Revised

Potrero Creek Groundwater Pumping Test Report
Lockheed Martin Corporation, Beaumont Site 1
Beaumont, California

Prepared for:

LOCKHEED MARTIN

TETRA TECH

301 E. Vanderbilt Way, Suite 450
San Bernardino, California 92408

TC# 22288-0306 / January 2010

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Energy, Environment, Safety and Health
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LOCKHEED MARTIN

January 25, 2009

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

Subject: Submittal of Revised *Potrero Creek Groundwater Pumping Test Report Lockheed Martin Corporation, Beaumont Site 1 Beaumont, California*

Dear Mr. Zogaib:

Enclosed please find a hard copy of the body of the report, *Potrero Creek Groundwater Pumping Test Report Lockheed Martin Corporation, Beaumont Site 1 Beaumont, California*, revised in accordance with agreed-on responses to DTSC comments. Also enclosed are two copies of the entire report on CD.

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

Sincerely,

Denise Kato

Denise Kato
Remediation Analyst Senior Staff

Enclosures

Copy with Enc:
Gene Matsushita, LMC (one hard copy, text: one electronic copy text & appendices)
John Eisenbeis, CDM (one electronic copy)
Thomas Villeneuve, Tetra Tech. Inc. (hard copy & electronic copy)

Response to Comments Dated October 5, 2009, Potrero Creek Groundwater Pumping Test Report, Lockheed Martin Corporation, Beaumont Site 1, Beaumont, California, dated June 2009.

Comments from Dina Kourda, DTSC (dated August 27, 2009)		
Comment	**Response**	**Proposed Action**
Minor Comment: 1. Section 1.0, Page 1-1: "zzz" at the beginning of the paragraph should be corrected.	Agree – The "zzz" text will be removed.	Delete the text at the beginning of the paragraph, Section 1.0, page 1-1, consisting of "zzz".
Specific Comments: 1. Figure 2-1: Cross-section traces B-B" through I-I" should be illustrated as cross-section traces as identified on Figure 2-2a, Cross-Section Location Map.	Cross-Section A-A' was intended to be the only cross-section in the report. The other cross-sections are much further upgradient of where the pumping test was performed and do not influence the interpretation of the subsurface geology in the area where the pumping test was performed.	Delete the cross-sections and references to them in Figure 2-2a, Cross-Section A-A'.
2. Figure 2-7 and 2-8: The screen on the pumping test well should be illustrated on both figures.	Concur. While the pumping test well is projected into the cross-section, the screened interval of the pumping well can be added as requested. The screened interval will be added to the pumping well in Figures 2-7 and 2-8.	Add the screened interval to the pumping well in Figures 2-7 and 2-8.
3. Section 3.4.2, Page 3-7: During filter pack emplacement, the sand should be surged to avoid bridging before the bentonite seal is set. This section should describe whether or not the filter pack was surged during well installation.	During well installation, the filter pack was surged before the bentonite seal was placed. Text will be added to clarify that the filter pack sand was surged prior to installing the bentonite seal.	A sentence will be added to the text in Section 3.4.2 that specifically states that surging of the filter pack sand was done prior to placing the bentonite seal.

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Potrero Creek Groundwater Pumping Test Report
Lockheed Martin Corporation, Beaumont Site 1
Beaumont, California

January 2010

TC 22288-0306

Prepared for

Lockheed Martin Corporation

Burbank, California

Prepared by

Tetra Tech, Inc

Holly Hanke

Project Geologist

William Muir, PG California 6762

Deputy Project Manager

PROFESSIONAL GEOLOGIST

WM

WILLIAM MUIR

No. 6762

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APPENDICES

1.0 INTRODUCTION

This Potrero Creek Groundwater Pumping Test Report for Beaumont Site 1 (herein referred to as "Potrero Creek") was prepared by Tetra Tech, Inc. (Tetra Tech), on behalf of Lockheed Martin Corporation (LMC). The work was conducted in accordance with the July 2008 Potrero Creek Groundwater Pumping Test Work Plan (Work Plan) (Tetra Tech, 2008a) approved by California Department of Toxic Substances Control (DTSC) in a letter dated 03 September 2008. The Work Plan described the procedures necessary to implement the pumping test. The investigations and testing were designed to characterize hydraulic and chemical conditions of the selected location in support of a site wide numerical groundwater flow model and the potential design of an interim remedial measure (IRM) groundwater extraction and treatment system to intercept impacted groundwater.

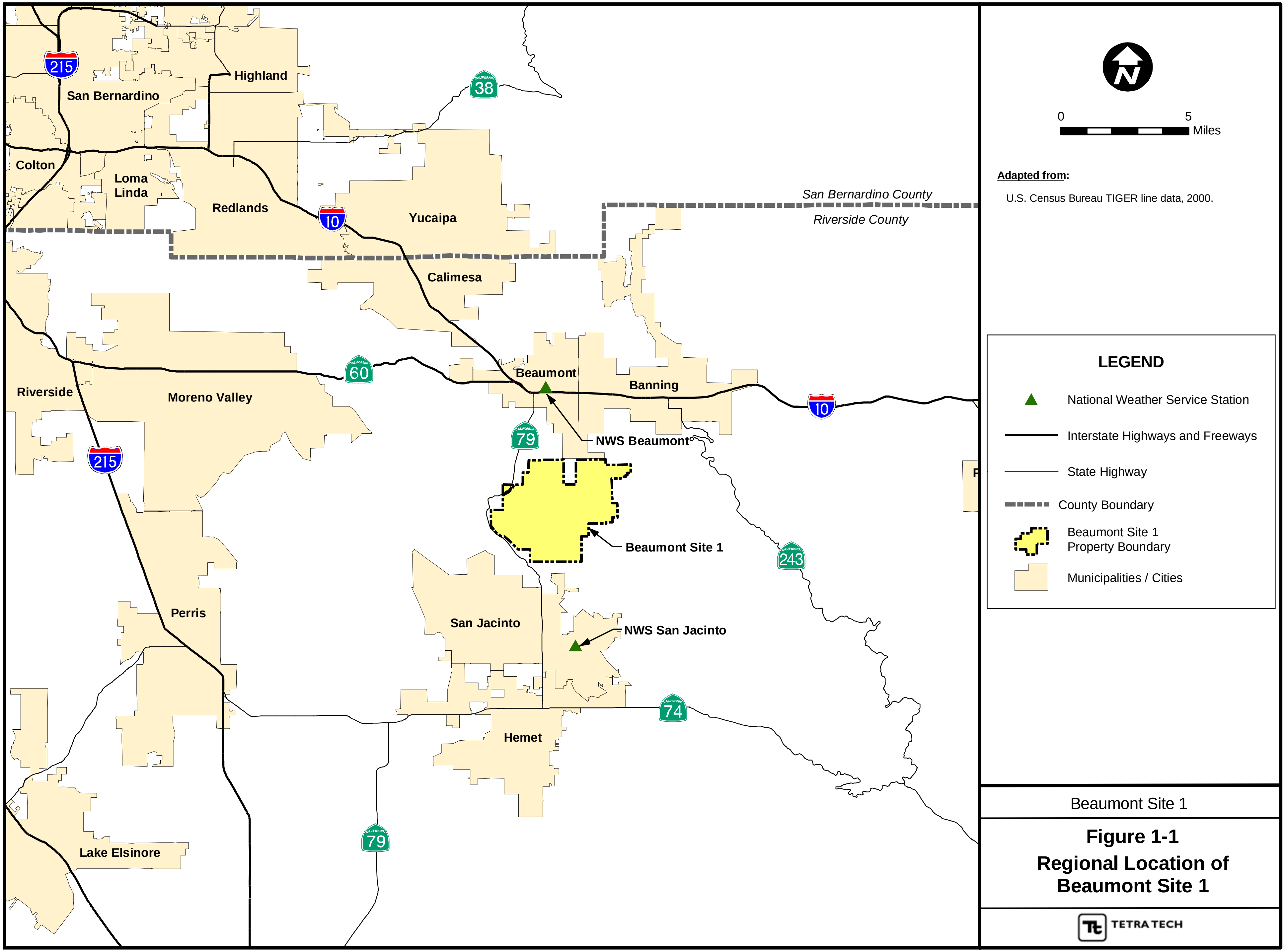
The objectives of this Report are to:

- Provide a description of fieldwork performed;
- Summarize the results of the pumping test;
- Provide an interpretation of the surface and subsurface geology and sampling activities conducted;
- Provide an analysis of the aquifer test data; and
- Evaluate the efficacy of implementing an IRM to intercept and treat groundwater contaminants flowing from known sources area in the Burn Pit (BPA) and Rocket Motor Production Areas (RMPA) into the Potrero Creek area at the location selected for the groundwater pumping test.

1.1 SITE BACKGROUND

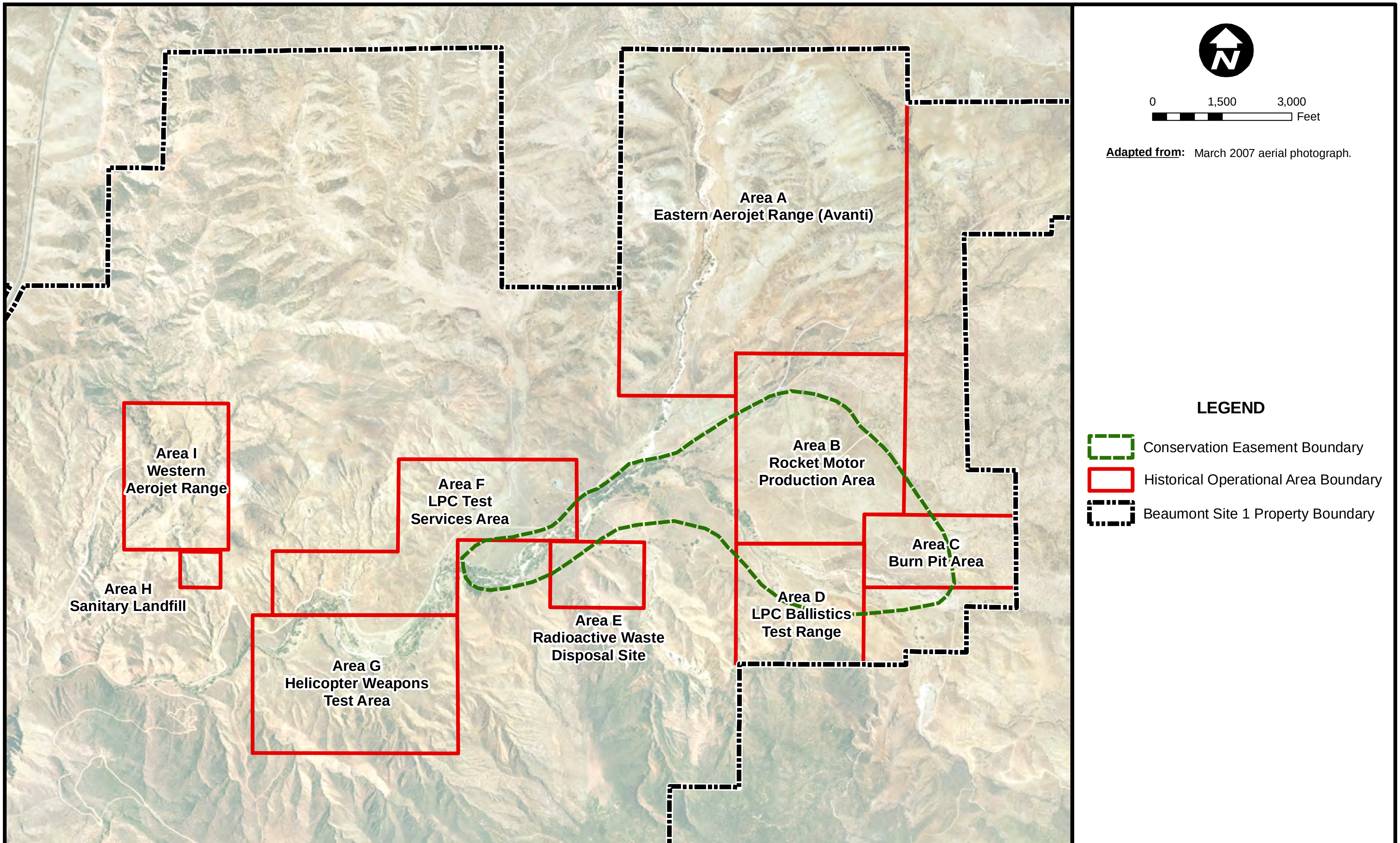
Lockheed Martin Beaumont Site 1 (Site) is a 9,117 acre parcel located south of Beaumont, California (Figure 1-1). The Site was primarily used for ranching prior to 1960. From 1960 to 1974, the Site was used by Lockheed Propulsion Company (LPC) for solid rocket motor and ballistics testing (Tetra Tech, 2003). Activities at the Site also included burning of process chemicals and waste rocket propellants in an area commonly referred to as the BPA. Nine Historical Operational Areas have been identified at the Site. The Historical Operational Areas and the Features are presented in Figure 1-2.

The groundwater beneath the Site is impacted with perchlorate, 1,1-dichloroethene (1,1-DCE), trichloroethene (TCE), and 1,4-dioxane. Recent data has also shown that impacted groundwater discharges to Potrero Creek near MW-15/MW-18. The site features, approximate lateral extent of groundwater impacted by the plume, and selected location for the pumping test are shown on Figure 1-3. In order to mitigate the migration of contaminants from the groundwater plume into Potrero Creek, LMC proposed an Interim Remedial Measure consisting of a groundwater extraction system to cut off the



Beaumont Site 1

Figure 1-1
Regional Location of Beaumont Site 1



Beaumont Site 1

Figure 1-2

Site 1 Historical Operational Areas and Features Map

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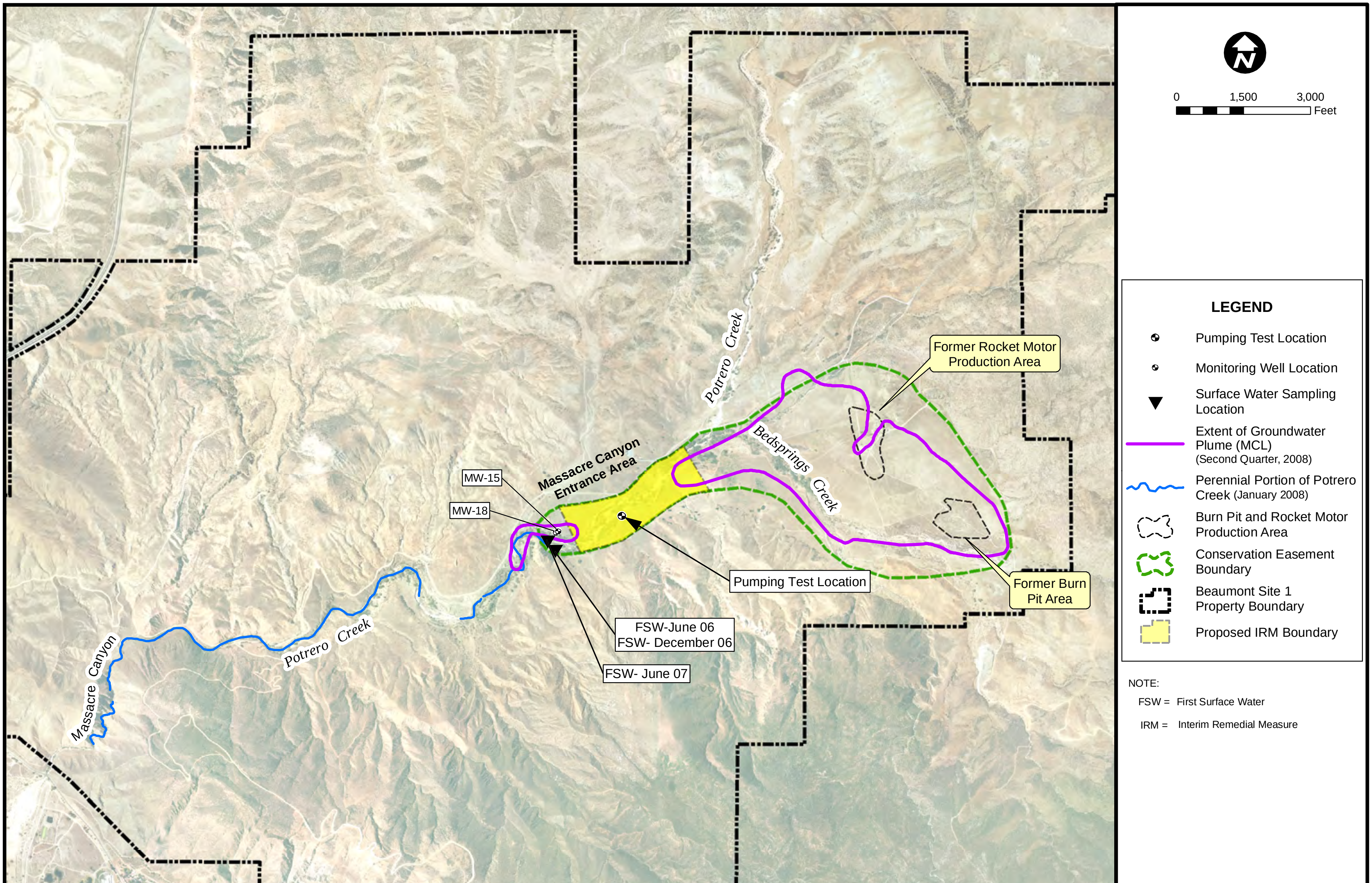
X:\GIS\Lockheed 22288-0306\GW Plume.mxd



Beaumont Site 1

Figure 1-3
IRM and Pumping Test Location

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plume near its leading edge before it discharges to surface water. The extracted groundwater would be treated to remove contaminants, and then discharged directly to the drainage to maintain the riparian areas and summer baseflows in Potrero Creek. The area chosen for the extraction well and piezometers is on the south side of Potrero Creek just northwest of monitoring well MW-14. It is part of what is considered the Massacre Canyon Entrance Area.

2.0 CONCEPTUAL SITE MODEL

The groundwater conceptual site model is given in several earlier site reports (Leighton and Associates, Inc., 1983; Radian, 1992; Earth Tech, 2000; and Tetra Tech, 2008b). This section presents a summary of the key elements of the groundwater conceptual site model relevant to the pumping test field investigations. For more details and supporting information on the groundwater conceptual model, the reader is also referred to the above referenced reports.

