Revised

Additional Offsite Well Installation and Aquifer Testing Report
Lockheed Martin Corporation, Beaumont Site 2
Beaumont, California

Prepared for:

LOCKHEED MARTIN

Prepared by:

TETRA TECH
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TC# 23522-0503, 23522-0603 / October 2010

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LOCKHEED MARTIN

October 25, 2010

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

Subject: Subject: Submittal of the *Additional Offsite Well Installation and Aquifer Testing Report, Lockheed Martin Corporation, Beaumont Site 2, Beaumont, California*

Dear Mr. Zogaib:

Please find enclosed one hard copy of body of the report and two compact disks with electronic copies of the report and appendices of the *Additional Offsite Well Installation and Aquifer Testing Report, Lockheed Martin Corporation, Beaumont Site 2, Beaumont, California*. This report is a final version which has been revised to address to all of DTSC's comments.

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

Sincerely,

Denise Kato

Denise Kato
Remediation Analyst Senior Staff

Enclosures

Copy with Enc:
Gene Matsushita, LMC (1 electronic and 1 hard copy)
Ian Lo, Camp, Dresser, McKee (1 electronic copy)
Thomas J. Villeneuve, Tetra Tech, Inc. (1 electronic and 1 hard copy)
Alan Bick, Gibson Dunn (electronic copy)

BUR229 Beau 2 Supplemental Soil Sampling Report

RESPONSES TO COMMENTS ON THE ADDITIONAL OFFSITE INVESTIGATION AND AQUIFER TESTING REPORT
LOCKHEED MARTIN CORPORATION, BEAUMONT SITE 2
BEAUMONT, CALIFORNIA
TETRA TECH, INC
AUGUST 2010

Comments from Dina Kourda, GSU		
Comment	**Response**	**Proposed Action**
Specific Comment 1. Figure 3-1: A distinct differentiation should be made between the contact lines and "fault, accurately located showing dip."	The symbol for a geologic contact in the legend of Figure 3-1, was labeled "Fault, accurately located showing dip" instead of "Contact." This error will be corrected.	The legend of Figure 3-1 will be revised to distinguish between contacts and faults.
Specific Comment 2. Figure 3-5: Because of Site 2's unique configuration, it should be explained how horizontal flow directions are calculated. It appears that the groundwater flow direction shifts slightly three times between TT-MW2-16 and TT-MW2-6S. Also, it should be specified if the groundwater gradient(s) is/are calculated site-wide or by area.	As alluded to in this comment, most of the monitoring wells at Site 2 lie essentially along a line due to the steep topography of the site, which limits drilling to the relatively flat canyon bottoms. As a result, groundwater flow direction cannot be determined by triangulation. The conceptual hydrogeologic model for the site suggests that shallow groundwater flow is focused within deeply weathered San Timoteo formation underlying the major canyons. This conceptual model is consistent with data showing very low to non-detectable perchlorate concentrations in monitoring wells TT-MW2-27 and TT-MW2-34A/B/C, which were installed in small side canyons off Laborde Canyon immediately south (generally downgradient) of areas with very high perchlorate concentration in groundwater (Tetra Tech, 2010b). Assuming that the canyon walls approximate a no-flow boundary, the equipotential lines are drawn perpendicular to the sides of the canyons. Groundwater gradients are calculated using a segmented path approximating a flowline through the canyon. Appendix E of the groundwater monitoring reports (e.g., Tetra Tech, 2010a) details the groundwater gradient calculation for both the entire site and individual segments	No changes proposed.

Comments from Dina Kourda, GSU		
Comment	**Response**	**Proposed Action**
	of the flowline.	
Specific Comment 3. Section 3.6: Although this section describes the evapotranspiration assessment, a precipitation summary at the site should be included in this report.	The rate of groundwater evapotranspiration in the riparian area cannot be directly compared with precipitation at the site, as precipitation rates do not account for infiltration to groundwater. The overall groundwater balance for the site, which includes both evapotranspiration and infiltration as components, is currently being evaluated and will be discussed in a future submittal to DTSC.	No changes proposed.
Specific Comment 4. Appendices F and G: The slug and pumping test data are displayed as .dat and .out files. They should also be provided as .PDF or .XLS files.	The Aqtesolv data and output files (i.e., the *.dat and *.out files included in Appendices F and G) are tab-delimited ASCII text files. These files may be viewed using any software capable of reading an ASCII file, including applications such as Microsoft Notepad, Microsoft Excel, and Microsoft Word.	No changes proposed.

REFERENCES

Tetra Tech, Inc. 2010a. Semiannual Groundwater Monitoring Report, Second Quarter 2009 and Third Quarter 2009, Lockheed Martin Corporation, Beaumont Site 2, Beaumont, California. March.

Tetra Tech, Inc. 2010b. Dynamic Site Investigation and Summary Remedial Investigation Report, Lockheed Martin Corporation, Beaumont Site 2, Beaumont, California. April.

Revised
Additional Offsite Well Installation and Aquifer Testing Report
Lockheed Martin Corporation
Beaumont Site 2
Beaumont, California

Prepared for:

Lockheed Martin Corporation

Prepared by:

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October 2010

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Acronyms

af/yr	acre-feet per year
ASTM	American Society for Testing and Materials
bgs	below ground surface
CDHS	California Department of Health Services
CIMIS	California Irrigation Management Information System
DO	dissolved oxygen
DOC	dissolved organic carbon
DSI	Dynamic Site Investigation
DTSC	California Department of Toxic Substances Control
DWNL	Drinking Water Notification Level
ET	evapotranspiration
ft/day	feet per day
ft/sec	feet per second
ft^2/day	$feet^2$ per day
ft/ft	feet per foot
gpm	gallons per minute
GPS	global positioning system
HSA	hollow-stem auger
IDW	investigation-derived waste
LCS	laboratory control sample
LMC	Lockheed Martin Corporation
µg/L	micrograms per liter

MCL	Maximum Contaminant Level
MEF	Mt. Eden formation
MS/MSD	matrix spike/matrix spike duplicate
msl	mean sea level
NDMA	N-nitrosodimethylamine
ORP	oxidation/reduction potential
PVC	polyvinyl chloride
Qal	Quaternary Alluvium
RPD	relative percent difference
SBA	South Boundary Area
STF	San Timoteo formation
TOC	total organic carbon
UCR	University of California, Riverside
USCS	Unified Soil Classification System
USFWS	United States Fish and Wildlife Service
VOCs	volatile organic compounds
WDA	Waste Discharge Area

Section 1 Introduction

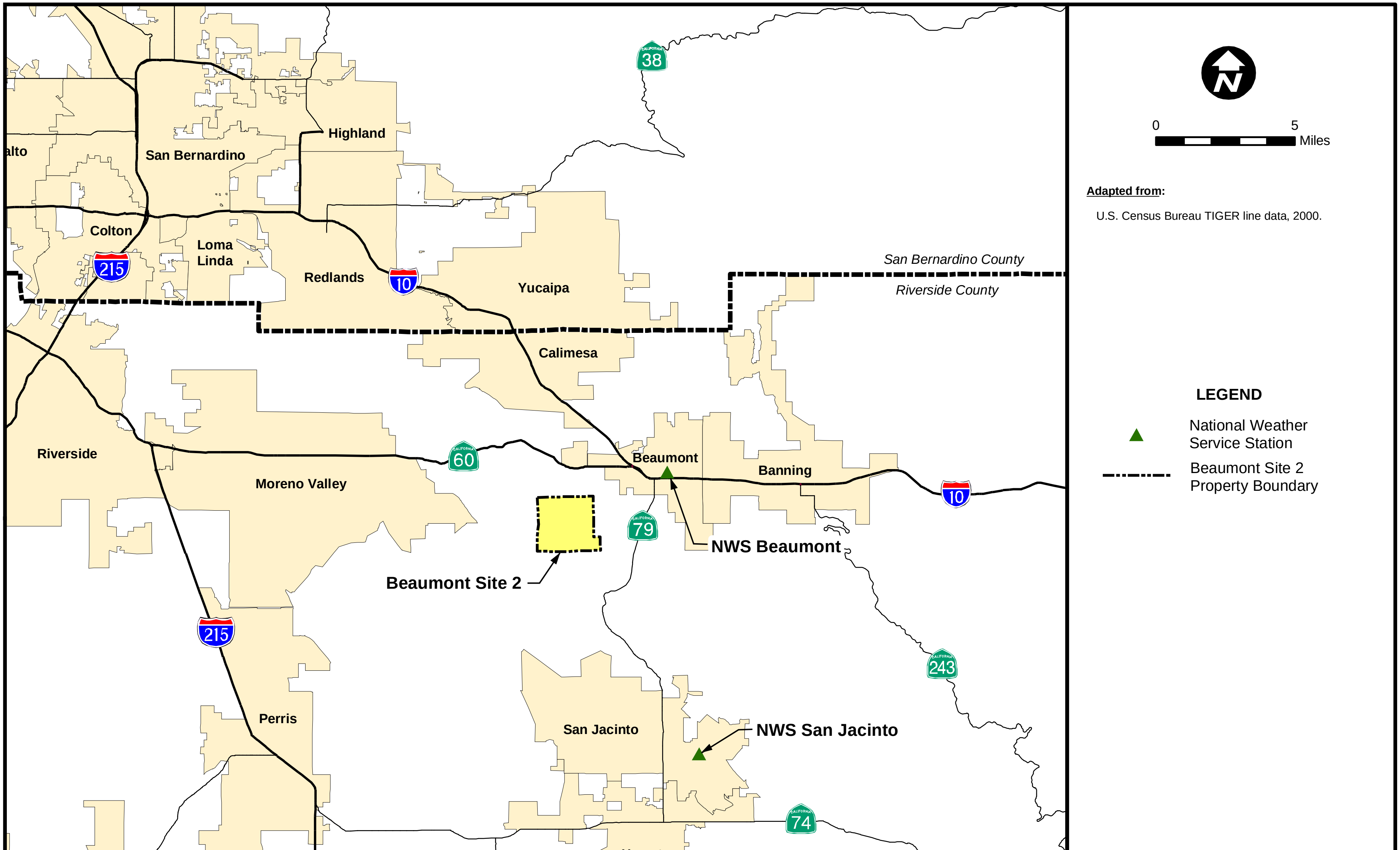
Tetra Tech, Inc. (Tetra Tech) has prepared this Additional Offsite Well Installation and Aquifer Testing Report on behalf of Lockheed Martin Corporation (LMC) for the Beaumont Jack Rabbit Trail facility (LMC Beaumont Site 2), hereinafter referred to as the Site. The Site is located southwest of the City of Beaumont, in Riverside County, California (Figure 1-1).

This report was prepared pursuant to Consent Order HSA 88/89 034 dated June 16, 1998, issued to LMC by the California Department of Health Services, Toxic Substances Control Division (CDHS; CDHS, 1989), and amended in 1991 (CDHS, 1991). The Consent Order required that LMC investigate and appropriately remediate any releases or threatened releases of hazardous substances to the air, soil, surface water, and groundwater at or from the Site.

1.1 Background

The recently-completed Draft Dynamic Site Investigation (DSI; Tetra Tech, 2009a) was conducted to characterize the nature and extent of contaminants in onsite soil and groundwater. The DSI found that two major perchlorate plumes are present in onsite groundwater: one originating in the Test Bay area, which extends approximately 2,100 feet downgradient from the source area, terminating onsite in Laborde Canyon; and one originating in the Waste Discharge Area (WDA), which extends beyond the southern boundary of the Site onto the adjacent former Wolfskill property.

Groundwater monitoring data indicates that perchlorate concentrations in shallow monitoring wells TT-MW2-7 and TT-MW2-8, located near the southern boundary of the Site (South Boundary Area; SBA), were 430 micrograms per liter (µg/L) and 290 µg/L, respectively, in May 2009 (Tetra Tech, 2010). Perchlorate was detected at 2.9 µg/L in well TT-MW2-19S, located approximately 4,200 feet south of the property boundary and was not detected in well TT-MW2-20S, located approximately 8,500 feet south of the property boundary (Tetra Tech, 2010). Two features of interest lie between the SBA and TT-MW2-19S: an area of riparian vegetation approximately 1,100 feet long located roughly 100 to 1,200 feet south of the property boundary,



Beaumont Site 2

Figure 1-1
Regional Location of Beaumont Site 2

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and an area approximately 3,000 feet south of the property boundary where a fault previously mapped by Morton and Miller (2006) crosses Laborde Canyon. Both of these features are shown on Figure 1-2. Although the available data provides broad constraints on the extent of perchlorate in groundwater, additional data are needed to better characterize the nature and extent of the offsite groundwater plume.

Additional information is also needed on aquifer properties at the SBA to support the evaluation of future remedial options. One of these options is the installation of remedial measures intended to cut-off the offsite portion of the groundwater plume near the SBA. It is anticipated that the relatively low-level plume south of the SBA would eventually dissipate due to natural processes, including phytoremediation within the riparian area to the south.

1.2 Investigation Objectives

The overall objectives of the investigation were as follows:

- to characterize the nature and extent of the WDA contaminant plume between the property boundary and TT-MW2-19S;
- to investigate the role of riparian vegetation and faulting on the fate of perchlorate in groundwater between the property boundary and TT-MW2-19S;
- to characterize aquifer properties near the southern property boundary to support the future evaluation of remedial alternatives for the Site.

1.3 Technical Approach

1.3.1 Characterization of Offsite Contaminant Plume

The scope of work for characterizing the extent of the offsite perchlorate plume included the installation four groundwater monitoring wells and two piezometers on the former Wolfskill property south of the Site (Figure 1-2). The monitoring wells were to be slug tested and sampled to characterize aquifer conditions. The areas selected for investigation include the riparian area immediately south of the property boundary and the area where the fault crosses Laborde Canyon. In addition to characterization of the extent of the perchlorate plume, the investigation included assessment of the potential effects of evapotranspiration (ET) in the riparian area and faulting on groundwater flow.

