangered or threatened species or part or product thereof.		Fish and Game Code Sections 2050-2098	Relevant and Appropriate	IR Site 70 remedial actions might affect areas that support California-listed endangered species or habitat. The NAVWPNSTA Seal Beach NWR supports endangered species.
California Coastal Act of 1976 *					
Coastal Zone	Regulates activities associated with development to control direct significant impacts on coastal waters and to protect state and national interests in California coastal resources.		Public Resources Code Sections 30000-30900; 14 CCR 13001-13666.4	Relevant and Appropriate	The project site is not in an area governed by this statute.
State Water Resources Control Board and California Regional Water Quality Control Board, Santa Ana Region *					
Describes water basins in Santa Ana Region. Establishes beneficial uses of groundwater and surface water. Establishes water quality objectives, including narrative and numerical standards. Establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies.	Public Water System.		Water Quality Control Plan for the Santa Ana Basin (Basin Plan).	Applicable	Substantive provisions in Chapters 2 through 4 of the Basin plan are ARARs. The beneficial uses for the Groundwater Management Zone - Orange County Basins are municipal/domestic use (potential drinking water), agricultural supply, industrial service supply, and industrial process supply. These uses also apply to the shallow groundwater system at NAVWPNSTA Seal Beach.
California Ocean Plan of 1997					
Ocean and Coastal Waters.	Provides for the protection of the quality of the ocean waters for use and enjoyment by the people of the State, requiring the control of discharge of waste into the ocean waters.	Discharge potentially affecting water quality.	California Ocean Plan, SWRCB Resolution No. 97-026	Applicable	The remedial actions to be conducted at IR Site 70 may result in discharge of treated groundwater to surface waters terminating in the ocean.

Table 11-4 (continued)
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Aquatic Habitat/ Species	Action must be taken if toxic materials are placed where they can enter waters of the State. There can be no release that would have a deleterious effect on species or habitat.		Fish and Game Code 5650(a), (b), and (f)	Relevant and Appropriate	These code sections prohibit the deposition into state waters of, *inter alia*, petroleum products (Section 5650(a)), factory refuse (Section 5650(b)), and any substance deleterious to fish, plants or birds (Section 5650(f)). These are substantive, promulgated environmental protection requirements. These requirements impose strict criminal liability on violators. (*People v. Chevron Chemical Company (1983) 143 Cal. App. 3d 50*). This imposition of strict criminal liability imposes a standard that is more stringent than federal law. The extent to which each subdivision of Section 5650 is relevant and appropriate depends on the site characterization. Section 5650 makes it unlawful "to deposit in, permit to pass into, or place where it can pass into the waters of this state," enumerated substances as petroleum products, sawdust, wood shavings, factory refuse, or any other substances or materials that are deleterious to fish, plant life, or bird life.
Wildlife Species	Action must be taken to prohibit the taking of birds and mammals, including the taking by poison		Fish and Game Code Section 3005 (Stats. 1957, c. 456, p. 1353, Section 3005)	Applicable	This code section prohibits the taking of birds and mammals, including taking by poison. "Take" is defined by Fish and Game Code Section 86 to include killing. "Poison" is not defined in the code. Although there is no state authority on this point, federal law recognizes that poison, such as Strychnine, may effect incidental taking. (*Defenders of Wildlife v. Administrator, Environmental Protection Agency (1989) 882. F. 2d. 1295*). This code section imposes a substantive, promulgated environmental protection requirement. Because the remediation of this site involves treatment of contaminants, this section appears to be applicable and relevant.
Rare Native Plants	Action must be taken to conserve native plants, there can be no releases and/or actions that would have a deleterious effect on species or habitat		Fish and Game Code Section 1908 (Added by Stats. 1977, c. 1181, p. 3869, Section 8)	Applicable	Section 1908 imposes a substantive requirement by forbidding any "person" to take rare or endangered native plants. California Code of Regulations Title 14, Section 670.2 provides a listing of the plants of California that have been declared to be Endangered, Threatened or Rare. Fish and Game Code Section 67 provides the definition of "person" as any natural person or partnership, corporation, limited liability company, trust, or other type of association. Whether the federal government or contractors acting on behalf of the federal government would fall within the definition is a potential issue. To the extent that there are rare or endangered plants on site, Section 1908 would be an ARAR

Table 11-4 (continued)
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Endangered Species	Action must be taken to conserve endangered species, there can be no releases and/or actions that would have a deleterious effect on species or habitat.		Fish and Game Code Section 2080 (Added by Stats. 1984, c. 1240, Section 2).	Applicable and Relevant	This section prohibits the take, possession, purchase or sell within the state, any species (including rare native plant species), or any product thereof, that the commission determines to be an endangered or threatened species, or the attempt of any of these acts. This section is applicable and relevant to the extent that there are endangered or threatened species in the area which have the potential of being affected if actions are not taken to conserve the species. This section prohibits releases and/or actions that would have a deleterious effect on species or their habitat. This section and applicable Title 14 regulations should be considered applicable, relevant, and appropriate due to the presence of the California least tern, the peregrine falcon, the California brown pelican, and the double-crested cormorant. California Code of Regulations Title 14 Section 670.2 provides a listing of the plants of California declared to be Endangered, Threatened or Rare. California Code of Regulations Title 145 Section 670.5 provides a listing of Animals of California declared to be endangered or threatened. California Code of Regulations Title 14 Section 783 et. seq., provides the implementation regulations for the California Endangered Species Act.
Wildlife / Domestic Species	Action must be taken to prohibit the use of steel-jawed leghold traps		Fish and Game Code Section 3003.1 (Prop. 4, Section 1 approved Nov. 3, 1998, eff. Nov. 4, 1998)	Applicable	This section prohibits the use of any body gripping trap and provides that it is unlawful for any person, including an employee of the federal government, to use or authorize the use of such device to capture any game mammal, fur-bearing mammal, non-game mammal, protected mammal, or any dog or cat. This prohibition will not apply in the extraordinary case where the use of such a device is the only method available to protect human health and safety.