As illustrated in Figures 2-1 through 2-4, key elements of the groundwater conceptual site model include the following:

- Groundwater occurs in four primary units: shallow Quaternary alluvium, deep Quaternary alluvium/weathered Mount Eden formation (MEF), more competent MEF, and the granitic basement material. Figures 2-2a and 2-2b illustrate the configuration of the major lithologic units. Groundwater in the alluvium occurs under semi-confined conditions, while groundwater in the competent MEF and granitic basement occurs under confined conditions.
- A thick sequence of saturated recent alluvium occurs in Bedsprings Creek Valley upgradient of the Potrero Fault, with a thinning layer of saturated recent alluvium in the lower reaches of Potrero Creek (below Potrero Fault) that pinches out just west of groundwater monitoring well (well) MW- 67 (Figure 2-5).
- Groundwater flow (Figure 2-4) is generally consistent with the direction of surface water flow and topography, with flow to the northwest at a gradient of 0.002 feet per foot (ft/ft) through the Bedsprings Creek alluvium turning southwest through the canyon at a gradient of 0.01 to 0.02 ft/ft. Based on very high gradients, aquifer thinning, and artesian conditions near Potrero Fault, this fault appears to restrict groundwater flow to some degree.
- There are downward vertical gradients and large seasonal water table fluctuations in the alluvium in the southeast portion of the Site where there is recharge, and there are upward vertical gradients and small seasonal water table fluctuations in the alluvium in the northwest and western portions of the Site where there is discharge to the riparian area and to Potrero Creek. A small artesian zone occurs in the area with upward vertical gradients near the confluence of Bedsprings and Potrero Creeks.
- There is limited vertical leakage into the competent MEF, and very limited vertical leakage into the granitic basement, as evidenced by differences in water levels, water chemistry, and historical site operations. In the canyon area, the combined effects of the shallowing MEF and the Potrero Fault appear to be forcing groundwater towards the surface.
- Total recharge to the alluvium (Tetra Tech, 2009) is estimated to be 246 acre-feet per year with 110 acre-feet per year due to diffuse recharge over the valley floor and 136 acre-feet per year due to recharge from Bedsprings Creek (Figure 2-3).
- Total discharge from the alluvium (Tetra Tech, 2009) is estimated to be 218 acre-feet per year with 139 acre-feet per year due to evapotranspiration from the riparian area, 71 acre-feet per year due to discharge to Potrero Creek, and 8 acre-feet per year due to leakage down into the MEF. During the 1992-2008 period, aquifer storage also increased by 28 acre-feet per year.
- As estimated in site pumping and slug tests (Radian, 1992), aquifer hydraulic conductivity values for the alluvium range from 0.24 to 137 feet/day (ft/day) with a geometric mean of 10.7 ft/day for the shallow alluvium and 35.5 ft/day for the deep alluvium. Aquifer transmissivity values are estimated to be up to 2,645 square feet per day (ft^2/day) in the Bedsprings Creek alluvium

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0 500 1,000 Feet

Adapted from: March 2007 aerial photograph.

Published fault locations from Hydrogeologic Investigations for Water Resources Development, Leighton and Associates, 1983.

LEGEND

- Well Location
- Geologic Cross Section Location
- Approximate Location of Buried Fault
- Approximate Location of Hidden Fault
- Bedrock/Alluvium Contact
- Inferred Bedrock/Alluvium Contact
- Burn Pit and Rocket Motor Production Area
- Historical Operational Unit Boundary

Beaumont Site 1

Figure 2-1
Cross Section Location Map

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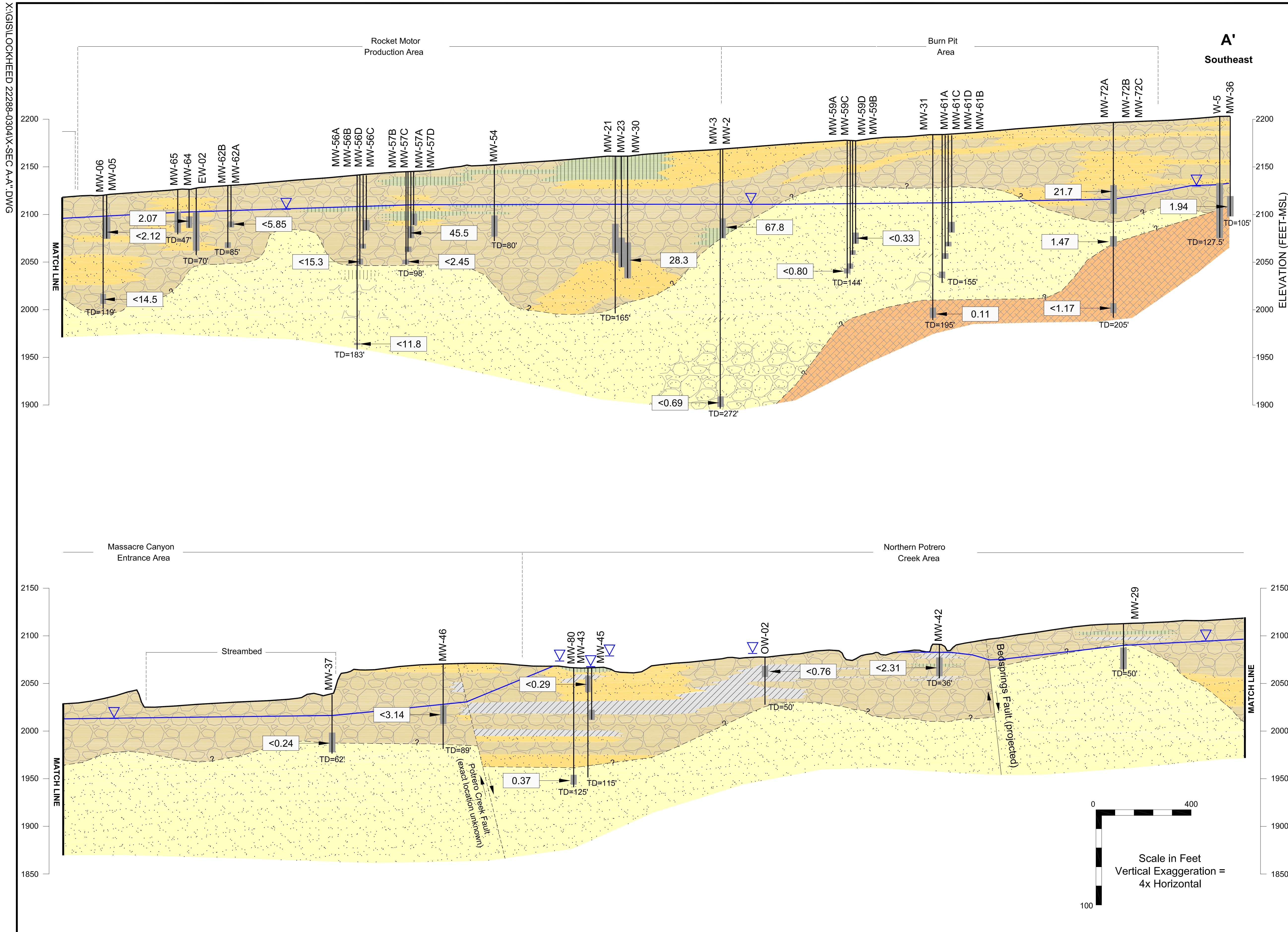

Adapted from:
Faults from Hydrogeologic Investigations for Water Resources Development, Leighton and Associates, 1983.

LEGEND

Groundwater Level

0.33 Hydraulic Conductivity (K) Value in Feet per Day

Quaternary Alluvium

- Clay
- Silt
- Predominantly fine to medium sand with clay and/or silt
- Predominantly coarse sand and/or gravel

Mount Eden Sandstone

- Sandstone with some gravelly and/or clayey layers

Weathered Granite/Metasedimentary Rocks, Undifferentiated

- Mix of granite to quartz diorite and metasedimentary rock including gneiss and schist. In borehole logs, basement material is generally called out as granite.

--?-- Inferred Contact

Well

Screened Interval

TD=60' Total Boring Depth (feet)

Note: < = Less than.
May 2008 groundwater level.

Beaumont Site 1

Figure 2-2a

Geologic Cross Section

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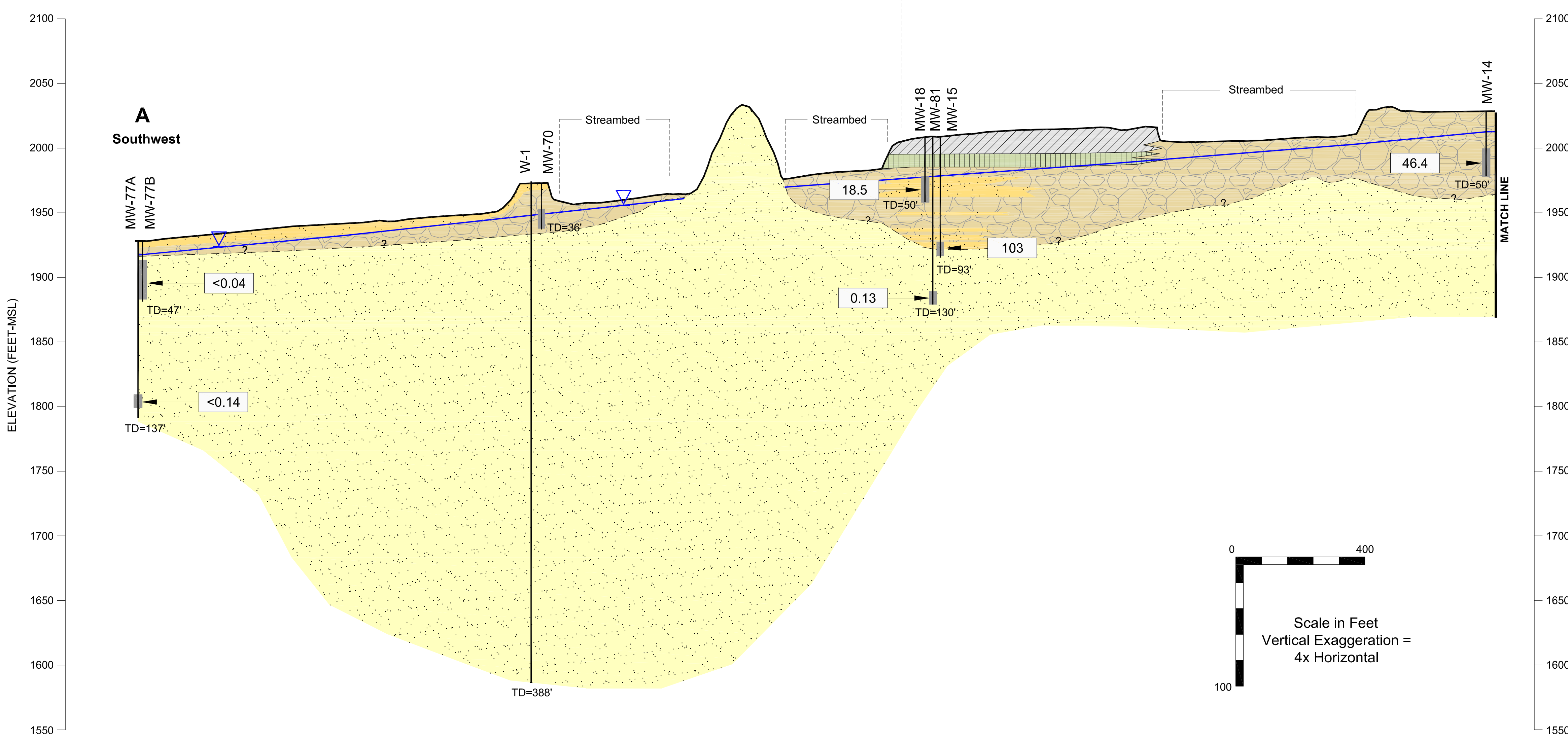
X:\GIS\LOCKHEED 22288-0304\X-SEC A-A''.DWG



Adapted from:
Faults from Hydrogeologic Investigations for Water Resources Development, Leighton and Associates, 1983.

LEGEND

Groundwater Level

0.33 Hydraulic Conductivity (K) Value in Feet per Day

Quaternary Alluvium

Clay

Silt

Predominantly fine to medium sand with clay and/or silt

Predominantly coarse sand and/or gravel

Mount Eden Sandstone

Sandstone with some gravelly and/or clayey layers

Weathered Granite/Metasedimentary Rocks, Undifferentiated

Mix of granite to quartz diorite and metasedimentary rock including gneiss and schist. In borehole logs, basement material is generally called out as granite.

– –?– – Inferred Contact

Well

Screened Interval

TD=60' Total Boring Depth (feet)

Note: < = Less than.
May 2008 groundwater level.

Beaumont Site 1

Figure 2-2b
Geologic Cross Section

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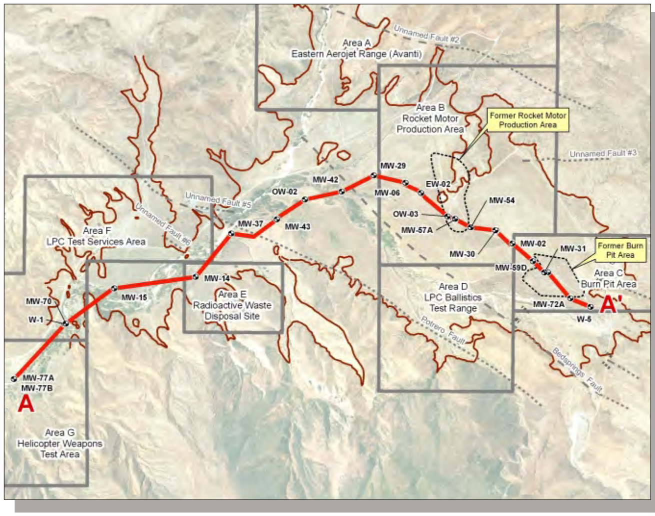
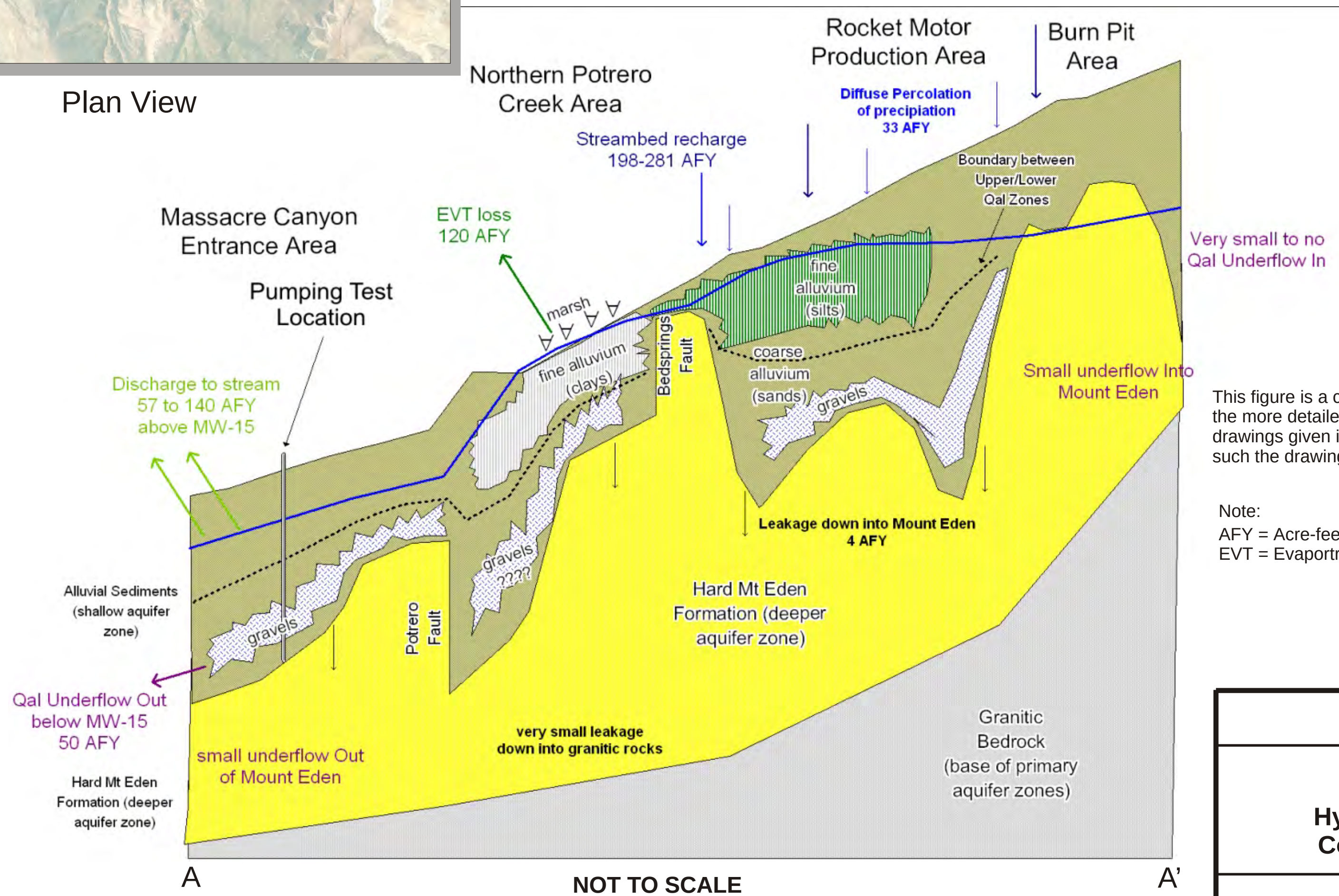


Plan View



This figure is a conceptual schematic based upon the more detailed cross-section and plan view drawings given in Figure 2-1 through 2-2b, and as such the drawing is not to scale.

Note:
AFY = Acre-feet per year.
EVT = Evaportranspiration

Beaumont Site 1

Figure 2-3

Hydrostratigraphic Conceptual Model

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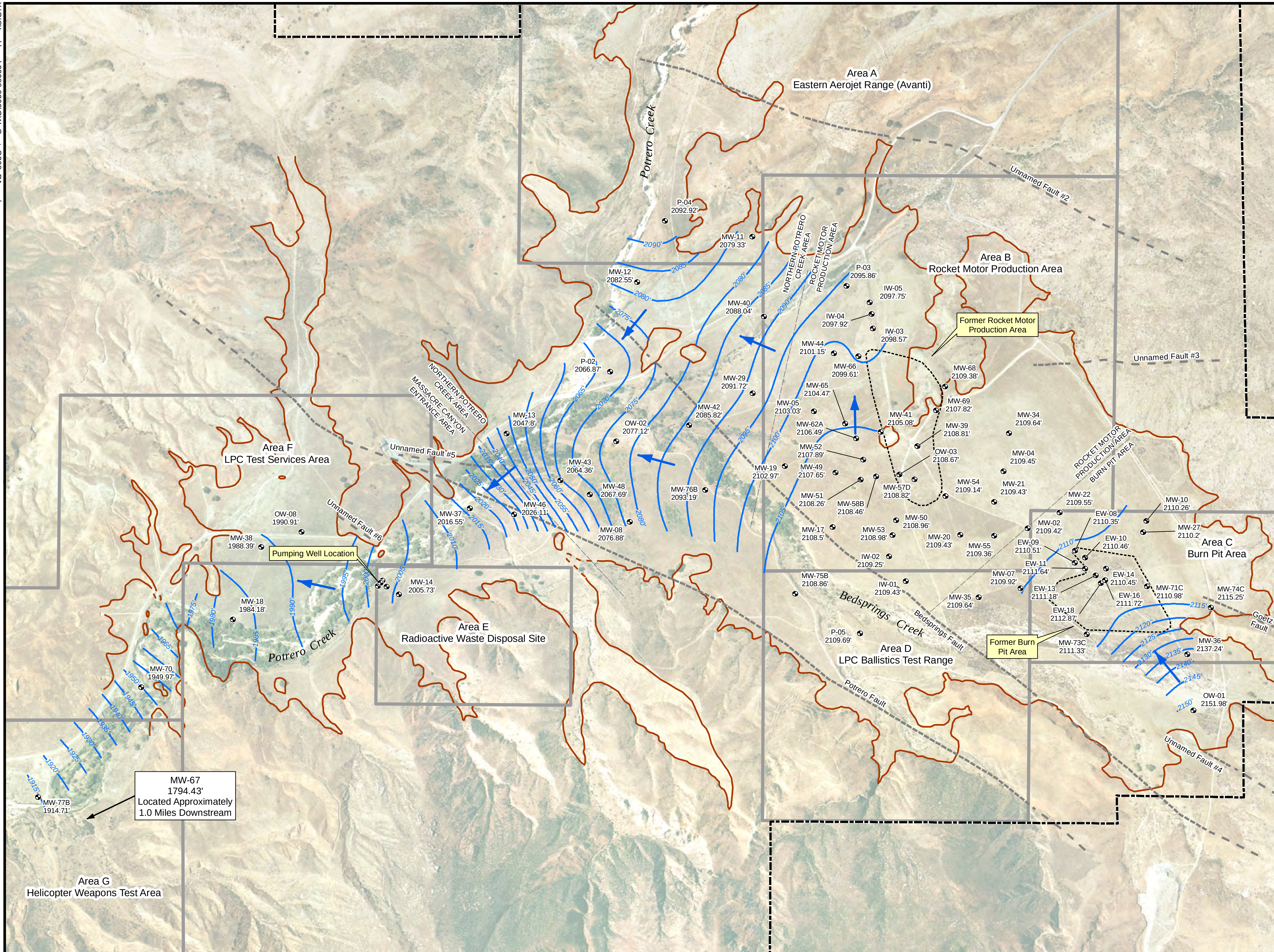

0 500 1,000 Feet

Adapted from: March 2007 aerial photograph.

