Revised

Characterization Report
Feature F-33, Former Large Motor Washout Area
Lockheed Martin Corporation, Beaumont Site 1
Beaumont, California

Prepared for:

LOCKHEED MARTIN

Prepared by:

TETRA TECH
348 W. Hospitality Lane, Suite 100
San Bernardino, California 92408

TC# 22288-0205 / June 2009

Lockheed Martin Corporation, Shared Services
Energy, Environment, Safety and Health
2950 North Hollywood Way, Suite 125 Burbank, CA 91505
Telephone: 818.847.0197 Facsimile: 818.847.0256

LOCKHEED MARTIN

June 19, 2009

Mr. Daniel Zogaib
Southern California Cleanup Operations
Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630

Subject: Submittal of Final *"Remedial Design Characterization Report, Feature F-33, Former Large Motor Washout Area, Beaumont Site 1, Beaumont California"*

Dear Mr. Zogaib:

Enclosed please find a hard copy of the body of the final report, as well as two copies of a CD containing the appendices of the *Remedial Design Characterization Report, Feature F-33, Former Large Motor Washout Area*; this version incorporates changes as outlined in our responses to comments approved by the State on June 16, 2009 and documents site characterization activities performed at Feature F-33 in 2008.

If you have any questions regarding this submittal or the status of site activities, please contact me at 408.756.9595 or denise.kato@lmco.com.

Sincerely,

Denise Kato
Remediation Analyst Senior Staff

Enclosures

Copy with Enc:
Gene Matsushita, LMC (one hard copy, text; one electronic copy text & appendices)
Tom Villeneuve, Tetra Tech, Inc. (hard copy & electronic copy)

RESPONSES TO DTSC COMMENTS ON THE CHARACTERIZATION REPORT FEATURE F-33,
FORMER LARGE MOTOR WASHOUT AREA, LOCKHEED MARTIN BEAUMONT SITE 1
BEAUMONT, CALIFORNIA, SUBMITTED APRIL 2009
TETRA TECH, INC
DTSC COMMENTS OF JUNE 10, 2009

General Comments		
Comment	**Response**	**Proposed Action**
1. A Recommendation section should be included in this report outlining the next steps at Feature F-33.	A Recommendations section has been added as requested. Text had been added as follows: "Based on the data collected at Feature F-33 during previous investigations, this investigation, and the routine groundwater monitoring program, the nature and extent of both the impacts to soil and groundwater are defined. Therefore, no further investigations are proposed. Because additional data collected indicate that the impacts to groundwater appear to be limited in their nature and extent and attenuate before leaving the Site, no IRM is proposed at this time. The following recommendations are made: • Continue sampling groundwater monitoring wells on a semiannual basis to determine the seasonal fluctuations in water levels, the distribution of contaminant concentrations, and natural attenuation parameters for wells around the site. • Include F-33 in the future Site wide RI / FS and risk assessments to evaluate and determine the appropriate mitigation measures for the area.	Add a "Recommendations" section to the last section of the report as noted in the response.

RESPONSES TO DTSC COMMENTS ON THE CHARACTERIZATION REPORT FEATURE F-33,
FORMER LARGE MOTOR WASHOUT AREA, LOCKHEED MARTIN BEAUMONT SITE 1
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General Comments		
Comment	**Response**	**Proposed Action**
2. Table of Contents, page ii: Appendix H – Weight and Volume Estimates should be included.	Agree. Appendix H will be added to the List of Appendices on page ii.	Add Appendix H to the list of Appendices on page ii.

Specific Comments		
Comment	**Response**	**Proposed Action**
1. Figure 3-2: An approximate groundwater elevation should be included on this figure. Also, intersections of D-D' should be added to both cross-sections.	An approximate groundwater elevation has been added to Cross-Sections A-A' and B-B'. In addition, the intersection of D-D' will be identified on both sections A-A' and B-B'	Add the changes requested by the reviewer.
2. Figure 3-3: The intersection of MW-82 and Cross-section A-A' should be added to Cross-Section C-C'	A note has been added to cross-section C-C' that shows where Cross-Section A-A' intersects this section at MW-82.	Add the changes requested by the reviewer.

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FORMER LARGE MOTOR WASHOUT AREA, LOCKHEED MARTIN BEAUMONT SITE 1
BEAUMONT, CALIFORNIA, SUBMITTED APRIL 2009
TETRA TECH, INC
DTSC COMMENTS OF JUNE 10, 2009

Specific Comments		
Comment	**Response**	**Proposed Action**
3. Appendix E: The bottom end cap in all well diagrams should be illustrated and identified. Also, the illustrations should indicate that the bentonite chip seal is hydrated.	As built well diagrams have been modified to include the requested changes. Bentonite Chips have been modified to "Hydrated Bentonite Chips", and "End Cap" has been added to each figure and identified as such.	Add the changes requested by the reviewer.

RESPONSES TO DTSC COMMENTS ON THE CHARACTERIZATION REPORT FEATURE F-33,
FORMER LARGE MOTOR WASHOUT AREA, LOCKHEED MARTIN BEAUMONT SITE 1
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Specific Comments		
Comment	**Response**	**Proposed Action**
4. Appendix F: The acronyms HSU, QA, and MEF should be identified in the table.	The table has been modified to delete the column referring to HSUs (Hydrostratigraphic units); therefore, HSU has not been defined. In the footnotes section at the bottom of the table, the following acronyms have been defined: QA = Quaternary Alluvium, PVC – polyvinyl chloride. In addition, the following acronyms have been modified to be more generic: TOC = top of casing, in feet below ground surface (bgs) TOS = top of screen in feet bgs BOS = bottom of screen in feet bgs bgs = below ground surface msl = elevation as measured in feet above mean sea level. The acronym MEF has been deleted from the table. There is no need to define it.	Modify the table to include those items identified in the "response"

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Revised

Remedial Design Characterization Report
Feature F-33, Former Large Motor Washout Area

Lockheed Martin Corporation, Beaumont Site 1
Beaumont, California

June 2009
TC 22288-0205

Prepared for
Lockheed Martin Corporation
Burbank, California

Prepared by
Tetra Tech, Inc

Holly Hanke
Project Geologist

William Muir, PG California 6762
Deputy Project Manager

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1.0 INTRODUCTION

This Remedial Design Characterization Report (Report) for the Former Beaumont Site 1 Feature F-33 Large Motor Washout Area (herein referred to as "Feature F-33") was prepared by Tetra Tech, Inc. (Tetra Tech), on behalf of Lockheed Martin Corporation (LMC). The work, conducted as part of the characterization of Feature F-33, was based on the June 2008 Characterization Work Plan (Work Plan, 2008), which outlined the characterization approach for Feature F-33 and was approved by California Department of Toxic Substances Control (DTSC) in a letter dated 01 July 2008. This Report documents the characterization activities associated with Feature F-33.

The objectives of this Report are to:

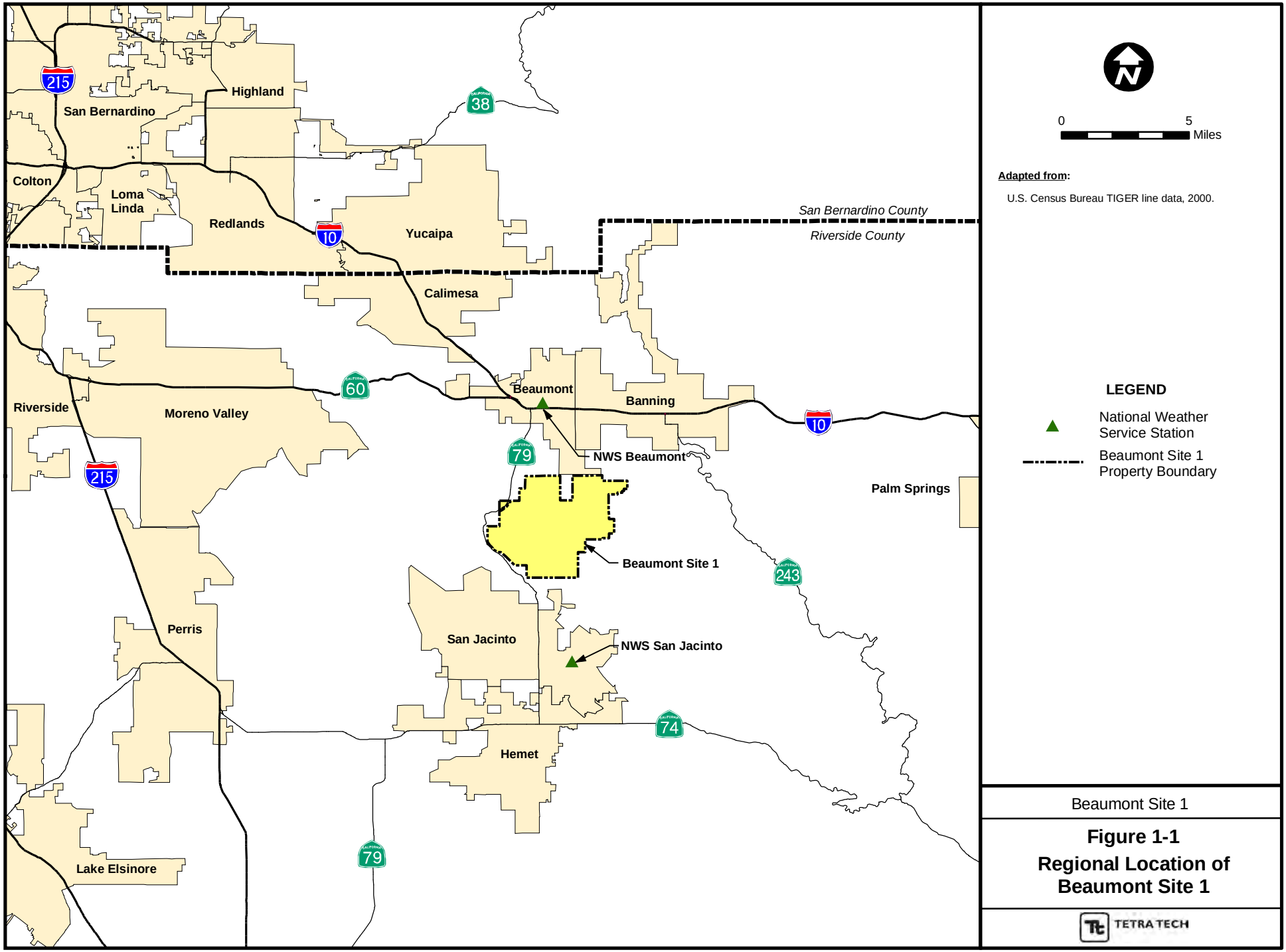
- Summarize the results of the previous investigations;
- Describe the technical approach implemented during the characterization activities;
- Provide an interpretation of the surface and subsurface geology and sampling activities conducted;
- Assess the impact to soils and groundwater in and around Feature F-33; and
- Provide data necessary to evaluate remedial alternatives.

This section of the Report provides an overview of the document and briefly summarizes historical operations and previous environmental investigations conducted at the Site and at Feature F-33. The remainder of this Report is organized as follows.

- Section 2 – Technical Approach: This section provides a description of the activities conducted as part of the characterization investigation including site preparation, field approach, and deviations from the work plan (if applicable).
- Section 3 – Results of the Characterization: This section provides a description of the field observations, laboratory analytical results, and extent of impacts.
- Section 4 – Summary and Recommendations: This section summarizes the results of the investigation, and makes recommendations for future actions.

1.1 SITE BACKGROUND

Lockheed Martin Beaumont Site 1 (Site), is a 9,117-acre parcel located south of Beaumont, California (Figure 1-1). The Site was primarily used for ranching prior to 1960. From 1960 to 1974, the Site was used by Lockheed Propulsion Company (LPC) for solid rocket motor and ballistics testing (Tetra Tech,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215
Highland
San Bernardino
38
Colton
Loma
Linda
Redlands
10
Yucaipa
San Bernardino County
Riverside County
Calimesa
60
Beaumont
Banning
Riverside
Moreno Valley
10
79
NWS Beaumont
215
Palm Springs
Beaumont Site 1
243
Perris
San Jacinto
NWS San Jacinto
74
Hemet
79
Lake Elsinore
0
5
Miles
Adapted from:
U.S. Census Bureau TIGER line data, 2000.
LEGEND
National Weather Service Station
Beaumont Site 1 Property Boundary
Beaumont Site 1
Figure 1-1
Regional Location of Beaumont Site 1
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2003a). Activities at the Site also included burning of process chemicals and waste rocket propellants in an area commonly referred to as the burn pit area (BPA). Nine (9) Historical Operational Areas have been identified at the Site. The Historical Operational Areas and the Features are presented in Figure 1-2.

Feature F-33 is located in the western portion of the Site in Historical Operational Area F. Operational Area F (The LPC Test Services Area) includes the following facilities: 1) three (3) bays for structural load tests, 2) a 13-foot-diameter spherical pressure vessel, 3) six (6) temperature conditioning chambers, 4) five (5) environmental chambers, 5) a 25-million electron volt Betatron for X-raying large structures, 6) personnel and instrumentation protection bunkers, and 7) supporting work shops and storage areas (Radian, 1986). These facilities were classified into 13 features, designated Features 33 through 45. The Large Motor Washout Area was designated Feature F-33 (Tetra Tech, 2003a).

