Final

Environmental Condition of Property Report

United States Army Garrison
Fort Hunter Liggett
Monterey County, California

Prepared for

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Abbreviations and Acronyms

AMEC	AMEC Environment and Infrastructure
AMSD	approximate minimum search distance
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
CER	computerized environmental report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
CESQG	Conditionally-Exempt Small Quantity Generator
CFR	Code of Federal Regulations
CORRACTS	Corrective Action Tracking System
DPW	Department of Public Works
DTSC	Department of Toxic Substances Control
ECP	Environmental Condition of Property
E&E	Ecology and Environment, Inc.
ERNS	Emergency Response Notification System
FEMA	Federal Emergency Management Agency
FHL	Fort Hunter Liggett
HMMWV	high mobility multipurpose wheeled vehicles
kg	kilogram
LQG	Large Quantity Generator
LUST	leaking underground storage tank
MCDOH	Monterey County Department of Health, Environmental Branch
MEP	Military Equipment Parking
NFRAP	No Further Remedial Action Planned
NPL	National Priorities List
NRCS	Natural Resources Conservation Service
PCB	polychlorinated biphenyls
pCi/L	picoCuries per liter

RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Act Information System
SLIC	Spills, Leaks, Investigation and Cleanup
SQG	Small Quantity Generator
SVE	Soil Vapor Extraction
SWF/LF	Solid Waste Facility/Landfill Sites
TPH	total petroleum hydrocarbon
TSD	treatment, storage, and disposal
USACE	United States Army Corps of Engineers
USAG	United States Army Garrison
USAR	United States Army Reserve
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank

SECTION 1

Summary

CH2M HILL prepared this Environmental Condition of Property (ECP) report[1] for use by the United States Army Corps of Engineers (USACE) and the United States Army Reserve (USAR) which includes the Army Reserve Installation Management Directorate, and the United States Army Garrison (USAG) Fort Hunter Liggett (FHL) for the proposed development of a parcel of land, hereafter referred to as the "Property." The Property is located in the southeast corner of the intersection of Mission Road and Bradley Drive, on Fort Hunter Liggett, in Monterey County, California. The Property includes approximately 54.8 acres of undeveloped land. A Property Location map (Figure 1) and Property Features map (Figure 2) are included in Appendices A and B, respectively.

This report meets the US Department of the Army's requirement to assess, determine, and document the environmental condition of property in an ECP report and complies with the American Society for Testing and Materials (ASTM) Designation: E1527-05, *Standard Practice for Environmental Site Assessments: Phase l Environmental Site Assessment Process.*

This ECP did not reveal any recognized environmental conditions in connection with the Property.

[1] Environmental Condition of Property (ECP) report is the *report* defined in § 3.2.78 of ASTM E 1527-05. Similarly, an "ECP" is an "ESA" as defined in § 3.2.30 of ASTM E 1527-05. Use of these terms is mandated by § 15-5 of Army Regulation 200-1. The ECP and report are required to conform to ASTM E1527-05. Terminology used throughout this report is intended to comply with ASTM E1527-05 usage, except where specifically noted.

SECTION 2

Introduction

2.1 Purpose

CH2M HILL conducted this ECP Report for the USACE and the USAR. The purpose of this report is to identify recognized environmental conditions affecting the Property, using the methodology recommended by the ASTM to assess potential environmental conditions that could materially impact the intended operations on the Property. This ECP conforms with ASTM Designation: E1527-05, *Standard Practice for Environmental Site Assessments: Phase l Environmental Site Assessment Process.*

Recognized environmental conditions are defined by ASTM E1527-05 as "...the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property. The term includes hazardous substances or petroleum products even under conditions in compliance with applicable laws. The term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies."

2.2 Detailed Scope of Services

The specific scope of work included a site reconnaissance, personal interviews, and a records review.

2.2.1 Site Reconnaissance

A site reconnaissance was conducted to obtain information indicating the likelihood of identifying recognized environmental conditions in connection with the Property. The site reconnaissance included visually assessing the Property for the presence of hazardous substances and petroleum products, drainages, paths, and potential sources of pollutant releases (odors, pools of liquid, stains, septic systems, drums, polychlorinated biphenyls [PCBs], drains and sumps, lagoons, stressed vegetation, etc.). The Property also was observed from its periphery, and obvious past and present Property uses were noted. In addition, a reconnaissance of the surrounding roads and adjacent properties was conducted to assess the Property's location with respect to surrounding property uses and natural surface features and to identify obvious past and present uses, and potential environmental conditions on adjoining properties as well as the surrounding area. Photographs taken as part of the site reconnaissance are included in Appendix C.

Grant Koster of CH2M HILL conducted a site visit on March 6, 2012. No Property representatives were present during the site reconnaissance. At the time of the site visit, it was sunny, and the temperature was approximately 60 degrees Fahrenheit. The site reconnaissance was conducted in a systematic manner. The perimeter of the Property was traversed, then

transects from east to west and north to south were traversed across the Property. There were no limiting factors associated with visual observations on the Property or surrounding properties with the exception of staging of military equipment that prohibited full visual observation of the soils of the Property.

2.2.2 Interviews

Persons were interviewed to obtain information regarding recognized environmental conditions in connection with the Property and adjoining properties, to determine current and past site uses, and to identify other present and previous activities and events potentially resulting in the environmental degradation of the Property. The following table summarizes the individuals interviewed, contacted, and to whom requests for documentation were made as part of this ECP. Information obtained from these interviews is discussed in Section 6 and documented in Appendix F.

Name	Affiliation
Persons Interviewed	
Elizabeth Clark	Wildlife Biologist, USAG FHL Department of Public Works (DPW), Environmental Division
Gary Houston	Environmental Chief, USAG FHL DPW, Environmental Division
Michael Moeller	Compliance Branch Manager, USAG FHL DPW, Environmental Division
Mark Grindstaff	Division Manager USAG FHL DPW, Operation and Maintenance Division
Jeff Minetti	Assistant Fire Chief – USAG FHL Fire Department
Linda Ortiz	Monterey County Health Department Environmental Health Bureau

2.2.3 Records Review

The purpose of the records review was to obtain and review records to identify recognized environmental conditions in connection with the Property. Reasonably ascertainable documents from standard sources were obtained and reviewed. If provided, alternative sources of information, such as appraisals environmental reports, permits, building plans, and specifications, were reviewed. Copies of all supporting documentation are included in Appendix G.

Standard historical sources, such as topographic maps, aerial photographs, local street directories, fire insurance maps, property tax files, recorded land title records, building department records, zoning/land use records, as well as other historical sources, were obtained and reviewed to identify previous activities on and in the vicinity of the Property. Standard historical documents reviewed as part of this ECP are included in Appendix D.

Reasonably ascertainable standard environmental record sources maintained by federal, state, and local agencies within the approximate ASTM minimum search distances were obtained and reviewed as described in Section 5. The computerized environmental report (CER), provided by FirstSearch Technology Corporation (FirstSearch) is included in Appendix E.

Published radon occurrence maps and provided radon surveys were reviewed to determine whether the Property is located in an area with a propensity for elevated radon concentrations.

2.3 Significant Assumptions

The information obtained from individuals interviewed and supporting documentation and records were considered to be accurate unless reasonable inquiries indicated otherwise. This ECP report presents a summary of reasonably ascertainable information on the environmental conditions of, and concerns relative to, the land, facilities, and real property assets at the Property. Its findings are based on a record search of publicly available documents; a review of reasonably ascertainable documents; a visual reconnaissance of the Property conducted on March 6, 2012; and interviews with personnel knowledgeable with the Property and its history. Reasonably ascertainable environmental investigation reports and historical documents associated with the Property were reviewed in support of this ECP. Information obtained from these additional sources is referenced within this report and provided in respective appendices.

2.4 Limitations and Exceptions

2.4.1 Limitations

The ground surface of the Property was visually inspected during the site reconnaissance. No intrusive investigations, sampling or analysis of any media was conducted during this survey. The staging of military equipment on the southern portion of the Property did limit visibility of the soils of the Property. This report has been prepared in compliance with ASTM E1527-05. In preparing this report, CH2M HILL has relied on certain information provided by federal, state, and local officials and other parties referenced herein, and on information contained in the files of governmental agencies, that were reasonably ascertainable at the time of this assessment. Although there may have been some degree of overlap in the information provided by these various sources, an attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this site assessment was not conducted. Observations were made of the Property and surrounding properties as indicated in this report.

2.4.2 Exceptions

There are no exceptions.

2.4.3 Data Gaps

According to § 3.2.20 of ASTM E1527-05, a data gap is a lack of or inability to obtain information required by the ASTM standard despite good faith efforts to gather the data. Data gaps may result from incompleteness in any of the activities required by the ASTM standard. A data gap is considered significant only if it affects the ability to identify recognized environmental conditions. No significant data gaps are identified. The following minor data gaps were identified:

Data Gap	Explanation	Significance of Gap
Site History	Site history research not conducted in 5-year intervals.	Low - Standard historical sources of information, such as aerial photographs, historic topographic maps, city directory abstracts, and interviews with knowledgeable individuals familiar with the Property, all indicated site use was consistent (vacant military owned land) back to 1940. Review of additional years of historical records sources would not likely provide additional information.

2.5 Special Terms and Conditions

CH2M HILL has prepared this report solely for the use of the USACE and the USAR in evaluating the Property for proposed development. This report, or any portions thereof, should not be disseminated to or relied on by any other party except in accordance with § 2.6 of ASTM E1527-05. This ECP did not include an evaluation of the Property for suitability; structural, mechanical, building or site safety; financial; or any other aspects of the Property other than as specifically noted herein.

2.6 User Reliance

This report has been produced under an agreement between CH2M HILL and the USACE. Any reliance upon this document, or upon CH2M HILL's performance of services in preparing this document, is conditioned upon the relying party's acceptance and acknowledgement of the limitations, qualifications, terms, conditions and indemnities set forth in the agreement between the parties, and property ownership/management disclosure limitations, if any. It is not to be relied upon by any party other than the United States Government, nor used for any purpose other than that specifically stated in Section 2.1 without advance and express written consent by CH2M HILL and the USACE.

SECTION 3

Site Description

3.1 Location and Legal Description

The Property is located in Monterey County, California, and is identified on local tax maps as part of Parcel No. 201-021-004-000. The Property Location map is included in Appendix A. The following provides general asset information for the Property:

Facility Name and Address:	Southeast corner of intersection of Mission Road and Route Tampa, Fort Hunter Liggett, California 93932
Property Owner:	United States Army Reserve
Building(s) Owner:	No Buildings Present
Date of Ownership:	December 1940
Current Occupant(s):	United States Army Reserve
Zoning:	Public/Quasi Public
United States Geological Survey (USGS) Quadrangle(s):	King City/Bryson and Cosio Knobb/Jolon, California
Latitude/Longitude:	36°0'0.33" North, 121°14'19.79" West
Legal Description:	Not Available; parcel is on property owned by USAG FHL as shown on Figure 2.
Property Size:	Approximately 54.8 acres

3.2 Site and Vicinity General Characteristics

The Property is triangular shaped and approximately 54.8 acres in size. The Property is bounded by Mission Road to the west, Route Tampa to the east, and an undeveloped portion of land to the south. A Property Features map is included in Appendix B. The Property is accessible by a gravel access road from Route Tampa, through a gate, and by Bradley Drive which is asphalt paved and connects Mission Road to Route Tampa. The Property is generally enclosed by a chain-linked fence and the portion of the Property south of Bradley Drive was used as temporary military equipment parking (MEP) area at the time of site reconnaissance. General equipment staging locations are as follows: high mobility multipurpose wheeled vehicles (HMMWVs) in the northeastern corner; tractor trucks and trailers central portion and southeast corner; troop transports in the southwest corner; trailer mounted temporary lights and generators in the western central portion of the MEP; and empty tanker trailers in the northwest corner of the MEP. The remainder of the Property north of Bradley Drive was undeveloped and not in use at the time of site reconnaissance. Sulphur Spring Creek flows

through the northern portion of the Property. Areas surrounding the Property are described as: the FHL recreation building to the east and undeveloped land to the south, west, and north. The Property and surrounding areas are relatively flat with an approximate surface elevation of 1,040 feet above mean sea level.

3.3 Current Use of the Property

The Property was utilized as a temporary MEP area by the USAR.

3.4 Description of Structures, Roads, Improvements to the Site

3.4.1 Utilities

The Property is served by the following utilities:

Water:	FHL owned private water well
Sanitary Sewer:	FHL Directorate of Public Works
Storm Sewer:	FHL Directorate of Public Works
Electric:	Southern California Edison
Natural Gas:	Southern California Edison

One surface water culvert was present in the northeast corner of the Property to allow surface water to flow beneath Bradley Drive. No other stormwater management systems were present on the Property at the time of site reconnaissance.

Electric transmission lines cross east-west through the central and eastern portion of the Property, as well as, entering from the north. One pole-mounted transformer was located in the center of the Property south of the access control point. A “non-PCB containing” label was not visible on the transformer; however, Michael Moeller, Compliance Branch Manager for the FHL DPW Environmental Division, indicated that all transformers on the garrison have been tested to ensure they comply with a “non-PCB containing” designation.

3.4.2 Building Description(s)

No buildings were present on the Property at the time of site reconnaissance.

3.4.3 Other Facilities and Site Features

Overhead transmission lines were located in the central and eastern portions of the Property. A water utility line oriented north-south crosses the Property’s west side. Sanitary sewer utilities were located on the west, south, and central portions of the Property. Telecommunication (fiber optic) lines were located in the southeast corner of the Property.

3.5 Current Uses of the Adjoining Properties

The Property is located on an active USAG and is adjoined by undeveloped land to the south, west, and north, and the FHL recreation center to the east. The following table summarizes the surrounding property usage.

Direction	Adjacent Properties	Surrounding Properties
North	Undeveloped land	FHL MEP, and FHL Movie Theater
East	FHL Recreation Center and MEP	Barracks, Organizational Maintenance Shop, and other operational buildings
West	Undeveloped Land	Undeveloped Land
South	Undeveloped Land	Tusi Army Heliport

No adjoining sites were listed on the regulatory databases. A detailed discussion on regulatory database information is included in Section 5.0.

SECTION 4

Records Review

4.1 Standard Environmental Record Sources

A copy of regulatory database information contained within a CER provided by FirstSearch is included in Appendix E. The CER is a listing of sites identified on select federal and state standard source environmental databases within the approximate minimum search distance specified by ASTM E1527-05. CH2M HILL reviewed each environmental database to determine if certain sites identified in the CER are suspected to represent a material negative environmental impact to the Property. The CER is included in Appendix E. The following table lists the number of sites by regulatory database within the prescribed minimum search distance appearing in the CER.

Databases Reviewed	Approximate Minimum Search Distance (AMSD)	Number of Sites Within AMSD
Federal National Priorities List (NPL) Site List	1 mile	0
Federal Delisted NPL Site List	0.5 miles	0
Federal Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) List	0.5 miles	0
Federal CERCLIS No Further Remedial Action Planned (NFRAP) Sites	0.5 miles	0
Federal Resource Conservation and Recovery Act Information System (RCRIS) Treatment, Storage, and Disposal (TSD) List	0.5 miles	0
Federal RCRIS Generators List	Onsite and adjoining properties	0
Federal Corrective Action Tracking System (CORRACTS)	1 mile	0
Federal Emergency Response Notification System (ERNS) List	Onsite	0
Federal Institutional/Engineering Control Registries	Onsite	0
State and Tribal Lists of NPL Equivalent Hazardous Waste Sites Identified for Investigation and/or Remediation	1 mile	0

Databases Reviewed	Approximate Minimum Search Distance (AMSD)	Number of Sites Within AMSD
State and Tribal Lists of CERCLIS Equivalent Hazardous Waste Sites Identified for Investigation and/or Remediation	0.5 miles	0
State and Tribal Landfills or Solid Waste Facilities List	0.5 miles	0
State and Tribal Petroleum Bulk Storage Tank Registered Underground Storage Tank Facility List	Onsite and adjoining properties	0
State and Tribal Leaking Underground Storage Tank (LUST)/Spill List	0.5 miles	0
State and Tribal Institutional/Engineering Control Registries	Onsite	0
State and Tribal Voluntary Cleanup Sites	0.5 miles	0
State and Tribal Brownfield Sites	0.5 miles	0
Spills, Leaks, Investigation and Cleanup (SLIC)	Unspecified	0

No unmapped sites were identified in the CER. A description of the databases reviewed by CH2M HILL and an analysis of sites identified within the prescribed search area are presented below.

4.1.1 Federal Databases

National Priorities List

The NPL database is a listing of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Comprehensive Environmental Response, Compensation, and Liability Act (Superfund). A site must be on the NPL to receive money from the Trust Fund for Remedial Action.

Analysis/Comment: The CER did not identify any NPL sites within the prescribed search radius.

Delisted National Priorities List Sites

The US Environmental Protection Agency (USEPA) may delete a final NPL site if it determines that no further response is required to protect human health or the environment. Under Section 300.425(e) of the National Contingency Plan (55 FR 8845, March 8, 1990). Sites that have been deleted from the NPL remain eligible for further Superfund-financed remedial action in the unlikely event that conditions in the future warrant such action. Partial deletions also can be conducted at NPL sites.

Analysis/Comment: The CER did not identify any delisted NPL sites within the prescribed search radius.

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)

CERCLIS is USEPA's system for tracking potential hazardous waste sites within the Superfund program. A site's presence on CERCLIS does not imply a level of federal activity or progress at a site, nor does it indicate that hazardous conditions necessarily exist at the location. Within one year of being entered into CERCLIS, the USEPA performs a preliminary assessment of a site. Based upon the results of the preliminary assessment, the USEPA may conduct additional investigations, which could lead to a site being listed on the NPL.

Analysis/Comment: The CER did not identify any CERCLIS sites within the prescribed search radius.

CERCLIS No Further Remedial Action Planned Sites

As of February 1995, CERCLIS sites designated NFRAP have been removed from the CERCLIS list. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to warrant federal Superfund action or NPL consideration.

Analysis/Comment: The CER did not identify any CERCLIS NFRAP sites within the prescribed search radius.

Resource Conservation and Recovery Act Information System Treatment, Storage, and Disposal List

The RCRIS TSD list contains information pertaining to those facilities that treat, store, or dispose of hazardous waste regulated under the RCRA. While these facilities represent some form of hazardous waste activity, they are most significant if determined to be out of compliance or to have violations.

Analysis/Comment: The CER did not identify any RCRA TSD facilities within the prescribed search radius.

Resource Conservation and Recovery Act Information System Generators

The RCRIS generator database contains information pertaining to sites that generate hazardous waste regulated under RCRA. Under RCRA, hazardous waste generators are classified by the quantity of hazardous waste generated in a calendar month into the following categories: Large Quantity Generator (LQG), greater than 1,000 kilograms (kg); Small Quantity Generator (SQG), 100 to 1,000 kg; and Conditionally-Exempt Small Quantity Generator (CESQG), less than 100 kg. RCRA generators, while they represent some form of hazardous waste activity, are most significant if they are determined to have Class I violations or to be noncompliant.

Analysis/Comment: The CER did not identify any RCRA-LQG, SQGs, or CESQGs within the prescribed search radius.

Corrective Action Tracking System

CORRACTS is a list of facilities that are found to have had hazardous waste releases and require RCRA corrective action activity, which can range from site investigations to remediation.

Analysis/Comment: The CER did not identify any CORRACTS sites within the prescribed search radius.

Emergency Response Notification System

The ERNS is a database of notifications of oil discharges and hazardous substance releases made to the federal government. These notifications are used by "on-scene coordinators" to determine an emergency response and release prevention. When a call is made to the National Response Center or one of the 10 USEPA regions, a report is created containing all of the release information that the caller provided. This report is transferred to an appropriate agency to evaluate the need for a response, and the records are electronically transferred to the ERNS database. As such, if a reported release of oil or a hazardous substance is deemed to require a response, it also should be listed in the appropriate federal or state environmental database such as CERCLIS, state equivalent CERCLIS, or state LUST or spills lists.

Analysis/Comment: The CER did not identify any ERNS site within the prescribed search radius.

Federal Institutional Control/Engineering Control Registries

The Federal Institutional/Engineering Control registries contain listings of sites that have engineering and/or institutional controls in place. Engineering controls include various physical control devices such as fences, caps, building slabs, paved areas, liners, and treatment methods to eliminate pathways for regulated substances to enter the environment or effect human health. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post-remediation care requirements intended to prevent exposure to contaminants remaining onsite. Deed restrictions (activity and use limitation) are generally required as part of institutional controls.

Analysis/Comment: The CER did not identify the Property on the Federal Institutional or Engineering Control registries.

4.1.2 State and Tribal Databases

California and Tribal NPL Equivalent Hazardous Waste Sites

The RESPONSE database identifies confirmed release sites of high priority and/or high potential risk, where the Department of Toxic Substances Control (DTSC) is involved in remediation.

Analysis/Comment: The CER did not identify any California and/or Tribal NPL Equivalent RESPONSE sites within the prescribed search radius.

California and Tribal CERCLIS Equivalent Hazardous Waste Sites

The DTSC's Site Mitigation and Brownfield Reuse Program's ENVIROSTOR database identifies sites that have known contamination or sites for which there may be reasons to investigate further. The following site types included in the database are Superfund sites, State response including Military, State, Voluntary Cleanup, and School sites.

Analysis/Comment: The CER did not identify any California and/or Tribal CERCLIS equivalent (ENVIROSTOR) sites within the prescribed search radius.

California and/or Tribal Landfill and/or Solid Waste Facilities List

The solid waste facilities/landfill sites (SWF/LF) list is an inventory of solid waste disposal facility or landfills, incinerators in California. The information comes from the Integrated Waste Management Board's Solid Waste Information System database.

Analysis/Comment: The CER did not identify any SWF/LF sites within a one-half mile radius of the Property.

California and/or Tribal Registered Storage Tanks Facility List

The Underground Storage Tank (UST) database contains information from the State Water Resources Control Board's Hazardous Substance Storage Container Database, and lists all registered USTs (California State Water Resources Control Board, 2012). Inclusion of a site on the UST list does not necessarily constitute environmental contamination, but instead merely indicates the presence of registered bulk storage tanks.

The Aboveground Storage Tank (AST) database contains registered ASTs. Inclusion of a site on the AST list does not necessarily constitute environmental contamination, but instead merely indicates the presence of registered bulk storage tanks.

Analysis/Comment: The CER did not identify any UST or AST sites within the specified search radius.

California and/or Tribal Leaking Underground/Aboveground Storage Tanks List

The LUST Incident Reports contain an inventory of reported LUST incidents. The Release Database is an inventory of reported spills and leaks, both active and inactive from USTs and ASTs. It includes the stationary and non-stationary source spills reported to the state, tribal, and federal agencies, including remediated and contaminated sites.

Analysis/Comment: The CER did not identify any LUST sites within the prescribed search radius.

Spills, Leaks, Investigation & Cleanup Cost Recovery Listings

The SLIC program is designed to protect and restore water quality from spills, leaks, and similar discharges.

Analysis/Comment: The CER did not identify any SLIC sites within the prescribed search radius.

California and Tribal Institutional Land Use Control Registries

The California Institutional Controls database lists properties within the state with recorded institutional controls.

Analysis/Comment: The CER did not identify any sites with recorded institutional controls within the prescribed search radius.

California and Tribal Voluntary Cleanup Program Sites

The California and Tribal voluntary cleanup program database lists sites where voluntary cleanup is occurring.

Analysis/Comment: The CER did not identify any state or Tribal voluntary cleanup program sites within the prescribed search radius.

California and Tribal Brownfield Sites

Brownfield sites are defined as "an abandoned, idled, or underused industrial or commercial facility, where expansion or redevelopment has been complicated by real or perceived environmental contamination." The Brownfield Program allows a non-responsible party to acquire a contaminated property with state liability protection for existing contamination by agreeing to perform an environmental assessment and/or remediation. The amount of environmental work is site-specific and dependent on the intended future use of the site.

Analysis/Comment: The CER did not identify any Brownfield sites within a one-half mile radius of the Property.

4.2 Additional Environmental Record Sources

Additional proprietary and non-proprietary environmental databases were searched by FirstSearch and descriptions of each are included in the CER in Appendix E. No records associated with the Property were found in any of the additional databases reviewed.

4.3 Physical Setting Source(s)

4.3.1 Topography

The Property is relatively flat with no visually apparent change in elevation. The FirstSearch topographic map reports show the Property's topographic elevation is approximately 1,040 feet above mean sea level. According to the USGS Jolon, California 7.5-minute series topographic map, topography in the vicinity of the Property slopes to the west-southwest toward Sulphur Springs Creek. The topography of the area is best described as flat lowland. Based on the topographic map review, the Property is located at a higher elevation than adjoining and surrounding areas to the west and south.

