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FINAL
RECORD OF DECISION
OPERABLE UNIT 2A
SITE 24 – VOC SOURCE AREA
VADOSE ZONE
FORMER MARINE CORPS AIR STATION
EL TORO, CALIFORNIA

April 2006

DECLARATION

DECLARATION

SITE NAME AND LOCATION

Site 24, Volatile Organic Compound (VOC) Source Area –
Operable Unit (OU)-2A – Vadose Zone

Former Marine Corps Air Station (MCAS) El Toro
Santa Ana, California 92709

National Superfund Database Identification Number: CA6170023208

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedy, no further action, for vadose zone soil at OU-2A Installation Restoration Program Site 24 at Former MCAS El Toro, located in Orange County, California. Site 24, the VOC Source Area, comprises two media, soil and groundwater. This ROD addresses vadose zone soil for Site 24; remediation of groundwater is addressed in the final ROD for OU-1/OU-2A (Sites 18 and 24) (SWDIV 2002).

This document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (Title 42 *United States Code* Section 9602 et seq.) and, in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (Title 40 *Code of Federal Regulations* Section 300 et seq.).

The decision for OU-2A Site 24 is based on information contained in the administrative record and results of public meetings. The administrative record index for this site (Attachment A) identifies the documents upon which the selection of the remedial action is based. Also, because of the close relationship between OU-2A and OU-1 (the regional groundwater VOC contamination plume), the administrative record for OU-1 is hereby incorporated by reference into the administrative record for OU-2A. A transcript of the public meeting held for the Proposed Plan is included as Attachment B.

The state of California (through the California Environmental Protection Agency Department of Toxic Substances Control [DTSC] as the lead state agency and the Santa Ana Regional Water Quality Control Board [RWQCB]) and the United States Environmental Protection Agency (U.S. EPA) concur on the selected remedy.

DESCRIPTION OF THE REMEDY

In September 1997, the Base Realignment and Closure Cleanup Team signed an OU-2A Interim ROD for Site 24, which documented soil vapor extraction (SVE) as the remedy selected to remove VOCs from the soil (SWDIV 1997b). The Site 24 ROD was interim because it did not address groundwater at the site and because the Navy agreed to reevaluate cleanup levels for soil in the final ROD. The cleanup levels for soil were further evaluated in the System Evaluation and Optimization Report (SEOR) (Earth Tech 1999) and concluded to be protective of groundwater quality. Additionally, a site closure strategy for the SVE system was developed in 2000; the SEOR and closure strategy both

were approved by the Federal Facility Agreement (FFA) signatories. Post-SVE closure sampling confirmed that SVE effectively remediated vadose zone soils at Site 24.

The Department of the Navy (DON), DTSC, Santa Ana RWQCB, and U.S. EPA have determined that further remedial action is not required to protect human health or welfare and/or the environment from soils at Site 24 on the basis of the following:

- site history
- field investigations
- laboratory analytical results
- evaluation of potential human-health risks
- completion of the remedial action and closure sampling

Results of investigations at Site 24 indicate that chemicals of concern (COCs) are not present in soil gas at concentrations exceeding cleanup levels established in the Interim ROD and documented in the Closure Report (Earth Tech 2002).

Although no monitoring or deed restrictions are required because of chemicals present in soils at Site 24, groundwater underlying the site is contaminated by trichloroethene and tetrachloroethene. Remedial investigations conducted in 1997 showed that the contaminants originated from the site. Institutional controls for groundwater at Sites 18 and 24 were addressed in the ROD for OU-1/OU-2A; they include prohibiting installation of wells and/or extraction of groundwater and allow access for groundwater monitoring and maintenance of remediation equipment.

STATUTORY DETERMINATIONS

The DON has determined that no further remedial action is necessary at Site 24 for vadose zone soils because the current condition of the site is protective of human health and the environment and complies with federal and state requirements. As part of the interim remedial action, SVE was selected for the vadose zone at Site 24 to reduce VOC concentrations in soil to levels that would be protective of groundwater quality and human health. Based on the human-health risk assessment, VOCs in Site 24 soils did not pose unacceptable risk to human health prior to cleanup (BNI 1997a). As agreed by the FFA signatories, SVE remediation of the vadose zone achieved the soil gas cleanup goals, which were initially set forth in the Interim ROD and reevaluated in the SEOR and in the Closure Report (Earth Tech 2002). The SVE system remediated the vadose zone to the extent economically and technically achievable and to a level that assures that VOCs will not be released into groundwater at concentrations exceeding maximum contaminant levels. The previous response at the site eliminated the need to conduct further remedial action. A 5-year review will not be required for Site 24 vadose zone soils because no hazardous substances, pollutants, or contaminants remain on-site in soil at concentrations that would prohibit unlimited use and/or unrestricted exposure. In addition, monitoring to assure that soil has not been recontaminated from VOCs in groundwater at the end of groundwater remediation will be incorporated into the selected remedy for groundwater

at Site 24. This action will be documented in an Explanation of Significant Differences to the Sites 18 and 24 groundwater ROD.

ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary:

- description of vadose zone interim remedial action (Section 2)
- COCs and their respective concentrations (Section 5)
- human-health risks represented by COCs prior to remediation (Section 7)
- other evaluation criteria established for COCs and the basis for these criteria (Sections 5 and 7)
- assumptions in the human-health risk assessment and this ROD for current and reasonably anticipated future land use (Section 7)
- attainment of remedial action objectives developed in the Interim ROD (Section 7)
- key factors that led to selecting the remedy (Section 8)

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

AUTHORIZING SIGNATURES

Signature: _____ Date: 27-FEB-06

Mr. Darren Newton
Base Realignment and Closure Environmental Coordinator
Marine Corps Air Station El Toro

Signature: _____ Date: 3/20/06

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

Signature: _____ Date: 3/7/06

Ms. Kathleen H. Johnson, Chief
Federal Facility and Site Cleanup Branch
United States Environmental Protection Agency, Region 9

Signature: _____ Date: 3/28/06

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

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ATTACHMENTS

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ACRONYMS/ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
BCT	Base Realignment and Closure Cleanup Team
bgs	below ground surface
BRAC	Base Realignment and Closure
Cal/EPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemical of concern
COPC	chemical of potential concern
CSF	cancer slope factor
DoD	Department of Defense
DON	Department of the Navy
DTSC	(Cal/EPA) Department of Toxic Substances Control
EPC	exposure point concentration
ESD	explanation of significant differences
FFA	Federal Facility Agreement
FS	feasibility study
HHRA	human-health risk assessment
HI	hazard index
IAS	initial assessment study
IRP	Installation Restoration Program
LRA	local redevelopment authority
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MCAS	Marine Corps Air Station
MCL	maximum contaminant level
MSL	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OCWD	Orange County Water District
OU	operable unit

PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RAB	Restoration Advisory Board
RAO	remedial action objective
RFA	Resource Conservation and Recovery Act facility assessment
RfD	reference dose
RI	remedial investigation
ROD	record of decision
RWQCB	(California) Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act of 1986
SEOR	System Evaluation and Optimization Report
SIPOA	site inspection plan of action
Station	Former MCAS El Toro
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TCE	trichloroethene
UCL	upper confidence limit
U.S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound

DECISION SUMMARY

Section 1
SITE NAME, LOCATION, AND DESCRIPTION

This Record of Decision (ROD) presents the determination by the Department of the Navy (DON) that no further remedial action is necessary for vadose zone soil at Operable Unit (OU)-2A Installation Restoration Program (IRP) Site 24 at Former Marine Corps Air Station (MCAS) El Toro. The National Superfund Database Identification Number for this former facility is CA6170023208.

This document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The decision for Site 24 vadose zone soil is based on information contained in the administrative record. The administrative record index for OU-2A Site 24 is provided in Attachment A. Attachment A also lists documents associated with OU-1 Site 18 (Regional Volatile Organic Compound [VOC] Groundwater Plume) because of the close relationship between OU-2A and OU-1.

1.1 SITE NAME

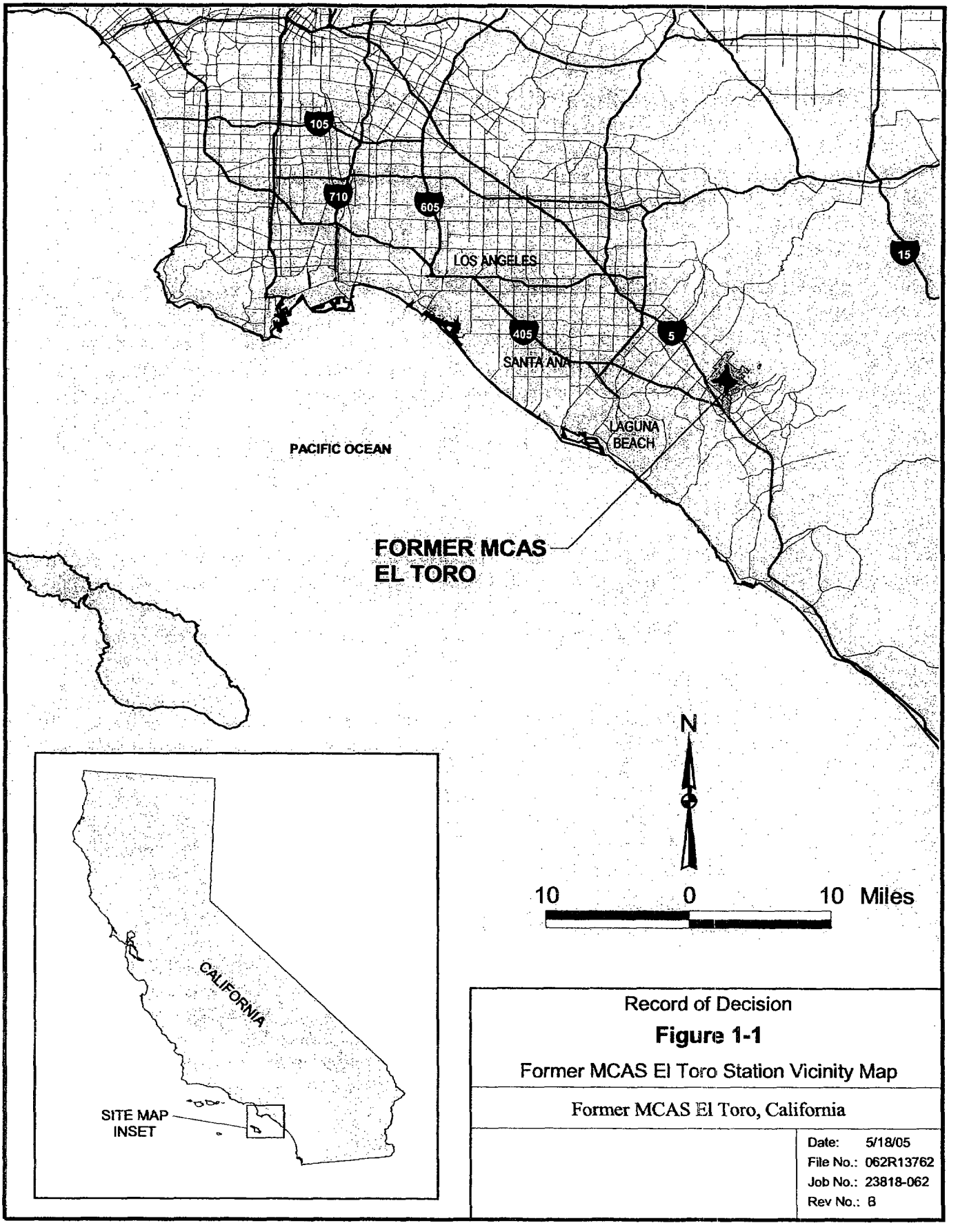
The portion of OU-2A addressed in this decision document consists of vadose zone soil at Site 24, the VOC Source Area, at Former MCAS El Toro (Station). The vadose zone soil was addressed previously in the Interim ROD (SWDIV 1997b). Groundwater at Site 24 is addressed in a separate ROD for OU-1/OU-2A (Sites 18 and 24) (SWDIV 2002).

1.2 SITE LOCATION

Former MCAS El Toro lies in a semiurban agricultural area in southern California, approximately 8 miles southeast of the city of Santa Ana and 12 miles northeast of the city of Laguna Beach (Figure 1-1). Land northwest of the former Station is used for agricultural purposes. The land to the south and northeast is used mainly for commercial, light industrial, and residential purposes. Residential areas in the vicinity of Former MCAS El Toro include the cities of Lake Forest, Irvine, and Laguna Hills. Site 24 is located in the southwest quadrant of Former MCAS El Toro (Figure 1-2).

1.3 LEAD AND SUPPORT AGENCIES

Former MCAS El Toro is a federal facility and is on the National Priorities List (NPL) of the Superfund Program. The DON is the lead agency responsible for environmental restoration, remedial investigation, and remedial action at the former Station. Regulatory agencies providing support and oversight include the United States Environmental Protection Agency (U.S. EPA), the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC), and the Santa Ana Regional Water Quality Control Board (RWQCB). The DON, U.S. EPA, DTSC, and Santa Ana RWQCB entered into a Federal Facility Agreement (FFA) for Former MCAS El Toro in 1990 (FFA 1990).



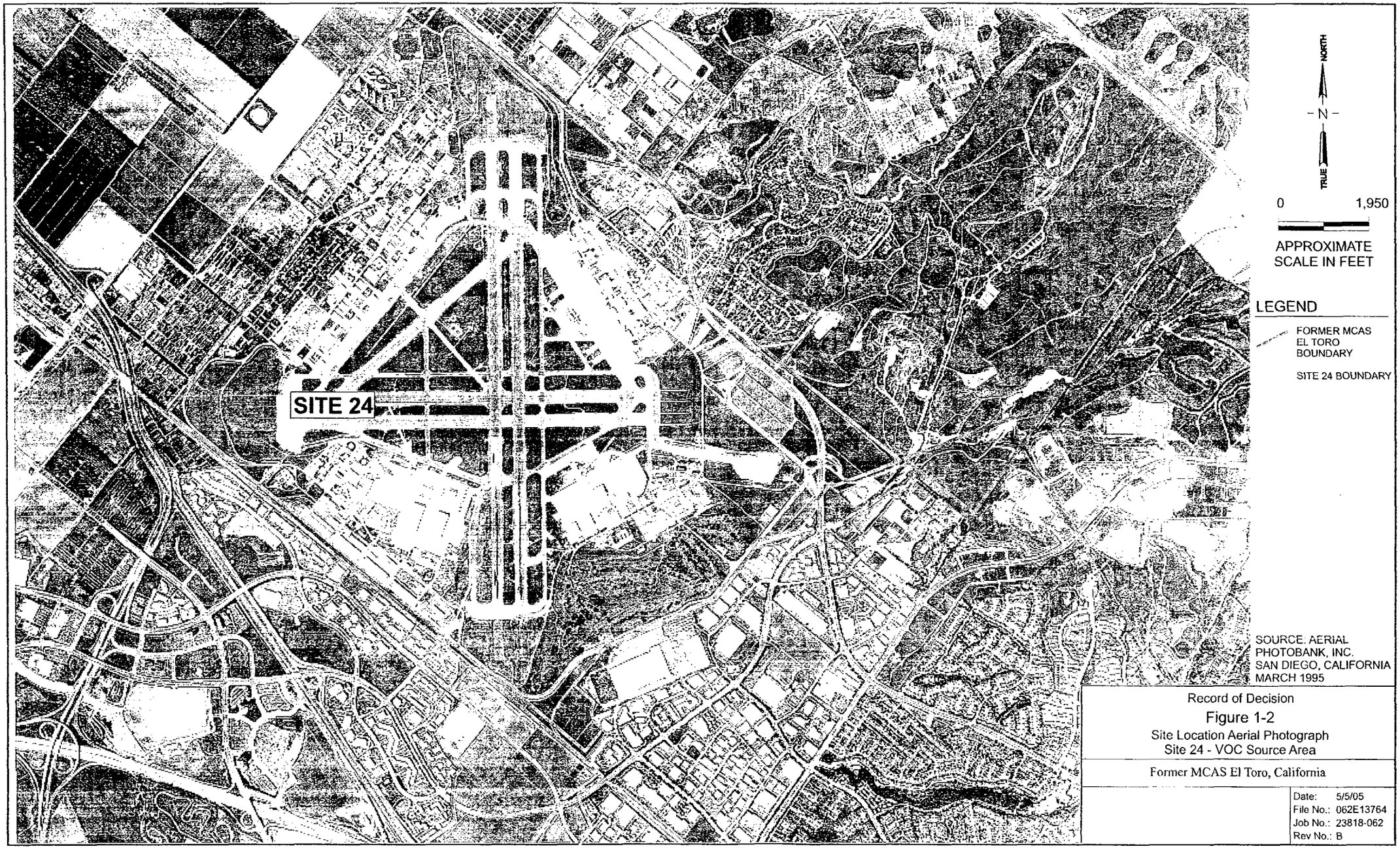
Record of Decision

Figure 1-1

Former MCAS El Toro Station Vicinity Map

Former MCAS El Toro, California

Date: 5/18/05
File No.: 062R13762
Job No.: 23818-062
Rev No.: B



Record of Decision

Figure 1-2

Site Location Aerial Photograph
Site 24 - VOC Source Area

Former MCAS El Toro, California

Date: 5/5/05
File No.: 062E13764
Job No.: 23818-062
Rev No.: B

1.4 SITE DESCRIPTION

Former MCAS El Toro was commissioned in 1943 as a Marine Corps pilot fleet operation training facility. In 1950, the Station was selected for development as a master jet station and a permanent center for Marine Corps aviation on the West Coast. The Station's mission has involved the operation and maintenance of military aircraft and ground-support equipment. Much of the industrial activity supporting this mission took place in the southwest quadrant of the Station, where Site 24 is located (Figure 1-2).

To support the Station's mission, facility operations were expanded over the years to include runways, aircraft maintenance and training facilities, housing, shopping facilities, and other support facilities. During operations, Former MCAS El Toro occupied approximately 4,738 acres of land, including 580 acres leased for commercial farming (DON 1999).

Former MCAS El Toro ceased operations 02 July 1999. The Marine Corps' mission at the Station was incorporated primarily into MCAS Miramar operations in San Diego, California.

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Section 2
SITE HISTORY AND ENFORCEMENT ACTIVITIES

Past operations and practices at Former MCAS El Toro have contributed to VOC contamination in soil and groundwater. Industrial activities at Site 24, such as dust suppression with waste liquids, paint stripping, degreasing, vehicle and aircraft washing, and waste disposal practices involved the use of solvents containing VOCs such as trichloroethene (TCE) and tetrachloroethene (PCE). Waste solvents may have reached the surface or subsurface through leakage, runoff, storm drain flow, or direct application to the soil. The precise origin, nature, and use of TCE released at the site and the circumstances and quantities of individual releases are not documented. TCE usage at Former MCAS El Toro is believed to have been discontinued in the mid-1970s.

Environmental remediation activities at Former MCAS El Toro are performed under the IRP. The IRP was developed in 1980 by the United States Department of Defense (DoD) to comply with federal guidelines to manage and control contamination from past hazardous waste disposal actions (DON 1997).

In June 1988, U.S. EPA recommended adding Former MCAS El Toro to the NPL of the Superfund Program because of VOC contamination in groundwater at the Station boundary and in agricultural wells west of the Station. Former MCAS El Toro was added to the NPL on 15 February 1990. In October 1990, the Marine Corps/DON signed an FFA with U.S. EPA Region 9, California Department of Health Services (now referred to as the DTSC), and Santa Ana RWQCB (FFA 1990). The FFA is a cooperative agreement that:

- assures environmental impacts are investigated and appropriate response actions are taken to protect human health and the environment;
- establishes a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions;
- facilitates cooperation, exchange of information, and participation of the parties; and
- assures adequate assessment, prompt notification, and coordination between federal and state agencies.

The Base Realignment and Closure (BRAC) Cleanup Team (BCT) is responsible for implementing the FFA. The BCT consists of representatives from the DON Naval Facilities Engineering Command (NAVFAC) Southwest, U.S. EPA, DTSC, and Santa Ana RWQCB. The team was established to manage and coordinate environmental restoration and compliance programs related to the operational closure of Former MCAS El Toro by 1999.

BCT's vision is to expedite restoration and reuse of Former MCAS El Toro. BCT's mission is "fast-track remediation of Former MCAS El Toro, to promote reuse and protect human health and the environment, by working cooperatively with the community and the stakeholders."

In March 1993, Former MCAS El Toro was placed on the BRAC III list of military facilities considered for closure. Under the terms of the FFA, Station closure would not affect the DON's obligation to investigate site contamination or to comply with the other requirements of the FFA (FFA 1990, Section 37, Base Closure).

The discussion of site history, investigations, and enforcement activities presented below includes descriptions of stationwide investigations, which may or may not be specifically relevant to Site 24, but are included to give the reader a broader understanding of the investigations conducted and results obtained on the background of the Station and in the vicinity of the site.

2.1 INITIAL INVESTIGATIONS

The first indication of contamination in the vicinity of Former MCAS El Toro was noted during routine water-quality monitoring in 1985, when the Orange County Water District (OCWD) discovered TCE in groundwater at an irrigation well located approximately 3,000 feet downgradient of the Station.

In 1985, the DON began an initial assessment study (IAS) to locate potentially contaminated sites on the Station. This study was conducted for NAVFAC under the Navy Assessment and Control of Installation Pollutants Program, which was the DON's version of the DoD IRP at that time. The IAS Report identified 17 sites as potential sources of contamination (Brown and Caldwell 1986). These sites were identified based on the results of record searches and employee interviews. The report recommended sampling locations and analytical parameters to confirm or negate suspected contamination at the sites.

In 1987, the Marine Corps contracted for a review of the IAS Report to produce a Site Inspection Plan of Action (SIPOA) (JMM 1988). The SIPOA, released in August 1988, recommended 19 sites for study and amended the site sampling plans proposed in the IAS Report. This SIPOA Report was the basis for a sampling and analysis plan for the remedial investigation (RI)/feasibility study (FS) sites.