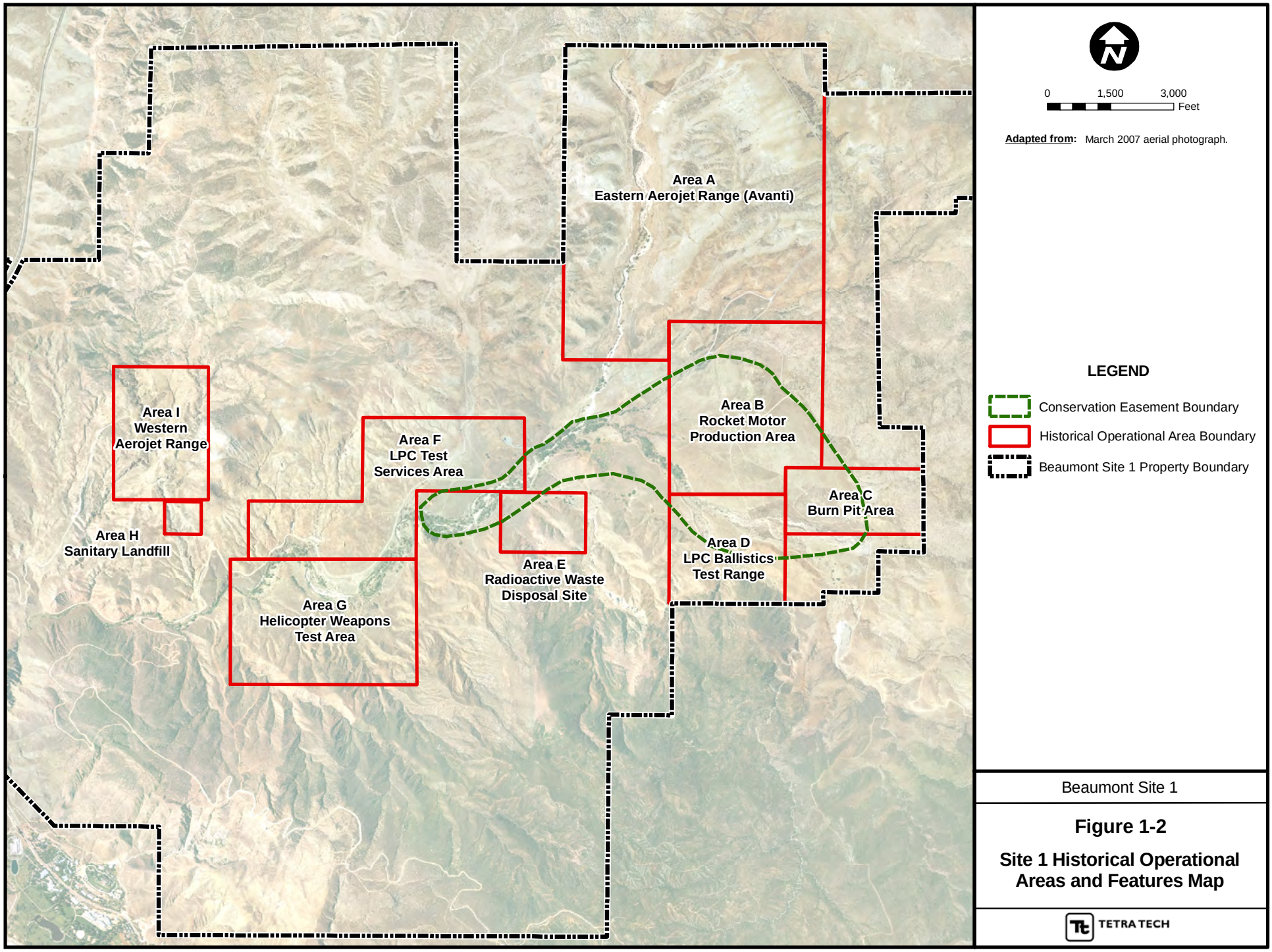
Feature F-33, located in the south-central portion of Historical Operational Area F (Figure 1-3), is on a bluff that extends out into the Potrero Creek drainage. The drainage wraps around the bluff, and the elevation of the bluff is approximately 15 to 20 feet higher than the drainage. The creek is ephemeral and supports a riparian corridor. Although flows increase during storm events, much of the time Potrero Creek's ephemeral flow is attributed to discharging groundwater.

Defective solid rocket propellant was washed out of the motor casings with groundwater supplied by a groundwater production well (W-1), which was properly destroyed (Tetra Tech, 2006). A high-pressure water jet was used to flush propellant from the motor casings. The solid propellant pieces produced from the washout activities were collected in a sieve and later packed into drums and taken to the burn pit landfill (Area C – Burn Pit) for burning. Additionally, an unlined catch basin caught the overspray. Figure 1-3, a map of Feature F-33, shows the various components that were present during the initial historic research conducted by Radian in 1986. After the water percolated into the soil, the remaining solid pieces of propellant were burned directly in the unlined catch basin. The solid propellants consisted of fuel (polymeric binder and aluminum), oxidizer, and a burn rate modifier. Butadiene, aluminum, ammonium perchlorate, and ferrocene were reportedly part of the propellant mixture. Ninety percent of the mixture was reported to be ammonium perchlorate (Radian 1986).

1.2 PREVIOUS INVESTIGATIONS AT FEATURE F-33

This section summarizes previous Feature F-33 investigations and provides a brief regulatory history.

Feature F-33 was identified by Radian in the 1986 Historical Report (Radian, 1986) and was subsequently investigated. This investigation focused on volatile organic compounds (VOCs) and no impacts were reported.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Area A
Eastern Aerojet Range (Avanti)
Area I
Western
Aerojet Range
Area F
LPC Test
Services Area
Area B
Rocket Motor
Production Area
Area C
Burn Pit Area
Area H
Sanitary Landfill
Area E
Radioactive Waste
Disposal Site
Area D
LPC Ballistics
Test Range
Area G
Helicopter Weapons
Test Area
N
0
1,500
3,000
Feet
Adapted from: March 2007 aerial photograph.
LEGEND
Conservation Easement Boundary
Historical Operational Area Boundary
Beaumont Site 1 Property Boundary
Beaumont Site 1
Figure 1-2
Site 1 Historical Operational Areas and Features Map
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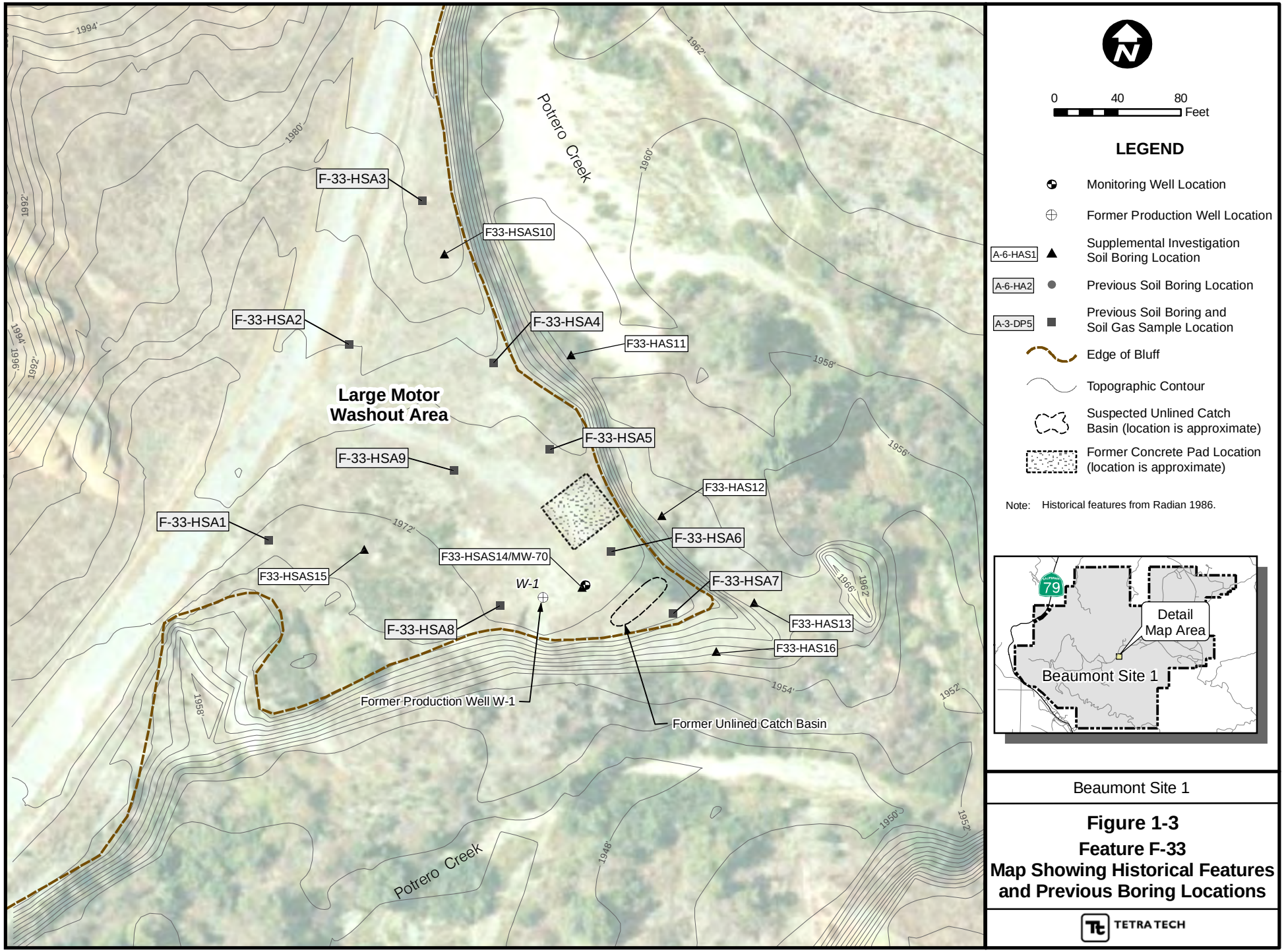

Beaumont Site 1

Figure 1-3
Feature F-33
Map Showing Historical Features and Previous Boring Locations

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In March 2000, Earth Tech prepared a Five Year Review Report that evaluated the protectiveness of remedial systems implemented at the Beaumont Site 1 facility. DTSC comments on the Five Year Review Report indicated the need to evaluate additional analytes, including the emerging contaminants 1,4-dioxane and perchlorate. LMC's response to DTSC comments included implementation of a Sampling and Analysis Plan (SAP), prepared by Earth Tech in June 2002 (Earth Tech, 2002).

During SAP implementation in 2002, perchlorate and 1,4-dioxane were detected in groundwater at concentrations above California Recommended Action Levels (Tetra Tech, 2002). As a result of the detection of these two compounds, characterization was reinitiated at the Site, including Feature F-33.

After a delay associated with protection of endangered species, the initial investigation of Feature F-33 began in 2004. Nine soil borings and soil gas probes were installed to a depth of 41.5 feet below ground surface (bgs) at Feature F-33 (Tetra Tech, 2005). Soil samples were analyzed for VOCs, semi-volatile organic compounds, total petroleum hydrocarbons (TPH), perchlorate, 1,4-dioxane, and Title 22 metals. 1,4-dioxane was not detected at concentrations above the reporting limits (RLs). Diesel-range TPH was detected at concentrations ranging from 6.3 to 45 milligrams per kilogram (mg/kg), and perchlorate was detected at concentrations ranging from 20 to 57,100 micrograms per kilogram (µg/kg). The organics acetone, benzene, toluene, 1,2,4-trichlorobenzene, and bis(2-ethylhexyl)phthalate were detected at concentrations ranging from 0.52 to 124 µg/kg. Acetone detections may have been associated with laboratory cross-contamination. However, benzene, toluene, and 1,2,4-trichlorobenzene are commonly associated with fuel, and bis(2-ethylhexyl)phthalate is found in many plastics and is widely used in the production of polyvinyl chloride (Agency for Toxic Substances and Disease Registry, 2002). Various metals were detected throughout the site. Arsenic was present at concentrations up to 19 mg/kg. The concentrations of metals at Feature F-33 do not appear unusual, but site-specific background concentrations are being established as part of the implementation of the Site 1 Dynamic Work Plan.. No VOCs were detected in soil gas above RLs. The only compound of concern (COPC) identified was perchlorate.

Additional characterization of Feature F-33 was conducted in 2007. Three hollow-stem auger (HSA) soil borings (F33-HSAS10, F33-HSAS14 and F33-HSAS15) were drilled to at least 31.5 feet bgs, and four hand auger borings (F33-HAS11, F33-HAS12, F33-HAS13 and F33-HAS16) were installed to 5 feet bgs (Tetra Tech, 2007a, Figure 1-4 illustration of former sampling locations and contaminant concentrations). HSA soil borings were located on the bluff and the hand auger borings were located at the base of the bluff. Soil samples were collected from each HSA boring at various depths and two soil samples were collected from each hand auger boring at 0.5 and 5 feet bgs; all samples were analyzed for perchlorate. Soils encountered at Feature F-33 were generally fine- to coarse-grained sand. Perchlorate was detected at