Table 11-4 (continued)
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Fully Protected Bird Species / Habitat	Action must be taken to prevent the taking of fully protected birds		Fish and Game Code Section 3511 (Added by Stats. 1970, c. 1036, p. 1848 Section 4)	Applicable and Relevant	This section provides that it is unlawful to take or possess any of the following fully protected birds: a. American peregrine falcon b. Brown pelican c. California black rail d. California clapper rail e. California condor f. California least tern g. Golden eagle h. Greater sandhill crane i. Light footed clapper rail j. Southern bald eagle k. Trumpeter swan l. White-tailed kite m. Yuma clapper rail Although some of the fully protected birds are not typically found in Site 70, this statute will be considered Applicable and Relevant if any of the above mentioned fully protected birds or their habitat are found on or near the site.
Wetlands	Actions must be taken to assure that there is "no net loss" of wetlands acreage or habitat value. Action must be taken to preserve, protect, restore, and enhance California's wetland acreage and habitat values.		Fish and Game Commission Wetlands Policy (adopted 1987) included in Fish and Game Code Addenda	TBC	This policy seeks to provide for the protection, preservation, restoration, enhancement, and expansion of wetland habitat in California. Further, it opposes any development or conversion of wetland that would result in a reduction of wetland acreage or habitat value. It adopts the USFWS definition of a wetland which utilizes hydric soils, saturation or inundation, and vegetable criteria, and requires the presence of at least one of these criteria (rather than all three) in order to classify an area as a wetland. This policy is not a regulatory program and should be included as a TBC.

Table 11-4 (continued)
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Fully Protected Mammals	Action must be taken to ensure that no fully protected mammals are taken or possessed at any time		Fish and Game Code section 4700 (Added by Stats. 1970, c. 1036, p. 1848 Section 6)	Relevant and Appropriate	This section prohibits the take or possession of any of the fully protected mammals or their parts. The following are fully protected mammals: a. Morro Bay kangaroo rat b. Bighorn sheep except Nelson bighorn sheep c. Northern elephant seal d. Guadalupe fur seal e. Ring-tailed cat f. Pacific right whale g. Salt-marsh harvest mouse h. Southern sea otter i. Wolverine Although some fully protected mammals are not typically found in Site 70, this statute will be considered Applicable and Relevant if any of the above mentioned fully protected mammals or their habitat are found on or near the site.
Fully Protected Reptiles and Amphibians	Actions must be taken to prevent the take or possession of any fully protected reptile or amphibian		Fish and Game Code Section 5050 (Added by Stats. 1970, c. 1036, p. 1849 Section 7)	Relevant and Appropriate	This section prohibits the take or possession of fully protected reptiles and amphibians or parts thereof. The following are fully protected reptiles and amphibians: a. Blunt-nosed leopard lizard b. San Francisco garter snake c. Santa Cruz long-toed salamander d. Limestone salamander e. Black toad Although some fully protected reptiles and amphibians are not typically found in Site 70, this statute will be considered Applicable and Relevant if any of the above mentioned fully protected reptiles or amphibians or their habitat are found on or near the site.
Birds	Action must be taken to avoid the take or destruction of the nest or eggs of any bird		Fish and Game Code Section 3503	Applicable	This section prohibits the take, possession, or needless destruction of the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.

Table 11-4 (continued)
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Birds of Prey	Action must be taken to prevent the take, possession, or destruction of any birds-of-prey or their eggs		Fish and Game Code Section 3503.5 (Added by Stats. 1985, c. 1334, Section 6)	Applicable	This section prohibits the take, possession, or destruction of any birds in the orders of Falconifromes or Strigifromes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto. This section will be applicable and relevant if such species or their eggs are located on or near the site.
Non-Game Birds	Actions must be taken to prevent the take of non-game birds		Fish and Game Code Section 3800 (Added by Stats. 1971, c. 1470, p. 2906, Section 13)	Applicable	This section prohibits the take of non-game birds, except in accordance with regulations of the commission, or when related to mining operations with a mitigation plan approved by the department. This section further provides requirements concerning mitigation plans related to mining. This section is applicable and relevant if non-game birds or their eggs are located on or near the site and such species have not been included in the Fish and Wildlife Conservation Plan filed pursuant to the Federal Fish and Wildlife Conservation Act. Species included in the plan will be protected at the federal standard making this section an ARAR to the extent that it is more stringent than the federal standard of protection.
Fur-Bearing Mammals	Provides manners under which fur-bearing mammals may be taken		Fish and Game Code Section 4000 et. Seq. (Stats. 1957, c. 456, p. 1380, Section 4000)	Applicable	This section provides that a fur-bearing mammal may be taken only with a trap, a firearm, bow and arrow, poison under a proper permit, or with the use of dogs
Non-Game Mammals	Action must be taken to avoid the take or possession of non-game animals		Fish and Game Code Section 4150 (Added by Stats. 1971, c. 1470, p. 2907, Section 21)	Applicable	Non-game mammals are those occurring naturally in California which are not game mammals, fully protected mammals, or fur-bearing mammals. These mammals, or their parts, may not be taken or possessed except as provided in this code or in accordance with regulations adopted by the commission.

Table 11-4 (continued)
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Non-Game Animals	Action must be taken to avoid the take of non-game mammals except as provided in applicable regulations		Title 14 California Code of Regulations (CCR) Section 472, Effective 07/01/74	Relevant and Appropriate	This Regulation provides that non-game birds and mammals may not be taken. a. The following non-game birds and mammals may be taken except as provided in Chapter 6: English sparrow, starling, coyote, weasels, skunks, opossum, moles and rodents (excludes tree and flying squirrels, and those listed as furbearers, endangered, or threatened species); b. Fallow, sambar, sika, and axis deer may be taken concurrently with the general deer season; c. Aoudad, mouflon, tahr, and feral goats may be taken all year; and d. American crows may be taken only under provisions of Section 485 and by landowners or tenants, or person authorized by landowners or tenants, when American crows are committing or about to commit depredations upon ornamental shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. If required by Federal regulations, landowners or tenants shall obtain a Federal migratory bird depredation permit before taking any American crows or authorizing any other person to take them. Although some of the non-game birds and mammals are not typically found in Site 70, this statute will be Applicable and Relevant if any of the above mentioned non-game birds and mammals or their habitat are found on or near the site.
Tidal Invertebrates	Action must be taken to avoid the take or possession of mollusks, crustaceans, or other invertebrates		Fish and Game Code Section 8500 (Added by Stats. 1972, c. 1248, p. 2436, Section 2, eff. Dec. 13, 1972)	Applicable	It is unlawful to possess or take, unless otherwise expressly permitted in this chapter, mollusks, crustaceans, or other invertebrates, unless a valid tidal invertebrate permit has been issued. The taking, possessing, or landing of such invertebrates pursuant to this section shall be subject to regulations adopted by the commission.
Protected Amphibians	Action must be taken to avoid the take or possession of protected amphibians		Title 14 CCR Sections 40 (Section 40 designated effective 03/01/74)	Applicable	This regulation makes it unlawful to capture, collect, intentionally kill or injure, possess, purchase, propagate, sell, transport, import, or export any native reptile or amphibian, or parts thereof unless under special permit from the department issued pursuant to Title 14 CCR, Sections 650, 670.7, or 783 of these regulations, or as otherwise provided in the Fish and Game Code or these regulations.