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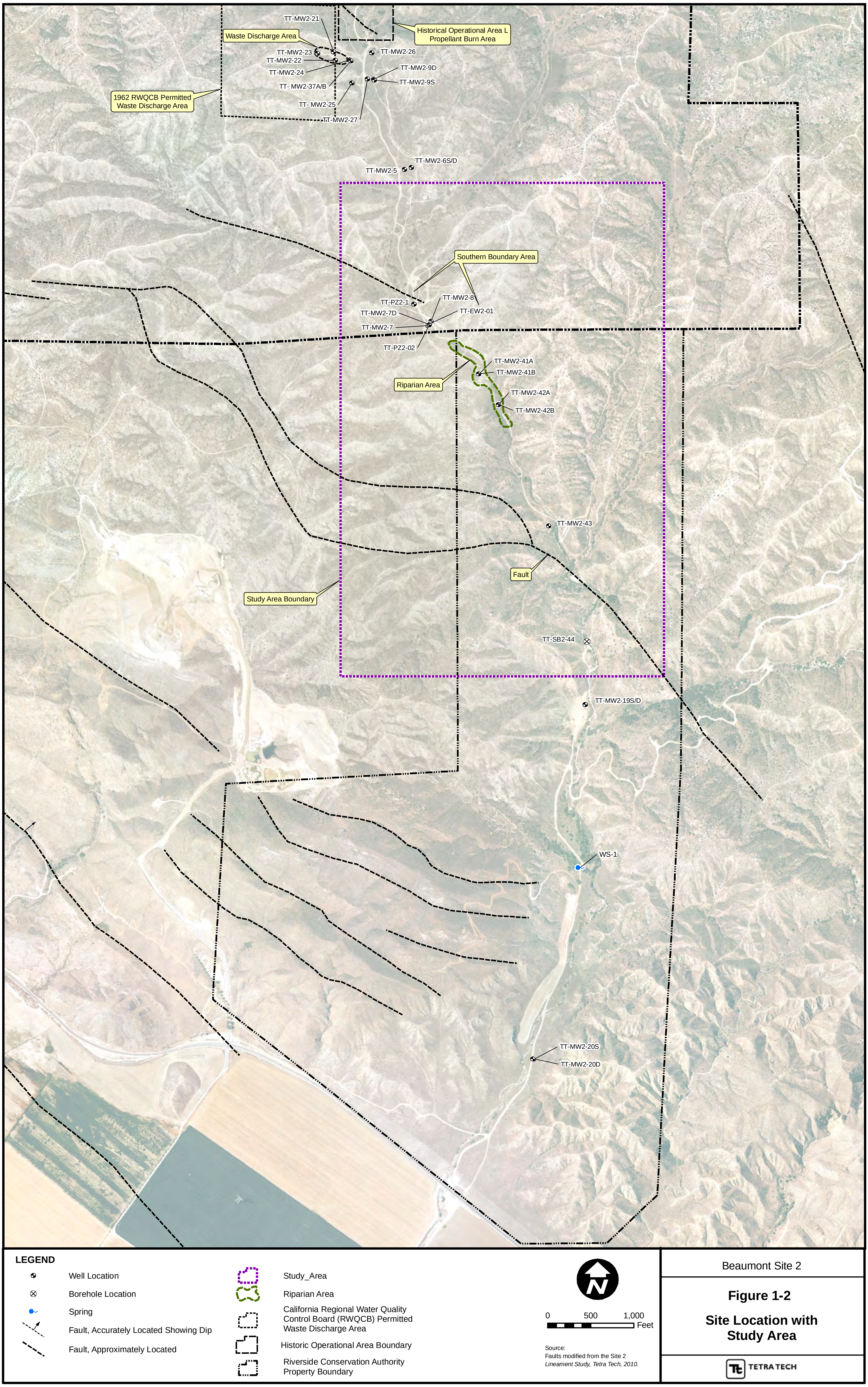

Beaumont Site 2

Figure 1-2

Site Location with Study Area

TETRA TECH

1.3.2 Evaluation of Evapotranspiration

The scope of work for evaluating the role of ET on the fate and transport of perchlorate in groundwater included installing two monitoring well/piezometer pairs within the riparian area immediately south of the property boundary (Figure 1-2). The proposed well locations were on alluvial terraces adjacent to relatively dense stands of native and non-native riparian vegetation (i.e., cottonwood, willow, mule fat, and tamarisk). In areas where plant growth is pulling water from shallow water tables, diurnal groundwater level fluctuations have been shown to correlate with the rate of ET from the water table (e.g., White, 1932; Lewis et al., 2002). Water levels in the monitoring wells were monitored for diurnal water level fluctuations for a period of one month. In addition, water levels in the monitoring well/piezometer pairs were monitored to evaluate potential upward hydraulic gradients induced by ET.

1.3.2.1 Evaluation of Faulting

The scope of work for evaluating the role of faulting on the fate and transport of perchlorate in groundwater consisted of two elements: a seismic reflection and refraction survey in the area where the fault mapped by Morton and Miller (2006) crosses Laborde Canyon (Figure 1-2), and the installation of two monitoring wells, one upgradient and one downgradient of the fault. The seismic reflection survey was conducted to confirm the bedrock profile, fault location, and the magnitude of any offset observed in hydrostratigraphic units. The proposed monitoring wells were installed on alluvial terraces underlain by weathered bedrock of the Mount Eden formation to assess whether faulting influences groundwater conditions in this area.

1.3.3 Onsite Aquifer Testing

The onsite aquifer testing was conducted to obtain additional information on aquifer properties and constrain the mass flow of perchlorate at the SBA to support the evaluation of potential remedial options, including an accelerated remedial response to control offsite migration of perchlorate in groundwater. The scope of work for onsite aquifer testing included the following:

- Installation and development of one groundwater extraction well and one piezometer in the area of existing wells TT-MW2-7, TT-MW2-7D, and TT-MW2-8;
- Conducting a step drawdown test and a 24-hour constant-rate pumping test using the new extraction well as a pumping well, the new piezometer and existing wells TT-MW2-7 and TT-MW2-8 to monitor drawdown in the shallow water table aquifer, and existing well TT-MW2-7D to monitor drawdown in the deeper water-bearing zone; and

- Collecting groundwater samples from the extraction well before and after the aquifer test.

1.4 Report Organization

This report is organized into the following sections:

- Section 1 – Introduction: This section provides the rationale for conducting the field activities and a brief overview of the report.
- Section 2 – Methodology: This section provides a description of procedures used to conduct the field activities. Deviations from the Work Plan (Tetra Tech, 2009b) are also summarized in this section.
- Section 3 – Results: This section provides an overview of the results of the field investigation.
- Section 4 – Updated Conceptual Site Model: This section presents a detailed discussion of the investigation results as they pertain to the conceptual site model.
- Section 5 – Conclusions and Recommendations: This section summarizes the conclusions drawn from the investigation results, and recommendations for additional investigation and potential remedial activities.
- Section 6 – References: This section provides a list of documents, sources, and publications referenced in this report.

Section 2 Methodology

This investigation is one of a series of ongoing investigations that have been conducted at the Site starting in 2003. Field procedures followed in conducting the previous soil and groundwater investigations, as well as this investigation, have been previously presented in various work plans which were approved by the California Department of Toxic Substance Control (DTSC). Field activities and the corresponding DTSC-approved plans include the following:

- Drilling and soil sampling: Lockheed Martin Beaumont Site 1 and 2 Soil Investigation Work Plan (Tetra Tech, 2003).
- Groundwater monitoring well installation and development: Groundwater Monitoring Well Installation Work Plan Lockheed Martin Corporation, Beaumont Site 2 (Tetra Tech, 2006).
- Groundwater monitoring well sampling: Groundwater Sampling and Analysis Plan Lockheed Martin Corporation, Beaumont Site 2 (Tetra Tech, 2007; LMC, 2007).

2.1 Site Preparation

The following preparation activities were conducted prior to field work:

- Site Access: written permission was obtained to access the Wolfskill property for the purpose of conducting field work, in accordance with the existing access license agreement between LMC and the Western Riverside County Regional Conservation Authority.
- Utility Clearance: the proposed drilling locations were marked with stakes and white paint, and recorded using a handheld global positioning system (GPS) unit. Underground Service Alert was then contacted to perform underground utility clearance. In addition, all soil boring locations were hand augered to a depth of five feet prior to drilling to clear underground utilities.
- Permitting: Well permits were obtained from the County of Riverside Department of Environmental Health. Copies of the permits are provided in Appendix A.
- On-and Offsite Natural and Cultural Resources: Natural and cultural resource surveys were conducted at the offsite well locations prior to the preparation of the work plan (Tetra Tech, 2009b). Based on those surveys, it was believed that the proposed offsite investigations could be conducted with no impact to the offsite resources. To ensure that the proposed activities did not impact on- or offsite biological resources, a United States Fish and Wildlife Service (USFWS)-approved biologist was present prior to, during, and after all field work, as specified in the Section 10B incidental take permit for the Site. Prior to entering each work location, the biologist would identify and mark potential or

suspected areas of concern for Stephen's Kangaroo Rat (SKR). This included the ingress and egress routes as well as areas that would be occupied by heavy equipment during the actual field work. Prior to the beginning of field activities on each day, the biologist met workers at the entrance to the Site and escorted the drill rig and/or other equipment to the work location. At the end of each day, the biologist would escort the rig and equipment out of the work areas and remove any protective boards covering potential SKR burrows. The approved biologist also conducted pre- and post-activity burrow mapping according to Montgomery (2006) guidelines at each work location as part of the incidental take permit requirements. This study assesses the impacts of the work activities conducted at each location. The results of the study are included in the annual monitoring report submitted to the USFWS in February of each year. All onsite activities were done conducted in accordance with the approved Habitat Conservation Plan (USFWS 2005) and subsequent clarifications (LMC, 2006a and 2006b).

2.2 Seismic Survey

Seismic reflection data were collected along one profile (Profile 19; Figure 2-1) to investigate a fault mapped by Morton and Miller (2006) which crosses Laborde Canyon. Seismic refraction data were also collected along Profile 19 to evaluate alluvium thickness and depth to competent bedrock in this area of Laborde Canyon. The seismic data were collected and interpreted by Terra Physics of Highland, California, under the direct supervision of a California-registered Professional Geophysicist.

The seismic survey used a 20 pound hammer striking a 1 foot square steel plate as a seismic wave source. To improve the signal to noise ratio, 10 to 12 individual hammer blows were stacked together to form a final data record. Individual records with obvious noise were not included in the final data stack. Mark Products Model L-40 geophones spaced 6 feet apart were used to sense the seismic waves. The geophone signals were input to a Geometrics model R-48 seismograph. Data were recorded electronically on the seismograph hard disk for later processing and interpretation. As needed, hard copy records were used in the field to evaluate data quality and adjust measurement parameters.

Additional information pertaining to survey design, field methodology, and data reduction and interpretation is provided in the Terra Physics report (Appendix B).

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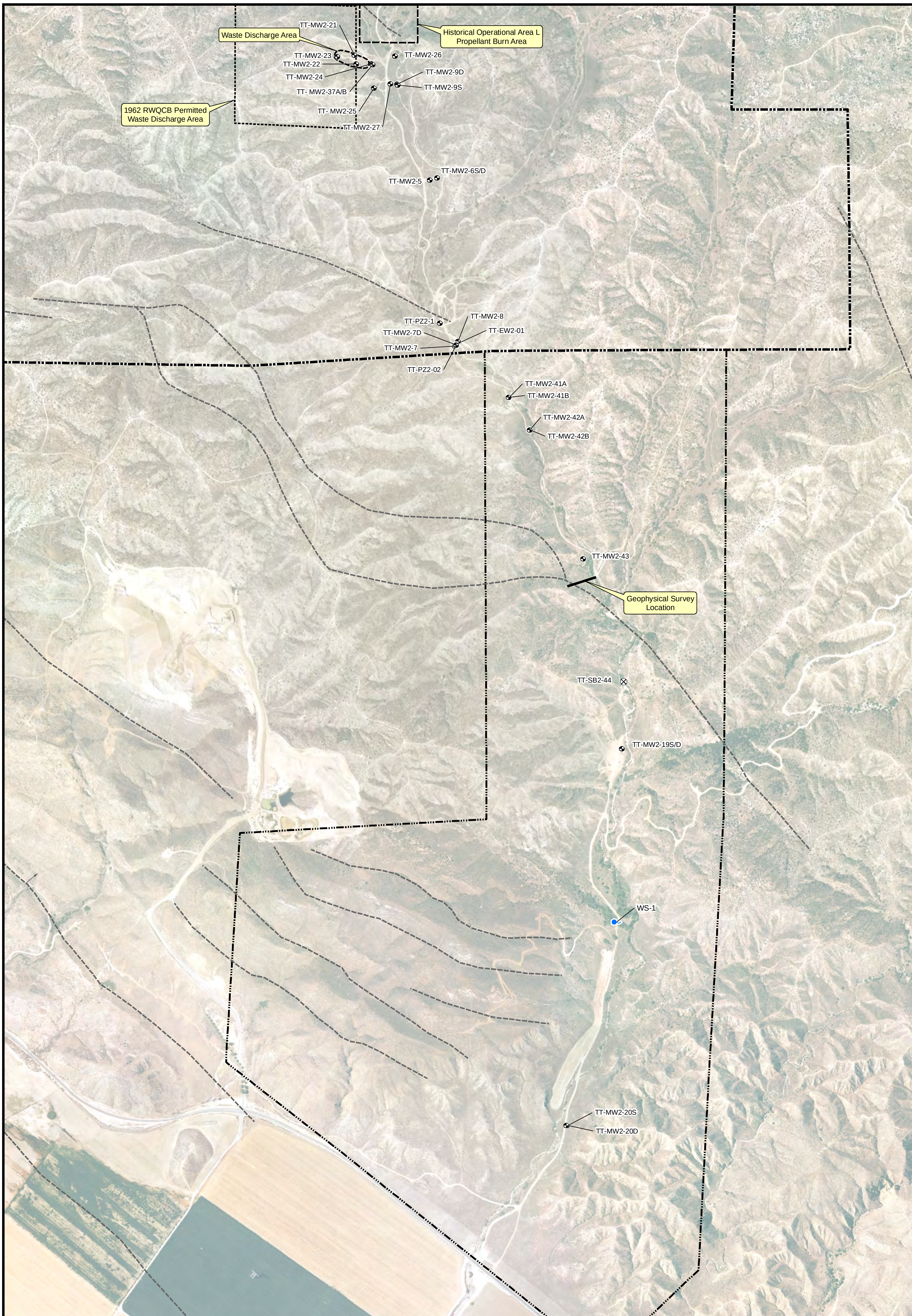

LEGEND

- Well Location
- ⊗
- Spring
- Geophysical Survey Line
- Fault, Accurately Located Showing Dip
- Fault, Approximately Located
- California Regional Water Quality Control Board (RWQCB) Permitted Waste Discharge Area
- Riverside Conservation Authority Property Boundary
- Historic Operational Area Boundary

0 500 1,000
Feet

Source:
Faults modified from the Site 2
Lineament Study, Tetra Tech, 2010.

Beaumont Site 2

Figure 2-1

Soil Boring and Monitoring Well Locations

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2.3 Well Installation

2.3.1 Drilling

Drilling procedures are described in Tetra Tech (2003b). Eight soil borings (designated TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-MW2-43, TT-SB2-44, TT-EW2-1, and TT-PZ2-2) were drilled at the Site between September 14 and October 13, 2009. Drilling was performed by Gregg Drilling and Testing, Inc., a California-licensed C-57 drilling contractor. The boring locations are shown in Figure 2-1, boring depths are summarized in Table 2-1.

All of the soil borings were drilled using the hollow-stem auger (HSA) method. Borings TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-MW2-43, and TT-SB2-44 are all located in a remote area accessed by a narrow foot trail. Due to access limitations, these borings were drilled using a track-mounted limited access drill rig. Borings TT-EW2-1 and TT-PZ2-1 are located in a more accessible area in the southern portion of the Site, and were drilled using a conventional truck-mounted drill rig.

2.3.2 Soil Sampling and Lithologic Logging

Procedures for collecting soil samples from HSA soil borings are described in Tetra Tech (2003). Soil samples were collected from all of the borings using conventional 18-inch long, 1.5- or 2-inch diameter split barrel samplers. Soil samples were collected at 5-foot depth intervals during drilling.

The soil borings were logged during drilling by a geologist working under the direct supervision of a California-licensed Professional Geologist. Unconsolidated materials (i.e., alluvium) were described in general accordance with the Unified Soil Classification System (USCS; American Society for Testing and Materials [ASTM] Standard D2487) using the visual manual procedure (ASTM Standard D2488). Bedrock materials [i.e., San Timoteo formation (STF) or Mt. Eden formation (MEF)] were classified in accordance with standard geologic nomenclature (e.g., Compton, 1985).

Copies of the boring logs are provided in Appendix C.

Table 2-1
Well Construction Details

Well ID	Date Installed	Well Type[1]	Ground Surface Elevation (feet msl)	TOC Elevation (feet msl)	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Screen Length (feet)	Measured Depth of Well (feet toc)	Reported Depth of Borehole (feet bgs)	Borehole Diameter (inches)	Casing Diameter (inches)	Screen Slot Material and Size[2] (inches)	Drilling Method[3]	Filter Pack Size	Northing Coordinate	Easting Coordinate
TT-MW2-41A	9/16/09	M	1809.64	1812.47	15.0	30.0	15	33.10	36.0	8	2	PVC 0.020	HSA	#2/16	2267666.07	6326749.39
TT-MW2-41B	9/15/09	PZ	1809.73	1812.22	41.0	43.0	2	45.77	51.0	8	2	PVC 0.020	HSA	#2/16	2267668.34	6326746.95
TT-MW2-42A	9/21/09	M	1796.28	1799.06	15.0	30.0	15	32.66	31.0	8	2	PVC 0.020	HSA	#2/16	2267311.28	6326978.10
TT-MW2-42B	9/18/09	PZ	1796.48	1799.07	41.0	43.0	2	45.86	50.0	8	2	PVC 0.020	HSA	#2/16	2267314.66	6326976.61
TT-MW2-43	9/23/09	M	1768.54	1771.44	20.0	40.0	20	43.33	46.0	8	2	PVC 0.020	HSA	#2/16	2265905.72	3627561.46
TT-EW2-1	10/13/09	E	1837.24	1840.24	10.0	40.0	30	43.85	41.0	8	4	SS 0.020	HSA	#3	2268247.15	6326173.44
TT-PZ2-2	10/12/09	PZ	1837.09	1840.76	10.0	40.0	30	43.32	41.0	10	2	PVC 0.020	HSA	#2/16	2268238.11	6326172.44

Notes:
msl: relative to mean sea level.
toc: top of well casing
bgs: below ground surface
1. M - monitoring wells; PZ - piezometer; E - extraction well
2. PVC - polyvinyl chloride; SS - stainless steel
3. HSA - hollow stem auger

2.3.3 Well Installation

Procedures for installing monitoring wells in HSA borings are described in Tetra Tech (2006). Borings TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-MW2-43, and TT-PZ2-2 were completed as 2-inch diameter monitoring wells using schedule 40 polyvinyl chloride (PVC) blank casing and 0.020-inch machine-slotted well screen. TT-MW2-41A and B and TT-MW2-42A and B are well clusters, consisting of a shallow completion (A-designated wells) screened across the water table, and a deeper piezometer (B-designated wells) with a 2-foot well screen installed at the base of shallow aquifer.