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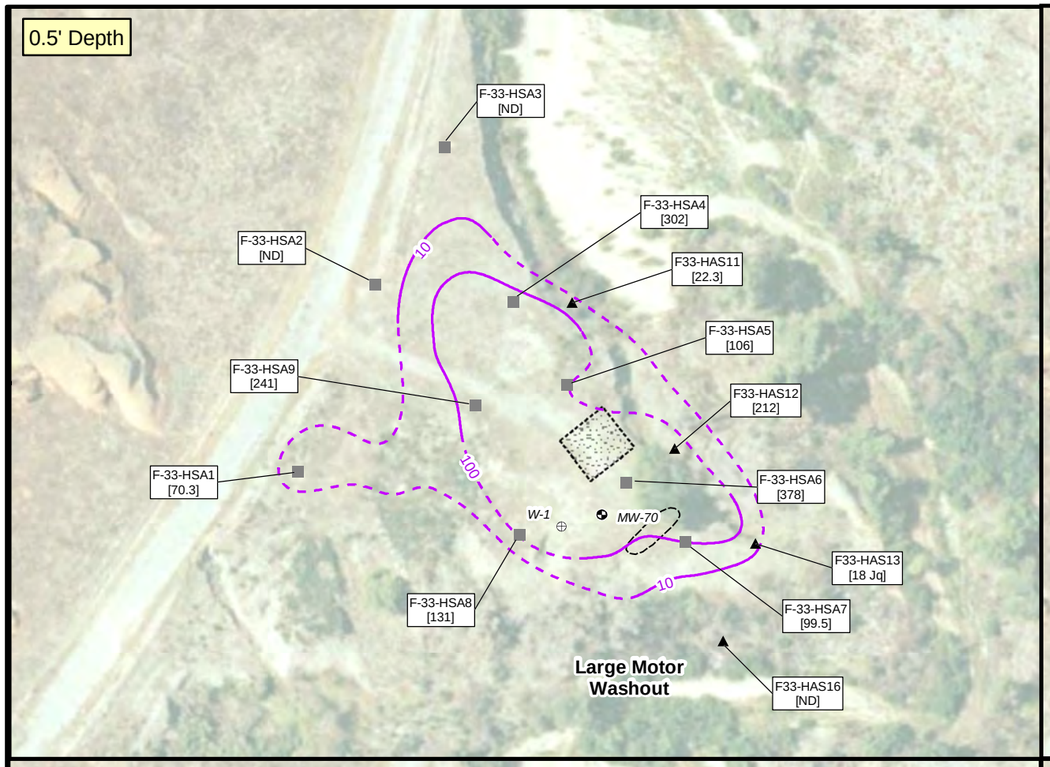
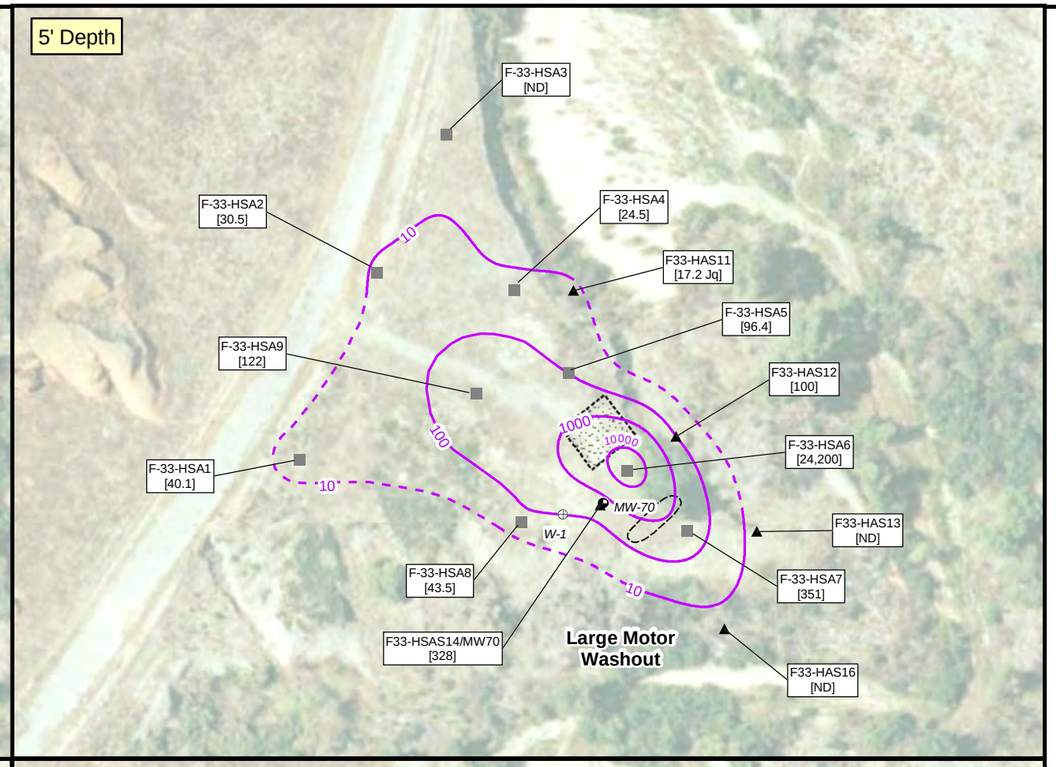
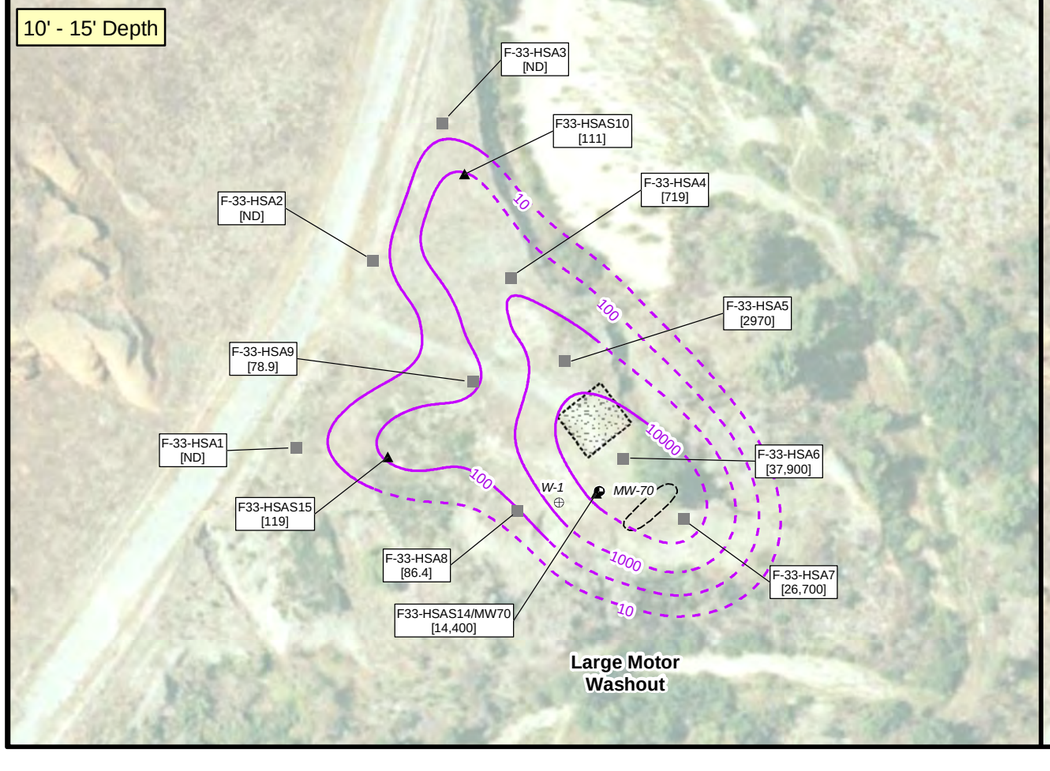
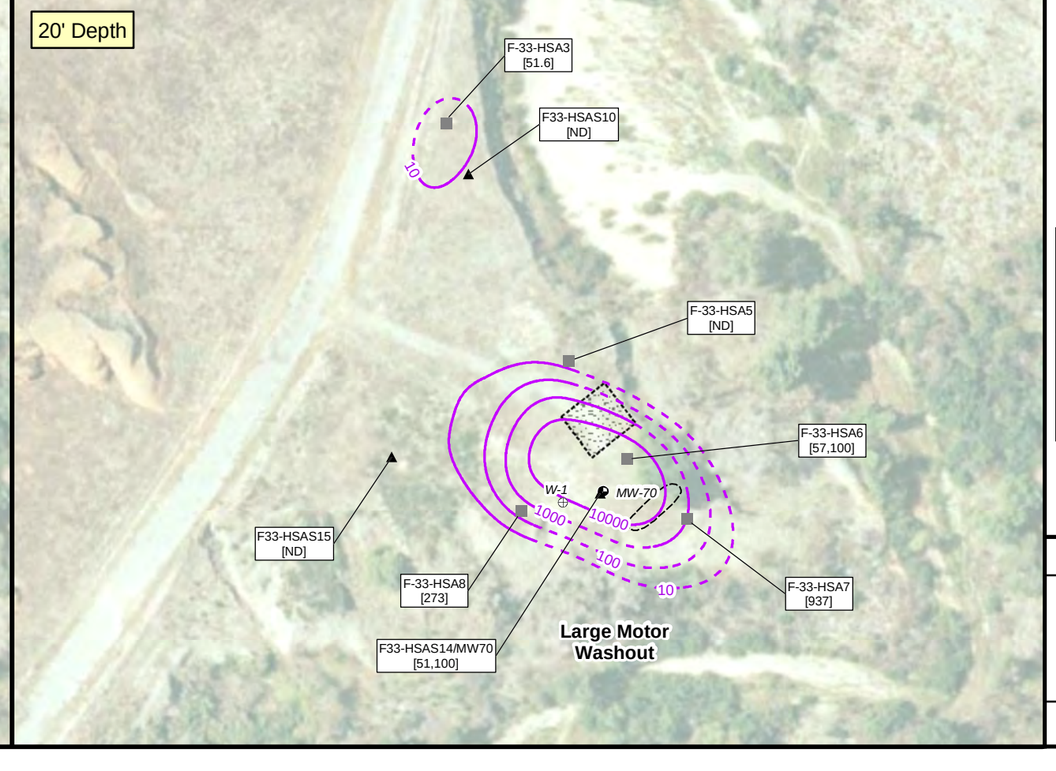








0 50 100 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

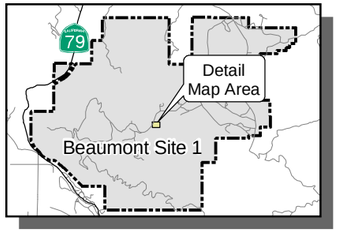
- Monitoring Well Location
- Former Production Well Location (W1)
- Supplemental Investigation Soil Boring Location (2007)
- Previous Soil Boring and Soil Gas Sample Location (2004)
- 10 — Perchlorate Isoconcentration Contour (Dashed where inferred)
- Suspected Unlined Catch Basin (location is approximate)
- Concrete Pad Location (location is approximate)

Note:

[#] Perchlorate results in µg/kg.

[ND] Non-Detect.

Figure summarizes data collected through 2007.



Beaumont Site 1

Figure 1-4

Perchlorate Concentrations in Soil Prior to 2008 Investigation Feature F-33

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concentrations above the method detection limit (MDL) in 13 of the 18 soil samples, with concentrations ranging from 17.2 to 51,100 µg/kg (Table 1-1).

During the 2007 investigation, groundwater was encountered between 21.5 and 25 feet bgs in the HSA borings. Hand auger locations were installed at the toe of the slope in the stream bed where groundwater was encountered between 5 and 8.2 feet bgs. A groundwater-screening sample was collected at HSA boring location F33-HSAS10 (on the bluff) at a depth of 25-26.5 feet bgs and analyzed for perchlorate. Perchlorate was detected at 54.9 micrograms per liter (µg/L) in the sample. Boring F33-HSAS14 was converted into monitoring well MW-70, which was screened from 20 to 35 feet bgs. A groundwater sample was collected from monitoring well MW-70 and analyzed for perchlorate, VOCs, and 1,4-dioxane. Perchlorate was not detected in the MW-70 groundwater sample. 1,4-dioxane was detected at 2.2 µg/L, 1,1-DCE was detected at 1.6 µg/L, and TCE was detected at an estimated value of 0.5J µg/L. All detected analytes were below their respective maximum contaminant levels (MCLs)/drinking water notification levels (DWNLs). Depth to groundwater in MW-70 was measured at 28.68 feet below top of casing (btoc) in January 2008 (approximately 26.5 feet bgs).

Soil Impacts: Based on characterization sampling through 2007, perchlorate concentrations appear to be highest in the area between the former concrete pad and the former production well (W-1). During the initial 2004 investigation, perchlorate was detected in soil at a concentration of 57,100 µg/kg in borehole F33-HSA6 at 20 feet bgs. F33-HSA6 is located just south of the former concrete pad. During the 2007 investigation, the highest concentration of perchlorate was detected in borehole F33-HSAS14 at a concentration of 51,100 µg/kg at 20 feet bgs (Tetra Tech 2008a). F33-HSAS14 was also located south of the concrete pad near the former production well (W-1). Elsewhere around the bluff, concentrations of perchlorate appear to decrease with depth.

Figure 1-4 shows the horizontal and vertical extent of perchlorate-impacted soil at Feature F-33 using analytical results from the previous investigations. Based on the isoconcentration maps, the highest concentrations are between 5 and 20 feet bgs in the central portion of Feature F-33 near borings F33-HSA6, F33-HSAS14, and F33-HSA7. Perchlorate concentrations decreased significantly in soil samples collected below the water table at a depth of 30 feet bgs.

Based on the isoconcentration contours and the topography of Feature F-33, the area of perchlorate-impacted soil greater than 15 feet bgs is limited to the bluff east of the road where the historical washout activities were conducted. The elevation difference between the bluff where the highest concentrations were detected and the stream bed is approximately 15 to 20 feet. Impacted soil within the stream bed, particularly the 0.5 foot bgs samples, could be a result of impacted soil from the bluff being washed down into the stream bed during periods of heavy rainfall, particularly the 0.5-foot-bgs samples.

Table 1-1 Feature F-33 - 2007 Sampling Results

Sample Location @ Depth (feet bgs)	Sample Date	Matrix	Perchlorate - Soil (µg/kg)	Perchlorate - Water	1,4-Dioxane -Water	1,1-Dichloroethene (1,1-DCE)-Water	Trichloroethene (TCE)-Water
			Laboratory Results µg/L unless otherwise specified				
MDL[1]			10.4 - 12.4	2.5 - 5	0.57	0.2	0.2
MCL/DWNL (µg/L)			-	6	3	6	5
F33-HAS11@0.5	4/27/2007	S	22.3	*NA*	*NA*	*NA*	*NA*
F33-HAS11@5.0	4/27/2007	S	17.2 Jq	*NA*	*NA*	*NA*	*NA*
F33-HAS12@0.5	4/27/2007	S	212	*NA*	*NA*	*NA*	*NA*
F33-HAS12@5.0	4/27/2007	S	100	*NA*	*NA*	*NA*	*NA*
F33-HAS13@0.5	4/27/2007	S	18 Jq	*NA*	*NA*	*NA*	*NA*
F33-HAS13@5.0	4/27/2007	S	ND	*NA*	*NA*	*NA*	*NA*
F33-HAS16@0.5	4/27/2007	S	ND	*NA*	*NA*	*NA*	*NA*
F33-HAS16@5.0	4/27/2007	S	ND	*NA*	*NA*	*NA*	*NA*
F33-HSAS10-10-11.5	4/27/2007	S	111	*NA*	*NA*	*NA*	*NA*
F33-HSAS10-15-16.5	4/27/2007	S	54.9	*NA*	*NA*	*NA*	*NA*
F33-HSAS10-20-21.5	4/27/2007	S	ND	*NA*	*NA*	*NA*	*NA*
F33-HSAS10GW	4/27/2007	W	*NA*	54.9	*NA*	*NA*	*NA*
F33-HSAS14-5-6.5	4/27/2007	S	328	*NA*	*NA*	*NA*	*NA*
F33-HSAS14-10-11.5	4/27/2007	S	6,260	*NA*	*NA*	*NA*	*NA*
F33-HSAS14-15-16.5	4/27/2007	S	14,400	*NA*	*NA*	*NA*	*NA*
F33-HSAS14-20-21.5	4/27/2007	S	51,100	*NA*	*NA*	*NA*	*NA*
F33-HSAS15-10-11.5	4/20/2007	S	44.2	*NA*	*NA*	*NA*	*NA*
F33-HSAS15-15-16.5	4/20/2007	S	119	*NA*	*NA*	*NA*	*NA*
F33-HSAS15-20-21.5	4/20/2007	S	ND	*NA*	*NA*	*NA*	*NA*
MW-70	6/15/2007	W	*NA*	ND	2.2	1.6	0.5Jq

Only the VOCs positively detected are presented in this table. All analytes are listed in the laboratory data package.
(1) Method Detection Limit (MDL) - MDLs may vary if sample was analyzed from a diluted aliquot .
bgs – below ground surface
µg/L – micrograms per liter
MCL – maximum contaminant level
DWNL – drinking water notification level
NA – not analyzed
ND – not detected at or above the method detection limit.
(MCL/DWNL).

q - The analyte detection was below the Practical Quantitation Limit (PQL).
J - The analyte was positively identified, but the analyte concentration is an estimated value.
Highlighted values equal or exceed exceed a regulatory action or notification level for groundwater

***Groundwater Impacts*:** Perchlorate was detected at a maximum concentration of 54.9 µg/L in a groundwater grab sample collected from boring F33-HSAS10 at 25 to 26.5 feet bgs in April 2007. Groundwater samples collected from monitoring well MW-70 were analyzed for perchlorate, VOCs, and 1,4-dioxane. 1,4-dioxane and VOCs are not compounds of concern (COPCs) at Feature F-33 but were included for analysis because of known upgradient sources. Perchlorate was not detected above its reporting limit (RL). 1,4-dioxane, 1,1-DCE, and TCE were detected in the MW-70 groundwater sample at concentrations below the MCLs/DWNLs (Table 1-1). MW-70 was installed in boring F33-HSA14, which had a perchlorate concentration of 51,100 µg/kg in soil at a depth of 20 feet bgs (Tetra Tech, 2008a). Depth to water at the time MW-70 was installed was about 28 feet bgs. However, perchlorate was not detected in groundwater samples collected from MW-70 during the first two quarterly sampling events. Monitoring Well MW-70 is included in the on-going site-wide groundwater monitoring program. Monitoring well MW-70 is screened from 20 to 35 feet bgs within this boring. Low dissolved oxygen (DO) concentrations (0.96 mg/L on 10/25/07 and 0.41 mg/L on 5/29/08) in the groundwater at this well may be an indicator that perchlorate biodegradation is occurring in this area. High organic content in the nearby stream bed and in some of the lithologic units upgradient of the area may be creating the anaerobic environment.