Table 11-4 (continued)
State Location-Specific ARARs

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Furbearing Mammals	Action must be taken to avoid take		Title 14 CCR, Section 460 (effective 07/01/59)	Applicable	Regulation makes it unlawful to take fisher, marten, river otter, desert kit fox, and red fox. Although some of the mammals are not typically found in Site 70, to the extent that the red fox, which is highly possible to occur in the area, or its habitat is found on or near Seal Beach NWS, this section will be an ARAR.
Furbearing Mammals	Provides methods of take for other forbearing mammals not listed in Title 14 CCR, Section 460		Title 14 CCR, Section 465 (effective 07/01/69)	Relevant and Appropriate	Furbearing mammals not listed specifically in Title 14 CCR Section 460 and listed in 14 CCR, Section 461, 462, 463, and Section 464 may be taken only with a firearm, bow and arrow, or with the use of dogs, or traps in accordance with the provisions of Section 465.5 of Title 14 and Section 3003.1 of the Fish and Game Code. Although these mammals may not be currently present in Site 70, if one is found on or near Site 70 at some future date, this section will become applicable and relevant.

Notes:

[a] Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate the DON accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading: only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:
ARAR – applicable or relevant and appropriate requirement
CCR – *California Code of Regulations*
DON – U.S. Department of the Navy
NAVWPNSTA Seal Beach – Naval Weapons Station Seal Beach
NWR – National Wildlife Refuge
SWRCB – State Water Resources Control Board
TBC – to be considered

Table 11-5
Federal Action-Specific ARARs for Selected Remedy

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Safe Drinking Water Act, 42 USC 300f et seq. *					
Underground injection of treated groundwater.	The UIC program regulates the underground injection of fluids under the SDWA to protect sources of drinking water and public health. Five classifications of wells are provided.	Underground injection well.	40 CFR 144, 146, and 147	TBC	Not an ARAR. Injection of EVO blended with site groundwater and KB-1™ will occur in the source area and biobarriers as part of the Remedial Action.
Resource Conservation and Recovery Act, 42 USC 6901 et seq.					
Waste generation	Generator must determine if waste is an RCRA hazardous waste.	Generation of solid waste, including extracted groundwater.	22 CCR 66262.10(a) and 10(b), 66262.11, 66261.2, 66261.3, 66261.10(a)(1)	Applicable	Applicable for any operation generating waste, including extracted groundwater, soil cuttings from well installation, trench spoils, excavated soils, and treatment residuals such as spent LPC or spent iron. The determination of whether materials are RCRA hazardous will be made at the time wastes are generated.
Clean Water Act, 40 USC 7401 et seq.					
Discharge to air.	Provisions of SIP approved by U.S. EPA under Section 110 of CAA.	Major sources of air pollutants.	40 USC Section 7140; portions of 40 CFR Section 52.220 applicable to SCAQMD	Applicable	Requirements applicable to potential emissions of VOCs from groundwater treatment systems or VOCs extracted with soil gas are discussed as state action-specific ARARs in Sections R-B2.5 and B4.3.2 and on Table R-B4-4. Limited VOC emissions from soil cuttings (e.g., soil off-gas) may be encountered during monitoring/extraction well installation. However, the levels of VOC emissions from soils are expected to be minimal.

Table 11-5 (continued)
Federal Action-Specific ARARs for Selected Remedy

Notes:
[a] Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate the DON accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading: only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:
A – applicable
ARAR – applicable or relevant and appropriate requirement
CAA – Clean Air Act
CAMU – corrective action management unit
CCR – *California Code of Regulations*
CFR – *Code of Federal Regulations*
CWA – Clean Water Act
DNAPL – dense nonaqueous-phase liquid
DON – U.S. Department of the Navy
EVO – emulsified vegetable oil
IR – Installation Restoration
LPC – liquid-phase carbon
MNA – monitored natural attenuation
NA – Not Applicable
NAVWPNSTA Seal Beach – Naval Weapons Station Seal Beach
POTW – publicly owned treatment works
ppmw – parts per million by weight
RA – relevant and appropriate
RCRA – Resource Conservation and Recovery Act
SCAQMD – South Coast Air Quality Management District
SDWA – Safe Drinking Water Act
SIP – State Implementation Plan
SWRCB – State Water Resources Control Board
TBC – to be considered
UIC – underground injection control
USC – *United States Code*
U.S. EPA – United States Environmental Protection Agency
VOC – volatile organic compound

Table 11--6
State Action-Specific ARARs for Selected Remedy

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
State Water Resources Control Board and California Regional Water Quality Control Board, Santa Ana Region*					
Actions affecting water quality in the Santa Ana Region	Describes water basins in the Santa Ana Region. Establishes beneficial uses of surface water and groundwater. Establishes water quality objectives, including narrative and numerical standards. Establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies.		Water Quality Control Plan for the Santa Ana River Basin (Basin Plan)	Applicable	Substantive provisions in Chapters 2 through 4 of the Basin Plan are ARARs. The beneficial uses of the Groundwater Management Zone - Orange County Basins are municipal and domestic use (potential drinking water), agricultural supply, industrial services supply, and industrial process supply. These uses also apply to the shallow groundwater system at NAVWPNSTA Seal Beach. Protection of these uses is a performance standard for all remedial actions addressing the IR Site 70 plumes.
Discharges to high-quality waters.	Incorporated into Basin Plan. Requires that high-quality waters be maintained unless certain findings are made. Discharges to high-quality waters must comply with antidegradation provisions. At a minimum, beneficial uses must be maintained.	Discharge potentially affecting water quality.	SWRCB Resolution No. 68-16 (Policy With Respect to Maintaining High Quality Waters in California)	TBC	Action-specific ARAR regulating discharge of treated groundwater by discharge into surface water at NAVWPNSTA Seal Beach. SWRCB Resolution No. 68-16 is only applicable to discharge of treated groundwater, not to the cleanup and/or potential migration of the IR Site 70 plumes.

