Supplemental Vertical Profiling

Requa Air Force Station
Formerly Used Defense Site
Klamath, California

March 2003

Report prepared for:

U.S. Army Corps of Engineers
Sacramento District

Prepared by:
EM Assist
Folsom, CA

Acknowledgements

EM Assist would like to acknowledge the assistance provided by staff of the National Park Service Requa Maintenance Facility in the conduct of this effort and preparation of this report. Specifically, we would like to acknowledge the assistance of Mr. Steve Carlton of the National Park Service.

Disclaimer

The recommendations of this report are based on environmental information collected at the former Requa Air Force Station (now National Park Service Requa Maintenance Facility) by various organizations including the U.S. Army Corps of Engineers and other organizations some of which were contracted by the U.S. Army Corps of Engineers and other. The recommendations of this report are based on the professional judgment of EM Assist staff and do not necessarily reflect the official position of the U.S. Army Corps of Engineers.

Acceptance of this document in performance of the contract under which it is prepared does not mean the U.S. Army Corps of Engineers adopts the conclusions, recommendations, or other views expressed herein, which are those of EM Assist staff only. Background information, design bases, and other data have been furnished to EM Assist by the U.S. Army Corps of Engineers or third parties, which EM Assist has used in preparing this document. EM Assist has relied on this information as furnished, and is not responsible for and has not confirmed its accuracy. This document has been prepared based on assumptions made by EM Assist, which may substantially affect the conclusions and recommendations of this report. These assumptions, although thought to be reasonable and appropriate, may not prove true in the future. EM Assist conclusions and recommendations are conditioned upon these assumptions.

Certification Statement

This report was prepared under my responsible charge. The report is based upon available data provided by the U.S. Army Corps of Engineers and others, which EM Assist has used in preparing this document. To the best of my knowledge, this report is current as of its date of issue. EM Assist has relied on this information as furnished, and is not responsible for and has not confirmed its accuracy.

Timothy Chapman
Registered Professional Engineer, California
C60973 Exp. 12/04

1.0 Introduction and Background

This document describes the fieldwork conducted on behalf of the U.S. Army Corps of Engineers (USACE) at the Requa Air Force Station (Requa) Formerly Used Defense Site (FUDS).

1.1 Site Location and History

Requa Air Force Station was established and activated on. 1 June 1949 and assigned to the Tenth Air Force, with logistical support from Kinsley Field. The property was originally leased in 1950 and then acquired from P.J. Murphy, *et al.*, by condemnation filed on 3 August 1955. Approximately 43 acres were acquired in fee and an additional 10 acres of easement interests were also acquired from the Murphy's. The Air Force constructed 64 buildings and 27 family housing units on the Requa sites, totaling 141,000 square feet. The mission of the station was an Aircraft Control and Warning Site in the developing air defense system during the 1970's.

The Requa property was determined to be excess to the Air Force because the radar functions were being transferred to the Federal Aviation Administration (FAA) as part of the Joint Surveillance System (JSS). Title 10 clearance was obtained from the Armed Services Committee in March 1981 and the Requa property (and the observation post) were reported to the General Services Administration (GSA) for disposal in May 1981. Approximately 2 fee acres were transferred to the FAA for a JSS site. The remaining 41 fee acres were transferred to the National Park Service (NPS) by the GSA on 10 March 1983. According to Mr. Joseph Lusa, Chief of Maintenance Division, Redwood National Park, the last Air Force personnel moved out in 1990. The Requa facilities are currently used as storage areas for NPS and California Conservation Corps (CCC) equipment, as maintenance shops, administrative offices, or as originally intended (*e.g.*,, the mess hall facility).