1.3 GEOPHYSICAL SURVEY OF FEATURE F-33, LARGE MOTOR WASHOUT AREA

A geophysical seismic refraction survey was conducted at Feature F-33 in October 2007 to delineate the competent topography of the Mt. Eden Formation across Potrero Creek (Terra Physics, 2008). A vertical seismic velocity survey was also conducted in MW-70 to provide control for the refraction profiles. A summary of the refraction survey for Feature F-33 is provided below. The complete seismic velocity survey is presented in the Work Plan. The location of the seismic refraction profile is shown in Figures 1-5a,b.

1.3.1 Geophysical Feature F-33 Large Motor Washout Area

The purpose of the refraction survey at Feature F-33 was to assess the Mt. Eden bedrock topography across the site and across Potrero Creek between two bedrock outcrops. A downhole velocity survey was also conducted at this site in MW-70. As shown in Figures 1-5a,b, Profile 7 (708 feet long) was conducted from the Mt. Eden sandstone exposures along the northwest side of Feature F-33, proceeding in a southeasterly direction across Feature F-33 and Potrero Creek to within two feet of a 20-foot-tall sandstone cliff (Mt. Eden Formation) on the east side of the creek. The results of the downhole velocity survey showed that the upper velocity zones (1a and 1b) probably represent dry alluvium with different degrees of compaction. The second zone is probably dry, moderately weathered Mt. Eden Formation. A velocity consistent with saturated material was not observed because the well did not penetrate far enough

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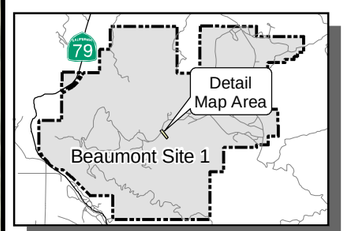
0 30 60 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

- Monitoring Well Location
- Former Production Well Location
- A-6-HAS1 — Supplemental Investigation Soil Boring Location
- A-6-HA2 — Previous Soil Boring Location
- A-3-DP5 — Previous Soil Boring and Soil Gas Sample Location
- (1) — Seismic Profile Location
- Suspected Unlined Catch Basin (location is approximate)
- Former Concrete Pad Location (location is approximate)

Note: Historical features from Radian 1986.



Beaumont Site 1

Figure 1-5a

Refraction Profile Location
Large Motor Washout Area

TETRA TECH

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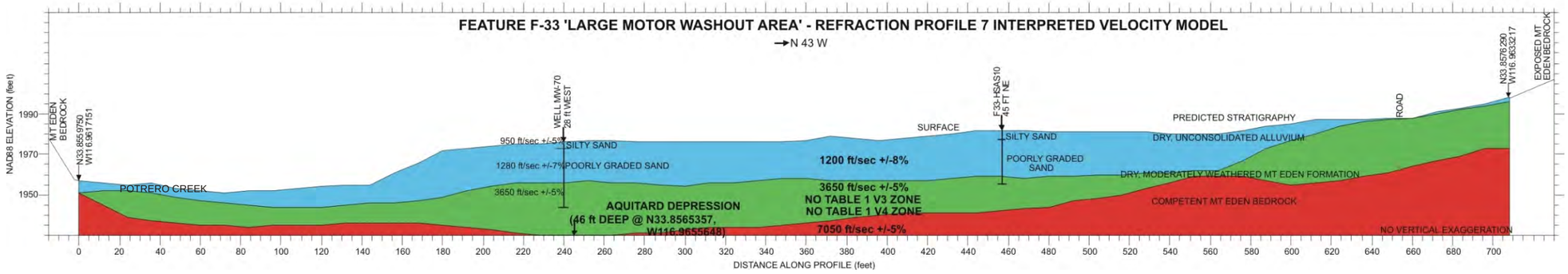
SE
7

NW
7'

FEATURE F-33 'LARGE MOTOR WASHOUT AREA' - REFRACTION PROFILE 7 INTERPRETED VELOCITY MODEL

→N 43 W



From TerraPhysics (2008)

0 30 60
Feet

Beaumont Site 1

Figure 1-5b

Refraction Profile
Large Motor Washout Area

TETRA TECH

into the saturated zone to allow for proper measurement of a seismic velocity at that depth. The seismic velocity survey was conducted in October 2007; the bottom of MW-70 was 34 feet bgs and the water table was measured at 31 feet bgs. Based on field logs, the well did not penetrate competent Mt. Eden material and, therefore, a velocity consistent with competent sandstone was not observed in the downhole velocity survey (Terra Physics, 2008).

Based on the seismic refraction data, the top of the competent Mt. Eden bedrock ranges from approximately 6 feet bgs near the southeastern end of the profile to about 46 feet bgs near MW-70. Moderately weathered Mt. Eden is exposed on the southeast and northwest ends of the profile and is represented as moderately weathered Mt. Eden in the seismic profiles.

Based on the profile, the stream bed appears to have historically meandered across a significant portion of the area surveyed. The deepest expression of the historic drainage is beneath the northwest edge of the current streambed. The weathered Mt. Eden unit is thickest beneath monitoring well MW-70.

2.0 INVESTIGATION APPROACH

The objective of this investigation was to complete the characterization of the lateral and vertical extent of chemicals of potential concern (COPCs) at Feature F-33. This data will then be used to evaluate remedial alternatives. The only COPC identified was perchlorate.

The investigation was designed to fill data gaps in areas where impacted soil and/or groundwater were identified during the previous investigations. This soil and groundwater investigation utilized a combination of direct-push, HSA soil borings, and hand-auger borings for soil and groundwater sampling. HSA drilling techniques were used to install the permanent wells once the soils were sampled. Hand augers were used to install temporary, shallow groundwater monitoring wells in and immediately adjacent to Potrero Creek. Well construction diagrams and a well construction summary table are presented in Appendices E and F respectively. The investigation goal was to adequately define the lateral and vertical extent of perchlorate-impacted soil so that remedial alternatives could be identified for the site. Table 2-1 defines the investigative objectives based on each sampling technique.

2.1 CHARACTERIZATION ACTIVITIES

Borings were advanced and soil samples were collected to characterize site geology and the extent of soil impacts. The method detection limit (MDL) for perchlorate in soil was 10.2 µg/kg. In addition, groundwater monitoring wells were installed to determine groundwater flow across the site, assess perchlorate impacts to groundwater, and to assess whether the carbon sources within the Potrero Creek drainage have any influence on the natural degradation of perchlorate in the groundwater at Feature F-33.

Tetra Tech completed 10 direct-push soil-sampling locations and collected 61 soil samples at Feature F-33 from July 14 through July 18, 2008 (Figure 2-1). Investigative borings were installed to gather additional information on the horizontal and vertical extent of impacted soil. Soil samples were analyzed for perchlorate only using EPA Method 314.0.

In addition, eight groundwater monitoring wells were installed at Feature F-33 to evaluate groundwater quality and flow direction. Two groundwater monitoring wells were installed on the bluff along the north end of the site (MW-82 and MW-83) and six shallow (temporary) groundwater monitoring wells were installed adjacent to the bluff in the Potrero Creek Drainage. All groundwater samples were analyzed for perchlorate (EPA Method 314.0), Volatile Organic Compounds (VOCs, EPA Method 8260B), 1,4-Dioxane (EPA Method 3520B), Inorganic Ions (EPA Method 300.0), sulfide (EPA Method 376.1), Dissolved Organic Carbon (DOC) and Total Organic Carbon (TOC) in water (EPA Method 415.1), Methane (Method RSK 175), and Volatile Fatty Acids (Method AM 236). Groundwater monitoring well development and sampling field sheets are presented in Appendix G.

Long-term monitoring of natural-attenuation parameters from these shallow groundwater monitoring wells will also be used to monitor natural-attenuation parameters within Potrero Creek.

Table 2-1 Feature F-33 Investigation Objectives

Sampling Method	Objectives
Direct Push Soil Sampling	● Delineate extent of perchlorate impacts to soil in the immediate area of Feature F-33.
HSA Drilling and Well Installation	● Delineate extent of perchlorate impacts to soil in the immediate area of Feature F-33. ● Install two groundwater monitoring wells at the site to assess feature specific COPC and Site-wide COPC impacts to groundwater and to evaluate the natural attenuation of perchlorate at Feature F-33.
Hand Auger Sampling and Well Installation	● Delineate extent of perchlorate impacts in soil within the stream channel and riparian corridor adjacent to Feature F-33. ● Install six shallow groundwater monitoring wells within the Potrero Creek drainage to assess feature specific COPC and Site-wide COPC impacts to groundwater and to evaluate the natural attenuation of perchlorate immediately adjacent to Feature F-33 and in the riparian corridor adjacent to Feature F-33.

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N

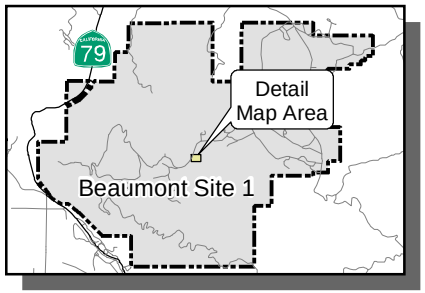
0 40 80
Feet

Adapted from: March 2007 aerial photograph.

LEGEND

- Monitoring Well Location
- Previous Soil Boring Location
- Previous Soil Boing and Soil Gas Sample Location
- Soil Boring Locations for Current Investigation
- Former Production Well Location
- Edge of Bluff
- Topographic Contour
- Suspected Unlined Catch Basin (location is approximate)
- Former Concrete Pad Location (location is approximate)

Note: Historic features from Radian 1986. 2-foot topographic contours.



Beaumont Site 1

Figure 2-1

Sampling Locations and Wells at Feature F-33

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3.0 RESULTS OF DETAILED SITE CHARACTERIZATION

This section describes the surface and subsurface geology and presents the characterization results.

3.1 SURFACE AND SUBSURFACE GEOLOGY

Based on numerous characterization studies performed to date, the surface and subsurface geology of Feature F-33 is very well understood. The site is situated on a bluff adjacent to Potrero Creek. The bluff contains alluvial sediment derived from local sources including alluvium from Potrero Creek and from the surrounding hillsides that are predominantly Mt. Eden Sandstone and the lower part of the San Timoteo Formation. The maximum depth to more competent Mt. Eden Sandstone is estimated to be about 45 feet bgs near monitoring well MW-70 based on seismic refraction data. Based on data collected from the numerous direct-push sampling points and borehole logs from the hollow-stem auger borings, depth to Mt. Eden Sandstone is 20 feet bgs at the north end of the site but was not encountered in the boreholes drilled on the bluff to a depth of 36 feet bgs (MW-82 and MW-70). Electronic boring logs are presented in Appendix A. Mapping soil and bedrock exposures along Potrero Creek shows that Mt. Eden Sandstone is exposed in Potrero Creek at several locations along the bluff – active channel interface. Also, within Potrero Creek itself, Mt. Eden Sandstone is present in several exposures at the eastern tip of the bluff. Based on numerous boreholes, field mapping of the site, and the seismic refraction data collected at the site, more competent Mt. Eden Sandstone is present at relatively shallow depths. Figure 3-1 shows sampling, well, and cross-section locations at Feature F-33. Figures 3-2 and 3-3 are idealized geologic cross-sections across Feature F-33.

The dominant soil type present at the site includes silty sand and sandy silt on the bluffs (see geologic cross-sections Figures 3-2 and 3-3). Within the stream channel itself, the dominant soil type is poorly graded sand. In general, the bluff soils do not contain a significant amount fine-grained soils such as silts and clays. Borehole logs suggest that the soil on the bluff is channel deposits that have been elevated as a result of down cutting of Potrero Creek over time. Small lenses of fine-grained silty sand and sandy silt are present in isolated locations but overall, the soil is predominantly sand.

3.2 SOIL CHARACTERIZATION

Recent investigations showed that the areas containing the highest concentrations of perchlorate were located between the former concrete pad and the former production well that was used to conduct the motor washouts. Table 3-1 is a summary of the validated soil analytical results from samples collected in July 2008. Analytical data packages are presented in Appendix B and validated analytical results are presented in Appendix C. Isoconcentration plots have been generated for depth intervals of 0.5 feet bgs, five to nine feet bgs, 10 to 14 feet bgs, 15 to 19 feet bgs, and 20 to 24 feet bgs (see Figure 3-4a and 3-4b).

X:\GIS\Lockheed 22288-03006\F-33_GPS_2.mxd

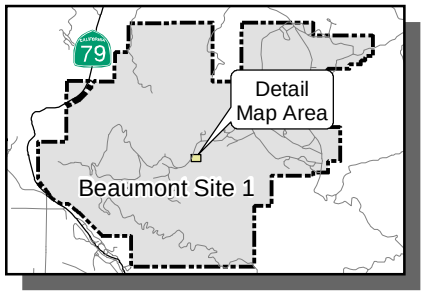
0 40 80 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

- Monitoring Well Location
- Previous Soil Boring Location
- Previous Soil Boing and Soil Gas Sample Location
- Soil Boring Locations for Current Investigation
- Former Production Well Location
- Geologic Cross Section Location
- Edge of Bluff
- Topographic Contour
- Suspected Unlined Catch Basin (location is approximate)
- Former Concrete Pad Location (location is approximate)

Note: Historic features from Radian 1986. 2-foot topographic contours.