In July 1987, while the SIPOA study was under way, Santa Ana RWQCB issued a Cleanup and Abatement Order to the Marine Corps requiring the Station to initiate a perimeter VOC groundwater investigation and submit a draft report. Because the investigation revealed VOCs in the shallow groundwater unit near the Station boundary, an interim groundwater pump and treat system was installed at this boundary. Between June 1989 and September 1993, the system pumped and treated groundwater from three extraction wells at approximately 30 gallons per minute. Over the life of the system, reported concentrations of TCE in the influent were about 10 to 160 micrograms per liter (µg/L) and reported concentrations of PCE were 25 to 100 µg/L. The extracted groundwater was treated with a granular activated carbon treatment system and used to irrigate the Station golf course. On 13 April 1993, the Santa Ana RWQCB rescinded the Cleanup and Abatement Order, because the required actions were complete and because the DON had entered into an FFA to investigate and remediate environmental impacts associated with past and present activities at Former MCAS El Toro. In September 1993, the pump and treat system was shut down (JEG 1996a).

2.2 PHASE I AND PHASE II REMEDIAL INVESTIGATIONS

In December 1989, the DON began preparing a Phase I RI work plan and associated documents for Former MCAS El Toro. The DON reviewed available reports and other documents pertinent to past disposal practices at the Station and concluded that 22 IRP sites should be investigated (JEG 1993a). These sites were grouped into three OUs. OU-1 addressed the regional VOC groundwater plume at Site 18 and throughout MCAS El Toro, including the area later defined as Site 24. OU-2 originally included four landfill sites (Sites 2, 3, 5, and 17) (OU-2A Site 24 was added later) and Site 10, the Petroleum Disposal Area (this site was later moved to OU-3). The remaining 16 sites (Sites 1, 4, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 19, 20, 21, and 22), grouped together as OU-3, were potential sources for a variety of contaminants. The principal objectives of the Phase I RI were to evaluate the source(s) of contamination in regional groundwater west of the Station and to determine whether contamination existed and, if so, whether contamination was affecting the environment at sites in OU-2 and OU-3.

The results of the Phase I RI were documented in a draft Technical Memorandum issued in May 1993 (JEG 1993a), a draft RI Report for OU-1 issued in July 1994 (JEG 1994a), a final Soil Gas Survey Technical Memorandum issued in October 1994 (JEG 1994b), and a draft final Interim RI/FS Report for OU-1 issued in August 1996 (JEG 1996a–h). During the Phase I RI, the source of contamination for regional groundwater was found to be in the southwest quadrant of the Station, but no specific source was identified; it was later determined during the Phase II RI that Site 24 was the source of the regional groundwater contamination. Sufficient information was obtained to warrant conducting a preliminary risk assessment for both groundwater and soil contamination. Results of the Phase I RI provided the primary data for the Phase II RI/FS and allowed further investigations of the VOC plume and source area to focus on VOCs, which were demonstrated to be the chemicals of concern (COCs) at these areas.

Issued in July 1995, the final Work Plan for the Phase II RI/FS presented an approach to conduct the Phase II RI at 24 sites, including the newly identified Sites 24 and 25 (Major Drainages) (BNI 1995). For Site 24, the Phase II Work Plan objectives were to determine whether VOC-contaminated soil at the site was an active source of the regional VOC groundwater plume, assess potential risks to human health and the environment, and characterize the site to evaluate potential response actions. The Phase II RI, conducted in 1995 and 1996, demonstrated that although negligible risks were associated with exposure to vadose zone soil (dermal contact, inhalation, and injection) at Site 24, vadose zone soil was the source of the regional VOC contamination to groundwater and that human-health risk from exposure to the groundwater exceeded U.S. EPA guidelines (BNI 1997a).

Concurrent with the Phase II RI, the DON performed a stationwide evaluation of background concentrations of metals in soils and reference levels for pesticides and herbicides in soils (BNI 1996a). This enabled site-specific analytical results from soil sampling to be compared with background and reference levels to identify potential releases.

2.3 GROUNDWATER MONITORING

Delineation of the nature and extent of groundwater contamination at Former MCAS El Toro was originally based on two rounds (Round 1 and 2) of groundwater data collected as part of the Phase I RI (September 1992 to February 1993 and June 1993 to December 1993, respectively), as well as off-Station data collected by OCWD. These early groundwater samples were analyzed for a large list of analytes, including VOCs, semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), herbicides, total fuel hydrocarbons, total recoverable petroleum hydrocarbons, metals, cyanide, general chemistry parameters, gross alpha/gross beta, and dioxins/furans (JEG 1995).

Routine on-Station groundwater monitoring was suspended during the Phase II RI but was resumed and continued in 1996 and 1997 (Rounds 3 through 7) in accordance with the initial RI/FS Groundwater Monitoring Plan developed in 1995 (JEG 1995). The plan was modified as required to reflect additions of new wells, deletions of wells where contaminants had not been reported, and evaluation of the information gathered.

In 1999, after a total of seven rounds of groundwater monitoring had been conducted, the DON prepared a comprehensive CERCLA Groundwater Monitoring Plan (BNI 1999a). This plan summarized the results of sampling to date; analyzed the frequency of detection and distribution of VOCs, SVOCs, pesticides/PCBs, herbicides, radionuclides, and metals in groundwater; and recommended which analytes and wells should be monitored in the future.

The evaluation summarized in the CERCLA Groundwater Monitoring Plan concluded that VOCs were the only category of chemicals to have impacted groundwater at Sites 18 and 24. SVOCs, pesticides/PCBs, and herbicides were eliminated as COCs for the following reasons.

- SVOCs were not consistently reported for every sampling event for any single well. For this reason, the reported SVOC concentrations were interpreted to be isolated occurrences, most likely attributable to sampling and/or analysis errors.
- PCBs were never reported in any groundwater samples.
- All the pesticides and herbicides were interpreted to be isolated occurrences because none of these compounds were consistently reported in every sampling event from a given well.

Radionuclides were recommended for further evaluation. The results of the evaluation of radionuclides and metals are summarized in Section 2.4.

Following issuance of the CERCLA Groundwater Monitoring Plan in June 1999, 11 additional groundwater monitoring rounds (Rounds 11 through 21) have been conducted at Former MCAS El Toro.

2.4 RECENT EVALUATIONS AND ASSESSMENTS

Subsequent to the Phase II RI, three groundwater evaluations were performed: for metals (BNI 1999a), for perchlorate (BNI 1999b, Earth Tech 2001a), and for radionuclides (Earth Tech 2001d). The purpose of these evaluations was to determine whether reported concentrations of these chemicals in groundwater at Former MCAS El Toro reflected ambient conditions or resulted from past Station activities.

The evaluation of metals showed that even though the reported concentrations of some metals at various sites within Former MCAS El Toro exceeded maximum contaminant levels (MCLs), such conditions reflected ambient stationwide variation in groundwater quality conditions and were not the result of site-related contamination (BNI 1999a).

An evaluation of perchlorate was conducted in 1998 and 1999 to determine its distribution at the Station, evaluate probable sources, and assess the need for further evaluation based on reported concentrations. These results, coupled with low concentrations, the lack of increasing concentration trends, and similar findings off-Station, support the premise that with the exception of Sites 1 and 2, there are no other sources of perchlorate at Former MCAS El Toro (Earth Tech 2003d).

From 1998 through 1999, the DON conducted a historical radiological assessment as part of the base closure process (Roy F. Weston, Inc. 2000). The resulting report recommended that a radiological survey be conducted at selected sites and buildings at Former MCAS El Toro. The on-site radiological surveys and sampling were completed in November 2001. Results either have been or are in the process of being summarized in various Radiological Release Reports (Weston 2004a,b,c).

Investigations identified radionuclides in groundwater at Former MCAS El Toro at concentrations exceeding the U.S. EPA MCLs for drinking water (BNI 1998b, Earth Tech 2000a). In response to uncertainties associated with previous results, a Phase II evaluation of radionuclides in groundwater was performed in 2001. Samples were collected from monitoring wells associated with former landfills (Sites 2, 3, 5, and 17), the Explosive Ordnance Disposal Range (Site 1), and the on-Station portion of the VOC plume (Sites 18 and 24). The absence of uranium-236 in groundwater samples confirmed that the uranium in the groundwater at Former MCAS El Toro is of natural origin (Earth Tech 2001d).

No significant VOC detections were identified during extensive soil gas surveys conducted at Building 307 during the RI. However, due to the nature of the historical practices at Building 307 (i.e., dry cleaning using chlorinated solvents), the DON conducted additional sampling for VOCs at Building 307 in September 2001. The additional assessment included 96 soil gas samples, 6 soil samples, and 3 groundwater samples.

A human-health risk evaluation was performed for Sites 16 and 24 to evaluate the potential exposure to indoor air vapors that could accumulate in buildings constructed at these sites under residential and industrial worker land-use scenarios (BEI 2004). Measured soil gas concentrations were used to calculate indoor air concentrations. On the basis of this evaluation, Sites 16 and 24 do not pose unacceptable risks to human

health via an indoor air inhalation exposure pathway, because risks are acceptable or may be acceptable depending on site-specific and other factors considered appropriate for risk point-of-departure analysis, per the NCP. Therefore, no action is required and no restrictions on reuse of these two sites are necessary relative to this potential exposure route.

Table 2-1 summarizes the enforcement activities and environmental investigations that have occurred at Former MCAS El Toro.

2.5 FEASIBILITY STUDIES FOR SITE 24

The following remedial action objectives (RAOs) for Sites 18 and 24 were developed during the RI:

- Site 18 groundwater
  - Reduce concentrations of VOCs in the area of concern in the shallow groundwater unit and in the principal aquifer downgradient of the source areas to federal or state cleanup levels.
  - Contain migration of VOCs above cleanup levels in the principal aquifer.
  - Prevent domestic use of groundwater containing VOCs at concentrations above cleanup levels.
- Site 24 groundwater
  - Reduce concentrations of VOCs in the Site 24 shallow groundwater unit to federal or state cleanup levels.
  - Prevent domestic use of groundwater containing VOCs at concentrations above cleanup levels.
  - Prevent VOCs at concentrations above cleanup levels from migrating beyond the shallow groundwater unit.
- Site 24 soil
  - Reduce concentrations of VOCs in the source areas to prevent or minimize further degradation of the shallow groundwater unit above the MCL for drinking water.
  - Continue vadose zone remediation until the average VOC soil gas concentrations are below threshold concentrations (concentrations capable of contaminating groundwater above MCLs).

The FS for Site 18 (JEG 1996b) and FSs for soil and groundwater at Site 24 (BNI 1997b,c) identified and screened numerous technologies to develop remedial alternatives capable of achieving the RAOs. Groundwater extraction and treatment was selected for both sites to permanently remove VOCs from the aquifer. The groundwater alternatives differed in the well locations based on the treatment and discharge options. The Site 24 FS Report for soil presented soil vapor extraction (SVE) as an effective technology to remove VOCs from vadose zone soil and minimize further groundwater contamination.

Table 2-1
Summary of Enforcement Actions and Environmental Investigations at Former MCAS El Toro

Date	Investigation/Activity	Objective	Summary of Findings
1985	IAS (Brown and Caldwell 1986)	Locate potentially contaminated sites using record searches and employee interviews.	Identified 17 sites as potential sources of contamination. Recommended sampling locations and analytical parameters to confirm suspected contamination at the 17 sites.
1986	OCWD groundwater investigation (Herndon and Reilly 1989)	Investigate source of TCE found in irrigation well west of the Station.	After installing a series of monitoring wells and soil vapor probes and reviewing independent investigations, OCWD concluded that Former MCAS El Toro was the source of TCE contamination reported in groundwater downgradient of the Station.
1988	Site inspection plan of action (JMM 1988)	Review IAS findings.	Recommended that 19 sites be investigated. Amended the site sampling plans proposed in the IAS Report, which included one site (Site 18) intended to address the off-Station groundwater contaminant plume of VOCs.
1988	Perimeter study investigation (JMM 1989)	Address the Santa Ana RWQCB Cleanup and Abatement Order requiring investigation of the source of regional VOC groundwater contamination.	VOCs were reported in shallow groundwater near the southwestern boundary of the Station.
1989	Interim pump and treat system (BNI 1995)	Pump and treat VOC-contaminated groundwater from three extraction wells near the Station boundary.	Groundwater was extracted at a combined rate of 30 gallons per minute from three wells and treated with granular activated carbon. Extracted groundwater had concentrations of TCE and PCE from 10 to 160 and 25 to 100 parts per billion, respectively.
1989	Development of Phase I RI Work Plan and associated documents (JEG 1993c)	Formulate work plan, field sampling plan, and other RI documents to direct the Phase I fieldwork.	The DON concluded that 22 sites would be investigated, and grouped the sites into three OUs.
1990	Superfund NPL (FFA 1990)	Identify sites with imminent risks to the public.	Former MCAS El Toro was added to the NPL for the Superfund Program because of VOC contamination at the Station boundary and in agricultural wells west of the Station boundary.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
1993	Base Closure and Realignment Act (JEG 1994d)	Identify sites for closure.	Former MCAS El Toro was placed on the BRAC III list. Under the terms of the FFA, Station closure would not affect the DON's obligation to conduct the RI/FS and comply with the other requirements of the FFA.
1993	Phase I RI (JEG 1993a)	Make an initial determination regarding the existence and risks of contamination at sites in OU-1, OU-2, and OU-3.	Various contaminants in the groundwater, soil, surface water, and sediment were reported at Former MCAS El Toro. Soil and sediment contaminants were primarily SVOCs, petroleum hydrocarbons, pesticides, herbicides, and PCBs. The Phase I RI concluded that the source of contamination for regional groundwater was the southwest quadrant of the Station, but it did not indicate specific sources. A preliminary risk assessment was conducted for contaminants in both groundwater and soil at the sites.
1993	RCRA facility assessment (JEG 1993b)	Evaluate whether an additional 140 sites would require further investigation under the Phase II RI/FS Program.	On the basis of the RCRA facility assessment results, further action was recommended for 25 SWMUs/AOCs. This action included additional subsurface investigation or other activities such as inspection of underground storage tanks, repair of cracks in concrete-paved areas, and excavation of contaminated soil. Of these 25 SWMUs/AOCs, further action was recommended for 2 sites under the Phase II RI/FS Program. Site 23 was investigated, and no further action was recommended.
1994	Phase I soil gas survey for Sites 24 and 25 (JEG 1994b)	Identify potential VOC sources at Sites 24 and 25.	The soil gas survey investigated soil conditions (generally 12 to 20 feet bgs). Elevated concentrations of VOCs were reported beneath the aircraft maintenance hangars (Buildings 296 and 297). TCE was the compound most frequently reported. Other VOCs reported included PCE, 1,1-dichloroethene, Freon 113, carbon tetrachloride, and chloroform.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
1994	Interviews with active and retired personnel (JEG 1994c)	Supplement and confirm information from past investigations and interviews, obtain a better understanding of current and historical operations, and identify new areas of potential environmental concern.	The interview panel provided information about types of operations that occurred on-Station and types of chemicals used in these operations.
1995	Development of final Work Plan for Phase II RI/FS and associated documents (BNI 1995)	Present an approach to conduct the Phase II RI at 24 sites using the U.S. EPA DQO process. Establish background concentrations of metals in soils. Establish a process to collect sufficient information to support decisions on risk management.	Established a DQO process for conducting an RI/FS. Two new sites, Sites 24 and 25, were established for investigation in Phase II.
1996	Evaluation of background concentrations and reference levels in soil (BNI 1996a)	Calculate background concentrations for metals in soil and reference levels for herbicides and pesticides in soil.	Background concentrations for metals and reference levels for herbicides were developed for comparison with site-specific analytical results in the RI to identify potential releases.
1996	Interim-action RI/FS for groundwater contamination designated as OU-1 (JEG 1996a,b,c)	Characterize groundwater contamination and evaluate potential actions to remediate VOC-contaminated groundwater in the principal aquifer.	A range of remedial alternatives was prepared. In June 2002, extraction and aboveground treatment was selected as the remedy for groundwater.
1996	RI for vadose zone and groundwater contamination at Site 24 (BNI 1997a)	Determine the nature and extent of VOC contamination at Site 24 and evaluate the human-health risk due to this contamination.	Soil and groundwater were investigated. The RI linked the groundwater hot spot identified during the Phase II RI with high concentrations of TCE in the vadose zone beneath Buildings 296 and 297.
1996	FS for vadose zone contamination at Site 24 (BNI 1997c)	Evaluate potential actions to remediate the VOC-contaminated soils at Site 24.	SVE is presented as the presumptive remedy most appropriate for remediation of contaminated soils.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
1997	RI for OU-3A (including OU-3B Site 16) and Site 25 (BNI 1997e)	Determine the nature and extent of contamination at Sites 4, 6, 8, 9, 10, 11, 12, 13, 15, 16, 19, 20, 21, 22, and 25 and evaluate the human-health risk due to this contamination.	Investigations revealed that contamination at Sites 4, 6, 9, 10, 13, 15, 19, 20, 21, and 22 is limited to shallow soils. Contamination at Site 25 is limited to sediment and surface water. In all cases, risks to human health are within the range generally considered allowable by U.S. EPA. A recommendation for no action was made to the BCT and was approved. An FS was recommended for OU-3B Site 16 and portions of Sites 8, 11, and 12.
1997	RIs for landfill sites (BNI 1996b; 1997f,g,h)	Determine the nature and extent of contamination at Sites 2, 3, 5, and 17 and evaluate the human-health risk due to this contamination.	Air, soil, and groundwater were investigated. Risks at each site are driven by contamination in soil. At Site 2, VOCs are present in groundwater with concentrations above MCLs. Landfill gas controls are not necessary, and no principal threat wastes were found in soil gas.
1997	FSs for landfill sites (BNI 1997i,j,k,l)	Evaluate potential actions to remediate the landfills and allow site closure.	Capping, institutional controls, and monitoring are presented as the presumptive remedies most appropriate for remediating the landfills.
1997	FS for groundwater at Site 24 (BNI 1997b)	Evaluate potential actions to remediate VOC-contaminated groundwater at Site 24.	A range of remedial alternatives has been prepared. Extraction and above-ground treatment was selected as the remedy for groundwater in June 2002.
1997	Interim ROD for Site 24 vadose zone (SWDIV 1997b)	Select an interim remedial alternative for soil at Site 24.	SVE was selected as the remedial alternative for soil at Site 24.
1997	ROD for OU-2A Site 25 and OU-3A no action sites (SWDIV 1997a)	Select a remedial alternative for Site 25 and selected OU-3A sites.	No action was selected for Sites 4, 6, 9, 10, 13, 15, 19, 20, 21, 22, and 25.
1998	FS for OU-3A Sites 8, 11, and 12 (BNI 1998c)	Evaluate potential actions to remediate contaminated soil.	Excavation and removal are presented as the actions most appropriate for remediating contaminated soil at portions of Sites 8, 11, and 12. Other portions of these sites do not require further action.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
1998	Evaluation of metals in groundwater (BNI 1998d)	Evaluate whether reported concentrations of metals in groundwater reflect ambient conditions or are the result of anthropogenic sources associated with historical Station operations.	Although concentrations of some metals at various sites at Former MCAS El Toro exceed MCLs, such conditions are characteristic of basinwide groundwater quality conditions and are not indicative of site-related contamination.
1998–1999	Evaluation of perchlorate in groundwater (BNI 1999b)	Evaluate whether reported concentrations of perchlorate in groundwater reflect ambient conditions or are the result of past Station operations.	Based on results from the evaluation, further monitoring was recommended at Site 1; landfill Sites 2, 3, 5, and 17; and other wells where perchlorate was reported.
1999	Continuation of RI for OU-3B Sites 7 and 14 (BNI 2000a)	Determine the nature and extent of contamination at Sites 7 and 14 and evaluate the human-health risk due to this contamination.	Investigations revealed that contamination at Sites 7 and 14 is limited to shallow soils. Human-health risks are within the range considered generally acceptable by U.S. EPA. A recommendation for no action was made to the BCT.
1999	ROD for Site 11 (SWDIV 1999)	Select an alternative for remediating contaminated soil.	Excavation and removal were selected to remediate soil at Site 11.
1999	Soil gas survey at Site 16 (BEI 2002)	Determine nature and extent of VOCs in soil gas.	Concentrations of total VOCs ranged from 828 to less than 1 µg/L. The highest concentrations of TCE were beneath the main pit. These concentrations increased with depth, with the highest concentrations reported at 150 feet bgs.
1999	Verification of perchlorate (Earth Tech 2001a)	Verify the presence of perchlorate in soil and groundwater at Site 1.	Investigation results confirmed the presence of perchlorate above the state PAL (in effect in 1999) in one well (01-MW201) and concluded that perchlorate in groundwater was probably localized near this well. All detected concentrations of perchlorate in the soil were below the residential preliminary remediation goal.
1999	Phase I radionuclides evaluation at former landfill sites and the EOD Range (Earth Tech 2000a)	Evaluate uranium isotopes in groundwater beneath landfill sites and Site 1.	Low radionuclide concentrations were reported in samples from Site 1. Further evaluation using higher resolution methodologies was recommended to confirm the origin of detected radionuclides.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
2000	Verification of VOCs in groundwater (Earth Tech 2000b)	Verify presence of VOCs in groundwater beneath Site 2.	The verification of VOCs in groundwater investigation confirmed localized concentrations of TCE and PCE in excess of the MCLs beneath Areas C1 and C2. However, the up-gradient lateral extent of TCE and PCE was only partially defined. The investigation yielded inadequate evidence for anaerobic biodegradation of chlorinated solvents. Further, perchlorate was not detected.
2000	Draft FS for OU-3B Site 16 (BNI 2000b)	Develop and evaluate remedial alternatives for soil and groundwater.	Eleven alternatives, including no action, were developed. MPE was the main component of each active alternative.
2000	Historical radiological assessment (Earth Tech 2000a)	Evaluate historical use, storage, and disposal of radiological materials and recommend follow-on investigations of potentially impacted areas.	The final Historical Radiological Assessment Report, dated May 2000, identified candidate sites for radiological surveys on the basis of historical information.
2001	MPE pilot test for OU-3B Site 16 (BNI 2002)	Evaluate the effectiveness of vacuum-enhanced extraction for remediating contaminated soil and groundwater.	The MPE pilot test was conducted from 17 October 2000 through 11 April 2001. Rebound testing performed in April 2001 and vadose zone confirmation sampling conducted in January 2002 showed that concentrations of VOCs in soil had been reduced to a level that would no longer impact groundwater above the MCLs. The pilot test had minimal impact on VOCs in groundwater.
2001	ROD for OU-3B Sites 7 and 14 (SWDIV 2001)	Select remedial alternative for Sites 7 and 14.	No action was selected for Sites 7 and 14.
2001	Preliminary assessment of VOCs at Building 307 (Earth Tech 2001c)	Identify and characterize the possible presence of VOCs in soil gas, soil, and groundwater as a result of laundry and dry cleaning operations at Building 307.	The preliminary assessment confirmed that there had not been a significant release to either the environment at Building 307 or along the sewer line segment from Building 307 to the former sewage disposal plant due to past dry cleaning operations. These results did not change previous conclusions regarding VOC contamination at Site 24 nor change the soil remedy already in place at the site.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
2001	EBS, IRP Site 1 (Earth Tech 2001b)	Update the stationwide EBS and the environmental condition of the Site 1 property, and provide information to facilitate the preparation of an environmental summary document to enable the transfer of Site 1 to another federal agency.	Site 1 can be transferred to another federal agency for like use after completion of the requisite documentation in accordance with DON protocol.
2001	Phase II stationwide evaluation of radionuclides (Earth Tech 2001d)	Confirm whether radionuclides detected in groundwater at MCAS El Toro are due to anthropogenic or naturally occurring sources.	Concluded that origin of radionuclides reported in groundwater is natural.
2000–2001	Radionuclide investigation of groundwater (Earth Tech 2000a)	Evaluate whether reported levels of radioactivity in groundwater reflect ambient conditions or are the result of past Station operations.	Laboratory analysis of radionuclide concentrations has shown that the reported levels of radionuclides are consistent with background. Therefore, radionuclides are not metals of concern in groundwater.
2001–2002	Radiological survey (Weston 2004a,b,c)	Evaluate selected sites and buildings for radiological materials or contamination.	The radiological survey was conducted from June through November 2001. It was concluded that there is a low potential for radiologically contaminated areas at Former MCAS El Toro. However, the area near Buildings 295, 296, and 297 (aircraft hangars) was investigated along with many other areas at the Station. The investigations either have been completed or are in the process of being documented in a series of radiological release reports.
2002	ROD for OU-1 Site 18 and OU-2A Site 24 (SWDIV 2002)	Select a remedial alternative for groundwater at Sites 18 and 24.	Extraction and aboveground treatment was the selected alternative for remediation of groundwater. Treatment will occur at the Irvine Desalter Project Treatment Plant.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
2002	Focused Feasibility Study for OU-3B Site 16 (BEI 2002)	Evaluate potential actions for contaminated soil and groundwater.	Groundwater alternatives included no action; MNA and institutional controls; and downgradient extraction and hydraulic containment, monitoring, and institutional controls. Potential remedies also included monitoring to assure that vadose zone concentrations of VOCs were not increasing. This was used to verify the effectiveness of the MPE pilot test in removing VOCs from soil. Soil grading was also proposed to reduce or prevent infiltration.
2003	ROD for OU-3 Site 16 (SWDIV 2003)	Select a remedial alternative for groundwater at Site 16.	MNA with institutional controls was the selected alternative for remediation of groundwater at Site 16.
2003	ESD, Site 11 (DON 2003)	Present information that describes and justifies modifications to selected remedy documented in the ROD for Site 11.	The ESD presented updated cleanup goals for the remedial action along with the rationale for the update.
2003	Reevaluation of Risk for Sites 8, 11, and 12 (Earth Tech 2003a)	Update the risk assessment performed during Phase II RI by including the investigation data collected subsequent to the Phase II RI and using more current exposure factors and toxicity indices.	In general, the updated risk assessment indicated lower estimated risks as compared to the Phase II RI risk assessment. The report presented revised risk management considerations and response action recommendations for different units of Sites 8, 11, and 12.
2003	Draft Screening Ecological Risk Assessment – Removal Site Evaluation, Anomaly Area 3 (Earth Tech 2003b)	Evaluate ecological risk at the site.	The document provides the procedures and methodologies used to evaluate the ecological risk at the site. The SRA concluded that the risk assessment needs to proceed to baseline risk assessment.
2003	EBS (Earth Tech 2003d)	Document environmental condition of property at Former MCAS El Toro and adjacent property.	The document provides a summary of the environmental condition of the Former MCAS El Toro property.
2003	Draft Expanded Site Inspection Report – Anomaly Area 3 (Earth Tech 2003e)	Document the data collection procedures and analytical results of the RSE field investigation. Provide an assessment of the nature and extent of any contamination.	Provided a summary of investigation results. Risks to human health were within the risk management range. Debris placed at this site was predominantly construction related.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
2003	Groundwater modeling for Operation Unit 1 and Operation Unit 2A (Earth Tech 2003f)	Update previous modeling results to incorporate new findings and evaluate groundwater extraction strategies for the selected response action.	Concluded that aggressive extraction at the source area, Site 24, coupled with extraction at the Station boundary would be the most effective restoration strategy for Site 24. Confirmed the extraction strategy for the principal aquifer would achieve the remedial action objectives.
2004	Technical Memorandum for Indoor Air Risk Evaluation, Sites 16 and 24 (BEI 2004)	Evaluate risk from indoor air under residential and industrial land-use scenarios.	Concluded that Sites 16 and 24 do not pose unacceptable risks to human health via an indoor air inhalation exposure pathway, because risks are acceptable or may be acceptable depending on site-specific and other factors considered appropriate for risk point-of-departure analysis, per the NCP. Therefore, no action is required and no restrictions on reuse of these two sites are necessary relative to this potential exposure route.
2004	Finding of Suitability to Transfer (Earth Tech 2004a)	Document environmentally related findings that support the conclusion that real property is suitable for transfer by deed.	Any necessary remedial and corrective action has been taken and the requirements of CERCLA Section 120(h) have been met for the transfer parcels; therefore, those parcels are suitable for transfer by deed for residential purposes, subject to notifications and restrictions set forth in the document.
2004	Finding of Suitability to Lease (Earth Tech 2004b)	Document environmentally related findings that support the conclusion that real property is suitable for lease subject to conditions, notifications, and restrictions.	The properties listed in the document are suitable for lease, subject to conditions, notifications, and restrictions set forth in the document.
2004	Draft Final Remedial Design, IRP Sites 2 and 17 (Earth Tech 2004c)	Provide design for remedial action at IRP landfill Sites 2 and 17.	Provided rationale and supporting engineering documentation for the remedial design package, including project drawings and specifications.
2004	Predesign investigation for the shallow groundwater unit at IRP Site 24 (Earth Tech 2004d)	Confirm the distribution of VOCs within groundwater at Site 24 and quantify the sustainable extraction rates.	Confirmed VOC distribution was consistent with previous assessments and documented that sustainable extraction rates were within the range used in groundwater modeling.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
2004	Aquifer Test, IRP Site 2 (Earth Tech 2004e)	Evaluate aquifer properties, extraction rates, and capture zones during sustained pumping using multiple wells. Further assess the potential for natural attenuation and determine distribution of VOCs and perchlorate in groundwater at Site 2.	Obtained better understanding of site hydrogeologic conditions. VOC and perchlorate plumes were adequately delineated.
2005	Design submittal for the shallow groundwater unit at IRP Site 24 (Weston 2005)	Develop and prepare construction drawing for the implementation of the selected remedy.	Presented detailed plans and specifications for the construction of the shallow groundwater unit remedy.
2005	Soil Sampling and Geophysical Survey at APHO 46 and MSC R2 (Earth Tech 2005a)	Assess impacts and releases resulting from potential disposal activities at APHO 46 and MSC R2.	Risk screening indicated that APHO 46 does not pose unacceptable risk to human health. Therefore, pending regulatory concurrence on recommendation for unrestricted radiological release, no further action was recommended for APHO 46. No evidence of waste placement was found during the geophysical surveys at MSC R2; therefore, no further action was recommended for MSC R2.
2005	Final Technical Memorandum, IRP Sites 3 and 5 (Earth Tech 2005b)	Present the results of the supplemental investigation to be used in support of the remedial design.	Refined estimates of the horizontal/ vertical extent and volume of wastes at Sites 3 and 5, conducted soil gas investigations that determined that low levels of landfill gases are present at both sites, and recommended FS amendment to reevaluate components of the previously selected remedy.
2005	Remedial Design / Remedial Action Work Plan for Site 11 (Earth Tech 2005c)	Present remedial design and implementation plan for remedial action at Site 11.	Remedial design and remedial construction drawings were prepared to implement the selected remedial action documented in the ROD as amended by the ESD.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
2005	Draft FS Addendum for OU-2B Site 2 (Earth Tech 2005d)	Develop and evaluate remedial alternatives for groundwater.	Six alternatives were developed and evaluated. They are no action, MNA and ICs, active hot spot remediation with MNA and ICs, active remediation for the entire plume with *in situ* thermal treatment using electrical resistance heating, pump and treat using GAC with ICs, and groundwater containment and restoration with ICs.
2005	Draft Landfill Test Fill Construction and Borrow Source Evaluation Report, IRP Sites 2 and 17 (Earth Tech 2005e)	Evaluate test fill construction methods and borrow source suitability for Sites 2 and 17 landfill construction.	Established procedures to be followed by the remedial action contractor to achieve soil performance requirements during landfill cover construction. Determined that adequate quantities of acceptable materials for landfill cap construction are available.
2005	Draft RI for Site 1 (Earth Tech 2005f)	Determine the nature and extent of contamination at Site 1 and evaluate the human-health and ecological risk due to this contamination.	Soil, sediment, surface water, and groundwater were investigated. Human-health and ecological risks at the site are driven by contamination in shallow soil in the central portion of the site. Munitions and explosives of concern risk is elevated in the Northern EOD Range. Although groundwater is not currently used for drinking water purposes, risk assessment indicated that perchlorate drives noncancer risk (HI).
2005	Draft Final FS Addendum, IRP Sites 3 and 5 (Earth Tech 2005g)	Update the FS to reflect the inclusion of landfill gas controls as part of the selected remedy for Sites 3 and 5. Incorporate findings of the predesign investigation.	Reevaluated alternatives and cost estimates to reflect inclusion of landfill gas controls as part of the selected remedy and completion of the predesign investigation.
2005	Draft Final FS Addendum for Site 8 (Earth Tech 2005h)	Develop and evaluate remedial alternatives for radium-226 contaminated soil at Units 1 and 4 of Site 8.	Presented remedial action objectives for soil contaminated with radium-226. Three remedial alternatives, including no action, were developed and analyzed with respect to nine NCP criteria.