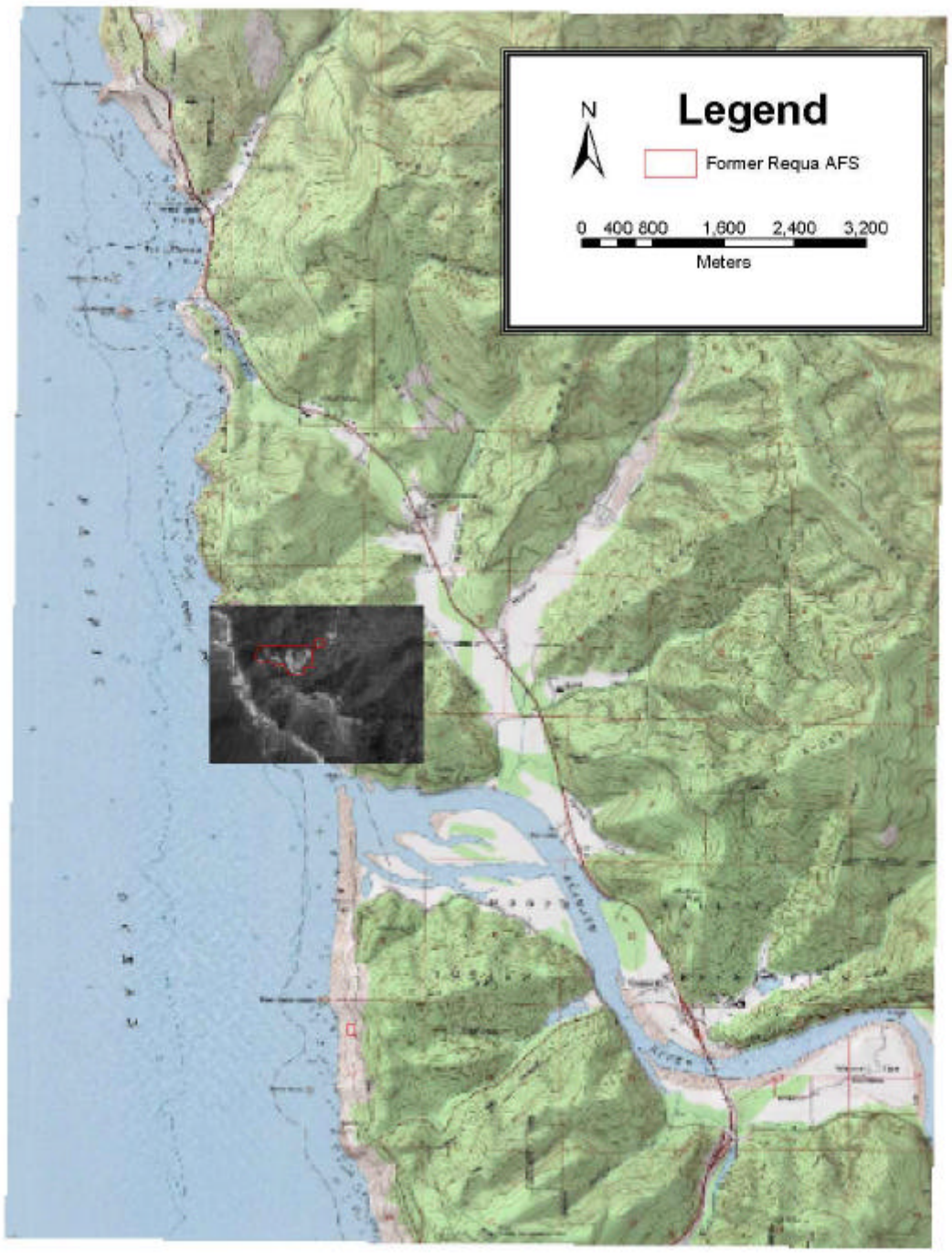

Figure 1. Location of former Requa Air Force Station

1.2 Previous Remedial Actions

In 1994, IT Corporation, under contract to the USACE, performed an inspection and removal of transformer and drums from Requa. In December 2000, Cape Environmental Management, under contract to the USACE, inspected and removed the contents of seven USTs (*i.e.*, Tanks 1, 2, 3, 4, 5, 6, and 7) at Requa. Tank 1 was determined to have an approximate 300-gallon capacity and approximately 40 gallons of residual liquid were removed. Approximately 2,000 gallons of liquid were removed from Tank 2, which has an estimated capacity of 10,150 gallons. Tank 3 was determined to have an estimated capacity of 1,000 gallons and approximately 400 gallons of liquids were removed. Tank 4 was inspected and no liquids were found. Tank 5 was reported to have a capacity of 750 gallons. During this effort, approximately 190 gallons of liquid was removed. Approximately 30 gallons of liquids were removed from Tank 6, which had a reported estimated capacity of 2,100 gallons. Tank 7 had an estimated capacity of 50 gallons; however, 70 gallons of liquid were removed. (CAPE, 2001).

In 2002, CAPE Environmental Management clean and removed the seven USTs (*i.e.*, Tanks 1-7) and three above-ground storage tanks (ASTs 1 to 3). Contaminated soils were found during the removals of Tanks 1, 2, 3, 5, 6, and 9. See CAPE 2002 for more details.

1.3 Scope of Investigations

As the vertical extent of the soil contamination from several of the tanks was not determined during the removal activities, the USACE determined to perform supplemental vertical profiling to assist in scoping future investigative efforts. The scope of this effort was limited to performing vertical profiling in the areas of several of the removed USTs and ASTs, assessing potential impacts from non-FUDS sources (*i.e.*, the abandoned OWS on the FAA property)), and a background location.

The general procedure followed for this profiling was to conduct a boring taking soil samples at discrete intervals until groundwater was encountered where a sample would be taken. Generally, the boring was to continue downward until a second groundwater zone was encountered, the auger was refused by the formation, or a total depth of 150 feet was reached. Soil samples were to be taken at 5 foot intervals from where native