Beaumont Site 1

Figure 3-1

Sampling, Wells and Cross Section Locations at Feature F-33

TETRA TECH

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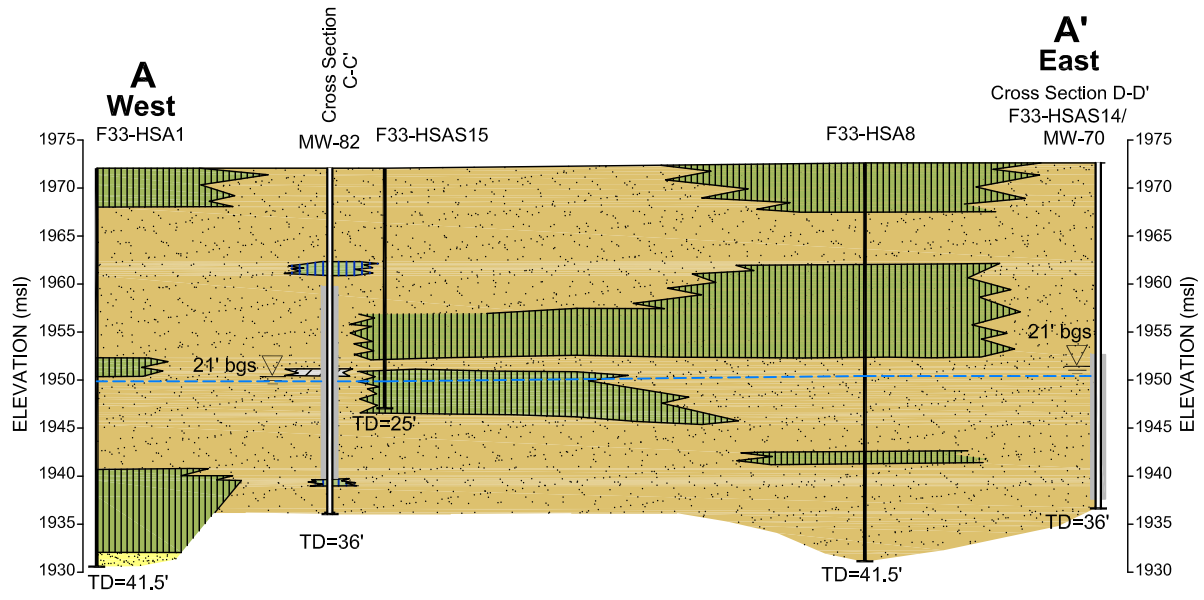
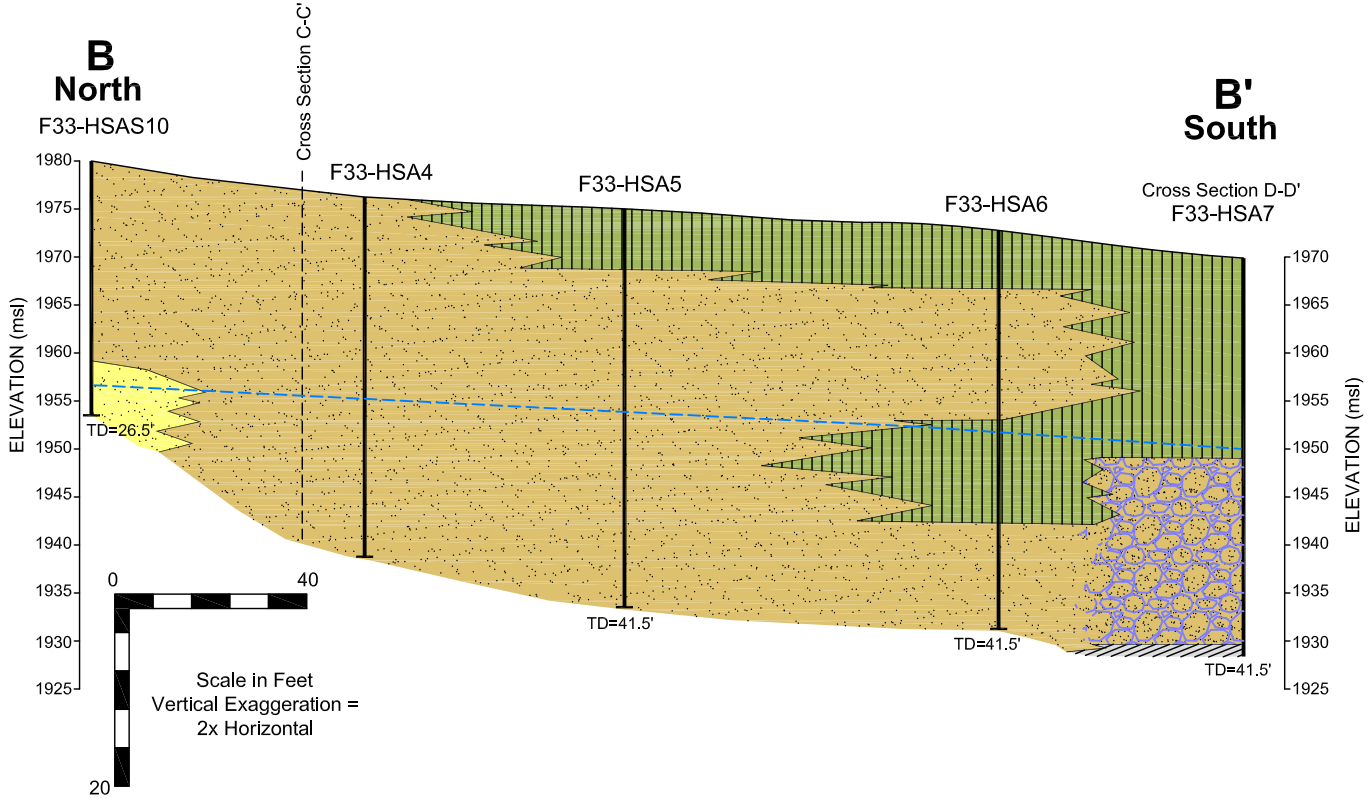
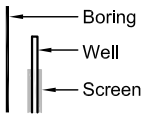




LEGEND

- Clay
- Silt
- Poorly graded sand, well graded sand, silty sand, poorly graded sand with silt
- Gravel
- Weathered Mt. Eden Formation
  Mt. Eden Formation
- Groundwater Level at Time of Drilling July - August 2008
- Contact
- Approximate water elevation line at time boreholes were installed, July-August 2008.



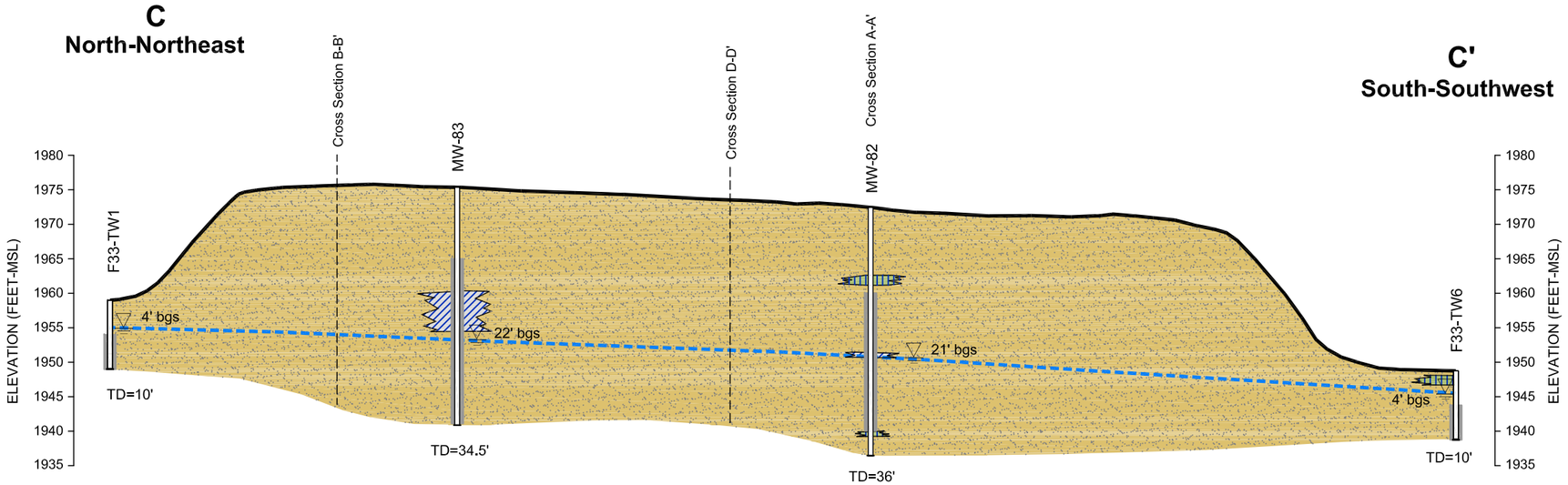
Note: No lithology data for F33-HSA4.

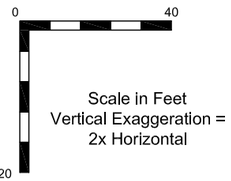
Beaumont Site 1

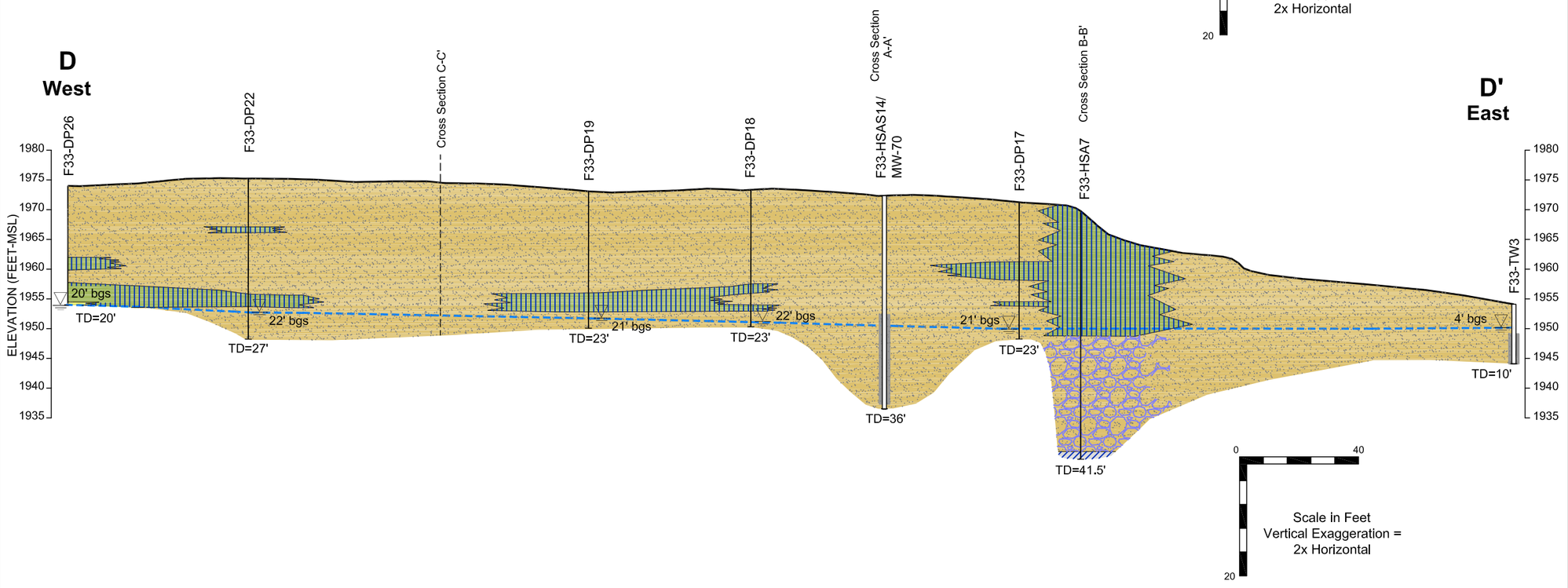
Figure 3-2
Idealized Geologic Cross Section A-A' and B-B' at Feature F-33

TETRA TECH

X:\GIS\LOCKHEED 22288-0202\X-SECTION C-C' D-D'.DWG

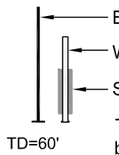






LEGEND

- Clay
- Silt, sandy silt, silt with sand
- Poorly graded sand, well graded sand, silty sand, poorly graded sand with silt
- Gravel
- Weathered Mount Eden Formation, Mount Eden Formation
- First Water
- Contact
- Approximate water elevation line at time boreholes were drilled, July-August 2008



Total Boring Depth (feet below ground surface)

Beaumont Site 1

Figure 3-3
Idealized Geologic Cross Sections C-C' and D-D' Large Motor Washout Area (Feature F-33)

TETRA TECH

Table 3.1 Summary of Validated Perchlorate Results in Soil at Feature F-33 Using EPA Method 314.0

Borehole Name	Feet below ground surface					
	0.5-2	3-4	5-9	10-14	15-19	20-24
MDL (1) 10.2 - 20.7	**Laboratory results in µg/kg**					
F33-DP17	2230	*NA*	324	12100	1390	*NA*
F33-DP18	258	*NA*	2170	4880 Jf	149000	*NA*
F33-DP19	38	*NA*	29.4	*NA*	4560 Jf	ND
F33-DP20	1700	*NA*	NA	133000	302000	210000
F33-DP21	41.6	*NA*	58.3	*NA*	134	ND
F33-DP22	31.7	*NA*	NA	ND	192	771
F33-DP23	ND	*NA*	ND	*NA*	ND	ND
F33-DP24	ND	*NA*	ND	*NA*	56.4	212
F33-DP25	*NA*	*NA*	ND	ND	ND	*NA*
F33-DP26	ND	*NA*	ND	ND	ND	*NA*
MW-82	*NA*	*NA*	ND	35.1	62.9	ND
MW-83	*NA*	*NA*	100	3020	230	ND
F33-TW1	ND	ND	*NA*	*NA*	*NA*	*NA*
F33-TW2	ND	ND	*NA*	*NA*	*NA*	*NA*
F33-TW3	ND	ND	*NA*	*NA*	*NA*	*NA*
F33-TW4	ND	ND	*NA*	*NA*	*NA*	*NA*
F33-TW5	ND	ND	*NA*	*NA*	*NA*	*NA*
F33-TW6	ND	ND	*NA*	*NA*	*NA*	*NA*

MDL - Method Detection Limit

(1) Method Detection Limit (MDL) - MDLs may vary if sample was analyzed from a diluted aliquot.