(table continues)

Table 2-1 (continued)

Date	Investigation/Activity	Objective	Summary of Findings
2005	Aquifer Characterization and Treatability Testing, IRP Site 1 (ECS 2005)	Characterize the hydraulic conditions that are influencing groundwater flow in the source areas where remediation is most likely to be implemented. Also provide information to assist in making effective decisions regarding the application of *in situ* or *ex situ* treatment technologies at the site.	Data are currently being evaluated.

Acronyms/Abbreviations:
AOC – area of concern
APHO – aerial photograph anomaly
BCT – BRAC Cleanup Team
bgs – below ground surface
BRAC – Base Realignment and Closure
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
DON – Department of the Navy
DQO – data quality objective
EBS – environmental baseline survey
EOD – explosive ordnance disposal
ESD – explanation of significant differences
FFA – Federal Facilities Agreement
FS – feasibility study
GAC – granular activated carbon
HI – hazard index
IAS – initial assessment study
IC – institutional control
IRP – Installation Restoration Program
µg/L – micrograms per liter
MCAS – Marine Corps Air Station
MCL – maximum contaminant level
MNA – monitored natural attenuation
MPE – multiphase extraction
MSC R2 – Miscellaneous Refuse Area 2
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
NPL – National Priorities List
OCWD – Orange County Water District
OU – operable unit
PAL – preliminary action level
PCB – polychlorinated biphenyl
PCE – tetrachloroethene
RCRA – Resource Conservation and Recovery Act
RI – remedial investigation
ROD – record of decision
RSE – removal site evaluation
RWQCB – (California) Regional Water Quality Control Board
SRA – screening (level) risk assessment
SVE – soil vapor extraction
SVOC – semivolatile organic compound

Table 2-1 (continued)

Acronyms/Abbreviations: (continued)
SWMU – solid waste management unit
TCE – trichloroethene
U.S. EPA – United States Environmental Protection Agency
VOC – volatile organic compound

2.6 PILOT TESTING AT SITE 24

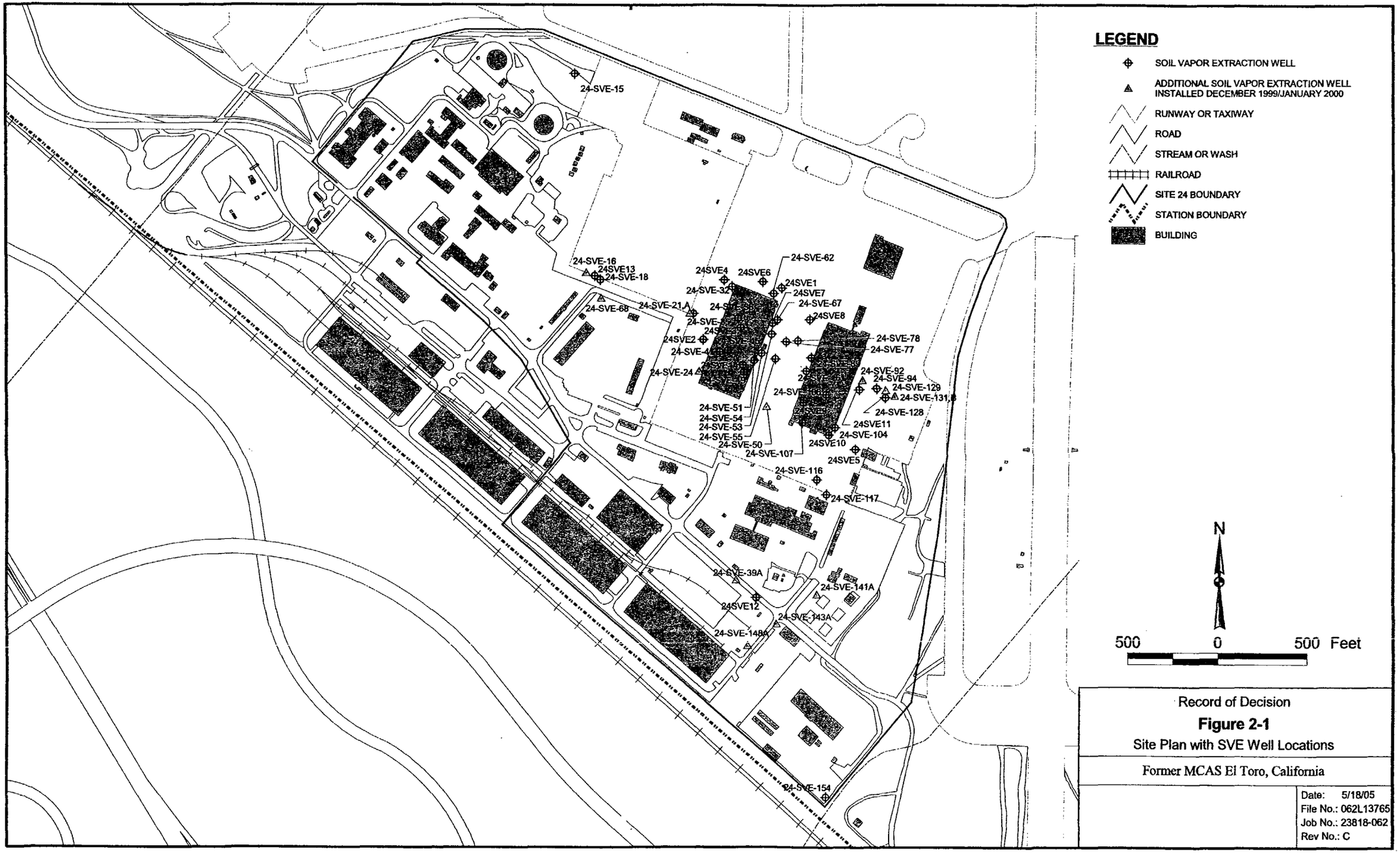
Pilot-test data from small-scale groundwater extraction (BNI 1997b) and SVE tests (BNI 1997d) were used to support FS evaluations. The pilot tests provided site-specific information to assess the effectiveness of the most promising remediation technologies and were used to support the SVE engineering design (BNI 1998a). Investigations performed during groundwater pilot testing helped demonstrate the migration pathway of VOCs from the shallow groundwater unit to the principal aquifer.

2.7 REMEDIAL ACTION FOR VADOSE ZONE SOILS AT SITE 24

As described in the Interim ROD (SWDIV 1997b) for vadose zone soils at Site 24, SVE was performed in three designated depth zones: the shallow zone (0 to 40 feet below ground surface [bgs]), the intermediate zone (40 to 70 feet bgs), and the deep zone (70 to 115 feet bgs). To accomplish extraction in these depth zones, the SVE wells were screened at depths that generally corresponded to the three zones. Figure 2-1 indicates the location of the SVE wells at Site 24. Vapor extraction was performed using a central SVE system for wells located near the former hangars and with portable treatment systems for wells located farther from the buildings.

Expansion of the pilot scale SVE system was conducted in April/May 1999 at Site 24 in accordance with the Interim ROD. Phase I operation of the system was initiated in May 1999. At the completion of Phase I operations, the concentrations of vapors extracted from the SVE wells were reduced below soil gas threshold concentrations developed to be protective of groundwater. Plume coverage was evaluated and data gaps were identified. Consequently, 14 additional extraction wells were installed in December 1999 and January 2000 as an extension to Phase I operations to provide monitoring points within the plume and confirm plume boundaries. None of the baseline samples from the new wells exceeded the soil gas threshold concentrations, indicating confirmation of plume boundaries. A PneuLog evaluation of the impact of groundwater on ten SVE wells was conducted to plot a depth-specific profile of cumulative flow and concentration. The results depict an inverse relationship between concentration in soil gas and distance from groundwater. Concentrations increased dramatically near groundwater and were relatively low in the upper screen interval farther from groundwater. Maximum concentrations were reported in samples collected from the deepest portion of the screen in all wells. The concentration versus depth profiles indicate volatilization of TCE from the groundwater and subsequent capture by the SVE wells (Earth Tech 2002).

At the time that the SVE system was shut down, TCE and PCE concentrations in the vadose zone source area were reduced to below the final soil gas threshold concentrations set forth in the Interim ROD, which were reevaluated and agreed to by the FFA signatories in the System Evaluation and Optimization Report (SEOR) and the Closure Report (Earth Tech 1999, 2002). Additionally, attainment of closure goals was confirmed by closure sampling conducted 7 months after shutdown. Between the start of pilot scale testing (April 1995) through September 2000, approximately 2,000 pounds of VOCs was extracted and treated at Site 24. Table 2-2 lists the mass of VOCs removed during vadose zone remediation (Earth Tech 2002).



Record of Decision

Figure 2-1

Site Plan with SVE Well Locations

Former MCAS El Toro, California

Date: 5/18/05
File No.: 062L13765
Job No.: 23818-062
Rev No.: C

Table 2-2
Mass of VOCs Removed During Vadose Zone Remediation at Site 24

Remediation Phase	Date	Mass* (pounds)	Remarks
Mass of VOCs removed during pilot scale testing	4/95–5/98	1,439	Mass estimates were based on pilot system flow rates and concentrations (BNI 1998a).
Mass of VOCs removed by portable SVE units	6/98–12/98	74	Mass estimates were based on portable unit flow rates and concentrations (Earth Tech 2002).
Mass of VOCs removed by central treatment system	5/99–9/00	283	Mass estimates were based on treatment system inlet concentrations and flow rates (Earth Tech 2002).
Mass of VOCs removed by portable SVE units	1/99–9/00	193	Mass estimates were based on treatment system inlet concentrations and flow rates (Earth Tech 2002).
	TOTAL	**1,989**	

Note:
* total mass of VOCs extracted is assumed to equal the total mass of primary contaminants (TCE, Freon, 1,1-DCE, and PCE) extracted

Acronyms/Abbreviations:
DCE – dichloroethene
PCE – tetrachloroethene
SVE – soil vapor extraction
TCE – trichloroethene
VOC – volatile organic compound

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Section 3
HIGHLIGHTS OF COMMUNITY PARTICIPATION

The community relations plan developed for Former MCAS El Toro was updated to document current concerns identified during community interviews and provides a detailed description of activities planned to facilitate two-way communication with the community. The plan also includes enhancements for improving communication in response to information received from the community (Brown and Caldwell 2005). The plan was initially prepared in 1991 and was revised in 1993, 1996, and again in 2005 to incorporate the most recent assessment of community issues, concerns, and informational needs about the ongoing environmental investigation and remediation program at Former MCAS El Toro.

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 remediation activities, maintaining an information repository where the public can access technical documents and program information, disseminating information to the local and regional media, and making presentations to local groups.

Community members and local government agencies have also participated in planning for the reuse of Former MCAS El Toro through development of the Community Reuse Plan (P&D Consultants Team 1996).

3.1 RESTORATION ADVISORY BOARD

In 1994, establishment of the Restoration Advisory Board (RAB) gave individuals from local communities a channel for increasingly significant participation in the environmental restoration process. Original membership on the board, which was solicited by the Marine Corps and the DON through paid newspaper notices, exceeded 50 business and homeowners' representatives, locally elected officials and local regulatory agencies, and interested residents.

RAB meetings are held every 2 months and are scheduled in the evenings after normal working hours (6:30 to 9:00 p.m.) at the Irvine City Hall Conference and Training Center. The meetings are open to the public and include representatives from the Marine Corps and the DON, city and county offices, and regulatory agencies. By sharing information from the regular meetings with the groups they represent, RAB members help increase awareness of the IRP 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 meeting held in September 2005 was the 77th meeting.

Copies of the RAB meeting minutes are available at the Former MCAS El Toro Information Repository, located at the Heritage Park Regional Library in Irvine, California. RAB meeting minutes are also located on the Navy BRAC website: www.navybracpmo.org.

VOC-contaminated groundwater at Sites 18 and 24 and soil at Site 24 have been key topics for presentations and discussions at more than 30 RAB meetings. Early presentations focused on the RI and provided background and educational information to RAB members on the extent of groundwater contamination both off-Station and

on-Station. The OU-1 interim action RI/FS was often the focus of technical presentations, which also provided information on alternatives that would potentially be implemented by the DON alone or as a joint project with local water districts (OCWD/Irvine Ranch Water District). Presentation handouts were provided to RAB members at all meetings.

At regularly scheduled BCT meetings, the regulatory agency representatives discussed technical issues and commented on reports and other documents pertaining to VOC-contaminated soil and groundwater, groundwater monitoring, FFA schedules, and related issues.