Published fault locations from Hydrogeologic Investigation for Water Resources Development, Leighton and Associates, 1983.

LEGEND

- Well Location
- Groundwater Flow Direction
- Groundwater Elevation Contour (mean sea lavel, dashed where inferred)
- Approximate Location of Inferred Fault
- Approximate Location of Buried Fault
- Bedrock/Alluvium Contact
- Inferred Bedrock/Alluvium Contact
- Burn Pit and Rocket Motor Production Area
- Historical Operational Area Boundary
- Beaumont Site 1 Property Boundary

Notes: Beaumont Site 1 property boundary is approximate.
5-foot contour interval.

Beaumont Site 1

Figure 2-4
Second Quarter (June) 2008 Groundwater Contours for Alluvium and Shallow Mount Eden Formation

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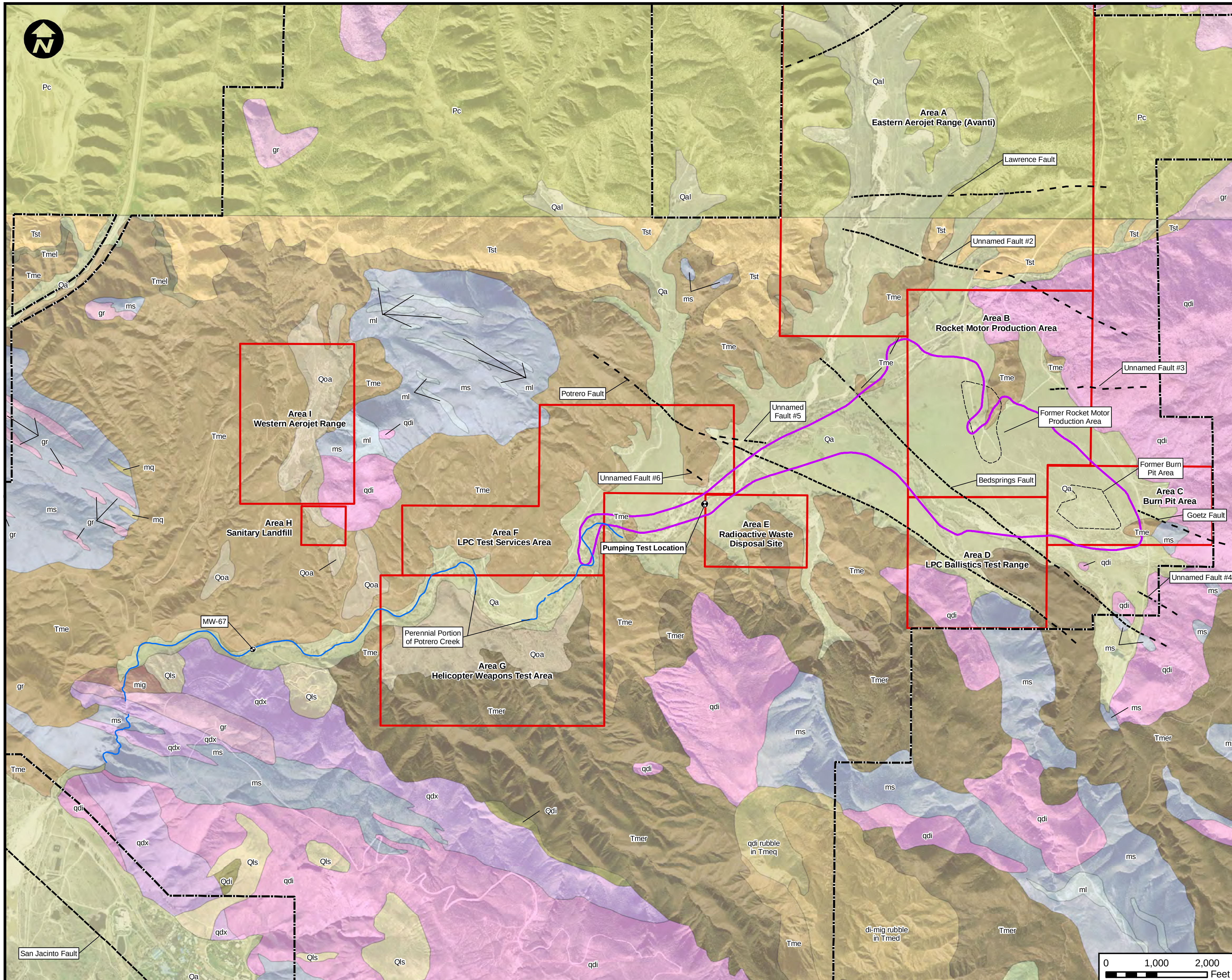

LEGEND

- Pumping Test Location
- Monitoring Well Location
- Perennial Portion of Potrero Creek (January 2008)
- Approximate Location of Buried Fault
- Approximate Location of Inferred Fault
- Extent of Groundwater Plume (MCL) (Second Quarter, 2008)
- Burn Pit and Rocket Motor Production Area
- Beaumont Site 1 Property Boundary
- Historical Operational Unit Boundary

Geology from Dibblee, 2003

SURFICIAL SEDIMENTS

Alluvial sediments, unconsolidated, undissected

Qa — Alluvial sand and clay of valley areas, covered by gray soil, includes stream channel gravel and sand in mountain area

LANDSLIDE DEBRIS

Qls — Landslide of rock rubble

OLDER SURFICIAL SEDIMENTS

Dissected older alluvial deposits, slightly indurated, undeformed, late Pleistocene age

Qoa — Alluvial gravel and sand of low terrace remnants Qog Alluvial gravel and sand of high terrace remnants

SAN TIMOTEO FORMATION

(of Frick, 1921), only lowest part exposed at north border in this quadrangle, weakly lithified; age, Pliocene

Tst — Sandstone, light gray to tan, arkosic, includes thin layers and interbeds of gray cobble - pebbled conglomerate of mostly granitic detritus

MOUNT EDEN FORMATION

(of Fraser, 1931), moderately lithified, derived from basement rocks of San Jacinto Mountains; age upper Miocene

Tme — Sandstone, light orange - red, bedded, arkosic, includes thin layers of reddish claystone and lenses of pebble - cobble conglomerate, gray, of unsorted boulders and cobbles of granitic rocks (qdi), lower part west of Massacre Canyon includes much pebble-cobble conglomerate

Tmer — Conglomerate - fanglomerate, reddish gray-brown of poorly to unsorted sub-granitic (qdi and qdx) detritus in sandy matrix, vaguely bedded

PLUTONIC ROCKS

Medium grained holocrystalline granitic rocks of San Jacinto Mountains, part of Peninsular Range batholith, of Cretaceous age

gr — Granite of Mount Eden (of Morton and Matti, 2001, granite to quartz monzonite, eucocratic, graywhite, hard, massive, of quartz, potassic feldspar and sadie plagioclase feldspar in nearly equal amounts, and less than 5% mica, mostly muscovite; intrusive as large pod into unit xqd at Massacre Canyon and as small pods in ms to northwest

qdi — Quartz diorite, ranges to granodiorite, leucocratic light gray, composed of about 1/3 quartz, 1/2 sadie plagioclase feldspar, less than 1/4 potassic feldspar, and 5-10% biotite, minor hornblende, massive to faintly gneissoid, contains few small dark gray discoid inclusions (xenoliths); most widespread rock of San Jacinto Mountains

qdx — Quartz diorite, gray, massive to gneissoid, composed of about 1/4 quartz, 1/2 sadie plagioclase feldspar, less than 1/4 potassic feldspar, 5-15% biotite and hornblende; contains few to abundant dark gray discoid inclusions (xenoliths) oriented parallel to gneissoid structure of rock; includes migmatized remnants of schist-gneiss (ms) in many places

METASEDIMENTARY ROCKS

Rocks crystallized at depth from deformed sedimentary rocks, mostly argillaceous, of Paleozoic? of Mesozoic? age

ml — Marble, white to light gray, fine-grained crystallized from limestone or dolomite

ms — Schist, dark gray, fine-grained, foliated, of mica (mostly biotite), feldspar and quartz, in some areas in part crystallized to fine grained gneiss

Geology from California Division of Mines and Geology, 1966

Qal — Alluvium

Pc — Undivided Pliocene nonmarine

gr — Mesozoic granitic rocks

ms — Pre-Cretaceous metasedimentary rocks

Note: Beaumont Site 1 property boundary is approximate.

Adapted from:

Geologic Map of the San Jacinto Quadrangle, Thomas W. Dibblee, Jr. 2003

Geologic Map of California - Santa Ana Sheet, California Division of Mines and Geology, 1966.

Faults from Hydrogeologic Investigations for Water Resources Development, Leighton and Associates, 1983.

Beaumont Site 1

Figure 2-5

Regional Geology

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between the BPA and RMPA. Further down stream where the alluvium is much thinner Potrero Creek becomes very narrow and transmissivity values range between 500 to 1500 ft^2/day. Annual average streamflow is estimated to be 1,230 acre-feet per year for Potrero Creek at Massacre Canyon (Leighton and Associates, Inc., 1983), with a baseflow of roughly 100 acre-feet per year in the dry season due to groundwater discharge.

- Primary contaminants at the Site are perchlorate, 1,1-DCE, TCE, and 1,4-dioxane, with the highest concentrations of contaminants consistently found in shallow screened wells located in the former BPA. Concentrations appear to rapidly decrease outside and downgradient of the former BPA in the direction of the former RMPA (Figure 1-3). Low levels of site contaminants have been periodically detected in groundwater as far downgradient as well MW-18 and in surface water in Potrero Creek. Some of the very low levels of groundwater contaminants found in the most downgradient locations may have migrated in surface water to that location since the groundwater and surface water are so well interconnected in the lower reaches of Potrero Creek.

2.1 RECENT INVESTIGATIONS

Three surveys were conducted to aid in the placement and design of an extraction well and associated piezometers. These wells were drilled and installed so that a long-term aquifer performance test could be conducted and sufficient data could be collected to support evaluations of potential IRMs and for remedial alternatives for the feasibility study. These surveys included a topographic survey of the area, a seismic refraction survey to determine the base of the alluvium and to accurately delineate the historic Potrero Creek channel, and geologic mapping of the bedrock – alluvium contact so that a better understanding of exactly where the alluvium and bedrock interface is located.

A licensed land surveyor conducted a topographic survey of the area proposed for the pumping test location between March and May 2008. A topographic map with 1-foot contour intervals provided accurate horizontal location and elevation information for the area proposed for the IRM aquifer performance tests. The topographic map with 1-foot contours of the aquifer test location is included in Figure 2-6.

The seismic refraction geophysical investigation (Terra Physics, 2008) was completed between April and June 2008 in the Potrero Creek canyon area near the leading edge of the plume with the intent to delineate the subsurface geometry of the saturated alluvium and the topography of the more competent MEF sandstone that may be acting as an aquitard or barrier to vertical groundwater flow and forcing the shallow groundwater to the surface. The seismic refraction lines are noted on Figure 2-6. This seismic investigation confirmed the site conceptual model depicting a buried alluvial channel in the canyon, and more precisely located the boundaries of the buried saturated alluvial channel that was eroded into the more competent MEF. Two of the seismic refraction lines (lines 9 and 10) are provided in Figures 2-7 and 2-8 that are situated near the pumping test location. The results from the six geophysical lines were used

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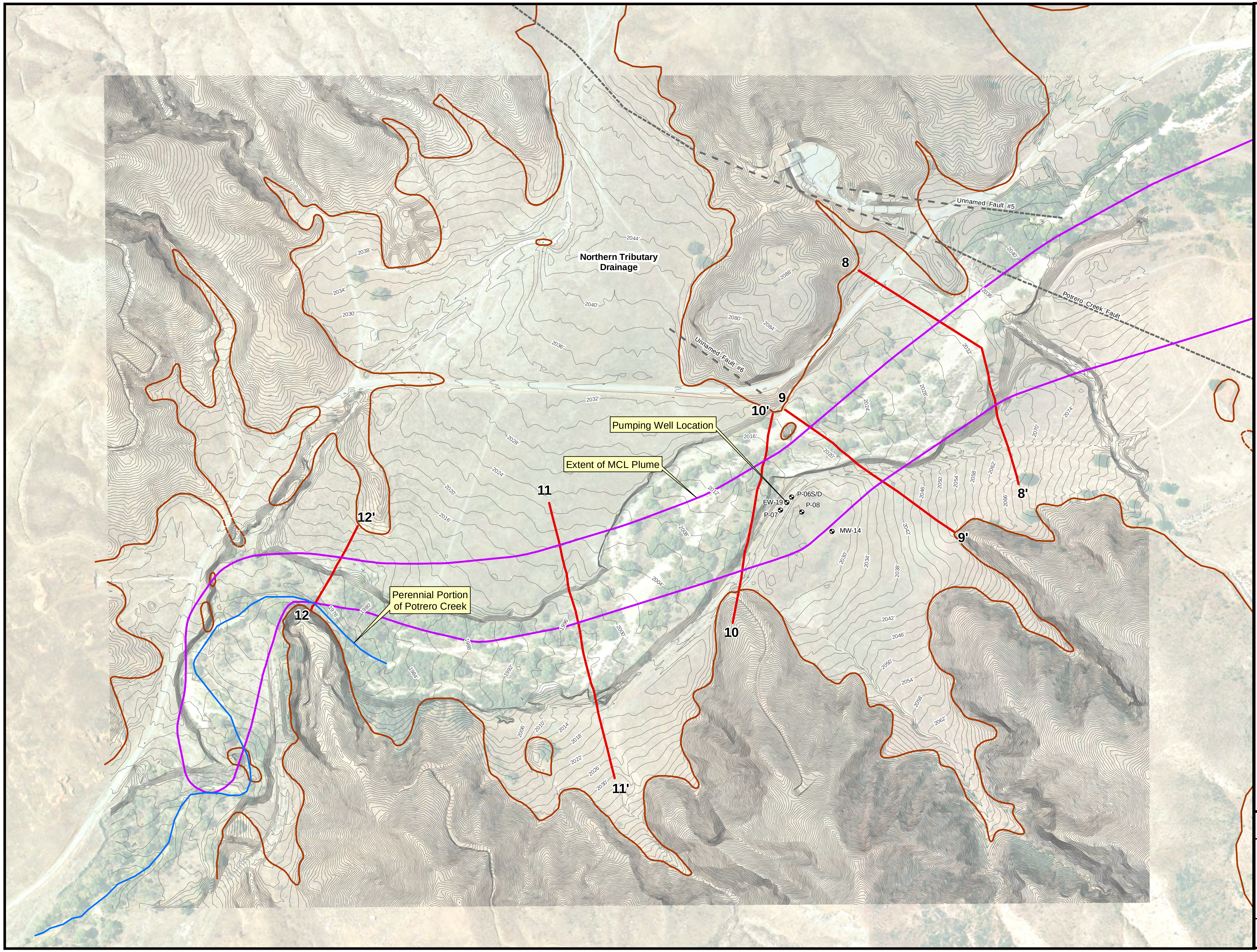

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0 200 400 Feet

Adapted from: March 2007 aerial photograph.

LEGEND

- Well Location
- Geophysical Survey Lines 8, 9, 10, 11 and 12
- Approximate Location of Buried Fault
- Approximate Location of Inferred Fault
- Perennial Portion of Potrero Creek (January 2008)
- Extent of Groundwater Plume (MCL) (Second Quarter, 2008)
- Bedrock/Alluvium Contact
- Inferred Bedrock/Alluvium Contact
- Topographic Contour (2-foot interval)

Note: 2-foot contour interval.

Topographic contours from Hillwig-Goodrow survey May 2008.

Beaumont Site 1

Figure 2-6
Detailed Topographic Map, Bedrock-Alluvium Contact, and Pumping Well Location

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to update the topography of the top of the more competent MEF (Figure 2-9, taken from Radian, 1992). Some major updates to the Radian contour map of the top of the MEF includes a new tributary alluvial channel coming in from the north between wells MW-14 and MW-15 and a shallower bedrock channel between wells MW-46 and MW-19. This updated interpretation of the bedrock elevation was used as part of the basis for picking the proposed pumping test location, including the locations of the pumping and monitoring wells as given in Figure 2-6. A detailed summary of the rationale for selecting the pumping test site is given in Section 3.1.

The area surrounding the location proposed for the extraction well was also field mapped. Field mapping was conducted to accurately locate the contact between the Quaternary alluvium and the MEF so that the relationship between bedrock exposures and what was observed in the seismic reflection data could be made. Geologists walked the area and identified the contact and then located it spatially with a hand held global positioning system (GPS). The location of the contact is presented in Figure 2-6.

In summary, the conceptual site model for groundwater conditions in the area of Middle Potrero Creek consists of a high permeability water table alluvial aquifer underlain by shallow bedrock. The depth to water is generally shallow, and just downgradient of the proposed pumping test site groundwater becomes very shallow and starts discharging to Potrero Creek. The leading edge of the plume is located in Middle Potrero Creek, with contamination found further down canyon in surface water due to discharge from groundwater into the creek and subsequent migration in groundwater and surface waters along Potrero Creek.