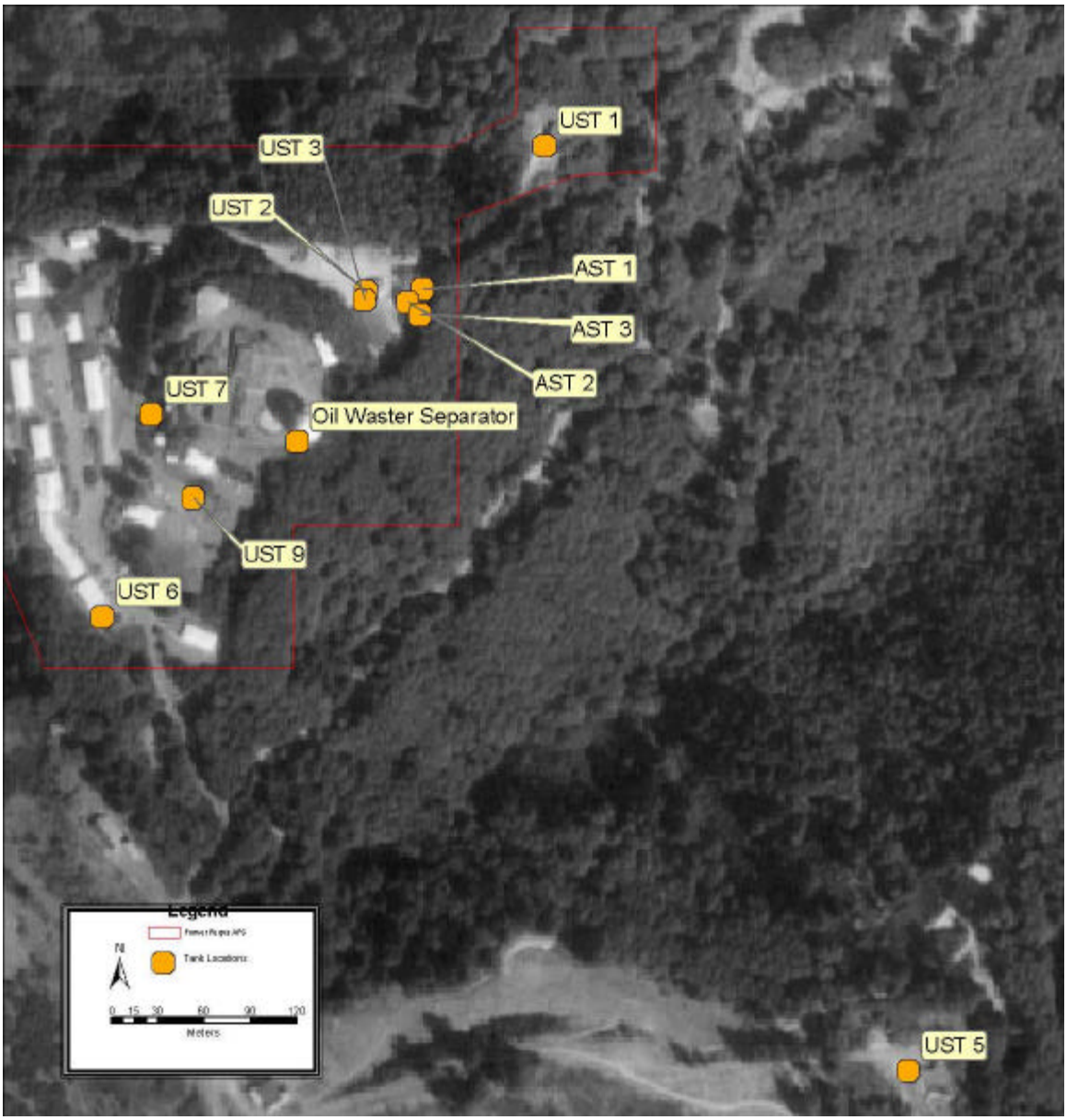

Figure 2. Location of Above- and Below-ground Storage Tanks

material was encountered (beneath the removed tank) for the first 25 feet changing to 10 foot intervals for all deeper depths. Soil and groundwater samples were to be analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX); methyl tert-butyl ether (MTBE); total petroleum hydrocarbons (TPH) as measured in the gasoline (TPH-g) and diesel range (TPH-d); and the five Leaking UST metals (*i.e.*, cadmium, chromium, lead, nickel, and zinc).

2.0 Field Investigations

The following sections describe the fieldwork conducted during 2002.

2.1 Introduction

On August 14, 2002, personnel from TRW and its subcontractors Gregg Drilling and Tetratech, Inc., mobilized to the Requa site and began sampling. From the mobilization through demobilization on August 21, 2002, a total of eight soil borings with accompanying groundwater samples were taken (See Figure 3). Table 1 presents a summary of the soil borings and samples taken during the site investigation.

Table 1. Sampling Summary

Sample ID	Location	Maximum Depth [ft bgs]	Sample	
			Soil	Groundwater
Requa B1	Near AST 2	85	12	1
Requa B2	Tank 3, Building 4120	70	8	1
Requa B3	Tank 6, near CCC	60	8	1
Requa B4	Tank 1, near Building 4150	30	5	1
Requa B5	Oil Water Separator, FAA area	25	5	1
Requa B6	Near Carpenter's Shop	25	5	1
Requa B7	Tank 5, Near GATR	40	8	1
Requa B8	Tank 9, near Plumbing Shop	45	7	1
IDW-1	IDW Pile	n/a	1	-
IDW-2	IDW Pile	n/a	1	-
IDW-3	IDW Pile	n/a	1	-
IDW-4	IDW Pile	n/a	1	-

ft bgs - feet below ground surface B - boring IDW - Investigative derived waste

2.2 Drilling Activities and Geology

Drilling was conducted using a standard drill rig equipped with hollow-stem augers and modified California split-spoon samplers. Groundwater was encountered at between 9 and 53 feet below ground surface (bgs). The deepest groundwater was found in the areas on the top of the ridge on the FAA property and in areas bordering the steep reliefs leading from the ridge to the Pacific Ocean.

On average, the shallow groundwater aquifer was found to be approximately 20 to 25 feet thick over the Requa site. Soils from the ground surface to the underlying basalt formation consist of silty and clayey sands and silts. A confining layer of slightly weathered, dense to very dense basalt was found beneath the shallow aquifer in all