Table 11-6 (continued)
State Action-Specific ARARs for Selected Remedy

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Cleanup and abatement of discharges into the waters of the state.	Incorporated into Basin Plan. Requires cleanup and abatement of discharges into the waters of the state that are consistent with Resolution No. 68-16, beneficial uses of water, and maximum benefit of the people. Establishes procedures for establishing Containment Zones.	Cleanup and discharge of groundwater into the groundwater or surface water and establishment of Containment Zones.	SWRCB Resolution No. 92-49. Policies and procedures for investigation and cleanup and abatement of discharges under Water Code 13304 (as amended on 21 April 1994 and 02 October 1996).	TBC	Action-specific policy and procedures regulating cleanup, abatement, and discharges to waters of the state. Provides for conformance to Resolution No. 68-16, Chapter 15, maximum benefit to the people of the state, not affecting current or future beneficial uses, and consistent with Basin Plan. Policy and procedures are no more stringent than Basin Plan.
Protection of the quality of the ocean waters for use and enjoyment by the people of the state.	Describes policy for protection of ocean water quality. Includes beneficial use designations, water quality objectives, general requirements, compliance criteria, and discharge prohibitions. All discharges into the ocean must comply with criteria set forth in the Ocean Plan.	Plan is applicable to point source discharges into the ocean and nonpoint sources of waste discharge. Plan provides water quality objectives for receiving waters. Plan does not apply to discharges into enclosed bays and estuaries.	SWRCB Resolution No. 97-026. California Ocean Plan (23 July 1997). Policy set forth in Section 13000 of Division 7 CWC Section 13170 and 13170.2	TBC	Action-specific policy regulating discharges into the ocean waters of the state. Standards are no more restrictive than the FAWQC.

Table 11-6 (continued)
State Action-Specific ARARs for Selected Remedy

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Discharges into the waters of the state.	Authorizes the RWQCB to define requirements under which a waste discharge may take place. These are known as Waste Discharge Requirements (WDRs). WDRs establish concentration levels for VOCs and other constituents in treated groundwater. WDRs issued for discharges into surface waters (including storm drains) also require NPDES permit under the federal CWA.		California Water Code, Section 13263; Water Quality Control Plan for the Santa Ana River Basin (Basin Plan.	Applicable	Discharge of treated groundwater may be to surface perimeter storm drain (Alternatives 6, 7, 9, and 10). The off-site discharges into surface water will require NPDES permits. Surface water discharge of treated groundwater,,an on-site response action exempt from permitting under CERCLA, must still comply with the substantive provisions of the Water Code and the Basin Plan. Injection of EVO and KB-1™ blended with site groundwater may require substantive compliance with WDRs.
California Environmental Protection Agency Department of Toxic Substances Control					
Waste generation	Generator must determine if waste is a non-RCRA hazardous waste.	Generation of solid waste in California.	22 CCR 66262.10(a) and 10(b), 66262.11, 66261.2, 66261.3, 66261.101(a) (1) and (1)(2)	TBC	Applicable for any operation which generates waste. The determination of whether material are non-RCRA hazardous will be made at the time wastes are generated.
Discharge into air.	Permits required to construct and operate major new source of air contaminants.	Major source of air pollutants.	SCAQMD Rules 201 and 203	TBC	Alternatives 9 and 10 have the potential to emit VOCs extracted with groundwater, but off-gassing of groundwater at IR Site 70 is not expected. If off-gassing occurs, the response action will require permitting by the SCAQMD.

Notes:

[a] Statutes and policies and their citations are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate the DON accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading: only substantive requirements of the specific citations are considered potential ARARs.

Table 11-6 (continued)
State Action-Specific ARARs for Selected Remedy

Acronyms/Abbreviations:

A – applicable
ARAR – applicable or relevant and appropriate requirement
BACT – best available control technology
CCR – *California Code of Regulations*
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
CWA – Clean Water Act
CWC – California Water Code
DNAPL – dense nonaqueous-phase liquid
DON – U.S. Department of the Navy
EVO – emulsified vegetable oil
GAC – granular activated carbon
HSC – California Health and Safety Code
IR – Installation Restoration
NPDES – National Pollutant Discharge Elimination System
NAVWPNSTA Seal Beach – Naval Weapons Station Seal Beach
RA – relevant and appropriate
RCRA – Resource Conservation and Recovery Act
RWQCB – California Regional Air Quality Management District
SCAQMD – South Coast Air Quality Management District
SWRCB – California State Water Resources Control Board
T-BACT – best available control technology for toxics
TBC – to be considered
VOC – volatile organic compound
WDR – Waste Discharge Requirement

environment. If a chemical has more than one cleanup level, the most stringent level has been identified as an ARAR for this remedial action. The selected remedial action can be implemented to comply with chemical-specific ARARs.

Chemical-specific ARARs have been identified for groundwater, surface water, and soil. Groundwater is a medium of concern at IR Site 70. Soil is not a medium of concern but soil cuttings generated from construction of monitoring and injection wells will require characterization as potential hazardous waste prior to disposal.

11.2.1.1 GROUNDWATER CHEMICAL-SPECIFIC ARARs

The substantive provisions of the following requirements were identified as Federal and state groundwater ARARs for remedial actions at IR Site 70:

- WQCP for the Santa Ana Region, 1995 (specifying water quality objectives, beneficial use, and waste discharge limitations), plus amendments
- federal MCLs for VOCs listed in the SDWA, 40 *Code of Federal Regulations* (C.F.R.) § 141.61 (a)
- state primary MCLs for VOCs in Cal. Code Regs. tit. 22, § 64444
- RCRA groundwater protection standards in Cal. Code Regs. tit. 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e)

The most stringent of these requirements are the RCRA groundwater protection standards and Cal. Code Regs. tit. 22, § 66264.94 requirements to restore affected groundwater to background conditions, if possible, or else attain the best water quality that is technically and economically feasible. A fate and transport study was conducted as part of the ERSE. Results indicate that migration through vadose zone soil leaching is considered negligible for existing conditions.

The DON has determined that the substantive provisions of Cal. Code Regs. tit. 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e) constitute relevant and appropriate federal requirements for groundwater at IR Site 70. These provisions are considered a federal ARAR because this requirement was approved by U.S. EPA in its 23 July 1992 authorization of the state of California's RCRA program and is federally enforceable. The state of California disagrees with the DON; this regulation is a part of the state's authorized hazardous waste control program, so the state contends that the regulation is a state ARAR and not a federal ARAR. See 55 *Federal Register* (Fed. Reg.) 8765, 08 March 1990, and *United States v. State of Colorado*, 990 F.2d 1565 (1993).