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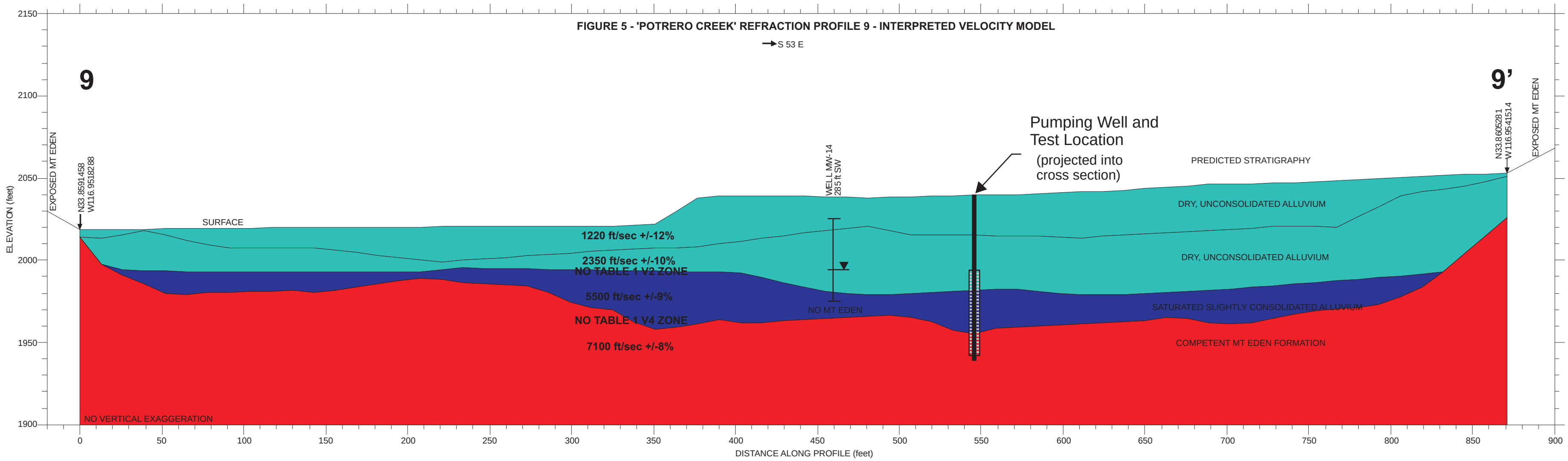

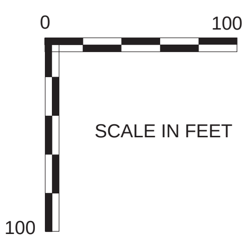

LEGEND

Pumping Test Location

Screen Interval

Dry, unconsolidated alluvium; seismic velocity ~ 1,130 ft/sec and 2,100 ft/sec

Saturated alluvium / weathered Mt. Eden; seismic activity 5,000 ft/sec

More competetnt Mt. Eden formation; possible aquitard; seismic velocity 6,600 ft/sec

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Figure 2-7

Potrero Creek Refraction Survey Profile 9 (Terra Physics 2008)

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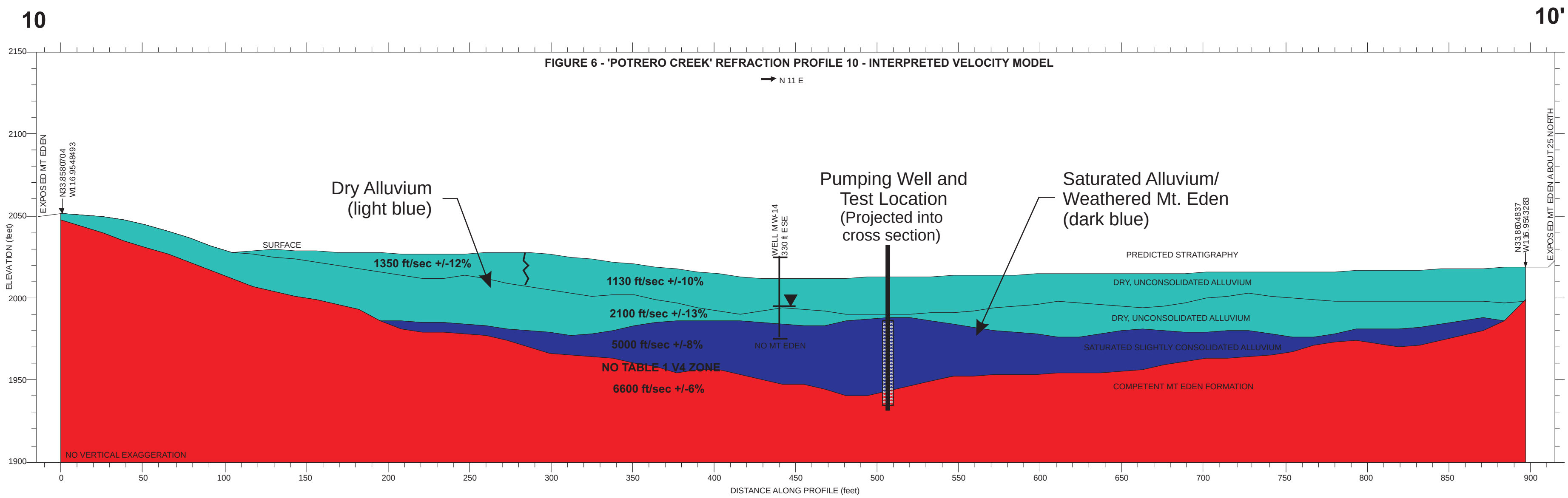

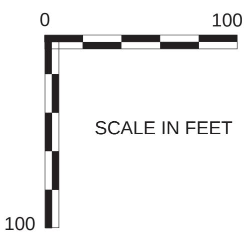

SCALE IN FEET

LEGEND

Pumping Test Location

Screen Interval

Dry, unconsolidated alluvium; seismic velocity ~ 1,130 ft/sec and 2,100 ft/sec

Saturated alluvium / weathered Mt. Eden; seismic activity 5,000 ft/sec

More competetnt Mt. Eden formation; possible aquitard; seismic velocity 6,600 ft/sec

Beaumont Site 1

Figure 2-8

Potrero Creek Refraction Survey Profile 10 (Terra Physics, 2008)

TETRA TECH

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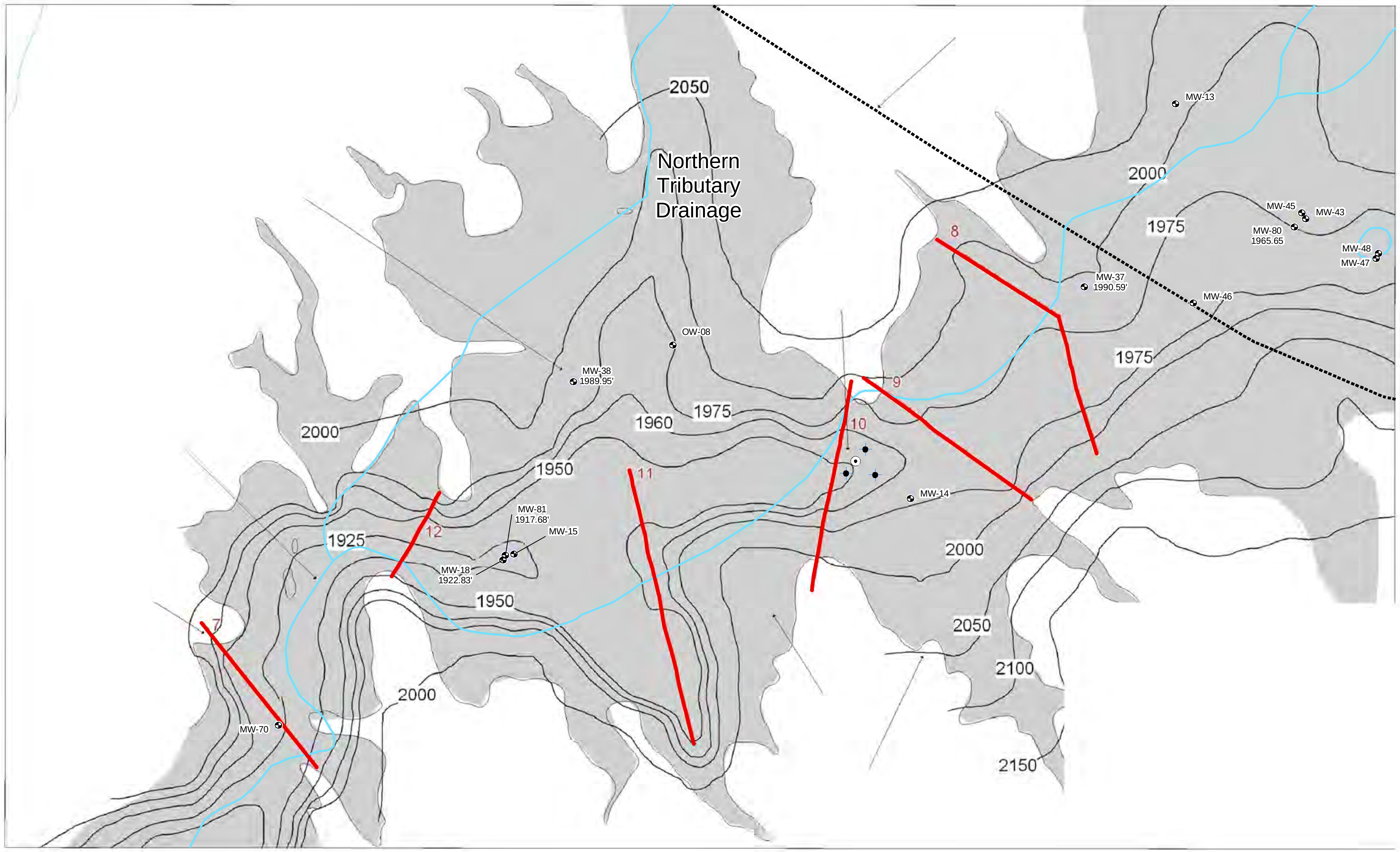

0 250 500 Feet

LEGEND

- Existing Monitoring Well (elevation is the elevation of Mt. Eden contact)
- Extraction Well Location
- Monitoring Well Location
- Seismic Line (refraction line)
- Potrero Creek and Tributaries
- Potrero Fault Location
- Elevation Contour for Top of Mt. Eden Formation
- Alluvial Material
- Bedrock Material (Mt. Eden, granitic, metamorphics, etc. undifferentiated)

Beaumont Site 1

Figure 2-9

Updated Top of Hard Mt. Eden Contour Map in Lower Potrero Creek, Including Locations of Pumping Test Extraction Well and Monitoring Wells

TETRA TECH

3.0 TECHNICAL APPROACH

The field work activities encompassed extraction well and piezometer installation, well development, aquifer testing, and management of extracted groundwater and drill cuttings. The objectives of this work were to:

- Determine the lithology, thickness, and characteristics of the aquifer at the proposed extraction location;
- Determine the maximum sustainable extraction rate for a pump and treat well, including the influence of any aquifer constraints that may impact the long term aquifer yield;
- Provide information to support groundwater model development;
- Calculate aquifer properties such as transmissivity, storativity, specific yield, and specific capacity of the new groundwater extraction well;
- Determine the hydraulic capture zone of the test well; and
- Determine contaminant concentrations at the extraction location and observe any fluctuations of contaminant concentrations over time during the aquifer pumping test.

3.1 PUMPING TEST LOCATION

3.1.1 Rationale for Pumping Test Location

The location of the pumping test extraction well and piezometers is illustrated in Figure 3-1. The pumping test location was chosen based on several factors. The chosen location is near the leading edge of impacted groundwater and nearly all contaminants are upgradient from the pumping test site. The groundwater comes to the surface within Potrero Creek about 2,000 feet downgradient of the pumping test location. The recent geophysical data indicates that the pumping test site is located in the deepest part of the buried alluvial channel which maximizes well yield and is the most likely pathway for the migration of contaminants. This location is also outside the likely influence of the Potrero and Bedsprings faults, which appear to be barriers to groundwater flow due to both shallow bedrock and the predominance of shallow fine grained sediments. The location meets all the project objectives without incurring excessive costs, while still avoiding locations that may be more detrimental to the riparian habitat located within close proximity.

3.2 PRE-DRILLING ACTIVITIES

3.2.1 Habitat Conservation

Consistent with the United States Fish and Wildlife Service (USFWS) approved Habitat Conservation Plan (HCP) (Tetra Tech, 2005 and USFWS, 2005) and subsequent clarifications (LMC, 2006a; 2006b) of the HCP describing activities at the Site, a biological survey of the surrounding area of the proposed extraction well and piezometer locations was conducted prior to initiating field activities. Biological surveys were conducted by a Section 10A permitted or sub permitted biologist in order to evaluate the

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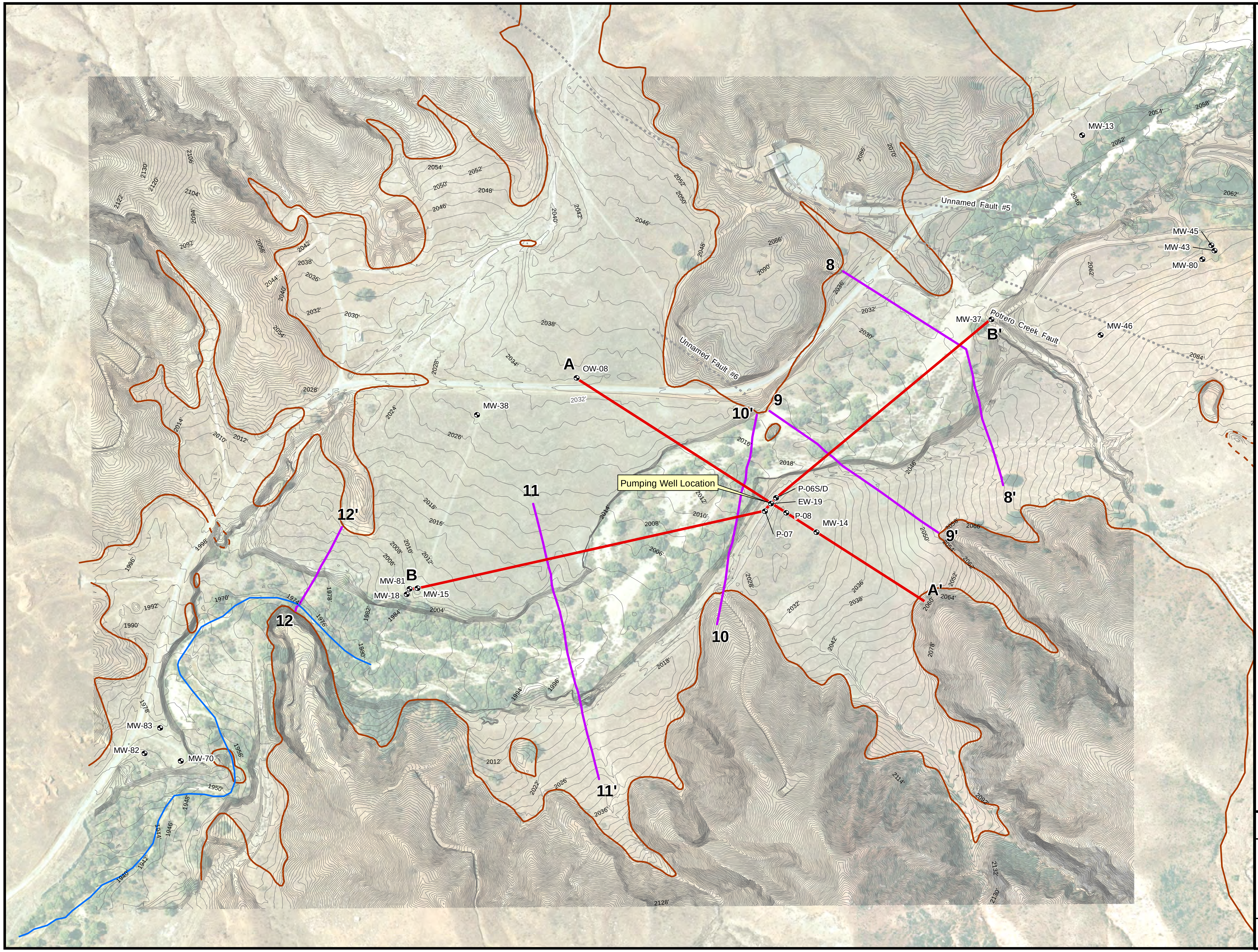


0 200 400
Feet

Adapted from: March 2007 aerial photograph.

LEGEND

- Well Location
- Geologic Cross Section Location
- Geophysical Survey Line
- Perennial Portion of Potrero Creek (January 2008)
- Approximate Location of Buried Fault
- Approximate Location of Inferred Fault
- Bedrock/Alluvium Contact
- Inferred Bedrock/Alluvium Contact
- Topographic Contour (2-foot interval)

Note: Topographic contours from Hillwig-Goodrow survey May 2008.

Beaumont Site 1

Figure 3-1

Detailed Topographic Map, Bedrock-Alluvium Contact, Pumping Test and Cross Section Locations Map

TETRA TECH

potential for impacts during field activities to sensitive species/habitats (i.e., Stephens' Kangaroo rat [SKR]). As part of the biological survey, the biologist identified and marked SKR burrows or suspected SKR burrows that were located within the vicinity of each proposed well location to avoid potential SKR "take" (i.e., harm, harassment, and/or death). The proposed drilling locations were in very dry consolidated alluvium and had very few burrows. The biologist also clearly marked the ingress and egress routes to each drilling location in an effort to minimize the overall footprint of field activities and impacts to SKR habitat.

3.2.2 Permitting

Prior to commencement of fieldwork, well permits were obtained from the Riverside County Department of Environmental Health. Copies of the well permits can be found in Appendix A. The proposed drilling locations were marked with wooden stakes, and Underground Service Alert was contacted prior to the commencement of field activities to identify potential above ground and underground utility and service lines.

Prior to initiating the pumping test permission was granted by the California Regional Water Quality Control Board to dispose of the extracted groundwater in two surface water ponds. The ponds were constructed between 1960 and 1974 while the facilities were operational. The ponds were located upgradient of the pumping test location.

3.2.3 Road Repairs

Road repairs were needed to ensure that the Investigative Derived Waste (IDW) roll-off bins and pumping test equalization tank used to contain pumping test water could be located reasonably close to drilling and pumping activities. An Ecorp biologist evaluated the area to ensure that no SKR burrows were going to be disturbed during the road repairs.

3.3 DRILLING

3.3.1 Lithological Logging

During drilling activities, borehole cuttings were logged for soil type using the Unified Soil Classification System (USCS) (United States Department of the Interior, United States Bureau of Reclamation, 1990. Information recorded on the boring log includes approximate lithological contacts and depth to water, and physical characteristics including grain size distribution, color, moisture, grading, hardness, density, consistency, angularity, plasticity, organic vapor analyzer (OVA) readings, staining/discoloration, odor, mineralogy, structure, cementation, and reaction to hydrochloric acid. Copies of the boring logs are presented in Appendix B.

3.3.2 Drilling Method

All boreholes (extraction well and piezometers) were drilled using sonic drilling technology. In the sonic method, the borehole is advanced by a high frequency resonant vibratory motion of a core barrel while casing is advanced down the hole. The resulting soil, retained as a continuous core is retrieved from the core barrel. Casing is driven, using the same high frequency resonant vibratory motion behind the advancing core barrel to case the borehole wall, prevent loss of borehole due to cave-in and slough and to seal the borehole wall.