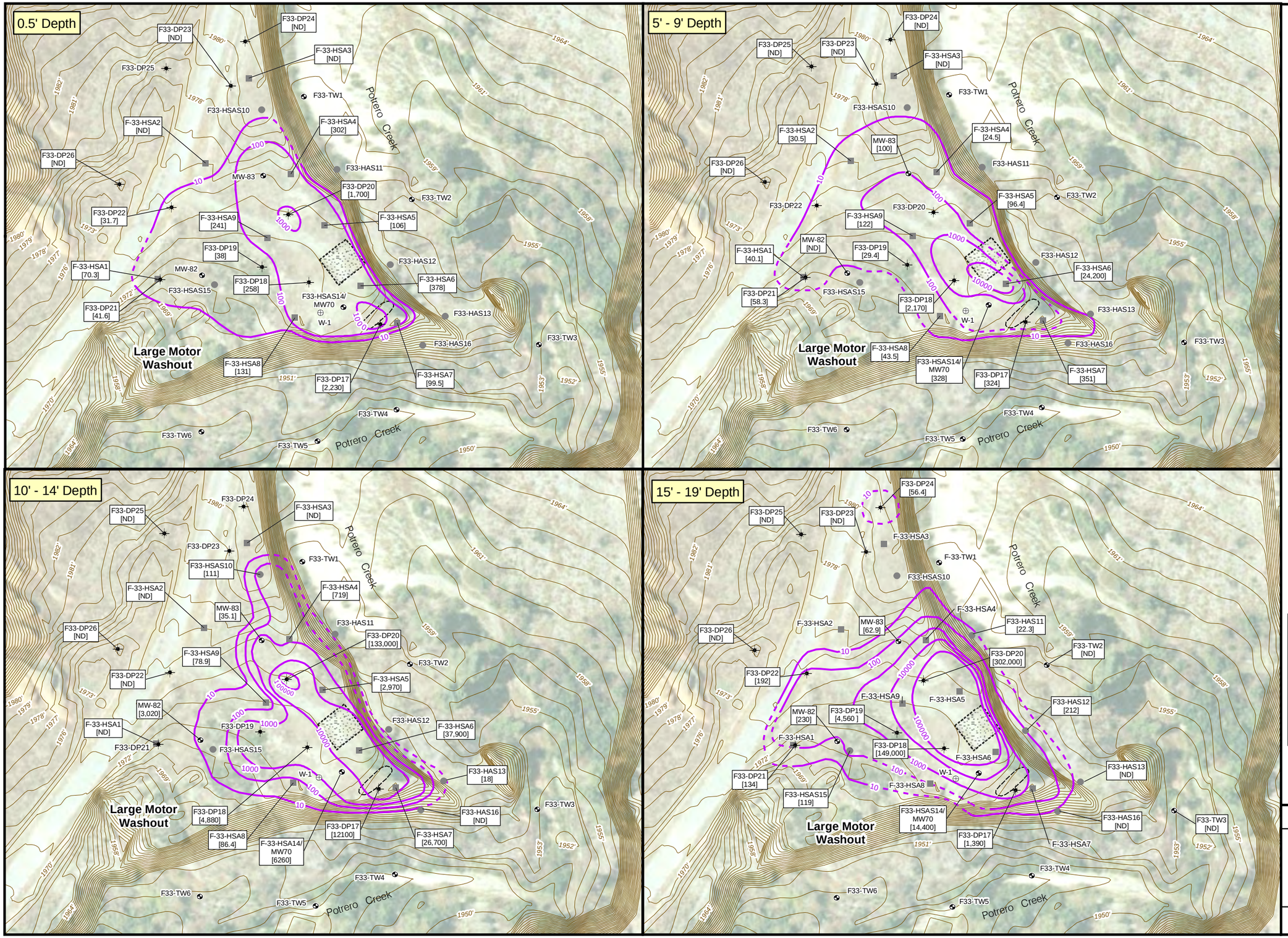
µg/kg - micrograms per kilogram

J - The analyte was positively identified, but the analyte concentration is an estimated value.

NA - not analyzed at indicated depth.

ND - sample was analyzed but was below the MDL

X:\GIS\Lockheed Meeting Site 1\F-33_PERCH 1.mxd



0 50 100 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

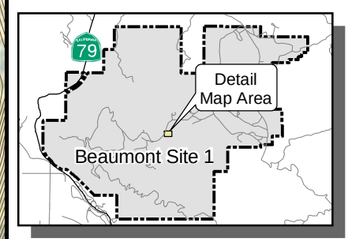
- Monitoring Well Location
- Former Production Well Location
- Soil Boring Locations for Current Investigation
- Previous Soil Boring Location
- Previous Soil Boring and Soil Gas Sample Location
- 10 — Perchlorate Isoconcentration Contour (Dashed where inferred)
- Suspected Unlined Catch Basin (location is approximate)
- Former Concrete Pad Location (location is approximate)

Note:

[#] Perchlorate results in µg/kg.

[ND] Non-Detect.

Historical features from radian 1986.



Beaumont Site 1

Figure 3-4a

Perchlorate Concentrations in Soil at Feature F-33

TETRA TECH

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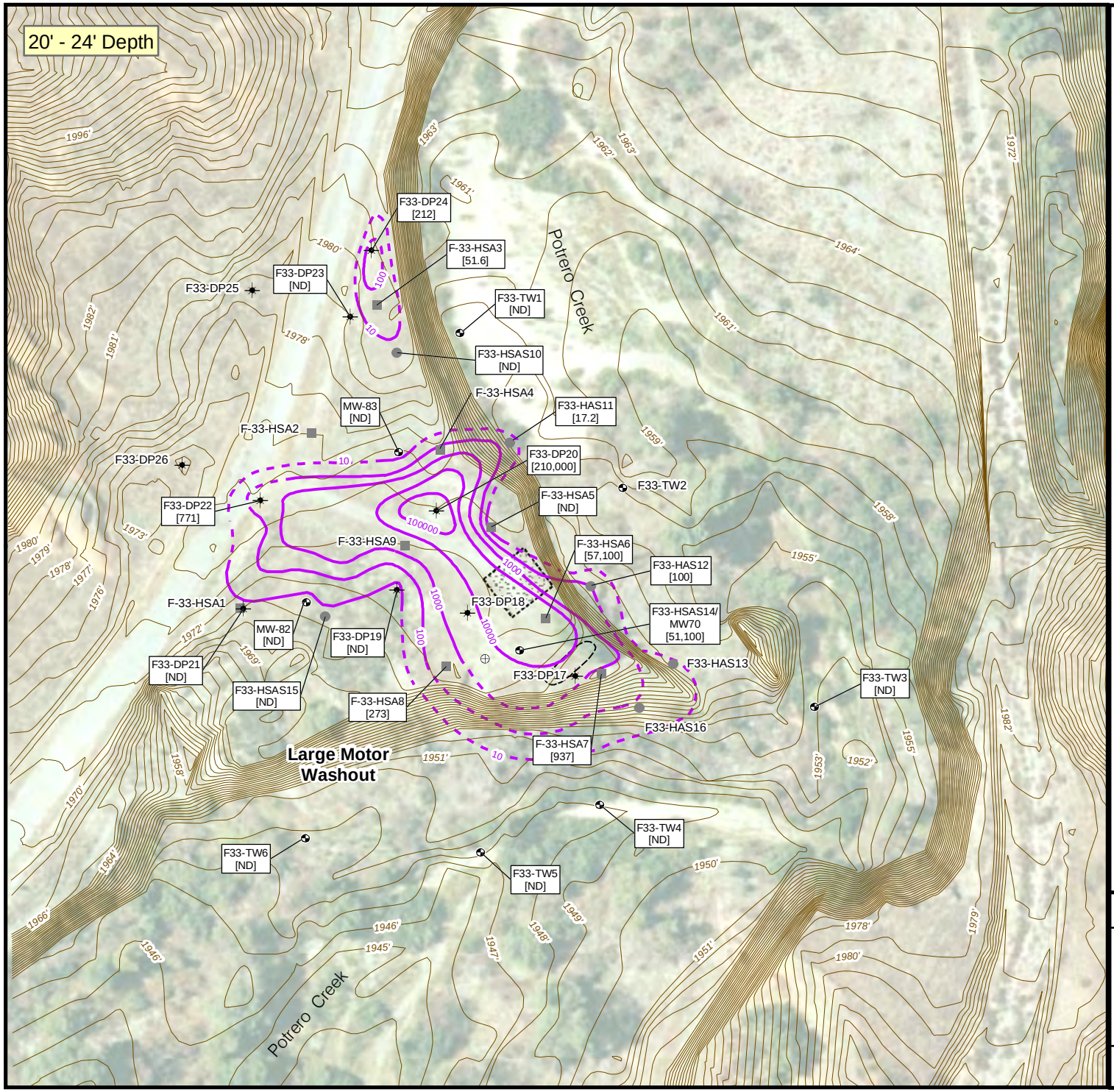


0 50 100 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

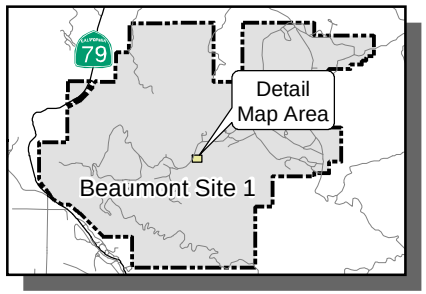
- Monitoring Well Location
- Former Production Well Location
- Soil Boring Location for Current Investigation
- Previous Soil Boring Location
- Previous Soil Boring and Soil Gas Sample Location
- 10 — Perchlorate Isoconcentration Contour (Dashed where inferred)
- Suspected Unlined Catch Basin (location is approximate)
- Former Concrete Pad Location (location is approximate)

Note:

[#] Perchlorate results in µg/kg.

[ND] Non-Detect.

Historical freatures from Radian 1986.



Beaumont Site 1

Figure 3-4b

Perchlorate Concentrations in Soil at Feature F-33

TETRA TECH

Concentrations ranged from non-detect (MDL of 10.2 µg/kg) to 302,000 µg/kg at F33-DP20-16 (16 feet bgs). The highest concentrations are found at sampling location F33-DP20, adjacent to the former concrete pad identified by Radian in their 1986 Records Search (Radian, 1986). Sampling locations located along the length of the bluff show that highest concentrations of perchlorate impacted soil are present from approximately F33-DP20 south-southeast to F33-HSA7.

Vertically, the highest perchlorate concentrations in soil are from 10 to 24 feet bgs, with the highest concentrations at or slightly above the water table. Based on limited water level measurements taken at the site, water levels on the bluff fluctuate between 19 and 31 feet bgs. These recent investigation results are consistent with past investigations. A consolidated analytical data summary table is presented in Appendix D. Based on the contaminant contour maps presented in Figures 3-4a and 3-4b, the estimated volume and weight of perchlorate-impacted soil is summarized in Table 3-2. The volume of perchlorate impacted soil and the weight of perchlorate above 10 µg/kg is approximately 36,672 cubic yards (yd^3) and 1470 pounds, assuming a total depth of 25 feet bgs.

The volume of in-place perchlorate impacted soil was calculated by determining the area within each concentration isopleth, averaging the area between like concentration isopleths, and multiplying that average area times the thickness of the interval. The total volume of in-place impacted soil within each concentration isopleth was then determined by adding the volumes calculated across each depth interval.

The weight of the in-place perchlorate-impacted soil was calculated by multiplying the volume of soil times a presumed weight of 130 lbs per cubic foot and converting that to tons (2000 lbs/ton).

The weight of the perchlorate between each concentration isopleth was calculated by subtracting the weight within each concentration isopleth from the weight within the adjacent concentration isopleth, converting that weight to a mass (2.2046 lbs/kg), multiplying that mass times the average of the two concentration isopleths, converting micrograms to grams, and converting that mass to pounds (453.59 grams/lbs).

3.2.1 Groundwater Characterization

Table 3-3 summarizes the analytical results from groundwater samples collected from each of the monitoring wells at Feature F-33. Based on one round of sampling, perchlorate was non-detect in all samples at a MDL of 0.5 µg/L. 1,4-Dioxane was detected in all samples at concentrations ranging from 2.0 to 3.9 µg/L. Three (3) samples exceeded the DWNL of 3 µg/L for 1,4--dioxane (3.0 µg/L in F33-TW1, 3.8 µg/L in F33-TW3, and 3.9 µg/L in MW-83). Other VOCs detected in groundwater, but below any action level, include chloromethane, 1,1-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene and trichloroethene.

Table 3-2
Estimate of Volume and Weight of Soil and Perchlorate at F-33

Concentration Isopleth	Volume of soil within each isopleth (yd^3)	Weight of soil within each isopleth (tons)	Weight of perchlorate between isopleths (lbs)	Weight of perchlorate within each isopleth (lbs)
10	36,672	64,359	3	1470
100	20,799	36,503	22	1467
1,000	9,392	16,483	100	1444
10,000	4,204	7,379	497	1344
100,000	1,528	2,682	848	848

Using monitoring wells F33-TW1 through F33-TW6, MW-70, MW-82, and MW-83, a depiction of groundwater flow under Feature F-33 was generated. Figure 3-5 uses water level measurements collected during the August 2008 sampling round to illustrate groundwater flow direction and gradient across Feature F-33. Based on water level measurements made in August 2008, groundwater flow is generally south coincident with surface water flow down Potrero Creek. The groundwater gradient based on the August 2008 measurements is approximately 0.03 feet per foot.

3.3 MONITORED NATURAL ATTENUATION (MNA) SUMMARY

Two groundwater MNA sampling events were conducted in May and August 2008. MNA samples were collected from monitoring wells that were downgradient of the main sources of perchlorate within the Site but included wells that were immediately upgradient and within close proximity to Feature F-33. Figure 3-6 shows the location of all groundwater monitoring wells used for the MNA sampling and their location relative to Feature F-33. Monitoring wells used for MNA sampling include F33-TW1 through F33-TW6, which surround Feature F-33; MW-18, MW-37, and MW-43, which are located upgradient and upstream of Feature F-33; monitoring well MW-67, which is located downgradient and downstream of Feature F-33; and monitoring wells MW-70, MW-82, and MW-83, which are Feature F-33 monitoring wells. These wells, which are in the path of the general hydraulic flow line from MW-37 to MW-67, are being sampled semiannually for conventional geochemical and MNA paramenters.