4.3.2 Surface Waters

Sulphur Spring Creek passes through the northern portion of the Property. The channel flows to the south-southwest where it discharges into the San Antonio River approximately 0.3 miles south-southwest of the Property. No other bodies of water are identified on or near the Property.

4.3.3 Geology

The Property is located within the California Coast Range section of the Pacific Border physiographic province of the United States (USGS, 2003). The geology in the area of the Property is unconsolidated and semi-consolidated alluvium (State of California Department of Conservation, 2007).

4.3.4 Hydrogeology

Under natural, undisturbed conditions, shallow groundwater flow generally follows the topography of the land surface, and on this basis, the topography suggests that localized groundwater flow is to the west-southwest toward Sulphur Springs Creek. However, localized conditions can alter flow direction; therefore, the presumed flow may not coincide with the actual flow in the vicinity of the Property. Based on previous reports, the depth to shallow groundwater as measured from nearby monitoring wells to the north was approximately 30 to 70 feet below grade. General groundwater flow direction on the Property is to the southwest (AMEC Environment and Infrastructure [AMEC], 2012).

4.3.5 Soils

According to the United States Department of Agriculture, Soil Conservation Service, the soil at the Property is classified predominantly as Arroyo Seco gravelly sandy loam, and as Chualar loam in the area of Sulphur Springs Creek (Natural Resources Conservation Service [NRCS], 2012).

Arroyo Seco gravel silt loam is found on foot slopes of hills as alluvium derived from weathered bedrock with slopes ranging from 0 to 5 percent. The general soil profile is gravelly sandy loam from 0 to approximately 42 inches below ground surface (bgs) and very gravelly coarse sandy loam from 42 inches to at least 60 inches bgs (NRCS, 2012). These soils are well drained and have a low water capacity.

Chualar loam is found on foot slopes of hills as alluvium derived from weathered igneous and metamorphic bedrock with slopes ranging from 0 to 2 percent. The general soil profile is gravelly sandy loam from 0 to approximately 42 inches bgs and very gravelly coarse sandy loam from 42 inches to at least 60 inches bgs (NRCS, 2012). These soils are well drained and have a low water capacity.

4.4 Historical Use Information on the Property

FHL is located on land that was previously privately owned, small farms along with a few large land tracts owned by William Hearst, under the Hearst Sunical Land and Packaging Corporation (FirstSearch, 2012a). The land upon which the Property is located was purchased by the military in 1940 (California State Military Department, 1990). The Property was not

historically utilized by the USAR prior to 2011, when a temporary fence was installed and the Property was used for temporary MEP. Use of the Property for MEP will end once construction/installation of a solar panel array is completed on the current MEP area (former easterly adjoining air field runway).

Historical research documentation including historical aerial photographs, topographical maps, fire insurance maps, and city directories are included in Appendix D.

4.4.1 Topographic Maps

CH2M HILL reviewed historical King City/Bryson and Cosio Knobb/Jolon 7.5-minute series topographic maps of the Property provided by FirstSearch (FirstSearch, 2012b). A summary of the findings are presented in the following table.

Year Revised	Property	Surrounding Properties
1919 King City/Bryson Quadrangles	No structures on Property.	No structures on adjoining properties. Three structures present approximately 0.75 miles north of the Property. One unnamed roadway located on the north side of the Property.
1939 King City/ 1941Bryson Quadrangles	No observable changes.	One additional structure depicted to northwest. No other observable changes from previous topographic map.
1948 King City/Bryson Quadrangles	No observable changes.	A new roadway is depicted adjoining the west side of the Property and the Hunter Liggett Airfield is depicted to the east of the Property. Additional structures are depicted to the northwest of the Property and one "tank" and two structures are depicted to the north of the Property.
1949 Cosio Knobb and Jolon Quadrangles	No observable changes.	No observable changes from previous topographic map.
1961 King City/Bryson Quadrangles	No observable changes.	Additional structures are depicted to the north and east of the Property. A control tower and heliport were depicted to the south of the Property. One sewage disposal area was depicted west of the Property.
1984 Cosio Knobb and Jolon Quadrangles (Revision of 1949)	No observable changes.	Additional structures depicted to the north and east of the Property. No other changes present from the previous (1949) Cosio Knobb and Jolon Quadrangles.

A sewage treatment area was indicated as being located west of the Property. The sewage treatment plant is topographically at a lower elevation and likely hydraulically downgradient of

the Property. Therefore, the sewage treatment site is likely no concern to the Property. No other landfills or other environmentally significant features are identified on the topographical maps.

4.4.2 Historical Maps

Sanborn maps constitute a source of prior site uses of real property for many cities and towns in the United States. The maps originally were created to assist insurance underwriters in understanding the potential fire risk of structures requiring insurance; however, they also are useful in determining the previous uses of a property. Sanborn maps often contain information relating to uses of individual structures, location of certain petroleum and chemical storage tanks, and the storage of other potentially toxic substances. Sanborn maps begin their coverage in 1867 and continue through the 1990s.

FirstSearch searched for Sanborn maps. This search did not identify Sanborn map coverage in the vicinity of the Property.

4.4.3 Aerial Photographs

Aerial photographs provide visual documentation of site conditions at the time of the photographs. Activities such as dumping or industrial use of a site can often be discerned through the examination of historical aerial photographs. CH2M HILL reviewed historical aerial photographs provided by FirstSearch (FirstSearch, 2012c) and Elisabeth Clark of the FHL DPW. The aerial photographs are included in Appendix D. The following is a synopsis of the aerial photographs reviewed.

Year	Property	Adjacent and Surrounding Properties
1939	Two access roads visible as passing through Property. No development observed on the Property.	Undeveloped areas adjoining and surrounding the Property to the north, east, south, and west.
1960	Access roads are no longer visible. No other observable differences from previous aerial photograph.	Mission Road to the west, Bradley Drive to the north, and Route Tampa to the east are present. Airplane runway is apparent beyond Route Tampa to the east. Development of other roadways surrounding the Property to the north and east are apparent.
1989	No observable changes for the Property from the 1960 aerial photograph.	Former airplane runway to east no longer present. Buildings are present immediately east of the Property, and numerous buildings are present to the northeast of the Property. The area south of the Property has been developed.
1994	No observable differences from 1989 aerial photograph.	No observable differences from the 1989 aerial photograph.

Year	Property	Adjacent and Surrounding Properties
2007	No observable differences from 1989 aerial photograph.	Equipment staging area is depicted on the former runway area southeast of the Property. No other observable differences from the1989 aerial photograph.

4.4.4 City Directories

City directories provide tenant listings, by address, for every year covered by the directory service. The FirstSearch city directory abstract included a directory review for the Property and adjacent properties for the following years: 1959, 1992, 2000, 2004, and 2007. Research detail sources were not available through FirstSearch for the Property or adjacent properties. The report did identify one property on Bradley Lockwood Road in Lockwood, California; however, this property is located over 10 miles from the Property, and is not considered relevant to this report (FirstSearch, 2012d). A complete copy of the FirstSearch city directory abstract is included in Appendix D.

4.4.5 Chain-of-Title

This section refers to title records which may provide information relating to previous owners and previous uses of the Property. No title record information has been provided to or acquired by CH2M HILL in the course of this ECP report, as the Property is known to have been owned and operated by the current site owner (USAR) since 1940. Therefore, no chain-of-title search was conducted for the Property.

4.4.6 Previous Reports

CH2M HILL has reviewed the following previous reports or documents related to the environmental condition of the Property. Copies of these documents are included in Appendix G.

Remedial Design Building 194 Area, Fort Hunter Liggett, California. April 2011.

The Building 194 Area is located approximately 0.5 miles northwest of the Property.

The Final Remedial Design for Building 194 was completed by MACTEC Engineering and Consulting, Inc. for the USACE and presents the selected remedy to remediate two petroleum releases to groundwater (located approximately 0.75 miles north of the Property). Three storage tanks were present at this location in the past, two 12,000-gallon gasoline USTs installed in 1958, and one waste oil UST installed in 1964. In 1981, a leak was discovered in one of the gasoline tanks. The tank was removed and replaced with a single-walled fiberglass UST. Oversight of the removal of the second gasoline tank in 1992 was performed by Ecology and Environment, Inc. (E&E). E&E indicated that strong odors were observed during the removal. Volatile organic compounds; benzene, toluene, ethylbenzene, and xylenes are present in groundwater of the site as a result of the leak.

The waste oil UST was removed in 1991 per guidance from the Monterey County Department of Health, Environmental Branch (MCDOH). Petroleum impacted soil surrounding the UST was observed during its removal.

The following is a record of remediation activities:

- Groundwater monitoring: conducted for the years of 1994, 1995, 1998, 2001-2004, and 2007-2010.
- Contaminated soil excavation: from 1996 to 1998, soil was excavated from the former gasoline UST locations and conveyance lines.
- Contaminated soil excavation: in 1997, impacted soils were removed from the area of the waste oil UST.
- Monitored natural attenuation was selected as the remedy for the release.

Groundwater flow direction at Building 194 where the release occurred is complex, due to near surface impenetrable bedrock. Flow of the contaminated groundwater plume from the release point is initially to the west, and then the flow begins to follow more regional flow directions and turns to the south. The plume is located approximately 0.4 miles northeast of the Property at its closest point, and is hydraulically up gradient.

Building 258 Area Site Characterization Report, Fort Hunter Liggett, California. February 2012.

The Building 258 Area is located approximately 1,000 feet east of the Property.

The characterization report for the Building 258 area was completed by AMEC to delineate the extent of groundwater contamination caused by a UST line rupture presumably from the October 1989 Loma Prieta earthquake. Strong odors and fuel were observed in a nearby surface water ditch. Four USTs were located in this area: one 10,000-gallon gasoline UST; two 10,000- and one 25,000-gallon diesel fuel USTs. The location of the release is approximately 700 feet east of the Property on 7th Division Road. No contamination from this site has been detected on the Property.

- In November 1989, all four USTs were removed from the ground. Total petroleum hydrocarbons (TPH) as gasoline and diesel fuel were found in soils within the UST excavations.
- Soil removal was conducted in the area contaminated with diesel fuel. Soil was excavated to a depth of approximately 22 feet bgs. Confirmation sampling indicated TPH results were below MCDOH cleanup levels of 100 milligrams per kg, and MCDOH approved closure of the site (diesel fuel release).
- Groundwater monitoring has occurred at the site since 2002. Analysis of the groundwater data indicates that the petroleum hydrocarbon contamination plume is relatively confined within a narrow bedrock channel. The contaminated groundwater plume is located approximately 300 feet southeast of the Property at its closest point. Due to the channelized nature of the groundwater flow from the presence of impermeable bedrock up gradient of the Property, the plume has remained narrow and is experiencing very little diffusion cross-gradient.
- A Soil Vapor Extraction (SVE) pilot study was conducted in 2007. The study was successful and the SVE system was expanded in 2009 and treatment began. Approximately 29,700 gallons of gasoline was extracted using this system to date.

4.5 Historical Use Information on Adjoining Properties

Historical use of adjoining properties as identified in available historical resources have been described previously in Sections 4.4.1 to 4.4.4. It is documented that petroleum hydrocarbon contaminated groundwater is present on adjoining properties to the north and east of the Property associated with the releases from the Buildings 194 and 258 areas. No other adjoining or immediately surrounding Properties were known to have historical activities considered a concern for the Property.

SECTION 5

Site Reconnaissance

5.1 Methodology and Limiting Conditions

CH2M HILL conducted a site visit on March 6, 2012 to obtain information for this ECP report. No Property representatives were present during the site walk. The purpose of the site visit was to identify any recognized environmental conditions associated with the Property. The following observations were based on conditions of the Property at the time of the visual site reconnaissance. Locations of pertinent observations are depicted in the Photograph Log (Appendix C) and on Figures 2 and 3 in Appendix B.

The visual reconnaissance included traversing the Property perimeter and transects of the Property on foot. There were no limiting factors associated with visual observations on the Property or surrounding properties.

5.2 General Site Setting

The following observations were based on conditions of the Property at the time of the visual site reconnaissance. The Property is approximately 54.8 acres in size. The Property is bounded by Mission Road to the west, Route Tampa to the east, and undeveloped land to the south. A Property Features map is included in Appendix B. The Property is accessible by a gravel access road from Route Tampa, through a gate. The Property and surrounding areas are relatively flat with an approximate surface elevation of 1,040 feet above mean sea level.

Adjoining Property Use

Mission Road and undeveloped land borders the Property to the west. Route Tampa and the FHL Recreation Center borders the Property to the east. Adjoining the Property to the south is undeveloped land. A temporary access control point for FHL is located on Bradley Drive (Photographs 11 and 16, Appendix C). There was no visual evidence, as observed from the Property periphery, of any recognized environmental conditions on the adjoining/surrounding properties. These sites were not identified in the CER.

5.3 Exterior Observations

Overhead transmission lines were located in the central and eastern portions of the Property. One pole-mounted electrical transformer was located in the center of the Property south of the access control point (Photograph 12, Appendix C). No label indicating the transformer was "Non-PCB Containing" was visible: however, Michael Moeller (Compliance Branch Manager for the FHL DPW Environmental Division) indicated that all transformers on the garrison have been tested to ensure they comply with a "non-PCB containing" designation. A water utility line oriented north-south crosses the Property's west side. Sanitary sewer utilities were located on the west, south, and central portions of the Property. Telecommunication (fiber optic) lines were located in the southeast corner of the Property.

The Property is bounded on its west side with a chain-linked fence and the portion of the Property south of Bradley Drive is used as a temporary MEP area at the time of site reconnaissance. The MEP area was completely enclosed by a chain-linked fence. General equipment staging locations are as follows: HMMWVs in the northeastern corner; tractor trucks and trailers central portion and southeast corner; troop transports in the southwest corner; trailer-mounted temporary lights and generators in the western central portion of the MEP; and empty tanker trailers in the northwest corner of the MEP. The remainder of the Property contained Bradley Drive and the access control point and undeveloped land north of Bradley Drive that Sulphur Spring Creek flowed through.

The site reconnaissance included visually assessing the Property for the presence of hazardous substances and petroleum products, drainages, paths, and potential sources of pollutant releases (odors, pools of liquid, stains, septic systems, drums, PCBs, drains and sumps, lagoons, stressed vegetation, etc.). No recognized environmental conditions were observed on the exterior of the Property exterior during the March 6, 2012 site reconnaissance.

5.4 Interior Observations

There were no structures located on the Property; therefore, this section is not applicable.

SECTION 6

Interviews

This section summarizes relevant information obtained from the interviews conducted by CH2M HILL from March 6, 2012 through March 30, 2012. A list of persons interviewed, as well as those from whom an interview was requested, is listed in Section 2.2.2. Interview documentation is presented in Appendix F.

6.1 Interview with Owner

Mr. Gary Houston, Environmental Chief of the FHL DPW Environmental Division, and representative of the current owner, the USARC, was interviewed in person on March 6, 2012. Mr. Houston indicated the Property is undeveloped and was being used temporarily for MEP at the time of the site reconnaissance, due to construction of a solar array on the actual MEP location. Mr. Houston indicated he has never known the Property to have been used in the past. Mr. Houston has been working at FHL and familiar with the Property since the 1980s. Mr. Houston was unaware of any recognized environmental conditions associated with the Property.

Mr. Houston did indicate that the area west of the Property known as the Building 258 Area, had experienced UST leaks with four 15,000-gallon diesel fuel USTs, that occurred as a result of the 1989 Loma Prieta earthquake and that all fuel within the tanks was released into the ground. Subsequent remedial efforts have delineated the extent of the plume and a remedial action has been implemented for the spill and associated plume. According to Mr. Houston, the Property has not been impacted by the groundwater plume associated with the Building 258 Area.

Mr. Houston was asked whether he was aware of: (1) any pending, threatened, or past litigation relevant to hazardous substances or petroleum products in, on, or from the property; (2) any pending, threatened, or past administrative proceedings relevant to hazardous substances or petroleum products in, on or from the property; and (3) any notices from any governmental entity regarding any possible violation of environmental laws or possible liability relating to hazardous substances or petroleum products. Mr. Houston responded that he was not aware of any environmental liens, restrictions or violations against the property.

Helpful Documents

Mr. Houston was aware of documentation records existing for areas near the Property, but was not aware of any records existing for the Property. Mr. Houston indicated Mr. Mark Grindstaff and Mr. Michael Moeller would know where to find documentation for the Property, if it exists, and could also provide documentation for sites near the Property. Contact information was provided for these additional resources.

6.2 Interviews with Occupants

6.2.1 Occupant Interview - Moeller

Mr. Michael Moeller, Compliance Branch Manager of the USAG FHL DPW Environmental Division, was interviewed in person on March 6, 2012. Mr. Moeller indicated that the Property had never been developed, and that it currently is utilized as temporary MEP while construction of solar arrays on the actual MEP is completed.

Mr. Moeller indicated that the adjoining properties to the north and east have groundwater contamination associated with a release from the Building 258 Area, where one UST was found to be leaking. Mr. Moeller, as the Compliance Branch Manager, is more familiar with the data and information related to this release than Mr. Houston; Mr. Moeller's account and documentation provided indicate that only one of the four USTs in this area had leaked. The release occurred east of the Property and an associated plume of contaminated groundwater passes close to the Property to the east and south.

Mr. Moeller also indicated there was a groundwater contamination issue further north of the Property at Building 194, the former AAFES station. At this location, a leaking gasoline UST contaminated groundwater in the general vicinity of the release, but does not impact the Property. Mr. Moeller was unaware of any other recognized environmental conditions associated with the Property.

Mr. Moeller indicated that to the best of the FHL DPW Environmental Division knowledge, documented releases from Building 194 and the Building 258 Areas have not affected groundwater of the Property. Mr. Moeller was asked whether he was aware of: (1) any pending, threatened, or past litigation relevant to hazardous substances or petroleum products in, on, or from the property; (2) any pending, threatened, or past administrative proceedings relevant to hazardous substances or petroleum products in, on or from the property; and (3) any notices from any governmental entity regarding any possible violation of environmental laws or possible liability relating to hazardous substances or petroleum products. Mr. Moeller responded that he was not aware of any environmental liens, restrictions or violations against the Property.

Helpful Documents

Mr. Moeller provided the Site Characterization Report for the Building 258 release as well as the Remedial Design Building report for the Building 194 release. He indicated he was unaware of further documentation related to the environmental condition of the Property.

6.2.2 Occupant Interview - Clark

Ms. Elizabeth Clark, Wildlife Biologist for the USAG FHL DPW Environmental Division, was interviewed in person on March 6, 2012. Ms. Clark indicated that the Property had never been developed, and that it currently is utilized as temporary MEP while construction of solar arrays on the actual MEP, southeast of the Property, is completed.

Ms. Clark was unaware of any spills or releases of hazardous substances on the Property. Ms. Clark indicated she has been familiar with the Property since the 1990s and has never known the Property to be used for anything in the past.

Ms. Clark was asked whether she was aware of: (1) any pending, threatened, or past litigation relevant to hazardous substances or petroleum products in, on, or from the property; (2) any pending, threatened, or past administrative proceedings relevant to hazardous substances or petroleum products in, on or from the property; and (3) any notices from any governmental entity regarding any possible violation of environmental laws or possible liability relating to hazardous substances or petroleum products. Ms. Clark responded that she was not aware of any environmental liens, restrictions or violations against the Property.

Helpful Documents

Ms. Clark indicated Mr. Gary Houston, Mr. Mark Grindstaff, and Mr. Michael Moeller would know where to find documentation for the Property, if it exists, and could also provide documentation for sites near the Property. Contact information was provided for these additional resources.

6.2.3 Occupant Interview – Grindstaff

Mr. Mark Grindstaff, Division Manager of the USAG FHL DPW Operation and Maintenance Division, was interviewed in person on March 6, 2012. Mr. Grindstaff indicated that to the best of his knowledge, the Property has been always been undeveloped, but is currently used for MEP. Mr. Grindstaff was unaware of any spills or releases of hazardous substances on the Property. Mr. Grindstaff was not aware of any environmental liens, restrictions or violations against the Property.

Helpful Documents

Mr. Grindstaff indicated he was not aware of specific documentation and that Mr. Michael Moeller would likely have information regarding documents relating to the environmental condition of the Property.

6.3 Interviews with Local Government Officials

6.3.1 Fort Hunter Liggett Fire Department

An interview was conducted on March 30, 2012 with Assistant Fire Chief, Jeff Minetti of the Fort Hunter Liggett Fire Department for records regarding current and historic storage, disposal, or use of hazardous or petroleum materials on the Property or adjoining properties.

Interview Information

Mr. Minetti indicated that to the best of his knowledge, the Fort Hunter Liggett Fire Department maintains no documentation for the Property relating to spills, storage tanks, or other environmental concerns. Mr. Minetti indicated that these files are maintained by the Environmental Division.

Helpful Documents

Mr. Minetti was unaware of any existing documentation related to the environmental condition of the Property.

6.3.2 Monterey County – Health Department

After several telephone calls, a records request was sent to Linda Ortiz with the Monterey County Department of Health, Environmental Health Bureau, who manages records reviews for the Health and Planning Departments, on March 30, 2012.

Interview Information

Ms. Ortiz responded on [insert upon receipt of response] indicating that she had no specific knowledge of the Property, beyond its current status as an Army Reserve base.

Helpful Documents

[Will insert once a response is received.]

6.4 Interview with Others

6.4.1 Adjacent Property Owner

The Property is completely surrounded by Fort Hunter Liggett; therefore, there are no adjacent property owners.

6.4.2 Others

No others were identified for interview.

SECTION 7

Findings

The ECP did not develop any information indicating the existence of a known or suspected *de minimis* condition, historical recognized environmental condition, or recognized environmental condition at the Property.

SECTION 8

Opinion

In my opinion, as the Environmental Professional conducting the investigation and preparation of this ECP, no *de minimis* conditions, historical recognized environmental conditions, or recognized environmental conditions exist on the Property.

SECTION 9

Conclusions

CH2M HILL has performed this ECP (Phase I Environmental Site Assessment) in conformance with the scope and limitations of ASTM Practice E1527-05 of the Property. Any exceptions to, or deletions from, this practice are described in Section 2.2. This assessment has revealed no evidence of recognized environmental conditions in connection with the Property.

SECTION 10

Deviations

This report was prepared in general accordance with ASTM E1527-05. There are no known deviations from the ASTM standard.

SECTION 11

Additional Services

This section outlines additional services contracted for between the User and CH2M HILL, including but not limited to, a broader scope of assessment, more detailed conclusions, liability/risk evaluations, recommendation for Phase II testing, remediation techniques, etc. Sections 11.8 and 11.9 are intended to provide only a cursory review of these items at the time of the site reconnaissance, and may not satisfy the requirements as set forth by the National Environmental Policy Act.

11.1 Asbestos-containing Material

There were no structures located on the Property; therefore, this section is not applicable.

11.2 Radon

Radon is a naturally occurring colorless, odorless gas that is a byproduct of the decay of radioactive materials potentially present in bedrock and soil. Radon gas may enter the lowest level of a building through floor cracks, structural joints, or plumbing conduits. The concentration of radon gas in a building depends on subsurface soil conditions, the integrity of the building's foundation, and the building's ventilation system. The potential adverse health effects associated with radon gas depend on various factors, such as the concentration of the gas and duration of exposure. The USEPA guidance action level for annual residential exposure to radon is 4 picoCuries per liter (pCi/L) of air. The guidance action level is not a regulatory requirement for private owners of real property, but is commonly used for comparison purposes to suggest whether further action at a building may be prudent.

CH2M HILL reviewed information on the USEPA Map of Radon Zones website. Monterey County, California, was listed as a Zone 2 county with an average predicted indoor radon screening level between 2 pCi/L and 4 pCi/L, with 4 pCi/L being the recommended action level established by USEPA (USEPA, 2011).

11.3 Lead-based Paint

There were no structures located on the Property; therefore, this section is not applicable.

11.4 Mold

There were no structures located on the Property; therefore, this section is not applicable.

11.5 100-Year Flood Zone

Review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map panel numbers 06053C1325G and 06053C1575G indicated that the area of the northern portion of the Property surrounding Sulphur Spring Creek is located within the 100-year floodplain

(FEMA, 2009). The floodplain on the Property is designated as not having an established base flood elevation. A copy of the FEMA maps can be found in Appendix G.

11.6 Wetlands

The USACE and USEPA jointly define wetlands as, "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

No wetland areas are mapped by the US Fish and Wildlife Service National Wetland Inventory (2011) in the vicinity of the Property. The site reconnaissance did not reveal the presence of any obvious wetland areas.

11.7 Coastal Zone

The Property is not located within a Coastal Zone Management Zone (Butler, 2012, personal communication).