Discussions of chemical-specific ARARs for groundwater follow.

Water Quality Control Plan for the Santa Ana Region, 1995 (plus amendments)

Under the SDWA and RCRA, a significant issue in identifying ARARs for groundwater is whether the groundwater can be classified as a source of drinking water. The U.S. EPA groundwater policy set forth in the NCP preamble uses the system in the U.S. EPA Guidelines for Groundwater Classification. Under the U.S. EPA Groundwater Protection Strategy (NCP, 55 Fed. Reg. 8752–8756) groundwater is classified in one of three categories (Class I, II, or III) based on ecological importance, its ability to be replaced, and vulnerability. Class I is irreplaceable groundwater currently used by a substantial population, or groundwater that supports a vital habitat. Class II consists of groundwater currently used or that might be used as a source of drinking water in the future. Class III is groundwater that cannot be used for drinking water because of its unacceptable quality (e.g., high salinity or widespread naturally occurring contamination) or insufficient quantity. The U.S. EPA guidelines define Class III as groundwater with TDS concentrations over 10,000 mg/L. The aquifer underlying NAVWPNSTA Seal Beach is classified as a Class II aquifer and is designated by RWQCB as a potential source of drinking water, along with other beneficial uses such as agricultural and industrial.

Primary Maximum Contaminant Levels

MCLs under the SDWA are potential relevant and appropriate requirements for aquifers with Class I and II characteristics and, therefore, are Federal ARARs. The point of compliance for MCLs under the SDWA is at the tap. For CERCLA remedies, however, U.S. EPA indicates that MCLs should be attained throughout the contaminated plume, or at and beyond the edge of the waste management area when the waste is left in place (55 Fed. Reg. 8753). In accordance with the RAOs, it is the DON's intent to restore potential beneficial uses of the shallow aquifer underlying NAVWPNSTA Seal Beach with regard to VOCs. The DON does not intend to establish a point of compliance for this remedial action.

Primary state MCLs for the COCs that are more stringent than federal MCLs are State ARARs for the remedial action at IR Site 70 and are set forth in Cal. Code Regs. tit. 22, § 64444 (Maximum Contaminant Levels – Organic Chemicals). MCLs for inorganics are not ARARs because there is no evidence that exceedances for these chemicals are caused by site-related activities.

Cleanup Levels

Cleanup levels for groundwater are set at health-based levels (MCLs), reflecting current and potential use and exposure. COCs in groundwater at IR Site 70 are VOCs, several of which exceed federal or state MCLs. The remediation goals for these chemicals are based on federal and state MCLs. Table 8-2 shows the remediation goals for COCs in groundwater. The shallow groundwater at NAVWPNSTA Seal Beach contains elevated background concentrations of inorganics, which result from sources unrelated to operations of the DON. Cleanup of this groundwater to below background conditions is not required by SWRCB under the Porter-Cologne Act. Therefore, the success of Alternative 11 would not be measured by reductions in any inorganic constituents that are not site-related contaminants.

RCRA Groundwater Protection Standards

Groundwater concentration limits for RCRA-regulated units are promulgated at Cal. Code Regs. tit. 22, § 66264.94. For corrective action programs, Cal Code Regs. tit. 22, § 66264.94(c) states that the concentrations of compounds must not exceed the background level of that constituent in groundwater or, if achieving background is shown to be technologically or economically infeasible, some higher concentration limit that is set as part of the corrective action program. In no event shall a concentration limit greater than background exceed MCLs established under the federal SDWA (Cal. Code Regs. tit. 22, §§ 66431 and 64444).

RCRA groundwater protection standards are applicable only for regulated units managing hazardous wastes. These standards are not applicable to IR Site 70 because this site does not contain a RCRA waste management unit and the VOC-affected groundwater to be addressed by this remedial action is not a RCRA-listed hazardous waste. However, these standards are considered relevant and appropriate because they address circumstances and contaminants similar to those encountered in the plume at and downgradient of IR Site 70. Accordingly, the DON has determined that the RCRA groundwater protection standards are Federal ARARs for this remedial action.

A discussion of the technical and economic infeasibility of remediating groundwater to background is presented in the Groundwater FS Report for IR Sites 40 and 70 (BNI 2002) and the Final Groundwater RFS Report for IR Site 70 (GCI, 2005). These documents were reviewed and accepted by Cal-EPA DTSC and RWQCB. Therefore, as provided for in Cal. Code Regs. tit. 22, § 66264.94, concentration limits based on MCLs are considered remedial goals for IR Site 70.

State Water Resources Control Board Resolutions 92-49 and 68-16

The DON and the state of California have not agreed whether the California SWRCB Res. 92-49 and Res. 68-16 are ARARs for the remedial action at IR Site 70. Therefore, this ROD/RAP documents each party's position but does not attempt to resolve the issue.

The DON Position Regarding SWRCB Resolutions 92-49 and 68-16. The DON recognizes that the key substantive requirements of Cal. Code Regs. tit. 22, § 66264.94 (and the identical requirements of Cal. Code Regs. tit. 23, § 2550.4 and Section III.G of SWRCB Res. 92-49) require cleanup of constituents to background levels unless that is technologically or economically infeasible and an alternative cleanup level will not pose a substantial present or potential hazard to human health or the environment. In addition, the DON recognizes that these provisions are more stringent than the corresponding provisions of 40 C.F.R. § 264.94 and, although they are federally enforceable under RCRA, they are also independently based on state law to the extent that they are more stringent than the federal regulations.

The DON has also determined that SWRCB Res. 68-16 is not a chemical-specific ARAR for determining remedial action goals but is an action-specific ARAR for discharge of treated groundwater to surface water. The DON has determined that further migration of VOCs through groundwater is not a discharge governed by the language in Res. 68-16. More specifically, the language of SWRCB Res. 68-16 indicates that it is prospective in intent, applying to new discharges in order to maintain existing high-quality waters. It is not intended to apply to restoration of waters that are already degraded.

The DON's position is that SWRCB Res. 68-16 and Res. 92-49 and Cal. Code Regs. tit. 23, § 2550.4 do not constitute chemical-specific ARARs for this remedial action because they are state requirements and are not more stringent than the federal ARAR provisions of Cal. Code Regs. tit. 22, § 66264.94. The NCP set forth in 40 C.F.R. § 300.400(g) provides that only state standards more stringent than federal standards may be ARARs (see also CERCLA Section 121[d][2][A][ii]).