Boring TT-EW2-1 was completed as a 4-inch diameter extraction well using schedule 40 PVC blank casing and stainless steel wire-wrap screen. Prior to installing the well, sieve analyses were conducted on soil samples collected at depths of 20, 30, and 40 feet below ground surface (bgs) to evaluate the appropriate filter pack gradation, using the methodology described in Driscoll (1986). Based on the sieve analysis results, a #3 sand filter pack and 0.020-slot screen was specified for this well.

Soil boring TT-MW2-43 met refusal at a depth of 48 feet bgs. An increase in moisture content was observed in the soil samples collected at depths between 25 and 40 feet bgs, and riparian vegetation, which suggest the presence of shallow groundwater, was noted in the adjacent stream channel. Similar conditions were observed while drilling borings TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, and TT-MW2-42B. Based on these similarities, the soil boring was completed as a 2-inch diameter monitoring well screened across the zone where increased moisture was observed (i.e., from 20 to 40 feet bgs). This well was found to be dry during subsequent groundwater monitoring.

Soil boring TT-SB2-44 was originally planned to be drilled on an alluvial terrace near the center of Laborde Canyon. In the field, it was found that this location was inaccessible for the drill rig due to the steep side slopes of the terrace. The boring was therefore relocated further to the south, at an alternate location adjacent to the terrace, on the western side of Laborde Canyon. The boring was refused in sandstones of the MEF at a depth of approximately 40 feet bgs. No changes in the moisture content of soil samples or other indications of the presence of shallow groundwater were noted during drilling, and groundwater did not enter the open borehole after being left overnight. Boring TT-SB2-44 was therefore abandoned by backfilling with cement-bentonite grout.

Construction details for the new wells are summarized in Table 2-1; well construction diagrams and copies of the sieve analysis data are provided in Appendix C.

2.3.4 Well Development

Well development procedures are described in Tetra Tech (2006). Wells TT-MW2-41A, TT-MW2-41B, TT-MW2-42A, TT-MW2-42B, TT-EW2-1, and TT-PZ2-2, and TT-EW2-1 were developed at least 48 hours following well construction, using the surge-and-bail and/or pumping methods. Well development procedures are described in Tetra Tech (2006). Copies of the well development field sheets are provided in Appendix D.

2.3.5 Surveying

The newly installed wells were surveyed using GPS techniques by Hillwig-Goodrow LLC, a California-licensed Professional Land Surveyor. Horizontal coordinates were referenced to the California State Plane Coordinate System, Zone 5, using the NAD83 datum for horizontal control. Elevations were referenced mean sea level, using the NAGVD88 datum for vertical control.

A copy of the survey data is provided in Appendix E.

2.4 Groundwater Sampling

Groundwater sampling procedures are described in Tetra Tech (2007) and LMC (2007). Groundwater purging and sampling was conducted using low-flow purging techniques, with either portable or dedicated submersible sampling pumps. Wells TT-MW2-41A, TT-MW2-42A, and TT-EW2-1 were initially sampled between October 21 and 23, 2009. Well TT-EW2-1 was sampled for the second time on October 30, 2009, immediately following the 24-hour pump test. Wells TT-MW2-41A and TT-MW2-42A were resampled on November 23, 2009.

Copies of the groundwater sampling field data sheets are provided in Appendix D.

2.5 Aquifer Testing

2.5.1 Slug Tests

Slug tests were conducted in wells TT-MW2-7, TT-MW2-7D, TT-MW2-8, TT-MW2-41A, and TT-MW2-42A. The slug tests included falling-head tests, which were conducted by displacing groundwater in the well upward by inserting a weighted PVC slug, and rising-head tests, which were conducted by displacing groundwater in the well downward by removing the slug.

Prior to conducting each slug test, water levels were measured manually with an electronic water level meter to determine the static groundwater level. An electronic pressure transducer was then suspended in the well, and water levels were monitored manually until static conditions were reestablished. A falling-head test was then conducted by smoothly lowering a weighted PVC slug into the well and securing it in place above the transducer. Once the water level had recovered to static conditions, a rising-head test was conducted by removing the slug and allowing the water level to recover to static conditions. Pressure transducers placed above the water table in wells TT-EW2-1 and TT-MW2-16 were used to monitor barometric pressure changes during each test. At the end of the rising-head test, water level data from the pressure transducers were downloaded to a laptop computer and compensated for barometric pressure effects prior to interpretation.

The slug test data were interpreted using AQTESOLV aquifer test interpretation software (Duffield and Rumbaugh, 1991). Based on hydrogeologic conditions at the Site, the Bouwer-Rice graphical semi-log analysis method (Dawson and Istok, 1991) was used to interpret the rising- and falling-head test data. Two sets of aquifer parameters were obtained from each well as a cross-check on the interpretation results.

Copies of the slug test interpretation figures and the AQTESOLV input and output files are provided in Appendix F.

2.5.2 Pumping Test

The pumping test was conducted between October 27 and October 30, 2009 using TT-EW2-1 as the extraction well and wells TT-PZ2-2, TT-MW2-7, TT-MW2-7D, TT-MW2-8, and TT-PZ2-1 as drawdown observation wells. The extraction and observation well locations are shown in Figure 2-2. The pumping test was conducted in two phases: an 8-hour step-drawdown test conducted on October 27, 2009, followed by a 24-hour constant-rate pumping test conducted from October 29 to 30, 2009.

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0 25 50
Feet

LEGEND

Well Location

Ground Surface Elevation Contour
(2-foot interval - feet msl)

Beaumont Site 2 Property Boundary

Beaumont Site 2

Figure 2-2
Southern Boundary Area Well Locations

TETRA TECH

2.5.3 Step-Drawdown Test

The step step-drawdown test was performed on October 27, 2009, using well TT-EW2-1 as the extraction well, and wells TT-MW2-7, TT-MW2-8, and TT-PZ2-2 as observation wells. The purpose of the step-drawdown test was to evaluate groundwater drawdown at various pumping rates, so that the optimum pumping rate could be established for the constant-rate aquifer test.

The step test was conducted by pumping well TT-EW2-01 at rates of approximately 0.1 and 0.2 gallons per minute (gpm), using a bladder pump for the 0.1 gpm step, and a Grundfos Redi-Flo 2 centrifugal pump for the 0.2 gpm step. Pumping was conducted for a period of at least three hours at each rate. Based on the large drawdown observed in TT-EW2-1 at the end of the 0.2 gpm step (15.66 feet), a planned 0.3 gpm step was not conducted.

Instantaneous flow rates were monitored throughout the test by directly measuring the volume of water discharged over a one minute period with a graduated cylinder during the 0.1 gpm step, and using a rotameter during the 0.2 gpm step. The extracted groundwater was discharged into a 55-gallon drum, which was periodically emptied into a 10,000-gallon holding tank using a sump pump. A totalizing flow meter placed in the sump pump discharge line was used to measure the total volume of water extracted during the test, as a check on the instantaneous flow rate measurements.

Water levels were monitored for a 48-hour period prior to the test, during the test, and for a 2-day recovery period after the test using electronic pressure transducers placed in the extraction and observation wells. The pressure transducers were programmed to collect measurements at 15-second intervals. Manual water level measurements were periodically recorded during the test with a precision of 0.01 feet to supplement the pressure transducer measurements. A pressure transducer placed above the water table in well TT-EW2-1 was used to monitor barometric pressure for the entire duration of the test. At the end of the recovery period, drawdown data from the pressure transducers was downloaded to a laptop computer and compensated for barometric pressure effects prior to interpretation.

Specific capacity values calculated from the step-drawdown test data were 0.022 gpm per foot (gpm/ft) at a pumping rate of 0.1 gpm, and 0.013 gpm/ft at a pumping rate of 0.2 gpm. Transmissivity values were calculated from the specific capacity values using the empirical relationship that transmissivity [in feet^2 per day (ft^2/day)] equals 200 times specific capacity (in gpm/ft; Dawson and Istok, 1991). Based on these results, a pumping rate of approximately 0.125 gallons per minute was selected for the constant rate pumping test.

2.5.3.1 Constant-Rate Pumping Test

The constant-rate pumping test was conducted from October 29 to 30, 2009, using TT-EW2-1 as the extraction well and, TT-MW2-7, TT-MW2-7D, TT-MW2-8, TT-PZ2-1, and TT-PZ2-2 as observation wells.

The aquifer test was conducted by pumping TT-EW2-1 at a rate of approximately 0.13 gallons per minute for 24 hours with a bladder pump. Instantaneous flow rates were monitored throughout the test by directly measuring the volume of water discharged over a one minute period with a graduated cylinder. The extracted groundwater was discharged into a 55-gallon drum, which was periodically emptied into a 10,000-gallon holding tank using a sump pump. A totalizing flow meter placed in the sump pump discharge line was used to measure the total volume of water extracted during the test, as a check on the instantaneous flow rate measurements. The time-weighted average of the instantaneous flow rate measurements (0.132 gpm) was in good agreement with the average flow rate determined from the totalizer readings (0.131 gpm).

Water levels were monitored for a 48-hour period prior to the test, during the test, and for a 4-day recovery period after the pumping cycle using electronic pressure transducers placed in the extraction and observation wells. The pressure transducers were programmed to collect measurements at 15-second intervals. Manual water level measurements were periodically recorded during the test to supplement the pressure transducer measurements. Barometric pressure was monitored throughout the test using a pressure transducer placed above the water table in well TT-EW2-1. At the end of the recovery period, drawdown data from the pressure transducers was downloaded to a laptop computer. The data were compensated for barometric pressure effects prior to interpretation.

The transient drawdown data was interpreted with the AQTESOLV pumping test interpretation software package (Duffield and Rumbaugh, 1991). Based upon hydrogeologic conditions and the observed pumping test responses, the data were initially tested against both the Theis aquifer model and the Hantush leaky aquifer model. Comparing the model goodness-of-fit as indicated by the residual error, the data from wells TT-EW2-1, TT-PZ2-2, and TT-MW2-8 matched the Theis model and the leaky aquifer model equally well. The Theis model was selected as most appropriate for the these wells because the Theis model achieves the same goodness-of-fit using two parameters versus three parameters for the leaky aquifer model, and because the aquifer parameter values calculated using the Theis model closely matched those derived using the Cooper-Jacob method, while the aquifer parameter values for the leaky aquifer model did not match those derived using the Cooper-Jacob method. Delayed yield would be a reasonable expectation for this setting and use of the Neuman delayed yield method was considered for the pump test data. However, the site data only display the early time semi-log straight line and flattening period behavior, and is missing the late time semi-log straight line that is characteristic of the Neuman delayed yield method. Therefore, the data could not be uniquely fit to the Neuman delayed yield model. The transient drawdown data was therefore interpreted using both the Theis type curve and Cooper-Jacob methods for both the drawdown and recovery phases of the test, yielding four sets of aquifer parameters to cross-check the interpretation results. In addition, the maximum drawdown data was interpreted using the distance-drawdown method, and specific capacity determined from the pumping test data was used to estimate transmissivity.

Copies of the time-drawdown and distance-drawdown plots used for interpreting the pumping test results and copies of the AQTESOLV input and output files are provided in Appendix G.

2.6 Evapotranspiration Evaluation

Wells TT-MW2-8, TT-MW2-41A, and TT-MW2-42A were monitored for ET-induced diurnal groundwater level fluctuations from October 7 to November 3, 2009. The water levels were monitored using electronic pressure transducers set to record data at 15-minute time intervals. A pressure transducer placed above the water table in well TT-MW2-16 was used to monitor barometric pressure. Water level data from the pressure transducers was downloaded to a laptop computer at the conclusion of the test period and compensated for barometric pressure effects prior to interpretation.

Values for the hourly rate of water table rise between midnight and 4 AM and daily net rise or fall of the water table were determined directly from the water level data. These data were interpreted using the method developed by White (1932), which relates these parameters to the ET rate.

Copies of the water level records used for the ET evaluation are provided in Appendix H.

2.7 Investigation-Derived Waste

Investigation derived waste (IDW) generated from the field activities included soil cuttings from drilling; groundwater from well development, groundwater sampling, and aquifer testing; and water used for equipment decontamination. Soil cuttings were temporarily stored onsite in a 20 cubic yard roll-off bin pending characterization, profiling and offsite disposal. Water generated during field activities was stored in a 10,000-gallon portable tank pending characterization, profiling and offsite disposal. Copies of the non-hazardous waste manifests are provided in Appendix I.

2.8 Habitat Conservation

Consistent with the USFWS approved Low-Effect Habitat Conservation Plan (Tetra Tech, 2005) describing low-effect activities for environmental remediation at the Site, biological surveys were conducted in the areas surrounding proposed drilling locations, equipment lay down areas, and roll-off bins prior to initiating field activities. The surveys were conducted to evaluate the potential for impacts to sensitive species/habitats, including SKR, during field activities. The surveys were performed by a USFWS-approved biologist.

As part of the biological surveys, the biologist identified and marked potential or suspected SKR burrows that were located in the vicinity of proposed drilling locations to avoid the “take” (i.e., harm, harassment, death, and/or disturbance of habitat) of SKR. The biologist clearly marked ingress and egress routes to each drilling location in an effort to minimize the overall footprint of field activities and impacts to SKR habitat. As needed, the biologist remained on Site during field activities to implement the requirements of the Low Effect Habitat Conservation Plan. Following the completion of field activities, the approved biologist also conducted a post-activity survey to assess the impacts of the work activities conducted at each location.