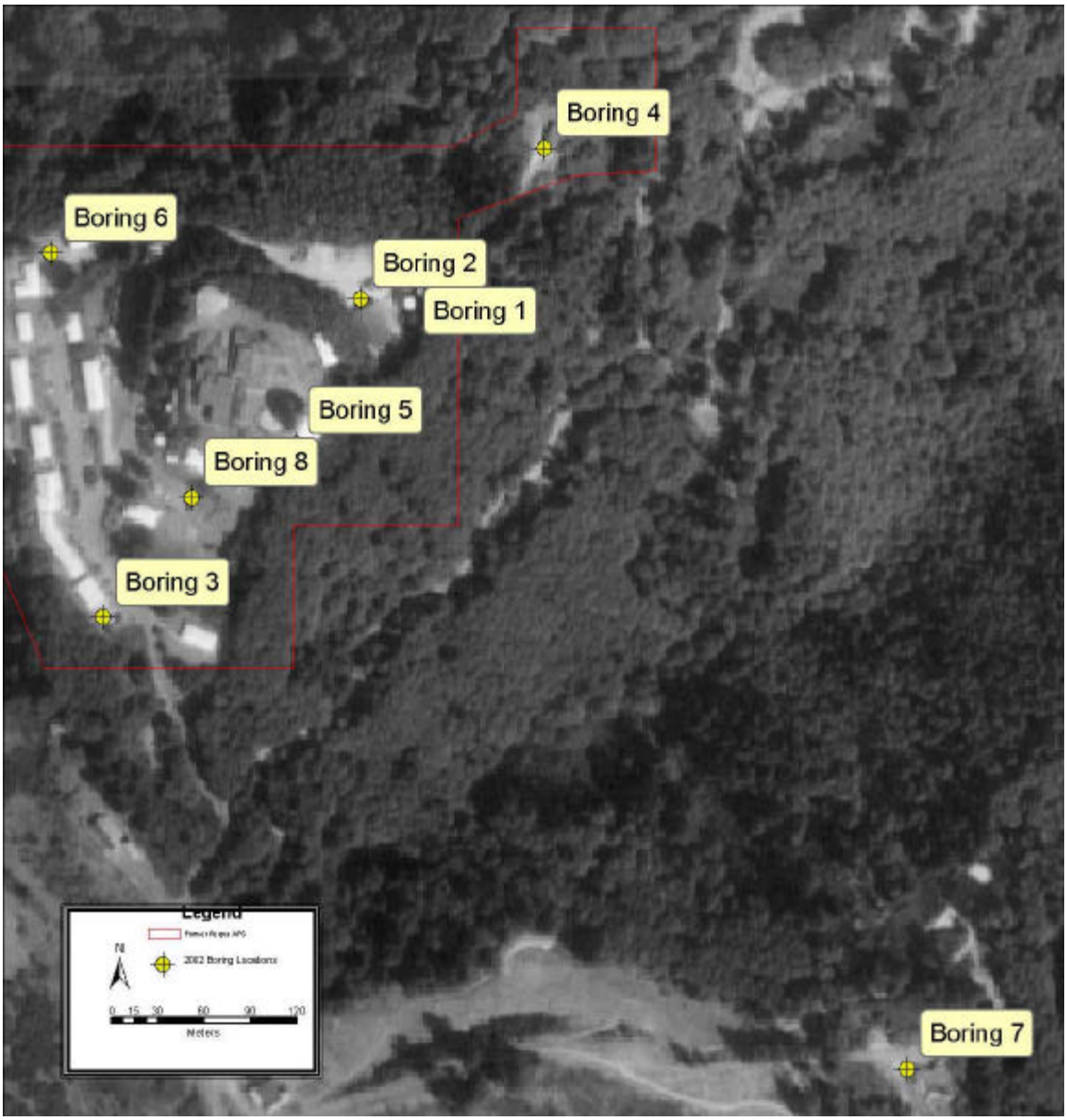

Figure 3. Location of Soil Borings

borings. The thickness of this layer could not be determined due to refusal of the drilling equipment used, however from the data collected it appears to extend at least 60 feet below the shallow groundwater zone. While there is insufficient information to assess whether fracturing has occurred within the basalt formation, the depth and density of the formation would tend to support that a pathway for vertical migration of groundwater from the shallow to deeper zones in this area does exist. More detailed information on the geology can be found in Attachment 1.

2.3 Results of Sampling

The following sections present the results of this sampling effort.

2.3.1 Above Ground Storage Tanks

Table 2 presents the results of the vertical profile conducted in the area of the three removed ASTs. A summary of the results of the sampling performed during tank removal is presented in Table 3. TPH-d and TPH-g were measured above laboratory detection limits in the soils in the area of the ASTs. TPH-d, TPH-g, ethylbenzene, and m,p-xylene, and o-xylene were measured in the soils of the saturated zone. TPH-d was measured in the groundwater sample taken in this area.

Cadmium, chromium, lead, nickel, and zinc were measured in soil samples taken from the area of the ASTs. Lead, nickel, and zinc were measured in the groundwater sample.

2.3.2 Tanks 2 and 3

Table 4 presents the results of the vertical profile conducted in the area of Tanks 2 and 3. A summary of the results of the sampling performed during tank removal is presented in Tables 5 and 6. TPH-d, TPH-g, toluene, ethylbenzene, and total xylenes were measured above laboratory detection limits in the soils in the area of Tanks 2 and 3. TPH-d, TPH-g, and m,p-xylene were measured in the groundwater sample taken in this area.

Cadmium, chromium, lead, nickel, and zinc were measured in the soils above laboratory detection limits. Chromium, lead, nickel, and zinc were measured in the groundwater sample taken in this area.

Table 2. Sample Results from Boring 1, near AST Number 2

Depth	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/kg						mg/kg						
5	< 4.9	< 4.9	< 4.9	< 4.9	< 4.9	< 20	**910 HY**	**2.1 HY**	1.6	30	42	70	77
10	< 5.0	< 5.0	65	< 5.0	< 5.0	< 20	**2.8**	**16 HY**	2.2	26	28	57	110
15	< 5.4	< 5.4	**160 C**	**39 C**	**250 C**	< 22	**3000**	**41 HY**	2.1	29	25	66	120
20	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 20	< 1.1	< 1.0	2.2	37	20	71	94
26	< 4.9	< 4.9	< 4.9	< 4.9	< 4.9	< 20	**6.4**	< 0.98	2.4	38	22	76	100
29.5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 20	**19**	< 0.99	2	32	18	63	85
35	< 5.1	< 5.1	< 5.1	< 5.1	< 5.1	< 20	**1.2 Y**	< 1.0	2.5	33	22	71	91
45	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 20	< 1.0	< 0.99	1.9	24	22	49	77
55	< 4.9	< 4.9	< 4.9	< 4.9	< 4.9	< 20	< 1.1	< 0.98	2.3	37	17	68	96
65	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8	< 19	< 1.0	<0.95	2.1	35	18	61	82
75	< 4.9	< 4.9	< 4.9	< 4.9	< 4.9	< 20	< 1.1	< 0.98	2.9	35	40	89	130
85	< 5.1	< 5.1	< 5.1	< 5.1	< 5.1	< 20	< 1.1	< 1.0	2.4	36	18	69	99
	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
14H	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	**950**	< 50	< 5.0	< 10	3.6	38	46

C - Compound confirmed in sample H - Compound heavier than laboratory standard Y - Unknown single or multiple peaks that do not match the laboratory standard

Table 3. Previous Sampling Summary, ASTs

Sample	Depth	Compound	Concentration	
1-001	1.5	TPH-d	290	mg/kg
		TPH-g	1.7	mg/kg
1-002	1.5	TPH-d	5.1	mg/kg
2-001	1.5	TPH-d	81	mg/kg
		TPH-g	2.4	mg/kg
2-002	1.5	TPH-d	160	mg/kg
3-001	1.5	TPH-d	1700	mg/kg
3-002	1.5	TPH-d	320	mg/kg
		TPH-g	4	mg/kg

2.3.3 Tank 6

Table 7 presents the results of the vertical soil profiling conducted in the area of Tank 6. Table 8 presents a summary of the soil samples taken during the removal of this tank. Ethylbenzene, o-xylene, TPH-d, and TPH-d were measured in the vadose zone in the area of Tank 6. Ethylbenzene, m,p-xylene, TPH-d, and TPH-g were measured in the groundwater sample taken.

Cadmium, chromium, lead, nickel, and zinc were measured in the soils above laboratory detection limits. Chromium, lead, nickel, and zinc were measured in the groundwater sample taken in this area.

2.3.4 Tank 1

Table 9 presents the results of the vertical profiling sampling. TPH-d was measured in one sample during previous sampling events (See Table 10). No organic compounds were measured in the groundwater.

Cadmium, chromium, lead, nickel, and zinc were measured in the soils above laboratory detection limits. Chromium, lead, nickel, and zinc were measured in the groundwater sample taken in this area.

2.3.5 FAA Oil-Water Separator

Table 11 presents the results of the vertical profiling sampling. TPH-d was the only organic compound measured in one shallow soil sample. No organic compounds were measured in the groundwater.