3.2 PUBLIC MAILINGS

Public mailings, including information updates, fact sheets, and proposed plans, have been used to broaden the dissemination of information within the local community. The first information update announcing the IRP process at Former MCAS El Toro was delivered in November 1991 to area residents and mailed to city, state, and federal officials; agencies; local groups; and individuals identified in the Community Relations Plan. Subsequent fact sheets were mailed to the community as significant remediation milestones were reached (Table 3-1). These publications included information concerning the status of site investigations, the upcoming remedy selection process, the means of public participation in the investigation and remediation of Former MCAS El Toro, and the availability of the administrative record.

Proposed plans summarize remedial alternatives proposed for a site or group of sites and identify the preferred alternative. A proposed plan is issued to the public prior to the beginning of a public comment period to provide information and solicit input on potential remedial options that underwent detailed evaluation. Once the public comment period closes, the comments are compiled, reviewed by the BCT, and used to refine the remedial action. The final decision and response to comments (known as a "Responsiveness Summary") on the Site 24 no further action Proposed Plan are presented in this ROD.

To reach as many community members as possible, the updates, fact sheets, and proposed plans are mailed to approximately 600 households, businesses, public officials, and agencies. Copies are also made available at the information repository located in the references section at Heritage Park Library and in the administrative record file at Former MCAS El Toro.

Table 3-1
Summary of Former MCAS El Toro Updates, Fact Sheets, and Proposed Plans

Fact Sheet Number	Date	Summary of Contents
—*	11/91	Information Update/IRP Process
—	12/92	Information Update
1	12/93	Phase II RI Results
2	12/93	RAB Formation
3	07/95	Information Update/Tank 398
4	10/95	Information Update, Engineering Evaluation/Cost Analysis
5	11/95	Former MCAS El Toro Building 673-T3 Certification for Closure
6	04/96	Looking Back–Moving Forward Update on IRP Progress
7	12/96	Groundwater Remediation OU-1 and OU-2A
—	04/97	Proposed Plan for Site 24 Vadose Zone
—	06/97	Proposed Plan for No Action Sites
—	05/98	Proposed Plan for Sites 2, 3, 5, and 17
8	02/99	SVE Design Completed, Proceed with Interim Action for Site 24 Vadose Zone
—	05/99	Proposed Plan for OU-3 Sites 8, 11, and 12
—	09/00	Proposed Plan for Sites 7 and 14
—	11/01	Proposed Plan for Groundwater at Sites 18 and 24
—	9/02	Proposed Plan for OU-3B Site 16
—	6/05	Fact Sheet for Site 11 Soil Cleanup
—	6/05	Fact Sheet for Site 24 Groundwater Remedial Design
—	7/05	Proposed Plan for No Further Action for Soil at Site 24 VOC Source Area

Note:
* dash indicates updates or proposed plans, which are not given fact sheet numbers

Acronyms/Abbreviations:
IRP – Installation Restoration Program
MCAS – Marine Corps Air Station
OU – operable unit
RAB – Restoration Advisory Board
RI – remedial investigation
SVE – soil vapor extraction
VOC – volatile organic compound

3.3 COMMUNITY PARTICIPATION FOR SITE 24

The RI Report for Site 24 was issued to the public in March 1997. The FS Reports for Site 24 vadose zone and groundwater were issued in March and December 1997, respectively. The initial Proposed Plan for the Site 24 vadose zone soil issued in April 1997 described the DON's preferred alternative for remediation of VOCs in soil using the presumptive remedy of SVE. The public comment period for this Proposed Plan was held from 30 April to 30 May 1997, and a public meeting was held on 15 May 1997 to inform the community about the Proposed Plan and provide an opportunity for community members to submit comments either orally or in writing directly to Marine Corps and DON representatives. The public meeting was announced in the *Orange County Register* and the *Los Angeles Times* (*Orange County Edition*) in April 1997, approximately 1 week prior to the start of the public comment period.

Public notices also informed the community that other key documents related to Sites 18 and 24, including the Interim-Action RI/FS Report for Site 18, the RI Report for Site 24, the FS Reports for Site 24 vadose zone and groundwater, the Proposed Plan for the Site 24 vadose zone, and the Interim ROD for the Site 24 vadose zone, were made available to the public at the information repository at the Heritage Park Regional Library. The notices of availability of these documents were published in the *Orange County Register* and the *Los Angeles Times (Orange County Edition)* approximately 1 week before the start of the public comment periods. The notices also announced the availability of the complete administrative record file at the SWDIV BRAC office in San Diego and at Former MCAS El Toro.

The Interim ROD for cleanup of Site 24 vadose zone soil using SVE was finalized in September 1997. Public notices also announced the signing of the Interim ROD for Site 24 soil cleanup.

The remedial design and remedial actions for the vadose zone were implemented before the remedial action for groundwater was finalized. In conjunction with the 27 January 1999 RAB meeting, a public briefing formally announced the Marine Corps' intent to proceed with the interim remedial action for soil at Site 24 by the end of March 1999. A fact sheet was distributed to those in attendance at the briefing and mailed to those on the Former MCAS El Toro project mailing list. The SVE system that was used at Norton Air Force Base was brought to Former MCAS El Toro to be used to remediate VOC-contaminated soil at Site 24. A tour of the SVE system at Site 24 was conducted for RAB members and other interested community members on 27 February 1999.

The Proposed Plan for groundwater at Sites 18 and 24 was mailed in November 2001 to recipients on the Former MCAS El Toro project mailing list. This plan described the DON's preferred alternative for groundwater remediation and documented the progress of soil remediation. A public comment period for the Proposed Plan for Sites 18 and 24 groundwater was held from 07 November to 07 December 2001, and a public meeting was held on 13 November 2001. The public meeting was announced in the *Orange County Register* and the *Los Angeles Times (Orange County Edition)* on 06 November 2001 and in the Proposed Plan. At the public meeting, representatives from the DON,

Former MCAS El Toro, and environmental regulatory agencies answered questions about site conditions and the remedial alternatives under consideration, and a court reporter recorded public comments.

3.4 PROPOSED PLAN FOR NO FURTHER ACTION FOR SOIL AT SITE 24 VOC SOURCE AREA

The no further action Proposed Plan for soil at the Site 24 VOC source area was released to the public in July 2005 and was also distributed to recipients on the Former MCAS El Toro project mailing list. This document was made available to the public at the information repository maintained at the Heritage Park Regional Library. The notice of availability for this document was published in the *Orange County Register* and the *Los Angeles Times (Orange County edition)* on 13 July 2005.

The notice also announced the availability of the administrative record file for review. Complete administrative record files are available at NAVFAC Southwest in San Diego and at Former MCAS El Toro. A partial record file is available for review at the information repository. The information repository also contains a complete index of the administrative record file along with information on how to access the complete file.

A public comment period was held from 14 July to 12 August 2005. In addition, a public meeting was held on 27 July 2005. This meeting was announced in the *Orange County Register* and the *Los Angeles Times (Orange County Edition)* on 13 July 2005 and in the Proposed Plan. News media that cover environmental restoration at Former MCAS El Toro were notified about the Proposed Plan for no further action for soil at Site 24 and the public meeting. Reporters were mailed a copy of the Proposed Plan and encouraged to publicize the public meeting. At this meeting, representatives from the DON, Former MCAS El Toro, and environmental regulatory agencies answered general questions about site conditions and the proposed no further action recommendation under consideration. A court reporter recorded the proceedings including public comments from community members. Comment forms were also provided to encourage submittal of written comments after the meeting. A transcript of the meeting is included as Attachment B. A response to the comments received during this period is included in the Responsiveness Summary, which is part of this ROD.

This ROD presents the selected remedial action of no further action for the Site 24 vadose zone soil at Former MCAS El Toro, which was developed in accordance with CERCLA (as amended by SARA) and the NCP. The decision for this site is based on information contained within the administrative record.

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Section 4
SCOPE AND ROLE OF OPERABLE UNIT

Twenty-five IRP sites have been investigated at Former MCAS El Toro. Twenty-four of these sites are grouped into six OUs. Site 23 was evaluated in a Resource Conservation and Recovery Act facility assessment (RFA) under the FFA and, as a result, was eliminated as an environmental concern. OU-1 encompasses Site 18 (Regional VOC Groundwater Plume). OU-2 is subdivided into OU-2A, OU-2B, and OU-2C. OU-3 is subdivided into OU-3A and OU-3B.

OU-2A, which includes Site 24 (VOC Source Area) and Site 25 (Major Drainages), was defined to address the potential sources of regional groundwater contamination. Site 25 was included in OU-2A because it was not known whether the major drainages at Former MCAS El Toro contributed to the regional VOC groundwater contamination. After the Phase II RI showed that Site 25 did not contribute to regional groundwater contamination, the site was recommended for no action and included with several OU-3A sites in a no action ROD that was signed in September 1997 (SWDIV 1997a). The vadose zone soil at OU-2A Site 24 addressed in this ROD is defined as the soil interval from the ground surface to the water table, approximately 85 to 120 feet beneath Site 24. Remediation of groundwater at Site 24 and OU-1 is addressed in a separate final ROD that was signed in June 2002 (SWDIV 2002).

OU-2B encompasses Sites 2 and 17, and OU-2C encompasses Sites 3 and 5 and Anomaly Area 3. Sites 2, 3, 5, and 17 are generally referred to as the landfill sites. Anomaly Area 3 is a former construction debris disposal area and is administratively linked to Site 3 since construction debris from Site 3 was disposed at Anomaly Area 3. Sites 2 and 17 were addressed in an interim ROD that was issued to the public in April 2000 and signed in July 2000 (SWDIV 2000). The ROD was interim because it presented the selected remedial action only for vadose zone soil at Site 2. Remediation of groundwater at Site 2 will be addressed in a final ROD, which will also summarize the results of a radiological survey conducted at Sites 2 and 17 in August through October 2001. Sites 3 and 5 will be addressed in an OU-2C ROD that is expected to be issued to the public in 2006.

OU-3 was defined to address the remaining IRP sites at Former MCAS El Toro. Of the 13 sites in OU-3A, Sites 4, 6, 9, 10, 13, 15, 19, 20, 21, and 22 were investigated, found to present no unacceptable risks to human health or the environment, and recommended for no action. These sites were addressed along with Site 25 in the signed no action ROD (SWDIV 1997a). OU-3A Site 11 was addressed in a ROD that was signed in September 1999 (SWDIV 1999) and in an Explanation of Significant Differences (ESD) that was signed in May 2003. OU-3B Sites 7 and 14 were addressed in a no further action ROD that was signed in June 2001 (SWDIV 2001). OU-3B Site 16 was addressed in a ROD that was signed in July 2003 (SWDIV 2003). The remaining sites at OU-3A (Sites 8 and 12) and OU-3B (Site 1) are currently being evaluated.

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Section 5

SUMMARY OF SITE CHARACTERISTICS

This section describes the regional characteristics of Former MCAS El Toro, provides a brief history of Site 24, and summarizes the nature and extent of contamination reported at the site.

The nature and extent of contamination at Site 24 are primarily based on the Phase I RI (JEG 1993a, 1994a), the Phase I Soil Gas Survey (JEG 1994b), the Phase II RI (BNI 1997a), and the draft final Site Closure Report for Vadose Zone Remediation (Earth Tech 2002). The remedial action described in the Interim ROD was successful in reducing VOC concentrations in soil gas to below remedial goals and attaining the RAOs (Earth Tech 2002).

5.1 REGIONAL CHARACTERISTICS

Former MCAS El Toro is situated on the southeastern edge of the Tustin Plain, a gently sloping surface of alluvial fan deposits derived mainly from the Santa Ana Mountains. The Tustin Plain, bounded on the north and east by the Santa Ana Mountains and on the south by the San Joaquin Hills, is at the southeastern end of the Los Angeles Basin, a large sedimentary basin in the Peninsular Ranges Geologic Province. The ground surface elevation at Former MCAS El Toro ranges from approximately 215 feet above mean sea level (MSL) in the western portion to approximately 800 feet above MSL in the eastern portion. The geology, hydrogeology, surface water hydrology, and climate of Former MCAS El Toro are briefly described below.

5.1.1 Geology and Hydrogeology

The Tustin Plain is a broad basin composed of Quaternary marine and alluvial sediments deposited on Tertiary marine sedimentary bedrock (Fife 1974). The Quaternary deposits are generally less consolidated and more permeable than the bedrock. The Tustin Plain is bounded by bedrock, exposed in the Santa Ana Mountains to the north and east and in the San Joaquin Hills to the south.

The Tertiary bedrock consists of semiconsolidated marine sandstones, siltstones, and conglomerates of the Sespe, Vaqueros, Topanga, Capistrano, Niguel, and Fernando Formations (CDMG 1981). The lower-Pliocene Fernando Formation forms the base of the water-bearing units at Former MCAS El Toro (Herndon and Reilly 1989). The Fernando Formation is interbedded with marine clayey and sandy siltstones of the Capistrano and Niguel Formations west of Former MCAS El Toro (JMM 1988).

Pleistocene sediments predominantly composed of interlayered fine-grained lagoonal and nearshore marine deposits unconformably overlie the Tertiary sedimentary bedrock (Singer 1973). These deeper Quaternary sediments may be equivalent to the lower-Pleistocene San Pedro Formation, which consists of semiconsolidated silts, clays, and sands with interbedded limestone.

Conformably overlying the Pleistocene sediments are Holocene materials consisting of isolated coarse-grained stream channel deposits within fine-grained overbank deposits. These Holocene sediments were deposited as alluvium and range in thickness up to 300 feet (Herndon and Reilly 1989).

Former MCAS El Toro lies within the Irvine Groundwater Management Zone, which has been designated by the Santa Ana RWQCB as a public water supply source (RWQCB 2004). Regional aquifer systems in the Irvine Subbasin have been described as a series of discontinuous lenses of clayey sands and gravels contained within an assemblage of sandy clay and silt. These aquifer systems are within the less consolidated and more permeable Quaternary sedimentary deposits. Regionally, the stratigraphic units within the aquifers are considered to be laterally extensive and representative of two homogeneous systems, a shallow aquifer and a deeper zone (referred to as the "principal aquifer"). An intervening horizon of fine-grained materials hydraulically separates the shallow and deep aquifers but appears to allow leakage at some locations.

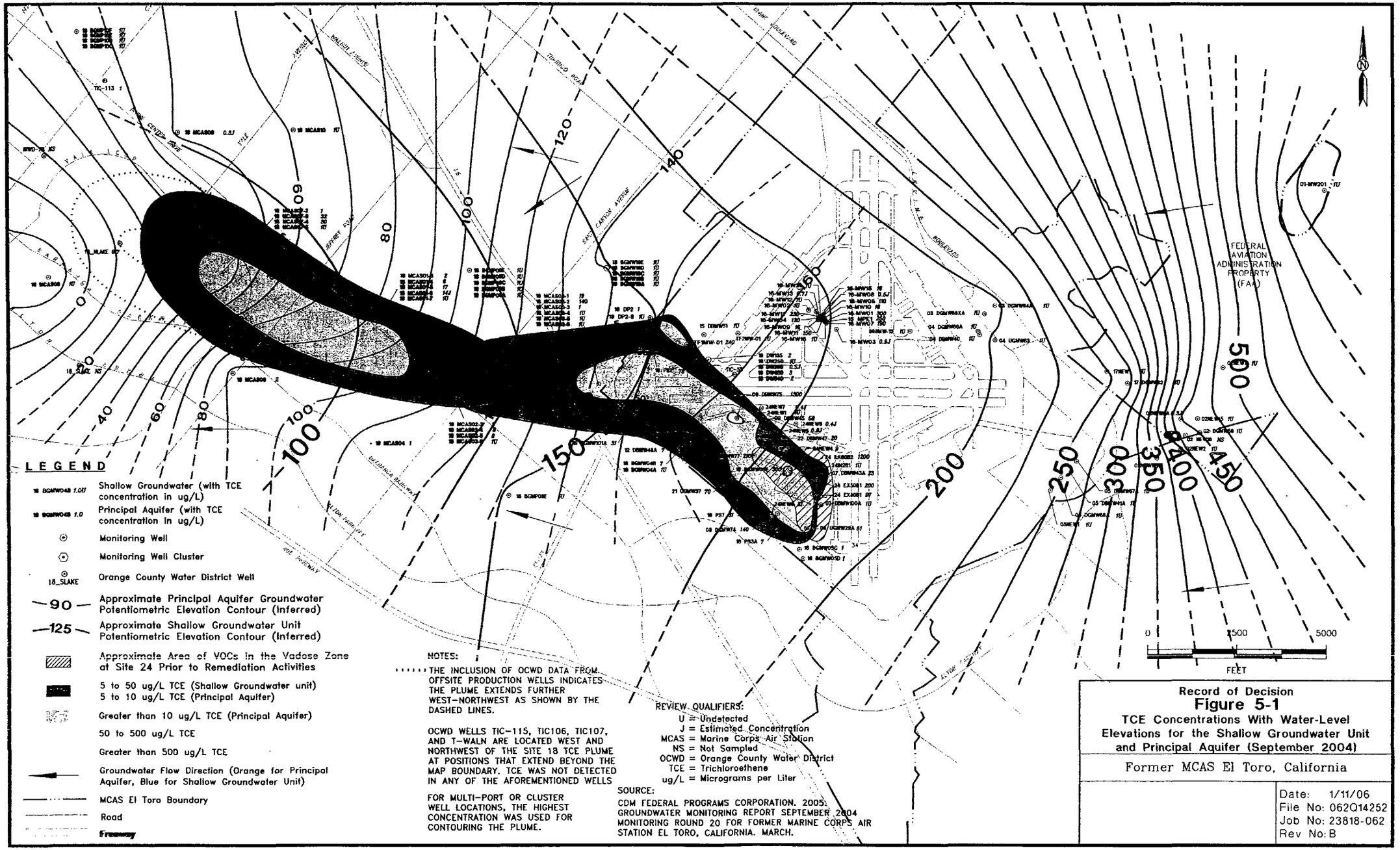
The depth to shallow groundwater beneath Former MCAS El Toro ranges from approximately 45 to 60 feet bgs in the foothills to approximately 85 feet bgs along the southwest boundary to greater than 240 feet bgs along Irvine Boulevard (JEG 1993a). Groundwater generally flows in a northwest to west-northwesterly direction in both the shallow and principal aquifers (CDM 2005). The horizontal gradients range from 0.005 to 0.025 foot/foot. Figure 5-1 presents the inferred potentiometric elevation contours for the twentieth round of groundwater sampling (CDM 2005). The hydraulic gradient has been influenced strongly by the pumping of irrigation wells west of Former MCAS El Toro. Average linear groundwater flow velocities are reported to range from 0.02 to 1.9 feet per day (JMM 1990).

5.1.2 Surface Hydrology

Surface drainage near Former MCAS El Toro generally flows southwest, following the slope of the land, perpendicular to the trend of the Santa Ana Mountains. Several washes originate in the hills northeast of Former MCAS El Toro and flow through or adjacent to the Station en route to San Diego Creek. Off-Station drainage from the hills and upgradient irrigated farmland combines with Station runoff at Former MCAS El Toro (generated from extensive paved surfaces) and flows into four main drainage channels. Three of these drainage channels (Borrego Canyon, Agua Chinon, and Bee Canyon) are contiguous with natural washes that originate in the Santa Ana Mountains. The fourth drainage is Marshburn Channel (Figure 5-2).

Borrego Canyon Wash flows along the southeastern boundary of Former MCAS El Toro. The wash is unlined in the Santa Ana Mountains and unlined downstream of Irvine Boulevard. Borrego Canyon Wash crosses the southern corner of the Station and joins Agua Chinon Wash about 1/4 mile downstream of the Station boundary.

Both Agua Chinon and the Bee Canyon Washes cross the central portion of Former MCAS El Toro and receive on-Station runoff mainly through storm sewers. These washes are contained in culverts through most of their pathways across the Station. Both washes are unlined along several hundred feet at the southwestern edge of the Station and are lined again in a culvert beneath the Irvine Spectrum development, adjacent to the southwestern boundary of the Station. Marshburn Channel is a lined drainage channel that runs along the northwestern boundary of Former MCAS El Toro and receives runoff from the western part of the Station. All the drainages ultimately discharge into San Diego Creek.



NOTES:

THE INCLUSION OF OCWD DATA FROM OFFSITE PRODUCTION WELLS INDICATES THE PLUME EXTENDS FURTHER WEST-NORTHWEST AS SHOWN BY THE DASHED LINES.

OCWD WELLS TIC-115, TIC106, TIC107, AND T-WALN ARE LOCATED WEST AND NORTHWEST OF THE SITE 18 TCE PLUME AT POSITIONS THAT EXTEND BEYOND THE MAP BOUNDARY. TCE WAS NOT DETECTED IN ANY OF THE AFOREMENTIONED WELLS

FOR MULTI-PORT OR CLUSTER WELL LOCATIONS, THE HIGHEST CONCENTRATION WAS USED FOR CONTOURING THE PLUME.