11.8 Threatened and Endangered Species

There are no known threatened or endangered species or potentially suitable habitats for threatened or endangered species on the Property. Downstream from the Property where Sulphur Spring Creek discharges into the San Antonio River, there is known habitat of the arroyo toad (Bufo californicus), an endangered species (Clark, 2012, personal communication).

11.9 Cultural Resources

There are no known archaeological resources located within the Property. A survey was conducted in 2011 of the cantonment area at FHL and no archaeological resources were discovered (Fort Hunter Liggett, 2011). A California State Historic Preservation Office (SHPO) letter dated 3 February 2012 concurred with the finding that no historic properties were identified (Donaldson, 2012, personal communication). The likelihood that cultural resources or artifacts may still be present on the Property is low. The following historic properties are located on FHL, north north-west of the Property:

- The Hacienda, also known as the Milpitas Ranch House, was constructed in 1930 in the Mission architectural style. Designed by architect Julia Morgan, it is laid out in a modified double "E" plan, with a central arcade forming the spine, and with wings projecting on either side. The Hacienda was designed as a ranch house and ranch headquarters for William Randolph Hearst. It is significant for its architecture, agriculture and for its association with William Randolph Hearst and Julia Morgan. It has been on the National Register of Historic Places since 1977. (McNeill, 1976)
- The Mission San Antonio de Padua was founded on July 14, 1771 by Father Junipero Serra. The mission was established in the land of the Salinan people. The present church onsite was completed in 1813.The Mission is significant for architecture, agriculture, engineering, and exploration, and is of regional significance as the third to be established in the chain of Franciscan Spanish missions. It has been on the National

Register of Historic Places since 1976 and is a California State Landmark (California Missions Foundation, 2012). (Arthur, 1975)

SECTION 12

References

AMEC Environment and Infrastructure (AMEC). 2012.

American Society for Testing and Materials Designation: E1527-05, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.*

Arthur, Brother Timothy. 1975. National Register of Historic Places Inventory Nomination Form, Mission San Antonio de Padua. National Park Service. August 2, 1975.

Butler, Katie/ Coastal Planner, California Coastal Commission – Central Coast District Office. 2012. Personal communication with Grant Koster/CH2M HILL on April 4, 2012.

California State Military Department. 1990. The California State Military Museum – Historic California Posts: Fort Hunter Liggett. http://www.militarymuseum.org/FtHLiggett.html . Accessed March 29, 2012.

California State Water Resources Control Board. 2012. Geotracker. http://geotracker.waterboards.ca.gov . February. Accessed on March 29, 2012.

Clark, Elizabeth/ Wildlife Biologist, US Army Garrison Fort Hunter Liggett – Directorate of Public Works Environmental Division. 2012. Personal communication with Haught, Laura/CH2M HILL on April 4, 2012.

Donaldson, Milford Wayne, FAIA. 2012. Personal communication with Gary Houston Re: Section 106 Consultation for Construction of 16 Buildings at Fort Hunter Liggett, Monterey County, CA. California Office of Historic Preservation, Department of Parks and Recreation. February 3, 2012.

FirstSearch. 2012a. *Environmental FirstSearch Environmental LienSearch Report*. April.

FirstSearch. 2012b. *Environmental FirstSearch Historical Topographic Map.* March.

FirstSearch. 2012c. *Environmental FirstSearch Historical Aerial Photo.* March.

FirstSearch. 2012d. *Environmental FirstSearch Historical Fire Insurance Maps.* March.

FirstSearch. 2012d. *Environmental FirstSearch City Directory Abstract*. April.

Federal Emergency Management Agency (FEMA). 2009. Flood Insurance Rate Map of Orange County, California and Incorporated Areas (Maps No. 06053C1325G & 06053C1575G).

Fort Hunter Liggett (FHL). 2011. Preliminary Final Integrated Natural Resource Management Plan (INRMP) and Environmental Assessment (EA). US Army Support Combat Training Complex. Fort Hunter Liggett, California. August.

McNeill, Charles L. 1976. National Register of Historic Places, Inventory Nomination Form, Milpitas Ranch House/Hacienda. National Park Service. November.

Natural Resources Conservation Service (NRCS). 2012. Online web soil survey. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. Accessed on March 7, 2012.

State of California Department of Conservation. 2007. 2010 Geologic Map of California. http://www.quake.ca.gov/gmaps/GMC/stategologicmap.html. Accessed on March 15, 2012.

United States Environmental Protection Agency (USEPA). 2011. Map of Radon Zones website, http://www.epa.gov/radon/states/california.html. Accessed on March 7, 2012.

US Fish and Wildlife Service National Wetlands Inventory. 2011. Wetlands Mapper. 2011. http://www.fws.gov/wetlands/Data/Mapper.html. Accessed on March 15, 2012.

United States Geological Survey (USGS). 2003. Physiographic Regions. http://tapestry.usgs.gov/physiogr/physio.html. Accessed on March 16, 2012.

SECTION 13

Signature(s) of Environmental Professional(s)

I declare that, to the best of my professional knowledge and belief, I meet the definition of Environmental Professional as defined in §312.10 of 40 Code of Federal Regulations (CFR) 312 and 12.13.2. I have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the Property. I have developed and performed the all appropriate inquiries in conformance with the standards and practices set forth in 40 CFR Part 312.

Andrea Naccarato
Project Manager
CH2M HILL

SECTION 14

Qualification(s) of Environmental Professional(s)

The résumé of the Environmental Professional, Andrea Naccarato, responsible for preparing this report, is included in Appendix H.

Appendix A

Property Location Map

N

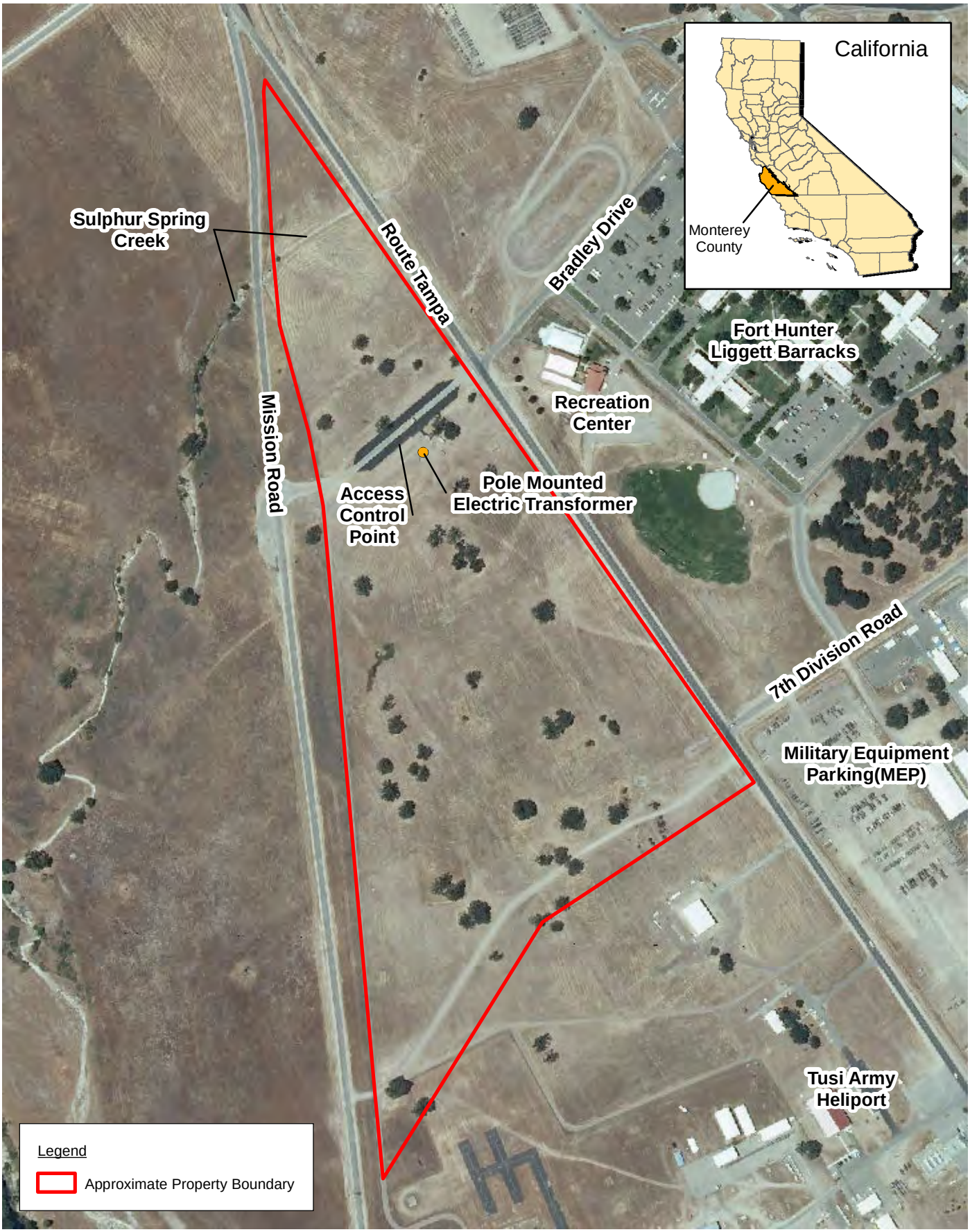
0 500 1,000

Feet

FIGURE 1
Property Location
US Army Reserve
Proposed Military Construction Project
Fort Hunter Liggett, CA

CH2MHILL

Appendix B
Property Features



N

0 225 450

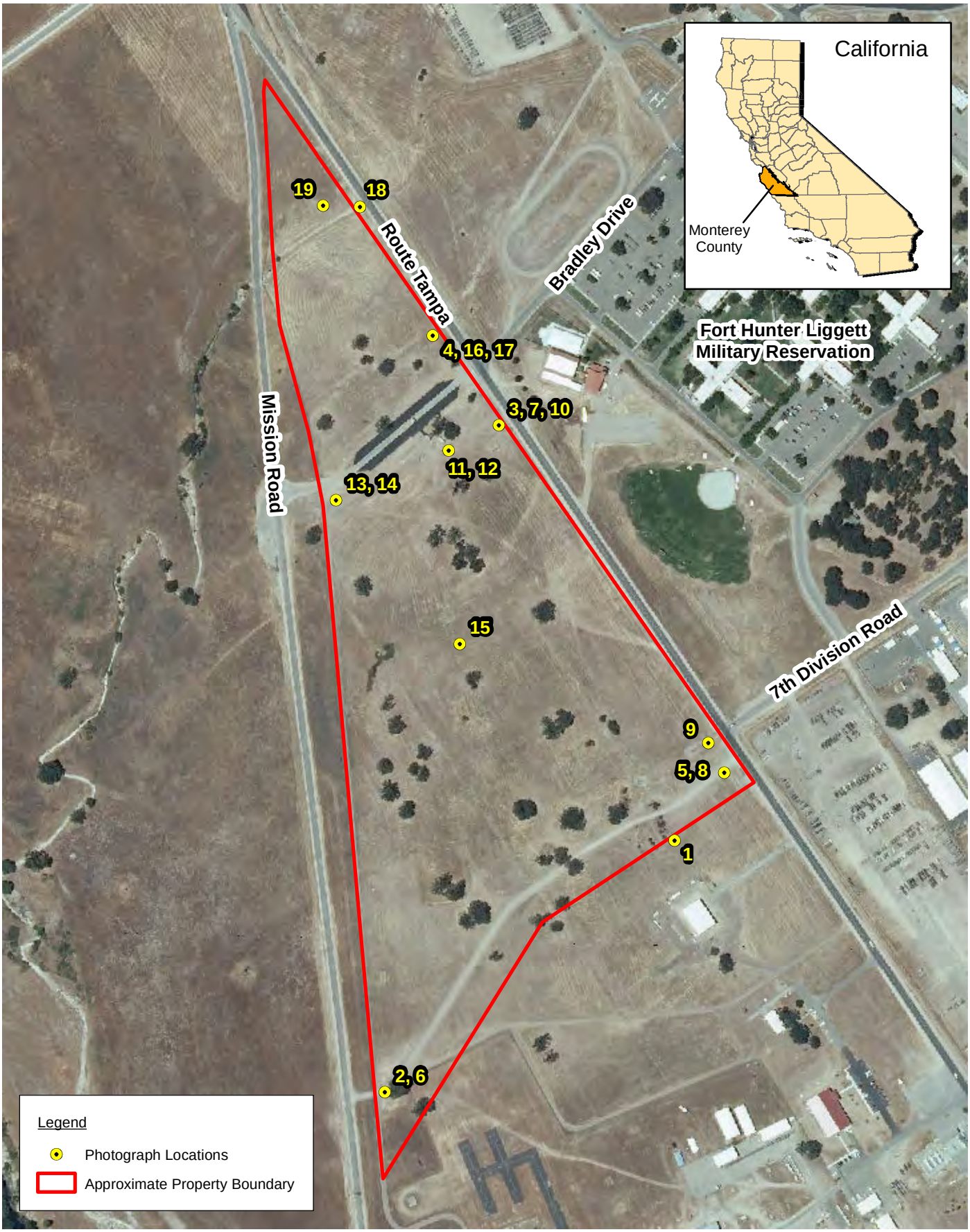
Feet

FIGURE 2
Property Features
US Army Reserve
Proposed Military Construction Project
Fort Hunter Liggett, CA

CH2MHILL

Appendix C

Site Photographs



N

0 225 450

Feet

APPENDIX C
Photograph Locations
US Army Reserve
Proposed Military Construction Project
Fort Hunter Liggett, CA

CH2MHILL

PHOTO LOG

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 1

Facing south toward the adjoining property.

PHOTO LOG

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 2

Facing west toward adjoining property.

PHOTO LOG

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 3

Facing east toward adjoining property.

PHOTO LOG

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 4

Facing north along Route Tampa, east side of the Property.

PHOTO LOG

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 5

Southeast Property corner facing southwest along the south side of the Property.

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 6

Southwest Property corner facing north along west Property border.

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 7

Facing south along the east border of the Property.

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 8

Facing north along the eastern portion of the Property.

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 9

Southern interior of the Property facing west.

Project Name: US Army Reserve Center – Fort Hunter Liggett, California Environmental Condition of Property Report	
Task: Site Walkover	Taken by: Grant Koster– March 7, 2012

Photograph 10

Facing west toward interior of the Property.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 11

Facing northwest toward Bradley Drive access control point.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 12

Pole-mounted electrical transformer, located south of access control point.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 13

Facing north toward northern portion of the Property.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 14

Corner of Bradley Drive and Mission Road facing southeast toward interior of Property.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Grant Koster– March 7, 2012

Photograph 15

Facing west - trailers containing temporary lights and generators.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Photographed by: Laura Haught– March 7, 2012

Photograph 16

Facing west towards interior of the Property north of Bradley Drive, from Route Tampa.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Taken by: Laura Haught– March 7, 2012

Photograph 17

Facing northwest toward the northern portion of the Property.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Taken by: Laura Haught– March 7, 2012

Photograph 18

Dry bed of Sulphur Springs Creek facing west.

PHOTO LOG

Project Name: US Army Reserve Center– Fort Hunter Liggett, California, Environmental Condition of Property Report	
Task: Site Reconnaissance	Taken by: Laura Haught– March 7, 2012

Photograph 19

Facing southeast toward under road channel of Sulphur Springs Creek.

Appendix D

Historical Research Documentation

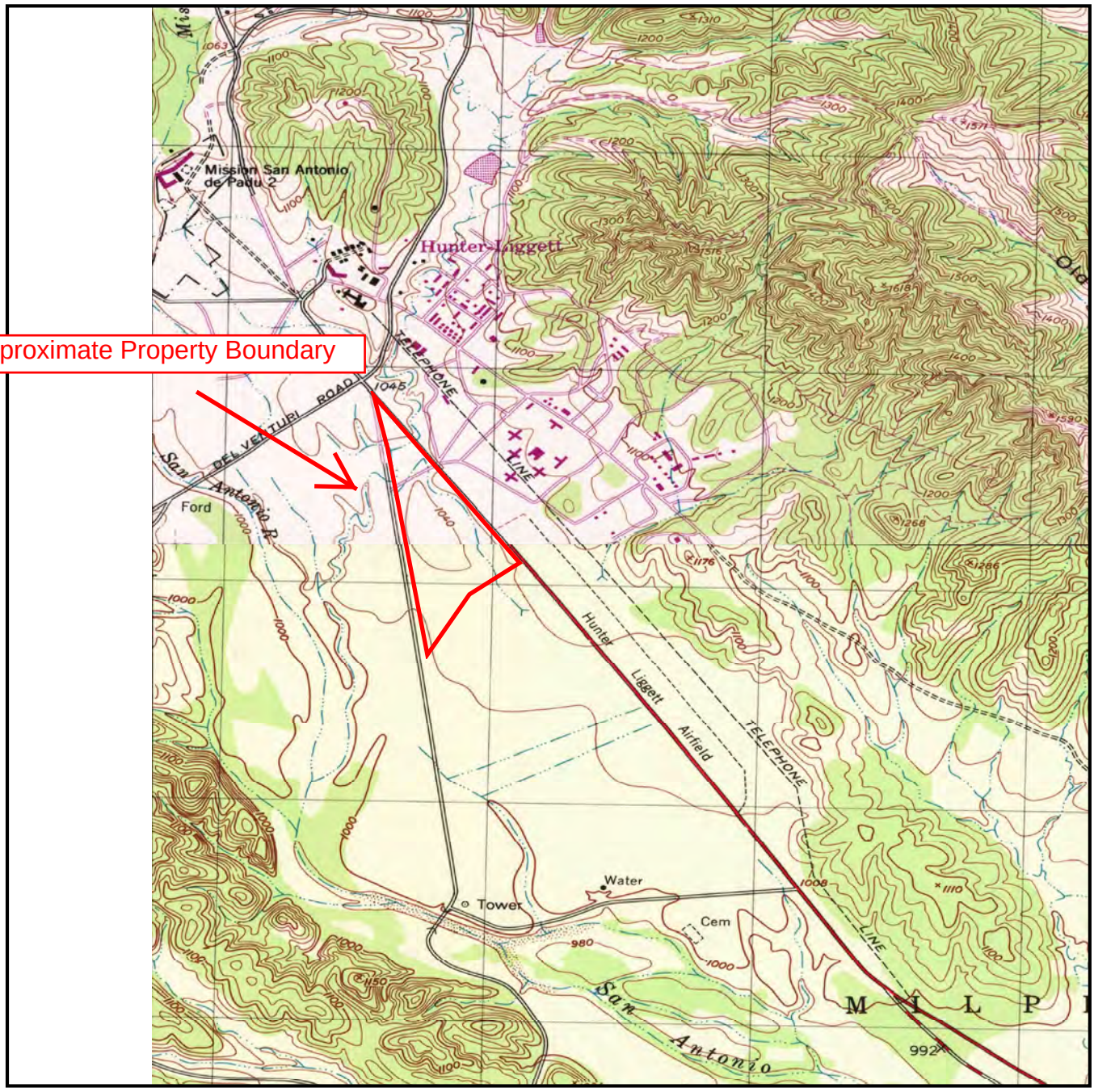
TOPOGRAPHIC MAPS

Environmental FirstSearch

Historical Topographic Map

Quad Name: Cosio Knob, CA
Year: 1949 (Revised 1984) Original Map Scale: 1: 24000

INFANTRY RD, LOCKWOOD, CA



Job Number: 426649.01.04.EC
Target Site: -121.238830, 36.000091

S Quad Name: Jolon, CA
Year: 1949 Original Map Scale: 1: 24000

0 miles 0.625 1.25

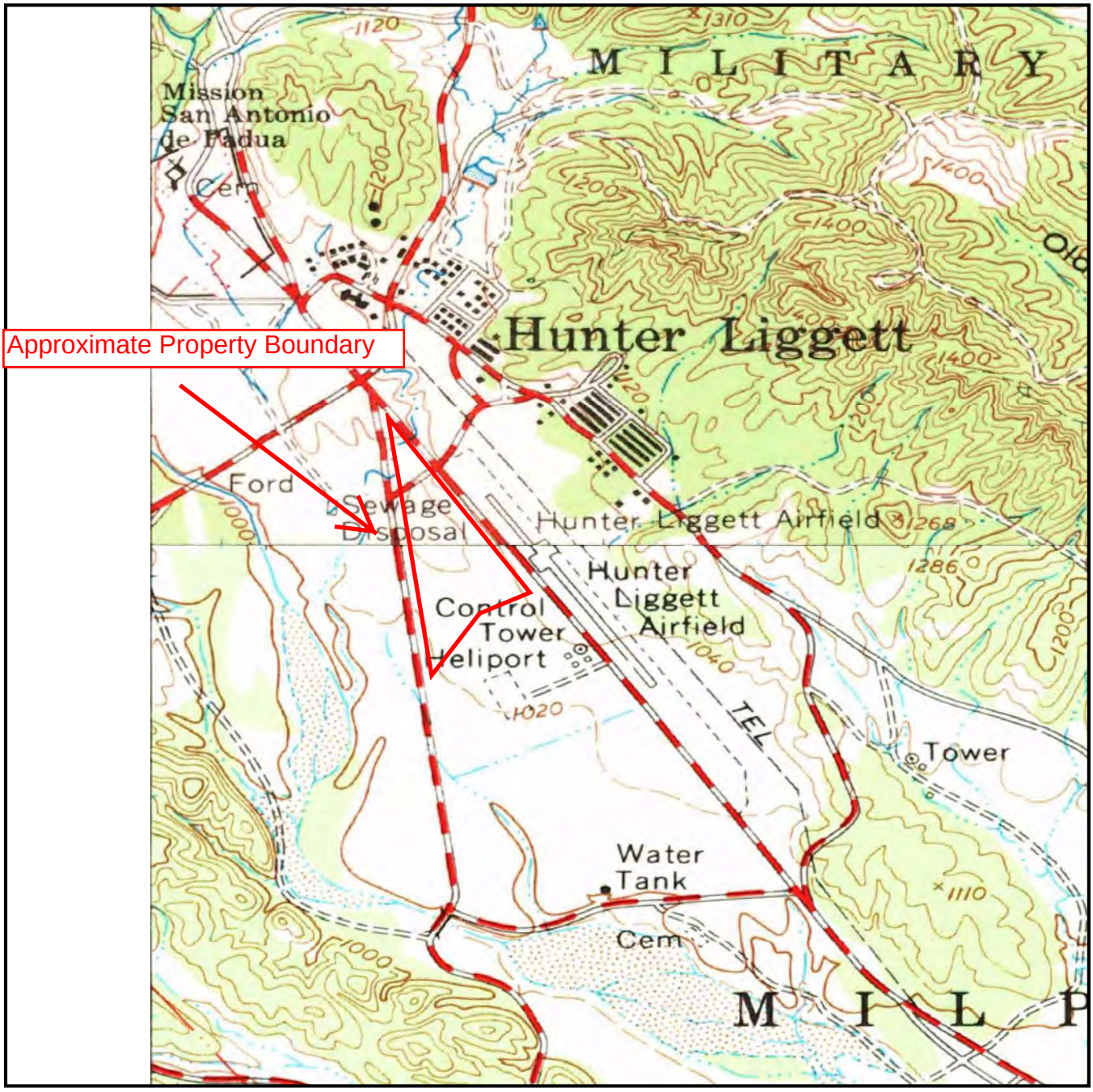
Building
Topo Contour
Depression
Quarry or Open Pit Mine
Railroad
Tanks
Primary Highway
Trail