3.3.3 Decontamination

Prior to and between drilling, surging, and developing the different borings, the drilling and development equipment was decontaminated. The outer casing, core barrel, surge block, tremie pipe, pump and all other equipment placed in the borings was rinsed using high pressure steam and Liquinox®. There was an additional step in drilling and development of the extraction well. All equipment used to drill, install and develop the extraction well was rinsed or wiped down with a three percent (3%) hydrogen peroxide solution to disinfect the drilling equipment. This was to avoid the introduction of microorganisms, such as iron bacteria, into the pumping well.

Well installation procedures followed the Groundwater Monitoring Well Installation Work Plan (Tetra Tech, 2007) and the procedures defined in the California Department Water Resources Bulletins 74-81 and 74-90 (the Supplement to Bulletin 74-81), California Well Standards (California Department of Water Resources, 1981 and 1991). A licensed California water well driller was contracted for all well construction activities. Prior to drilling, all boreholes were hand augered to five feet below ground surface (bgs) to ensure that no underground utilities were encountered during drilling. All drilling activities were supervised by a professional geologist, certified by the State of California. All field activities were conducted by a qualified geologist. A detailed log of the drilling activities and materials encountered were maintained by the site geologist or hydrogeologist.

3.3.4 Geology

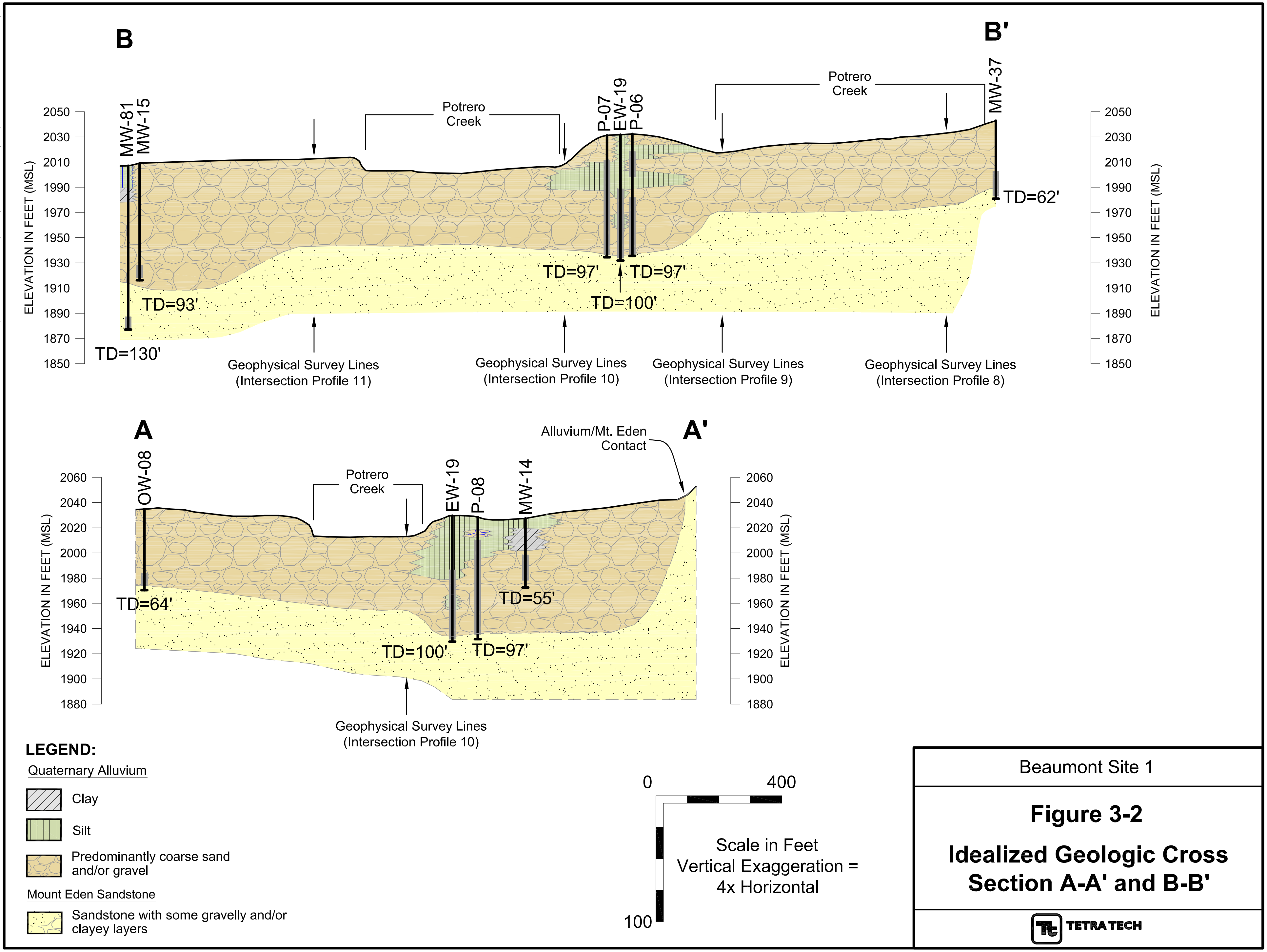
A total of four boreholes were drilled for the pumping test as described in the Work Plan (Tetra Tech, 2008a); this includes one extraction well (EW-19) and three piezometers (P-06, P-07 and P-08). The lithology is consistent with that of a fluvial depositional environment. Based on the borehole log for P-06, silt and silty sand predominate from the surface to about 38 feet bgs. Water level data collected during drilling indicates that first water was encountered at about 38 feet bgs. Water level measurements made following drilling to total depth suggested that static water was about 25 feet bgs, indicating a confining zone is present at the extraction well site. The sediment oscillates between fine to coarse grained sand, silt, and clay with varying percentages of each. A dominant gravel lens about one foot in thickness in each of the borings is present within a few feet of the MEF contact. The MEF was encountered between 93 and 96 feet bgs in all borings. Extraction well EW-19 was drilled to 100 feet bgs and the screened interval was set from 98 to 43 feet bgs. Based on the borehole log, the depth to MEF was between 95 and 97 feet bgs. One of the borings, P-08, is located in a depression approximately 75 feet southeast of the extraction well, EW-19. The ground surface is approximately two to three feet lower in elevation than the extraction well and the other two piezometers. The elevation of the MEF is fairly consistent in all four borings. Borehole logs are presented in Appendix B. Idealized cross sections shown in Figure 3-2 are based on data collected during drilling of the one extraction well and three piezometers, seismic refraction data, and geologic mapping conducted as part of the scope of work. Groundwater is approximately 35 to 38 feet bgs and flows southwest coincident with Potrero Creek (see Figure 2-4).

3.4 WELL INSTALLATION ACTIVITIES

Three piezometers (one dual completed) and one groundwater extraction well were installed from late October through late November 2008. All wells were installed in accordance with the approved Work Plan (Tetra Tech, 2008a).

3.4.1 Extraction Well Design

Between October 28 and November 17, 2008 sonic drilling and well installation activities were conducted. The first location drilled was P-06 located approximately 25 feet northeast of the proposed extraction well location. P-06 is the piezometer located closest to the extraction well and, as specified in the Work Plan (Tetra Tech, 2008a), aquifer material was collected at several intervals down the borehole so that sieve analyses could be conducted on the aquifer materials. To design the extraction well, seven samples were collected from throughout the aquifer during the drilling of piezometer P-06 located approximately 25 feet east of the extraction well location. Samples were collected from depths of 30, 38, 50, 60, 70, 82, and 90 feet bgs. These samples were collected from various zones to adequately represent materials present in the aquifer. A sieve analysis was performed on each depth interval in the field so that data could be obtained rapidly and the well design could be completed without any delay to the drilling operation. Data from the sieve analysis was used to select the filter pack and the gradation of the filter pack was then used to determine the screen slot size based on the method described by Driscoll (Driscoll, 1989). A #8/16 mesh filter pack was determined to be the best commercially available filter pack (see Appendix C). Based on the filter pack, a 0.040-inch slot screen was determined to be the optimum screen slot size for the filter pack and aquifer material encountered. Appendix C contains the sieve analyses results. Included in Appendix C is a graph showing various commercially available filter pack mixes and



Beaumont Site 1

Figure 3-2

Idealized Geologic Cross Section A-A' and B-B'

X:\GIS\LOCKHEED 22288-0306\CAD\X-SECTION A-A'.DWG (04-30-09 5:16:16PM) the associated screen slot sizes. The sieve analyses data were used to determine the size of the filter pack to be used and the extraction well screen slot size that would provide maximum yield from the extraction well while minimizing the amount of silt drawn into the well. Once the sieve analyses were conducted and screen slot size and filter pack combination were determined, the 8-inch diameter stainless-steel well screen was special ordered. The other piezometers were installed while the stainless-steel screen for the extraction well was being made.

3.4.2 Piezometer Well Installation

All piezometer wells were drilled using 8-inch diameter drill casing except P-06 which was dual completed and therefore set in a nine-inch borehole. Each piezometer was constructed vertically with the well casing suspended in place during construction. A tremie pipe was used to install all annular materials below 30 feet bgs. The screen and filter pack design criteria followed industry standard methods, such as those described in Driscoll (1986). The screen slot was 0.020 -inch and the filter pack material in the piezometer wells consists of clean, reagent-free #2/16 sand. It was installed in the annulus between the well screen and the borehole wall. The filter pack sand in all wells was surged prior to placement of the bentonite seal in the following manner. The filter pack was added in 20-foot increments with each segment being surged until there was no more settlement. This process was followed until the entire filter pack was placed approximately two feet above the top of the well screen. Well construction details are provided in the well construction table and in as-built well construction diagrams provided in Appendix D. A one-foot thick layer of clean, reagent-free #0/30 transition sand was placed on top of the filter pack prior to placement of the bentonite seal.

As described in the Work Plan (Tetra Tech, 2008a) P-06 is dual completed with one deep well (P-06D) and one shallow well (P-06S) set in the same nine-inch boring. To maintain a two-inch annulus between the borehole wall and the well casing, these dual completed wells were installed with one and one-half inch diameter polyvinyl chloride (PVC) casing in a nine-inch diameter borehole. The borehole for P-06 was drilled to 97 feet bgs and encountered the competent MEF contact at 96 feet bgs. The boring log is included in Appendix B. All borings are slightly deeper than expected but as stated in the Work Plan (Tetra Tech, 2008a) the bottom of the screens were placed just above the MEF-alluvium contact. The deep well, (P-06D) screen interval is from 50 to 95 feet bgs and is constructed of one and one-half inch schedule 80 PVC with a 0.020 inch slot size.

The nested P-06S/P-06D well was constructed in the same borehole. The interval between P-06S and P-06D has an 11-foot seal, comprised of bentonite chips installed between the top of the filter pack/transition sand in P-06D and the bottom of the filter pack for P-06S. Bentonite chips were placed in the annulus between the PVC well casing and the borehole wall. The seal was allowed to hydrate in place for approximately one hour. The second well, P-06S, was placed in the same borehole with the screened interval from 14 to 34 feet bgs. The same basic procedures, as described above, were followed for the shallow well installation. However the bentonite seal above the transition sand was two feet thick above which a cement-bentonite sanitary seal was placed to approximately two feet bgs. The detailed well construction diagram is presented in Appendix D.

P-07 is located 50 feet southwest of the extraction well and in line with P-06S/D, on the road and paralleling Potrero Creek. P-08 is located approximately 75 feet southeast of the extraction well location roughly in line with the extraction well and monitoring well MW-14 (Figure 3-1). Both P-07 and P-08 were drilled to about 97 feet bgs. MEF was encountered in P-07 at approximately 95 feet bgs, whereas, in P-08 it was encountered at approximately 93 feet bgs.

P-07 and P-08 both have 75 foot screens constructed of two-inch schedule 80 PVC with a 0.020-inch screen slot size. The bottom of the screen for P-07 is set at 95 feet bgs. The bottom of the screen for P-08 is set at 93 feet bgs. A three-foot thick bentonite chip seal was installed on top of the filter pack/transition sand in both wells. The bentonite chips were placed in the annulus between the PVC well casing and the borehole wall. The seal was allowed to hydrate in place for approximately one hour prior to installing the cement-bentonite sanitary seal. The seal consists of a five percent bentonite cement grout which was placed in the borehole through a side discharging tremie pipe. Detailed well construction logs are provided in Appendix D.

3.4.3 Extraction Well Installation

As mentioned in Section 3.3.3, before drilling the extraction well, the core barrel and casing were rinsed with a three percent (3%) hydrogen peroxide solution to disinfect all pieces of drilling equipment that would come in contact with the groundwater. This was to avoid the introduction of microorganisms such as iron bacteria into the pumping well. A standard garden sprayer was used to administer the peroxide to the inside and outside of the casing and core barrel.

The extraction well boring was drilled to a total depth of 100 feet bgs. The MEF contact was somewhere between 95 and 97 feet bgs (see boring log in Appendix B). Several attempts to collect the last nine feet of core from the borehole, were unsuccessful. The core would not stay in the core barrel and there was no recovery from 91 to 100 feet bgs. Based on drilling resistance as noted by the driller and geologist on site during drilling the contact was identified at approximately 96 feet bgs. This is consistent with borehole logs from the two adjacent piezometers, P-06 and P-07.

Initial drilling and coring of the extraction well started with an 8-inch diameter borehole. The 8-inch borehole was advanced to 100 feet bgs. To accommodate the 8-inch diameter extraction well casing, the 8-inch diameter borehole was then overwashed with 12-inch diameter casing to allow for a two-inch annulus between the borehole wall and the extraction well casing. The 12-inch diameter borehole was advanced to 99 feet bgs, where it met refusal. The extraction well design called for 0.040-inch wire wrapped stainless steel screen from 43 feet to 98 feet bgs (55-foot screened interval) and the placement of a two-foot sump at the bottom of the well to allow the collection of sediment during the extraction process. Therefore, the bottom one-foot of the sump was placed in the 8-inch borehole.

The stainless steel wire wrap screen slot size for the extraction well is 0.040 inches. The slot size combined with 8/16 mesh filter pack was selected based on the sieve analysis data collected from borehole P-06 (presented in Appendix C). The blank casing above the stainless steel screen is constructed of 8–inch diameter schedule 80 PVC. The well was constructed vertically with the well string suspended in place during construction. A tremie pipe was used to place the well construction material in the annulus around the well. A rod with an 8-inch rubber disk attached to it was used to surge the well after each 15 to 20 foot segment of filter-pack sand was added. Each section was surged for at least 10 minutes to help seat the sand grains tightly in place and minimize settlement of the filter pack during the pumping test and possible future extraction activities. A total of about seven feet of settlement occurred as a result of surging. It should be noted that between 99 and 79 feet bgs the steel weight on the end of the driller's sounder was lost during well construction and they were unable to retrieve it from the annular space. The piece of steel is now a part of the filter pack. The screen is 55 feet in length and the filter pack was placed three feet above the top of the screen (TOS) at 40 feet bgs. The filter pack is topped with one foot of clean, reagent-free #0/30 transition sand. A three foot bentonite seal, consisting of bentonite chips was installed on top of the filter pack/transition sand and allowed to hydrate for approximately one hour before the cement-bentonite sanitary seal was placed. The sanitary seal consists of a five percent bentonite cement grout mixture which was placed in the borehole through a side discharging tremie pipe from 36 feet to one-foot bgs. A detailed well construction diagram is presented in Appendix D.

All wells were completed with above ground protective steel monuments with locking lids, and set in place with two square-feet by one and one-half feet deep concrete aprons. The locking lids were secured with a standard padlock keyed to the other wells on site.

3.4.4 Well Development

Each newly installed well was developed no sooner than 48 hours following well completion. Well development activities began on 16 November 2008 and were completed on 19 November 2008. Well development field data sheets are included in Appendix E. The wells were developed using a combination of bailing, swabbing, and pumping. The wells were initially bailed until most of the settleable solids had been removed. The well casing bottoms were then probed to confirm the total depth of the well. The wells were swabbed in ten foot sections using a surge block to flush fine grained materials from the surrounding formation and the filter pack. After swabbing the entire screen length in ten foot sections, the fine grained materials that had accumulated inside the well casings were bailed from the wells until most of the settleable solids were removed. The well casing bottoms were then probed a second time. A submersible pump was placed inside the wells and the well was pumped. During pumping, the pump was moved in twenty foot intervals through the entire screen interval. During development the shallow piezometer, P-06S was bailed dry and did not recover (field sheets in Appendix E).

The large diameter extraction well, (EW-19) required a larger pump for development than was used in the piezometers. A steel pipe was used to suspend the pump in the well for development. Before lowering the pump into the well, the pipe and exterior of the pump was wiped down with a clean rag saturated with a three percent (3%) hydrogen peroxide solution. The pipe was disinfected with the hydrogen peroxide solution to avoid the introduction of microorganisms such as iron bacteria into the pumping well.

During pumping and bailing, water level and water quality parameters consisting of pH, temperature, electrical conductivity (EC), dissolved oxygen (DO), and turbidity were recorded on the groundwater monitoring well development field data sheets (included in Appendix E). After turbidity reached approximately 50 nephelometric turbidity units (NTUs) within each 20-foot screen section, development was considered complete and the submersible pump was turned off and removed from the well.

3.4.5 Survey of Newly Installed Well Locations

The well locations were surveyed by a licensed land surveyor for location and elevation following well installation and development. All wells were surveyed to an accuracy of 0.1 feet horizontally and 0.01 feet vertically in accordance with the Groundwater Monitoring Well Installation Work Plan (Tetra Tech, 2007).

3.5 AQUIFER TEST

Based on the objectives defined in Section 1.0 of this report, the pumping test was designed to collect sufficient data to characterize aquifer characteristics in that portion of Potrero Creek near monitoring well MW-14. The one extraction well and three piezometers were placed such that given sufficient extraction rates, water level draw down in the adjacent piezometers would define the radius of influence and maximum sustained pumping rates. The data would be used in conjunction with what is known about basin discharge and recharge to support evaluations of potential IRMs and/or remedial alternatives for the feasibility study.

As part of the pumping test, a four-inch diameter, five-horsepower Goulds Model 75GS, submersible pump was installed in EW-19. The pump was installed in the lower part of the well near the bottom of the screen (BOS) at 90 feet bgs. The pump was connected to the surface with a two-inch diameter steel pipe. Between the pump and the steel drop pipe, a check valve was installed to prevent backflow into the well when the pump was shut off. In addition, a second check valve was installed at the top of the steel drop pipe to ensure no water remaining in the line when the pump was shut off would discharge into the well during the recovery phase of the pumping test.

Extracted water was discharged to a water-tight roll-off bin where the water accumulated (an equalizing tank) prior to being pumped to the discharge point. From the discharge pipe to the roll-off bin, two in-line flow meters were installed, a Great Plains Industries TM series digital flow meter capable of reading instantaneous flow and total flow and a direct read brass totalizing flow meter (Hendry Econo Performance 02).

The roll-off bins were installed with float level switches to automatically turn off and turn-on the 500 gallons per minute (gpm) transfer pump that was used to transfer extracted groundwater from the equalization tank to the discharge point. The discharge point was two man-made ponds (the ponds) constructed several years ago for agricultural purposes. The ponds are located approximately 2,500 feet east of the pumping well in an area adjacent to Potrero Creek. Based on California Regional Water Quality Control Board approval (email dated June 9, 2008; see Work Plan) extracted water was conveyed to the ponds via 8-inch diameter aluminum irrigation pipe. The irrigation pipe was laid on the ground surface from the equalization tank to the ponds. The pipe joints were sealed using victaulic fittings. Based on a detailed topographic survey, the ponds were capable of holding over one million gallons of water.