The objective of the MNA sampling and analysis effort is to continue to develop an understanding of the geochemical characteristics that appear to be contributing to the natural attenuation of perchlorate in groundwater in the vicinity of Feature F-33. Specifically, soil perchlorate concentrations have been detected as high as 302,000 µg/kg at F33-DP20 (located 16 feet below ground surface) while groundwater concentrations have fluctuated from below detections limits up to 48.4 µg/L . While natural attenuation of perchlorate is apparently playing a role in contaminant reduction, a better understanding of the

Table 3-3 Summary of Analytes Detected in Groundwater at Feature F-33- 2008

Sample Name	Filter Status	Sample Date	Matrix	Perchlorate -ug/L	1,4-Dioxane -ug/L	Methane -ug/L	Sulfide -mg/L	Sulfate -mg/L	Total Organic Carbon - mg/L	Dissolved Organic Carbon -mg/L	Iron -mg/L	Acetic Acid -mg/L	Lactic Acid And Hiba - mg/L	Chloromethane -ug/L	1,1-Dichloroethane - ug/L	1,1-Dichloroethene - ug/L	c-1,2-Dichloroethene - ug/L	Trichloroethene -ug/L
MDL				0.5	0.6	0.6	0.100	0.250 - 1.25	0.500	0.500	0.04	0.04	0.7	0.2	0.2	0.2	0.2	0.2
MCL/DWNL				6	3	-	-	-	-	-	-	-	-	-	5	6	6	5
F33-TW1	Unfiltered	8/18/2008	W	ND	3	55	0.8	109	3.06	*NA*	0.118 Jq	0.14	ND	ND	ND	0.55 Jq	0.2 Jq	ND
F33-TW1-F	Filtered	8/18/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3.22	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
F33-TW2	Unfiltered	8/18/2008	W	ND	2	150	0.8	62.1	3.03	*NA*	0.8	0.26	0.37	ND	ND	0.34 Jq	ND	ND
F33-TW2-F	Filtered	8/18/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	2.88	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
F33-TW3	Unfiltered	8/18/2008	W	ND	3.8	16	0.8	55.9	1.76	*NA*	0.454	0.14	0.15	2.5	0.22 Jq	1.4	0.21 Jq	0.79 Jq
F33-TW3-F	Filtered	8/18/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	1.82	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
F33-TW4	Unfiltered	8/19/2008	W	ND	2.7	61	0.8 Jq	73.8	3.22	*NA*	0.521	0.1	0.15	ND	ND	0.29 Jq	ND	ND
F33-TW4-F	Filtered	8/19/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3.28	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
F33-TW5	Unfiltered	8/18/2008	W	ND	2.8	97	1.2	74.1	3.45	*NA*	0.12 Jq	0.11	0.20	ND	ND	ND	ND	ND
F33-TW5-F	Filtered	8/18/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3.73	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
F33-TW6	Unfiltered	8/19/2008	W	ND	2.9	1.8 Jq	0.8 Jq	94.3	3.36	*NA*	0.295	0.12	0.15	ND	ND	ND	ND	ND
F33-TW6-F	Filtered	8/19/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3.16	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
MW-82	Unfiltered	8/19/2008	W	ND	2.7	3.8	ND	125	3.24	*NA*	1.07	0.12	0.16	ND	ND	ND	ND	ND
MW-82-F	Filtered	8/19/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3.69	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
MW-83	Unfiltered	8/19/2008	W	ND	3.9	3.7	0.8 Jq	101	2.79	*NA*	0.309	0.12	0.14	ND	ND	0.34 Jq	ND	ND
MW-83-F	Filtered	8/19/2008	W	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3.57	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*

Only the VOCs positively detected are presented in this table. All analytes tested for are listed in the laboratory data package.

(1) Method Detection Limit (MDL) - MDLs may vary if sample was analyzed from a diluted aliquot .

bgs – below ground surface

µg/L – micrograms per liter

MCL – maximum contaminant level

DWNL – drinking water notification level

NA – not analyzed

ND – not detected at or above the method detection limit.

J - The analyte was positively identified, but the analyte concentration is an estimated value.

q - The analyte detection was below the Practical Quantitation Limit (PQL).

Highlighted values exceed a regulatory action or notification level for groundwater (MCL/DWNL).

X:\GIS\Lockheed 22288-0306\F-33_Wells-2.mxd

0 25 50 Feet

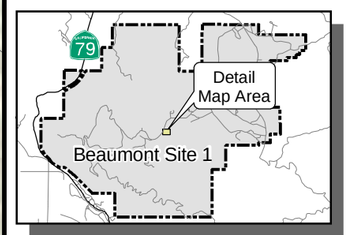
Adapted from: March 2007 aerial photograph.

LEGEND

- Monitoring Well Location
- Topographic Contour
- Groundwater Flow Direction
- 1953 — Groundwater Elevation in Feet relative to Mean Sea Level
- Suspected Unlined Catch Basin (location is approximate)
- Former Concrete Pad Location (location is approximate)

Note: Groundwater elevation data from 3rd quarter 2008.

Historical features from Radian 1986.



Beaumont Site 1

Figure 3-5

Groundwater Flow Direction and Gradient at Feature F-33

TETRA TECH

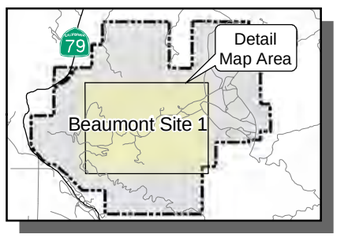
X:\GIS\Lockheed 22288-0306\Natural Atten_3.mxd

0 500 1,000 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

- Monitoring Well Location
- Beaumont Site 1 Property Boundary



Beaumont Site 1

Figure 3-6
Location Map Showing Groundwater Monitoring Wells Used for Monitoring Natural Attenuation Sampling

TETRA TECH

geochemistry and its seasonal variations is needed to evaluate the long term implications of these processes.

3.3.1 Geochemical Study

Table 3-4 summarizes results of the various field and laboratory chemical and geochemical parameters measured during the May, August, and November 2008 sampling events. Table 3-5 is a summary of water level measurements and perchlorate concentrations. The May 2008 sampling event consisted of existing wells MW-18, MW-37, MW-43, MW-67, and MW-70. The August and November 2008 sampling events included eight new sampling locations F33-TW1 through F33-TW6, MW-82, and MW-83. Geochemical parameters included time sensitive parameters such as DO, oxidation-reduction potential (ORP), ferrous iron, and sulfide. In addition, other routine geochemical parameters such as total iron and sulfate were measured. Finally, more specialized parameters such as methane, TOC, dissolved organic carbon (DOC), hydrogen, and VFAs were also measured. The following paragraphs summarize the findings of this geochemical study.

3.3.2 Perchlorate

In general, perchlorate concentrations are below detection limits in most monitoring wells within the Feature F-33 area. The only well with perchlorate detections within the Feature F-33 area was MW-70, with a concentration as high as 48.5 µg/L in February/March 2008 and only slightly above detection limits at 6.91 µg/L during the May 2008 sampling event. The concentration during the August 2008 event was 21.7 µg/L. By November 2008, perchlorate was non-detect. In samples collected from MW-70 prior to 2008, perchlorate was not detected.

Based on the extremely high levels of perchlorate contamination present in the vadose-zone soil, the fact that most monitoring wells within the Feature F-33 area show perchlorate at or below detection limits is perhaps the most important indicator that geochemical conditions in groundwater are conducive to natural biodegradation. The increases in perchlorate concentrations at MW-70 in March and August 2008 appear to correspond to increased rainfall and higher groundwater levels. Figures 3-7a and b are histograms that show perchlorate concentrations relative to precipitation and water levels from January 2007 through December 2008.

3.3.3 Nitrate

Nitrate was either absent or detected at very low concentrations. Nitrate is often considered the most critical electron acceptor competitor to perchlorate. Its absence in the aquifer permits native groundwater microorganisms to utilize perchlorate as an electron acceptor in the respiratory process. The absence of nitrate is also significant because it means that natural organic carbon that exists in the aquifer does not get consumed for denitrification.

Table 3-4 Summary of Results for Various Field and Laboratory Chemical and Geochemical Parameters

Field Parameters					Analytes																
Sample Location	Sample Date	Perchlorate ug/L	DO - mg/L	ORP - mVs	Acetic Acid - mg/L	Butyric Acid - mg/L	i-Hexanoic Acid -mg/L	Hexanoic Acid - mg/L	Lactic Acid and HIBA - mg/L	Pyruvic Acid - mg/L	i-Pentanoic Acid - mg/L	Propionic Acid - mg/L	Pentanoic Acid - mg/L	Dissolved Organic Carbon - mg/L	Total Organic Carbon - mg/L	Hydrogen -nM	Methane - ug/L	Sulfide - mg/L	Nitrate (as N) - mg/L	Sulfate - mg/L	Ferrous Iron - mg/L	Iron - mg/L
F33-TW1	8/18/2008	ND	0.33	45.5	0.14	<0.06	<0.08	<0.08	<0.07	<0.07	<0.07	<0.05	<0.07	3.22	3.06	NA	55	0.8	<0.05	109	<2.5	0.118 Jq
F33-TW2	8/18/2008	ND	0.33	-120.7	0.26	<0.06	<0.08	<0.08	0.37	<0.07	<0.07	<0.05	<0.07	2.88	3.03	NA	150	0.8	<0.05	62.1	<2.5	0.8
F33-TW3	8/18/2008	ND	0.27	-94.2	0.14	<0.06	<0.08	<0.08	0.15	<0.07	<0.07	<0.05	<0.07	1.82	1.76	NA	16	0.8	<0.05	55.9	<2.5	0.454
F33-TW4	8/19/2008	ND	0.62	-124.9	0.1	<0.06	<0.08	<0.08	0.15	<0.07	<0.07	<0.05	<0.07	3.28	3.22	NA	61	0.8 Jq	<0.05	73.8	<2.5	0.521
F33-TW5	8/18/2008	ND	0.34	16.2	0.11	<0.06	<0.08	<0.08	0.20	<0.07	<0.07	<0.05	<0.07	3.73	3.45	NA	97	1.2	<0.05	74.1	<2.5	0.12 Jq
F33-TW6	8/19/2008	ND	0.37	-34.5	0.12	<0.06	<0.08	<0.08	0.15	<0.07	<0.07	<0.05	<0.07	3.16	3.36	NA	1.8 Jq	0.8 Jq	<0.05	94.3	<2.5	0.295
MW-18	11/2/2007	4.7	0.29	53.6	0.140	<0.060	<0.080	<0.080	0.300	<0.070	<0.070	<0.050	<0.070	9.43	1.47	2.400	2.7	<0.1	0.633	57.5	<2.5	<0.04
MW-18	5/30/2008	6.7	0.14	112.3	0.12	<0.06	<0.08	0.25	0.2	<0.07	<0.07	<0.05	<0.07	1.26	2.13	2.1	1.2 Jq	<0.1 UJe	0.457	52.2	<2.5	<0.04
MW-37	11/8/2007	7.3	0.58	-57.1	0.130	<0.060	<0.080	<0.080	<0.070	<0.070	<0.070	<0.050	<0.070	1.32	0.816 Jq	5.200	1.2 Jq	<0.1	<0.05	41.9	<2.5	<0.04
MW-37	5/29/2008	2.6	0.36	-171.8	0.14	<0.06	<0.08	0.13 Jf	0.21	<0.07	<0.07	0.11	<0.07	0.815 Jq	1.21	3.1	1.2 Jq	<0.1	0.496	34.4	<2.5	<0.04
MW-43	5/29/2008	5.4	0.31	172.5	0.19	<0.06	<0.08	<0.08	0.29	0.3	<0.07	<0.05	<0.07	0.555 Jq	0.69 Jq	11	330	<0.1	0.846	11.7	<2.5	0.064 Jq
MW-67	11/2/2007	0.78 Jq	0.24	59.1	0.210	<0.060	<0.080	<0.080	<0.070	<0.070	<0.070	<0.050	<0.070	13.3	4.89	1.600	4.2	<0.1	<0.05	220	<2.5	<0.04
MW-67	5/30/2008	0.86 Jq	0.15	153.1	0.14	<0.06	<0.08	0.18	<0.07 UJc	<0.07 UJc	<0.07	<0.05	<0.07	5.35	6.45	60	25	<0.1 UJe	<0.05	106	<2.5	<0.04
MW-70	11/8/2008	ND	1.3	49.3	0.200	<0.060	<0.080	<0.080	<0.070	<0.070	<0.070	<0.050	<0.070	3.31	2.37	1.400	140	<0.1	<0.05	88.6	<2.5	<0.04
MW-70	5/29/2008	2.2	0.41	-69.9	0.14	<0.06	<0.08	0.16	0.23	<0.07	<0.07	<0.05	<0.07	3.41	3.83	2.3	8.8	<0.1	0.0573 Jq	69.8	<2.5	<0.04
MW-82	8/19/2008	ND	0.38	99.1	0.12	<0.06	<0.08	<0.08	0.16	<0.07	<0.07	<0.05	<0.07	3.69	3.24	NA	3.8	<0.4	<0.05	125	<2.5	1.07
MW-83	8/19/2008	ND	1.05	83.9	0.12	<0.06	<0.08	<0.08	0.14	<0.07	<0.07	<0.05	<0.07	3.57	2.79	NA	3.7	0.8 Jq	<0.05	101	<2.5	0.309
TW1	11/6/2007	2.7	1.25	50.5	0.750	<0.060	<0.080	<0.080	0.350	<0.070	<0.070	0.060 Jq	<0.070	3.39	3.16	25.0	11	<0.1	0.0577 Jq	92	<2.5	0.0423 Jq
TW2	11/6/2007	2.2	0.36	14.2	0.200	<0.060	<0.080	<0.080	0.220	<0.070	<0.070	<0.050	<0.070	3.55	3.04	130.0	220	<0.1	0.0933 Jq	66	<2.5	2.69
Reporting Limit		-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	2	0.5	0.1	2.5	5	0.2
Method Detection Limit		-	-	-	0.07	0.07	0.10	0.10	0.10	0.07	0.07	0.07	0.07	0.5	0.5	0.6	0.6	0.1	0.05	1.25	2.5	0.04
MCL/DWNL		6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		10	250		0.3

Notes:
Only analytes positively detected are presented in this table. For a complete list, refer to the laboratory data package.
mg/L - milligrams per liter
µg/L - micrograms per liter.
nM - nanomoles
MCL - Maximum Contaminant Level.
DWNL - California Department of Health Services state drinking water notification level.
NA - not analyzed.
"-" - MCL or DWNL not available.
U - The analyte was not detected above the MDL.
J - The analyte was positively identified, but the analyte concentration is an estimated value.
e - a holding time violation occurred.
q - The analyte detection was below the Practical Quantitation Limit (PQL).
Highlighted values equal or exceed a regulatory action or notification level for groundwater (MCL/DWNL)

Table 3-5. Summary of Perchlorate Concentrations with Groundwater Elevations

Sample Name	Sample Date	Perchlorate -ug/L	Well ID	Date Measured	Measuring Point Elevation (feet MSL)	December 2008 Depth to Water (feet bgs)	December 2008 Groundwater Elevation (feet MSL)
MW-70	6/15/2007	**<0.5**	MW-70	05/31/07	1976.15	28.15	1948.00
MW-70	9/28/2007	<0.5	MW-70	09/10/07	1976.15	30.78	1945.37
MW-70	10/25/2007	<0.5	MW-70	09/12/07	1976.15	30.78	1945.37
MW-70	11/8/2007	<0.5	MW-70	11/05/07	1976.15	31.03	1945.12
MW-70	3/6/2008	48.5	MW-70	02/19/08	1976.15	26.27	1949.88
MW-70	5/29/2008	6.91	MW-70	05/12/08	1976.15	26.18	1949.97
MW-70	8/22/2008	**22**	MW-70	08/11/08	1976.15	28.53	1947.62
MW-70	11/10/2008	<0.5	MW-70	12/04/08	1976.15	28.12	1948.03
Method Detection Limit		0.5					
MCL (unless noted) / DWNL		6					

Notes:

µg/L - Micrograms per liter

MCL - California Department of Health Maximum Contaminant Level.

< # - Method detection limit concentration is shown.