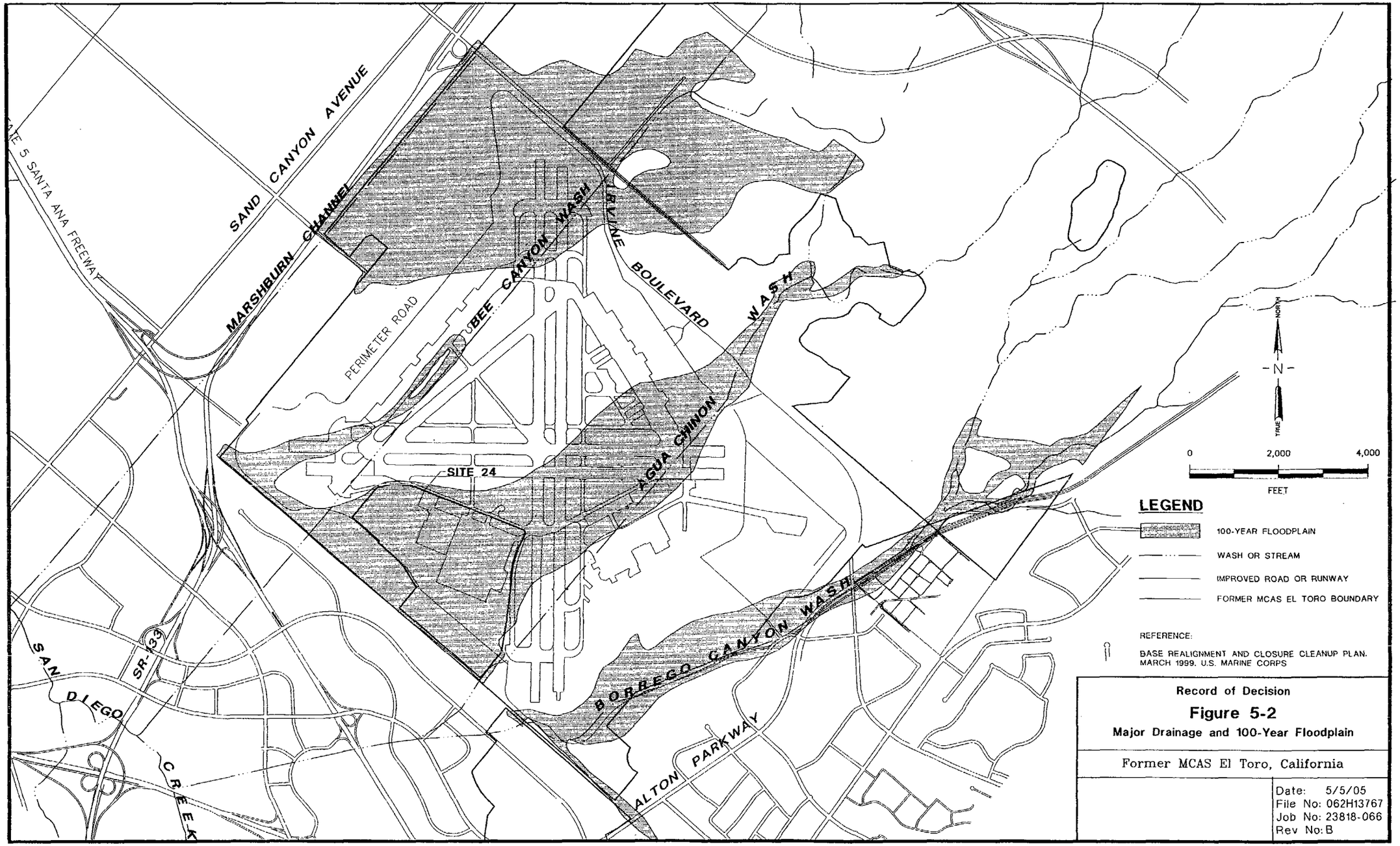
REVIEW QUALIFIERS:
U = Undetected
J = Estimated Concentration
MCAS = Marine Corps Air Station
NS = Not Sampled
OCWD = Orange County Water District
TCE = Trichloroethene
ug/L = Micrograms per Liter

SOURCE:
CDM FEDERAL PROGRAMS CORPORATION. 2005. GROUNDWATER MONITORING REPORT SEPTEMBER 2004 MONITORING ROUND 20 FOR FORMER MARINE CORPS AIR STATION EL TORO, CALIFORNIA. MARCH.

Record of Decision
Figure 5-1
TCE Concentrations With Water-Level Elevations for the Shallow Groundwater Unit and Principal Aquifer (September 2004)

Former MCAS El Toro, California

Date: 1/11/06
File No: 062Q14252
Job No: 23818-062
Rev No: B



Record of Decision

Figure 5-2

Major Drainage and 100-Year Floodplain

Former MCAS El Toro, California

Date: 5/5/05
File No: 062H13767
Job No: 23818-066
Rev No: B

The MCAS El Toro Master Plan indicates that much of the Station lies within the 100-year floodplain. Existing drainage systems were developed for agricultural use, not for the increased flows generated by the urban development now surrounding the Station. Approximately 15 acres of an agricultural lease was flooded and crops were destroyed during a storm on 29 November 1997. The area included in the 100-year floodplain is shown on Figure 5-2.

5.1.3 Rainfall and Prevailing Wind Conditions

The mean average rainfall at Former MCAS El Toro is approximately 12.2 inches, most of which occurs from November through April (JEG 1993a). Net infiltration from precipitation is estimated to be less than 2 inches per year (BNI 2000b) because of the low average annual rainfall and high evapotranspiration rates.

From March through October, the prevailing wind is from the west, averaging 6 knots. From November through February, the prevailing wind is from the east, averaging 4 knots. Dry, gusty, offshore winds (locally known as "Santa Ana winds") are common during late fall and winter. The typically dry conditions and persistent winds may result in light-to-moderate wind erosion.

5.2 SITE CHARACTERISTICS

Site 24 encompasses approximately 200 acres. The site slopes to the west from an elevation of about 320 feet above MSL at the intersection of the east-west and north-south runways to approximately 240 feet above MSL near the end of the east-west runway. The site is largely industrialized and contains two large aircraft hangars (Buildings 296 and 297) and several smaller buildings that were used for aircraft and vehicle maintenance and repair (Figure 5-3). Maintenance activities (e.g., degreasing) that occurred within these buildings may have contributed to the VOC contamination present at the site.

The Site 24 surface cover consists of unpaved open ground, asphalt, and concrete. The majority of the site (approximately 170 acres) is paved. Asphalt-covered areas were used primarily for access roads and parking lots for military and personal vehicles. Asphalt ranges from approximately 2 to 4 inches thick and varies in condition across the Station. Concrete-covered areas historically had the highest frequency of industrial activities at Site 24, including slabs for Buildings 296 and 297 (the two aircraft hangars), Building 295 (the helicopter hangar), and Building 324 (the former engine test facility).

A network of storm drains discharges rainwater and other fluids that accumulate on paved surfaces at Site 24. The majority of the wastewater that feeds this network is generated from the concrete-paved areas of Site 24 where most of the industrial activity took place. The storm drain network for the industrial facilities of Site 24 discharges to Agua Chinon and Bee Canyon Washes near the Station boundary.

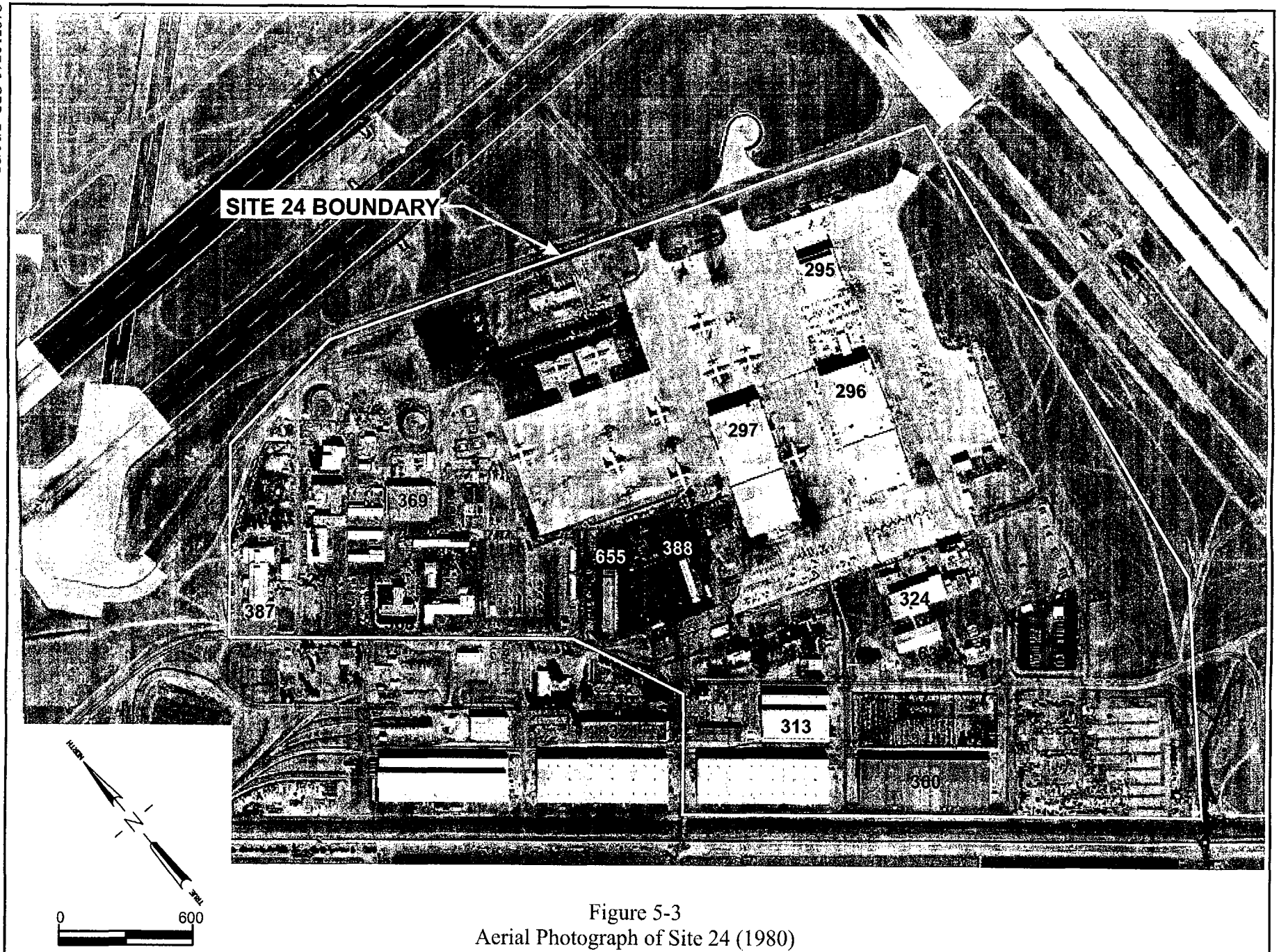


Figure 5-3
Aerial Photograph of Site 24 (1980)

An analysis of soil boring logs at Site 24 indicates that three units of alluvial fan deposition are present. Coarse-grained stream channel deposits (sands and gravels) are interbedded with intermediate-grained (silty sand and clayey sand) and fine-grained overbank deposits (silts and clays), which were investigated to approximately 260 feet bgs. These units were found to be somewhat continuous and laterally extensive on a large scale, yet highly heterogeneous on a small scale due to the interbedded nature of sediments deposited in the alluvial setting.

Groundwater is first encountered approximately 85 to 120 feet beneath Site 24. This first water-bearing unit, or shallow groundwater unit, appears to be laterally continuous across the site. The total thickness of the unit appears to be greater than 100 feet based on boring logs from the Site 24 RI. The upper 40 to 50 feet is relatively sandy with some fine-grained interbeds. The lower portion (the bottom 50 to 120 feet) of the unit, while still containing massive sandy units, becomes increasingly interbedded with finer-grained sediments.

An intermediate zone separates the shallow groundwater unit from a deeper, principal aquifer. The intermediate zone beneath Former MCAS El Toro consists of finer-grained alluvial sediments that are estimated to be approximately 90 feet thick (JEG 1994a). At Site 24, separation of the shallow groundwater unit from the principal aquifer is supported by lithologic, geochemical, and cone penetrometer test data. Geotechnical analytical results indicate that vertical hydraulic conductivities for the intermediate zone are several orders of magnitude lower than either the overlying shallow groundwater unit or the underlying principal water-bearing zone (BNI 1997a).

5.2.1 Potential Sources of Contamination

The VOCs at Site 24 may have come from solvents containing TCE and PCE that were used at Site 24 until approximately 1975. The precise origin, nature, and use of VOCs released at the site and the specific circumstances and quantities of individual releases are not documented. Active VOC sources no longer exist at Site 24. There were no clearly visible nor currently active aboveground sources (or activities) that could be used as an initial focus for the RIs. Most of the storage facilities have either been abandoned in place or completely removed, and former disposal practices were discontinued. Because there were no currently active aboveground sources to locate former release areas, potential VOC sources were identified by reviewing the RFA and Phase I data; reviewing Station records; conducting interviews with former operations staff involved with solvent storage, use, and disposal; and inspecting facilities within Site 24. Potential sources for contamination at Site 24 were divided into two categories, subsurface and surface, based on the mechanism by which VOCs may have been released into the subsurface.

5.2.1.1 POTENTIAL SUBSURFACE SOURCES

Potential subsurface sources include former degreaser pits and solvent tanks, storm drain and industrial wastewater sewer lines, vehicle wash racks with associated drains and sumps, and underground storage tanks. These are areas and features where releases may have occurred at discrete point source locations, at regular intervals, and directly into the

subsurface. Potential subsurface source areas exist where permanent, man-made facilities are designed into the infrastructure that may have directed solvents to precise locations (point sources) of release. These facilities were designed to handle industrial waste at regular intervals as a function of the industrial activities they supported. These point source areas are subsurface features that were in direct contact with soil beneath Site 24.

5.2.1.2 POTENTIAL SURFACE SOURCES

Potential surface sources are located where practices, as opposed to infrastructure, resulted in intermittent releases at different Site 24 locations. These types of potential releases may have occurred at random locations on the ground surface as a result of aircraft washing, temporary waste storage, handling and disposal practices, surface cover runoff, and dust-suppression activities. Potential surface sources at Site 24 include hazardous waste storage areas, ditches that collected runoff adjacent to paved areas, areas where solvents may have been used with water for aircraft washing, and open areas of the ground where occasional dumping of liquid waste may have occurred.

5.2.2 Types of Contamination and Affected Media

The COCs identified at Site 24 were VOCs, including TCE, PCE, 1,1-dichloroethene, and carbon tetrachloride, which were present in soil and groundwater. Soil remediation has been completed in the vadose zone soils at Site 24 (Earth Tech 2002). The following describes the extent of soil contamination prior to remediation.

The horizontal and vertical extent of VOCs in the vadose zone was characterized using soil and soil gas sampling and analysis. This characterization showed that the primary VOC source was present beneath Buildings 296 and 297, extending to the south with decreasing concentrations to the southern Station boundary. Several smaller source areas existed in the soil beneath Site 24, including a PCE soil gas plume located west of Building 297. The VOC concentrations in soil gas generally increased with depth, and the highest concentrations occurred near the water table. VOCs in the area of Buildings 296 and 297 extended to groundwater directly beneath those buildings.

The horizontal and vertical extent of VOCs in groundwater was characterized using Phase I RI data combined with additional monitoring well and HydroPunch sampling and analysis data. This characterization showed that although VOCs from the soils at Site 24 had impacted shallow groundwater beneath the site, the deeper groundwater or principal aquifer beneath Site 24 had not been affected. However, the principal aquifer at distances of approximately 3 miles west of the Station boundary has low-level TCE contamination. Other VOCs besides TCE were found in the groundwater, but only within the extent of the TCE plume.

5.2.2.1 VADOSE ZONE CONTAMINATION

This section presents the nature and extent of vadose zone contamination before and after implementation of SVE. The risk assessment summarized in Section 7 was based on concentrations in the subsurface prior to soil remediation.

Preremediation

The Phase I RI sampling and analysis program demonstrated that soil gas sampling was the most effective way to characterize the nature and extent of VOCs in the vadose zone. Potential source areas were identified by investigating the upper 20 feet of soil, with some samples collected as deep as 30 feet bgs. TCE hot spots were identified beneath Buildings 296 and 297. The Phase II investigation extended the Phase I soil gas survey by sampling for VOCs from approximately 30 feet bgs to first groundwater. Together, these soil gas investigations helped characterize the horizontal and vertical extent of VOCs in the vadose zone.

In general, preremediation TCE concentrations in soil gas increase and are more widely distributed with depth. VOC concentrations in soil gas generally increased with depth, with the highest concentrations near the water table. VOCs in the area of Buildings 296 and 297 extend to groundwater directly beneath those buildings. The TCE-contaminated area also extends to the south of Buildings 296 and 297, decreasing in concentration to the southern Station boundary.

VOCs were reported in soil samples only at very low concentrations. This is probably due to a low organic carbon content in the soil, release of TCE to the vadose zone in the dissolved phase, release to the atmosphere, and flushing with infiltrating surface water. Although much of the VOC contamination at Site 24 is believed to have entered the soil at or close to the surface, contaminant concentrations increased with depth in the vadose zone. Soil samples collected from the upper 10 feet of soil at Site 24 contained VOC concentrations less than 21 micrograms per kilogram (µg/kg). Maximum TCE concentrations reported in soil from the vadose zone during the Phase I and Phase II RI were 400 and 190 µg/kg, respectively.

Postremediation

A site closure strategy for vadose zone soils was developed and presented to the BCT in April 2000. The site closure strategy, with concurrence from the BCT, included sampling SVE wells with baseline concentrations (from initial 24-hour results) that previously exceeded soil gas threshold concentrations (Table 5-1). Soil gas threshold concentrations were developed to represent contaminant concentrations that have the potential to continue to contaminate groundwater at concentrations exceeding respective MCLs. Seven months after system shutdown, systemwide closure sampling confirmed that vapor concentrations in the SVE wells (Table 5-2, Figure 5-4) remained below the soil gas threshold concentrations (27 µg/L for TCE and 69 µg/L for PCE) (September 2000).

The FFA signatories in the SEOR reviewed and concurred with the shutoff criteria developed for the SVE system. Because MCLs for the VOCs listed in Table 5-1 have not changed since the approval of the SEOR, the soil gas threshold concentrations should still be considered protective.

Table 5-1
Soil Gas Threshold Concentration Calculations

VOC	U.S. EPA MCL (µg/L)	Henry's Constant (dimensionless)	Threshold Concentration Calculations	Soil Gas Threshold Concentration (µg/L)
trichloroethene	5	0.363	5 × 15 × 0.363	27
tetrachloroethene	5	0.923	5 × 15 × 0.923	69
carbon tetrachloride	5	0.813	5 × 15 × 0.813	61
1,1-dichloroethene	6	6.26	6 × 15 × 6.26	563
Freon 113	1,200*	13.0	1,200 × 15 × 13.0	234,000

Note:
* California MCL

Acronyms/Abbreviations:
Freon 113 – 1,1,2-trichloro-1,2,2-trifluoroethane
µg/L – micrograms per liter
MCL – maximum contaminant level
VOC – volatile organic compound
U.S. EPA – United States Environmental Protection Agency

5.2.2.2 GROUNDWATER CONTAMINATION

The Phase I RI groundwater characterization identified a plume of TCE in groundwater originating from the VOC source area at Site 24. The plume originated in the shallow aquifer at Site 24 and has migrated off-Station into the principal aquifer, approximately 3 miles to the west, beneath the city of Irvine (Site 18). VOCs were identified as the only chemical category to have impacted groundwater at Sites 24 and 18. Groundwater monitoring is currently conducted twice a year at Former MCAS El Toro and includes collecting samples from groundwater monitoring wells at Sites 18 and 24. Figure 5-1 depicts the extent of the TCE plume in groundwater based on analytical results from monitoring during September 2004 (CDM 2005).

Groundwater contamination identified in the shallow groundwater unit at Site 24 is addressed by the final ROD for OU-1/OU-2A (SWDIV 2002). Alternative 10B', modified Irvine desalter project with SVE, was selected as the final remedy in the ROD and includes extraction and treatment of contaminated groundwater and institutional controls. When the treatment system becomes operational, groundwater will be extracted from areas of maximum reported TCE concentrations at Site 24. To enhance remediation of the shallow groundwater unit, SVE will be selectively applied in the dewatered source area zones at Site 24 as described in the approved 100 percent design submittal for the shallow groundwater unit (Weston 2005).

Table 5-2
Closure Sampling Results
(results in micrograms per liter)

Well Identification	Treatment Zone	Baseline TCE* Concentrations	Preshutdown TCE* Concentrations	Closure Sample TCE* Concentrations
Central Treatment System				
24SVE2	Deep	171.7	0.38	2
24SVE3	Deep	27	1.8	0.12
24SVE5	Deep	30	1	0.2
24SVE9	Deep	53	5.1	8.5
24SVE10	Deep	41	1.9	ND
24SVE11	Deep	89	7.7	5.3/5.4 (DUP)
24SVE14	Deep	48	1.7	ND
24SVE21	Deep	26	4.7	ND
24SVE35	Deep	150	0.05	ND
24SVE35A	Intermediate	45.3	0.5	ND
24SVE45	Deep	110	2	ND
24SVE49	Deep	120	1	0.36
24SVE51	Deep	58	0.69	ND
24SVE54	Deep	44	0.74	ND
24SVE55	Deep	69	0.65	0.89
24SVE67	Deep	84	3.2	ND
24SVE77	Deep	37	0.95	0.12
24SVE78	Deep	37	1.3	0.22
24SVE89	Deep	130	1.6	4/4
24SVE94	Deep	56	5.8	ND
24SVE116	Deep	41	1.7	0.02
24SVE128B	Shallow	50	ND	0.16
24SVE161	Deep	50	ND/0.048 (DUP)	ND
Portable Treatment System				
24SVE12	Intermediate	235	0.21	13
24SVE13	Deep	69 (PCE)	30 (PCE)	30 (PCE)
24SVE138A	Intermediate	139.8	0.5	ND
24SVE147A	Intermediate	137.5	0.08	0.1

Note:
* results in table are for TCE unless noted otherwise

Acronyms/Abbreviations:
DUP – a duplicate sample was collected; results of both the primary and duplicate sample are included in the table
ND – not detected at a concentration above the method reporting limit
PCE – tetrachloroethene
TCE – trichloroethene

5.2.3 Routes of Exposure

Currently, there are no complete exposure pathways to receptors from groundwater at Site 24 because groundwater beneath this site is not being used for potable purposes or for irrigation. Potential ingestion of groundwater provides the only direct risk to human health at the site.