Environmental FirstSearch

Historical Topographic Map

Quad Name: King City, CA
Year: 1961 Original Map Scale: 1: 62500

INFANTRY RD, LOCKWOOD, CA



Job Number: 426649.01.04.EC
Target Site: -121.238830, 36.000091

S Quad Name: Bryson, CA
Year: 1961 Original Map Scale: 1: 62500

0 miles 0.625 1.25

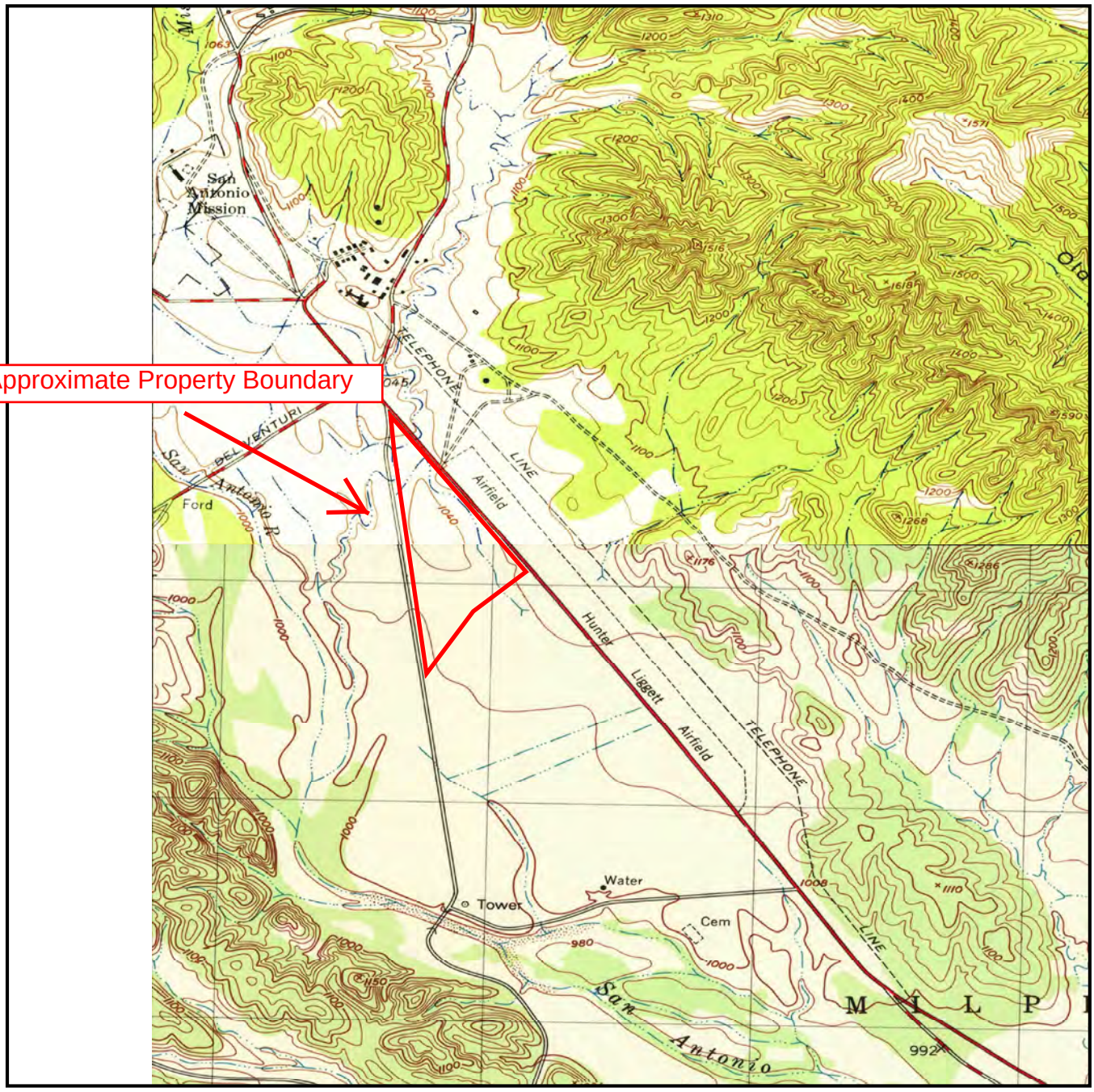
Building
Topo Contour
Depression
Quarry or Open Pit Mine
Railroad
Tanks
Primary Highway
Trail

Environmental FirstSearch

Historical Topographic Map

Quad Name: Cosio Knob, CA
Year: 1949 Original Map Scale: 1: 24000

INFANTRY RD, LOCKWOOD, CA



Job Number: 426649.01.04.EC
Target Site: -121.238830, 36.000091

S Quad Name: Jolon, CA
Year: 1949 Original Map Scale: 1: 24000

0 miles 0.625 1.25

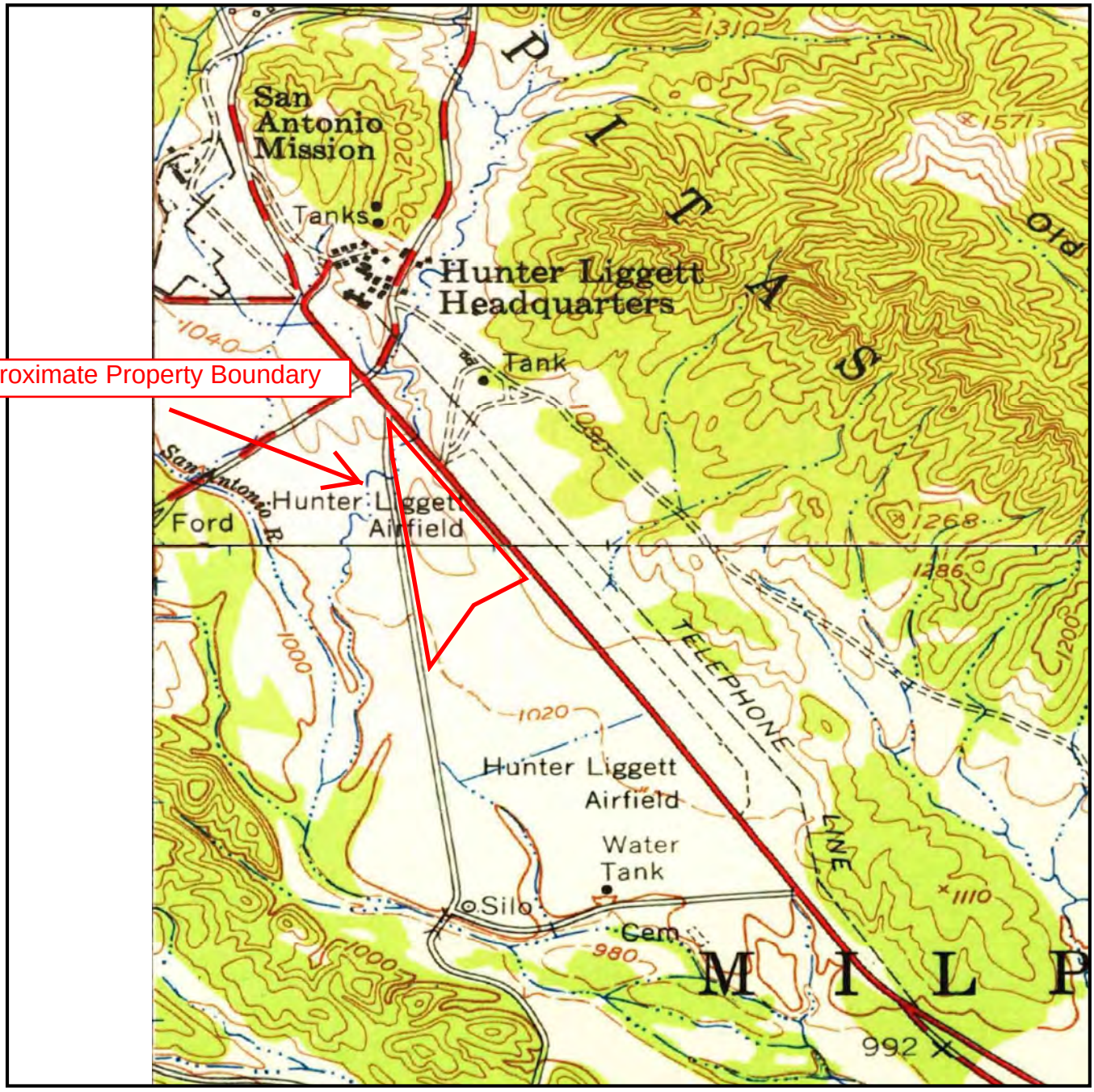
Building
Topo Contour
Depression
Quarry or Open Pit Mine
Railroad
Tanks
Primary Highway
Trail

Environmental FirstSearch

Historical Topographic Map

Quad Name: King City, CA
Year: 1948 Original Map Scale: 1: 62500

INFANTRY RD, LOCKWOOD, CA



Job Number: 426649.01.04.EC
Target Site: -121.238830, 36.000091

S Quad Name: Bryson, CA
Year: 1948 Original Map Scale: 1: 62500

0 miles 0.625 1.25

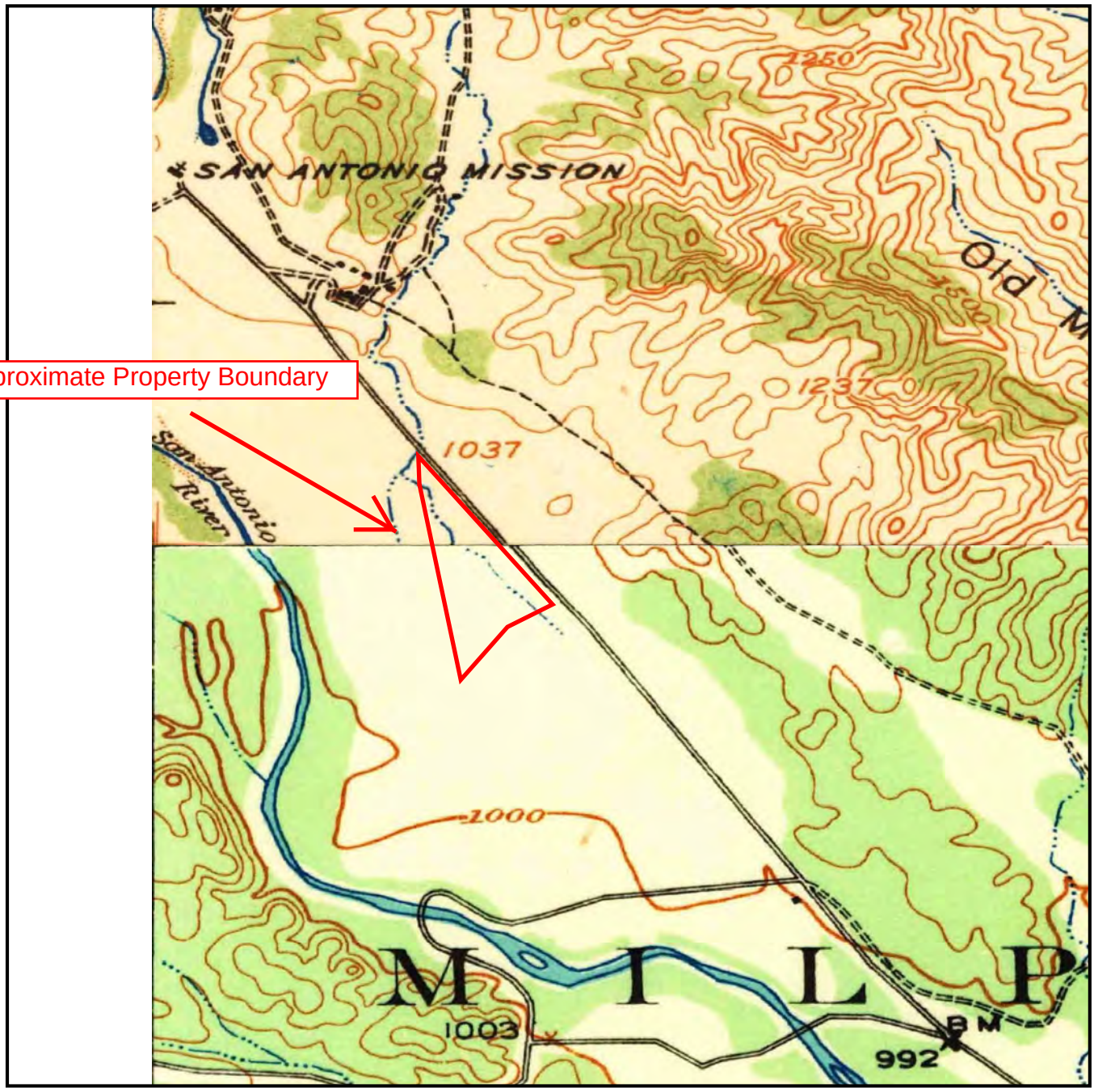
Building
Topo Contour
Depression
Quarry or Open Pit Mine
Railroad
Tanks
Primary Highway
Trail

Environmental FirstSearch

Historical Topographic Map

Quad Name: King City, CA
Year: 1939 Original Map Scale: 1: 62500

INFANTRY RD, LOCKWOOD, CA



Job Number: 426649.01.04.EC
Target Site: -121.238830, 36.000091

S Quad Name: Bryson, CA
Year: 1941 Original Map Scale: 1: 62500

0 miles 0.625 1.25

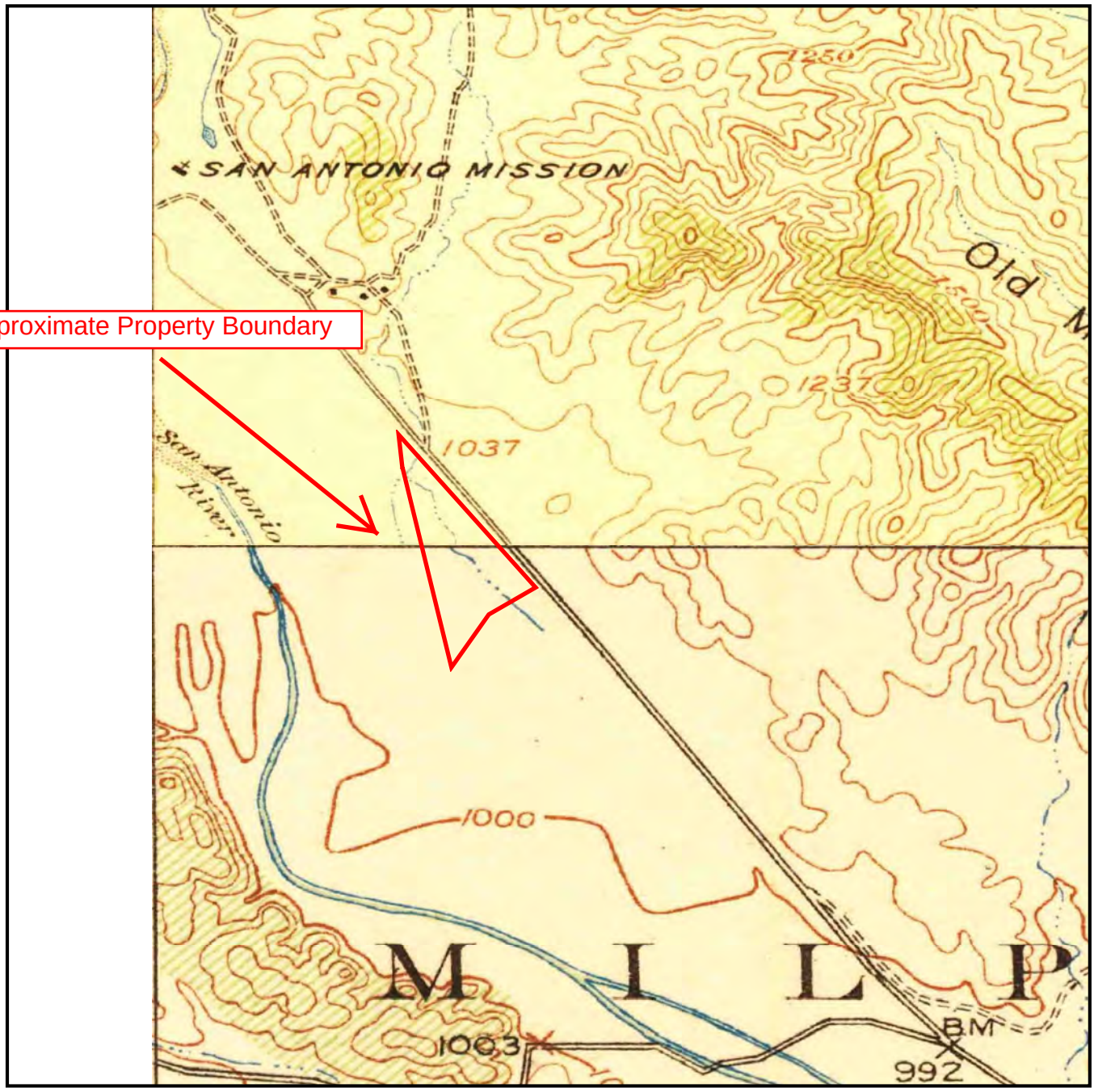
Building
Topo Contour
Depression
Quarry or Open Pit Mine
Railroad
Tanks
Primary Highway
Trail

Environmental FirstSearch

Historical Topographic Map

Quad Name: King City, CA
Year: 1919 Original Map Scale: 1: 62500

INFANTRY RD, LOCKWOOD, CA



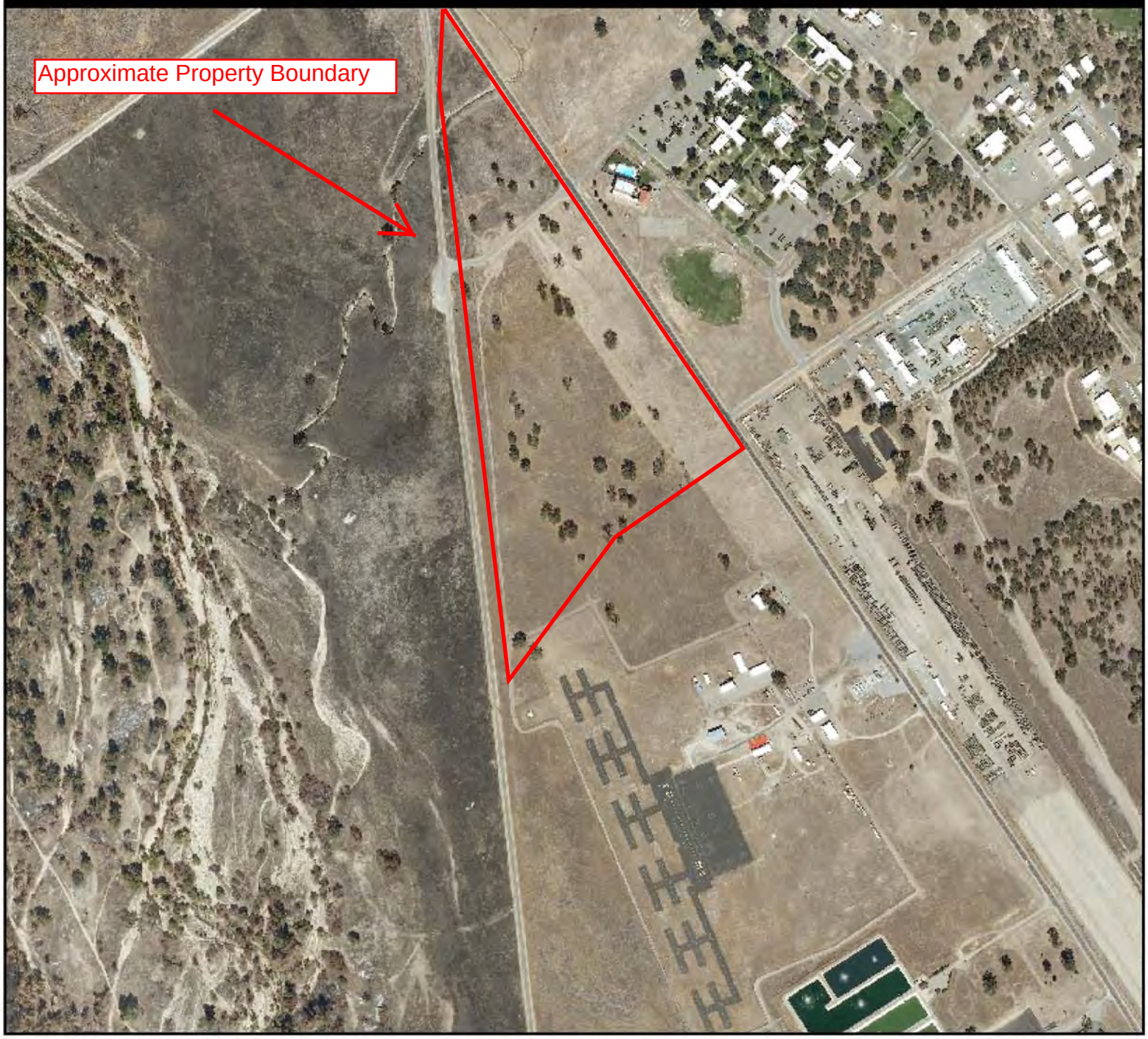
Job Number: 426649.01.04.EC
Target Site: -121.238830, 36.000091

S Quad Name: Bryson, CA
Year: 1919 Original Map Scale: 1: 62500

0 miles 0.625 1.25

Building
Topo Contour
Depression
Quarry or Open Pit Mine
Railroad
Tanks
Primary Highway
Trail

AERIAL PHOTOGRAPHS



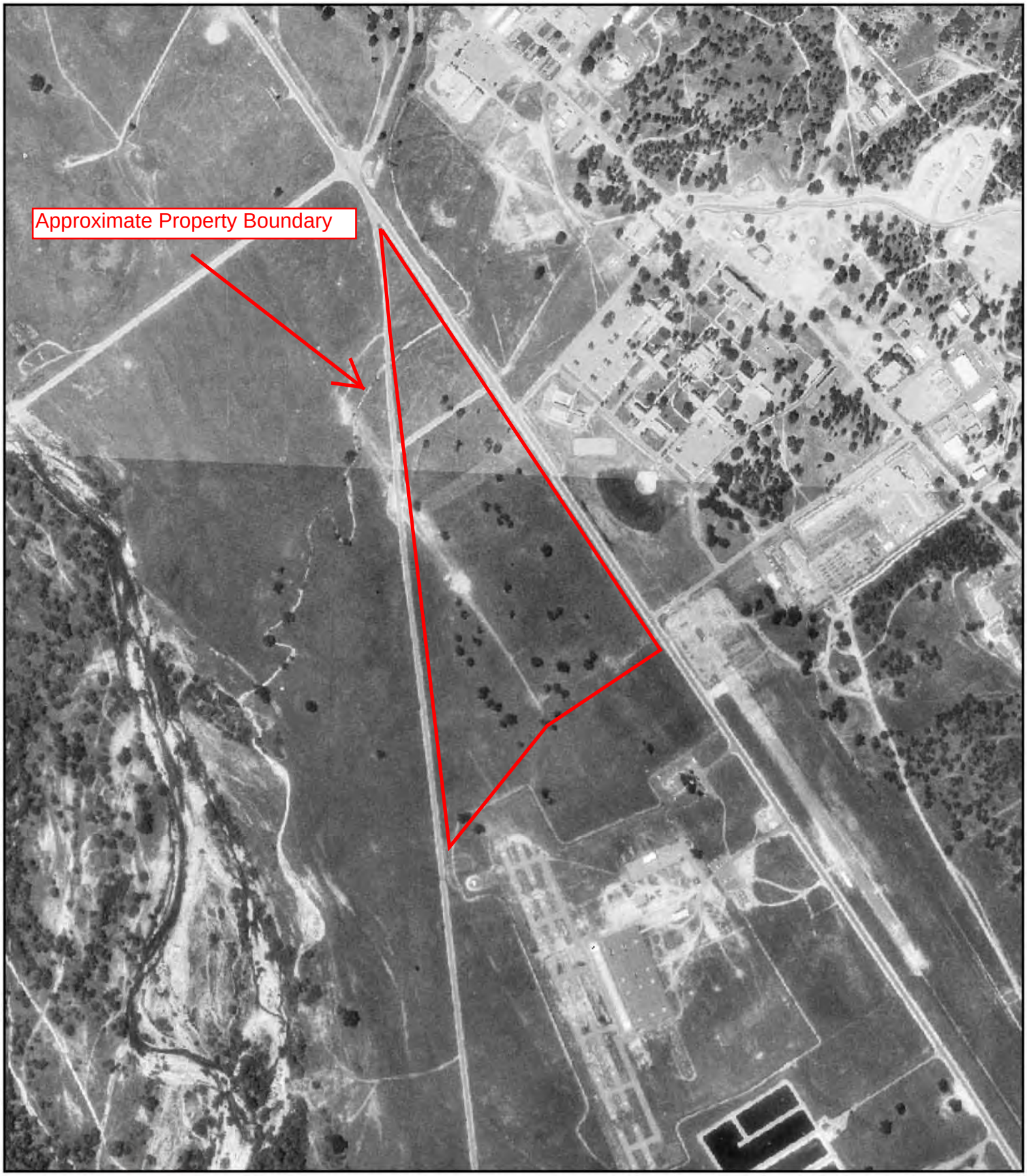
Historical Aerial Photo
2007

INFANTRY RD
LOCKWOOD, CA 93932

Target Site: 36.000091 -121.23883; Job Number: 426649.01.04.EC

N
W E
S

1 inch equals 750 feet



Historical Aerial Photo
1994
INFANTRY RD
LOCKWOOD, CA 93932

Target Site: 36.000091 -121.23883; Job Number: 426649.01.04.EC

N
W E
S

1 inch equals 750 feet

Historical Aerial Photo
1989

INFANTRY RD
LOCKWOOD, CA 93932

Target Site: 36.000091 -121.23883; Job Number: 426649.01.04.EC

N
W E
S

1 inch equals 750 feet

Historical Aerial Photo
1960

INFANTRY RD
LOCKWOOD, CA 93932

Target Site: 36.000091 -121.23883; Job Number: 426649.01.04.EC

N
W E
S

1 inch equals 750 feet

Historical Aerial Photo
1939

INFANTRY RD
LOCKWOOD, CA 93932

Target Site: 36.000091 -121.23883; Job Number: 426649.01.04.EC

N
W E
S

1 inch equals 750 feet

SANBORN MAPS

HISTORICAL FIRE INSURANCE MAPS

NO MAPS AVAILABLE

Report Date: 3/13/2012
Client Job Number: 426649.01.04.EC
FirstSearch Index Number: 303457
Site Address(es): INFANTRY RD
LOCKWOOD, CA 93932

A search of FirstSearch Technology Corporation's proprietary database of historical fire insurance map availability confirmed that there are NO MAPS AVAILABLE for the Subject Location as shown above.