Section 3 Results

3.1 Geophysical Survey

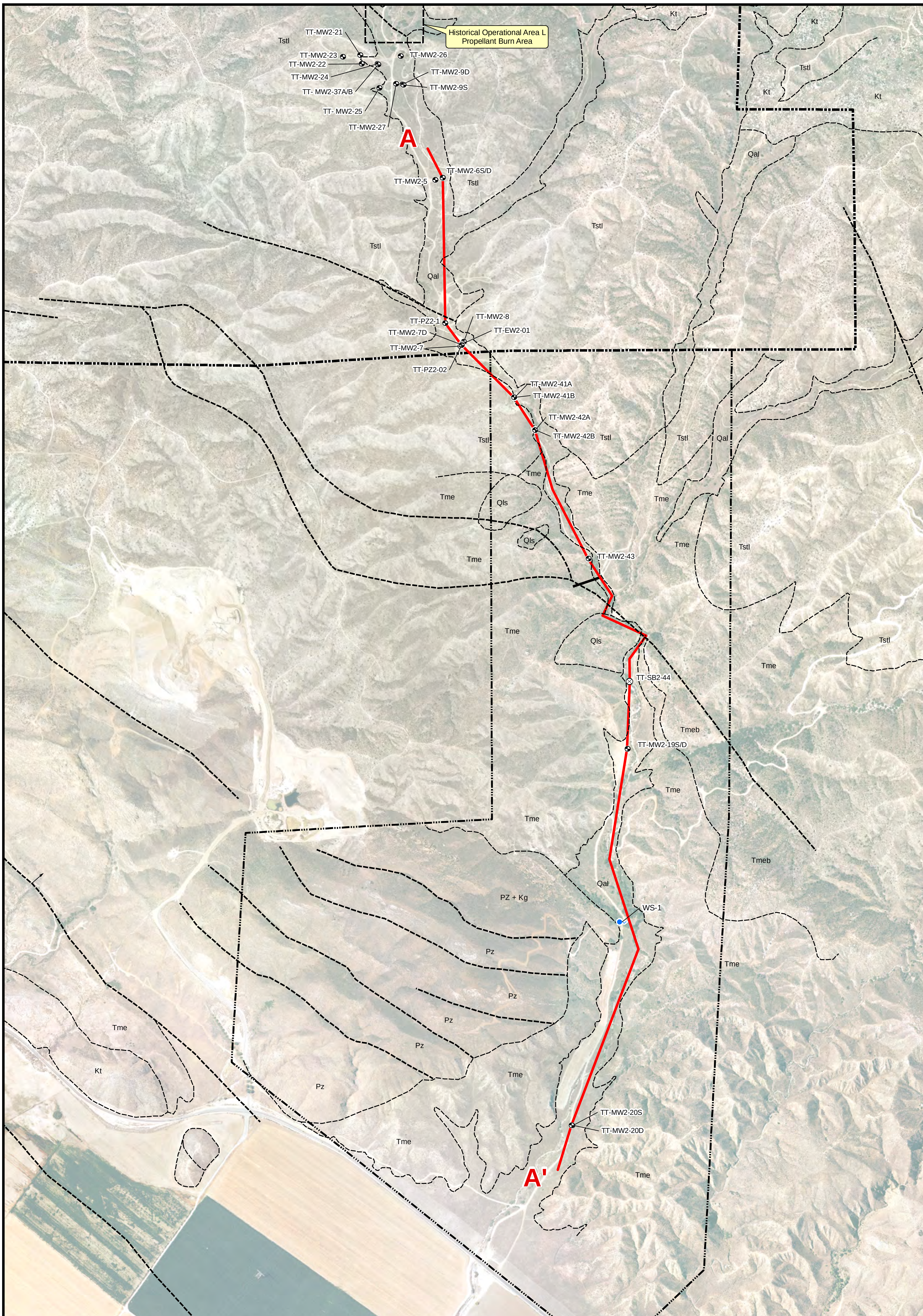
Figure 3-1 shows the seismic profile location with respect to the fault mapped by Morton and Miller (2006). The seismic reflection profile (Appendix B) shows reflector offsets interpreted as a possible normal fault, which project to the surface approximately 240 feet from the eastern end of the profile line. The fault location, based on recent mapping of the area by Morton (presented in Tetra Tech, 2010) and revised based on the geophysical survey, is shown in Figure 3-1.

The fault offset interpreted from the geophysical survey is approximately 20 feet. However, the vertical offset of units mapped by Morton and Miller (2006) implies a normal fault with a vertical throw on the order of 100 to 150 feet. Several possible explanations are possible for this discrepancy, including the angle between the fault and the geophysical survey line, problematic correlation of the reflectors across the fault in the geophysical survey, and problematic mapping of this area, which has relatively complex geological relationships and poor exposures.

Seismic refraction data were also collected along Profile 19 to evaluate alluvium thickness and the depth to relatively unweathered bedrock. The seismic refraction profile identified three layers with distinct seismic velocities:

- a shallow 10- to 15-foot thick layer with a velocity of approximately 1,330 feet per second (ft/sec), which is continuous across the profile;
- an intermediate layer with a velocity of approximately 2,490 ft/sec, which is absent in the area underlying the existing stream channel; and
- a deep layer with a velocity of approximately 6,980 ft/sec.

Based on the low seismic velocities, correlations with the boring log for TT-MW2-43, and general geologic observations in the vicinity of the seismic profile, the shallow layer is interpreted as unconsolidated alluvium. The deep layer has seismic velocities consistent with competent rock, and is interpreted as relatively unweathered MEF. The intermediate layer is interpreted as deeply-



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LEGEND

- Well Location
- Borehole Location
- Spring
- Geologic Cross Section Line
- Geophysical Survey Line
- Contact
- Fault, Approximately Located, Showing Dip
- Riverside Conservation Authority Property Boundary
- Historic Operational Area Boundary

Qaf	-	Artificial Fill
Qal	-	Undifferentiated Quaternary alluvial deposits along canyon floors
Qls	-	Quaternary landslide deposits
Tstm	-	Middle member of the San Timoteo formation
Tstl	-	Lower member of the San Timoteo formation
Tme	-	Undifferentiated Mount Eden formation
Tmeb	-	Tonalite breccia deposits of the Mount Eden formation
Kg	-	Cretaceous biotite monzogranite
Kt	-	Cretaceous biotite-hornblende tonalite and hornblende-biotite tonalite
Pz	-	Undifferentiated Paleozoic schist, gneiss, and marble

0 500 1,000 Feet

Source:
Faults modified from the Site 2
Lineament Study, Tetra Tech, 2010.

Beaumont Site 2

Figure 3-1

Geologic Map
Lower Laborde Canyon

TETRA TECH

weathered MEF. The absence of deeply-weathered MEF in the area underlying the existing stream channel suggests localized removal of this material by erosion.

The seismic reflection and refraction data do not indicate significant offset of shallow hydrostratigraphic units (i.e., alluvium, deeply-weathered MEF, and relatively unweathered MEF) due to faulting, suggesting that alluvium deposition and development of the current weathering profile in the MEF occurred subsequent to displacement along the fault.

3.2 Geology

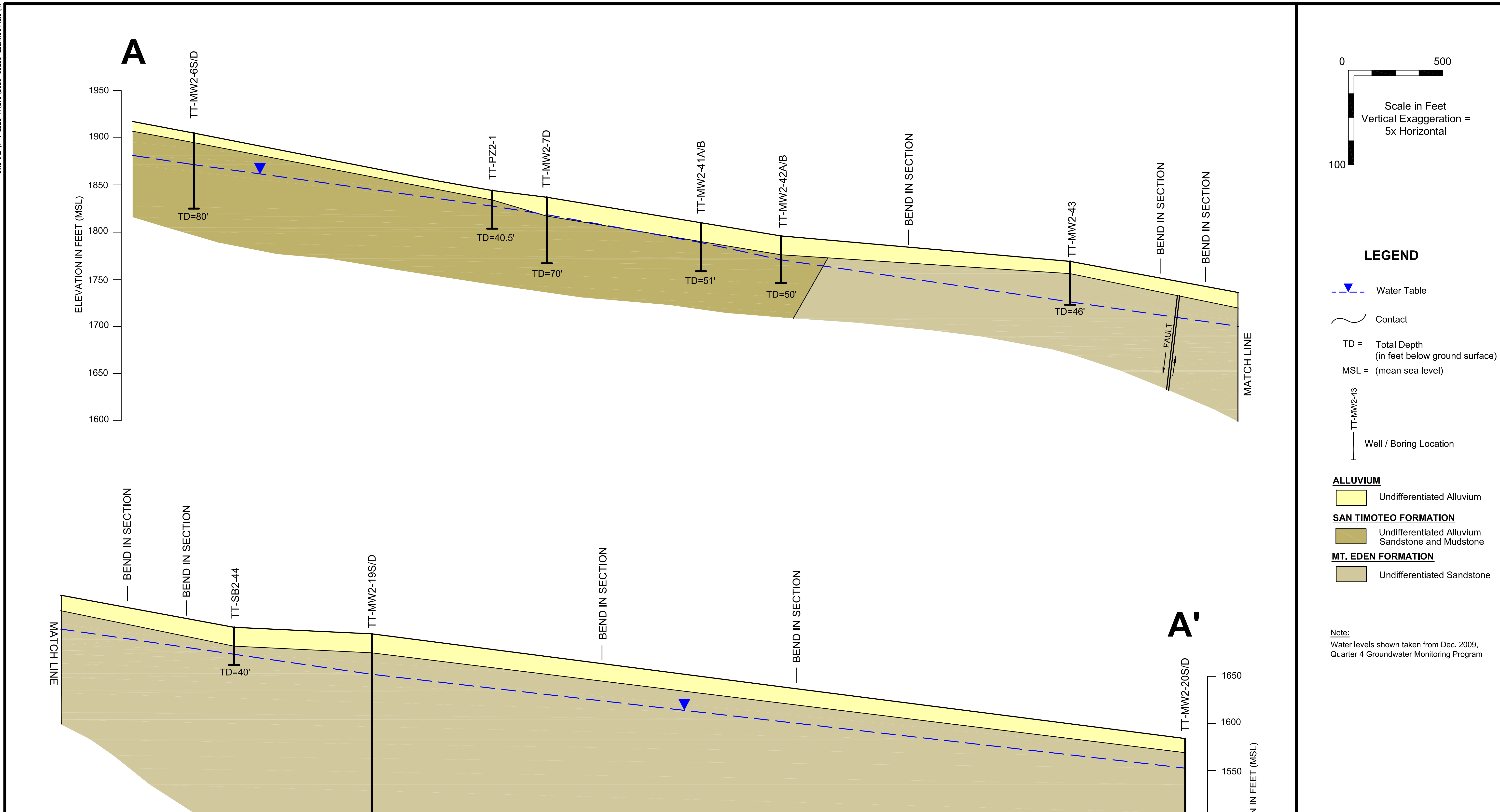
Geologic units encountered during drilling include Quaternary-age alluvium and sandstones of the Tertiary-age STF and MEF. Lithologies observed in the borings were as follows:

- Mt. Eden Formation: the MEF was encountered at depths below 12 to 17 feet bgs in borings TT-MW2-43 and TT-SB2-44, respectively. The MEF consists of gray very fine- to medium-grained sandstones. The degree of induration of the MEF generally increases with depth in the soil borings.

- San Timoteo Formation: The STF was encountered at depths below 17 to 22 feet bgs in borings TT-EW2-1, TT-PZ2-2, TT-MW2-41A and B, and TT-MW2-42A and B. The STF consists primarily of grayish-brown fine grained sandstones and mudstones. The degree of induration of the STF generally increases with depth in the soil borings.

- Alluvium: Alluvium consists of crudely stratified unconsolidated gravel, sand, silty sand, and silt across the bottom of Laborde Canyon. The alluvium ranges in thickness from approximately 12 to 17 feet.

The geology of lower Laborde Canyon is shown in Figure 3-1. Schematic cross-section A-A' (Figure 3-2) shows the generalized subsurface geology along the Laborde Canyon drainage channel, from TT-MW2-6S/D, located approximately 1,900 feet north of the property boundary, to TT-MW2-20S/D, located approximately 8,500 feet south of property boundary. Schematic cross-section A-A' is intended to show the geologic relationships along the drainage channel, and includes a number of bends to conform to the approximate channel geometry. The primary features of schematic cross-section A-A' are the north-dipping contact between the San Timoteo and Mt. Eden formation to the south of TT-MW2-42A/B; and the fault discussed in Section 3.1, which offsets the Mt. Eden formation to the north of TT-MW2-43. The bedrock deposits are overlain by a thin mantle of alluvium.



Beaumont Site 2

Figure 3-2
Geologic Cross Section A-A'

TETRA TECH

The south boundary area is shown in more detail on Figure 3-3. Cross-section B- B' (Figure 3-4) shows the subsurface geology in the area of TT-EW2-1. Bedrock in this area consists of poorly-indurated sandstones of the San Timoteo formation, which are overlain by alluvium consisting of silty sand interbedded with coarser-grained lenses of gravel, gravelly sand, and sand with gravel. Under current conditions, the gravelly zones are only a few feet above the water table.

3.3 Hydrogeology

Groundwater level measurements and calculated groundwater elevations for the Site are summarized in Table 3-1. The water level data were collected in December 2009 as part of the GMP, and include all of the wells installed at the Site. The depth to groundwater in the newly installed wells ranges from approximately 18.6 to 25.2 feet bgs; groundwater elevations range from 1818.36 feet above mean sea level (msl) at TT-PZ2-2 to 1771.04 feet msl at TT-MW2-42A. Based on observations made during drilling, groundwater in the area of TT-EW2-1 and TT-PZ2-2 appears to be unconfined. Groundwater at TT-MW2-42A/B and TT-MW2-42A/B appears to be unconfined to semiconfined.

Groundwater contours based on the December 2009 water level measurements are shown in Figure 3-5. The average horizontal gradient from TT-MW2-16 in the north to TT-MW2-20 in the south is approximately 0.03 feet per foot (ft/ft); locally, the horizontal gradient varies from approximately 0.02 to 0.04 ft/ft. The groundwater gradient between wells TT-MW-42A and TT-MW2-19S is similar to the gradient to the north and to the south, suggesting that no large discontinuities are present in the area of the fault. Groundwater flow is interpreted to be generally to the south, following Laborde Canyon. Vertical gradients calculated for well pairs TT-MW2-41A/B and TT-MW2-42A/B were upward, at approximately +0.17 and +0.19 ft/ft, respectively. Both wells in each pair are screened within the shallow aquifer.

3.4 Analytical Results

3.4.1 Data Quality Review

The data for the groundwater sampling activities were provided in analytical data reports generated by E.S. Babcock & Sons, Inc. and Microseeps, Inc. The quality control samples were reviewed as described in the Revised Groundwater Sampling and Analysis Plan (Tetra Tech, 2003), using the latest versions of the National Functional Guidelines for organic and inorganic

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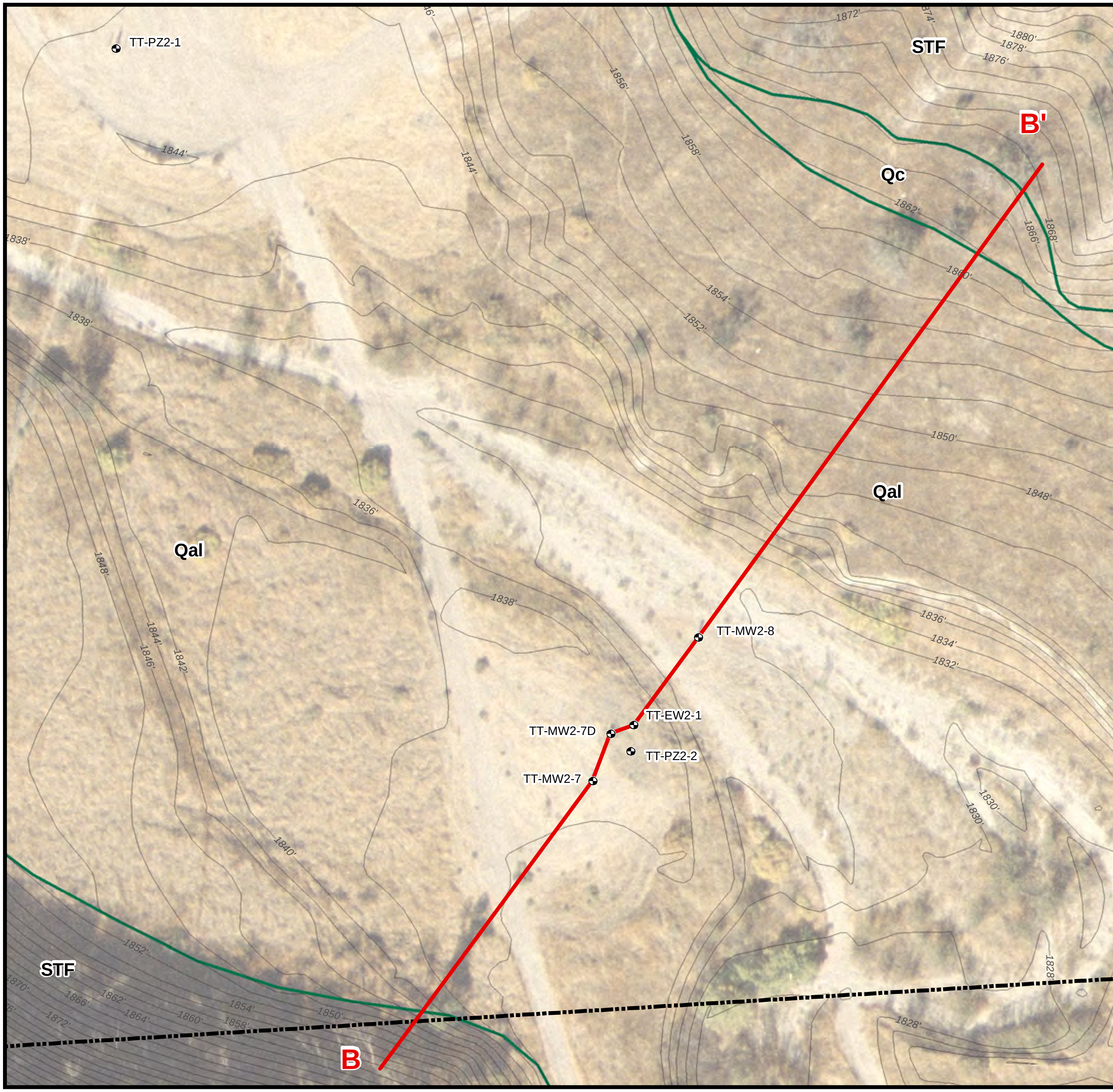