3.5.1 Step Draw Down Test Field Activities

A step draw down test was performed on November 19, 2008 following development of the extraction well, and piezometers. Prior to this test, the extraction well was allowed to stabilize for about 70-hours. Electronic pressure transducers were initially placed in each well and piezometer to monitor the barometric and diurnal effects on static water levels and to ensure stable conditions prior to the start of the long-term pumping test. The purpose of stepdraw down test was to determine the amount of groundwater drawdown experienced at various pumping rates. This was to determine the optimal pumping rate to be used during the long-term 72-hour pumping test. The step test was conducted on EW-19 by pumping the well at three pumping rates (41, 81, and 99 gpm). Pumping continued at each pumping rate for a minimum of one-hour after water levels stabilized. Measured drawdowns in the extraction well were 2.25, 4.81, and 6.24 feet, respectively (see Table 3-1). Pre- and post- water-level measurements were collected to adequately document local background conditions in the aquifer. All water-level measurements were recorded within 0.01 feet precision. Because water levels dropped rapidly within the first several minutes of pumping, water level measurements were taken manually and electronically using transducers set at 30-second intervals. Additional test data recorded during the step drawdown test include the start and stop time, pumping rate, cumulative flow, and drawdown at each pumping rate, see Appendix E.

By the end of the step test, approximately 18,630 gallons of extracted groundwater were discharged to the ponds. As part of the test maintenance, Tetra Tech staff walked the entire pipeline to confirm that there were no leaks at the joints and at the pressure relief valves. During these inspections the freeboard of the ponds was also monitored. Inspection of the pipeline and the ponds was monitored at a frequency of no less than every two hours.

3.5.2 Long-Term Pumping Test Field Activities

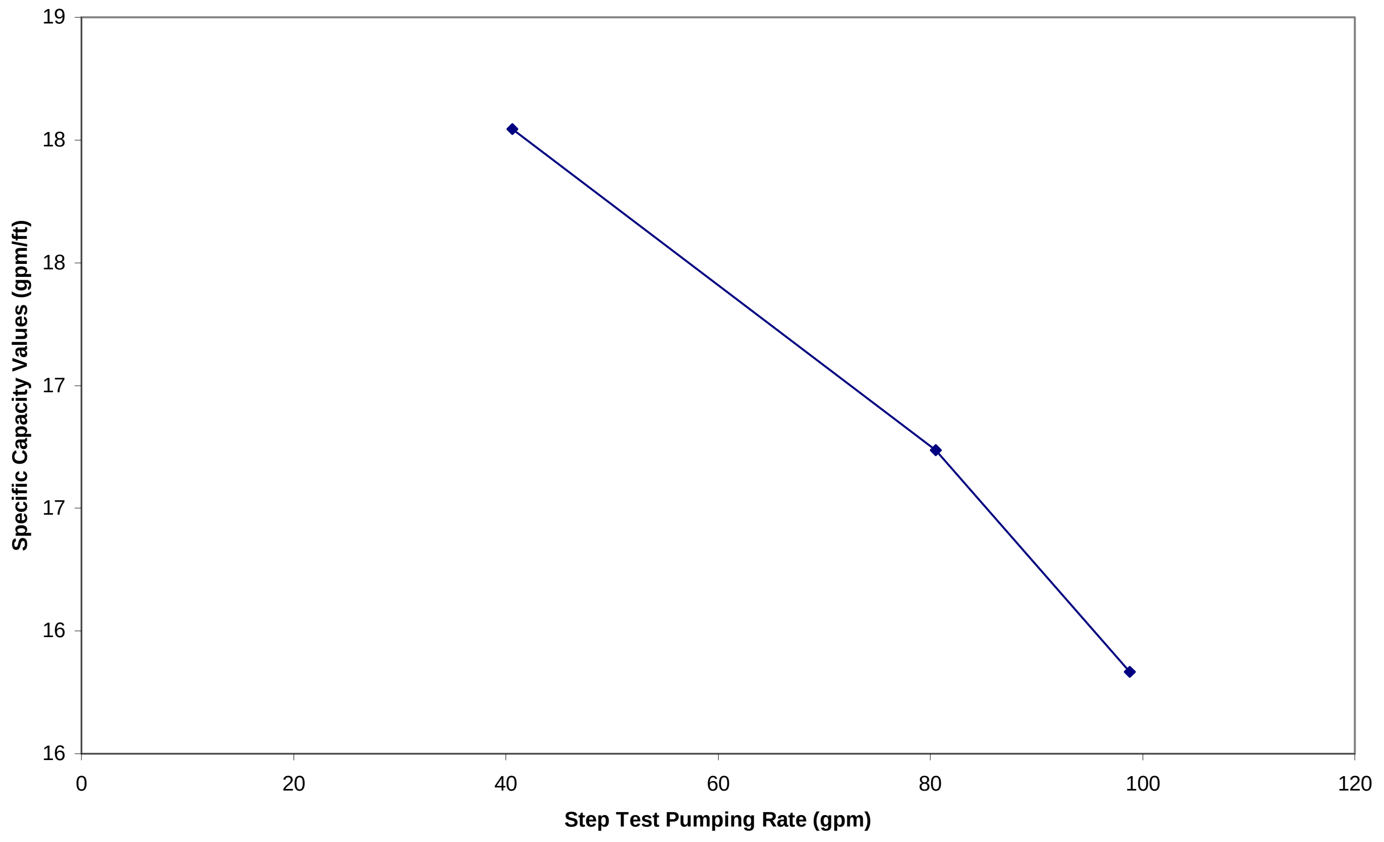
The 72-hour pumping test commenced on November 21, 2008 following 46.5 hours of recovery from the step-drawdown test. The long-term pumping test was conducted at a constant pumping rate of 90 gpm in EW-19. Maximum drawdown reached in EW-19 was approximately 7 feet. Pre- and post-aquifer test water-level measurements were collected to adequately document local background conditions in the aquifer. Water levels were monitored with transducers in well EW-19, piezometers P-06D, P-07, P-08, and monitoring well MW-14 two days prior to the test and during the 72-hour aquifer pumping period. Aquifer recovery was also monitored in pumping well EW-19, piezometers P-06D, P-07, P-08, and monitoring well MW-14 using transducers only for a 7 day period after pumping ceased. Appendix F provides histograms of water levels measured in EW-19, P-06, P-07, P-08, and MW-14 prior to, during, and following the long-term pumping test. Data was not collected in P-06S since the well was dry. The static water levels were also measured and recorded for EW-19, P-06D, P-07, P-08, and MW-14 using a water level meter throughout the pumping test period, see Appendix E.

Water quality parameters were also measured and recorded for EW-19. Frequent inspections of the pipeline and ponds were performed throughout the pumping test. Groundwater samples were collected from EW-19 at the beginning and end of the pumping test. Shortly after the start of the test, groundwater samples were collected from EW-19 for laboratory analysis of volatile organic compounds (VOCs, EPA Method 8260B), perchlorate (EPA Method 314.0) and 1,4-dioxane (EPA Method 3520B), see Section 4.3 for discussion of analytical results. At the end of the pumping test groundwater samples were collected for laboratory analysis of perchlorate, VOCs, 1,4-dioxane, metals (EPA Method 6010B), inorganic ions

Table 3-1
Specific Capacity Step Test Summary

Test Type	Rate (gpm)	Drawdown (feet)	Specific Capacity (gpm/ft)	Transmissivity (ft^2/day)
Step 1	40.6	2.25	18.04	
Step 2	80.5	4.81	16.74	
Step 3	98.8	6.24	15.83	
Pumping	90	6.99	12.88	2,575
				calculated as 200 x Specific Capacity (Dawson and Istok, 1991)

EW-19 Specific Capacity versus Step Test Pumping Rate



(EPA Method 300.0), gross alpha and gross beta (EPA Method 900.0), carbon-14 (14C) (EPA Method EERF C-01 Modified), sulfur-35 (35S) (Method NAS-NS-3054), tritium (3H) (EPA Method 906.0 Modified), and general minerals parameters. The general mineral parameters consist of total dissolved solids (EPA Method160.1), chloride (Cl), nitrate and sulfate (SO_4) (EPA Method 300.0), carbonate and bicarbonate (HCO_3) (EPA Method 310.1), and potassium (K), magnesium (Mg), sodium (Na) and calcium (Ca) (EPA Method 6010B).

A total of approximately 391,635 gallons of groundwater was extracted during the 72-hour long-term pumping test. This equates to an average flow rate of 90 gpm. All groundwater withdrawn from the extraction well was discharged to the ponds. Including the step draw-down test, a total of 410,265 gallons of water was discharged to the ponds over the course of the entire test period. Once the pumping test was complete, water that remained in the piping was removed using a vacuum truck and discharged to the ponds as well. Upon completion of all pumping test activities, the site was cleaned up and restored to as near original conditions as possible.

4.0 ANALYSES OF AQUIFER TEST DATA

This section presents the results of the long-term pumping test.

4.1 STEP DRAW DOWN TEST

The step-drawdown test was performed on November 19, 2008 in extraction well EW-19. Flow rates of 40 gpm, 80 gpm, and 120 gpm were proposed prior to the start of the pumping test. During the actual test, the submersible pump was only able to obtain a maximum flow rate of 99 gpm. Therefore, actual pumping rates during the step tests were 41, 81, and 99 gpm. However, based on the results from the step-drawdown test, sufficient data were collected to continue with the long-term, 72-hour pumping test.

Based on the step-drawdown tests, some general observations about the aquifer can be made. Specific capacity values during the step test (see Table 3-1) decreased with the increase in pumping rate, from a high of 18 gallons per minute per foot (gpm/ft) at 41 gpm to a low of 15.8 gpm/ft at a rate of 99 gpm. These specific capacity values are the highest recorded in any of the LMC Beaumont Site 1 wells tested to date (Radian Corporation, 1992). Drawdowns had reached a relatively stable condition towards the end of each of the three Step Test rate periods. Based on the pumping test results, this is attributed to the well primarily draining water from semi-confined storage during the short step test.

4.2 PUMPING TEST

After completion of the step-drawdown test, the aquifer was allowed to recover for 46.5 hours before the long-term pumping test was initiated. Based on the step-drawdown test, it was concluded that the long-term pumping test would be conducted at 90 gpm. The long-term pumping test began at 1400 hours on Thursday, November 21, 2008 and pumping continued until 1400 hours on November 24, 2008 when the pump was shut off. Water levels continued to be made as part of the recovery phase portion of the long-term pumping test using transducers that were installed in the wells prior to initiating the long-term pumping test. The pump and all transducers were left in the wells until December 1st, 2008 so complete recovery could be captured on the transducers (data logger). Raw data collected from monitoring points is provided in Appendix H. Rainfall occurred during the test, but no background water level fluctuations were noted in response to the rainfall. This is attributed to the rainfall being the first precipitation event of the 2009 water year, where antecedent conditions were likely so dry that streamflow or deep percolation to the aquifer did not occur. Note that no streamflow was observed at the Site during this period.

During the pumping test, the specific capacity began to decline with longer pumping times to a value of 12.9 gpm/ft. This is attributed to the well beginning to feel the effects of drainage from the water table, increasing the drawdown in the well It is expected that the long-term specific capacity will still be quite high for a 60-foot thick zone, perhaps on the order 5 to 10 gpm/ft. Specific capacity values can be used to approximate the transmissivity of the pumping well screened interval using the following empirical correlation: transmissivity in ft^2/day equals 200 times specific capacity in gpm/ft (from Dawson and Istok, 1991). Since transmissivity has been estimated using specific capacity data for all the other wells at the Site, transmissivity is also estimated for EW-19 using specific capacity so this value can be directly compared to the transmissivity values derived in the other wells from specific capacity. Based on the data collected during this long-term pumping test, aquifer transmissivity in the area of EW-19 equates to a value of approximately 2,575 ft^2/day (see Table 3-1), which is the highest transmissivity value at the Site derived using specific capacity data. It should be noted, however, that the pumping test results provide a better estimate of transmissivity than the specific capacity values, since the pumping test analyses do not rely on all of the simplifying assumptions of the specific capacity method. The hydraulic conductivity value for a 60-foot zone would be equated to approximately 43 ft/day.

4.2.1 Drawdown Distance Interpretation

The maximum drawdown recorded in the piezometers during the pumping test (see Table 4-1) were used along with the distance to the observation wells to develop the drawdown-distance plot provided in Figure 4-1. The slope of the semi-log line on the Drawdown-Distance Plot is approximately 3.1 feet per log cycle, which can be used to estimate an aquifer transmissivity value of approximately 2,032 ft^2/day. Note, however, that the vertical movement of water suggested by the pumping test curves may deviate from the horizontal flow assumptions inherent in the distance drawdown analysis, so that this estimate of transmissivity from the distance drawdown analysis is only an approximation.

The extrapolated drawdown at well EW-19 using this plot is between 9 and 10 feet, somewhat more than the 7 feet of drawdown observed during the pumping test. Well efficiency, defined as the ratio of the drawdown estimated at the pumping well using the distance-drawdown plot (9 feet) to the drawdown measured in the pumping well (7 feet), is estimated to be 129 percent. The well efficiency over 100 percent is attributed to enhanced aquifer hydraulic conductivity near the pumping well and good well construction/well development procedures. This may suggest a region of enhanced aquifer transmissivity near the pumping well. A region of enhanced aquifer transmissivity near the pumping well may be attributed to encountering a localized gravel lens in the extraction well. This would also be consistent with the very high specific capacity of the extraction well.

Based on the long-term pumping test, the radius of influence is estimated as 800 feet by extrapolating the semi-log distance-drawdown plot (Dawson and Istok, 1991) for the data measured during the EW-19 test.

4.2.2 Transient Drawdown Interpretation

The drawdown data was interpreted with both type curve and graphical semi-log analysis methods (Dawson and Istok, 1991), using the AQTESOLV program for pumping test interpretation (Duffield and Rumbaugh, 1991).The drawdown and recovery data versus time typically had a distinct shape, with a flattening of the slope of the drawdown and recovery data at intermediate times followed by an increase in the slope of the drawdown and recovery data at later times. These effects are commonly observed in wells that display delayed drainage from the water table as illustrated in Figure 4-2 below (Dawson and Istok, 1991, and Moench et al., 2000), and are consistent with the aquifer site conceptual model.

Based upon the site hydrogeologic conditions and the observed pumping test response, the data was tested against the following common aquifer models:

- The Theis Aquifer Model
- The Hantush Leaky Aquifer Model
- The Hantush Leaky Aquifer Model with Storage
- The Neuman Unconfined Aquifer Model with delayed drainage

Barrier boundary effects were initially considered as one potential cause of the "S" shaped curve. However, barrier boundary effects would cause the late time semilog slopes to be higher than the observed values used for transmissivity estimates, and the rather large distance to the barrier boundary of 400 feet inferred from the site geophysics were not consistent with the observed drawdown when interpreting the data using barrier boundary type curves. Thus, barrier boundary effects were discarded as a explanation for the response observed during the tests, Comparing the model goodness of fit indicated by the residual error, the data from all wells did not match the Theis Model due to the flattening of the intermediate time drawdown curve, and also did not match the Hantush Leaky Aquifer Model due to the rise of the late time drawdown curve. Comparing the model goodness of fit indicated by the residual error, the data from all observation wells matched the Neuman Unconfined Model with delayed drainage, while the extraction well matched the Hantush Leaky Aquifer with Storage Model.

For the Neuman Unconfined Model, the semi-log Cooper Jacob plot for observation wells shows two straight-line regions (Batu, 1998), one at early time where the storage value reflects the confined aquifer storage coefficient, and one at late time where the storage value reflects the aquifer specific yield. This use of the Cooper-Jacob method to interpret the Neuman Unconfined Model is referred to by some authors as the Neuman Semilog Method (Batu, 1998). The early time Cooper-Jacob straightline corresponds to the Neuman Type A Type Curve and the storage coefficient from the early time straightline reflects the aquifer confined storage coefficient, while the late time Cooper-Jacob straightline corresponds to the Neuman Type B Type Curve and the storage coefficient from the late time straightline

Table 4-1 Site 1
EW-19 Transient Pumping Test Interpretation Summary

Well	distance to EX-19 (ft)	maximum drawdown (ft)	Drawdown									K_v/K_h
			Cooper-Jacob Method				Neuman Type Curve Method*					
			Early Time		Late Time							
			Trans. (ft^2/min)	S	Trans. (ft^2/min)	S_y	Trans. (ft^2/min)	S	S_y	β		
P-06D	31	3.95	1.87	1.07E-03	1.72	1.90E-02	1.92	8.72E-04	7.64E-03	4.92E-04		1.84E-03
P-07	42	4.34	1.77	3.11E-04	2.14	1.00E-03	1.92	2.50E-04	2.05E-03	1.58E-04		3.22E-04
P-08	74	3.20	1.99	5.22E-04	2.06	4.68E-03	1.91	4.64E-04	6.59E-03	2.84E-03		1.87E-03
MW-14	225	1.61			1.87	1.82E-02	1.79	1.27E-03	1.96E-02	2.21E-01	Early time SLSL not visible (typical of distant wells using Neuman Method)	1.57E-02
EW-19	NA	6.99	2.61	NA	1.91	NA	1.62	NA	NA	NA	S not valid in pumping well	

Well	distance to EX-19 (ft)	maximum Recovery (ft)	Recovery									K_v/K_h
			Cooper-Jacob Method				Neuman Type Curve Method*				Comment	
			Early Time		Late Time							
			Trans. (ft^2/min)	S	Trans. (ft^2/min)	S	Trans. (ft^2/min)	S	S_y	β		
P-06D	31	3.93	1.92	1.02E-03	2.11	1.29E-02	1.78	1.06E-03	3.00E-02	1.26E-03	Theis Recovery Method: T= 1.73	4.72E-03
P-07	42	4.34	1.77	3.95E-04	2.07	3.30E-03	1.69	3.89E-04	1.09E-02	8.18E-04	Theis Recovery Method: T= 1.99	1.67E-03
P-08	74	3.17	1.96	6.16E-04	1.8	2.17E-02	1.81	5.76E-04	1.98E-02	5.30E-03	Theis Recovery Method: T= 2.38	3.48E-03
MW-14	225	1.41	Early time SLSL not visible (typical of distant wells using Neuman Method)		1.97	4.98E-02	2.01	2.17E-03	5.10E-02	1.22E-01	Theis Recovery Method: T= 2.17	8.66E-03
EW-19	NA	7.00	1.87	NA	2.07	NA	2.06	NA	NA	NA	Theis Recovery Method: T= 2.16	

EW-19 Pumping Rate is 90 gpm for 72 hours

All wells fit Neuman Type Curve except:

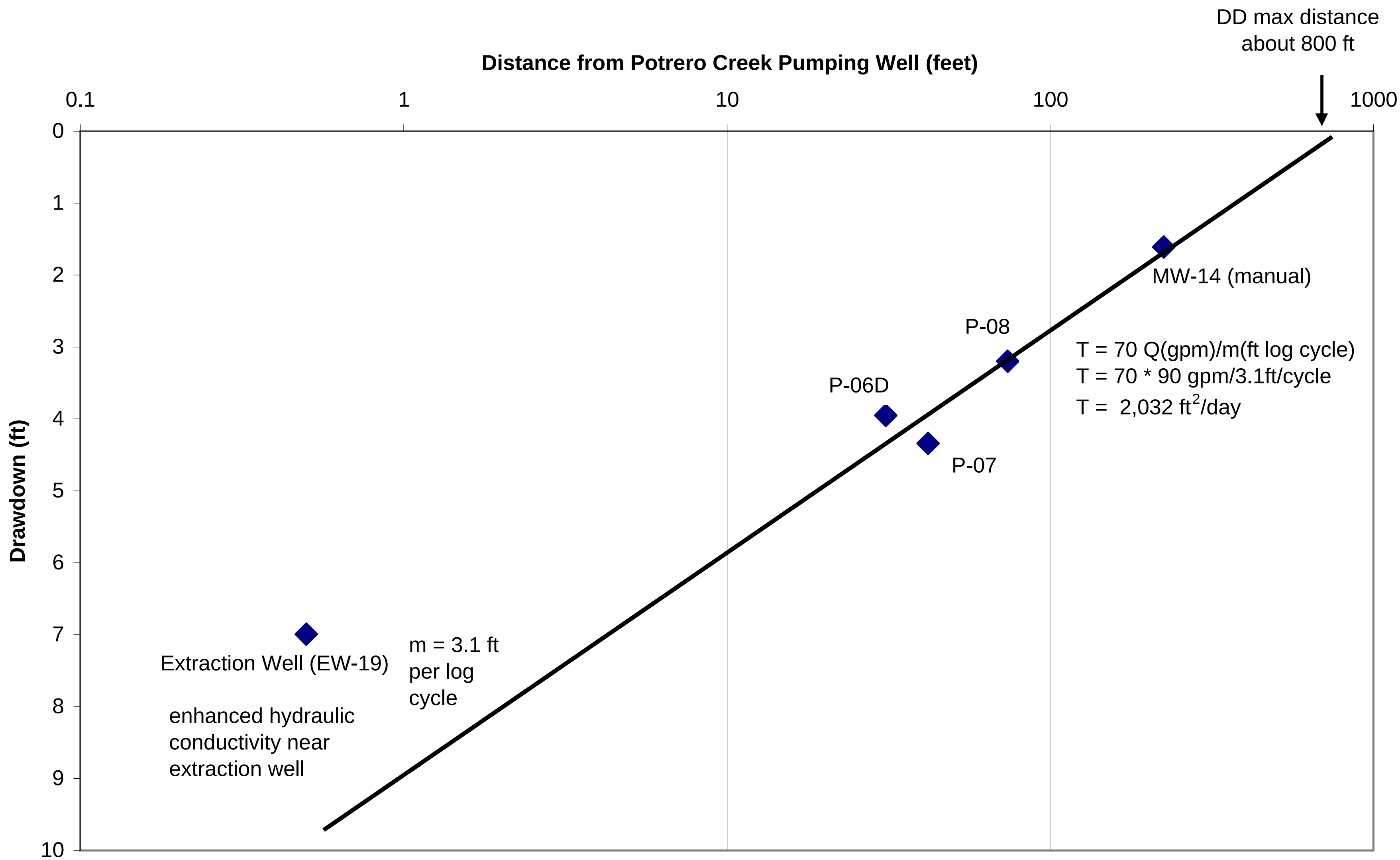
*Hantush (leaky aquifer, storage in aquitards) Type Curve for pumping well

SLSL = Semi-log Straight Line

NA = Storage and β values not valid at pumping well

$K_v/K_h=\beta*(D^2/R^2)$ where R= distance to well and B = aquifer thickness of 60 ft

Figure 4-1 LMC Beaumont Site 1
Drawdown vs Distance from Potrero Creek Pumping Well



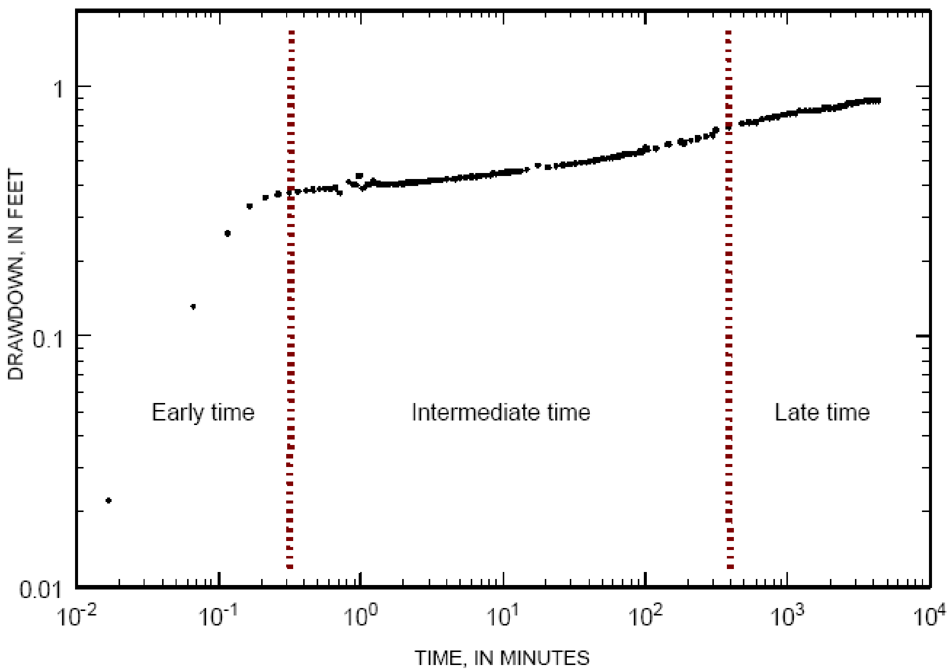


Figure 4-2 Transient Drawdown Diagram (Taken from Moench et al., 2000)

reflects aquifer specific yield. Both of these straight-line periods are visible on all but the most distant monitoring well MW-14, where only the late time specific yield storage straight-line was observed. This is commonly observed in water table aquifers (Moench et al., 2000), since confined storage effects are felt most strongly near the pumping well and water table drainage effects are felt most strongly at the more remote monitoring wells.

During the recovery period, a semi-log analysis was also conducted using the Theis Recovery Method as a cross-check of the Cooper Jacob semi-log method, with very similar results as shown in the Theis Recovery Method transmissivity values given in Table 4-1.

The pumping test analysis results are summarized in the attached Table 4-1. For EW-19 semi-log and type curve interpretation see Figures 4-3 through 4-6 and semi-log and type curve interpretation Figures for the piezometers and MW-14 are included in Appendix G. Aquifer transmissivity values range from 2,333 ft^2 per day (1.62 ft^2 per minute) to 3,758 ft^2 per day (2.61 ft^2 per minute) with a geometric mean value of 2,758 ft^2 per day (1.92 ft^2 per minute). Thus, there is fairly good agreement on this key aquifer parameter amongst the various interpretation methods and observation locations.

Aquifer storage values span a fairly wide range from 2.5 x 10^{-4} to 0.051. These values reflect semi-confined to unconfined conditions consistent with the site hydrogeologic model. Aquifer confined storage coefficient values are on the order of 5 x 10^{-4}, with specific yield values of up to 0.05 as measured in the most remote monitoring location MW-14 (specific yield values are typically better estimated in more remote wells since water table drainage effects are felt to a greater degree at the more remote monitoring locations). However, the ultimate aquifer specific yield may be difficult to measure in a 3 day pumping test at this location, since the water table is located in the shallow, silty, low permeability zone that is unlikely to quickly drain into the deeper more permeable zone. Thus, a specific yield value was also estimated using volumetric calculations by assuming that the drawdown measured in the observation wells was only due to storage released from the water table, where the aquifer bulk volume dewatered is directly estimated from the drawdown-distance plot. This alternative specific yield value was 0.08-0.09, much higher than the value of 0.05 estimated from the pumping test, again perhaps since the test duration was only three days. Vertical to horizontal hydraulic conductivity ratio is estimated to be on the order of 5 x 10^{-3}, reflecting the low hydraulic conductivity of the shallow zone at the site where water table drainage is occurring.

The hydraulic conductivity in the aquifer is estimated to be 46 feet per day (ft/day) from the ratio of the aquifer transmissivity value of 2,758 ft^2 per day divided by the 60 feet thickness of the deep permeable zone.

4.2.3 Aquifer Properties and Underflow Estimates

Considering the aquifer transmissivity values derived from the specific capacity values (2,575 ft^2/day), the distance drawdown analysis (2,032 ft^2/day), and the transient pumping test analyses (2,758 ft^2/day), the aquifer transmissivity value is estimated as the average of these three values or 2,455 ft^2/day. The aquifer specific yield is estimated to be on the order of 0.05 to 0.09, although storage parameter estimates from pumping tests are usually more uncertain than transmissivity parameter estimates.

The aquifer underflow at the site is estimated as the product of the average aquifer transmissivity, the aquifer hydraulic gradient, and the average width of the aquifer, where the aquifer geometry is taken from the recent geophysical survey of the pumping test site given in the pumping test workplan (Tetra Tech, Inc., 2008a). Therefore, the average underflow rate is as follows: Q (ft^3/day) = 2,455 ft^2/day x 0.012 x 600 feet x 0.5 = 8,838 ft^3/day or 74 acre-feet per year or 46 gpm.

This flow varies with the seasonal hydraulic gradient in the manner given in the Figure 4-2 above, with a low value of 34 gpm during dry season when the gradient is as low as 0.009, and a high value of 65 gpm during the wet season when the gradient is as high as 0.017. These flowrates can be used as interim guidance for evaluating a pump and treat system in this portion of the site, and will be refined later in this project using the results of the groundwater flow model currently under development for the site. Applying a safety factor, the suggested nominal extraction rate for a potential pump and treat system in this area of the Site is 75 to 125 gpm.