FirstSearch Technology Corporation's proprietary database of historical fire insurance map availability represents abstracted information from the Sanborn® Map Company LLC obtained through online access to the Library of Congress as well as the result of a review of the other fire insurance map microfilm collections available via various local libraries.

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FirstSearch Technology Corporation *10 Cottage Street, Norwood, MA 02062*
Tel: 781-551-0470 Fax: 781-551-0471

CITY DIRECTORY

CITY DIRECTORY REVIEW

Report Date: 3/30/2012

Client Job Number: 426649.01.04.EC

FirstSearch Index Number: 303460

Site Address(es):

LOCKWOOD, CA 93932

A search was conducted for the subject area noted above to identify any Historical City Directory coverage/tenant information maintained at national repositories, local city/town libraries and/or various public sources.

The following information is the result of the search:

Year/Source	Address (es)	Listings
2007/Cole Directory		
	53523 Bradley Lockwood, CA:	Pierce, William
2004/Cole Directory		
	Street Not Listed	
2000/Cole Directory		
	Street Not Listed	
1995/Cole Directory		
	Street Not Listed	
1992/Cole Directory		
	Street Not Listed	

No additional coverage was available at the time of this search.

The above listed search includes listings from 1992-2007 for the subject property plus four adjacent addresses up from the subject property and four adjacent addresses down from the subject property if available.

Although great care has been taken by FirstSearch Technology Corporation in compiling and verifying the information contained in this report to insure that it is accurate, FirstSearch Technology Corporation disclaims any and all liability for any errors, omissions, or inaccuracies in such information and data.

ENVIRONMENTAL LIEN SEARCH REPORT

FirstSearch Technology Corporation

Environmental Lien Report

TARGET PROPERTY:

Infantry Road

Lockwood, CA 93932

Job Number: 426649.01.04.EC

FirstSearch #: 304374

Date 4/4/12

Tel: (781) 551-0470 *Fax: (781) 551-0471*

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SOURCES – LIMITATIONS - DISCLAIMER

This lien report has been produced from a limited search of the public land records and/or real property deed records of the county and state as defined in the legal description below for any current environmental liens up through the indicated date as shown on this report. This limited search includes only the current recorded deed and most easements and surface leases affecting the ownership history of the subject property. This report is being provided for use only as a limited part of an overall Phase I Environmental Site Assessment as performed by a qualified Environmental Engineer/Consultant as specified in the ASTM Standard E 1527-05, AAI, and as specified in the Comprehensive Environmental Response, Compensation and Liabilities Act of 1980, as amended, and may not be relied upon for any other purpose.

This report is not to be considered an Abstract, a Title Commitment, Title Opinion, Title Guaranty, or a representation of the legal status of the property. The information presented is simply a report of instruments filed of record pertaining to the above property and was obtained from the county public records. No guaranty as to the integrity or correctness of said records is implied. In the process of compiling the information presented in this report, the public records were accessed primarily by the name(s) shown in the vesting instrument only and although reasonable care was taken to provide accuracy, this report and provider does not claim responsibility for instruments filed under any variation of name(s) and/or legal description.

Although great care has been taken by FirstSearch Technology in compiling and verifying the information contained in this report to insure that it is accurate, FirstSearch Technology disclaims any and all liability for any errors, omissions, or inaccuracies in such information and data.

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FirstSearch Technology Corporation

Environmental Lien Report

LEGAL DESCRIPTION: All that certain plot, piece and parcel of land, situate, lying and being in the town of Lockwood, County of Monterey, and State of CA, described in the County of Monterey land records as parcel 201-021-004-000

SUBJECT PARCEL: All that certain plot, piece and parcel of land, situate, lying and being in the town of Lockwood, County of Monterey, and State of CA, described in the County of Monterey land records as parcel 201-021-004-000

TABLE SUMMARY

DATE	DOCUMENT TYPE	GRANTOR (Seller/Lessor)	GRANTEE (Buyer/Lessee)	PARCEL or LOT #	DOCUMENT NUMBER
12/12/1940	Deed	Hearst Sunical Land and Packing Corporation	United States of America	201-021-004-000	Document #: 699/12
Environmental Liens:	None				
AUL's:	None				

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FirstSearch Technology Corporation

Environmental Lien Report

ENVIRONMENTAL LIEN RESEARCH NOTES:

ASTM Notes:

ASTM E 1527-05, Section 8.3 on Historical Use Information requires a review of "*Reasonably Ascertainable standard historical sources.*"

"Reasonably Ascertainable means information that is publicly available, obtainable from a source with reasonable time and cost constraints, and practically reviewable."

This task requires reviewing only as many of the standard historical sources as are necessary, and that are reasonably ascertainable and likely to be useful.

AAI Notes:

The Environmental Protection Agency published a final rule setting federal standards for the conduct of all appropriate inquiries (AAI). The final rule establishes specific regulatory requirements for conducting all appropriate inquiries into ***the previous ownership***, uses, and environmental conditions of a property for the purposes of qualifying for certain landowner liability protections under CERCLA.

After November 1, 2006, parties must comply with the requirements of All Appropriate Inquiries Final Rule, to satisfy the statutory requirements for conducting all appropriate inquiries. All appropriate inquiries must be conducted to obtain protection from potential liability under CERCLA as an innocent landowner, a contiguous property owner, or a bona fide prospective purchaser.

Inquiries conducted by or for the prospective landowner or grantee include:

- ***environmental liens***
- ***easements***
- ***restrictions***
- ***activity and use limitations***

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FirstSearch Technology Corporation

ENVIRONMENTAL CHAIN OF TITLE SEARCH GLOSSARY

There are certain terms used in Chain of Title searches, which may require clarification. This glossary is designed to provide definitions for some of the most common terms.

1. ENVIRONMENTAL LIEN:	The Environmental Lien is a record of a document/instrument filed by the City, County, State or Federal Government that prevents the conveyance of a property because of severe environmental problems existing on the premises.
2. BREAK IN CHAIN:	There may appear to be a break in the chain of title as indicated when the sequential tracing of ownership fails. An example of a break would be: *Samson to James. . .James to Watson. . .Black to White*. The missing link is from Watson to Black. There are several possible reasons for this occurrence. • Due to the size or other physical characteristics of the property, there could be multiple owners at any time when tracing the history of the ownership of the property. • There could be an "easement title" over some portion of the property, allowing for use of that portion for a specific purpose. • There could be a "multi-percentage interest" in the property, with concurrent multiple owners making up 100% of the fee title. Then, a percentage owner deeds out his particular interest or a percentage of this interest to one or more parties. This causes a perceived break in the chain.
3. EASEMENT:	An easement is the right to enter and use another person's property: a non-possessor right to use another person's real property. Traditionally easements are granted to utility companies and other service organizations or as a right of access to another property.
4. MULTIPLE OWNERS:	When "others" or "et al" appears on the report in the owner category, it indicates multiple ownership of a single parcel, with too many names to record in summary. It is frequently used to denote more than a single owner. If the owners are a married couple, both names may appear on the report or may be denoted by "et ux". The term "owners' is usually used to indicate owners of multiple parcels, all recorded under a document that covers the multiple parcels.
5. MULTIPLE PARCELS:	Some properties are created by combining several adjoining parcels into one large parcel. When this occurs; there might be several different owners until the time of unification of the property. Sometimes the ownership appears to be cloudy until each owner conveys his/her interest to the single owner of the new larger parcel.
6. INSTITUTIONAL CONTROLS:	Institutional controls are a form of "deed restriction" placed on a property by a governing authority to reduce exposure to contaminants. A common deed restriction might be to prohibit residential or school use on a property.

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BK 699
Pg 12

My Commission Expires Jan. 1st, 1941.

Recorded at request of COAST COUNTIES LAND TITLE CO., Dec. 6, 1940, at 43 min. past 10 A.M.....#87677.....Fee $1.40.....Allison.

GRANT DEED

U. S. INT. REV. STAMPS $2200.00 Cancelled

For value received HEARST SUNICAL LAND AND PACKING CORPORATION, a corporation Grants, Bargains and sells to UNITED STATES OF AMERICA all that certain real property situate in the County of Monterey, State of California, described as follows, to-wit:

PARCEL 1-

The Rancho Milpitas, containing 43,314.09 acres of land according to the United States Government Survey thereof, as described in the patent from the United States of America to Ignacio Pastor, dated February 18, 1875 and recorded April 19, 1875 in Volume A of Patents, Monterey County Records, page 485, but not including that certain tract of land commonly known as the Mission San Antonio containing 33.19 acres, according to the United States Government Survey thereof, as described in the patent from the United States of America to Joseph S. Alemany, Bishop of Monterey, dated May 1, 1862 and recorded June 29, 1874 in Volume A of Patents, Monterey County Records, at page 416, leaving a net area of 43,280.90 acres of land.

EXCEPTING therefrom that certain tract containing 100 acres of land, as conveyed by Elizabeth B. Diaz et vir to The Indians Hunting and Fishing Club, a corporation, by deed dated December 10, 1927 and recorded December 28, 1927 in Volume 137 Official Records of Monterey County, at page 87.

ALSO EXCEPTING therefrom that certain tract containing 285.9 acres of land, as conveyed by William L. Earl, an unmarried man, to John Olden Earl, by deed dated January 29, 1929 and recorded May 22, 1936 in Volume 478 Official Records of Monterey County, at page 394.

ALSO EXCEPTING therefrom that certain tract containing 192.13 acres of land, as conveyed by Ellen R. Smith, a widow, to Florence B. Smith, by deed dated January 31, 1927, and recorded February 8, 1927 in Volume 103 Official Records of Monterey County, at page 125.

ALSO EXCEPTING that certain tract containing 80 acres, as conveyed by George M. Black and Mary A. Black, his wife, to Jasper W. Paulsen, by deed dated November 16, 1925 and recorded February 1, 1926 in Volume 73 Official Records of Monterey County, at page 399.

ALSO EXCEPTING therefrom that certain 2 acre parcel of land acquired by San Antonio School District, to be used for school purposes, from the Estate of Faxon D. Atherton, Deceased, by Order Confirming Sale issued from the Superior Court of the State of California, in and for the County of San Mateo in the matter of said estate, rendered February 8, 1883, a certified copy of which appears recorded

BK 699
Pg 13

February 19,1883 in Volume B of Decrees, Monterey County Records, at page 246.

Leaving a net area of 42,620.87 acres, more or less.

PARCEL 2-

The Rancho San Miguelito, containing 22,135.91 acres of land, according to United States Government Survey thereof, as described in the Patent from United States of America to Mauricio Gonzalez, dated August 8, 1867, recorded April 15, 1875, in Volume A of Patents, Monterey County Records, at page 476.

PARCEL 3-

The Rancho El Piojo, containing 13,329.28 acres of land, according to United States Government Survey thereof, as described in the Patent from United States of America to the heirs of Joaquin Soto, dated April 30, 1866, recorded August 10, 1868 in Volume A of Patents, Monterey County Records, at page 134.

PARCEL 4-

The Rancho Los Ojitos, containing 8,900.17 acres of land, according to the United States Government Survey thereof, as described in the Patent from United States of America to Mariano Soberanes, dated April 18, 1871, recorded April 17, 1875 in Volume A of Patents, Monterey County Records, at page 483.

EXCEPTING therefrom that certain tract containing 2 acres, more or less, as conveyed by James R. Bolton to Right Reverend William Ingraham Kip as Bishop of the Protestant Episcopal Church, by deed dated September 28, 1883 and recorded October 24, 1883 in Volume 7 of Deeds, Monterey County Records, at page 182.

ALSO EXCEPTING therefrom that certain tract containing 100 acres of land as conveyed by Frank Schnoeberg and Minna Schnoeberg, his wife, to G. F. Roth and Emma H. Roth, his wife, by deed dated September 25, 1918 and recorded October 2, 1918 in Volume 160 of Deeds, Monterey County Records, at page 42.

Leaving a net area of 8,798.17 acres, more or less.

PARCEL 5-

The Rancho Pleyto, containing 13,299.27 acres, according to United States Government Survey thereof, as described in the Patent from United States of America to W. S. Johnson, et al, dated March 7, 1872, recorded April 9, 1873 in Volume A of Patents, Monterey County Records, at page 347.

EXCEPTING therefrom that certain tract containing 1 acre of land, as conveyed by William Pinkerton to County of Monterey, by deed dated April 15, 1908 and recorded October 27, 1911 in Volume 122 of Deeds, Monterey County Records, at page 207, for the sole purpose of a public cemetery, for the sole use, accomodation, benefit, convenience and advantage of the residents of the neighborhood and village in the County of Monterey known as Pleyto.

ALSO EXCEPTING therefrom that certain 1513.3 acre tract of land, as conveyed by Mary H. Pinkerton, et al to Rachel P. Pinkerton, by deed dated December 27, 1920 and recorded December 28, 1920 in Volume 179 of Deeds, Monterey County Records, at page 204.

ALSO EXCEPTING therefrom that certain 3,631.78 acre tract of land, as conveyed by The Hibernia Savings & Loan Society, a corporation, to The United Investment Company, a corporation, by deed dated December 23, 1925 and recorded

BK 699
Pg 14

December 29, 1925 in Volume 74 Official Records of Monterey County, at page 30.

ALSO EXCEPTING therefrom that certain 0.455 acre tract of land, as conveyed by Piedmont Land and Cattle Company, a corporation, to Robert M. Digges, Jr., by deed dated December 24, 1934 and recorded February 27, 1935 in Volume 427 Official Records of Monterey County, at page 487.

Leaving a net area of 8,152.735 acres, more or less.

PARCEL 6-

IN TOWNSHIP 21 SOUTH, RANGE 5 EAST, M.D.M.

Of Section 13: Lots 2, 3 and 4;

Of Section 14: Lots 1, 2, 3 and 4;

Of Section 15: Lots 1, 2, 3, 4 and NW¼ of NW¼;

Of Section 16: Lots 4 and 5;

Of Section 25: Lots 1 and 2;

Of Section 36: All except the SW¼ of NE¼;

Containing 922.15 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 7-

IN TOWNSHIP 21 SOUTH, RANGE 6 EAST, M. D. M.

Of Section 1: S½;

Of Section 10: S½ of SE¼;

Of Section 12: The whole;

Of Section 13: N½ of NE¼; SE¼ of NE¼ and NE¼ of SE¼;

Of Section 15: E½;

Of Section 24: All except Lots 3 and 4;

Of Section 25: Lots 1 and 2;

Containing 2,083.03 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 8-

IN TOWNSHIP 21 SOUTH, RANGE 7 EAST, M. D. M.

Of Section 6: Lots 4, 5, 6 and 7, SE¼ of SW¼, SW¼ of SE¼ and E½ of SE¼;

Of Section 7: S½ of SE¼;

Of Section 8: SW¼ of SW¼;

Of Section 15: S½ of SW¼ and SW¼ of SE¼;

Of Section 17: SW¼ of SE¼, SW¼, W½ of NW¼ and SE¼ of NW¼;

Of Section 18: E½ of NW¼, SE¼ of SW¼ and the E½;

Of Section 19: The whole;

Of Section 20: W½, the W½ of NE¼, NE¼ of NE¼ and NW¼ of SE¼;

Of Section 21: NE¼ of SW¼, NE¼ and N½ of SE¼;

Of Section 22: NW¼, NW¼ of SW¼ and NW¼ of NE¼;

Of Section 29: All except the E½ of NE¼ and NE¼ of SE¼;

Of Section 30: The whole;

Of Section 32: The whole;

Of Section 33: Lots 1, 2, 3, 4 and 5;

Containing 4,085.01 acres, more or less, according to U. S. Government Survey

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thereof.

PARCEL 9-

IN TOWNSHIP 22 SOUTH, RANGE 4 EAST, M. D. M.

Of Section 10: Lots 5, 6, 7 and 8;

Of Section 11: SW¼ of SW¼;

Of Section 13: The whole;

Of Section 14: The whole;

Of Section 15: Lots 2, 3, 5, 6, 9 and N½ of NW¼;

Of Section 22: Lots 3 and 4;

Of Section 23: The whole;

Of Section 24: The whole;

Of Section 25: All except the SE¼ of SW¼ and S½ of SE¼;

Of Section 26: The whole;

Of Section 36: The whole;

Containing 3,899.40 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 10-

IN TOWNSHIP 22 SOUTH, RANGE 5 EAST, M. D. M.

Of Section 18: Lots 3, 4 and SE¼ of SW¼;

Of Section 19: The whole;

Of Section 20: W½ of W½, SE¼ of SW¼ and S½ of SE¼;

Of Section 21: SW¼ of SW¼;

Of Section 28: NW¼ of NW¼;

Of Section 29: All that portion thereof lying north of Mill Creek;

Of Section 30: The whole;

Of Section 31: Lot 1, NE¼ of NW¼, NW¼ of NE¼, NW¼ of SE¼ and E½ of E½;

Of Section 32: All except the NE¼ of NE¼;

Of Section 33: SW¼ of SW¼;

Containing 3,073.91 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 11-

IN TOWNSHIP 22 SOUTH, RANGE 6 EAST, M. D. M.

Of Section 16: The whole;

Of Section 20: SE¼ of NE¼ and NE¼ of SE¼;

Of Section 21: Lot 3 and NW¼ of SW¼;

Of Section 29: SW¼ and SW¼ of SE¼;

Of Section 30: SE¼ of NW¼, NW¼ of NE¼, S½ of NE¼ and NE¼ of SE¼;

Of Section 32: All except Lot 1 and SW¼ of SW¼;

Containing 1,512.77 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 12-

IN TOWNSHIP 22 SOUTH, RANGE 7 EAST, M. D. M.

Of Section 24: All except that portion of the E½ of NE¼ lying south and east of the County Road leading from Argyle District to Jolon. Said excepted

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portion containing about 7 acres.

Of Section 25: The whole;

Of Section 35: Lot 1;

Of Section 36: The whole;

Containing 1,613.72 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 13-

IN TOWNSHIP 22 SOUTH, RANGE 8 EAST, M. D. M.

Of Section 29: NW¼;

Of Section 30: Lots 3, 4 and E½;

Of Section 31: All except the SE¼;

Containing 1,037.71 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 14-

IN TOWNSHIP 23 SOUTH, RANGE 4 EAST, M. D. M.

Of Section 1: The whole;

Of Section 12: The whole;

Of Section 13: Lots 1 and 2;

Containing 424.46 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 15-

IN TOWNSHIP 23 SOUTH, RANGE 5 EAST, M. D. M.

Of Section 4: Lots 3, 4, S½ of NW¼, N½ of SW¼ and W½ of SE¼;

Of Section 5: The whole;

Of Section 6: The whole;

Of Section 7: All except Lot 2, SE¼ of NW¼ and NE¼ of SW¼;

Of Section 8: The whole;

Of Section 9: S½ of NW¼, W½ of SW¼, SE¼ of SW¼ and SW¼ of SE¼;

Of Section 10: W½ of NW¼, SE¼ of NW¼, NW¼ of SW¼ and W½ of E½;

Of Section 16: W½, NW¼ of NE¼ and S½ of SE¼;

Of Section 17: All except the S½ of NW¼ and E½ of NE¼;

Of Section 18: All except Lot 3;

Of Section 19: All except the E½ of E½;

Of Section 20: S½ of SW¼, S½ of NE¼ and SE¼;

Of Section 21: N½ of NE¼, SW¼ of NE¼ and NW¼ of SE¼;

Of Section 28: SW¼ of SE¼;

Of Section 29: The whole;

Of Section 30: The whole;

Of Section 31: The whole;

Of Section 32: All except Lot 1;

Of Section 33: All except the SE¼ of SW¼, NE¼ of SE¼ and S½ of SW¼;

Containing 7,353.04 acres, more or less, according to U. S. Government Survey thereof.

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PARCEL 16-

IN TOWNSHIP 23 SOUTH, RANGE 6 EAST, M. D. M.

Of Section 13: Lot 1;

Of Section 14: Lots 3 and 4;

Of Section 22: E½ of SW¼ and SW¼ of SE¼;

Of Section 23: NE¼ of NE¼;

Of Section 24: All except Lot 2;

Of Section 25: Lots 1, 3, SE¼ of NW¼ and NE¼ of SW¼;

Of Section 27: NW¼ of NE¼;

Containing 547.99 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 17-

IN TOWNSHIP 23 SOUTH, RANGE 7 EAST, M. D. M.

Of Section 1: The whole;

Of Section 9: Lots 3, 4 and E½ of E½;

Of Section 10: S½ of NW¼, E½ of SW¼ and N½ of SE¼;

Of Section 11: All except the SW¼ of SW¼;

Of Section 12: Lot 1;

Of Section 13: The whole;

Of Section 14: All except the NW¼ of NW¼;

Of Section 15: Lots 1, 2, NE¼ of SW¼ and SE¼;

Of Section 16: Lot 1;

Of Section 22: The whole;

Of Section 23: The whole;

Of Section 31: Lots 1, 2, 4, 5 and 6;

Of Section 32: Lot 1;

Containing 2,318.92 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 18-

IN TOWNSHIP 23 SOUTH, RANGE 8 EAST, M. D. M.

Of Section 6: All except the E½ of NE¼;

Of Section 14: SW¼;

Of Section 15: All except the NE¼;

Of Section 16: E½;

Of Section 21: Lot 1;

Of Section 22: The whole;

Of Section 23: All except the NW¼ of NW¼, E½ of NW¼ and NE¼;

Of Section 25: The whole;

Of Section 26: The whole;

Of Section 27: Lot 1;

Of Section 28: The whole;

Of Section 31: The whole;

Of Section 32: Lots 6, 9, 11, 12, 13, 14 and 15;

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Of Section 33: Lot 2, SE¼ of NE¼ and the S½;

Of Section 34: Lots 1, 2, 3, 4, S½ of NW¼, NE¼ of SW¼, SW¼ of NE¼ and NW¼ of SE¼;

Of Section 35: Lots 1, 2, 3, 4, 5, NW¼ of SE¼ and SE¼ of SE¼;

Of Section 36: Lots 1, 2 and S½ of SW¼;

Containing 3,951.08 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 19-

IN TOWNSHIP 23 SOUTH, RANGE 9 EAST, M. D. M.

Of Section 31: Lot 1;

Containing 0.80 of an acre, more or less, according to U. S. Government Survey thereof.

PARCEL 20-

IN TOWNSHIP 24 SOUTH, RANGE 5 EAST, M. D. M.

Of Section 4: All except the N½ of NE¼, SE¼ of NE¼ and SE¼ of SE¼;

Of Section 5: All except Lots 1, 2 and 3; Also excepting from the NW¼ of NE¼ of said Section 5, that certain 2 acre tract of land conveyed by Piedmont Land and Cattle Company, a corporation, to State of California, by deed dated February 10, 1932 and recorded February 27, 1932 in Volume 325 Official Records of Monterey County, at page 372.

Of Section 10: All except the NW¼ of NW¼;

Of Section 11: All except the N½ of N½, W½ of SW¼ and SW¼ of SE¼;

Of Section 12: SW¼ and S½ of SE¼;

Of Section 13: The whole;

Of Section 14: Lot 1, the N½ and E½ of SE¼;

Of Section 15: The whole;

Of Section 23: All except Lot 1;

Of Section 24: The whole;

Of Section 25: All except Lot 6;

Containing 3,988.69 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 21-

IN TOWNSHIP 24 SOUTH, RANGE 6 EAST, M. D. M.

Of Section 18: Lot 2;

Of Section 26: SW¼ of SW¼;

Of Section 27: SW¼ of NW¼ and S½;

Of Section 28: All except the W½ of W½ and NE¼ of NE¼;

Of Section 30: NE¼ of SE¼ of SW¼; S½ of SE¼ of SW¼; N½ of SE¼ and SW¼ of SE¼; Excepting from the NW¼ of SE¼ that certain 0.91 acre tract conveyed by Piedmont Land and Cattle Company, a corporation, to United States of America, by deed dated January 6, 1931 and recorded January 7, 1931 in Volume 272 Official Records of Monterey County, at page 413.