0 25 50 Feet

LEGEND

- Well Location
- Cross Section Line
- Contact (dashed where inferred)
- Ground Surface Elevation Contour (2-foot interval - feet msl)
- Beaumont Site 2 Property Boundary

Qal - Alluvium

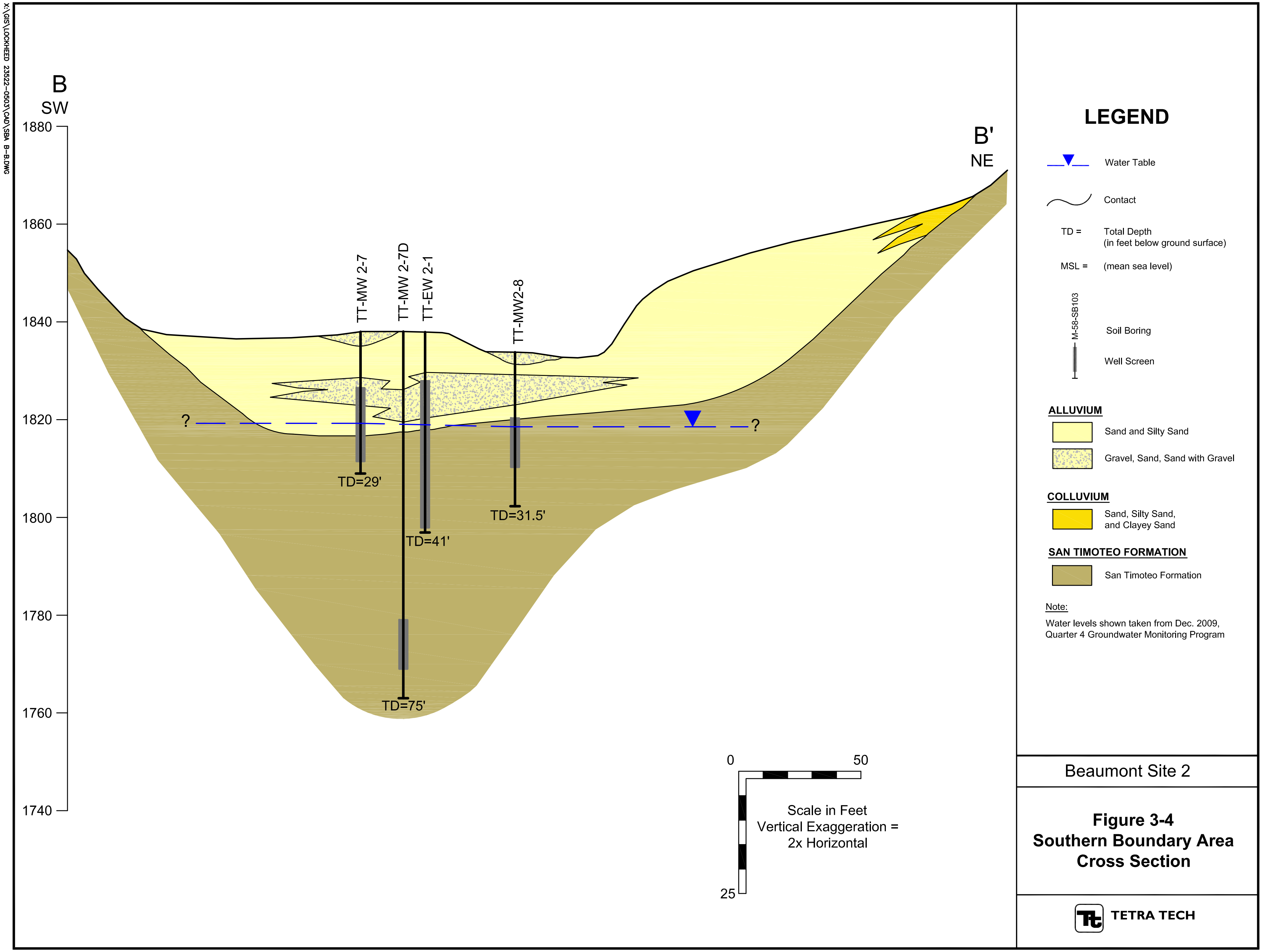
Qc - Colluvium

STF - San Timoteo Formation

Beaumont Site 2

Figure 3-3
Geologic Map of Southern Boundary Area

TETRA TECH



Beaumont Site 2

Figure 3-4
Southern Boundary Area
Cross Section

TETRA TECH

Table 3-1
Groundwater Elevations, December 2009

Well ID	Date Measured	Measuring Point Elevation[1] (feet MSL)	Dec 2009 Depth to Water[2] (feet)	Dec 2009 Groundwater Elevation[3] (feet MSL)
Tt-MW2-1	12/01/09	2035.21	57.97	1977.24
Tt-MW2-2	12/01/09	2137.75	70.25	2067.50
Tt-MW2-3	12/01/09	2094.66	70.55	2024.11
Tt-MW2-4S	12/01/09	1986.94	50.86	1936.08
Tt-MW2-4D	12/01/09	1987.17	58.05	1929.12
Tt-MW2-5	12/01/09	1911.31	40.16	1871.15
Tt-MW2-6S	12/01/09	1908.00	36.71	1871.29
Tt-MW2-6D	12/01/09	1908.07	37.67	1870.40
Tt-MW2-7	12/01/09	1839.25	21.52	1817.73
Tt-MW2-7D	12/01/09	1838.96	19.00	1819.96
Tt-MW2-8	12/01/09	1836.32	18.21	1818.11
Tt-MW2-9S	12/01/09	1938.38	39.35	1899.03
Tt-MW2-9D	12/01/09	1938.78	43.24	1895.54
Tt-MW2-10	12/01/09	2001.57	57.83	1943.74
Tt-MW2-11	12/01/09	2004.51	49.88	1954.63
Tt-MW2-12	12/01/09	2016.26	50.85	1965.41
Tt-MW2-13	12/01/09	2049.39	66.59	1982.80
Tt-MW2-14	12/01/09	2074.78	66.31	2008.47
Tt-MW2-16	12/01/09	2137.20	62.20	2075.00
Tt-MW2-17S	12/01/09	2095.55	71.25	2024.30
Tt-MW2-17D	12/01/09	2095.33	71.45	2023.88
Tt-MW2-18	12/01/09	2035.32	57.88	1977.44
Tt-MW2-19S	12/01/09	1698.34	45.42	1652.92
Tt-MW2-19D	12/01/09	1698.37	26.36	1672.01
Tt-MW2-20S	12/01/09	1587.77	34.54	1553.23
Tt-MW2-20D	12/01/09	1587.48	33.79	1553.69
Tt-MW2-21	12/01/09	1978.45	66.32	1912.13
Tt-MW2-22	12/01/09	1975.86	65.14	1910.72
Tt-MW2-23	12/01/09	1995.17	82.94	1912.23
Tt-MW2-24	12/01/09	1964.26	53.78	1910.48
Tt-MW2-25	12/01/09	1966.96	63.96	1903.00
Tt-MW2-26	12/01/09	1944.43	38.19	1906.24
Tt-MW2-27	12/01/09	1948.27	50.25	1898.02
Tt-MW2-28	12/01/09	1995.65	62.02	1933.63
Tt-MW2-29A	12/01/09	2147.77	Dry	Dry
Tt-MW2-29B	12/01/09	2147.90	121.60	2026.30
Tt-MW2-29C	12/01/09	2147.83	127.71	2020.12
Tt-MW2-30A	12/01/09	2074.37	72.95	2001.42
Tt-MW2-30B	12/01/09	2074.41	75.43	1998.98
Tt-MW2-30C	12/01/09	2074.35	77.68	1996.67

Table 3-1
Groundwater Elevations, December 2009

Well ID	Date Measured	Measuring Point Elevation[1] (feet MSL)	Dec 2009 Depth to Water[2] (feet)	Dec 2009 Groundwater Elevation[3] (feet MSL)
Tt-MW2-31A	12/01/09	2036.11	58.86	1977.25
Tt-MW2-31B	12/01/09	2036.15	66.61	1969.54
Tt-MW2-32	12/01/09	2004.87	53.69	1951.18
Tt-MW2-33A	12/01/09	2070.54	61.22	2009.32
Tt-MW2-33B	12/01/09	2070.54	65.95	2004.59
Tt-MW2-33C	12/01/09	2070.54	64.05	2006.49
Tt-MW2-34A	12/01/09	2066.84	65.97	2000.87
Tt-MW2-34B	12/01/09	2066.85	73.15	1993.70
Tt-MW2-34C	12/01/09	2066.84	74.77	1992.07
Tt-MW2-35A	12/01/09	2003.20	49.59	1953.61
Tt-MW2-35B	12/01/09	2003.20	55.05	1948.15
Tt-MW2-36A	12/01/09	2100.99	79.01	2021.98
Tt-MW2-36B	12/01/09	2101.04	79.78	2021.26
Tt-MW2-36C	12/01/09	2100.88	79.76	2021.12
Tt-MW2-37A	12/01/09	1963.62	63.25	1900.37
Tt-MW2-37B	12/01/09	1963.67	71.26	1892.41
TT-MW2-38A	12/01/09	2084.56	59.48	2025.08
TT-MW2-38B	12/01/09	2084.42	81.45	2002.97
TT-MW2-38C	12/01/09	2084.63	88.90	1995.73
TT-MW2-39	12/01/09	2079.53	61.95	2017.58
TT-MW2-40A	12/01/09	2096.28	72.48	2023.80
TT-MW2-40B	12/01/09	2096.24	83.82	2012.42
TT-MW2-40C	12/01/09	2096.28	88.88	2007.40
Tt-MW2-41A	12/01/09	1812.47	23.90	1788.57
Tt-MW2-41B	12/01/09	1812.22	21.06	1791.16
Tt-MW2-42A	12/01/09	1799.06	28.02	1771.04
Tt-MW2-42B	12/01/09	1799.07	25.60	1773.47
Tt-MW2-43	12/01/09	1771.44	Dry	Dry
Tt-EW2-1	12/01/09	1840.24	22.27	1817.97
Tt-MW2-PZ1	12/01/09	1847.06	19.91	1827.15
Tt-MW2-PZ2	12/01/09	1840.76	22.40	1818.36

Notes:
1. Measuring point is top of well casing (TOC).
2. Relative to TOC.
3. Relative to mean sea level.

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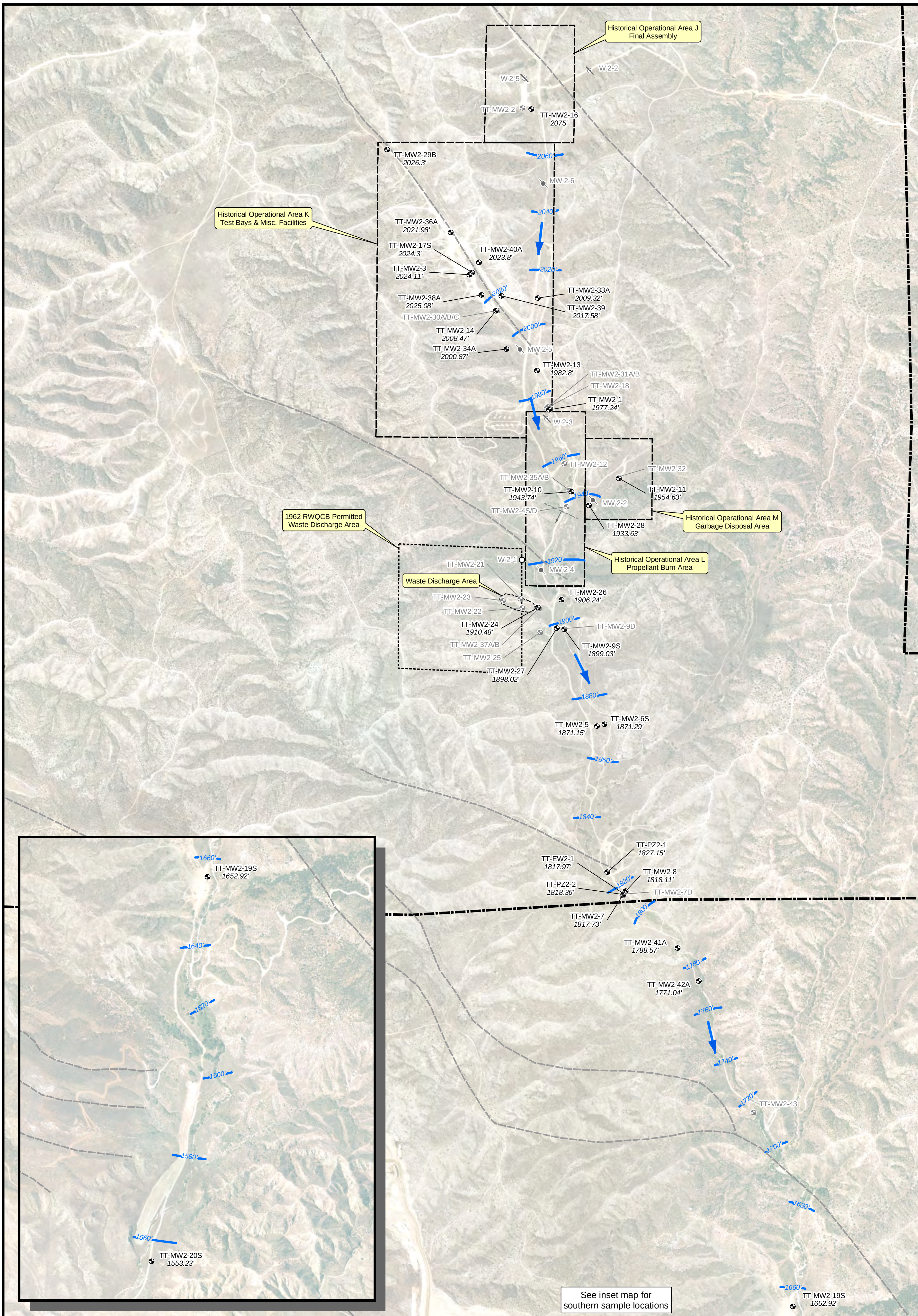

LEGEND

- Well Location
- Destroyed Production Well Location
- Destroyed Monitoring Well Location
- Reported Production Well Location
- Groundwater Elevation Contour
- Groundwater Flow Direction
- Fault, Accurately Located Showing Dip
- Fault, Approximately Located
- California Regional Water Quality Control Board (RWQCB) Permitted Waste Discharge Area
- Historical Operational Area Boundary
- Beaumont Site 2 Property Boundary

0 500 1,000 Feet

Adapted from: April 2007 aerial photograph.

Faults from the *Site 2 Lineament Study, Tetra Tech, 2009.*

Note: Beaumont Site 2 property boundary from Hillwig-Goodrow survey, May 2004.

20-foot groundwater interval.

Groundwater elevations in feet msl.

msl - Mean sea level.

Beaumont Site 2

Figure 3-5

Groundwater Contours December 2009

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data review documents from the United States Environmental Protection Agency (USEPA) (USEPA, 2008; USEPA, 2005).