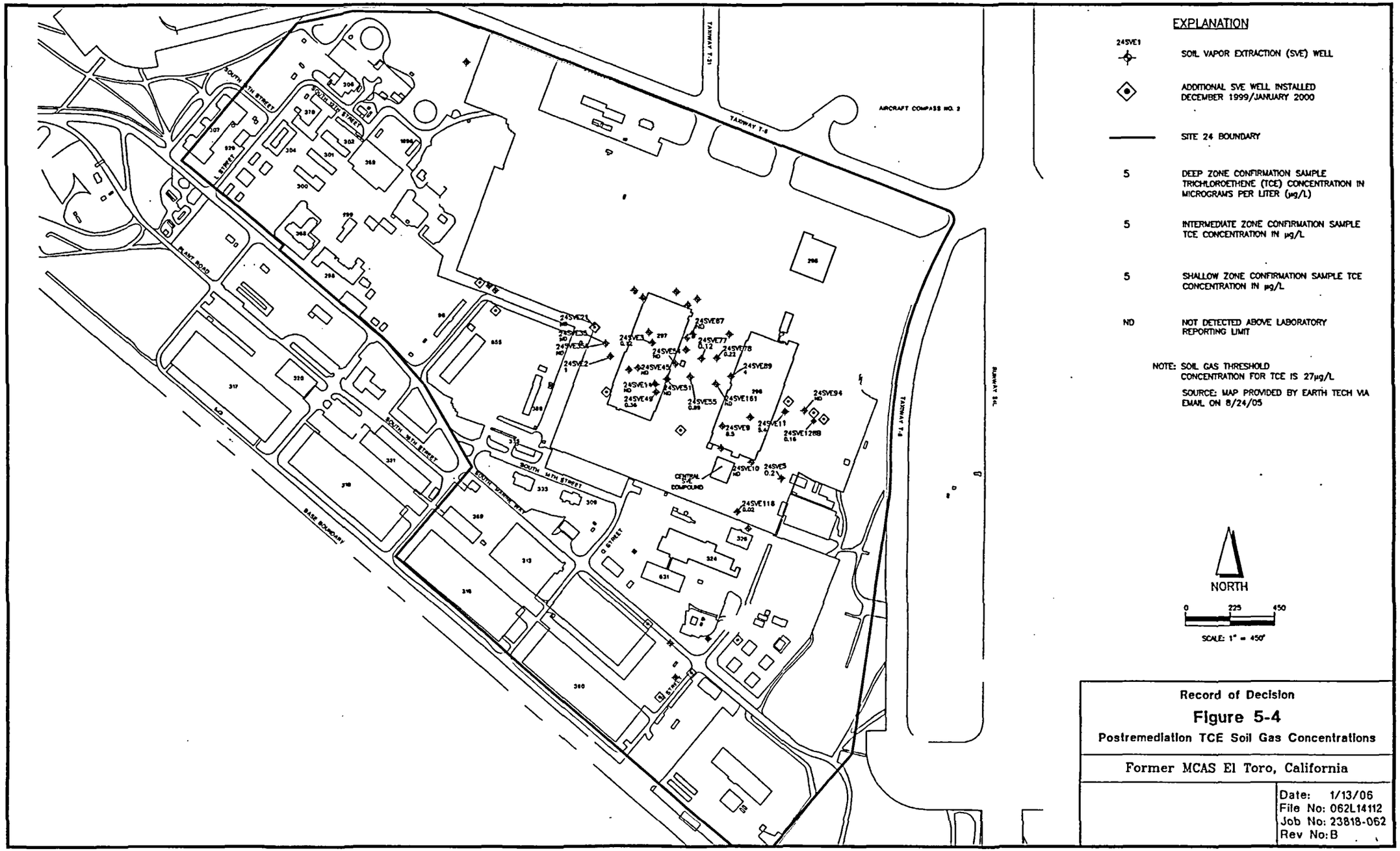
Remediation of vadose zone soils at Site 24 has reduced current soil gas concentrations to below soil gas threshold values, the concentrations at which vadose zone soils could act as a continuing source of contamination to groundwater at levels exceeding respective MCLs. Although residential exposure to contamination in soils could occur through ingestion, inhalation, or dermal contact, it did not pose an unacceptable risk to human health either before or after remediation of vadose zone soils.

The fate and transport discussion presented in the Phase II RI Report (BNI 1997a) indicated that VOCs reported in soil at Site 24 have the ability to migrate to groundwater. VOCs in soils can migrate through the vadose zone in the following ways:

- as a vapor
- dissolved in soil moisture
- as a dense nonaqueous-phase liquid

The RI concluded that since most of the VOCs released at Site 24 were dissolved in water as a result of cleaning and washing activities, it is likely that the majority of the contamination in the vadose zone was found in the dissolved form. The relatively low VOC concentrations in the vadose zone supported this hypothesis.

During the Phase II RI, migration of vapors and dissolved-phase VOCs from the vadose zone to groundwater was a concern. The concern was based on modeling results indicating concentrations of TCE and PCE in soils were high enough for these VOCs to continue to contaminate the shallow groundwater unit beneath Site 24 at concentrations exceeding respective MCLs (BNI 1997a). This meant that remediation of groundwater alone might not be effective in protecting human health, and that the source of groundwater contamination (i.e., VOCs in the vadose zone) should also be addressed. To address this concern, remediation of the vadose soils by SVE was conducted as described in the Interim ROD (SWDIV 1997b).



Record of Decision

Figure 5-4

Postremediation TCE Soil Gas Concentrations

Former MCAS El Toro, California

Date: 1/13/06
File No: 062L14112
Job No: 23818-062
Rev No: B

Section 6
CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

This section summarizes current and potential future land and resource uses at Site 24.

6.1 LAND USES

Former MCAS El Toro was closed on 02 July 1999. The County of Orange, the initial Local Redevelopment Authority (LRA), proposed a commercial aviation reuse for Former MCAS El Toro. This proposal became the BRAC reuse plan (P&D Consultants Team 1996). In March 2002, county voters overturned those planning efforts with the passage of Measure W, a referendum that changed the Orange County General Plan for Former MCAS El Toro to a nonaviation use and recreational theme, with limited development intensities. After the March 2002 vote, the LRA decided that it would not update the BRAC reuse plan for the property. Consequently, the DON decided to dispose of the property without any particular reuse or redevelopment plan, deciding that reuse would ultimately be determined by local zoning applicable at the time of conveyance. In 2003, the city of Irvine annexed the former Station property and passed zoning ordinances that were consistent with a conceptual reuse plan titled "Orange County Great Park."

In July 2005, the DON conveyed by deed approximately 2,798 acres of the former Station through public sale to a private developer. An additional 921 acres was retained by the DON to complete ongoing environmental actions, but was leased under a lease in furtherance of conveyance to allow for the interim redevelopment of the property. The leased areas, referred to as carve-out areas, include locations of concern where further evaluation, implementation of response actions, or completion of response actions is required. The carve-out areas will be transferred by deed once response actions are complete.

Prior to the public sale, approximately 23 acres was transferred to the California Department of Transportation for the Bake Parkway/Interstate 5 public highway expansion project in 1998. In 2001, approximately 897 acres in the northeast portion of the Station was transferred to the Federal Aviation Administration. Environmental documentation on these transferred properties is included in the administrative record for Former MCAS El Toro. Approximately 70 acres, referred to as Site 1, in the northeastern corner of the Station remains under DON ownership.

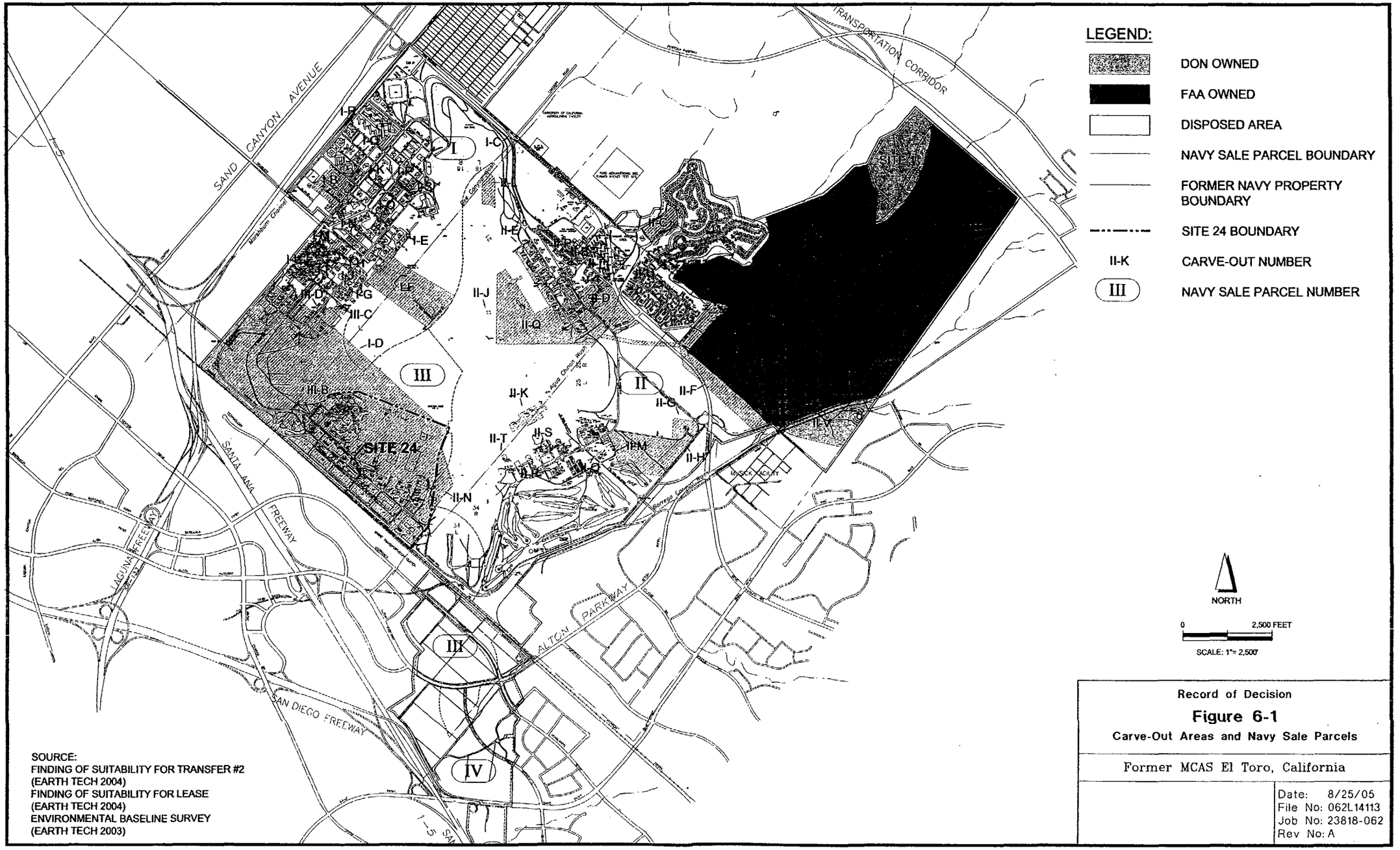
Figure 6-1 presents carve-out areas and Navy sale parcels based on the Finding of Suitability for Transfer and Finding of Suitability for Lease documentation. Site 24 is located in the southwestern quadrant of Former MCAS El Toro. The site is highly industrialized and contains two large aircraft hangars (Buildings 296 and 297) and several smaller buildings that were used for aircraft and vehicle maintenance and repair. Site 24 is located in carve-out III-B. On the basis of current local zoning, the future use of Site 24 is designated as recreational and institutional.

6.2 GROUNDWATER USE

Former MCAS El Toro lies within the Irvine Groundwater Management Zone, which has been designated by Santa Ana RWQCB as a public water supply source (RWQCB 2004). The regional aquifer beneath Former MCAS El Toro is not currently a source of municipal drinking water because of widespread elevated concentrations of total dissolved solids and nitrates that exceed water quality standards; however, groundwater in the vicinity of the Station is used for agricultural purposes. A full discussion of groundwater use beneath Former MCAS El Toro is presented in the ROD for OU-1 and OU-2A (SWDIV 2002).

6.3 SURFACE WATER USE

Surface drainages near Former MCAS El Toro (described in Section 5.1.2, shown on Figure 5-2) all ultimately drain to San Diego Creek. Southwest of Former MCAS El Toro, San Diego Creek flows through commercial and agricultural areas. Approximately 5 miles downstream from the Station, the creek runs through a recreational area that includes hiking and bicycle paths. The creek flows into Upper Newport Bay, an ecological preserve used by migratory birds (BNI 1995), about 7 miles downstream from its intersection with the Marshburn Channel. Recreational uses of the bay include swimming and fishing.



SOURCE:
FINDING OF SUITABILITY FOR TRANSFER #2
(EARTH TECH 2004)
FINDING OF SUITABILITY FOR LEASE
(EARTH TECH 2004)
ENVIRONMENTAL BASELINE SURVEY
(EARTH TECH 2003)

Record of Decision

Figure 6-1

Carve-Out Areas and Navy Sale Parcels

Former MCAS El Toro, California

Date: 8/25/05
File No: 062L14113
Job No: 23818-062
Rev No: A

Section 7
SITE RISKS

A human-health risk assessment (HHRA) was conducted for Site 24 using data collected during the RI to represent conditions at the site prior to any remedial activities. The human-health evaluation methodology for this HHRA is provided in Section 6 and in Appendix P of the draft final Phase II RI Report (BNI 1997a). An additional human-health risk evaluation was performed using measured soil gas concentrations to calculate indoor air concentrations and to evaluate the potential exposure to indoor air vapors that could accumulate in buildings constructed at Site 24 (BEI 2004). An ecological risk assessment was not required for this site because it is highly industrialized and does not provide a suitable habitat for any endangered or threatened wildlife species.

7.1 CONTAMINANT IDENTIFICATION

The procedures used to identify the chemicals of potential concern (COPCs) evaluated in this risk assessment are consistent with U.S. EPA's Risk Assessment Guidance for Superfund (U.S. EPA 1989) and Guidance for Data Usability in Risk Assessment (U.S. EPA 1992). Only VOCs were evaluated as COPCs in the risk assessment. These included 14 COPCs identified for groundwater and for the upper 10 feet of soil during the Phase I RI and 10 additional VOCs identified for groundwater during the Phase II RI (Table 7-1). The only COPC identified for soil and not for groundwater was 2-hexanone.

7.2 EXPOSURE ASSESSMENT

Site 24 is located in a highly industrialized portion of Former MCAS El Toro and contains buildings that formerly supported aircraft activities at the Station and concrete parking areas for vehicles and aircraft. Off-Station land near Site 24 is zoned for commercial, industrial, and agricultural use. According to the proposed reuse plan at the time the HHRA was prepared, the primary reuse of Site 24 was aviation support. However, since this plan did not represent the final reuse of Site 24, a variety of scenarios were considered in the risk assessment, including residential, industrial, recreational, and excavation worker.

7.2.1 Residential Scenario

Under a residential scenario, residents are assumed to live in a house on-site from birth to age 30. Thirty years is the 90th percentile of time that people in the United States live at one address (U.S. EPA 1989). Because soil excavation to about 10 feet bgs may occur during the construction of basements and/or swimming pools and some of the excavated soil may be left at the surface, it is assumed that residents could be exposed to COPCs in this soil. Under a residential scenario, water used in the home is assumed to come from a private well that draws contaminated water from the shallow aquifer beneath the house. The exposure routes used in the risk assessment for the resident included ingestion, dermal contact, and inhalation of soil VOCs and ingestion, dermal contact, and inhalation of groundwater VOCs. Although it is unlikely that anyone would install a private well to obtain water for home use (due to the availability of a municipal water supply), the

Table 7-1
Chemicals of Potential Concern in Soil and Groundwater

COPCs in Soil* (0 to 2 feet bgs)	COPCs in Soil* (0 to 10 feet bgs)	COPCs in Groundwater
acetone	acetone	acetone
benzene	benzene	benzene
2-butanone	2-butanone	bromodichloromethane
carbon disulfide	carbon disulfide	bromoform
carbon tetrachloride	carbon tetrachloride	2-butanone
1,2-dichloroethene (mixture)	1,2-dichloroethene (mixture)	carbon disulfide
ethylbenzene	ethylbenzene	carbon tetrachloride
2-hexanone	2-hexanone	chloroform
methylene chloride	methylene chloride	chloromethane
tetrachloroethene	tetrachloroethene	dibromochloromethane
toluene	toluene	1,2-dichloroethane
1,1,1-trichloroethane	1,1,1-trichloroethane	1,1-dichloroethene
trichloroethene	trichloroethene	1,2-dichloroethene (mixture)
xylenes	xylenes	ethylbenzene
		4-methyl-2-pentanone
		methylene chloride
		styrene
		tetrachloroethene
		toluene
		1,1,1-trichloroethane
		1,1,2-trichloroethane
		trichloroethene
		xylenes

Note:
* COPCs for soil are from samples collected before the soil remedial action was completed

Acronyms/Abbreviations:
bgs – below ground surface
COPC – chemical of potential concern

potential risk presented by the COPCs in groundwater was estimated using exposure conditions associated with its domestic use (e.g., as tap water, for bathing and drinking).

7.2.2 Industrial Scenario

Under an industrial scenario, it was assumed that the site would be redeveloped for a commercial business, and the individuals most likely to be exposed to contamination would be owners and/or employees of businesses. An office worker was chosen to represent business owners and employees, one who works 8 hours a day in a commercial building on-site for a period of 25 years, which is the exposure duration recommended by U.S. EPA (1989) for industrial workers. Only COPCs in the upper 2 feet of soil are considered to be available for exposure to the office worker. The workplace water supply is assumed to be provided by a local water utility. Therefore, exposure of an office worker to COPCs in groundwater at the workplace is not considered possible. Exposure routes for soil include ingestion, dermal contact, and inhalation of VOC vapors.

7.2.3 Recreational Scenario

Under a recreational scenario, it was assumed that the site would be developed into a park, and the most highly exposed individuals would be people involved in grounds maintenance or park users, depending on the frequency and amount of time spent at the park. A park user was chosen for the risk assessment rather than a grounds maintenance worker because the risk to the park user approximates the risk to the grounds maintenance worker if the latter spends 1 or 2 days a week on maintenance work. The park user is assumed to be an older child, 9 to 16 years of age, who plays daily unsupervised in the park 2 hours a day for 7 years. This exposure regimen was arbitrarily chosen after evaluation for its reasonableness. As with the office worker, only COPCs in the upper 2 feet of soil are considered to be available for exposure to the park user. Exposure routes for soil include ingestion, dermal contact, and inhalation of VOC vapors. COPCs in groundwater are assumed to be unavailable to the park user.

7.2.4 Excavation Worker Scenario

The excavation worker is assumed to be a person who installs underground utility lines, basements, and/or swimming pools. This worker is assumed to work 8 hours a day for 1 year (250 work days). The excavation worker is exposed to soil at the surface down to a depth of 10 feet bgs. Exposure routes for soil include ingestion, dermal contact, and inhalation of VOC vapors.

7.2.5 Exposure Assumptions

Table 7-2 presents the exposure assumptions for each of the scenarios evaluated in the risk assessment for Site 24. Exposure conditions used in the estimation of risk were chosen to represent what is known as "reasonable maximum exposure." Use of these exposure conditions tends to overestimate risk. This effort to overestimate risk is deliberate; it provides risk managers a margin of error when making remediation

Table 7-2
Values Assigned to Dose Equation Parameters

Equation Parameter	Units	Resident Child[a]	Resident Adult	Office Worker	Excavation Worker	Recreational Child[b]
Averaging time (cancer)	days	25,550	25,550	25,550	25,550	25,550
Averaging time (noncancer)	days	ED × 365	ED × 365	ED × 365	ED × 365	ED × 365
Body weight	kg	15	70	70	70	46
Dermal absorption factor	unitless	Value depends on chemical				
Exposed skin surface area (soil)[c]	cm^2	2,000	5,000	5,000	5,000	3,000
Exposed skin surface area (water)[d]	cm^2	7,000	19,000	NA	NA	NA
Exposure duration (cancer)	years	6	24[e]	25	1	7
Exposure duration (noncancer)	years	6	24	25	1	7
Exposure frequency (air)[f]	days/year	350	350	250	250	350
Exposure frequency (water, bath)	days/year	350	350	NA	NA	NA
Exposure frequency (soil)[f]	days/year	350	350 (oral) 100 (dermal)	250	250	350
Exposure time (water, bath)	hours/day	0.25	0.25	NA	NA	NA
Exposure time (air)	hours/day	24	24	8	8	2
Intake rate (air)	m^3/hr	0.42	0.83	0.83	2.5	2.5
Intake rate (soil)	mg/day	200	100	50	480	100
Intake rate (water)	liters/day	1	2	NA	NA	NA
Permeability constant	cm/hr	Value depends on chemical				
Soil adherence factor	mg/cm^2	1	1	1	1	1

Notes:
- [a] child age = 0 to 6 years
- [b] child age = 9 to 16 years
- [c] exposed skin = 25 percent of mean total body surface area; values rounded to the nearest 1,000 cm^2
- [d] exposed skin (percent of mean total body surface area): resident child/adult = 100 percent (bath); values rounded to the nearest 1,000 cm^2
- [e] for the resident adult, the total exposure duration is 30 years with 6 years as a child and 24 years as an adult
- [f] exposure frequency: standard default for resident and worker; exposure regimen for recreational child developed specifically for this assessment

Acronyms/Abbreviations:
- cm^2 – square centimeter
- cm/hr – centimeters per hour
- ED – exposure duration
- kg – kilogram
- mg/cm^2 – milligrams per square centimeter
- mg/day – milligrams per day
- m^3/hr – cubic meters per hour
- NA – not applicable

decisions. The combination of the intake variables, expressing the exposure conditions for each receptor, results in a chronic daily dose. The dose is an estimate of exposure for each pathway.

7.2.6 Calculation of Exposure Point Concentration

An exposure point concentration (EPC) is the concentration of a chemical in soil, water, or air at the point of contact with a receptor. In observance of the concept of the reasonable maximum exposure, the 95 percent upper confidence limit (UCL) of the arithmetic mean of the measured concentrations of each COPC was used as the exposure point concentration, except when the number of measurements was less than four or when the 95 percent UCL exceeded the maximum reported concentration. In those cases, the maximum reported concentration was used as the exposure point concentration. The reported concentrations were assumed to have a lognormal distribution. Therefore, the 95 percent UCL for a lognormal distribution was calculated in accordance with procedures recommended by U.S. EPA (1992).

7.3 TOXICITY ASSESSMENT

Cancer slope factors (CSFs) have been developed by the U.S. EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. In addition to the U.S. EPA-derived CSFs, Cal/EPA has developed CSFs for a group of carcinogens. Following DON policy, both U.S. EPA and Cal/EPA CSFs were used in the estimation of risk from those chemicals when present. Cancer potency factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by U.S. EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs are estimates of lifetime daily exposure levels for humans, including sensitive individuals. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help assure that the RfDs do not underestimate the potential for adverse noncarcinogenic effects to occur.

Table 7-3 presents the CSFs and RfDs for the COPCs identified in soil and groundwater at Site 24.