Cadmium, chromium, lead, nickel, and zinc were measured in the soils above laboratory detection limits. Chromium, lead, nickel, and zinc were measured in the groundwater sample taken in this area.

2.3.6 Downgradient Sample Location

Table 12 presents the results of the vertical profiling conducted in an unimpacted area potentially downgradient from several of the UST locations. TPH-d was measured at very low levels in this soil sample.

Table 4. Sample Results from Boring 2, in Front of Building 4120 Machine Shop (Tank 3)

	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
Depth	ug/kg						mg/kg						
15	< 5.5	< 5.5	< 5.5	< 5.5	< 5.5	< 22	**2**	< 1.1	1.6	24	15	52	77
20	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8	< 19	**7**	< 0.95	2.2	31	17	63	94
25	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 20	< 0.99	< 1.0	1.5	29	14	48	66
30	< 4.7	< 4.7	< 4.7	< 4.7	< 4.7	< 19	< 1.0	< 0.94	2.3	29	22	67	91
35	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8	< 19	< 1.0	< 0.96	1.9	29	16	58	79
40	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 20	< 1.0	< 1.0	2.1	37	19	70	93
50	< 4.7	< 4.7	< 4.7	< 4.7	< 4.7	< 19	< 1.0	< 0.94	1.8	29	14	55	79
60	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	< 1.0	< 1.1	1.7	28	15	52	76
70	< 4.8	< 4.8	< 4.8	< 4.8	< 4.8	< 19	< 1.0	< 0.96	1.9	29	15	56	87
	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
11.3H	< 0.5	< 0.5	< 0.5	**0.56**	< 0.5	< 2.0	**18000**	**61 HY**	< 5.0	14	4.5	80	88

Table 5. Previous Sample Result Summary, Tank 2

Sample	Depth	Compound	Concentration	
2-001	9.5	TPH-d	110	mg/kg
		TPH-g	9.9	mg/kg
2-002	14.5	TPH-d	7100	mg/kg
		TPH-g	660	mg/kg
		toluene	5.7	µg/kg
		ethylbenzene	15	µg/kg
		Xylenes	41	µg/kg

Table 6. Previous Sample Results Summary, Tank 3

Sample	Depth	Compound	Concentration	
3-001	14	TPH-d	23	mg/kg
3-002	14	TPH-d	220	mg/kg
		TPH-g	43	mg/kg

Table 7. Boring 3, near CCC Building (Tank 6)

Depth	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/kg						mg/kg						
11	< 5.1	< 5.1	< 5.1	< 5.1	< 5.1	< 20	**39 HY**	< 1.0	1.7	53	19	64	60
15	< 5.1	< 5.1	**27 C**	< 5.1	**34 C**	< 20	**1100**	**8.5 HY**	2.1	76	19	67	60
20	< 5.4	< 5.4	< 5.4	< 5.4	**16 C**	< 22	**2.5 Y**	**9.3 HY**	2.3	44	25	68	100
25	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	**3.6 HY**	< 1.1	0.87	17	12	29	44
30	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2	< 21	**1.2 HY**	< 1.0	1.2	25	15	45	64
40	< 4.5	< 4.5	< 4.5	< 4.5	< 4.5	< 18	< 1.2	< 0.91	1.3	32	12	66	69
50	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2	< 21	< 1.2	< 1.0	0.91	23	11	60	61
60	< 4.7	< 4.7	< 4.7	< 4.7	< 4.7	< 19	< 1.1	< 0.94	2.2	95	23	130	98
	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
53H	< 2.5	< 2.5	**25 C**	**8.3**	< 2.5	< 10	**770000**	**8400 HY**	< 5.0	11	7.7	180	300

Table 8. Previous Sample Results Summary, Tank 6

Sample	Depth	Compound	Concentration	
6-001	3	TPH-d	75	mg/kg
6-002	14.5	TPH-d	1300	mg/kg
		TPH-g	7.6	mg/kg

Table 9. Boring 4, Tank 1 near Electrical Shop

Depth	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/kg						mg/kg						
11	< 4.9	< 4.9	< 4.9	< 4.9	< 4.9	< 20	< 1.1	< 0.98	1.5	18	28	48	65
15	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	< 1.1	< 1.1	1.5	18	21	32	67
20	< 5.4	< 5.4	< 5.4	< 5.4	< 5.4	< 20	< 1.1	< 1.1	2.1	22	27	45	86
25	< 5.1	< 5.1	< 5.1	< 5.1	< 5.1	< 20	< 1.1	< 1.0	1.9	23	16	40	69
30	< 5.1	< 5.1	< 5.1	< 5.1	< 5.1	< 20	< 1.1	< 1.0	1.7	20	18	37	66
	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
26H	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 50	< 50	< 5.0	< 10	21	21	60

Table 10. Summary of Previous Sampling, Tank 1

Sample	Depth	Compound	Concentration	
1-002	8	TPH-d	23	mg/kg

Table 11. Boring 5, Oil-Water Separator near former FAA Radar Tower

Depth	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/kg						mg/kg						
5	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0	< 24	36 HY	< 1.2	0.9	95	6.2	350	27
10	< 6.3	< 6.3	< 6.3	< 6.3	< 6.3	< 25	< 1.3	< 1.3	2.1	95	6.2	350	27
15	< 7.1	< 7.1	< 7.1	< 7.1	< 7.1	< 28	< 1.4	< 1.4	1.6	47	20	63	61
20	< 5.7	< 5.7	< 5.7	< 5.7	< 5.7	< 23	< 1.1	< 1.1	1.2	50	12	54	61
25	< 5.6	< 5.6	< 5.6	< 5.6	< 5.6	< 23	< 1.1	< 1.1	1.7	48	20	68	90
30	< 6.3	< 6.3	< 6.3	< 6.3	< 6.3	< 25	< 1.2	< 1.3	0.47	14	10	19	30
35	< 5.6	< 5.6	< 5.6	< 5.6	< 5.6	< 23	< 1.2	< 1.2	1.5	40	13	60	86
45	< 5.5	< 5.5	< 5.5	< 5.5	< 5.5	< 22	< 1.1	< 1.1	1.5	42	24	59	74
	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
45H	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 50	< 50	2.8 J	4.0 J	25	57	160