Of Section 31: Lots 1, 2, 3, 4 and 6;

Of Section 33: NE¼, E½ of SE¼;

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Of Section 34: The whole;

Of Section 35: All except the NE¼ of NE¼;

Of Section 36: The S½ of NW¼ and S½;

Excepting from the SE¼ of NE¼ of said Section 33 and the SW¼ of NW¼ of said Section 36 that certain 5.11 acre tract conveyed by William J. Evans et ux to James Pierce Baldwin, et ux, by deed dated May 26, 1925 and recorded June 4, 1925 in Volume 58 Official Records of Monterey County, at page 324.

Containing 2,985.36 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 22-

IN TOWNSHIP 24 SOUTH, RANGE 7 EAST, M. D. M.

Of Section 1: Lot 1;

Of Section 4: The whole;

Of Section 9: The whole;

Of Section 10: The whole;

Of Section 11: The whole;

Of Section 12: The whole;

Of Section 13: The whole;

Of Section 14: The whole;

Of Section 15: The whole;

Of Section 16: The whole;

Of Section 21: The whole;

Of Section 22: The whole;

Of Section 23: The whole;

Of Section 24; All except the NE¼ of NE¼;

Of Section 25: The whole;

Of Section 26: The whole;

Of Section 27: All except the S½ of SW¼;

Of Section 28: All except the SE¼ of NW¼, NE¼ of SW¼;

Of Section 29: N½ of NE¼ and SE¼ of NE¼;

Of Section 31: Lots 7, 8, 9, 10, 11, 12 and the SE¼;

Of Section 32: Lots 1, 2, 3, 4, 5, 6, 7, and 8;

Of Section 33: Lots 4, 5, 6, 7 and NE¼ of NE¼;

Of Section 34: N½ of N½, SE¼ of NW¼, SE¼ of NE¼ and NE¼ of SE¼;

Of Section 35: The whole;

Of Section 36: The whole;

Containing 11,348.12 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 23-

IN TOWNSHIP 24 SOUTH, RANGE 8 EAST, M. D. M.

Of Section 1: All except the S½ of S½;

Of Section 2: Lot 1 and SE¼ of NE¼;

Of Section 5: All except Lots 1, 2, 8 and 9;

Of Section 6: The whole;

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Of Section 7: The whole;

Of Section 8: All except the SE¼ of NW¼;

Of Section 9: NW¼ of NW¼, S½ of NW¼ and NE¼ of SW¼;

Of Section 16: NW¼, W½ of SW¼ and N½ of NE¼;

Of Section 17: NW¼ and NW¼ of NE¼;

Of Section 18: All except the SE¼ of SE¼;

Of Section 19: Lots 2, 3 and 4;

Of Section 20: N½ of N½;

Of Section 29: NE¼ of NW¼, N½ of NE¼, SW¼ of NE¼ and SE¼ of SE¼;

Of Section 30: Lot 1;

Of Section 31: Lots 2, 3, 4, E½ of SW¼ and SW¼ of SE¼;

Containing 4,830.65 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 24-

IN TOWNSHIP 24 SOUTH, RANGE 9 EAST, M. D. M.

Of Section 1: SE¼ of SE¼;

Of Section 2: W½ of SW¼ and SE¼ of SW¼;

Of Section 3: Lot 7, NW¼ of SE¼ and E½ of SE¼;

Of Section 5: Lot 1;

Of Section 6: All except Lot 8, SE¼ of SW¼ and SW¼ of SE¼;

Of Section 10: Lot 1;

Of Section 12: NE¼ of NW¼, NE¼ of NE¼, S½ of SE¼ and that part of the S½ of SW¼ of said Section 12 described as follows: Beginning at a 4" x 4" post marked "M,K,LGH", standing on the boundary between Sections 12 and 13, Township 24 South, Range 9 East, M.D.M., at an angle in the old line fence 1077 feet East of the corner of Sections 11, 12, 13 and 14; thence following fence, North 50° 30' East, 2195 feet to a 4" x 4" post marked "M, K, S12, LGH", standing on the East and West line through the center of the S½ of Section 12; thence leaving said fence, and following said East and West line, easterly 22 feet to the center of the South ½ of Section 12; thence southerly along the North and South line through the center of said Section, 1314 feet to the 1/4 Section corner between Sections 12 and 13; thence westerly 1690 feet to the point of beginning.

Of Section 13: The whole;

Of Section 14: Lot 1;

Of Section 23: Lot 3;

Of Section 26: All except lots 2, 3, 6, 7, 8 and 9, also excepting from Lot 5 of said Section 26 that certain 1 acre tract of land conveyed by Walter Gaghagen, a single man, to William R. Basham et ux, by deed dated November 5, 1929 and recorded November 23, 1929 in Volume 216 Official Records of Monterey County, at page 393,

Of Section 27: Lots 1, 2, 3, 4 and NE¼ of SE¼, excepting therefrom that portion thereof lying west of the County Road, as the same existed on May 13, 1929.

Containing 1,749.52 acres, more or less, according to U. S. Government Survey thereof.

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PARCEL 25-

IN TOWNSHIP 24 SOUTH, RANGE 10 EAST, M. D. M.

Of Section 7: Lots 1, 4, E½ of W½ and W½ of SE¼;

Of Section 18: All except the NE¼ of NE¼;

Of Section 19: All except Lot 3;

Containing 1,089.30 acres, more or less, according to U. S. Government Survey thereof.

PARCEL 26-

Lot 5 of Section 1, the Lots 3 and 4 of Section 13, and the Lot 1 of Section 24 in Township 23 South of Range 4 East, M.D.M., the Lots 4, 5 and 6 of Section 31, in Township 23 South and the Lot 5 of Section 5, and Lot 5 of Section 10, the Lots 4 and 5 of Section 15, the Lot 5 of Section 23, the Lot 2 of Section 4, and the Lot 6 of Section 23 in Township 24 South, all in Range 5 East, M.DM.

Containing 2.66 acres, more or less, according to U. S. Government Survey thereof.

CONTAINING in all the aggregate of 153,865.255 acres of land, a little more or less, according to U. S. Government Survey thereof.

EXCEPTING from all the above described lands all minerals reserved in United States Patents.

Together with any and all real property owned by the Grantor herein, within the limits of Monterey County, State of California, at the date hereof, excluding and excepting only those certain lands specifically described as follows, to-wit:

SW¼ of SE¼ of Section 24; N½ of NE¼, SE¼ of NE¼, N½ of S½ and S½ of SE¼ of Section 25; Lot 16 of Section 26; Lots 2, 6, 7 and 11 of Section 35, all in Township 18 South, Range 1 East, M.D.M., Lots 3, 4 and E½ of SW¼ of Section 30, Lot 1, E½ of NW¼, NE¼, N½ of SE¼ and SW¼ of SE¼ of Section 31, N½ of S½ and SE¼ of SE¼ of Section 32; SW¼ of SW¼ of Section 33, all in Township 18 South, Range 2 East, M.D.M. Containing 1,409.09 acres, more or less, according to U. S. Government Survey thereof.

IN WITNESS WHEREOF, said corporation has executed these presents by its officers thereunto duly authorized, this 12th day of December, 1940.

HEARST SUNICAL LAND AND PACKING CORPORATION

By L. J. BURRUD

Vice-President

(CORPORATE SEAL) By GROVE J. FINK

Secretary

STATE OF CALIFORNIA)
SS
CITY AND COUNTY OF SAN FRANCISCO)

On December 12th, 1940, before me WM. E. SCHORD a Notary Public in and for said City, County and State, personally appeared L. J. BURRUD and GROVE J. FINK known to me to be the Vice President and Secretary respectively of the corporation that executed the within instrument, and also known to me to be the persons who

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executed it on behalf of such corporation and acknowledged to me that such corporation executed the same.

WM. E. SCHORD

Notary Public in and for the City and County of San Francisco, State of California.

My commission expires: March 22nd,1942 (Notarial Seal)

Recorded at request of SALINAS TITLE GUARANTEE COMPANY, Dec. 12, 1940, at 48 min. past 3 P. M.....#87964.....Fee $6.00.....Barretto.

GRANT DEED

(JOINT TENANCY)

U. S. INT. REV. STAMPS $.55 Cancelled

For value received FRANK REED, a single man, Grants to OMIES R. BURKS and IRENE BURKS, his wife, as Joint Tenants all that real property situate in the County of Monterey, State of California, described as follows:

A portion of Lot Fifteen (15) as said lot is laid down and designated upon that certain map entitled, "Map of Elton B. Hebbron Subdivision of Part of the Rancho El Sausal, Monterey County, Calif.", surveyed by Howard D. Peters, Licensed Land Surveyor November 1929 and filed for record November 25, 1929 in the office of the County Recorder of the County of Monterey, State of California, in Volume 3 of Maps, "Cities and Towns" at page 63, described as follows:

Beginning at a point from which the Southwest corner of said Lot 15 bears the following two courses and distances, N. 82° 58' W., 175 feet and S. 7° 08' W., 450 feet; thence from said point of beginning S. 82° 58' E., 50 feet to a point; thence N. 7° 08' E., 125 feet to a point in the center line of that certain street known as Terrace Street; thence N. 82° 58' W., along said center line of Terrace Street 50 feet to a point; thence leaving said Terrace Street S. 7° 08' W., 125 feet to the point of beginning.

Subject to a right of way for road purposes and public utility purposes over a strip of land 15 feet wide, lying Southerly of and contiguous to the Northerly boundary of the above described parcel of land.

Granting also a right of way for road purposes, to be used in common with adjacent property owners over a strip of land 30 feet wide, the center line of which is described as follows:

Beginning at the Northeast corner of the above described parcel of land, thence N. 82° 58' W., 150 feet to a point.

WITNESS my hand November 26th, 1940.

FRANK REED

STATE OF CALIFORNIA)
SS.
COUNTY OF MONTEREY)

On November 26th, 1940, before me, E. J. DRUSSEL, a Notary Public, in and for

Appendix E

Regulatory Records Documentation

FirstSearch Technology Corporation

Environmental FirstSearch™ Report

Target Property:

INFANTRY RD

LOCKWOOD CA 93932

Job Number: 426649.01.04.EC

PREPARED FOR:

CH2M HILL

7927 Nemco Way

Brighton, MI 48116

03-12-12

Tel: (781) 551-0470 *Fax: (781) 551-0471*

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Environmental FirstSearch
Search Summary Report

Target Site: INFANTRY RD
LOCKWOOD CA 93932

FirstSearch Summary

Database	Sel	Updated	Radius	Site	1/8	1/4	1/2	1/2>	ZIP	TOTALS
NPL	Y	02-01-12	1.00	0	0	0	0	0	0	0
NPL Delisted	Y	02-01-12	0.50	0	0	0	0	-	0	0
CERCLIS	Y	01-01-12	0.50	0	0	0	0	-	0	0
NFRAP	Y	01-01-12	0.50	0	0	0	0	-	0	0
RCRA COR ACT	Y	01-10-12	1.00	0	0	0	0	0	0	0
RCRA TSD	Y	01-10-12	0.50	0	0	0	0	-	0	0
RCRA GEN	Y	01-10-12	0.25	0	0	0	-	-	0	0
RCRA NLR	Y	01-10-12	0.12	0	0	-	-	-	0	0
Federal Brownfield	Y	02-01-12	0.50	0	0	0	0	-	0	0
ERNS	Y	01-11-12	0.12	0	0	-	-	-	0	0
Tribal Lands	Y	12-01-05	1.00	0	0	0	0	0	1	1
State/Tribal Sites	Y	02-08-12	1.00	0	0	0	0	0	0	0
State Spills 90	Y	01-10-12	0.12	0	0	-	-	-	0	0
State/Tribal SWL	Y	01-10-12	0.50	0	0	0	0	-	0	0
State/Tribal LUST	Y	01-10-12	0.50	0	0	0	0	-	0	0
State/Tribal UST/AST	Y	06-13-11	0.25	0	0	0	-	-	0	0
State/Tribal EC	Y	NA	0.25	0	0	0	-	-	0	0
State/Tribal IC	Y	01-18-12	0.25	0	0	0	-	-	0	0
State/Tribal VCP	Y	02-08-12	0.50	0	0	0	0	-	0	0
State/Tribal Brownfields	Y	NA	0.50	0	0	0	0	-	0	0
State Permits	Y	01-10-12	0.25	0	0	0	-	-	0	0
State Other	Y	02-08-12	0.25	0	0	0	-	-	0	0
Federal IC/EC	Y	11-01-11	0.50	0	0	0	0	-	0	0
-TOTALS-				0	0	0	0	0	1	1

Notice of Disclaimer

Due to the limitations, constraints, and inaccuracies and incompleteness of government information and computer mapping data currently available to FirstSearch Technology Corp., certain conventions have been utilized in preparing the locations of all federal, state and local agency sites residing in FirstSearch Technology Corp.'s databases. All EPA NPL and state landfill sites are depicted by a rectangle approximating their location and size. The boundaries of the rectangles represent the eastern and western most longitudes; the northern and southern most latitudes. As such, the mapped areas may exceed the actual areas and do not represent the actual boundaries of these properties. All other sites are depicted by a point representing their approximate address location and make no attempt to represent the actual areas of the associated property. Actual boundaries and locations of individual properties can be found in the files residing at the agency responsible for such information.

Waiver of Liability

Although FirstSearch Technology Corp. uses its best efforts to research the actual location of each site, FirstSearch Technology Corp. does not and can not warrant the accuracy of these sites with regard to exact location and size. All authorized users of FirstSearch Technology Corp.'s services proceeding are signifying an understanding of FirstSeaarch Technology Corp.'s searching and mapping conventions, and agree to waive any and all liability claims associated with search and map results showing incomplete and or inaccurate site locations.

Environmental FirstSearch
Site Information Report

Request Date:	03-12-12	**Search Type:**	COORD
Requestor Name:	GKOSTER/CH2M/BC	**Job Number:**	426649.01.04.EC
Standard:	ASTM-05	**Filtered Report**	

Target Site: INFANTRY RD
LOCKWOOD CA 93932

Demographics

Sites: 1 **Non-Geocoded:** 1 **Population:** NA

Radon: NA

Fire Insurance Map Coverage: No

Site Location

	Degrees (Decimal)	Degrees (Min/Sec)		UTMs
Longitude:	-121.238830	-121:14:20	**Easting:**	658742.923
Latitude:	36.000091	36:0:0	**Northing:**	3985192.363
Elevation:	1043		**Zone:**	10

Comment

Comment: GTA FHL

Additional Requests/Services

Adjacent ZIP Codes:

ZIP Code	City Name	ST	Dist/Dir	Sel

Services:

	Requested?	Date
Fire Insurance Maps	Yes	03-12-12
Aerial Photographs	Yes	03-12-12
Historical Topos	Yes	03-12-12
City Directories	Yes	03-12-12
Title Search	No	
Municipal Reports	No	
Liens	No	
Historic Map Works	No	
Online Topos	No	

Environmental FirstSearch
Target Site Summary Report

Target Property: INFANTRY RD
LOCKWOOD CA 93932

JOB: 426649.01.04.EC

TOTAL: 1 **GEOCODED:** 0 **NON GEOCODED:** 1 **SELECTED:** 0

Map ID	DB Type	Site Name/ID/Status	Address	Dist/Dir	ElevDiff	Page No.

No sites found for target address

Environmental FirstSearch
Sites Summary Report

Target Property: INFANTRY RD
LOCKWOOD CA 93932

JOB: 426649.01.04.EC

TOTAL: 1 **GEOCODED:** 0 **NON GEOCODED:** 1 **SELECTED:** 0

Map ID	DB Type	Site Name/ID/Status	Address	Dist/Dir	ElevDiff	Page No.
	TRIBALLA	BUREAU OF INDIAN AFFAIRS CONTACT I BIA-93932/	UNKNOWN CA 93932	NON GC	N/A	N/A

Environmental FirstSearch
Site Detail Report

Target Property: INFANTRY RD
LOCKWOOD CA 93932

JOB: 426649.01.04.EC

No sites were found!

Environmental FirstSearch Descriptions

NPL: EPA NATIONAL PRIORITY LIST - The National Priorities List is a list of the worst hazardous waste sites that have been identified by Superfund. Sites are only put on the list after they have been scored using the Hazard Ranking System (HRS), and have been subjected to public comment. Any site on the NPL is eligible for cleanup using Superfund Trust money. A Superfund site is any land in the United States that has been contaminated by hazardous waste and identified by the Environmental Protection Agency (EPA) as a candidate for cleanup because it poses a risk to human health and/or the environment.FINAL - Currently on the Final NPLPROPOSED - Proposed for NPL

NPL DELISTED: EPA NATIONAL PRIORITY LIST Subset - Database of delisted NPL sites. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.DELISTED - Deleted from the Final NPL

CERCLIS: EPA COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY INFORMATION SYSTEM (CERCLIS)- CERCLIS is a database of potential and confirmed hazardous waste sites at which the EPA Superfund program has some involvement. It contains sites that are either proposed to be or are on the National Priorities List (NPL) as well as sites that are in the screening and assessment phase for possible inclusion on the NPL.PART OF NPL- Site is part of NPL siteDELETED - Deleted from the Final NPLFINAL - Currently on the Final NPLNOT PROPOSED - Not on the NPLNOT VALID - Not Valid Site or IncidentPROPOSED - Proposed for NPLREMOVED - Removed from Proposed NPLSCAN PLAN - Pre-proposal SiteWITHDRAWN - Withdrawn

NFRAP: EPA COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY INFORMATION SYSTEM ARCHIVED SITES - database of Archive designated CERCLA sites that, to the best of EPA's knowledge, assessment has been completed and has determined no further steps will be taken to list this site on the National Priorities List (NPL). This decision does not necessarily mean that there is no hazard associated with a given site; it only means that, based upon available information, the location is not judged to be a potential NPL site.NFRAP – No Further Remedial Action PlanP - Site is part of NPL siteD - Deleted from the Final NPLF - Currently on the Final NPLN - Not on the NPLO - Not Valid Site or IncidentP - Proposed for NPLR - Removed from Proposed NPLS - Pre-proposal SiteW – Withdrawn

RCRA COR ACT: EPA RESOURCE CONSERVATION AND RECOVERY INFORMATION SYSTEM SITES - Database of hazardous waste information contained in the Resource Conservation and Recovery Act Information (RCRAInfo), a national program management and inventory system about hazardous waste handlers. In general, all generators, transporters, treaters, storers, and disposers of hazardous waste are required to provide information about their activities to state environmental agencies. These agencies, in turn pass on the information to regional and national EPA offices. This regulation is governed by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984.RCRAInfo facilities that have reported violations and subject to corrective actions.

RCRA TSD: EPA RESOURCE CONSERVATION AND RECOVERY INFORMATION SYSTEM TREATMENT, STORAGE, and DISPOSAL FACILITIES. - Database of hazardous waste information contained in the Resource Conservation and Recovery Act Information (RCRAInfo), a national program management and inventory system about hazardous waste handlers. In general, all generators, transporters, treaters, storers, and disposers of hazardous waste are

required to provide information about their activities to state environmental agencies. These agencies, in turn pass on the information to regional and national EPA offices. This regulation is governed by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984.Facilities that treat, store, dispose, or incinerate hazardous waste.

RCRA GEN: EPA/MA DEP/CT DEP RESOURCE CONSERVATION AND RECOVERY INFORMATION SYSTEM GENERATORS - Database of hazardous waste information contained in the Resource Conservation and Recovery Act Information (RCRAInfo), a national program management and inventory system about hazardous waste handlers. In general, all generators, transporters, treaters, storers, and disposers of hazardous waste are required to provide information about their activities to state environmental agencies. These agencies, in turn pass on the information to regional and national EPA offices. This regulation is governed by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984.Facilities that generate or transport hazardous waste or meet other RCRA requirements.LGN - Large Quantity GeneratorsSGN - Small Quantity GeneratorsVGN – Conditionally Exempt Generator.Included are RAATS (RCRA Administrative Action Tracking System) and CMEL (Compliance Monitoring & Enforcement List) facilities. CONNECTICUT HAZARDOUS WASTE MANIFEST – Database of all shipments of hazardous waste within, into or from Connecticut. The data includes date of shipment, transporter and TSD info, and material shipped and quantity. This data is appended to the details of existing generator records. MASSACHUSETTES HAZARDOUS WASTE GENERATOR – database of generators that are regulated under the MA DEP. VQN-MA = generates less than 220 pounds or 27 gallons per month of hazardous waste or waste oil.SQN-MA = generates 220 to 2,200 pounds or 27 to 270 gallons per month of waste oil.LQG-MA = generates greater than 2,200 lbs of hazardous waste or waste oil per month.

RCRA NLR: EPA RESOURCE CONSERVATION AND RECOVERY INFORMATION SYSTEM SITES - Database of hazardous waste information contained in the Resource Conservation and Recovery Act Information (RCRAInfo), a national program management and inventory system about hazardous waste handlers. In general, all generators, transporters, treaters, storers, and disposers of hazardous waste are required to provide information about their activities to state environmental agencies. These agencies, in turn pass on the information to regional and national EPA offices. This regulation is governed by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984.not currently classified by the EPA but are still included in the RCRAInfo database. Reasons for non classification: Failure to report in a timely matter. No longer in business. No longer in business at the listed address. No longer generating hazardous waste materials in quantities which require reporting.

Fed Brownfield: EPA BROWNFIELD MANAGEMENT SYSTEM (BMS) - database designed to assist EPA in collecting, tracking, and updating information, as well as reporting on the major activities and accomplishments of the various Brownfield grant Programs./n CLEANUPS IN MY COMMUNITY (subset) - Sites, facilities and properties that have been contaminated by hazardous materials and are being, or have been, cleaned up under EPA's brownfield’s program.

ERNS: EPA/NRC EMERGENCY RESPONSE NOTIFICATION SYSTEM (ERNS) - Database of incidents reported to the National Response Center. These incidents include chemical spills, accidents involving chemicals (such as fires or explosions), oil spills, transportation accidents that involve oil or chemicals, releases of radioactive materials, sightings of oil sheens on bodies of water, terrorist incidents involving chemicals, incidents where illegally dumped chemicals have been found, and drills intended to prepare responders to handle these kinds of incidents. Data since January 2001 has been received from the National Response System database as the EPA no longer maintains this data.

Tribal Lands: DOI/BIA INDIAN LANDS OF THE UNITED STATES - Database of areas with boundaries established by treaty, statute, and (or) executive or court order, recognized by the Federal Government as territory in which American Indian tribes have primary governmental authority. The Indian Lands of the United States map layer shows areas of 640 acres or more, administered by the Bureau of Indian Affairs. Included are Federally-administered lands within a reservation which may or may not be considered part of the reservation.BUREAU OF INDIAN AFFIARS CONTACT - Regional contact information for the Bureau of Indian Affairs offices.

State/Tribal Sites: CA EPA SMBRPD / CAL SITES- The California Department of Toxic Substances Control (DTSC) has developed an electronic database system called Envirostor with information about sites that are known to be contaminated with hazardous substances as well as information on uncharacterized properties where further studies may reveal problems. The Site Mitigation and Brownfields Reuse Program Database (SMBRPD), formerly known as CalSites, is used primarily by DTSC's staff as an informational tool to evaluate and track activities at properties that may have been affected by the release of hazardous substances. The SMBRPD displays information in six categories, two of which are found in ST. The categories listed under ST are: 1. State Response Sites. 2. School Property Evaluation Program Properties (SCH) Please Note: Our reports list the above sites as DB Type (STATE). Other categories found in the SMBRPD are listed in our reports in the DB Types OT and VC. Each Category contains information on properties based upon the type of work taking place at the site. State Response Sites contains only known and potential hazardous substance release sites considered as posing the greatest threat to the public. School sites included in ST will be found within the SMBRPD's School Property Evaluation Program. CORTESE LIST-Pursuant to Government Code Section 65962.5, the Hazardous Waste and Substances Sites List has been compiled by Cal/EPA, Hazardous Materials Data Management Program to provide information about the location of hazardous materials release sites. Cortese List sites that fall under DTSC's guidelines for State Response sites are included in our reports in the ST category as are qualifying sites from the Annual Work Plan (formerly Bond Expenditure Plan) and the historic ASPIS databases.

State Spills 90: CA EPA SLIC REGIONS 1 - 9- The California Regional Water Quality Control Boards maintain report of sites that have records of spills, leaks, investigation, and cleanups.