The substantive technical standard in the equivalent state requirements (i.e., Cal. Code Regs. tit. 23, Division [div.] 3, Chapter [ch.] 15 and SWRCB Res. 92-49 and Res. 68-16) is identical to the substantive technical standard in Cal. Code Regs. tit. 22, § 66264.94. This section of Cal. Code Regs. tit. 22 will likely be applied in a manner consistent with equivalent provisions of other regulations, including SWRCB Res. 92-49 and Res. 68-16.

State of California Position Regarding SWRCB Resolutions 68-16 and 92-49. The state does not agree with the DON determination that SWRCB Res. 92-49 and Res. 68-16 and certain provisions of Cal. Code Regs. tit. 23, div. 3, ch. 15 are not ARARs for this response action. SWRCB has interpreted the term "discharges" in the *California Water Code* to include the movement of waste from soils to groundwater and from contaminated to uncontaminated water (SWRCB 1994). However, the state agrees that the proposed action would comply with SWRCB Res. 92-49 and Res. 68-16, and compliance with Cal. Code Regs. tit. 22 provisions should result in compliance with Cal. Code Regs. tit. 23 provisions. The state does not intend to dispute the ROD/RAP, but reserves its rights if implementation of the Cal. Code Regs. tit. 22 provisions is not as stringent as state implementation of Cal. Code Regs. tit. 23 provisions. Because the Cal. Code Regs. tit. 22 regulation is part of the state's authorized hazardous waste control program, it is also the state's position that Cal. Code Regs. tit. 22, § 66264.94 is a state ARAR and not a federal ARAR (*United States v. State of Colorado*, 990 F.2d 1565 [1993]).

Whereas the DON and the state of California have not agreed on whether SWRCB Res. 92-49 and Res. 68-16 and Cal. Code Regs. tit. 23, § 2550.4 are ARARs for this response action, this ROD/RAP documents each of the parties' positions on the resolutions but does not attempt to resolve the issue.

11.2.1.2 SURFACE WATER CHEMICAL-SPECIFIC ARARs

Treated groundwater discharge to surface water through the storm drain is not an element of the selected remedy. As such, chemical-specific ARARs for this discharge do not apply.

11.2.1.3 AIR CHEMICAL-SPECIFIC ARARs

Air is not a medium of concern at IR Site 70 and the selected remedy does not involve discharge to air.

11.2.2 Location-Specific ARARs

Location-specific ARARs are restrictions on the concentrations of hazardous substances or on activities solely because they are in specific locations such as floodplains, wetlands, historic places, and sensitive ecosystems or habitats. The selected remedial action will be implemented to comply with location-specific ARARs.

The substantive provisions of the following requirements were identified as the most stringent of the Federal and state location-specific ARARs for the remedial actions at IR Site 70:

- 40 C.F.R § 6.302(a) (Executive Order No. 11990, Protection of Wetlands)
- 40 C.F.R. § 6.301(a) (Historic Sites, Buildings, and Antiquities Act of 1935 [16 U.S.C. §§ 461–167])
- 40 C.F.R § 6.301(b) (National Historic Preservation Act [NHPA] of 1966, as Amended [16 U.S.C. § 470–470x-6])
- 40 C.F.R. § 6.301(c) (Archaeological and Historic Preservation Act [16 U.S.C. § 469–469c-1])
- 16 U.S.C. §§ 1531–1543 (Endangered Species Act [ESA])
- 16 U.S.C. §§ 1451–1464 (Coastal Zone Management Act [CZMA])
- 16 U.S.C. §§ 703–712 (Migratory Bird Treaty Act)
- *California Fish and Game Code* (Cal. Fish & Game Code) § 2080 (California ESA)
- *California Public Resources Code* (Cal. Pub. Res. Code) §§ 30000–30900; Cal. Code Regs. tit. 14, §§ 13001–13666.4 (California Coastal Act)

11.2.2.1 WETLANDS

Jurisdictional wetlands exist at NAVWPNSTA Seal Beach, identified by the United States Army Corps of Engineers and located close to IR Site 70. Title 40 C.F.R. § 6.302(c) requires that actions within wetlands be implemented to minimize the destruction, loss, or degradation of wetlands. The DON will take appropriate action during the remedial design and remedial action phase to minimize impact on wetlands and will consider the location of the wetlands in siting the injection and monitoring wells and their associated piping and equipment.

11.2.2.2 CULTURAL RESOURCES

An archaeological survey conducted at NAVWPNSTA Seal Beach indicates the presence of 186 out of the 250 structures surveyed as eligible for contributing to the historic district. Several buildings located at IR Site 70 are listed. NHPA requires that potential impacts to federally funded properties included in or eligible for the National Register of Historic Places be identified and mitigated. The DON will coordinate with the State Historic Preservation Officer as required to minimize impacts on these structures.

11.2.2.3 ENDANGERED SPECIES

The ESA of 1973 (16 U.S.C. §§ 1531–1543) provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction. The ESA defines an endangered species and provides for the designation of critical habitats. Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. Under Section 7(a) of the ESA, federal agencies must carry out conservation programs for listed species. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented. Consultation regulations at 50 C.F.R. § 402 are administrative in nature and therefore are not ARARs.

The NAVWPNSTA Seal Beach NWR supports endangered species. Five bird species and one plant species are listed as endangered either by federal or state agencies and are known to inhabit NAVWPNSTA Seal Beach and the wetlands of the NWR. Salt marsh bird's beak is listed as an endangered plant species by federal and state agencies. Because of the rapidly disappearing habitat on the coast of southern California, two species of federally listed endangered birds, the California least tern and the light-footed clapper rail, rely on the limited habitat at NAVWPNSTA Seal Beach for their survival. Two other federally listed endangered birds, the California brown pelican and the peregrine falcon, along with the state-listed Belding's Savannah sparrow, also use the habitat at NAVWPNSTA Seal Beach and the NWR wetlands. Because these endangered species are present in the vicinity of IR Site 70, the ESA of 1973 and the California ESA have been determined to be applicable.