J - Compound concentration reported as estimated by laboratory

Table 11a. Summary of Previous Sampling, FAA OWS May 2001 CAL Inc Report

Compound	Sample ID	Depth [ft bgs]	Concentration	Units
bis (2-ethylhexyl) phthalate	OFS-1	0.5	0.134	mg/kg
toluene	SB-1	2	7	µg/kg
tce	SB-3	4	8	µg/kg
napthalene	SB-1	2	8	µg/kg
napthalene	SB-3	4	20	µg/kg
1,2,4-trimethylbenzene	SB-3	4	12	µg/kg
m,p-xylene	SB-1	2	10	µg/kg
m,p-xylene	SB-3	4	9	µg/kg
TPH-d	SB-1	2	19	mg/kg
TPH-g	OFS-1	1	0.56	mg/kg
TPH-mo	SB-1	2	530	mg/kg
TPH-mo	SB-2	8	40	mg/kg
TOG	SB-1	2	14,000	mg/kg
TOG	SB-2	8	450	mg/kg
TOG	SB-3	4	23	mg/kg
TOG	SB-4	4	40	mg/kg
TOG	OFS-1	0.5	47	mg/kg
TOG	OFS-1	1	43	mg/kg
Sept 2001 CAL Inc Report				
TOG	SB-5	2	14,000	mg/kg
TOG	SB-5	4-6	37	mg/kg
TOG	SB-5	9.5	21,000	mg/kg
TPH-mo	SB-5	2	410	mg/kg
TOG	SB-6	8	10	mg/kg
TOG	SB-6	10	59	mg/kg
TOG	SB-7	10	13	mg/kg
TOG	SB-8	4	4,600	mg/kg
TOG	SB-8	10	540	mg/kg
TOG	SB-8	15	ND	mg/kg
TOG	SB-8	20	ND	mg/kg
TOG	OFS-6	1	29	mg/kg
TOG	OFS-6	2	14	mg/kg
TOG	OFS-6	3	2,100	mg/kg
TPH-d	OFS-6	1	35	mg/kg
TPH-mo	OFS-6	1	360	mg/kg
TPH-mo	OFS-6	3	230	mg/kg

Cadmium, chromium, lead, nickel, and zinc were measured in the soils and groundwater above laboratory detection limits.

2.3.7 Tank 5

Table 13 presents the summary of samples taken during the vertical profiling near Tank 5. A summary of the previous samples is presented in Table 14. TPH-d and TPH-g were measured in the soils in the vadose zone. No target organic compounds were measured in the groundwater or soils in the saturated zone.

Cadmium, chromium, lead, nickel, and zinc were measured in the soil samples. Chromium, lead, nickel, and zinc were measured above laboratory detection limits in the groundwater.

2.3.8 Tank 9

Table 15 presents the results of the vertical profiling near Tank 9. A summary of the previous sampling is presented in Table 16. Benzene, ethylbenzene, xylenes, TPH-d, and TPH-g were measured in the soils in vadose and saturated zones. Benzene, ethlylbenzene, xylenes, TPH-g, and TPH-d were measured in the groundwater sample.

Cadmium, chromium, lead, nickel, and zinc were measured in the soils and groundwater above laboratory detection limits.

2.3.9 Soils Piles

Table 17 presents the results of sampling of the excavation overburden from the removal of the USTs during 2002 (*i.e.*, the Investigative Derived Waste [IDW]). TPH-d and TPH-g were measured in the soil samples.

2.4 Evaluation of Sampling Results

The following sections evaluate the sampling results from the tank removal and from the supplemental vertical profiling conducted in 2002.

Table 12. Boring 6, Unimpacted Area near Carpenter's Shop

	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
Depth	ug/kg						mg/kg						
5	< 8.5	< 8.5	< 8.5	< 8.5	< 8.5	< 34	2.7 HY	< 1.7	1.9	80	23	74	79
10	< 7.9	< 7.9	< 7.9	< 7.9	< 7.9	< 31	< 1.6	< 1.6	1.9	90	23	91	89
15	< 6.6	< 6.6	< 6.6	< 6.6	< 6.6	< 26	< 1.3	< 1.1	2.1	27	30	62	130
20	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	< 1.1	< 1.1	1.7	31	18	55	86
25	< 5.6	< 5. 6	< 5.6	< 5.6	< 5.6	< 23	1.2 HY	< 1.1	0.91	18	13	31	55

	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
22H	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 50	< 50	0.64 J	6.7 J	49	40	84

Table 13. Boring 7, Tank 5 near GATR Building

	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
Depth	ug/kg						mg/kg						
5	< 6.2	< 6.2	< 6.2	< 6.2	< 6.2	< 25	**350 H**	< 1.2	2	27	24	58	180
10	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	**2600**	**0.75J**	2	26	20	57	100
15	< 5.6	< 5.6	< 5.6	< 5.6	< 5.6	< 22	**1800**	**5.2 HY**	2.1	29	22	54	80
20	< 5.6	< 5.6	36 C	< 5.6	< 5.6	< 22	**20 L**	**21 HY**	2	35	20	62	120
25	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	**4.9**	**0.25 J**	1.5	26	26	56	91
30	< 5.5	< 5.5	< 5.5	< 5.5	< 5.5	< 23	< 1.1	< 1.1	1.9	28	17	58	98
35	< 5.5	< 5.5	< 5.5	< 5.5	< 5.5	< 22	1.4 Y	< 1.1	2.3	36	16	66	120
40	< 5.1	< 5.1	< 5.1	< 5.1	< 5.1	< 21	110	< 1.0	1.9	30	19	59	110

	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
33	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 50	< 50	< 5.0	2.2 J	3.8	6.7 J	56

L - Compound lighter than laboratory standard

Table 14. Summary of Previous Sampling, Tank 5 replace date from Cape Samples 5-001 and 5-002

Sample	Depth	Compound	Concentration	
6-001	3	TPH-d	75	mg/kg
6-002	14.5	TPH-d	1300	mg/kg
		TPH-g	7.6	mg/kg