State/Tribal SWL: CA IWMB/SWRCB/COUNTY SWIS SOLID WASTE INFORMATION SYSTEM-The California Integrated Waste Management Board maintains a database on solid waste facilities, operations, and disposal sites throughout the state of California. The types of facilities found in this database include landfills, transfer stations, material recovery facilities, composting sites, transformation facilities, waste tire sites, and closed disposal sites. For more information on individual sites call the number listed in the source field.. Please Note: This database contains poor site location information for many sites in our reports; therefore, it may not be possible to locate or plot some sites in our reports. WMUDS-The State Water Resources Control Board maintained the Waste Management Unit Database System (WMUDS). It is no longer updated. It tracked management units for several regulatory programs related to waste management and its potential impact on groundwater. Two of these programs (SWAT & TPCA) are no longer on-going regulatory programs as described below. Chapter 15 (SC15) is still an on-going regulatory program and information is updated periodically but not to the WMUDS database. The WMUDS System contains information from the following agency databases: Facility, Waste Management Unit (WMU), Waste Discharger System (WDS), SWAT, Chapter 15, TPCA, RCRA, Inspections, Violations, and Enforcement's. Note: This database contains poor site location information for many sites in our reports; therefore, it may not be possible to locate or plot some sites in reports. ORANGE COUNTY LANDFILLS LIST- A list maintained by the Orange County Health Department.

State/Tribal LUST: CA SWRCB/COUNTY LUSTIS- The State Water Resources Control Board maintains a database of sites with confirmed or unconfirmed leaking underground storage tanks. Information for this database is collected from the states regional boards quarterly and integrated with this database. SAN DIEGO COUNTY LEAKING TANKS- The San Diego County Department of Environmental Health maintains a database of sites with confirmed or unconfirmed leaking underground storage tanks within its HE17/58 database. For more information on a specific file call the HazMat Duty Specialist at phone number listed in the source information field.

State/Tribal UST/AST: CA EPA/COUNTY/CITY ABOVEGROUND STORAGE TANKS LISTING-The Above Ground Petroleum Storage Act became State Law effective January 1, 1990. In general, the law requires owners or operators of AST's with petroleum products to file a storage statement and pay a fee by July 1, 1990 and every two years thereafter, take specific action to prevent spills, and in certain instances implement a groundwater monitoring program. This law does not apply to that portion of a tank facility associated with the production oil and regulated by the State Division of Oil and Gas of the Dept. of Conservation. SWEEPS / FIDS STATE REGISTERED UNDEGROUND STORAGE TANKS- Until 1994 the State Water Resources Control Board maintained a database of registered underground storage tanks statewide referred to as the SWEEPS System. The SWEEPS UST information was integrated with the CAL EPA's Facility Index System database (FIDS) which is a master index of information from numerous California agency environmental databases. That was last updated in 1994. We have included the UST information from the FIDS database in our reports for historical purposes to help our clients identify where tanks may possibly have existed. For more information on specific sites from individual paper files archived at the State Water Resources Control Board call the number listed with the source information. INDIAN LANDS UNDERGROUND STORAGE TANKS LIST- A listing of underground storage tanks currently on Indian Lands under federal jurisdiction. California Indian Land USTS are administered by US EPA Region 9.CUPA DATABASES & SOURCES- Definition of a CUPA: A Certified Unified Program Agency (CUPA) is a local agency that has been certified by the CAL EPA to implement six state environmental programs within the local agency's jurisdiction. These can be a county, city, or JPA (Joint Powers Authority). This program was established under the amendments to the California Health and Safety Code made by SB 1082 in 1994. A Participating Agency (PA) is a local agency that has been designated by the local CUPA to administer one or more Unified Programs within their jurisdiction on behalf of the CUPA. A Designated Agency (DA) is an agency that has not been certified by the CUPA but is the responsible local agency that would implement the six unified programs until they are certified. Please Note: We collect and maintains information regarding Underground Storage Tanks from the majority of the CUPAS and Participating Agencies in the State of California. These agencies typically do not maintain nor release such information on a uniform or consistent schedule; therefore, currency of the data may vary. Please look at the details on a specific site with a UST record in the First Search Report to determine the actual currency date of the record as provided by the relevant agency. Numerous efforts are made on a regular basis to obtain updated records.

State/Tribal IC: CA EPA DEED-RESTRICTED SITES LISTING- The California EPA’s Department of Toxic Substances Control Board maintains a list of deed-restricted sites, properties where the DTSC has placed limits or requirements on the future use of the property due to varying levels of cleanup possible, practical or necessary at the site.

State/Tribal VCP: CA EPA SMBRPD / CAL SITES- The California Department of Toxic Substances Control (DTSC) has developed an electronic database system called Envirostor with information about sites that are known to be contaminated with hazardous substances as well as information on uncharacterized properties where further studies may reveal problems. The Site Mitigation and Brownfields Reuse Program Database (SMBRPD), formerly known as CalSites, is used primarily by DTSC’s staff as an informational tool to evaluate and track activities at properties that may have been affected by the release of hazardous substances. The Voluntary Cleanup Program (VCP) category contains only those

properties undergoing voluntary investigation and/or cleanup and which are listed in the Voluntary Cleanup Program.Please Note: Our reports list the above sites as DB Type VC.

State Permits: CA EPA/COUNTY SAN DIEGO COUNTY HE17 PERMITS- The HE17/58 database tracks establishments issued permits and the status of their permits in relation to compliance with federal, state, and local regulations that the County oversees. It tracks if a site is a hazardous waste generator, TSD, gas station, has underground tanks, violations, or unauthorized releases. For more information on a specific file call the HazMat Duty Specialist at the phone number listed in the source information field. SAN BERNARDINO COUNTY HAZARDOUS MATERIALS PERMITS- Handlers and Generators Permit Information Maintained by the Hazardous Materials Division.

State Other: CA EPA/COUNTY SMBRPD / CAL SITES- The California Department of Toxic Substances Control (DTSC) has developed an electronic database system called Envirostor with information about sites that are known to be contaminated with hazardous substances as well as information on uncharacterized properties where further studies may reveal problems. The Site Mitigation and Brownfields Reuse Program Database (SMBRPD), formerly known as CalSites, is used primarily by DTSC's staff as an informational tool to evaluate and track activities at properties that may have been affected by the release of hazardous substances. The SMBRPD displays information in six categories, two of which are found in ST. The categories listed under OT are: 1. Unconfirmed Properties Referred to Another Local or State Agency (REF) 2. Properties where a No Further Action Determination has been made (NFA) Please Note: Our reports list the above sites as DB Type (OTHER). Other categories found in the SMBRPD are listed in our reports in the DB Types ST and VC.LA COUNTY SITE MITIGATION COMPLAINT CONTROL LOG- The County of Los Angeles Public Health Investigation Compliant Control Log. ORANGE COUNTY INDUSTRIAL SITE CLEANUPS- List maintained by the Orange County Environmental Health Agency. RIVERSIDE COUNTY WASTE GENERATORS-A list of facilities in Riverside County which generate hazardous waste. SACRAMENTO COUNTY MASTER HAZMAT LIST-Master list of facilities within Sacramento County with potentially hazardous materials. SACRAMENTO COUNTY TOXIC SITE CLEANUPS-A list of sites where unauthorized releases of potentially hazardous materials have occurred.

Federal IC / EC: EPA FEDERAL ENGINEERING AND INSTITUTIONAL CONTROLS- Superfund sites that have either an engineering or an institutional control. The data includes the control and the media contaminated. RESOURCE CONSERVATION AND RECOVERY INFORMATION SYSTEM SITES (RCRA) – RCRA site the have institutional controls.

Environmental FirstSearch Database Sources

NPL: EPA Environmental Protection Agency

Updated quarterly

NPL DELISTED: EPA Environmental Protection Agency

Updated quarterly

CERCLIS: EPA Environmental Protection Agency

Updated quarterly

NFRAP: EPA Environmental Protection Agency.

Updated quarterly

RCRA COR ACT: EPA Environmental Protection Agency.

Updated quarterly

RCRA TSD: EPA Environmental Protection Agency.

Updated quarterly

RCRA GEN: EPA/MA DEP/CT DEP Environmental Protection Agency, Massachusetts Department of Environmental Protection, Connecticut Department of Environmental Protection

Updated quarterly

RCRA NLR: EPA Environmental Protection Agency

Updated quarterly

Fed Brownfield: EPA Environmental Protection Agency

Updated quarterly

ERNS: EPA/NRC Environmental Protection AgencyNational Response Center.

Updated annually

Tribal Lands: DOI/BIA United States Department of the InteriorBureau of Indian Affairs

Updated annually

State/Tribal Sites: CA EPA The CAL EPA, Depart. Of Toxic Substances Control Phone: (916) 323-3400 For Cortese List information contact The CAL EPA, Department of Toxic Substances Control at (916) 445-6532

Updated quarterly/when available

State Spills 90: CA EPA The California State Water Resources Control Board For phone number listings of departments within each region visit their web sites at: http://www.swrcb.ca.gov/regions.html

Updated when available

State/Tribal SWL: CA IWMB/SWRCB/COUNTY The California Integrated Waste Management Board
Phone:(916) 255-2331
The State Water Resources Control Board
Phone:(916) 227-4365
Orange County Health Department
Phone:(714) 834-3536

Updated quarterly/when available

State/Tribal LUST: CA SWRCB/COUNTY The California State Water Resources Control Board Phone:(916) 227-4416
San Diego County Department of Environmental Health Phone:(619) 338-2242

Updated quarterly/when available

State/Tribal UST/AST: CA EPA/COUNTY/CITY The State Water Resources Control Board
Phone:(916) 227-4364
CAL EPA Department of Toxic Substances Control
Phone:(916)227-4404
US EPA Region 9 Underground Storage Tank Program
Phone: (415) 972-3372
ALAMEDA COUNTY CUPAS:
* County of Alameda Department of Environmental Health
* Cities of Berkeley, Fremont, Hayward, Livermore / Pleasanton, Newark, Oakland, San Leandro, Union
ALPINE COUNTY CUPA:
* Health Department (Only updated by agency sporadically)
AMADOR COUNTY CUPA:
* County of Amador Environmental Health Department
BUTTE COUNTY CUPA
* County of Butte Environmental Health Division (Only updated by agency biannually)
CALAVERAS COUNTY CUPA:

* County of Calaveras Environmental Health Department
COLUSA COUNTY CUPA:
* Environmental Health Dept.
CONTRA COSTA COUNTY CUPA:
* Hazardous Materials Program
DEL NORTE COUNTY CUPA:
* Department of Health and Social Services
EL DORADO COUNTY CUPAS:
* County of El Dorado Environmental Health - Solid Waste Div (Only updated by agency annually)
* County of El Dorado EMD Tahoe Division (Only updated by agency annually)
FRESNO COUNTY CUPA:
* Haz. Mat and Solid Waste Programs
GLENN COUNTY CUPA:
* Air Pollution Control District
HUMBOLDT COUNTY CUPA:
* Environmental Health Division
IMPERIAL COUNTY CUPA:
* Department of Planning and Building
INYO COUNTY CUPA:
* Environmental Health Department
KERN COUNTY CUPA:
* County of Kern Environmental Health Department
* City of Bakersfield Fire Department
KINGS COUNTY CUPA:
* Environmental Health Services
LAKE COUNTY CUPA:
* Division of Environmental Health
LASSEN COUNTY CUPA:
* Department of Agriculture
LOS ANGELES COUNTY CUPAS:
* County of Los Angeles Fire Department CUPA Data as maintained by the Los Angeles County Department of Public Works
* County of Los Angeles Environmental Programs Division
* Cities of Burbank, El Segundo, Glendale, Long Beach/Signal Hill, Los Angeles,Pasadena, Santa Fe Springs, Santa Monica, Torrance, Vernon
MADERA COUNTY CUPA:
* Environmental Health Department
MARIN COUNTY CUPA:
* County of Marin Office of Waste Management
* City of San Rafael Fire Department
MARIPOSA COUNTY CUPA:
* Health Department
MENDOCINO COUNTY CUPA:
* Environmental Health Department

MERCED COUNTY CUPA:
* Division of Environmental Health
MODOC COUNTY CUPA:
* Department of Agriculture
MONO COUNTY CUPA:
* Health Department
MONTEREY COUNTY CUPA:
* Environmental Health Division
NAPA COUNTY CUPA:
* Hazardous Materials Section
NEVADA COUNTY CUPA:
* Environmental Health Department
ORANGE COUNTY CUPAS:
* County of Orange Environmental Health Department
* Cities of Anaheim, Fullerton, Orange, Santa Ana
* County of Orange Environmental Health Department
PLACER COUNTY CUPAS:
* County of Placer Division of Environmental Health Field Office
* Tahoe City
* City of Roseville Roseville Fire Department
PLUMAS COUNTY CUPA:
* Environmental Health Department
RIVERSIDE COUNTY CUPA:
* Environmental Health Department
SACRAMENTO COUNTY CUPA:
* County Environmental Mgmt Dept, Haz. Mat. Div.
SAN BENITO COUNTY CUPA:
* City of Hollister Environmental Service Department
SAN BERNARDINO COUNTY CUPAS:
* County of San Bernardino Fire Department, Haz. Mat. Div.
* City of Hesperia Hesperia Fire Prevention Department
*City of Victorville Victorville Fire Department
SAN DIEGO COUNTY CUPA:
* The San Diego County Dept. of Environmental Health HE 17/58
SAN FRANCISCO COUNTY CUPA:
* Department of Public Health
SAN JOAQUIN COUNTY CUPA:
* Environmental Health Division
SAN LUIS OBISPO COUNTY CUPAS:
* County of San Luis Obispo Environmental Health Division
* City of San Luis Obispo City Fire Department
SAN MATEO COUNTY CUPA:
* Environmental Health Department
SANTA BARBARA COUNTY CUPA:

* County Fire Dept Protective Services Division
SANTA CLARA COUNTY CUPAS:
* County of Santa Clara Hazardous Materials Compliance Division
* Santa Clara County Central Fire Protection District (Covers Campbell, Cupertino, Los Gatos, & Morgan Hill)
* Cities of Gilroy, Milpitas, Mountain View, Palo Alto, San Jose Fire, Santa Clara, Sunnyvale
SANTA CRUZ COUNTY CUPA:
* Environmental Health Department
SHASTA COUNTY CUPA:
* Environmental Health Department
SIERRA COUNTY CUPA:
* Health Department
SISKIYOU COUNTY CUPA:
* Environmental Health Department
SONOMA COUNTY CUPAS:
* County of Sonoma Department Of Environmental Health
* Cities of Healdsburg / Sebastopol, Petaluma, Santa Rosa
STANISLAUS COUNTY CUPA:
* Department of Environmental Resources Haz. Mat. Division
SUTTER COUNTY CUPA:
* Department of Agriculture
TEHAMA COUNTY CUPA:
* Department of Environmental Health
TRINITY COUNTY CUPA:
* Department of Health
TULARE COUNTY CUPA:
* Environmental Health Department
TUOLUMNE COUNTY CUPA:
* Environmental Health
VENTURA COUNTY CUPAS:
* County of Ventura Environmental Health Division
* Cities of Oxnard, Ventura
YOLO COUNTY CUPA:
* Environmental Health Department
YUBA COUNTY CUPA:
* Yuba County of Emergency Services

Updated quarterly/annually/when available

State/Tribal IC: CA EPA The California EPA Department of Toxic Substances Control.Phone:(916) 255-3745

Updated Updated quarterly/annually/when available

State/Tribal VCP: CA EPA The California EPA Department of Toxic Substances Control.Phone:(916) 255-3745

Updated Updated quarterly/annually/when available

State Permits: CA EPA/COUNTY The San Diego County Depart. Of Environmental Health Phone:(619) 338-2211 San Bernardino County Fire Department Phone:(909) 387-3080

Updated quarterly/when available

State Other: CA EPA/COUNTY The CAL EPA, Depart. Of Toxic Substances Control Phone: (916) 323-3400 The Los Angeles County Hazardous Materials Division Phone: (323) 890-7806 Orange County Environmental Health Agency Phone: (714) 834-3536 Riverside County Department of Environmental Health, Hazardous Materials Management Division Phone:(951) 358-5055 Sacramento County Environmental Management Department Phone: (916) 875-8550

Updated quarterly/when available

Federal IC / EC: EPA Environmental Protection Agency

Updated quarterly

Environmental FirstSearch
Street Name Report for Streets within .25 Mile(s) of Target Property

Target Property: INFANTRY RD
LOCKWOOD CA 93932

JOB: 426649.01.04.EC

Street Name	Dist/Dir	Street Name	Dist/Dir
INFANTRY RD	0.00--		

HISTORICAL FIRE INSURANCE MAPS

NO MAPS AVAILABLE

03-12-12
426649.01.04.EC
INFANTRY RD
LOCKWOOD CA 93932

A search of FirstSearch Technology Corporation's proprietary database of historical fire insurance map availability confirmed that there are NO MAPS AVAILABLE for the Subject Location as shown above.

FirstSearch Technology Corporation's proprietary database of historical fire insurance map availability represents abstracted information from the Sanborn® Map Company obtained through online access to the U.S. Library of Congress via local libraries.

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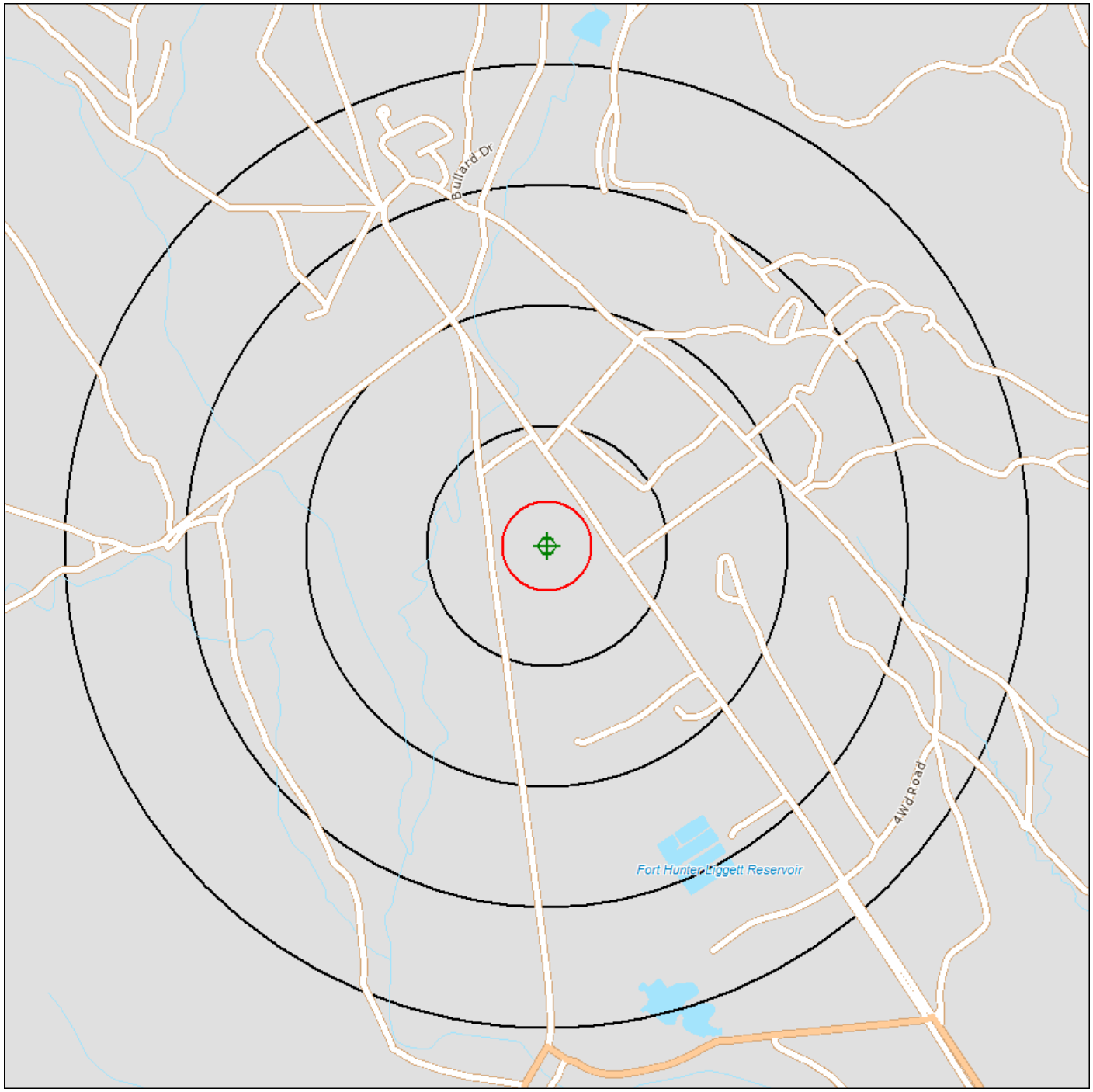
Environmental FirstSearch

1 Mile Radius

ASTM Map: NPL, RCRACOR, STATE Sites

INFANTRY RD, LOCKWOOD CA 93932



Source: Tele Atlas

Target Site (Latitude: 36.000091 Longitude: -121.238830) .....

Identified Site, Multiple Sites, Receptor .....

NPL, DELNPL, Brownfield, Solid Waste Landfill (SWL), Hazardous Waste

Triballand.....

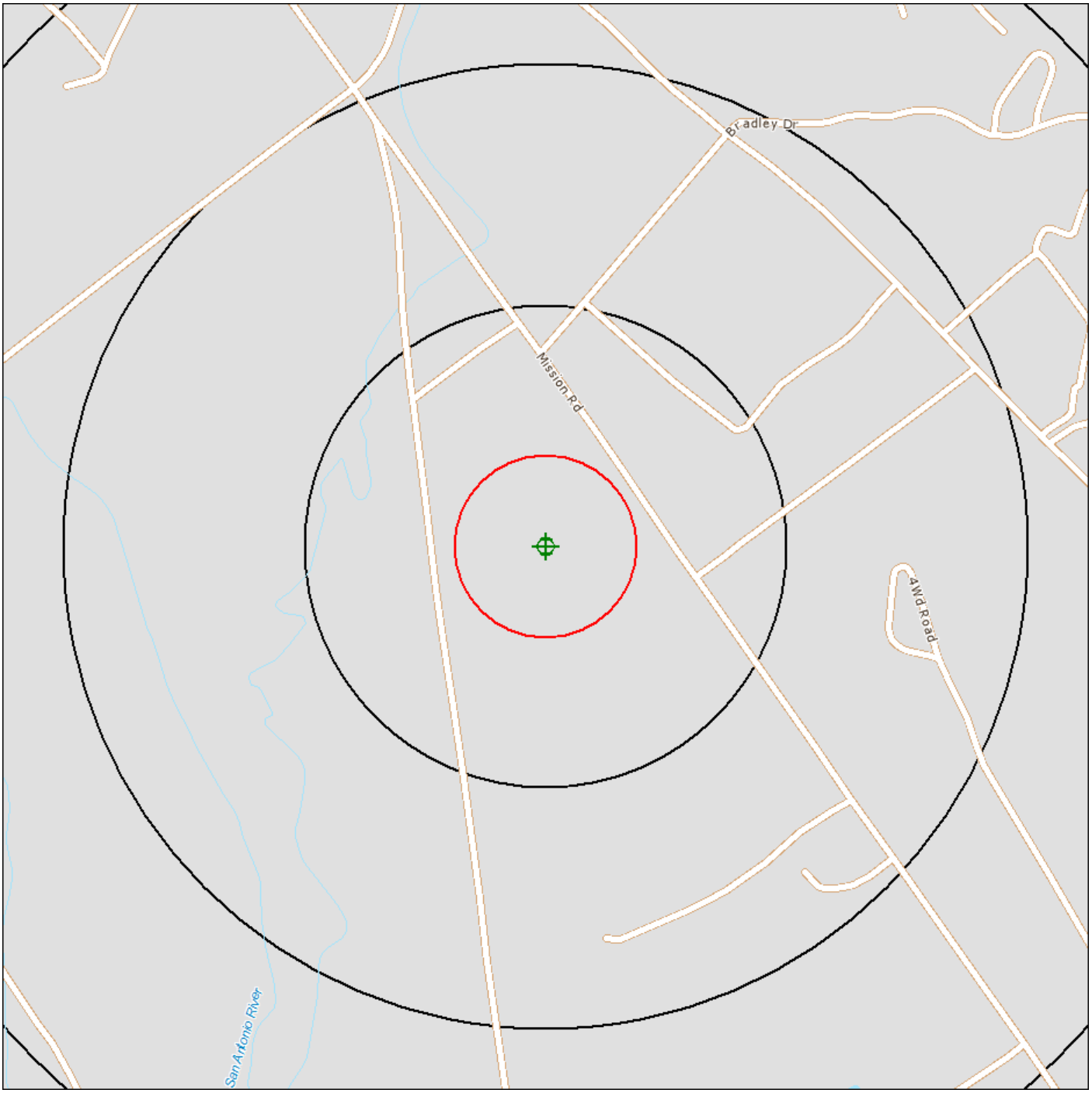
Black Rings Represent 1/4 Mile Radius; Red Ring Represents 500 ft. Radius

Environmental FirstSearch

.5 Mile Radius

ASTM Map: CERCLIS, RCRATSD, LUST, SWL

INFANTRY RD, LOCKWOOD CA 93932



Source: Tele Atlas

Target Site (Latitude: 36.000091 Longitude: -121.238830) .....