11.2.2.4 COASTAL ZONE MANAGEMENT ACT

The CZMA is not applicable to IR Site 70 because, under the CZMA, federal land is specifically excluded from the definition of a coastal zone. The CZMA (16 U.S.C. §§ 1451–1464) and the accompanying implementing regulations in 15 C.F.R. § 930 require that federal agencies conducting or supporting activities directly affecting the coastal zone conduct or support those activities in a manner that is consistent with the approved state coastal zone management programs. A state coastal zone management program (developed under state law and guided by the CZMA) sets forth objectives, policies, and standards to guide public and private uses of lands and water in the coastal zone. Activities affecting the coastal zone, including lands thereunder and adjacent shore land, will be conducted in manner consistent with approved state management programs. However, because of the location of IR Site 70, the CZMA has been determined to be relevant and appropriate.

11.2.2.5 CALIFORNIA COASTAL ACT OF 1976

Cal. Pub. Res. Code §§ 30000–30900 and Cal. Code Regs. tit. 14, §§ 13001–13666.4 regulate activities associated with development to control direct significant impacts on coastal waters and to protect state and national interests in California coastal resources. The policies set forth in the California Coastal Act constitute the standards used by the California Coastal Commission in its coastal development permit decisions and for the review of local coastal programs. These policies contain the following substantive requirements that have been determined to be state relevant and appropriate requirements as follows: protection and expansion of public access to the shoreline and recreation opportunities (Cal. Pub. Res. Code §§ 30210–30224); protection, enhancement, and restoration of environmentally sensitive habitats including intertidal and nearshore waters, wetlands, bays and estuaries, riparian habitat, grasslands, streams, lakes, and habitat for rare or endangered plants or animals (Cal. Pub. Res. Code §§ 30230–30240); protection of productive agricultural lands, commercial fisheries, and archaeological resources (Cal. Pub. Res. Code §§ 30234, 30241–30244); and protection of the scenic beauty of coastal landscapes (Cal. Pub. Res. Code § 30251). Activities affecting the coastal zone, including lands thereunder and adjacent shore land, will be conducted in a manner consistent with approved state management programs.

11.2.2.6 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act (16 U.S.C. §§ 703–712) has been identified as a federal relevant and appropriate requirement because of the potential presence of migratory birds at IR Site 70. This act prohibits at any time, using any means or manner, the pursuit, hunting, capturing, and killing or attempting to take, capture, or kill any migratory bird. The act also prohibits the possession, sale, export, and import of any migratory bird or any part of a migratory bird, as well as nests and eggs. The remedial action will be conducted in a manner protective of the migratory birds on or near IR Site 70.

11.2.3 Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations that apply to particular remediation activities. Actions that trigger these ARARs at IR Site 70 include installation of injection and monitoring wells and groundwater monitoring.

Injection of biological agents into groundwater for *in situ* treatment does not trigger federal or state ARARs. There are no specific federal or state ARARs concerning injection of nutrients/adjuvants and/or chemical reagents into the groundwater. In addition,RCRA § 3020(a), which bans hazardous waste disposal by underground injection above a formation that contains an underground source of drinking water, does not apply to this action because commercial chemicals or chemical by-products injected into groundwater for *in situ* treatment are not considered hazardous waste (U.S. EPA 2000).

Federal and state action-specific ARARs for installation of wells and groundwater monitoring are discussed in the following subsections.

11.2.3.1 FEDERAL

Federal laws that give rise to potential ARARs for actions to be undertaken as part of the selected alternative include RCRA requirements for monitoring and for characterizing, managing, and treating hazardous waste. These regulations are discussed below.

RCRA requirements for monitoring and for identification, management, and treatment of hazardous wastes (soil cuttings, wastewater generated in the course of installing monitoring and injection wells) are federal action-specific ARARs identified for the selected alternative. Portions of the RCRA groundwater protection standards contained in Cal. Code Regs. tit. 22 are considered relevant and appropriate for the groundwater potentially impacted by the releases from IR Site 70 because the hazardous chemicals being addressed by this alternative are similar or identical to those found in RCRA hazardous wastes.

The DON has determined that soil and groundwater at IR Site 70 would not be classified as RCRA-listed hazardous wastes. However, testing would still be required to classify these materials with respect to the RCRA hazardous waste characteristics. This determination would be made at the time the waste is generated. If testing at the time of generation indicates a hazardous waste, then the appropriate RCRA requirements in Table 11-5 for storing, treatment, and disposal would be potentially applicable ARARs for on-site activities.

A groundwater monitoring program will be developed during the remedial design phase. Substantive provisions of the following requirements are relevant and appropriate to the development and implementation of the monitoring program:

- groundwater monitoring and response (Cal. Code Regs. tit. 22, § 66264.91[a] and [c]), except as it cross-references permit requirements
- requirements for monitoring groundwater, surface water, and the vadose zone (Cal. Code Regs. tit. 22, § 66264.97[e])
- detection monitoring (Cal. Code Regs. tit. 22, § 66264.98)
- corrective-action monitoring (Cal. Code Regs. tit. 22, § 66264.100[d])

These regulations are not applicable because the sites are not RCRA-regulated units.

RCRA requirements for determining whether the waste is hazardous (Cal. Code Regs. tit. 22, §§ 66262.10 [a] and 66262.11) and for laboratory analysis if required (Cal. Code Regs. tit. 22, § 66264.13[a] and [b]) are applicable federal requirements for soil and monitoring wastes at IR Site 70. The hazardous waste determination and required analysis will be conducted using the ARARs identified in Table 11-1. If groundwater or soil is hazardous, substantive requirements of Cal. Code Regs. tit. 22, § 66264.34 for accumulation of waste and § 66264.171 through .174, .175(a) and (b), and .178 for storing waste in containers would be applicable federal requirements.

The waste groundwater accumulated during sampling and the soil from drill cuttings will be disposed off site. CERCLA ARARs address only on-site actions. Off-site actions must comply with substantive and procedural requirements of applicable requirements. Therefore, no ARARs are identified for the off-site disposal of groundwater accumulated during the monitoring or for the soil cuttings accumulated during the drilling of monitoring wells.

11.2.3.2 STATE

State laws that give rise to potential ARARs for actions to be undertaken as part of the selected alternative include state requirements for characterizing non-RCRA hazardous waste. These are discussed below.

Waste streams generated in the course of implementing the selected alternative would be characterized with respect to state criteria for identification of non-RCRA hazardous waste. Materials that would be tested under this requirement are the soil cuttings and development water from installation of monitoring and injection wells. Although not anticipated based on existing sample results, any waste exhibiting a characteristic of non-RCRA hazardous waste would be managed in accordance with the appropriate requirements of Cal. Code Regs. tit. 22, § 66264 already identified as federal ARARs in Section 11.2.3.1.