Holding times, field blanks, laboratory control samples (LCS), method blanks, duplicate environmental samples, spiked samples, and surrogate and spike recovery data were reviewed. For each environmental sample, the sample-specific quality control spike recoveries were examined. These data examinations include comparing statistically calculated control limits to percent recoveries of all spiked analytes and duplicate spiked analytes. Relative percent difference (RPD) control limits are compared to actual matrix spike/matrix spike duplicate (MS/MSD) RPD results. Surrogate recoveries were examined for all organic compound analyses and compared to their control limits.

Environmental samples were analyzed by the following methods: Method E332.0 for perchlorate, Method SW8260B for volatile organic compounds (VOCs), Methods SW8270C for 1,4-dioxane, Method E521 for low level N-nitrosodimethylamine (NDMA), Method SM5310 for total and dissolved organic carbon, (TOC and DOC respectively), Methods SW6010B and E200.7 for metals, Method E300.0 for nitrate and chloride, Method AM23G for volatile fatty acids, and Method RSK-175 for ethane, ethene, and methane. Unless discussed below, all data results met required criteria, are of known precision and accuracy, did not require any qualification, and may be used as reported.

- Method SW8260B for VOCs had one detection of methylene chloride in the associated trip blank. Blank contamination caused 0.4 percent of the total SW8260B data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

- Method E521 for low level NDMA had one holding time error that qualified as estimated 16.7 percent of the total E521 data. The data qualified as estimated are usable for the intended purpose.

- Method SM5310B for total and dissolved organic carbon had field duplicate RPD errors that qualified as estimated 16.7 percent of the total SM5310B data. The data qualified as estimated are usable for the intended purpose. Blank contamination caused 8.3 percent of the total SM5310B data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

- Method AM23G for volatile fatty acids had LCS and matrix spike errors that qualified as estimated 3.7 percent of the total AM23G data. The data qualified as estimated are usable for the intended purpose. Blank contamination caused 9.3 percent of the total AM23G data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

- Method RSK-175 for methane, ethane, and ethane had methane blank contamination that caused 11.1 percent of the total RSK-175 data to be qualified for blank contamination. The blank-qualified data should be considered not detected.

The validated, positively detected analytical results are summarized in Table 3-2 and Table 3-3. Complete validated analytical results are tabulated in Appendix J; copies of the laboratory reports are provided in Appendix K.

3.4.2 Perchlorate

Analytical results for perchlorate are summarized in Table 3-2. Perchlorate was detected in monitoring well TT-MW2-41A at concentrations of 0.66 µg/L and 0.36 µg/L in October and November, 2009, respectively. Perchlorate was not detected in monitoring well TT-MW2-42A during either sampling event. Perchlorate was detected in extraction well TT-EW2-1 at a concentration of 2.6 µg/L prior to the aquifer test, and at a concentration of 5.4 µg/L immediately following the aquifer test. All of the perchlorate detections were below the California Maximum Contaminant Level (MCL) of 6 µg/L.

The analytical results for perchlorate in TT-EW2-1 (2.6 and 5.4 µg/L) are significantly lower than for nearby wells Tt-MW2-7 and TT-MW2-8 (430 and 290 µg/L, respectively, in May 2009). These concentration differences may be related to well construction: TT-EW2-1 is screened across the entire 20 foot thickness of the shallow aquifer, whereas TT-MW2-7 and TT-MW2-8 are screened only in the upper 5 to 8 feet of the aquifer (Figure 3-4). The observed differences in perchlorate concentration between TT-EW2-1, TT-MW2-7, and TT-MW2-8 suggest that perchlorate-impacted groundwater is present primarily in the uppermost portion of the shallow aquifer.

3.4.3 VOCs

Analytical results for VOCs are summarized in Table 3-2. The only VOC detected in the newly-installed monitoring wells was methylene chloride, which was detected during the October sampling event at a concentration of 0.62 µg/L in well TT-MW2-41A, well below the California MCL of 5 µg/L. Methylene chloride was not detected in TT-MW2-41A during the November sampling event, and was not detected in the samples collected from TT-MW2-42A or TT-EW2-1.

Table 3-2
Summary of Validated Analytical Results: Environmental Analyses

Well No.	Date Sampled	Perchlorate[1] (µg/L)	Methylene Chloride[2] (µg/L)	1,4-Dioxane[3] (µg/L)	NDMA[4] (µg/L)
California MCL		6	5	-	-
California DWNL		-	-	3	0.01
TT-MW2-41A	10/21/09	0.66	<0.15	<0.10	0.003
	11/23/09	0.36	<0.15	<0.10	0.003
TT-MW2-42A	10/22/09	<0.071	0.62 Jq	<0.10	0.002 Je
	11/23/09	<0.071	<0.15	<0.10	<0.0007
TT-EW2-1	10/23/09	2.6	<0.15	0.20	<0.0007
	10/30/09	5.4	-	-	-

Notes:
µg/L: micrograms per liter.
"-": not applicable
MCL: Maximum Contaminant Level
DWNL: California Drinking Water Notification Level.
1. Analyzed by Method E332.0.
2. Analyzed by Method SW8260B
3. Analyzed by Method SW8270C-SIM
4. N-Nitrosodimethylamine, analyzed by Method E521

Data Qualifiers:
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).
e: A holding time violation occurred.

Table 3-3
Summary of Validated Analytical Results: Natural Attenuation Parameters

							Volatile Fatty Acids[5] (mg/L)									Dissolved Gases[6] (µg/L)			Field Measurements[7]			
Well No.	Date Sampled	Total Organic Carbon[1] (mg/L)	Dissolved Organic Carbon[1] (mg/L)	Iron[2] (mg/L)	Nitrate as N[3] (mg/L)	Sulfate[4] (mg/L)	Acetic Acid	Butyric Acid	Hexanoic Acid	i-Hexanoic Acid	Lactic Acid and HIBA	Pentanoic Acid	i-Pentanoic Acid	Propionic Acid	Pyruvic Acid	Ethene	Ethane	Methane	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Ferrous Iron (mg/L)	Sulfide (mg/L)
TT-MW2-41A	10/21/2009	1.2	1.7	4.1	<0.11	130	0.077	<0.006	4.5 Jc	<0.018	0.47 Jd	<0.016	0.11	<0.002	<0.026	0.52	0.06 Jq	1.1	63.3	1.09	0.21	0.1
	11/23/2009	1.6	11	11	0.34	130	0.052 BJkq	<0.006	<0.007	<0.018	0.23 Bk	<0.016	<0.032	<0.002	<0.026	0.53	0.11	1.2	-35.3	0.65	0.33	0.41
TT-MW2-42A	10/22/2009	2.3	2.1 Bk	0.23	<0.11	57	0.088 Ba	<0.006	2.3	<0.018	<0.042	<0.016	<0.032	<0.002	<0.026	0.33	0.43	4.6	54.9	1.1	0.00	0.02
	11/23/2009	0.74 Ba	8.2	0.28	<0.11	46	0.11	<0.006	<0.007	<0.018	0.4	<0.016	<0.032	<0.002	<0.026	0.18	0.32	3.6	-6.1	0.93	0.03	0.03
TT-EW2-1	10/23/2009	0.61 Jq	0.76 Jf	0.39	<0.11 Jep	140	0.11 Bk	<0.006	<0.007	<0.018	<0.042	<0.016	<0.032	<0.002	<0.026	0.04 Jq	0.04 Jq	0.86 Bk	73.8	5.11	0.06	0.03

Notes:
mg/L: milligrams per liter.
µg/L: micrograms per liter
mV: millivolts
<: not detected above the indicated method detection limit (MDL).
1. Analyzed using Method A5310B.
2. Analyzed using Method E200.7 or SW6010.
3. Analyzed using Method E300N.
4. Analyzed using Method E300S.
5. Analyzed using Method AM23G.
6. Analyzed using Method RSK175.

Data Qualifiers:
J: The analyte was positively identified, but the analyte concentration is an estimated value.
B: The sample result is less than 5 times (10 times for common organic laboratory contaminants) the blank contamination. The result qualified for blank contamination is considered not to have originated from the environmental sample, since cross-contamination is suspected.
a: The analyte was found in the method blank.
c: The Matrix Spike (MS) and/or Matrix Spike Duplicate (MSD) recoveries were outside control limits.
d: The Laboratory Control Sample (LCS) recovery was outside control limits.
e: A holding time violation occurred.
f: The duplicate relative percent difference (RPD) was outside the control limit.
k: The analyte was found in a field blank.
p: The result was qualified based on professional judgement.
q: The analyte detection was below the Practical Quantitation Limit (PQL).

Methylene chloride is a common laboratory contaminant, and the detection of methylene chloride in one groundwater sample is not considered to be significant.

3.4.4 1,4-Dioxane

Analytical results for 1,4-dioxane are summarized in Table 3-2. 1,4-Dioxane was detected in well TT-EW2-1 at a concentration of 0.20 µg/L in October 2009; and was detected in a duplicate sample collected from well TT-EW2-1 at a concentration of 0.19 µg/L. 1,4-Dioxane was not detected in downgradient wells TT-MW2-41A and TT-MW2-42A. The 1,4-dioxane detection was well below the California Drinking Water Notification Level (DWNL) of 3 µg/L. 1,4-dioxane was not detected in wells TT-MW2-7 and TT-MW2-8, which are located near TT-EW2-1, during the second quarter 2009 groundwater monitoring event. Because the detected 1,4-dioxane concentration is low compared with the DWNL and 1,4 dioxane was not detected in other wells located near TT-EW2-1, the 1,4-dioxane detection is not considered to be significant.

3.4.5 NDMA

Analytical results for NDMA are summarized in Table 3-2. NDMA was detected in well TT-MW2-41A at a concentration of 0.003 µg/L during both the October and November sampling events, and was detected in TT-MW2-42A at a concentration of 0.002 µg/L during the October sampling event. NDMA was not detected in TT-MW2-42A during the November sampling event, and was not detected in well TT-EW2-1. All of the NDMA detections were below the California DWNL of 0.01 µg/L.

A dedicated pump was used to purge and sample well TT-MW2-41A. Testing performed as part of the groundwater monitoring program (Tetra Tech, 2010) suggests that NDMA detections elsewhere at the Site may be sampling artifacts caused by leaching of NDMA from dedicated sampling pumps, and the dedicated sampling pump is suspected to be the source of the NDMA detected in TT-MW2-41A. Additional work proposed to further evaluate NDMA in groundwater is discussed in the groundwater monitoring report for the second and third quarter of 2009 (Tetra Tech, 2010).

3.4.6 Monitored Natural Attenuation Parameters

The monitoring wells were also analyzed for several indicators of natural attenuation, including total and dissolved organic carbon, iron, nitrate, sulfate, volatile fatty acids, and dissolved gases (ethane, ethene, and methane). In addition, sulfide and ferrous iron were analyzed in the field using test kits, and field measurements of oxidation/reduction potential (ORP) and dissolved oxygen (DO) were collected during well purging. The results of the natural attenuation parameter analyses are provided in Table 3-3.

The October 2009 DO and ORP measurements for wells TT-MW2-41A, TT-MW2-42A, and TT-EW2-1 are indicative of aerobic conditions, and are consistent with aquifer disturbance associated with well installation. The November 2009 DO and ORP measurements for wells TT-MW2-41A and TT-MW2-42A are lower and indicative of slightly anaerobic conditions. Sulfide was also detected at 0.4 mg/L in TT-MW2-41A, consistent with anaerobic conditions and possibly indicating a sulfate-reducing environment in this area. DOC concentrations in November 2009 were relatively high in both wells (11 mg/L in TT-MW2-41A, and 8.2 mg/L in TT-MW2-42A), and volatile fatty acids were detected in TT-MW2-42A. Nitrate was detected at 0.34 mg/L in TT-MW2-41A, and was not detected in TT-MW2-42A in November 2009. Overall, conditions suitable for natural bioreduction of perchlorate appear to be present in the shallow aquifer in the area immediately south of the property boundary.

3.5 Aquifer Testing Results

3.5.1 Slug Tests

Hydraulic conductivity values interpreted from the slug test data for wells TT-MW2-7, TT-MW2-7D, TT-MW2-8, TT-MW2-41A, and TT-MW2-42A are summarized in Table 3-4. The average of the two hydraulic conductivity values obtained for each well range from 0.0023 feet per day (ft/day) for TT-MW2-41A to 0.49 ft/day for TT-MW2-8.

3.5.2 Constant-Rate Pumping Test

A summary of results for the constant-rate pumping test results is provided in Table 3-5. A maximum drawdown of 10.90 feet was achieved in extraction well TT-EW2-1 during the constant-rate test; drawdown ranging from 3.40 to 0.05 feet was measured in all of the observation

Table 3-4
Summary of Slug Test Results

Well	Hydraulic Conductivity (ft/day)		
	Falling Head[1]	Rising Head[2]	Average[3]
Tt-MW-2-7	0.042	0.038	0.040
Tt-MW2-7D	0.090	0.079	0.08
Tt-MW2-8[4]	0.50	0.49	0.49
Tt-MW2-41A	0.00051	0.0040	0.0023
Tt-MW2-42A	0.065	0.043	0.054

Notes:
1. Data collected during falling-head (slug-in) phase of test.
2. Data collected during rising-head (slug-out) phase of test.
3. Mean of hydraulic conductivity values for falling- and rising-head tests.
4. Hydraulic conductivity values for slug tests considered upper bound because semi-log slope decreases with time.

Table 3-5
Summary of Constant Rate Pumping Test Results

Well	Screened Interval (feet bgs)	Distance from Tt-EW2-1 (feet)	Test Phase[1]	Maximum Drawdown or Recovery (feet)	Cooper-Jacob Method[2]		Theis Type Curve Method[3]		Average Transmissivity[4] (ft^2/day)	Average Storativity[5]
					Transmissivity (ft^2/day)	Storativity	Transmissivity (ft^2/day)	Storativity		
TT-EW2-1	10.1-30.1	NA	P	10.90	0.63	NA	0.90	NA	0.69	NA
			R	10.90	0.53	NA	0.75	NA		
TT-PZ2-2	10.1-30.1	9.1	P	3.40	1.4	1.7E-03	1.6	2.0E-03	1.4	0.0019
			R	3.37	1.2	1.7E-03	1.2	2.3E-03		
TT-MW2-7[6]	11.5-26.5	24.3	P	0.05	83	5.9E-02	50	8.6E-02	58	0.099
			R	0.03	79	1.2E-01	36	1.6E-01		
TT-MW2-8	13.5-23.5	37.4	P	0.44	7.9	4.5E-03	8.3	2.6E-03	9.2	0.0031
			R	0.39	11	2.3E-03	10	3.2E-03		
TT-PZ2-1	14.3-34.3	292.2	P	0	-	-	-	-	-	-
			R	0	-	-	-	-		
TT-MW2-7D[6]	59-69	9.0	P	0.05	34	3.6E-01	17	4.3E-01	33	0.59
			R	0.02	58	8.9E-01	36	8.9E-01		

Notes:
Pumping rate is 0.131 gallons per minute for 24 hour test period.
NA: Not applicable; storativity values not valid for pumping well
Shaded values considered invalid (see note 5)

1. P = pumping phase; R = recovery phase.
2. Data interpreted using Cooper-Jacob semilog method.
3. Data interpreted using Theis type curve method.
4. Geometric mean of Cooper-Jacob and Theis type curve values, for pumping and recovery data.
5. Mean of Cooper-Jacob and Theis type curve values, for pumping and recovery data.
6. Results not considered valid based on small drawdowns, poor agreement between aquifer parameters derived using Cooper-Jacob and Theis type curve methods, and poor agreement with slug test results.

wells except for TT-PZ2-1. No response was observed in TT-PZ2-1, which is located 292 feet from the pumping well.

Table 3-5 shows that maximum drawdown in wells TT-MW2-7 and TT-MW2-7D (0.05 and 0.05 feet, respectively) was weak compared with wells TT-MW2-8 and TT-PZ2-2 (3.40 and 0.44 feet, respectively), even though these wells are located at similar distances from the extraction well. The weak response in TT-MW2-7D is consistent with this well being screened in a deeper water-bearing zone (59 to 69 feet bgs) than the extraction well (10 to 40 feet bgs). The weak response observed in TT-MW2-7 suggests that this well is hydraulically isolated from the pumping well, which is attributed to lateral anisotropy in the weathered San Timoteo formation. The evidence for poor hydraulic communication between the pumping well and wells TT-MW2-7 and TT-MW2-7D suggests that the modeled aquifer parameters for these wells may be invalid.