Table 15. Boring 8, Tank 9 near Plumbing Shop

	Soil												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
Depth	ug/kg						mg/kg						
10	< 57	< 57	**500 C**	**120**	< 57	< 25	**1500**	**200 HY**	2.4	34	20	74	130
15	< 5.4	< 5.4	< 5.4	< 5.4	< 5.4	< 22	**1.1 J**	**0.62 J**	2.4	39	19	72	120
20	< 5.6	< 5.6	< 5.6	< 5.6	< 5.6	< 22	**8.6**	< 1.1	1.9	33	18	60	91
25	< 5.2	< 5.2	< 5.2	< 5.2	< 5.2	< 21	**4**	< 1.1	2	33	15	64	94
30	< 5.4	< 5.4	< 5.4	< 5.4	< 5.4	< 22	**1.6**	< 1.1	1.8	30	16	54	90
37	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	**1.0 J**	< 1.1	2	32	18	58	110
45	< 5.3	< 5.3	< 5.3	< 5.3	< 5.3	< 21	**16 H**	< 1.1	2	45	16	56	99

	Groundwater												
	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/L												
9H	**6.4**	< 0.5	**5.1**	< 0.5	**0. 21 J**	< 2.0	**5900**	**340 HY**	0.36 J	2.7 J	10	14 J	45

Table 16. Summary of Previous Sampling, Tank 9

Sample	Depth	Compound	Concentration	
9-001	8	TPH-d	1900	mg/kg
		TPH-g	270	mg/kg
		benzene	3.9	µg/kg
		ethylbenzene	18	µg/kg
		xylenes	16	µg/kg
9-002	10	TPH-d	2400	mg/kg
		TPH-g	210	mg/kg
		benzene	6.8	µg/kg
		ethylbenzene	36	µg/kg
		xylenes	45	µg/kg

18

Table 17. IDW Soil Stockpiles Sample Results

Sample ID	Benzene	Toluene	Ethylbenzene	m,p-xylene	o-xylene	MTBE	THP-d	TPH-g	Cd	Ch	Pb	Ni	Zn
	ug/kg						mg/kg						
R-IDW-1	< 5.9	< 5.9	< 5.9	< 5.9	< 5.9	< 23	**780 H**	< 1.2	1.4	43	52	98	85
R-IDW-2	<5.4	<5.4	<5.4	<5.4	<5.4	< 22	**930 H**	< 1.1	1.5	37	21	71	96
R-IDW-3	< 5.8	< 5.8	< 5.8	< 5.8	< 5.8	< 23	**2500**	**2.8 HY**	1.2	34	16	66	65
R-IDW-4	< 6.4	< 6.4	< 6.4	< 6.4	< 6.4	< 26	**740 H**	< 1.3	1.5	45	18	110	86

19

2.4.1 Tank 1

Following the removal of Tank 1, one sample revealed the presence of TPH-d. The concentration of the TPH-d at 23 mg/kg was below the Tri-Regional Guidance of 100 mg/kg for potential impacts to groundwater (See Table 18 for a summary of potentially relevant and appropriate clean up standards for the compounds of concern for this effort). The levels of inorganic compounds are in the background range for metals in Northern California. No further investigations or remedial actions are recommended for the area of Tank 1.

2.4.2 Tanks 2 and 3

The concentration of toluene measured at 5.7 µg/kg is well below the EPA Region IX Residential PRG of 660 µg/kg. Similarly, the Ethylbenzene concentration of 15 µg/kg is below the residential PRG of 8,900 µg/kg and the concentration of total xylenes of 41 µg/kg is well below the residential PRG or 270,000 µg/kg. The residual TPH-d in the soils ranges from less than the laboratory detection limits to 7,100 mg/kg. Overall, the concentrations of TPH-d exceed the Tri-Regional Guidance for potential taste and odor impacts to groundwater. The TPH-g concentrations remaining in the soil range from nondetected to 660 mg/kg.

Groundwater beneath this area has been impacted by TPH-d, TPH-g, and m,p-xylene. The concentration of m,p-xylene 0.56 µg/l is well below the California Primary MCL of 1,750 µg/l. There is no established drinking water standards for TPH, the TPH-d concentration of 18,000 µg/l and TPH-g concentration of 61 µg/l are above the taste and odor thresholds of 100 µg/l and 5 µg/l respectively. Further investigation of the extent of the groundwater contamination in this area appears warranted.

2.4.3 ASTs 1, 2, and 3

The concentrations of TPH-d remaining in the soils surrounding the former ASTs ranges up to 1,700 mg/kg. The TPH-g concentrations measured in the soils are very close to the laboratory detection limits and are probably related to the diesel fuel stored in these tanks and not related to spills or leaks of gasoline in the area. The concentrations of

Table 18. Potential Applicable or Appropriate Clean Up Standards

Compound	Media	Concentration	Units	Source
Benzene	Soil	800	µg/kg	EPA Region IX Residential PRG
	Groundwater	1	µg/l	CA Primary MCL
Ethylbenzene	Soil	8,900	µg/kg	EPA Region IX Residential PRG
	Groundwater	300	µg/l	CA Primary MCL
		29	µg/l	Taste & Odor
Toluene	Soil	660,000	µg/kg	EPA Region IX Residential PRG
	Groundwater	150	µg/l	CA Primary MCL
		42	µg/	Taste and Odor
TPH-g	Soil	not established		
	Groundwater	5	µg/l	Taste & Odor
TPH-d	Soil	100	mg/kg	Tri-Regional Guidance (taste & odor)
	Groundwater	100	µg/l	Taste & Odor
Total xylenes	Soil	270,000	µg/kg	EPA Region IX Residential PRG
	Groundwater	1,750	µg/l	CA Primary MCL
		17	µg/l	Taste & Odor
Cadmium	Soil	37,000	µg/kg	EPA Region IX Residential PRG
	Groundwater	5	µg/l	CA Primary MCL
		1	µg/l	Marine Aquatic Toxicity 6-month Median
Chromium, total	Soil	210,000	µg/kg	EPA Region IX Residential PRG
	Groundwater	50	µg/l	CA Primary MCL
		2	µg/l	Marine Aquatic Toxicity 6-month Median
Lead	Soil (tetraethyl)	6.1	µg/kg	EPA Region IX Residential PRG
	Groundwater (total inorganic)	15	µg/l	CA Primary MCL
		2	µg/l	Marine Aquatic Toxicity 6-month Median
Nickel	Soil	1,600,000	µg/kg	EPA Region IX Residential PRG
	Groundwater	100	µg/l	CA Primary MCL
		15	µg/l	Marine Aquatic Toxicity 6-month Median
Zinc	Soil	23,000,000	µg/kg	EPA Region IX Residential PRG
	Groundwater	5,000	µg/l	CA Secondary MCL
		20	µg/l	Marine Aquatic Toxicity 6-month Median

ethylbenzene measured in the vadose zone (65 µg/kg) may be attributable to spills from the ASTs or may be the result seasonable fluctuations in the groundwater table (as the highest level of ethylbenzene of 160 µg/kg in this area was measured in the saturated

zone). However, both of these concentrations are well below the EPA residential PRG of 8,900 µg/kg. The concentrations of xylenes in soil of the saturated zone are 289 µg/kg, well below the residential PRG of 270,000 µg/kg.