11.3 COST-EFFECTIVENESS

The selected remedy has been determined to provide overall effectiveness proportional to its costs; it is therefore considered cost effective. The estimated net present-worth cost for this remedial action is approximately $14.7 million. This total includes capital costs of approximately $4.3 million, operation and monitoring costs of approximately $11.4 million, and indirect costs of approximately $3.2 million for treatment of the source area and the dissolved phase plume. This includes costs associated with the pilot study, biostimulation/ bioaugmentation treatment of the source area, installation of the biobarriers for in-situ treatment of the dissolved plume, and construction and operation of the groundwater monitoring system. This technology is front end loaded in that the well construction, oil injection, bioaugmentation, and initial monitoring represent a significant effort within the initial implementation. Periodic monitoring and maintenance of the system will continue for the duration of the active treatment phase and then a long term monitoring program will continue to evaluate performance throughout the remediation areas.

Technologies included in Alternative 11 are innovative and require site-specific testing to verify their effectiveness. Much of this testing has been performed and has been demonstrated to be effective. Additional testing will be performed during the remedial design phase. Although *in situ* treatment results in capital costs higher than those of the other alternatives, Alternative 11 is considered cost-effective because costs are proportional to effectiveness. For this reason, Alternative 11 is considered to represent a low-cost, effective, permanent solution for groundwater remediation.

11.4 USE OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES (OR RESOURCE RECOVERY TECHNOLOGIES) TO THE MAXIMUM EXTENT PRACTICABLE

Alternative 11 uses bioremediation to achieve a permanent and irreversible chemical reaction to reduce VOC contamination in the source area and biobarriers for treating VOC contamination in the dissolved phase plume at IR Site 70. This alternative is protective of human health and the environment and complies with the ARARs for the site. A significant mass of VOC contaminants within the source area will be converted to harmless by-products by anaerobic reductive dechlorination and, therefore, will be permanently destroyed. Groundwater within the dissolved plume will be similarly treated *in situ* through a series of biobarriers to remove VOC contamination permanently. Although some residual contamination may remain in groundwater at the completion of remediation (as defined by MCLs), the concentration would not be high enough to present an unacceptable risk to human health. Anaerobic reductive dechlorination has been tested and found to be effective at this particular site for contaminant mass reduction.

The concentrations of VOCs in groundwater are expected to be significantly reduced within approximately 6 years of operation. The effectiveness of the remedy will be evaluated throughout this time. If this evaluation shows that the effectiveness of the proposed remedy has reached a plateau (i.e., the mass removal efficiency has reached an asymptotic state) before cleanup levels are achieved, MNA will be used for the duration of the remediation period. In the meantime, the DON will protect human health by using the NEPA review process for on-station projects and memorandum of agreement (for off-station projects.

The most decisive factors in the selection of Alternative 11 are that this alternative will permanently reduce the mass, toxicity, and volume of VOC contaminants and will assist in restoring the groundwater to its designated beneficial uses. Bioremediation would be the most aggressive form of treatment available and should result in lower residual risks in the source area, following treatment, than other process options evaluated.

11.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

CERCLA Section 121(b) identifies a statutory preference for alternatives that use treatment to reduce the toxicity, mobility, or volume of contamination. The selected alternative complies with this requirement.

Section 12
DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for IR Site 70 was released for public comment on 30 March 2006. The Proposed Plan/draft RAP identified Alternative 11, Enhanced In Situ Bioremediation (source area and dissolved phase plume), as the preferred alternative for remediation of groundwater at IR Site 70. The DON has reviewed all written and verbal comments submitted during the comment period and determined that no changes to the proposed remedy are required.

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Section 13
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COUNTY OF ORANGE
HEALTH CARE AGENCY

**REGULATORY HEALTH SERVICES
ENVIRONMENTAL HEALTH**

JULIETTE A. POULSON, RN, MN
DIRECTOR

MIKE SPURGEON
DEPUTY AGENCY DIRECTOR
REGULATORY HEALTH SERVICES

STEVEN K. WONG, REHS, MPH
DIRECTOR
ENVIRONMENTAL HEALTH

MAILING ADDRESS:
2009 EAST EDINGER AVENUE
SANTA ANA, CA 92705-4720

TELEPHONE: (714) 667-3600
FAX: (714) 972-0749
E-MAIL: environhealth@hca.co.orange.ca.us

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RECEIVED
AUG 1 4 2002
By

August 12, 2002

Hoover Ng
Water Replenishment District of Southern California
12621 East 166th Street
Cerritos, California 90703

Re: Well Construction in the Alamitos Seawater Intrusion Barrier Exclusion Zone.

Dear Mr. Ng:

This letter is in response to your request regarding clarification of the County of Orange Health Care Agency's permitting authority for the construction of production wells within 2000 feet of the Water Replenishment District of Southern California's Alamitos Barrier Project. The Alamitos Barrier Project is a recycled water groundwater recharge project that will directly inject recycled water along the Orange County/Los Angeles County border near Los Alamitos to prevent saltwater intrusion. As a condition of approval and to protect public health, the State Department of Health Services requires that no recycled water shall be extracted within 2000 feet of the Alamitos Barrier Project for use as a drinking water supply.

County of Orange Ordinance 2607 authorizes the Orange County Health Care Agency to regulate the construction and destruction of wells. Section 4-5-14 of the Ordinance states, "It is the purpose of this article to control the construction and reconstruction of wells to the end that the groundwater of this County will not be impaired in quality and that water obtained from such wells will be suitable for the purpose for which used and will not jeopardize the health, safety or welfare of the people of this County . . ."

To this end, future well permit applications received by this Agency for the construction of production wells within 2000 feet of the Alamitos Barrier Project will be reviewed in consultation with the State Department of Health Services, the Water Replenishment District of Southern California and the Orange County Water District to determine compliance with applicable sections of County of Orange Ordinance 2607. Production well permit applications not meeting the requirements will be denied.

If you have any questions or require further information, please feel free to contact me at (714) 667-3750, Dan Matsui at (714) 667-3758 or Dan Yokoyama at (714) 667-3657.

Very truly yours,

Larry W. Honeybourne, REHS
Environmental Health Engineering Specialist
Water Quality Section
Environmental Health

cc: Frank Hamamura, California State Department of Health Services
Michael Wehner, Orange County Water District