Measurable recovery after the pumping cycle was observed in all wells except TT-PZ2-1. Water level recoveries during the post pumping period were generally within a few hundredths of a foot of the maximum drawdown value (Table 3-5).

The drawdown and recovery data for the wells which showed a strong response to pumping (TT-EW2-1, TT-PZ2-2, and TT-MW2-8) have a shape that is generally consistent with the Theis aquifer model. Some flattening of the slope of the drawdown and recovery data was observed at very late times, which may represent the onset of either leakage or delayed yield effects. Leakage and/or delayed yield effects are commonly observed in multi-layer aquifer systems or systems with delayed drainage from the water table (Dawson and Istok, 1991). Leakage effects are further supported by the weak drawdown observed in the deep well TT-MW2-7D, which is screened in a deeper water-bearing zone. The pumping well also displayed deviations from the Theis model at early times, which are consistent with wellbore storage effects. The wells with weak responses to pumping (TT-MW2-7 and TT-MW2-7D) generally exhibited behavior consistent with the Theis aquifer model, and did not show flattening of the slope of the drawdown and recovery data at very late times.

Transmissivity values interpreted from the transient drawdown data are summarized in Table 3-5. Copies of the semilog Cooper-Jacob and log-log Theis type curve interpretation figures are provided in Appendix G. The average transmissivity values for wells showing a strong drawdown response (TT-EW2-01, TT-PZ2-02, and TT-MW2-08) range from 0.69 ft^2/day in TT-EW2-1 to 9.6 ft^2/day in TT-MW2-8, with an overall geometric mean of 2.05 ft^2/day. The average transmissivity values correspond to average hydraulic conductivities of 0.034 to 0.46 ft/day, assuming a saturated thickness for 20 feet for the aquifer. The average hydraulic conductivity value for TT-MW2-8 (0.46 ft/day) is in good agreement with the average hydraulic conductivity obtained from the slug tests (0.49 ft/day). Average hydraulic conductivity values for the wells with weak responses to pumping (TT-MW2-7 and TT-MW2-7D) were much higher than the slug test values, further suggesting that these wells are isolated from the pumping zone and that the pumping test results are likely invalid for these wells.

The maximum drawdown observed during the pumping test (Table 3-5) was also interpreted using the drawdown-distance method (Appendix G). An aquifer transmissivity of 1.67 ft^2/day is obtained using the drawdown data for wells TT-EW2-1, TT-PZ2-2, and TT-MW2-8. A transmissivity of 1.91 ft^2/day is obtained if the pumping well data are excluded based on possible well efficiency effects. The distance-drawdown transmissivity values are in good agreement with the geometric mean of the transmissivity values obtained from the transient analysis (2.05 ft^2/day). The extrapolated drawdown at the pumping well is 9.6 feet, compared with the observed value of 10.9 feet, which gives a well efficiency factor of 88% for TT-EW2-1. The approximate radius of influence of the pumping well is 50 feet.

The specific capacity of TT-EW2-1 calculated from the pumping test data was 0.012 gpm/ft. Using the empirical relationship between specific capacity and transmissivity given by Dawson and Istok (1991), this value corresponds to a transmissivity of 2.40 ft^2/day.

Groundwater velocities estimated from the average hydraulic conductivities (0.034 to 0.46 ft/day) range from approximately 2.5 to 100 feet per year, assuming a value of 0.03 for the hydraulic gradient and a porosity of 5 to 15 percent, based on the observed soil types and the site water balance. The estimated groundwater velocities suggest that contaminant transport rates at the SBA are very low.

The pumping test and slug test results show a general spatial trend for increasing aquifer transmissivity and hydraulic conductivity towards well TT-MW2-8. This trend may reflect greater aquifer transmissivity and hydraulic conductivity due to more intense weathering of the San Timoteo formation toward the center of Laborde Canyon.

Aquifer storativity values for wells showing a strong drawdown response (TT-EW2-1, TT-PZ2-2, and TT-MW2-8) range from 0.0019 to 0.0031, which most likely reflects semi-confined conditions since these storage values would represent an aquifer specific yield less than 0.5 percent. These results are generally consistent with the Site hydrogeologic model.

3.6 Evapotranspiration Assessment

A portion of the water level record for well TT-MW2-42A is provided in Figure 3-6. Figure 3-6 shows that water levels fluctuate approximately 0.03 to 0.08 feet on a daily basis, with decreasing water levels during the day and recovering levels at night. These diurnal water level fluctuations are consistent with groundwater ET. This interpretation is supported by the presence of obligate phreatophyte species (e.g., cottonwood and willow) in the riparian corridor; the shallow depth to groundwater (approximately 10 to 15 feet bgs) beneath the surface of the riparian corridor; the presence of deep-rooted plants, including cottonwood and tamarisk; and the presence of upward vertical gradients observed within the shallow aquifer at well pairs TT-MW2-41A/B and TT-MW2-42A/B.

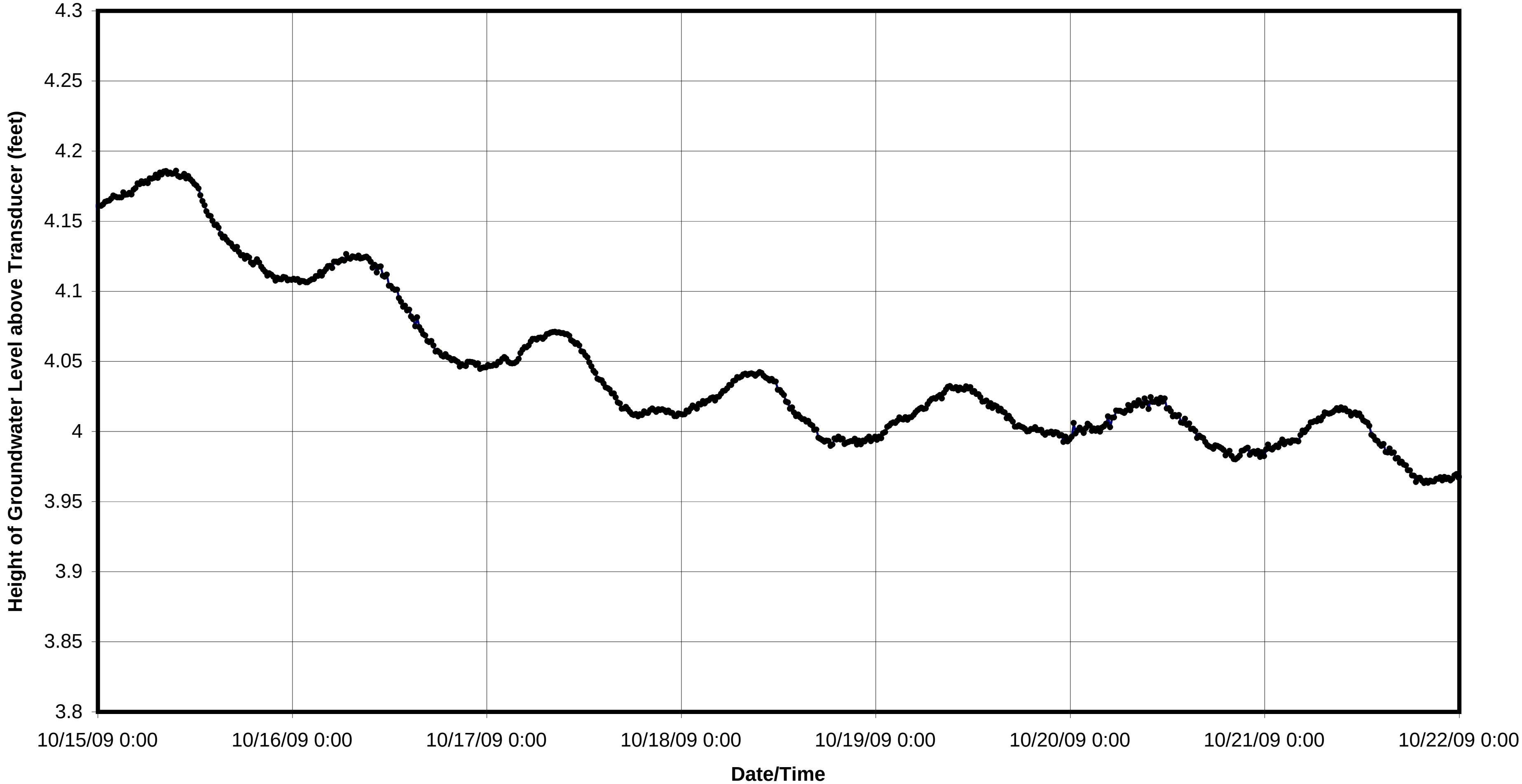
The daily water level fluctuations found observed at the Site are similar to those observed in other studies of ET from the groundwater table (e.g., White, 1932; Lewis et al., 2002). These studies of areas overlain by vegetation and underlain by shallow groundwater have found that the rate of ET from the water table can be estimated from daily variations in monitoring well water levels using the following equation (White, 1932):

$$ET = Sy\ (24\ r + s) \quad \text{(Equation 3-1)}$$

Where ET is the ET rate, in inches per day (in/day), Sy is the specific yield, r is the hourly rate of water table rise between midnight and 4 AM, in inches per hour (in/hr), and s is the net rise or fall of the water table per day, in inches per day.

Except during periods when the effects of ET on water levels are masked by the influence of precipitation and/or pumping, the values for the hourly rate of water table rise between midnight and 4 AM (r) and the daily net rise or fall of the water table per day (s) can be directly estimated

Figure 3-6
Water Level Fluctuations, TT-MW2-42A



from the water level fluctuation data. Specific yield has not been directly measured in each of the wells; however, specific yield has been estimated to be 5 to 15 percent based on the observed soil types and the site water balance. Specific yield can also be indirectly evaluated using ET rates measured from at the nearby California Irrigation Management Information System (CIMIS; California Department of Water Resources, 2009) monitoring station at the University of California, Riverside (UCR) as follows (Lewis et al., 2002):

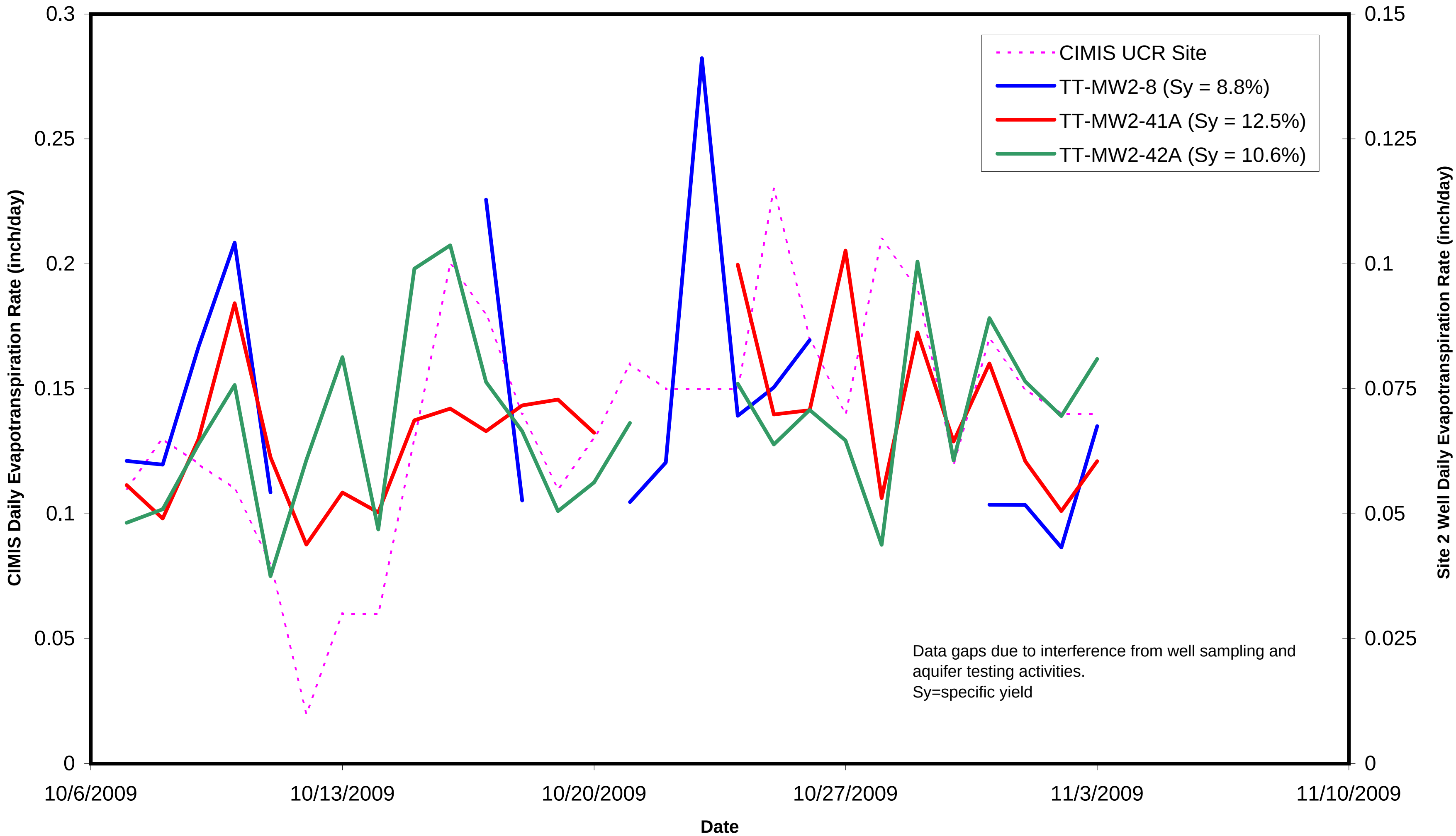
$$Sy = ET / (24r + s) \quad \text{Equation 3-2}$$

The specific yield values estimated from Equation 3-2 range from 9 to 12.5 percent, in fairly good agreement with the range of specific yield values estimated above.

The water level fluctuation data measured at the Site (Appendix H) were used with Equations 3-1 and 3-2 to estimate the ET rates in the riparian area south of the property boundary during October 2009. The results of this evaluation are shown in Figure 3-7. Also shown on Figure 3-7 are reference ET rates for the UCR CIMIS station. CIMIS stations are automated weather stations which are placed over a standard, well-watered grass surface. The weather stations collect data for a variety of weather parameters related to ET, including solar radiation, air temperature, relative humidity, and wind speed. These data are used to model reference ET rates for the standard grass crop. Actual ET values for a specific plant in the same microclimate as the CIMIS station may be calculated by multiplying the reference ET by a crop coefficient. The trends in the ET rates derived from the groundwater data are generally consistent with the UCR CIMIS ET rate measurements. There is more variation in the ET rates estimated from the Site groundwater level fluctuations than those measured at the UCR site, similar to observations at other locations (e.g., Lewis et al., 2002). The Site ET rates are approximately one-half of those measured at the UCR CIMIS site.

The ET rates derived from the water level fluctuation data, combined with the presence of obligate phreatophyte species, the shallow depth to groundwater, the presence of deep-rooted plants, and the upward vertical hydraulic gradients strongly suggest that ET is removing groundwater from the shallow aquifer in the riparian area. Long-term annual average ET rates for the Site are likely to be roughly one-half of the 56.37 inches per year long-term annual average rate for the UCR CIMIS monitoring station, or approximately 28.2 inches per year. ET rates at specific locations are likely to depend upon depth to groundwater, with higher ET rates in areas with shallower groundwater.