7.4 RISK CHARACTERIZATION

Excess lifetime cancer risks are determined by multiplying the chronic daily dose by the CSF. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6} or 1E-6). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one-in-a-million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site. The U.S. EPA has established guidelines to

manage cancer risks. Using these guidelines, excess cancer risks between 10^{-6} and 10^{-4} or less are generally considered acceptable.

Potential concern for noncarcinogenic effects from a single contaminant in a single medium is expressed as the hazard quotient (or the ratio of the estimated dose to the contaminant's RfD). By adding the hazard quotients for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the hazard index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. The U.S. EPA has established guidelines for noncancer risks. Using these guidelines, an HI of less than 1.0 is generally considered protective of human health. If the HI exceeds 1.0, an assessment of the chemicals is performed to determine whether the HI represents an unacceptable noncarcinogenic human-health risk.

Total cancer and noncancer risks (HIs) estimated for receptors at Site 24 are summarized in Table 7-4. This table also identifies COPCs, or those chemicals contributing the majority of risk (risk drivers), the media associated with risk drivers, and the exposure routes by which the risk drivers exert their effects. Cancer risks and risk drivers shown in Table 7-4 are based on a combination of U.S. EPA and Cal/EPA CSFs. Noncancer risk to a resident child was estimated; however, noncancer risk to a resident child is higher than to a resident adult because the child would consume more soil over the assumed 6 years of exposure than an adult would over the assumed 24 years of exposure.

Risk results indicate that if no remediation occurred and homes were built on-site, the lifetime excess upper-bound cancer risk presented by COPCs in the groundwater and soil to resident adults would be about 2 chances in 1,000 (risk estimate of 2×10^{-3}) (Table 7-4). This risk is primarily due to exposure to groundwater contaminated with 11 risk drivers that account for most of the risk. Risk to the resident child from exposure to COPCs in groundwater and soil would be approximately 7.4×10^{-4}. The results also showed that concentrations of TCE and carbon tetrachloride in groundwater from on-site wells are high enough to cause noncancer (systemic) effects in residents since HIs for both of the compounds exceed 1.0.

Risk results also indicate that if no remediation were performed and the site contained an office building or a park, or if a 10-foot-deep pit were excavated, the lifetime excess upper-bound cancer risk presented by COPCs in the soil would be no more than about five chances in one billion (5×10^{-9}) to people working in the building, playing in the park, or working in the pit. The results also indicate that the concentrations of the COPCs in the soil are not high enough to cause systemic effects (noncarcinogenic effects) to the same people.

Table 7-3
Cancer Slope Factors and Reference Doses for Chemicals of Potential Concern in Soil and Groundwater at Site 24

Analyte	CAS No.	CANCER CLASS			ORAL		INHALATION		ESTIMATED DERMAL		U.S. EPA ORAL		U.S. EPA INHALATION		CALCULATED DERMAL	
		Oral	Inhalation	Dermal	CSF	Ref	CSF	Ref	CSF	Ref	RfD	Ref	RfD	Ref	RfD	Ref
4-methyl-2-pentanone	108-10-1	NE	NE	NE	NA	NA	NA	—	—	—	8.00E-02	H2	2.29E-02	H2	8.00E-02	R
acetone	67-64-1	D	D	D	NA	NA	NA	—	—	—	1.00E-01	I	1.00E-01	R	1.00E-01	R
benzene	71-43-2	A	A	A	2.90E-02	I	2.90E-02	I	2.90E-02	R	1.71E-03	R	1.71E-03	E	1.71E-03	R
bromodichloromethane	75-27-4	B2	B2	B2	6.20E-02	I	6.20E-02	R	6.20E-02	R	2.00E-02	I	2.00E-02	R	2.00E-02	R
bromoform (tribromomethane)	75-25-2	B2	B2	B2	7.90E-03	I	3.85E-03	I	7.90E-03	R	2.00E-02	I	2.00E-02	R	2.00E-02	R
carbon disulfide	75-15-0	NE	NE	NE	NA	NA	NA	—	—	—	1.00E-01	I	2.00E-01	I	1.00E-01	R
carbon tetrachloride	56-23-5	B2	B2	B2	1.30E-01	I	5.25E-02	I	1.30E-01	R	7.00E-04	I	5.71E-04	E	7.00E-04	R
chloroform	67-66-3	B2	B2	B2	6.10E-03	I	8.05E-02	I	6.10E-03	R	1.00E-02	I	1.00E-02	R	1.00E-02	R
chloromethane	74-87-3	C	C	C	1.30E-02	H	6.30E-03	H	1.30E-02	R	—	—	—	—	—	—
dibromochloromethane	124-48-1	C	C	C	8.40E-02	I	8.40E-02	R	8.40E-02	R	2.00E-02	I	2.00E-02	R	2.00E-02	R
1,2-dichloroethane	107-06-2	B2	B2	B2	9.10E-02	I	9.10E-02	I	9.10E-02	R	—	—	—	—	—	—
1,2-dichloroethene (mixture)	540-59-0	D	D	D	NA	NA	NA	—	—	—	9.00E-03	H2	9.00E-03	R	9.00E-03	R
1,1-dichloroethene	75-35-4	C	C	C	6.00E-01	I	1.75E-01	I	6.00E-01	R	9.00E-03	I	9.00E-03	R	9.00E-03	R
ethylbenzene	100-41-4	D	D	D	NA	NA	NA	—	—	—	1.00E-01	I	2.90E-01	I	1.00E-01	R
2-hexanone	591-78-6	NA	NA	NA	6.00E-02[a]		5.71E-02[a]	—	—	—	—	—	—	—	6.00E-02[a]	R
methyl ethyl ketone	78-93-3	D	D	D	NA	NA	NA	—	—	—	6.00E-01	I	2.86E-01	I	6.00E-01	R
methylene chloride	75-09-2	B2	B2	B2	7.50E-03	I	1.65E-03	I	7.50E-03	R	6.00E-02	I	8.57E-01	H2	6.00E-02	R
styrene	100-42-5	B2	B2	B2	2.00E-01	I	2.90E-01	I	—	—	—	—	—	—	2.00E-01	R
tetrachloroethene	127-18-4	B2	B2	B2	5.20E-02 5.10E-02[b]	E	2.03E-03 2.10E-02[b]	E	5.20E-02	R	1.00E-02	I	1.00E-02	R	1.00E-02	R
toluene	108-88-3	D	D	D	NA	NA	NA	—	—	—	2.00E-01	I	1.14E-01	I	2.00E-01	R
1,1,1-trichloroethane	71-55-6	D	D	D	NA	NA	NA	—	—	—	9.00E-02	X	2.86E-01	X	9.00E-02	R
1,1,2-trichloroethane	79-00-5	C	C	C	5.70E-02	I	5.60E-02	I	5.70E-02	R	4.00E-03	I	4.00E-03	R	4.00E-03	R
trichloroethene	79-01-6	B2	B2	B2	1.10E-02	E	6.00E-03	E	1.10E-02	R	6.00E-03	E	6.00E-03	R	6.00E-03	R
xylenes	1330-20-7	D	D	D	NA	NA	NA	—	—	—	2.00E+00	I	2.00E-01	R	2.00E+00	R

Notes:
[a] estimated
[b] CSFs derived from California Environmental Protection Agency

Acronyms/Abbreviations:
A – human carcinogen
B2 – probable human carcinogen with sufficient evidence in animals and inadequate or no evidence in humans
C – possible human carcinogen
CAS – Chemical Abstracts Service
CSF – cancer slope factor (units in inverse of milligrams per kilogram per day)
D – not classifiable as to human carcinogenicity
E – 1994 Environmental Criteria and Assessment Office
H – 1994 Health Effects Assessment Summary Table
H2 – 1995 Health Effects Assessment Summary Table
I – 1995 Integrated Risk Information System
NA – not available
NE – not established
R – route-to-route extrapolation
Ref – reference
RfD – reference dose (units in milligrams per kilograms per day)
U.S. EPA – United States Environmental Protection Agency
X – withdrawn from Integrated Risk Information System and/or Health Effects Assessment Summary Table

Table 7-4
Summary of Human-Health Risk Results

Characteristic	Resident Adult	Resident Child	Recreational Child	Office Worker	Excavation Worker
Total Cancer Risk					
COPCs in soil	2.2E-08	9.4E-09	2.4E-09	5.4E-09	5.1E-10
COPCs in groundwater	2.0E-03	7.4E-04	NA	NA	NA
Total	2.0E-03	7.4E-04	2.4E-09	5.4E-09	5.1E-10
Hazard Index					
COPCs in soil	9.4E-04	2.5E-03	4.7E-04	2.9E-04	7.8E-04
COPCs in groundwater	8.6E+01	2.0E+02	NA	NA	NA
Total	8.6E+01	2.0E+02	4.7E-04	2.9E-04	7.8E-04
Risk drivers (carcinogenic effects and associated risk)[a,b]	benzene (1.3E-06) bromodichloromethane (5.2E-06) carbon tetrachloride (1.1E-05) chloroform (1.1E-05) chloromethane (1.1E -06) dibromochloromethane (1.1E-06) 1,2-dichloroethane (4.6E-06) 1,1-dichloroethene (5.0E-05) tetrachloroethene (4.7E-06)[c] 1,1,2-trichloroethane (4.2E-06) trichloroethene (1.9E-03)	bromodichloromethane (1.9E-06) carbon tetrachloride (4.2E-06) chloroform (4.2E-06) 1,2-dichloroethane (1.7E-06) 1,1-dichloroethene (1.8E-05) tetrachloroethene (1.7E-06) 1,1,2-trichloroethane (1.6E-06) trichloroethene (7.1E-04)	None	None	None
Risk drivers (noncancer effects) and associated hazard index	trichloroethene (8.5E+01)	carbon tetrachloride (1.3E+00) trichloroethene (2.0E+02)	None	None	None
Medium of concern[c]	Groundwater	Groundwater	NA	NA	NA
Exposure route of concern[d]	Ingestion, inhalation, dermal contact	Ingestion, inhalation, dermal contact	NA	NA	NA

Notes:
[a] based on United States Environmental Protection Agency and California Environmental Protection Agency cancer slope factors
[b] risk driver – COPC that poses a minimum multimedia cancer risk of 1.0E-06 or minimum hazard index of 1.0
[c] medium of concern – medium (e.g., soil) with COPCs that pose minimum multimedia cancer risk of 1.0E-06 or minimum hazard index of 1.0
[d] exposure route of concern – intake route through which COPCs pose a minimum multimedia cancer risk of 1.0E-06 or minimum hazard index of 1.0

Acronyms/Abbreviations:
COPC – chemical of potential concern
NA – not applicable

7.5 INDOOR AIR RISK EVALUATION

A human-health risk evaluation was performed for Sites 16 and 24 at Former MCAS El Toro to evaluate the potential exposure to indoor air vapors that could accumulate in buildings constructed at these sites under residential and industrial worker scenarios (BEI 2004). Measured soil gas concentrations were used to calculate indoor air concentrations.

The risk evaluation was conducted in accordance with Risk Assessment Guidance for Superfund: Part A (U.S. EPA 1989) and Part B (U.S. EPA 1991) and supporting documents and guidelines published by Cal/EPA (1992). Exposure conditions used in the risk evaluation were chosen to represent reasonable maximum exposure conditions, the use of which tends to deliberately overestimate risk, thus providing risk managers a safety margin when making risk-management decisions.

The soil gas data set for Site 24 consisted of analytical results from the 30 closure soil gas samples collected systemwide from the 27 SVE wells at the site, which were installed at various depths within the three vadose zone depth intervals. The samples were collected in September 2000, approximately 7 months after the remediation system was shut down to assess whether any rebound concentrations were above the cleanup threshold, in accordance with the approved closure strategy for the vadose zone source area (Earth Tech 2003c). Concentrations of VOCs in soil gas at the site were reported at depths from 15 to 111 feet bgs, where the deepest sample was collected.

To evaluate potential exposure to soil gas VOCs at Site 24, concentrations of indoor chemical vapors were calculated on the basis of EPCs of the COPCs in soil gas. All VOCs reported above laboratory detection limits were identified as COPCs. Table 7-5 presents the COPCs and soil gas EPCs used in the indoor air modeling calculations.

The residential exposure scenario assumed that a U.S. EPA-default residential structure was located within the boundaries of the site. Since U.S. EPA does not specify building dimensions under an industrial worker exposure scenario, the risk assessment assumed that the industrial worker occupied a two-story, 200-foot-long by 100-foot-wide (20,000 square feet) building at the site. An advanced Johnson and Ettinger model was used to estimate the volatile emissions from contaminated soil gas (U.S. EPA 2003a).

The estimated cancer risk for a hypothetical resident adult exposed to COPCs in indoor air at Site 24, 350 days a year for over 30 years, was quantified at 7.8×10^{-6} (using U.S. EPA criteria) and 3.1×10^{-7} (using Cal/EPA criteria). The estimated noncancer HI under this scenario was quantified at 0.011. The estimated cancer risk for an industrial worker exposed to COPCs in indoor air, 250 days a year for over 25 years, was quantified at 3.3×10^{-7} (using U.S. EPA criteria) and 1.3×10^{-8} (using Cal/EPA criteria). The cancer risk using U.S. EPA criteria is primarily associated with TCE exposure, which accounts for 94 percent of the risk. The estimated HI under this scenario was quantified at 0.00031.

Table 7-5
Site 24 Soil Gas EPCs and Resultant Indoor Air Concentrations

Chemical	Residential Air EPC (mg/m^3)	Industrial Air EPC (mg/m^3)	Soil Gas EPC (µg/L)
trichlorotrifluoroethane	2.76E-05	7.57E-06	0.67
1,1,2-trichloroethane	4.19E-07	1.19E-07	0.0225
1,1-dichloroethene	1.24E-06	3.49E-07	0.0582
1,2-dichloroethane	1.52E-07	4.34E-08	0.0103
carbon tetrachloride	8.84E-07	2.50E-07	0.0478
chloroform	2.41E-06	6.77E-07	0.0986
tetrachloroethene	4.54E-05	1.29E-05	2.65
trichloroethene	1.30E-04	3.56E-05	3.11

Acronyms/Abbreviations:
EPC – exposure point concentration
IRP – Installation Restoration Program
µg/L – micrograms per liter
mg/m^3 – milligrams per cubic meter

U.S. EPA residential cancer risk at Site 24 is acceptable (i.e., less than the 10^{-6} point of departure for acceptable risk specified in the NCP) or falls within the 10^{-4} to 10^{-6} range for risk that may be acceptable depending on site-specific and other factors considered appropriate for risk point-of-departure analysis (per NCP Preamble). Likewise, Cal/EPA cancer risk is also acceptable. The difference in the U.S. EPA and Cal/EPA estimated total cancer risks is largely attributable to differing CSFs for TCE recognized by the two agencies.

The noncancer HIs estimated for indoor air exposure under residential and industrial worker scenarios at Site 24 are less than 1. An HI of less than 1 indicates little potential for adverse noncancer health effects to develop. Consequently, the modeled noncancer risks associated with the indoor air inhalation pathway at Site 24 is acceptable.

Cancer risks for Site 24 using U.S. EPA criteria are principally attributable to TCE exposures. However, the CSF for TCE, which was developed by U.S. EPA's National Center for Environmental Assessment, is provisional and subject to change; therefore, the U.S. EPA cancer risk estimates are considered to overestimate the risk.

7.6 SUMMARY OF SITE RISKS

Risks posed by VOCs in soils are below the risk range considered acceptable by the U.S. EPA. However, risks posed by VOCs in groundwater exceed this risk range. In addition, the fate and transport analysis for Site 24 showed that the VOCs in soil had the potential to migrate to groundwater where they might continue to contaminate groundwater at concentrations exceeding respective MCLs. Therefore, it was necessary

to take action to remediate VOCs in soils to prevent further contamination of the groundwater.

On the basis of the indoor air risk evaluation results, Site 24 does not pose unacceptable risks to human health via an indoor air inhalation exposure pathway, because risks are acceptable or may be acceptable depending on site-specific and other factors considered appropriate for risk point-of-departure analysis, per the NCP (BEI 2004). Therefore, no action is required and no restrictions on reuse of this site are necessary relative to this potential exposure route. This conclusion was agreed to by the BCT.

An ecological risk assessment was not required for Site 24 during the RI because it was highly industrialized and did not provide suitable habitat for any endangered or threatened wildlife species. In addition, given the potential reuse of Site 24 (recreational/ institutional), it was unlikely to support suitable habitat for any endangered or threatened wildlife species.

A review of site conditions and COPCs indicates that based on the current use (industrial) and the future reuse (recreational/institutional), there are no significant completed pathways of exposure to ecological receptors. The COPCs at Site 24 consist of VOCs. Wildlife may be exposed to COPCs through three major pathways: dermal contact, inhalation, and ingestion.

Dermal exposure to soil contaminants is considered to be minimal; in addition, bird feathers and the fur of mammals are believed to limit the contact of skin surface with contaminated media. Therefore, dermal exposure is not typically addressed through an ecological risk assessment (U.S. EPA 2003b).

VOCs in soil and soil gas may be transported to ambient air through vapor migration as a consequence of barometric pumping and diffusion. Vapor concentrations in ambient air are diluted and dispersed, resulting in significantly lower exposure than might be observed in indoor air. In contrast, HHRAs usually identify greater potential risk from the inhalation of air in indoor environments. Thus, the potential for ecological exposure through inhalation is considered minimal.

Regarding the potential for ingestion exposure, only those chemicals that are persistent, enter food webs, and/or have the potential to bioaccumulate are generally monitored for the purposes of ecological risk assessment. In general, VOCs have high volatility, low ability to enter food webs, and low potential for bioaccumulation (ORNL 1996). VOCs therefore do not pose a risk to ecological receptors via trophic transfer. In addition, toxicity reference values are generally not available for VOCs in soils. On the basis of these factors, VOCs were not retained as COPCs for ecological receptors. The potential for underestimation of potential ecological risk is considered low based on the success of site remedial actions, which have significantly reduced VOC concentrations in surface soils. The ingestion pathway is potentially incomplete since the remaining VOCs are primarily at the 80- to 100-foot-bgs depth.

7.7 REMEDIAL ACTION FOR VADOSE ZONE SOILS

In response to the Site 24 fate and transport analysis, remedial action for VOCs in soils at Site 24 was conducted. In September 1997, the BCT signed an OU-2A Interim ROD for Site 24 that documented the remedy selected to remove VOCs from the soil. The ROD was interim because it did not address groundwater at Site 24 and because the Navy agreed to reevaluate cleanup levels for soil in the final ROD.

The following RAOs were established in the Interim ROD for soil at Site 24 to assure that VOC-contaminated soils did not continue to contaminate the shallow groundwater unit beneath the site:

- reduce concentrations of VOCs in the VOC source areas to prevent or minimize further degradation of the shallow groundwater unit above the MCL for drinking water
- continue vadose zone remediation until the average VOC soil gas concentrations are below threshold concentrations (concentrations capable of contaminating groundwater above the MCLs)

The selected remedy for remediation of soil at Site 24 was SVE, the U.S. EPA presumptive remedy for VOC-contaminated soil. This process used a vacuum to extract VOC-contaminated vapors from the soil through SVE wells. The following five components of the selected remedy were presented in the Interim ROD:

- construction, operation, and maintenance of an SVE system to remove TCE and other VOCs from the soil
- performance monitoring throughout the predicted 2 to 4 years of remediation
- treatment of VOC-contaminated soil gas (vapors) with activated carbon filters to meet air quality standards prior to discharge to the atmosphere
- confirmatory soil gas sampling at the end of the vadose zone remediation to confirm that average VOC concentrations are too low to contaminate groundwater above the MCLs
- resampling of the vadose zone at the conclusion of groundwater remediation; if the average soil gas concentrations are found to be above the threshold limits, additional vadose zone remediation may be necessary

7.7.1 Development of Cleanup Levels

The Interim ROD established "threshold concentrations" as cleanup goals to determine when cleanup would be complete. Although VOCs in soil did not pose unacceptable risk to human health through ingestion, inhalation, or dermal contact, the primary objective of the cleanup action was to reduce VOC concentrations in soil such that VOCs could not migrate to and act as a continuing source of contamination to groundwater at concentrations exceeding MCLs. These cleanup levels would therefore be protective of groundwater quality and human health.

The DON included language in the Interim ROD (provided by the Santa Ana RWQCB) which explained that the Santa Ana RWQCB did not agree that the method and criteria used for determining threshold concentrations for shutoff of the SVE system complied with State Water Resources Control Board Resolution No. 92-49 or Title 22, *California Code of Regulations*, Section 2550.4 or Section 66264.94. It was the Santa Ana RWQCB's position that the use of a 40-foot mixing zone and a point-of-compliance in the groundwater, and other assumptions used in setting "threshold concentrations," would not necessarily result in cleanup of the vadose zone to the extent technically and economically achievable and at least to a level that assures that contaminants would not discharge into groundwater at concentrations greater than the aquifer cleanup levels for the underlying groundwater. Because the DON agreed to reevaluate the shutoff criteria in the final ROD for Site 24, the Santa Ana RWQCB did not dispute the Interim ROD (SWDIV 1997b).

Soil cleanup goals were established during the design of the SVE system based on soil gas concentrations that would not cause groundwater contamination above MCLs (Table 5-1). It was anticipated at the time that MCLs would be selected as the ultimate groundwater cleanup levels based upon the approved FS Report for groundwater at Sites 18 and 24. MCLs were subsequently selected as the final groundwater cleanup goal in the approved groundwater ROD for OU-1/OU-2A (Sites 18 and 24) (SWDIV 2002).

The soil cleanup goals were further evaluated in the SEOR (Earth Tech 1999). The evaluation concluded that the cleanup goals were derived from very conservative assumptions and were indeed protective of groundwater quality. The soil cleanup goals and the maximum VOC concentrations reported before and after cleanup are presented in Table 7-6. The SEOR also presented an SVE well shutdown strategy that was approved by FFA signatories and incorporated into the Site Closure Report.

The MCLs for TCE (5 µg/L), PCE (5 µg/L), carbon tetrachloride (5 µg/L), and 1,1-dichloroethene (6 µg/L) are currently the same as when the soil gas cleanup goals were established. Therefore, the soil gas threshold values are considered protective based on current standards of protectiveness.