Figure 3-7a
Well MW-70 - Hydrograph with Precipitation Overlay
Beaumont Site 1

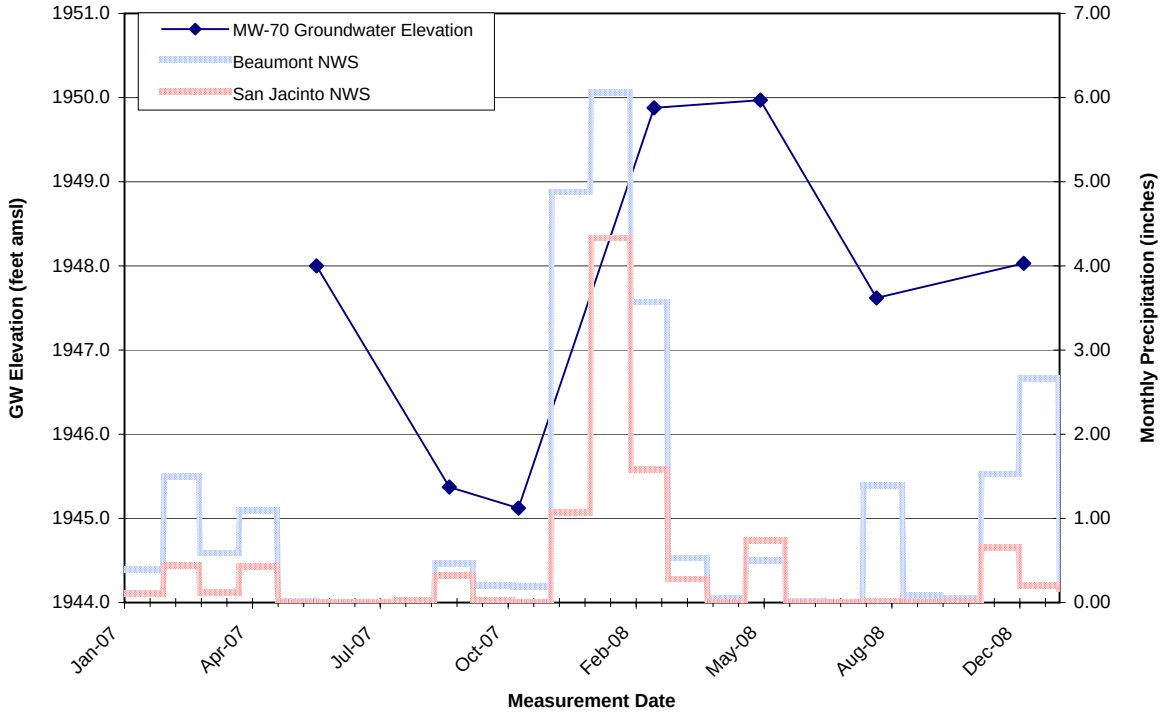
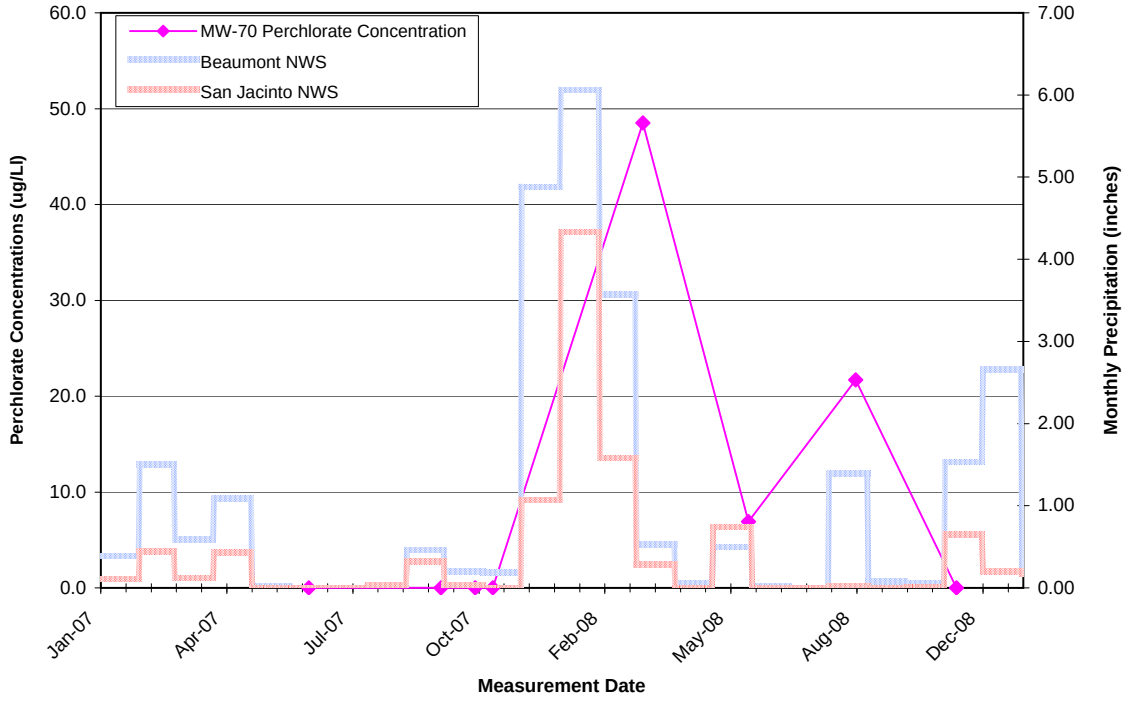


Figure 3-7b
Well MW-70 - Perchlorate Concentrations with Precipitation Overlay
Beaumont Site 1



3.3.4 DO and ORP

DO measurements are used to assess whether the aquifer is aerobic or anaerobic. With the exception of DO concentrations in MW-70, one instance at MW-83, and one instance in TW1, DO concentrations in all remaining monitoring wells were less than 1.0 mg/L. A majority of the monitoring wells showed DO concentrations of less than 0.5 mg/L, which is considered to be anaerobic; in other words, the aquifer appears to possess an environment that could sustain natural perchlorate biodegradation. Additional monitoring is needed to assess seasonal fluctuations in DO concentrations. DO data collected to date suggest that concentrations increase in MW-70 during the rainy season and drop during the drier part of the year. ORP values in the newly installed Feature F-33 vicinity wells (F33-TW1 through F33-TW6) were all measured below 50 millivolts (mVs), several of which were substantially less than 0 mV. These results are indicative of the onset of anaerobic conditions. Therefore, the DO and ORP values in tandem, suggest a redox environment that encourages natural perchlorate biodegradation, at least during drier periods of the year.

3.3.5 Total Iron and Ferrous Iron

Both total and ferrous iron were measured and, in general, not detected in the groundwater. Therefore, it appears that there is almost no oxidized or reduced iron in the aquifer. Oxidized iron can consume valuable natural organic carbon in the process of biological iron reduction. In the Feature F-33 vicinity, this does not appear to be the case, leaving the available organic carbon for direct consumption by native perchlorate-reducing microorganisms.

3.3.6 Sulfate and Sulfide

Sulfate has been detected at elevated concentrations up to 125 mg/L in several monitoring wells. Sulfide has generally been absent or detected at very low concentrations. Very little biological sulfate reduction appears to be occurring in this vicinity, primarily because redox conditions do not strongly support such an occurrence. In general, sulfate is not a major competitor for perchlorate as an electron acceptor, in comparison with nitrate. However, it is important to note that sulfate does exist at high enough concentrations that it could consume natural organic carbon that would otherwise be used for perchlorate respiration and biodegradation.

3.3.7 Methane

Methane was detected at 150 µg/L in F33-TW2 on August 18, 2008 (Table 3-2). Methanogenesis generally occurs when the aquifer becomes strongly anaerobic and, as a result, methane is found in the 1,000 µg/L range. Under moderately anaerobic conditions, methane may generally be greater than 500

µg/L; and under mildly methanogenic conditions, methane is generally measured at concentrations greater than 100 µg/L. In this area, it appears that conditions are mildly anaerobic, albeit sufficiently to support perchlorate biodegradation.

3.3.8 Hydrogen

Hydrogen concentrations were greater than 1.0 nanoMoles (nM) in all monitoring wells where it was analyzed. This high level of hydrogen detected in TW1 and TW2 is likely artificially elevated. Newly installed monitoring wells should be allowed up to six months to stabilize prior to testing for hydrogen. These wells were not allowed to stabilize before they were sampled. Once stabilized, hydrogen greater than 1.0 nM is indicative of anaerobic conditions with the likelihood of the onset of mildly sulfate-reducing conditions. This level of hydrogen is supportive of natural perchlorate biodegradation. Hydrogen is a much better indicator of redox conditions than ORP because it is easier to measure to a higher degree of accuracy because instrument ORP measurements can sometimes be impacted by the various redox pairs in the groundwater. In general, hydrogen measurements in all monitoring wells at Feature F-33 suggest anaerobic conditions are reducing enough to support perchlorate biodegradation.

3.3.9 TOC and DOC

These parameters were both generally measured at concentrations greater than 3 mg/L. Although these concentrations do not suggest an aquifer rich in natural organic carbon, they are likely to be sufficient to sustain natural biodegradation of low levels of perchlorate. Furthermore, the fact that other electron acceptors such as iron, nitrate, and DO do not appear to be competing for organic carbon supports the case that native organic carbon in groundwater is currently sufficient for native microorganisms to degrade low concentrations of perchlorate.

3.3.10 VFAs

Volatile fatty acids are a more direct indication of the carbon substrate form that is immediately available to native microorganisms. Perhaps the most important of the VFAs is acetic acid. Acetic acid plays an important and direct role in metabolism and energy generation. Acetic acid, when present even in small amounts, could indicate that there is an excess of it available for consumption by perchlorate-reducing microorganisms. In the Feature F-33 vicinity, acetic acid concentrations ranged from 100 to 260 µg/L, which appears to be currently sufficient to sustain the metabolic activity of perchlorate-reducing microorganisms.

3.3.11 Summary of Geochemical Findings

The preceding summary of the various geochemical parameters indicates that environmental conditions in the aquifer are generally able to support natural perchlorate biodegradation in groundwater. The redox conditions, the absence of electron acceptor competition, and the availability of low levels of useable organic carbon appear to be degrading perchlorate that enters the Feature F-33 area. It is likely that the riparian area and the organic rich lithologic units upstream of the site are contributing to the TOC, which is in turn creating the small amounts of VFAs that provide the carbon substrate for perchlorate-reducing microorganisms. However, seasonal detections of perchlorate in MW-70 indicate that, during periods of heavy rainfall, perchlorate contamination from the overlying soil is migrating into the groundwater aquifer in the vicinity of that well at concentrations exceeding the MCL. However, it appears the majority of the perchlorate is being degraded before it reaches the water table, likely in the capillary fringe. The continued sampling of monitoring wells in the vicinity of Feature F-33 for both chemical and geochemical testing will be necessary to evaluate the long term implications of the natural processes that appear to be attenuating the perchlorate in the groundwater at Feature F-33.

4.0 SUMMARY AND RECOMMENDATIONS

4.1 SUMMARY

Investigations of Feature F-33 indicate that approximately 37,783 cubic yards of vadose-zone soil are impacted with perchlorate at concentrations above 10.2 µg/kg. The depth of vadose-zone-contaminated soil ranges from ground surface to the groundwater table, which is encountered from 19.5 to 31 feet bgs. The highest detected perchlorate concentration in soil is 302,000 µg/kg at 16 feet bgs at sampling location F33-DP20. The highest concentrations of impacted soil are located along the northeast side of the bluff between sampling locations F33-HSAS4 and F33-HSA7.

Several sampling events have been conducted within the vicinity of Feature F-33 to assess the extent of perchlorate contamination in groundwater, as well as to gain a better understanding of the geochemical environment in the groundwater aquifer at this feature. As part of these sampling efforts, the primary source area well, MW-70, has been sampled and analyzed for perchlorate eight times since it was installed in 2007. Although most of the sampling events indicated perchlorate concentrations below detection limits, three events from March to August 2008 detected elevated perchlorate concentrations, ranging from 6.9 to 48.5 µg/L. During the four month period between the November 2007 (perchlorate not detected) and the March 2008 (highest detected perchlorate concentration of 48.5 µg/L) sampling events, 14.5 inches of rain were recorded. These results suggest that as groundwater levels became higher, perchlorate contamination from the overlying soil was flushed into the groundwater aquifer, resulting in the observed increase in perchlorate concentrations. The second highest detection of 21.7 µg/L also correlates with increased precipitation.

Analysis of geochemical parameters in the aquifer reveals that the environmental conditions are capable of supporting natural perchlorate biodegradation in groundwater. The redox conditions, the absence of electron acceptor competition, and the availability of low levels of useable organic carbon appear to be promoting perchlorate degradation. The groundwater currently possesses the appropriate geochemical characteristics to naturally biodegrade perchlorate, and this biodegradation appears to be occurring for the bulk of soil contamination in the area. However, during periods of high rainfall, some perchlorate is being transported downward into the groundwater as observed locally in MW-70.

4.2 RECOMMENDATIONS

Based on the data collected at Feature F-33 during previous investigations, this investigation, and the routine groundwater monitoring program, the nature and extent of both the impacts to soil and groundwater are defined. Therefore, no further investigations are proposed.

Because additional data collected indicate that the impacts to groundwater appear to be limited in their nature and extent and attenuate before leaving the Site, no IRM is proposed at this time.

The following recommendations are made:

- Continue sampling groundwater monitoring wells on a semiannual basis to determine the seasonal fluctuations in water levels, the distribution of contaminant concentrations, and natural attenuation parameters for wells around the site.
- Include F-33 in the future Site wide RI / FS and risk assessments to evaluate and determine the appropriate mitigation measures for the area.

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6.0 ACRONYMS AND ABBREVIATIONS

AQMD	(South Coast) Air Quality Management District
BPA	Burn Pit Area
bgs	below ground surface
btoc	below top of casing
CHHSL	California Human Health Screening Level
COPC	Compounds of Concern
cy	cubic yards
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DTSC	California Department of Toxic Substances Control
DWNL	Drinking Water Notification Level
EPA	United States Environmental Protection Agency
HFCS	High Fructose Corn Syrup
HSA	hollow-stem auger
LMC	Lockheed Martin Corporation
LPC	Lockheed Propulsion Company
MCL	Maximum Contaminant Level
MDL	method detection limit
MEC	Munitions and Explosives of Concern
mg/kg	milligrams per kilogram
µg/kg	micrograms per kilogram
µg/L	microgams per liter
MNA	Monitored Natural Attenuation
mV	millivolts
nM	nanoMoles
ORP	Oxydation-Reduction Potential
PQL	Practical Quantitation Limit
RL	Reporting Limit
SAP	Sampling and Analysis Plan

TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
VFA	Volatile Fatty Acids
VOC	volatile organic compound