Figure 3-7
Estimated Evapotranspiration Rates



Section 4 Updated Conceptual Site Model

4.1 Extent of Perchlorate in Groundwater

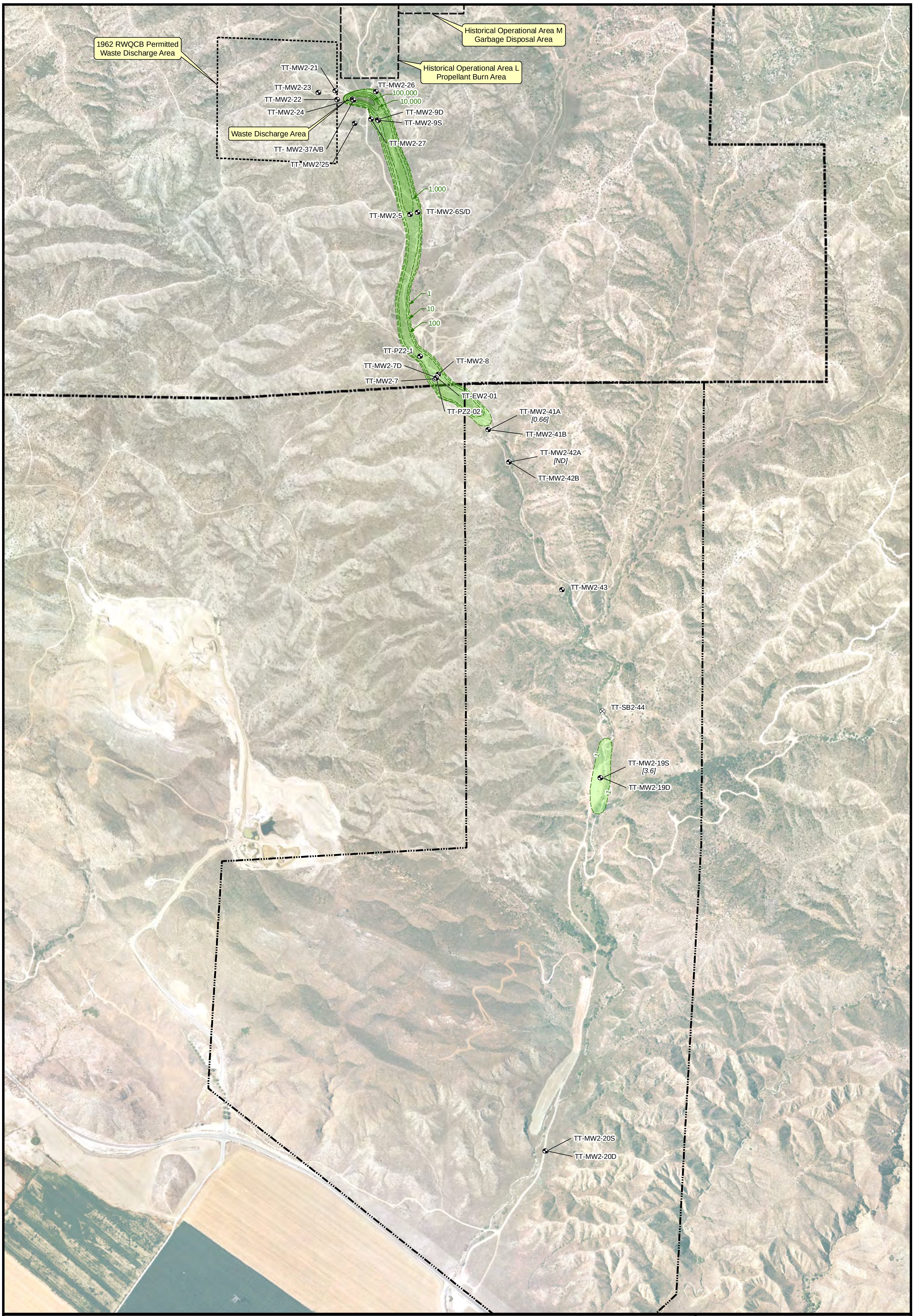
The extent of perchlorate in shallow groundwater, based on analytical data from May 2009 for previously installed wells (Tetra Tech, 2010) and the data presented in this report for the newly-installed wells, is illustrated in Figure 4-1. The results for new wells TT-MW2-41A and TT-MW2-42A indicate that perchlorate concentrations in groundwater attenuate to non-detectable concentrations within several hundred feet of the southern Site boundary. However, perchlorate has also been detected at low concentrations (less than the California MCL of 6 µg/L) in well TT-MW2-19S, most recently at concentrations of 2.9 and 3.6 µg/L in May and August 2009, respectively (Tetra Tech, 2010). Perchlorate has not been detected in well TT-MW2-19D, a deep well located adjacent to TT-MW2-19S, or in wells TT-MW2-20S and TT-MW2-20D, which are located downgradient of TT-MW2-19S. The available data suggests that the perchlorate detection in TT-MW2-19S is isolated, and may represent a discontinuous, "stranded" section of the perchlorate plume.

Several possible scenarios were considered to account for the detection of perchlorate in TT-MW2-19S, including the following:

- Downgradient transport of perchlorate by surface water flow during large precipitation events;
- Transport of perchlorate by flow through a deep groundwater system; and
- Transport of perchlorate through coarser-grained (and presumably more conductive) alluvial sediments.

Significant transport of perchlorate by surface water flow is considered to be unlikely. Surface water flow is rarely observed at the Site, and then only during periods of heavy, prolonged precipitation. Runoff samples collected in the SBA had perchlorate concentrations below detection limits in January 2008 and 1.59 µg/L in February 2009; concentrations at the mouth of Laborde Canyon were below detection limits during both sampling events. In view of the low

X:\GIS\Lockheed 23522-0503\Southern Plume.mxd



LEGEND

- Well Location
- Borehole Location
- Riverside Conservation Authority Property Boundary
- California Regional Water Quality Control Board (RWQCB) Permitted Waste Discharge Area
- Historic Operational Area Boundary
- Beaumont Site 2 Property Boundary

Perchlorate in Groundwater

- 1 µg/L
- 10 µg/L
- 100 µg/L
- 1,000 µg/L
- 10,000 µg/L
- 100,000 µg/L

Note:

[#] - Perchlorate concentration in µg/L.

msl - Mean sea level.

0 500 1,000 Feet

Beaumont Site 2

Figure 4-1

Extent of Perchlorate Contamination in Groundwater

TETRA TECH

concentrations of perchlorate detected in surface water, surface water flow is not considered to be a significant mechanism for downgradient perchlorate transport.

Transport of perchlorate through a deep groundwater flow system which discharges near TT-MW2-19S/D is generally consistent with the overall pattern of vertical hydraulic gradients at the Site, which are generally downward over most of the Site itself, including the primary perchlorate source areas, and generally upward south of the property boundary, including at TT-MW2-19S/D. However, perchlorate is not present at detectable concentrations in TT-MW2-19D, which is screened at greater depth than TT-MW2-19S. In addition, in deep onsite wells perchlorate is either non-detectable or has a pattern of declining concentrations suggesting that perchlorate will stabilize at extremely low or non-detectable levels. Furthermore, no deep, highly-conductive water-bearing zones have been observed in deep wells installed onsite, and Site-wide slug test data (Tetra Tech, in preparation) show a marked decline in aquifer hydraulic conductivity with depth, supporting the hypothesis that the primary pathway for migration is through the shallower units. All of these observations suggest that perchlorate migration through a deep flow pathway is unlikely.

Coarse-grained gravelly alluvial sediments are present above the water table at the SBA and to the south of the SBA. These materials are not saturated under current conditions, but are located near the present-day water table (Figure 3-4). It is possible that during sustained periods of above average precipitation, groundwater levels could rise to the point where the more conductive alluvium becomes saturated, allowing perchlorate-impacted groundwater to migrate downgradient at higher velocity. Under this scenario, the SBA functions somewhat like a valve, allowing flow through a preferred pathway (the temporarily saturated alluvium) when groundwater levels are higher than currently observed, and which constrains flow to the deeper, poorly-conductive weathered bedrock materials when groundwater levels are similar to or lower than currently observed. Significant downgradient transport of perchlorate would thus occur in pulses related to long-term rainfall cycles. This scenario can readily account for the apparently discontinuous, stranded nature of the groundwater plume near TT-MW2-19S, and is the preferred conceptual model for transport of perchlorate near and to the south of the property boundary.

4.2 Groundwater Underflow at the Site Boundary

Underflow in the shallow aquifer at the southern boundary of the Site under current conditions can be estimated from Darcy's Law using following equation:

$$Q = -K\ i\ A \text{ (equation 4-1)}$$

where Q is the flow across the entire cross section of the aquifer, i is the groundwater gradient, and A is the cross-sectional area of the aquifer. Noting that transmissivity T = Kb, where b is the aquifer thickness, this expression may be rewritten as

$$Q = -T\ i\ w \text{ (equation 4-2)}$$

where w is the width of the aquifer.

For the purpose of estimating the groundwater flux, a best estimate transmissivity value of 2 ft^2/day was assumed. This value is consistent with the transmissivity values obtained from the specific capacity test conducted during development of TT-EW2-1 (2.4 ft^2/day), the drawdown-distance analysis (1.67 to 1.91 ft^2/day), and the geometric mean of the transient pumping test analyses (2.05 ft^2/day). However, transmissivity values as high as 10.6 ft^2/day were obtained from the transient pumping test analyses for TT-MW2-8, which may reflect the presence of a higher transmissivity zone near this well. The value of 10 ft^2/day was therefore assumed as an upper bound on the average aquifer transmissivity. The groundwater gradient is assumed to be 0.03 (the average gradient for the Site), the shallow water-bearing zone is assumed to have a constant thickness of 20 feet, and the width of the shallow aquifer is assumed to be 400 feet, the approximate width of Laborde Canyon.

Based on these assumptions, underflow at the Site boundary is estimated to be approximately 0.12 gpm [0.20 acre-feet per year (af/yr)], with a likely upper limit of 0.62 gpm (1.0 af/yr). These estimates do not include underflow in deeper water-bearing zones, such as the deeper zone encountered between 60 and 70 feet bgs in well TT-MW2-7D, and do not account for possible flow through more conductive alluvial materials during periods when water levels are higher.

4.3 Perchlorate Mass Flow at the Site Boundary

The perchlorate mass flow (M) across the southern property boundary can be estimated from the underflow calculated estimate above and the average concentration (C) of perchlorate in the shallow water-bearing zone, using the mass balance equation:

$$M = Q \times C \text{ (equation 4-3)}$$

where M is the mass flow of perchlorate, Q is the underflow estimated in Section 4.2, and C is the average concentration of perchlorate in the shallow aquifer.

In May 2009, perchlorate concentrations in wells near the southern property boundary were approximately 430 µg/L in TT-MW2-7 and 290 µg/L in TT-MW2-8. Both of these wells are screened across the uppermost portion of the shallow water-bearing zone, and, as previously noted, may not be representative of the average perchlorate concentration in the shallow water-bearing zone. Much lower perchlorate concentrations were observed in TT-EW2-1, ranging from 2.6 µg/L prior to the aquifer test to 5.2 µg/L immediately following the aquifer test. Well TT-EW2-1 is screened across the entire shallow aquifer. As previously noted, the differences in perchlorate concentration between wells TT-MW2-7, TT-MW2-8, and TT-EW2-1 may appear to be related to vertical heterogeneity in the distribution of perchlorate within the shallow aquifer.

For the purpose of estimating the offsite mass flow, three values were assumed for the average perchlorate concentration in the shallow aquifer: the concentration detected in TT-EW2-1 after the pumping test (5.2 µg/L), the geometric mean of the perchlorate concentrations in TT-MW2-7, TT-MW2-8, and TT-EW2-1 (88 µg/L), and the maximum concentration detected at the SBA (430 µg/L in TT-MW2-7). The calculations were performed for the full range of underflow estimates (0.12 to 0.62 gpm).

The resulting estimate of the perchlorate mass flow ranges from 0.0028 to 0.014 pounds per year (lbs/yr) for the low concentration estimate of 5.2 µg/L, 0.048 to 0.24 pounds per year lbs/yr for the intermediate concentration estimate of 88 µg/L, and 0.24 to 1.2 lbs/yr for the upper bound concentration estimate of 430 µg/L.

4.4 Evapotranspiration in Riparian Area

The ET evaluation (Section 3.6) suggests that ET in the riparian area south of the Site is roughly half that measured at the UCR CIMIS monitoring station, or approximately 28 in/yr. Assuming that this value is representative of the vegetated portion of the riparian area, the net loss of groundwater from the shallow aquifer due to ET can be estimated from:

$$Q_{ET} = ET \times A \text{ (equation 4-4)}$$

where ET is the ET rate in inches per year, and A is the area of riparian vegetation.

For the purpose of estimation, the entire riparian area immediately south of the Site boundary is assumed to be approximately 1,100 feet long and to have an average width of 15 feet, which corresponds to an area of approximately 0.38 acres. For the purpose of the calculation, between 25% and 50% of the riparian area is assumed to be vegetated. These assumptions yield a range of 0.18 gpm (0.29 af/year) to 0.37 gpm (0.59 af/yr) for discharge of groundwater from the shallow aquifer due to ET. These calculations suggest that a minimum of 30%, and possibly more than 100% of the annual underflow in the shallow aquifer may be removed from the groundwater system by ET.

The ET evaluation suggests that a large fraction of the shallow groundwater flowing across the property boundary may be removed by riparian vegetation within the riparian area. Phytoremediation (uptake and transformation of perchlorate by plants) within the riparian area may represent a significant mechanism for the removal of perchlorate from groundwater in this area.

4.5 Influence of Faulting on Groundwater Flow

The geophysical survey did not find evidence for offset of the contacts between the shallow hydrostratigraphic units (alluvium, deeply-weathered MEF, and relatively unweathered MEF), and the groundwater elevation data does not indicate the presence of a large hydraulic discontinuity across the fault. Faulting does not appear to significantly affect groundwater flow within the area investigated, and does not appear to be acting as either a barrier or a conduit for groundwater flow or plume migration.

Section 5 Conclusions and Recommendations

5.1 Conclusions

The conclusions of this investigation are as follows:

- Perchlorate concentrations in shallow groundwater appear to attenuate to near non-detectable concentrations within several hundred feet of the southern Site boundary. Low perchlorate concentrations detected in TT-MW2-19S, located further to the south, appear to represent a discontinuous, "stranded" segment of the perchlorate plume. The stranded segment is likely related to intermittent flow within more conductive alluvial sediments during periods when groundwater levels are higher than currently observed.

- Average aquifer transmissivity in the SBA is approximately 2 ft^2/day. Transmissivity appears to vary across the aquifer test area, becoming somewhat greater near the axis of Laborde Canyon. Estimated groundwater velocities range from approximately 1.5 to 20 feet per year, indicating that contaminant transport rates at the SBA are very low.

- Estimates of underflow in the shallow aquifer near the property boundary are very low (roughly 0.1 to 0.6 gpm). Perchlorate mass flow estimates in the shallow aquifer are also very low, ranging from 0.0028 to 1.2 lbs/yr. The mass of perchlorate leaving the Site appears to be relatively small under present conditions.

- Estimated ET rates in the riparian area south of the property boundary range from 30% to over 100% of underflow, suggesting that significant amounts of water may be removed from the shallow aquifer by plants. Naturally-occurring phytoremediation may play a major role in the fate of perchlorate in this area. Aquifer conditions also appear to be suitable for natural perchlorate bioreduction, and biodegradation may also be a factor in the fate of perchlorate in groundwater.

- Faulting does not appear to significantly influence groundwater flow in the area investigated.

5.2 Recommendations

Based on the investigation results, the following recommendations are presented:

- The extent of perchlorate in groundwater is adequately defined by the new wells installed as part of this investigation. No additional offsite monitoring wells or soil borings are recommended at this time.

- ET and natural bioreduction of perchlorate may play a significant role in the fate and transport of perchlorate downgradient of the SBA. Continued monitoring of ET trends and natural biodegradation is recommended.

- There does not appear to be a need for an accelerated remedial response to control offsite perchlorate migration at this time. This recommendation is based on the limited extent of the offsite perchlorate plume, the relatively low perchlorate concentrations detected in the offsite area, the low groundwater velocity and perchlorate mass flow at the site boundary, and evidence for naturally-occurring perchlorate phytoremediation and bioreduction in the offsite riparian area. Possible remedial actions in the SBA will be considered further in the Feasibility Study and Remedial Action Plan for the Site.

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