Figure 4-3 EW-19 Cooper Jacob Drawdown Plot

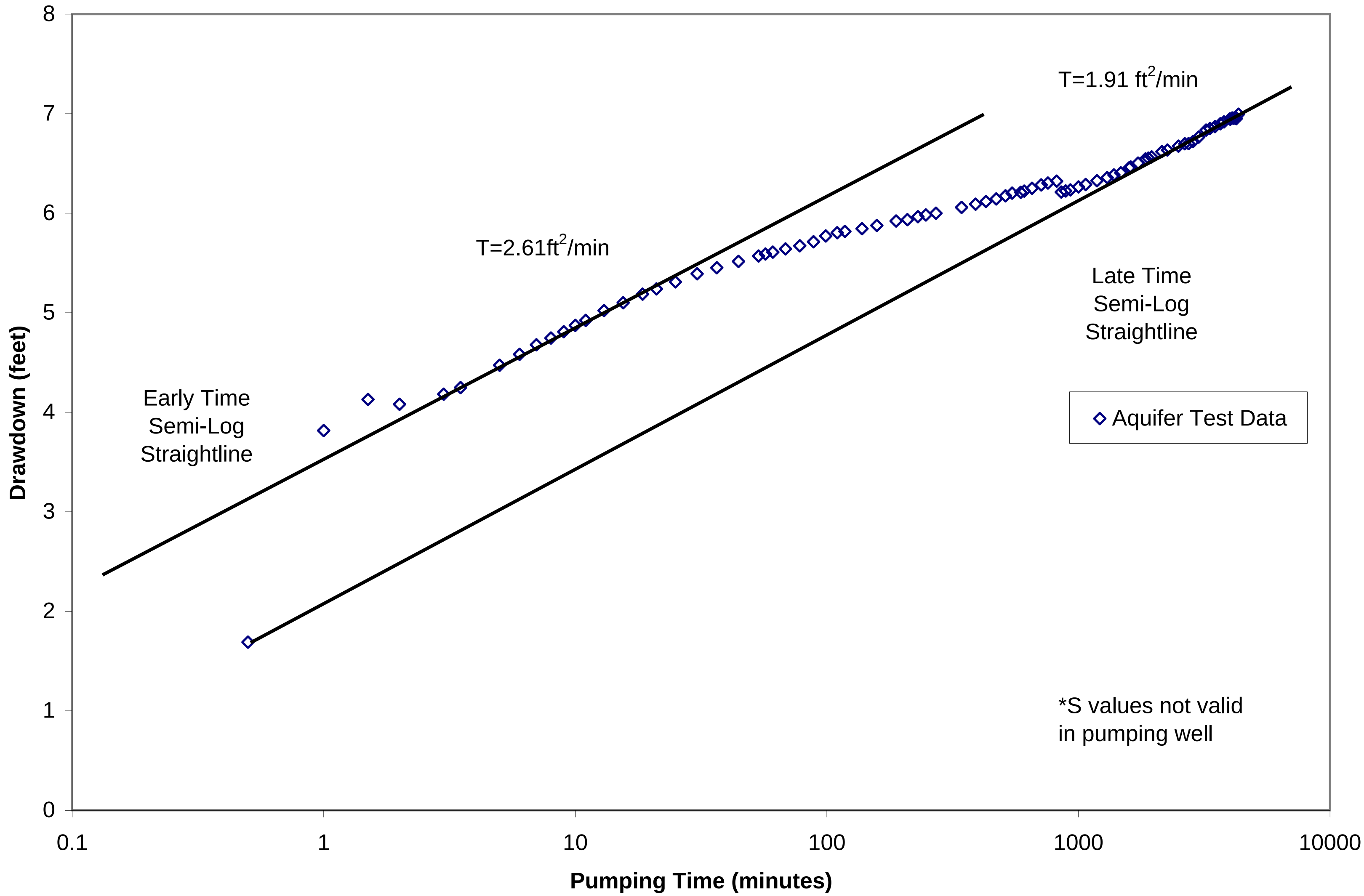


Figure 4-4 EW-19 Type Curve Drawdown Plot

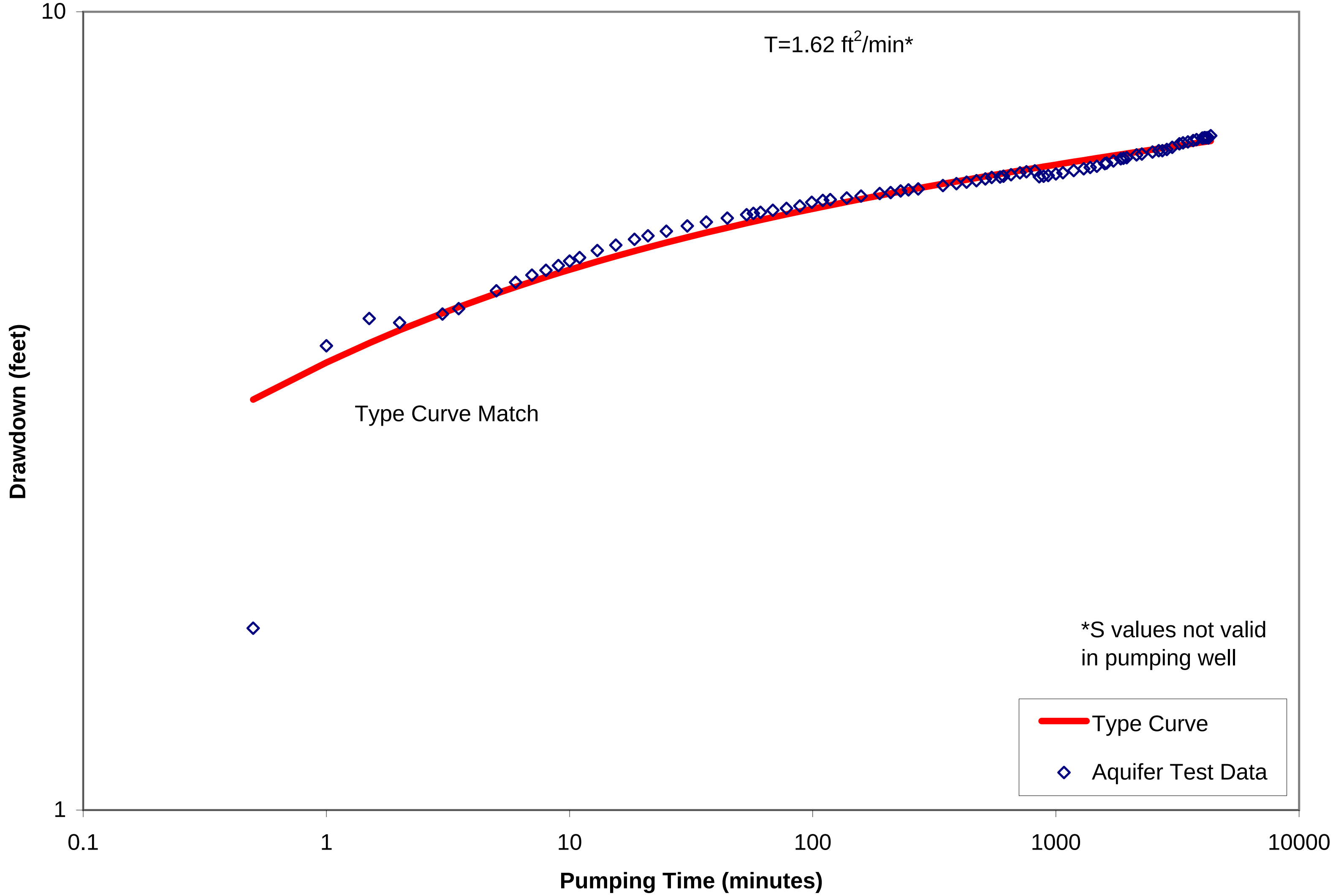


Figure 4-5 EW-19 Cooper Jacob Recovery Plot

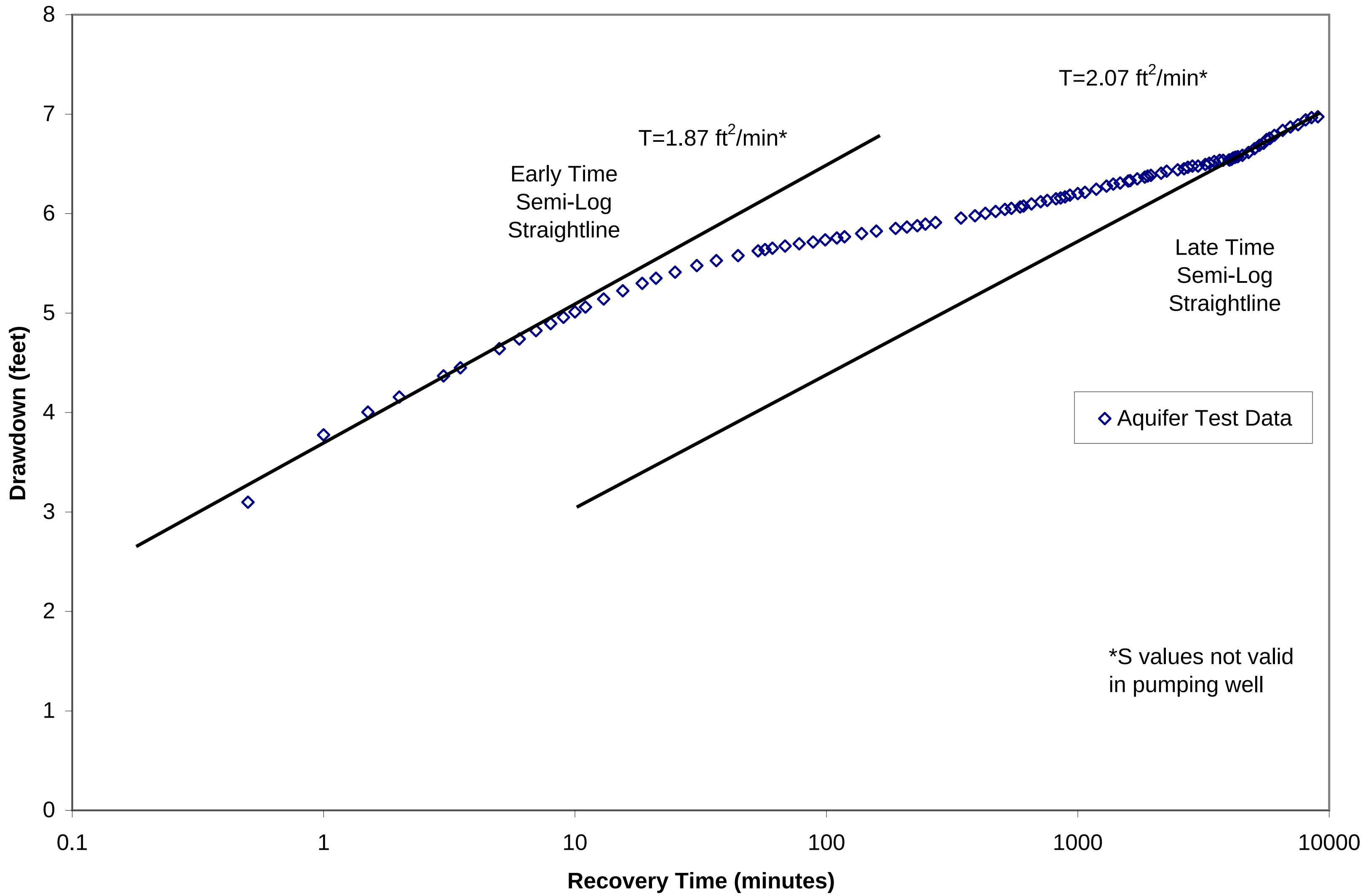
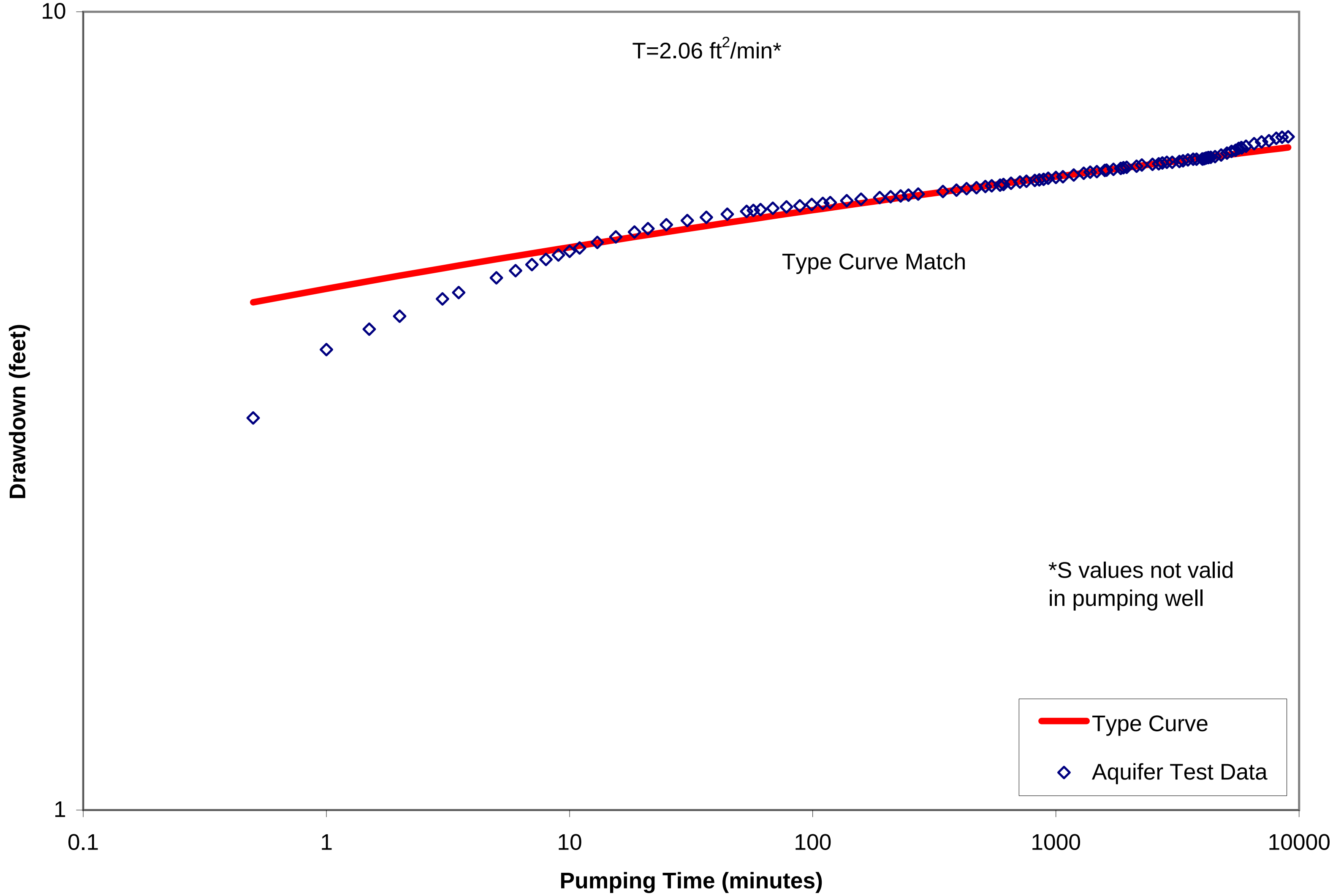


Figure 4-6 EW-19 Type Curve Recovery Plot



4.3 GROUNDWATER ANALYTICAL RESULTS

In November 2008, groundwater samples were collected from EW-19 at the beginning and at the end of the pumping test to evaluate if there were any changes in concentration for VOCs, perchlorate and 1,4-dioxane (see field data sheets in Appendix E). In addition, the groundwater samples collected towards the end of the pumping test were analyzed for metals and general mineral parameters for remedial design consideration. Samples were also analyzed for gross alpha and beta, 14C, 35S and 3H for comparison to previous samples collected from MW-14 and three other upgadient wells in August 2008.

4.3.1 Organic and Inorganic Analytes

Perchlorate was not detected in the samples collected from the extraction well at either the beginning or the end of the pumping test. Low level 1,4-dioxane concentrations were detected at the beginning of the pumping test and were relatively unchanged by the end of the test. There were three VOCs detected at the beginning of the pumping test, 1,1-DCE, Toluene, and TCE. All three VOC analytes detected were at concentrations less than 1.5µg/L. By the end of the pumping test 1,2-DCA was detected just above the method detection limit (MDL), 1,1-DCE and TCE were detected at concentrations less than 1.5 micrograms per liter (µg/L). All analytes detected at both the beginning and the end of the test were at concentrations less than their respective maximum contaminant level (MCL). Table 4-2 lists the concentrations of the detected analytes. The data packages, validated data and consolidation table are included in Appendices I through L, respectively.

4.3.2 Radiological

Radian's Source and Hydrogeologic Investigation (1990) states that in 1986, Radian identified that there had been a one-time burial of radioactive wastes. This radioactive waste had been generated at another Lockheed site and was the result of cleaning laboratory surfaces. According to the Radian report, the low level radioactive material was disposed at the Beaumont Site 1 location in 1971. The radionuclides reported to have been disposed included 3H, 14C, and 35S. These radionuclides also occur naturally as the result of anthropogenic activities.

The Radian (1990) Source and Hydrogeologic Investigation report states that in September 1989 the radioactive waste disposal site was located, sampled, excavated, and confirmation samples collected. Over-excavation of soils around the waste-containing jars and collection of confirmation samples determined that radioactivity in soils did not exceed naturally occurring levels. In the subsequent draft Human Health Risk Assessment Radian 1992), Radian stated that the radioactive waste site was no longer a possible source of contamination since all containers and surrounding soils were excavated and disposed of properly.

Table 4-2 Validated Analytical Data Detected in Groundwater

				General Minerals						Metals								Volatiles			
Sample Name	Sample Date	**1,4-Dioxane -µg/L**	**Perchlorate -µg/L**	**Bicarbonate Alkalinity -mg/L**	**Carbonate Alkalinity -mg/L**	**Chloride -mg/L**	**Dissolved Solids -mg/L**	**Nitrate as N -mg/L**	**Sulfate -mg/L**	**Arsenic -mg/L**	**Barium -mg/L**	**Calcium -mg/L**	**Lead -mg/L**	**Magnesium -mg/L**	**Potassium -mg/L**	**Sodium -mg/L**	**Zinc -mg/L**	**1,1-Dichloroethane -µg/L**	**1,1-Dichloroethene -µg/L**	**Toluene -µg/L**	**Trichloroethene -µg/L**
EW-19	11/21/2008	2.7	<0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.2	0.83 Jq	1.4	0.93 Jq
EW-19	11/24/2008	2.8	<0.5	197	<1	15.4	360	0.562	45.5	0.00676 Jq	0.0494	56.5	0.0116	6.7	1.46 Jq	51.7	0.0298	0.21 Jq	1.1	<0.2	0.95 Jq
Reporting Limit		1.0	2.0	5.00	5.00	0.200	10.0	0.100	1.00	0.01	0.01	1.00	0.01	1.00	2.00	1.00	0.01	1.0	1.0	1.0	1.0
Method Detection Limit		0.56	0.50	1.00	1.00	0.100	5.00	0.05000	0.500	0.005	0.002	0.100	0.003	0.100	0.100	0.100	0.005	0.20	0.20	0.2	0.20
MCL/DWNL		3 (1)	6	-	-	250	-	-	250	0.05	1	-	0.015	-	-	-	5	5	6	150	5

Notes: Only analytes positively detected are presented in this table. For a complete list, refer toappendicies H through J.
µg/L - micrograms per liter.
mg/L - milligrams per liter.
DWNL - California Department of Health Services state drinking water notification level.
MCL - Maximum Contaminant Level.
(1) California Department of Health Services state DWNL
"-" - MCL or DWNL not available.
q - The analyte detection was below the Practical Quantitation Limit (PQL).
NA - not analyzed
J - The analyte was positively identified, but the analyte concentration is an estimated value.
<# - the analyte is not detected above the method detection limit
MDL - method detection limit.

In July 2008, Tetra Tech sampled groundwater in four groundwater monitoring wells, MW-14, MW-37, MW-46, and MW-08, to assess whether 3H, 14C, and 35S are present in groundwater downgradient of the excavated radioactive waste disposal site. Sampling was conducted at one downgradient well MW-14, and three wells MW-37, MW-46, and MW-08 upgradient of the reported disposal area (Figure 4-7). The ungradient wells were selected from available groundwater monitoring wells located in alluvial material derived from the same source rock as the potentially impacted well. In November 2008, groundwater samples were collected from EW-19 for the same evaluation. Groundwater samples were collected from each well and submitted for laboratory analysis for gross-alpha and gross-beta using gas-proportional counting. Samples were also analyzed for 3H, 14C, and 35S using liquid scintillation counting. The results are summarized in Table 4-4.

Table 4-3 Activities of Radionuclides Present in Groundwater (pCi/L)

Sample Name	Sample Date	Carbon-14	Sulfur-35	Gross Alpha	Gross Beta	Tritium
EW-19	11/24/2008	<49.0	<14.2	<2.80	<4.80	<451
MW-08	7/16/2008	<49.0	<14.2	<2.80	<4.80	<451
MW-14	7/16/2008	<49.0	<14.2	**4.24 Jq**	<4.80	<451
MW-37	7/16/2008	<49.0	<14.2	<2.80	<4.80	<451
MW-46	7/16/2008	<49.0	<14.2	<2.80	<4.80	<451
Reporting Limit		50	100	5.0	5.0	500
Method Detection Limit		<49.0	<14.2	<2.80	<4.80	<451
MCL/DWNL		-	-	15	50	20,000

Notes:
q - The analyte detection was below the Practical Quantitation Limit (PQL).
J - The analyte was positively identified, but the analyte concentration is an estimated value.
<# - the analyte is not detected above the reporting limit.
MCL - Maximum Contaminant Level.
DWNL - California Department of Health Services state drinking water notification level.

With the exception of gross alpha radiation in monitoring well MW-14, all radioisotopes are below the MDL. Gross alpha activities detected in MW-14, while above the MDL are below the reporting limit (i.e., are Jq -qualified).

Ruberu et al. (2005) conducted a survey of radium, gross alpha, and uranium concentrations in the major drinking water aquifers in California. Gross alpha activities in the study ranged from no detectable activity to 642 picocuries per liter (pCi/L). Thirty-two of the 112 wells sampled showed no detectable gross alpha activity. Minimum detectable gross alpha activity ranged from 0.53 to 5.43 pCi/L.

Thirteen of the 112 wells sampled are located in aquifers surrounding the Lockheed Beaumont site. Gross alpha activities in these 13 wells ranged from 12.1 to 92 pCi/L. These activities are at least three times higher than the activities measured in well MW-14 on the Lockheed property. Based on a comparison of

X:\GIS\Lockheed 22288-0306\Middle Potrero w_Geophys 3.mxd

0 200 400
Feet

Adapted from: March 2007 aerial photograph.

LEGEND

- Wells Sampled July 2008 for Radioisotopes
- Well Location
- Approximate Location of Inferred Fault
- Approximate Location of Buried Fault
- Perennial Portion of Potrero Creek (January 2008)
- Bedrock/Alluvium Contact
- Inferred Bedrock/Alluvium Contact
- Topographic Contour (2-foot interval)
- Canyon Used for Radioactive Waste Disposal

Beaumont Site 1

Figure 4-7

Well Locations Sampled for Radioisotopes in July 2008

TETRA TECH

analytical data from the groundwater samples collected at the Lockheed Beaumont Site 1 gross alpha concentrations of 4.24 pCi/L in monitoring well MW-14 are well within the detectable gross alpha activity reported by Ruberu et al. (2005). Therefore, it is highly likely that the gross alpha activities measured in well MW-14 are naturally occurring.

5.0 SUMMARY AND RECOMMENDATIONS

Results of the long-term pumping test conducted at extraction well EW-19, show that aquifer transmissivity values ranged from 2,575 ft^2/day to 2,032 ft^2/day with an average transmissivity value of 2,455 ft^2/day. Based on the transmissivity values, the hydraulic conductivity value for a 60-foot thick aquifer is estimated to be 41 ft/day. The aquifer specific yield is estimated to be on the order of 0.05 to 0.09 (5 to 9 percent).

Based on the aquifer geometry, the average underflow in the area of EW-19 is estimated to be about 74-acre feet per year or about 46 gpm. This flow is thought to vary based on the seasonal fluctuations of the hydraulic gradient. During the summer months, flow is estimated to be as little as 34 gpm when the gradient is on the order of 0.009 and could be as high as 65 gpm during the wet season when the gradient is as high as 0.017. These underflow rates are generally consistent with baseflows measured in the dry season in Potrero Creek in the groundwater monitoring program, providing independent confirmation of the underflow rates calculated in this report.

The geometry of the aquifer in the area of EW-19 is based on the geophysical data (seismic refraction) and geological mapping conducted as part of this study. Using the depth versus drawdown data, the radius of influence is approximately 800 feet. The data suggests that extraction well EW-19 has been located in the portion of the aquifer that would provide capture of groundwater moving downgradient from the source areas. Pumping test data collected as part of this study show that the specific capacity at well EW-19 is high enough that it could pump enough water to adequately capture all groundwater moving through this portion of the aquifer.

Analytical data from groundwater samples collected at the beginning and end of the long-term pumping test show that contaminants moving through this portion of the aquifer are not very high (perchlorate is non-detect, TCE, 1,1-DCA, and 1,1-DCE are barely above reporting limit, and 1,4-dioxane is below the DWNL). In addition, the concentration of contaminants did not vary after the extraction of over 400,000 gallons of water, indicating that contaminant concentrations are consistent across the capture area and fairly stable in this area of the Site.

While extraction well EW-19 is sufficient to capture groundwater moving through this area of the Site, the installation of a groundwater pump and treat is not recommended at this time. First, a small secondary source containing chemicals of potential concern has been identified downgradient of the proposed IRM location, making this location less desirable. Second, the groundwater contaminants present in this portion of the aquifer are not high enough to make treatment of the extracted groundwater economically sensible if an additional source is present further downgradient, most of the contaminant levels actually meet or exceed contaminant MCLs. While groundwater contaminants are not high enough to warrant treatment at this particular location, the presence of trace levels of contaminants in this area suggest that the migration of contaminants downgradient of this site is likely occurring, especially during the wetter part of the year. Therefore, future monitoring is recommended at the EW-19 location to insure that contaminant levels do not rise to a higher level. To control offsite migration of contaminants, it is recommended that source area control of contaminants be evaluated. By treating groundwater further upgradient of Middle Potrero Creek closer to the source areas, the concentration of site contaminants being treated would be higher making treatment much more effective and reducing the levels further upgradient would further reduce the likelihood of any offsite migration.

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7.0 ACRONYMS

µg/L	micrograms per liter
1,1-DCE	1,1-Dichloroethene
3H	Tritium
14C	Carbon-14
35S	Sulfur-35
bgs	below ground surface
BOS	bottom of the screen
BPA	burn pit area
Ca	calcium
Cl	chloride
DO	dissolved oxygen
DTSC	California Department of Toxic Substances Control
DWNL	Drinking Water Notification Level
EC	electrical conductivity
ft/day	feet per day
ft^2/day	square feet per day
ft^3/day	cubic feet per day
ft/ft	feet per foot
gpm	gallons per minute
gpm/ft	gallons per minute per foot
GPS	global positioning system
HCO_3	bicarbonate
HCP	Habitat Conservation Plan
IDW	Investigative Derived Waste
IRM	Interim Remedial Measure
K	potassium
LMC	Lockheed Martin Corporation
LPC	Lockheed Propulsion Company
MCL	maximum contaminant level

MDL	method detection limit
MEF	Mount Eden formation
Mg	magnesium
Na	sodium
NTUs	nephelometric turbidity units
OVA	organic vapor analyzer
pCi/L	picocuries per liter
PQL	practical quantitation limit
PVC	polyvinyl chloride
RMPA	Rocket Motor Production Area
Site	Lockheed Martin Beaumont Site 1
SKR	Stephens’ Kangaroo Rat
SO_4	sulfate
TCE	Trichloroethene
TOS	top of the screen
USCS	Unified Soil Classification System
USFWS	U.S. Fish and Wildlife Service
VOCs	volatile organic compounds

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