Table 7-6
Site 24 Soil Gas Concentrations and Cleanup Goals
(concentrations in micrograms per liter)

VOC	Maximum Precleanup Concentrations	Soil Gas Cleanup Goals	Average Postcleanup Concentrations
trichloroethene	6,120	27	1.3
tetrachloroethene	192	69	1.1
carbon tetrachloride	31	61	NA
1,1-dichloroethene	447	563	NA

Acronyms/Abbreviations:
NA – not applicable (precleanup concentrations were below cleanup goals)
VOC – volatile organic compound

7.7.2 Establishment of Final Cleanup Levels

In the Interim ROD, it was stated that shutoff criteria or soil gas cleanup goals (Table 7-6) would be reevaluated in this final ROD. The reevaluation of soil gas cleanup goals performed in the SEOR (Earth Tech 1999) meets the intent of that statement in the Interim ROD. The FFA signatories concurred with the cleanup levels in the SEOR, and this is documented in a July 2000 letter (DON 2000). The technical parameters used to develop the soil gas cleanup goals have not changed since July 2000 and, therefore, are still protective of groundwater quality and human health.

Soil gas cleanup goals represent contamination levels that have the potential to contaminate groundwater above the MCLs (SWDIV 1997b). Soil gas cleanup goals are based on the following criteria:

- soil gas extending to the saturated zone
- a 40-foot groundwater mixing zone
- Henry's law equilibrium conditions between soil gas and infiltrating soil moisture
- use of MCLs to define contaminated groundwater

The soil gas cleanup goals were calculated for each contaminant by multiplying its respective groundwater MCL value by a common dilution factor determined by the above criteria and then converting the value to a soil gas concentration based on Henry's law coefficient (Table 5-1). The calculations were developed using site-specific data or, when not available, using conservative values to estimate VOC transport to groundwater. The SEOR also evaluated the diffusion of VOCs from groundwater to assess potential contributions to soil gas concentrations in the vadose zone.

7.7.3 Attainment of Remedial Action Objectives

During SVE system operation, progress reports were submitted monthly to the BCT. These reports documented that significant mass was removed during the initial 6 months of SVE, when VOC concentrations were relatively high. However, very little mass was removed in the final 6 months of SVE because the concentrations had been reduced to low levels. The VOC concentrations had decreased substantially as a result of SVE. Figures 7-1 and 7-2 show the pounds of contaminants removed by the SVE system over time and the typical decline of TCE concentrations in the vapor wells. The graphs show that continued operation of SVE would result in the removal of negligible additional mass. Groundwater concentrations were also monitored, and the VOC concentrations generally declined during SVE operations, which could potentially be a result of the reduction in vadose zone source contamination.

In addition, tests were conducted to confirm that soil gas cleanup goals had been achieved. The tests consisted of continuous sampling over the entire depth of the soil column, also referred to as vertical profiling. The profiling results indicated that residual

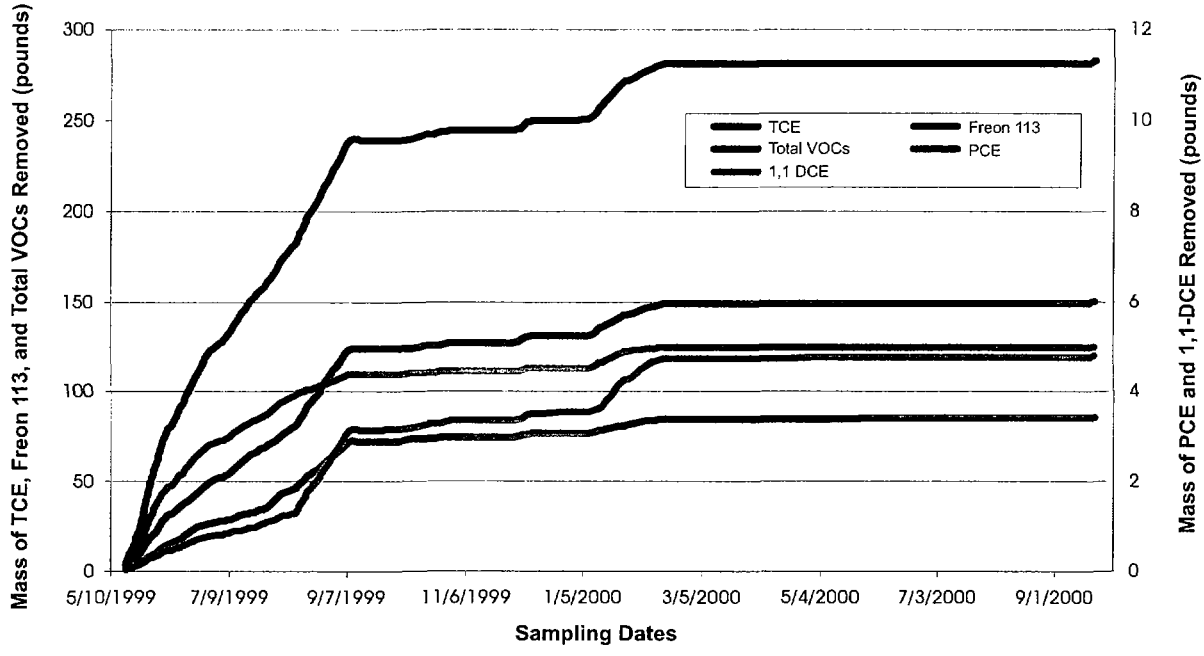


Figure 7-1
Cumulative Mass of VOCs Removed

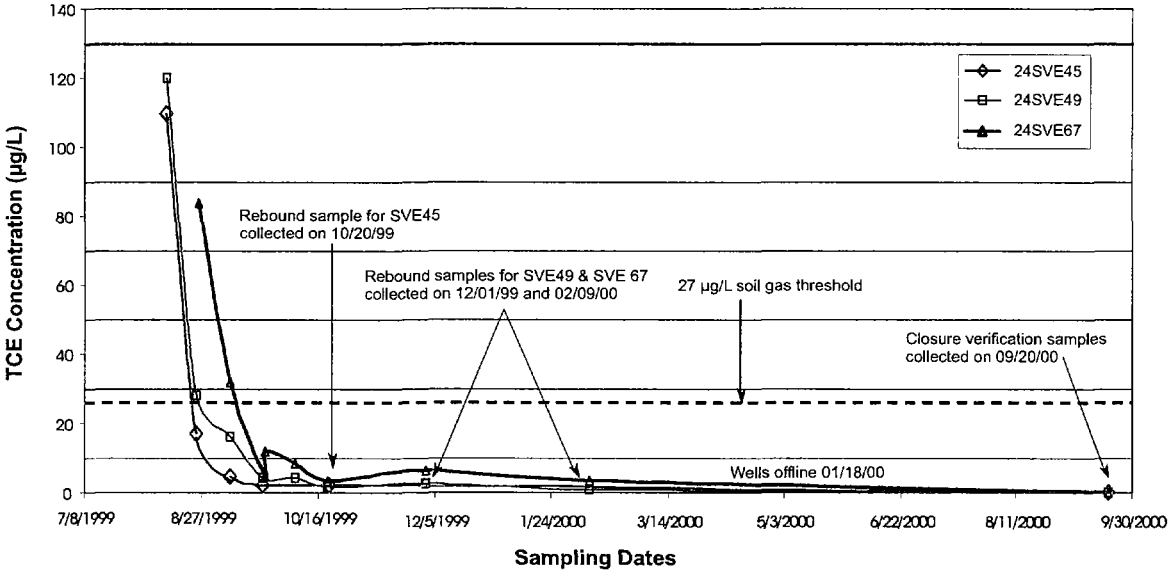


Figure 7-2
Typical Vapor Concentration Decline During Vadose Zone Remediation

contaminants were located primarily in the deep soil directly above groundwater, and that the contaminants were coming from the groundwater to the soil, rather than from the soil to the groundwater. As a result, SVE was included as a potential enhancement to the Site 24 groundwater remedy, as discussed in the ROD for groundwater at Site 24 (SWDIV 2002). During the course of groundwater remedy implementation, SVE may be used to remove VOCs from dewatered zones created by fluctuations in groundwater levels.

In February 2000, a comprehensive sampling of active SVE wells was conducted; results from this sampling event were used to develop a site closure strategy that was presented to the BCT for review and input in April 2000. The strategy involved a systemwide sampling and testing event. A letter dated 26 July 2000 from the DON to the Santa Ana RWQCB summarized the proposed verification sampling strategy and documented regulatory agreement on the reevaluation and acceptability of the soil gas threshold values established in the Interim ROD as soil cleanup criteria (DON 2000).

In September 2000, 7 months after the SVE system was last operated, confirmation samples were collected from SVE extraction wells for analysis. Waiting several months after system shutdown allows for a "rebound" analysis. If significant mass is still present in the soil, the resultant soil gas concentrations will increase, or rebound, over time. However, all soil gas sampling results were below the soil gas cleanup goals, indicating that nearly all the mass had been removed from the soil (Earth Tech 2002). SVE system performance data confirmed that residual VOCs do not pose a risk to groundwater, continued SVE will result in negligible benefit, and background concentrations cannot be achieved.

A Closure Report (Earth Tech 2002) incorporating BCT review comments was issued in June 2002. The BCT concurred with the report conclusions that soil at Site 24 was no longer a source of contamination to groundwater, and the RAOs as specified in the Interim ROD have been attained.

Following remediation, soil gas concentrations are below the threshold concentrations developed to protect groundwater, thus achieving the soil cleanup levels set forth in the Interim ROD. Based on the results of the verification sampling conducted after soil remediation, the vadose zone soils no longer pose a risk to groundwater underlying Site 24. The Navy has remediated the vadose zone to the extent economically and technically achievable and to a level that assures that VOCs will not be released into groundwater at concentrations exceeding respective MCLs for the underlying groundwater.

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Section 8
DESCRIPTION OF NO FURTHER ACTION ALTERNATIVE

The HHRA for Site 24 indicates that soil at the site does not pose an unacceptable risk to human health. Previous to soil remedial action, the primary risk posed by soil contamination at Site 24 was potential impact to groundwater. SVE was used at Site 24 to remove and permanently destroy contaminants from vadose zone soils, thereby significantly reducing the toxicity, mobility, and/or volume of hazardous substances in this medium (SWDIV 1997b). By removing VOCs from the soil, further groundwater contamination was minimized or prevented, thereby reducing the time required for groundwater cleanup as addressed in the ROD for OU-1/OU-2A (Sites 18 and 24) (SWDIV 2002). Accordingly, no further action is appropriate for vadose zone soils at Site 24. However, SVE was incorporated into the groundwater remedy (SWDIV 2002, Weston 2005) and may be selectively applied in dewatered source area zones at Site 24 for mass removal enhancement.

The DON's determination that no further remedial action is necessary for vadose zone soils at Site 24 reflects the determination that site-specific releases from Site 24 to soil do not represent a threat to human health or the environment. Under the no further action alternative, monitoring, periodic reviews, deed restrictions, and CERCLA 5-year reviews are not required. U.S. EPA, DTSC, and Santa Ana RWQCB agree with the no further action determination for vadose zone soil at Site 24. This determination of no further action applies only to vadose zone soil at Site 24 investigated under CERCLA and does not apply to groundwater at Site 24 or any other programmatic activities at Former MCAS El Toro that may fall within the footprint of Site 24.

CERCLA Section 121(d) states that remedial actions at CERCLA sites must, upon completion, attain any federal (or state if more stringent) environmental standards, requirements, criteria, or limitations that are determined to be applicable or relevant and appropriate requirements (ARARs). However, ARARs do not apply unless remedial action is being taken at a site. Therefore, ARARs are not applicable to the no further action remedy for vadose zone soils at Site 24 addressed in this ROD. The previous remedial action complied with ARARs as presented in the Interim ROD.

Although no land-use restrictions are required because of chemicals present in vadose zone soils at Site 24, the shallow groundwater unit underlying the site is contaminated with TCE and PCE. Use restrictions including prohibiting drilling of wells and/or extraction of groundwater and allowing access to install, operate, and maintain equipment and to monitor the remedial action are addressed in the ROD for OU-1/OU-2A (SWDIV 2002).

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Section 9
DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for Site 24 vadose zone soils was released for public comment in July 2005. It identified no further action as the appropriate response for vadose zone soils at this site. The DON reviewed all written and verbal comments submitted during the comment period. Upon review of these comments, it was determined that no significant change to the response, as it was originally identified in the Proposed Plan, was necessary.

An ESD to the Sites 18 and 24 groundwater ROD will be prepared to explain differences between the Interim and final RODs for soils at Site 24 that are associated with groundwater. The primary focus of the ESD will be resampling of the vadose zone at the conclusion of groundwater remediation to assure that soil has not been recontaminated from VOCs in groundwater. This resampling was presented as one of the components of the selected remedy in the Interim ROD for the Site 24 VOC Source Area (Vadose Zone); however, it will be incorporated into the selected remedy for groundwater at Sites 18 and 24.

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RESPONSIVENESS SUMMARY

RESPONSES TO COMMENTS
RECEIVED DURING THE PUBLIC COMMENT PERIOD

RESPONSIVENESS SUMMARY
FORMER MARINE CORPS AIR STATION – EL TORO, CALIFORNIA
DRAFT RECORD OF DECISION FOR OPERABLE UNIT 2A SITE 24 – VOC SOURCE AREA

Comments Received During Public Meeting Held on 27 July 2005

Comments by: ***Don Zweifel, RAB Member***

Number	Comment	Response
1	You know, I must admit that this sounds well good on the surface, however, the thing is, you know, what Andy is saying, "Well, there hasn't been a rebound yet. We only looked at it on a narrow window for seven months of opportunity." I am saying, "Wait a minute." You know, I remember some comments from the employees at MCAS El Toro that told me they buried barrels of contaminants. And why did they do it? I don't know if that's important right now. I can tell you later about why they did it – but actually it had to do with the – if it was a half-filled barrel of PCE, they had to remove that barrel because they wouldn't get a full barrel or – barrels of PCE is vital for cleaning aircraft, they had to have it. The thing is, I'm saying, there are probably barrels buried down here and they are sealed and they are coated, but the thing is, eventually you've got to face it, those barrels are going to leak. They will leak. Maybe they haven't leaked yet, but they eventually will leak. We really don't know – you say, "Oh, we're going to have a site characterization." You have never done a site characterization. You can't. You're not a magician. There is no way you can determine that – you cannot do a characterization of that site. I'm sorry, you can't do it. I mean we would love to, I wish you could, but I know that there are barrels down there. I don't know how many and I know that employees – Miller Jackson, he was in charge with the physical plant at El Toro years ago, and he said that he knows what they did. When the MG inspection was about to come, they buried – he didn't say where. I don't know if he is alive anymore. I talked to him ten years ago about this. And remember, Andy, I told you about this. And, Content, I already mentioned it to her, most of you guys know. I am just reiterating an old song. The thing is, ladies and gentlemen, this is a great concern to me. What is going to happen to those barrels? Right know it appears everything is okay, but the thing is, I think those barrels will eventually leak. And I	The purpose of this Record of Decision (ROD) is to address vadose soil at Operable Unit 2A Site 24. Extensive investigations, including record searches, employee interviews, and soil and groundwater investigations have been performed at this site. Information obtained during record searches and interviews with Former MCAS El Toro personnel was used as part of the input for the design of sampling programs used during the Phase I and II remedial investigations (RIs) at Site 24. Results from the RIs as well as from subsequent feasibility studies and remedial actions at Site 24 were all approved by the regulatory agencies including the United States Environmental Protection Agency (U.S. EPA), California Department Toxic Substances Control (DTSC), and California Regional Water Quality Control Board (RWQCB) Santa Ana Region. No further action (NFA) is recommended for vadose zone soil at Site 24 and therefore no additional monitoring is recommended in the ROD. It should be noted that there will be additional monitoring at Site 24 related to the groundwater cleanup. Information related to groundwater cleanup at Site 24 is contained within the Sites 18 and 24 ROD. The Department of the Navy (DON) also has a comeback policy that states the circumstances under which the DON will return to perform additional cleanup. One of those circumstances is the subsequent discovery of additional contamination attributable to DON activities. This would allow for additional investigation if buried barrels of contaminants where found anywhere on Former MCAS El Toro property in the future.

	don't know how many of them there are, but I am almost sure there are some barrels there. So what I am proposing, if I may, is that continued monitoring of Site 24 on the periphery, downgradient mind you, for, I don't know, maybe, five, ten, 15, 20 years maybe. Because it will take a while for those barrels to leak, especially if they are coated. And most of the barrels were. And you may say, "Well, how long is it going to take to erode a steel barrel?" Who knows. It's hard to say. But I'm saying that eventually those barrels will leak. We tentatively or at least potentially think they are there, that's why I'm proposing – I'm sorry, you're going to have to monitor this site for years and years to come to make sure that those barrels, that are probably there, don't leak. And if they do leak, then you're going to have to come back and – see I'm worried about the City of Irvine and Lennar and – because you're going – I mean restrictive covenants on this site, until you can guarantee that. If you want to sign off on this and say, "There is not going to be any more contamination from this site. You can go ahead." Well, that's great, but your neck should be on the line. And if they find that these barrels have leaked, if they are truly there, well, then you are going to have to come back, the Navy is going to have to come back and solve that problem. And you're going to have to promise that – the Department of the Navy is going to have to promise us that they are not going to leak. And if they do, you are going to have to come back and remediate.	

RESPONSIVENESS SUMMARY
FORMER MARINE CORPS AIR STATION – EL TORO, CALIFORNIA
DRAFT RECORD OF DECISION FOR OPERABLE UNIT 2A SITE 24 – VOC SOURCE AREA

Comments Received During Public Meeting Held on 27 July 2005

Comments by: ***Greg Hurley, City of Laguna Beach, RAB Member***

Number	Comments	Responses
1	Don's comment reminded me of the late Dr. Chuck Bennett's concern years ago, that the source area of the groundwater of VOCs was not Site 24, it was actually much more dispersed in general. There is no evidence of that, but just a comment, I believe going back for the ten plus years we've been here, that maybe Site 24 isn't the source area; notwithstanding that we have the Desalter in place with groundwater controls. But the reality, I think what Don is saying, if I am paraphrasing it, is there is probably other contaminated soil out there and Site 24 isn't the end of it. And notwithstanding the fact they are still open to mediation, I don't know if there is any investigations.	The purpose of this ROD is to address vadose zone soil at Site 24. Results presented in this ROD, which have been approved by the U.S. EPA, DTSC, and RWQCB, indicate that contaminants in vadose zone soil at Site 24 will no longer impact groundwater at concentrations exceeding regulatory threshold values. The potential presence of other sources of groundwater contamination at Former MCAS El Toro is beyond the scope of this ROD. However, as stated in the response to Don Zweifel's comment, the DON's comeback policy would allow for additional investigation if previously unknown contaminants which are attributable to Station activities where found anywhere on Former MCAS El Toro property in the future. In addition, there are still ongoing investigation/cleanup activities at being conducted at Former MCAS El Toro pursuant to the Federal Facility Agreement. There is a potential that additional contamination could be discovered and addressed during these ongoing activities.

RESPONSIVENESS SUMMARY
FORMER MARINE CORPS AIR STATION – EL TORO, CALIFORNIA
DRAFT RECORD OF DECISION FOR OPERABLE UNIT 2A SITE 24 – VOC SOURCE AREA

Comments Received During Public Meeting Held on 27 July 2005

Comments by: ***Peter Hersh***

Number	Comment	Response
1	I would like to pick up a little bit at, you're looking at an interim ROD having an issue, we concluded this process back in January of 2000, it's now five years later. I guess my comment would be something to the effect, we have in slides Nos. 19 and 20 – if we can confirm that the maximum of post-cleanup concentrations have not changed over time, I think that would help in my comfort level. And I don't know if that's where Don was doing on his comment, but the five years have passed, maybe nothing has changed, maybe the cleanup is fully completed, but I think that would help the conclusion that we're not being asked to support a ROD, and I think it's valid. But if there is something that could be done and responded to help our comfort level based on your experience and maybe the experience at Norton that there is little or no likelihood that these levels will go up. That's my comment.	The soil vapor extraction (SVE) system at Site 24 was shut down in January 2000. A comprehensive sampling of SVE wells at Site 24 in February 2000 indicated that soil gas concentrations were below site cleanup goals. In September 2000, approximately 7 months later, additional samples were collected in the SVE wells. Waiting several months allowed for a "rebound" analysis. If significant contaminant mass was still present in the soil at Site 24 resultant soil gas concentrations should have increased. However, soil gas concentrations generally decreased slightly and stayed below site cleanup goals. Based on the contaminant trends, the rebound concentrations, and the consistently low VOC concentrations in the soil at Site 24 (see Figure 7-1 and 7-2 in the ROD), the residual VOCs have been reduced to concentrations that are below thresholds that would impact groundwater above drinking water standards. Therefore, there is little or no likelihood that these concentrations will increase to concentrations that would impact groundwater above the drinking water standards in the future. In addition, the groundwater remedy for Site 24 has provisions to use SVE as a means of removing VOCs at the source areas once the water table is lowered by groundwater extraction.

RESPONSIVENESS SUMMARY FORMER MARINE CORPS AIR STATION – EL TORO, CALIFORNIA DRAFT RECORD OF DECISION FOR OPERABLE UNIT 2A SITE 24 – VOC SOURCE AREA		
Comments Received During Public Meeting Held on 27 July 2005		
Comments by: ***Larry Laven***		
Number	**Comments**	**Responses**
1	And if the soil vapor extraction works so well in the soil, how come they don't just pump up the water, let it run down into the soil and use it to clean the water as it seeps through the soil, if it works so well? It's going to take, what, 60 years, 50 years to clean this water? And you say that to get this stuff out of the soil is a cinch, compared to getting it out of the water. So why don't they just pump it up, let it go down through the soil and extract it?	One of the primary purposes of any active remediation system is to prevent contaminant migration as well as contamination of additional media. Pumping contaminated groundwater through soil would increase the volume of contaminated media and reverse the remedial process already performed for vadose zone soils at Site 24. In addition, contaminants such as those in groundwater at Site 24 can be much more efficiently removed from groundwater though an *ex situ* physical processes such as air stripping and carbon treatment. The amount of time needed for a groundwater cleanup is related to the time needed for extraction and not the removal of contaminants from groundwater. More details about groundwater cleanup at Site 24 can be found in the Sites 18 and 24 ROD.

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ATTACHMENT A

ADMINISTRATIVE RECORD FOR SITE 24
(on CD)

ATTACHMENT B

TRANSCRIPT FROM PUBLIC MEETING
(on CD)

UNSCANNABLE MEDIA

To use the unscannable media document # 2096906
contact the Region IX Superfund Records Center
at 415-536-2000.

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