The TPH-d concentration of 950 µg/l that was measured in groundwater is above the implied taste and odor threshold limit of 100 µg/l for drinking water. Further evaluation of the extent of the groundwater contamination in this area appears to be warranted.

2.4.4 Tank 5

The concentrations of TPH-d remaining in soils range up to 2,800 mg/kg with the highest concentrations being near the bottom of the tank removal excavation. TPH-g concentrations in soil range up to 88 mg/kg. Ethylbenzene was measured in one soil sample at a concentration of 36 µg/kg, well below the residential PRG. No organic contaminants were measured in the groundwater sample taken at this location.

2.4.5 Tank 6

Ethylbenzene was measured in one sample at a concentration of 37 µg/kg and two samples reported xylene concentrations of 16 and 34 µg/kg. All of these results were less than the corresponding residential PRG. Low-level concentrations of TPH-g remain in the soils. TPH-d concentrations in the soil range from not detected to 1,300 mg/kg.

Ethylbenzene was measured at 25 µg/l and m,p-xylene was measured at 8.3 µg/l in the groundwater sample taken during the vertical profiling. Both of these concentrations are below the corresponding MCLs and taste and odor thresholds. The measured TPH-g concentration in groundwater of 8400 µg/l is well above the 5 µg/l taste and odor threshold. However, as the TPH-d concentration measured in groundwater was 770000 µg/l. and the TPH-g measurement was qualified as heavier than the gasoline standard, it is likely the TPH-g measurement results from the lighter fraction of diesel fuel. The TPH-d concentration in groundwater is high, well above the 100 µg/l taste and odor threshold. Further investigation of the extent of the groundwater contamination in this area is recommended.

2.4.6 Tank 7

TPH-d was measured at 1.4 mg/kg at the bottom of the excavation following the removal of Tank 7. This concentration is well below the Tri-Regional guidance for potential impacts to groundwater. No further investigation or remedial actions are recommended for this area.

2.4.7 Tank 8

TPH-d was measured at concentrations of 2.4 mg/kg and 1.3 mg/kg in the bottom of the excavation following the removal of Tank 8. TPH-g was measured with a concentration of 1.8 mg/kg. These concentrations are below the Tri-Regional guidance on residual contamination in soils. No further investigation or remedial actions are recommended for this area.

2.4.8 Tank 9

Residual TPH-d concentrations ranged up to 2,400 mg/kg in the soils following the removal of Tank 9, which exceeds the Tri-Regional guidance. Concentrations of TPH-g remaining in the soils ranged up to 270 mg/kg. Benzene and toluene were not measured in the soils. Ethylbenzene was measured from not detected to 500 µg/kg within the soil column. Xylenes were measured from not detected to 120 µg/kg. Each of the BTEX compounds detected was measured at concentrations below the corresponding residential PRGs.

Benzene was measured at a concentration of 6.4 µg/l, which is above the MCL of 1 µg/l. Ethylbenzene at 5.1 µg/l and o-xylene at 0.21 µg/l were measured in groundwater below their corresponding MCLs. TPH-d had a measured concentration of 5900 µg/l in groundwater and TPH-g had a measured concentration of 340 µg/l in the groundwater sample. Both TPH-d and TPH-g were measured at concentrations above their corresponding taste and odor thresholds.

2.5 Waste Handing and Disposal

Cuttings from drilling activities were initially containerized at the boring location and transported to the existing IDW piles from the 2002 field effort. See Section 2.3 for

composite results from the IDW stockpiles. In February 2003, the contaminated soils were transported and disposed of in an approved landfill by Cape Environmental and its subcontractors on behalf of the USACE.

Water from decontamination activities were containerized in 55-gallon drums and sampled. The decon water was found to contain 260 µg/l of TPH-g. This water and settled fines were transported and disposed of in an approved facility by TRW and its subcontractors on behalf of the USACE.

3.0 Conclusions and Recommendations

Based on the results of the original tank removals and this supplemental vertical investigation further DoD actions are recommended at the Requa site.

Soil and groundwater contamination were not found in the downgradient locations near the Carpenter's Shop, in the area below Tank 1, or in the area of the OWS abandoned in place on the FAA property. Low levels of soil contamination mainly from TPH-d and TPH-g was found from the bottom of the tank excavation to the groundwater table in borings completed in the area of the ASTs as well as Tanks 2, 3, 6, and 9. Groundwater contamination was found in the area of the ASTs; Tanks 2 and 3; Tank 6; and Tank 9.

Further investigations are recommended to assess the potential for the spread of groundwater contamination and to determine if further remedial actions are required. Given the apparent underlying aquitard, the spread of groundwater contamination would be limited to the shallow groundwater zone. Based on the locations of the groundwater contamination, it would not appear that any human receptors are present. In that, there are no residences that would have installed spring boxes in the areas downgradient of where contaminated groundwater exists. Any future investigations should include consultations with the Yurok Tribe to assess any potential cultural impacts from the near-surface groundwater contamination.

4.0 References

CAPE Environmental Services (CAPE), 2001. Investigation and Removal of Contents from Eight Underground Storage Tanks at Requa Air Force Station California. Report prepared for the U.S. Army Corps of Engineers. June 2001. Tustin, California.

CAPE Environmental Services (CAPE), 2002. Closure Report USTs 1, 2, 3, 4, 5, 6, 7, 8, and 9; ASTs 1, 2, and 3; and Oil/Water Separator, Former Requa Air Force Station. Report prepared for the U.S. Army Corps of Engineers. Draft October 2002. Irvine, California.