Identified Site, Multiple Sites, Receptor .....

NPL, DELNPL, Brownfield, Solid Waste Landfill (SWL), Hazardous Waste

Triballand.....

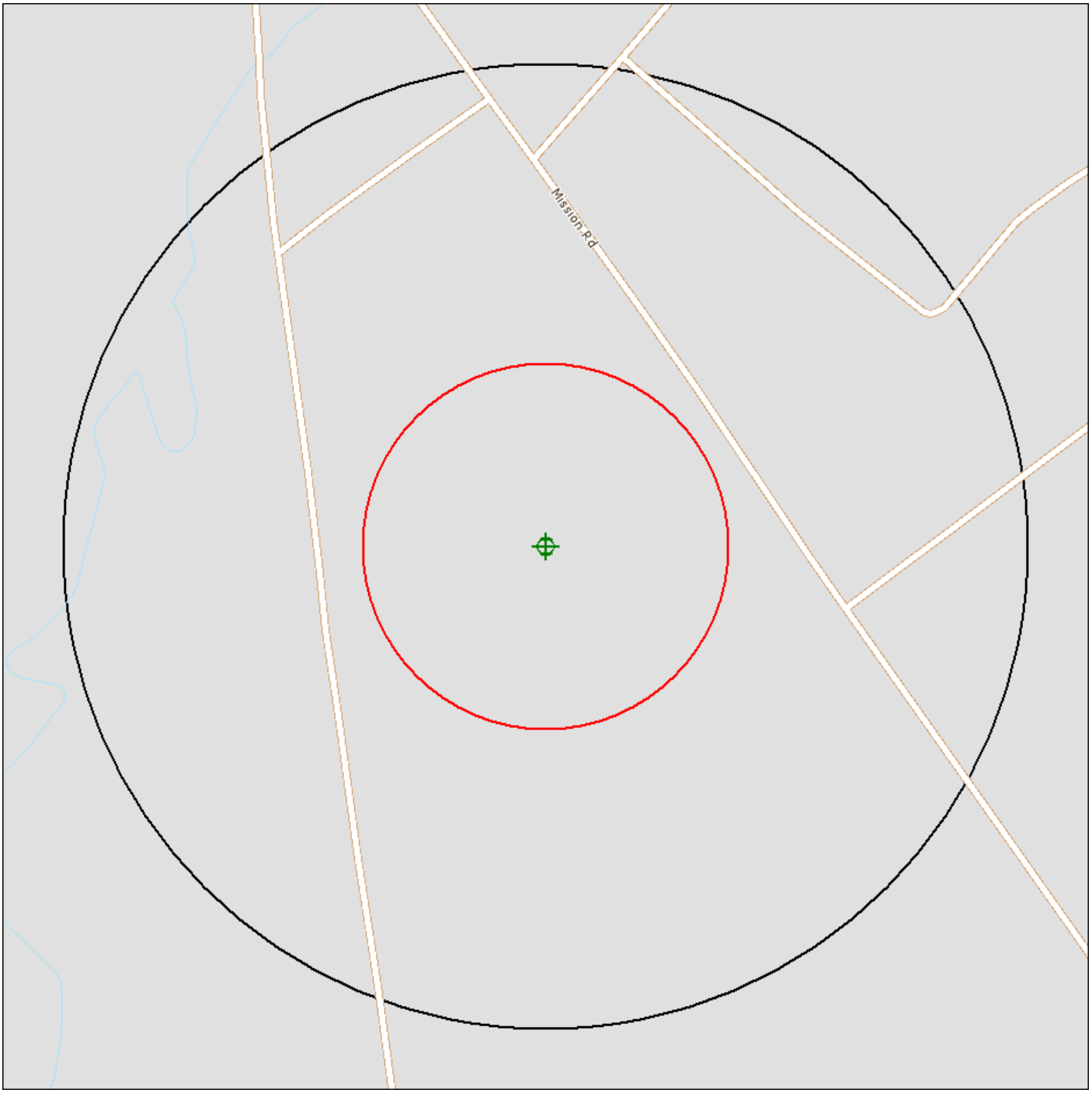
Black Rings Represent 1/4 Mile Radius; Red Ring Represents 500 ft. Radius

Environmental FirstSearch

.25 Mile Radius

ASTM Map: RCRAGEN, ERNS, UST, FED IC/EC, METH LABS

INFANTRY RD, LOCKWOOD CA 93932



Source: Tele Atlas

Target Site (Latitude: 36.000091 Longitude: -121.238830) .....

Identified Site, Multiple Sites, Receptor .....

NPL, DELNPL, Brownfield, Solid Waste Landfill (SWL), Hazardous Waste

Triballand.....

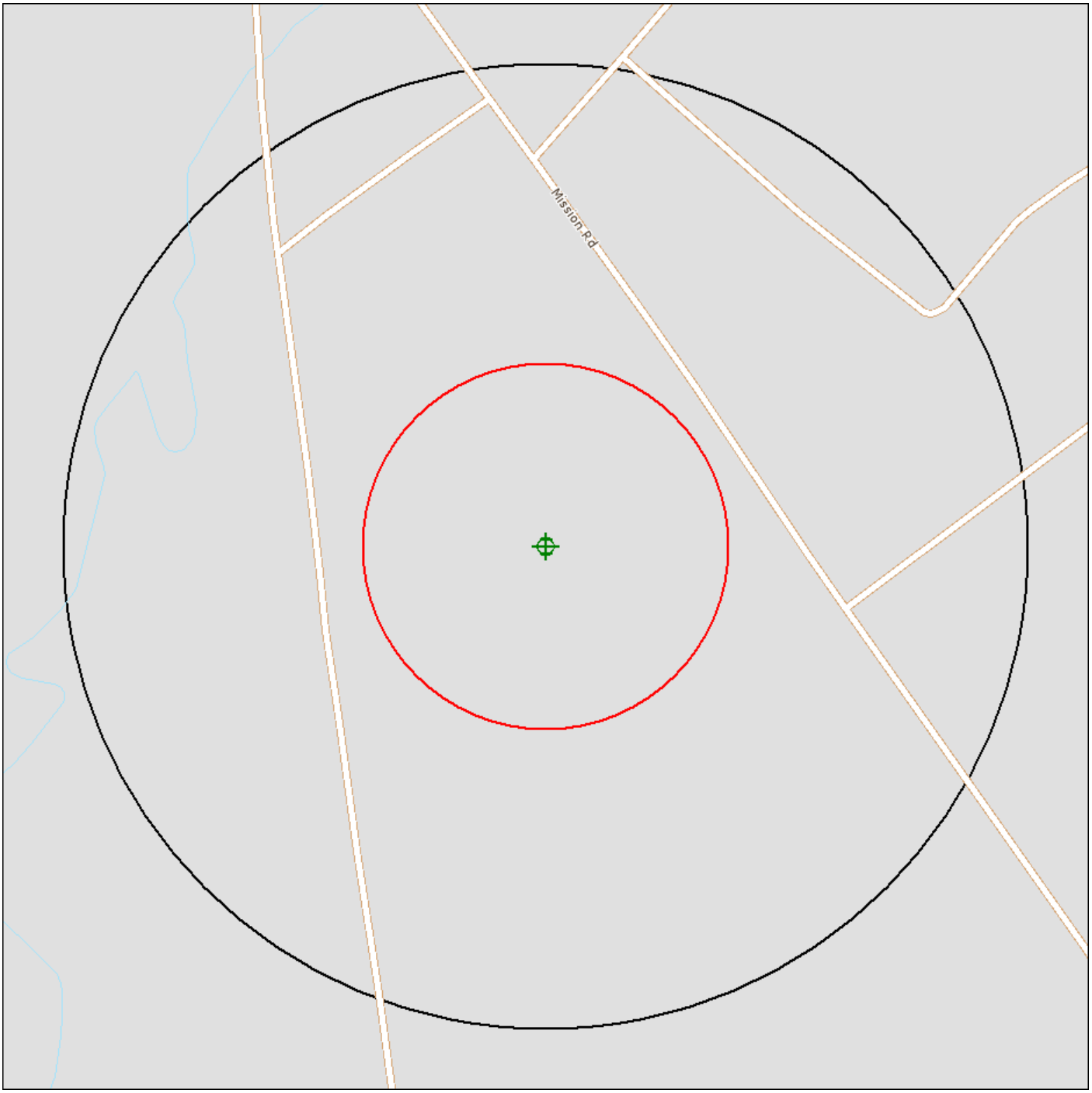
Black Rings Represent 1/4 Mile Radius; Red Ring Represents 500 ft. Radius

Environmental FirstSearch

.25 Mile Radius

Non-ASTM Map: No Sites Found

INFANTRY RD, LOCKWOOD CA 93932



Source: Tele Atlas

Target Site (Latitude: 36.000091 Longitude: -121.238830) .....

Identified Site, Multiple Sites, Receptor .....

NPL, DELNPL, Brownfield, Solid Waste Landfill (SWL), Hazardous Waste

Triballand.....

National Historic Sites and Landmark Sites .....

Black Rings Represent 1/4 Mile Radius; Red Ring Represents 500 ft. Radius

Appendix F

Interview Documentation

Interview Record

Project: **US Army Reserve**
Proposed Military Construction Project
Mission Road, Fort Hunter Liggett, California

Interview Date: March 6, 2012

Person Interviewed: Elizabeth Clark
Title: DPW Environmental Division – Wildlife Biologist
Organization: United States Army Garrison Fort Hunter Liggett

Interviewer: Grant Koster - CH2M HILL

Knowledge of Current Property Use: Currently is undeveloped and utilized for MEP until the solar array construction is complete on the assigned MEP area. No other specific knowledge of the Property.

Knowledge of Historical Property Uses: Has been familiar with the Property since the 1990s and has no knowledge of the Property being used for any activities or having contained any structures during this time. No specific knowledge of historical Property use for years prior to her employment at the garrison.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Property:
No specific knowledge of treatment, storage, disposal or use of hazardous materials on the Property.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Adjacent Properties:
No specific knowledge of storage, disposal, or use of hazardous materials on adjacent properties.

Knowledge of any Environmental Liens, Land use Restrictions, or Engineering Controls on Property: No special knowledge of any Liens, restrictions or controls in place on the Property.

Additional Information Pertaining to Environmental Condition of Property:
Was aware that there was documentation records existing for areas near the Property, but was not aware of any records for the Property. Indicated Mr. Mark Grindstaff, Michael Moeller, or Gary Houston would know where to find documentation for the Property if it exists and could also provide documentation for sites near the Property. Contact information was provided for these additional resources.

Interview Record

Project: **US Army Reserve**
Proposed Military Construction Project
Mission Road, Fort Hunter Liggett, California

Interview Date: March 6, 2012

Person Interviewed: Gary Houston
Title: DPW Environmental Division – Environmental Chief
Organization: United States Army Garrison Fort Hunter Liggett

Interviewer: Grant Koster - CH2M HILL

Knowledge of Current Property Use: Currently is undeveloped and utilized for MEP until the solar array construction is complete on the assigned MEP area. No other specific knowledge of the Property.

Knowledge of Historical Property Uses: Has been familiar with the Property since the 1980s and has no knowledge of the Property being used for any activities or having contained any structures during this time. No specific knowledge of historical Property use for years prior to his employment at the garrison.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Property:
No specific knowledge of treatment, storage, disposal or use of hazardous materials on the Property.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Adjacent Properties:
It was indicated that the area west of the Property known as the Building 258 Area, had experienced UST leaks with each of their 4 - 15,000 gallon diesel fuel USTs, that occurred as a result of the 1989 Loma Prieta earthquake and that all contained fuel within the tanks was released into the ground. Subsequent remedial efforts have delineated the extent of the plume and a remedial action has been implemented for the spill and associated plume. No impaction resulting from the releases or the plume has been identified on the Property.
No other specific knowledge of storage, disposal, or use of hazardous materials on adjacent properties.

Knowledge of any Environmental Liens, Land use Restrictions, or Engineering Controls on Property: No special knowledge of any Liens, restrictions or controls in place on the Property.

Additional Information Pertaining to Environmental Condition of Property:
Was aware of documentation records existing for areas near the Property, but was not aware of any records existing for the Property. Indicated Mr. Mark Grindstaff and Michael

Moeller would know where to find documentation for the Property, if it exists and could also provide documentation for sites near the Property. Contact information was provided for these additional resources.

Interview Record

Project: **US Army Reserve**
Proposed Military Construction Project
Infantry Road, Fort Hunter Liggett, California

Interview Date: March 6, 2012

Person Interviewed: Mark Grindstaff
Title: DPW Operation and Maintenance Division – Division Manager
Organization: United States Army Garrison Fort Hunter Liggett

Interviewer: Grant Koster - CH2M HILL

Knowledge of Current Property Use: Currently Property is undeveloped. No other specific knowledge of the Property.

Knowledge of Historical Property Uses: To the best of his knowledge the Property has always been undeveloped. No other specific knowledge of historical Property use.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Property:
No specific knowledge of treatment, storage, disposal or use of hazardous materials on the Property.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Adjacent Properties:
No specific knowledge of treatment, storage, disposal or use of hazardous materials on adjoining properties.

Knowledge of any Environmental Liens, Land use Restrictions, or Engineering Controls on Property: No special knowledge of any Liens, restrictions or controls in place on the Property.

Additional Information Pertaining to Environmental Condition of Property:
Was not aware of any documentation records existing for Property, but indicated that Michael Moeller would know of documentation pertaining to this.

Interview Record

Project: **US Army Reserve**
Proposed Military Construction Project
Mission Road, Fort Hunter Liggett, California

Interview Date: March 6, 2012

Person Interviewed: Michael Moeller
Title: DPW Environmental Division – Compliance Branch Manager
Organization: United States Army Garrison Fort Hunter Liggett

Interviewer: Grant Koster - CH2M HILL

Knowledge of Current Property Use: Currently Property is undeveloped. No other specific knowledge of the Property.

Knowledge of Historical Property Uses: To the best of his knowledge the Property has always been undeveloped. No other specific knowledge of historical Property use.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Property:
No specific knowledge of treatment, storage, disposal or use of hazardous materials on the Property.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Adjacent Properties:
Indicated that in 1989 a leak was detected in a diesel fuel UST in the area of Building 258 and the tank was removed. The other steel USTs were also removed and replaced at this time. Some visually impacted soils were removed from the UST location. There had been visual confirmation of fuel in the nearby surface water drainage ditch adjoining 7th Division Road, and a groundwater investigation determined that a plume of petroleum hydrocarbons was present and migrating to the southwest. The plume was delineated and a remedy selected for treatment.
It was also indicated that there was a previous release at the Building 194 location, (former AAFES site) where a former gasoline UST was found to be leaking. Removal of the UST was conducted and monitored natural attenuation of the associated groundwater contamination is being performed.

Knowledge of any Environmental Liens, Land use Restrictions, or Engineering Controls on Property: No special knowledge of any Liens, restrictions or controls in place on the Property.

Additional Information Pertaining to Environmental Condition of Property:
Was aware of documentation records existing for areas near the Property, but was not aware of any records existing for the Property. Provided reports indicating the extent of the

petroleum hydrocarbon plume from Building 258, as well as the remedial action report summarizing the selected remedy for Building 194.

Interview Record

Project: **US Army Reserve**
Proposed Military Construction Project
Infantry Road, Fort Hunter Liggett, California

Interview Date: March 30, 2012

Person Interviewed: Jeff Minetti
Title: Assistant Fire Chief
Organization: United States Army Garrison Fort Hunter Liggett Fire Department

Interviewer: Grant Koster - CH2M HILL

Knowledge of Current Property Use: Currently Property is undeveloped and used for MEP. No other specific knowledge of the Property.

Knowledge of Historical Property Uses: To the best of his knowledge the Property has always been undeveloped. No other specific knowledge of historical Property use.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Property:
No specific knowledge of treatment, storage, disposal or use of hazardous materials on the Property.

Knowledge of Storage, Disposal, or Use of Hazardous Materials on Adjacent Properties:
No specific knowledge of treatment, storage, disposal or use of hazardous materials on adjoining properties.

Knowledge of any Environmental Liens, Land use Restrictions, or Engineering Controls on Property: No special knowledge of any Liens, restrictions or controls in place on the Property.

Additional Information Pertaining to Environmental Condition of Property:
Was not aware of any recorded documentation existing for Property, but indicated that the Environmental Division would.

Appendix G

Supporting Documentation

FINAL REMEDIAL DESIGN BUILDING 194 AREA, 2011

MACTEC

engineering and constructing a better tomorrow

April 22, 2011

Mr. Grant Himebaugh
California Regional Water Quality Control Board, Central Coast Region
895 Aerovista Place, Suite 101
San Luis Obispo, California 93401

Subject: **LETTER OF TRANSMITTAL**
Final
Remedial Design
Building 194 Area
Fort Hunter Liggett, California
MACTEC Project No. 4084096558 3.3.6

Dear Mr. Himebaugh:

Please find enclosed one hard copy and one electronic copy (CD) of MACTEC's *Final Remedial Design, Building 194 Area, Fort Hunter Liggett, California,* dated April 22, 2011.

If you have any questions, please call us at (707) 793-3800.

Yours very truly,

MACTEC ENGINEERING AND CONSULTING, INC.

Bethany Flynn
Principal Geologist

Edward J. Ticken
Senior Principal Environmental Scientist

BF/EJT:sac

Enclosure

cc: Michael Moeller, Department of the Army (1 hard copy and 1 CD)
Teresa Rodgers, U. S. Army Corps of Engineers (1 CD)
Pamela Wehrmann, U. S. Army Corps of Engineers (1 CD)
Robert Fernandez, Monterey County Department of Health (1 CD)
David Eisen, U. S. Army Corps of Engineers (1 CD)
Daniel Walsh, IRP Program Management Support (1 CD)
Mark Eldridge, U.S. Army Environmental Command (1 CD)

FL63804_Bldg 194 Remedial Design LOT

MACTEC Engineering and Consulting, Inc.
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Final
Remedial Design
Building 194 Area
Fort Hunter Liggett, California

Prepared for

Department of the Army
Sacramento District Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

MACTEC Project No. 4084096558 3.3.6

Alfonso Ang
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April 22, 2011

MACTEC Engineering and Environmental Services
1465 North McDowell Boulevard, Suite 200
Petaluma, CA 94954 - (707) 793-3800

Final
Remedial Design
Building 194 Area
Fort Hunter Liggett, California

MACTEC Project No. 4084096558 3.3.6

This document was prepared by MACTEC Engineering & Consulting, Inc. (MACTEC) at the direction of the U.S. Army Corps of Engineers (USACE) for the sole use of the U.S. Army (Army), USACE, and the regulatory agencies, the only intended beneficiaries of this work. No other party should rely on the information contained herein without the prior written consent of the USACE and the Army. This report and the interpretations, conclusions, and recommendations contained within are based in part on information presented in other documents that are cited in the text and listed in the references. Therefore, this report is subject to the limitations and qualifications presented in the referenced documents.

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ACRONYM LIST

1,2-DCA	1,2-Dichlorethane
AES	Ahtna Engineering Services
Army	U. S. Army
bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
C&T	Curtis & Thompson
$C_{12}H_{26}$	dodecane
$C_{18}H_{18}$	octane
CAP	Corrective Action Plan
CO_2	Carbon dioxide
COC	Chemicals of Concern
COD	Chemical oxygen demand
CSM	Conceptual site model
DO	Dissolved oxygen
DOT	U.S. Department of Transportation
E&E	Ecology and Environmental, Inc.
EPA	U.S. Environmental Protection Agency
FOC	Fraction Organic Carbon
FHL	Fort Hunter Liggett
ft/ft	foot per feet
H_2O	water
H_2O_2	hydrogen peroxide
HLA	Harding Lawson Associates
IDW	investigation derived waste
ITRC	Interstate Technology Regualtory Council
ISCO	in-situ chemical oxidation
JMM	James M. Montgomery
kg	kilograms
$KMnO_4$	potassium permanganate
lbs	pounds
MACTEC	MACTEC Engineering and Consulting, Inc.
MCDOH	Monterey County Department of Environmental Health
µg/L	micrograms per liter
MCLs	maximum containment levels
mg/kg	millgrams per kilogram
MNA	monitored natural attenuation
MSL	Mean sea level
MTBE	Methyl tertiary butyl ether
$Na_2S_2O_8$	sodium persulfate
OH•	hydroxyl radical
O_2	oxygen
O_3	ozone
ORC™	Oxygen releasing compound
ORP	Oxygen Reduction Potential
PTS	PTS Laboratories
psi	pounds per square inch

QA/QC	Quality Assurance/Quality Ccontrol
RD	Remedial Design
ROI	radius of influence
RWQCB	Regional Quality Water Control Board
$SO_4^{-\bullet}$	sulfate radical
SC	Site characterization
sf	square feet
Site	Building 194 Area
SM	StandardMethod
TOC	Total organic carbon
TPH-DRO	Total petroleum hydrocarbon as diesel range organics
TPH-GRO	Total petroleum hydrocarbons as gasoline range organics
USACE	U.S. Army Corps of Engineers
UST	Underground storage tank
VOCs	Volatile organic compounds
WP	Work Plan

1.0 INTRODUCTION

This Final Remedial Design (RD) for Building 194 Area (Site) at Fort Hunter Liggett (FHL), California (Figures 1-1 and 1-2) was prepared by MACTEC Engineering and Consulting, Inc. (MACTEC) under the direction of the U. S. Army Corps of Engineers (USACE), Sacramento District, Contract No. W91278- 7-D-005 CM02. The RD presents the design of the selected remedy to protect human health and the environment from known releases of contaminants at the Site. The remedy represents an optimization to the monitored natural attenuation (MNA) remedy presented in the Corrective Action Plan (CAP, *Harding Laswson Associates [HLA], 1997*). The remedial design was developed using site characterization data presented in the *Draft Site Characterization (SC) Report, Building 194 Area, Fort Hunter Liggett, California* (*MACTEC, 2010c*).

1.1 Objectives

The objective of this RD is to present the design analysis for the selected optimization remedy and provides guidelines for the implementation of the selected remedy.

1.2 Remedial Design Report Organization

This document is organized as follows: Section 2.0 presents background information regarding site location, geology and hydrogeology, site usage, previous investigations, distribution of chemicals, conceptual site model (CSM), and a summary of previous enhanced natural attenuation studies. Section 3.0 presents Site lithology, saturated soil testing results, and contaminant mass distribution. Section 4.0 presents a description of the selected remedy. Section 5.0 presents the remedy implementation plan. Section 6.0 presents the remedy groundwater monitoring sampling and laboratory analysis plan. Section 7.0 presents proposed additional monitoring well installations. Section 8.0 presents decontamination and management of investigation derived waste (IDW). Section 9.0 presents references. Tables and figures are included in separate tabbed sections following the text.

2.0 BACKGROUND

This section presents a discussion of the site location and topography, geology and hydrogeology, site usage and previous studies including regulatory history, and the CSM.

2.1 Location and Topography

The Site (Figures 1-1, 1-2, and 2-1) is bounded by hills to the immediate north and east and is located west of the Jolon fault. Reportedly, before the former Building 194 fueling station was constructed, a portion of the hill was removed east of the site to aloow construction of a foundation pad for the fueling station.

The elevation of the Site ranges from 1,045 feet (near Building 156) to 1,080 feet above mean sea level (MSL) (near Building 194). The surface of the site slopes down to the west; the surface slope is relatively steep in the eastern two-thirds of the site, with a vertical drop of 20 feet over a 500 feet horizontal distance, and flattens in the western third of the site near Sulfur Springs Creek. Surface runoff flows towards Sulfur Springs Creek, an intermittent stream that flows south to the San Antonio River.

2.2 Geology and Hydrogeology

The geologic formations in the vicinity of Building 194 (i.e., the Building 290 and Former PX Facility areas; Figure 1-2) include Plio-Pleistocene terrestrial deposits (Paso Robles Formation) and unconsolidated Holocene alluvium.

Subsurface deposits near Building 194 are silty sand and clay units interbedded with sand and gravel units. The physiographic, structural, and lithologic evidence suggests that Building 194 is situated on alluvial fan deposits fed by ephemeral streams and washes that drain from the uplifted hills along the north and east sides of the site. Geological cross-sections are presented in the SC.

Several subsurface folds and faults that sub-parallel the Jolon Fault were identified at the northeast portion of the Site during a seismic reflection survey performed on or before 1995. Shallow groundwater flow does not appear to be impeded within the site by these structural features, as there is no surface trace of the faults; the seismic survey imaged a depth range greater than the groundwater monitoring well depths. The faults have been buried by recent sedimentation since the last movement occurred. The seismic survey covered a depth range of between approximately 70 to 350 feet.

Groundwater flow at the Site has been divided into an upper and lower hydrostratigraphic units. The hydrostratigraphic units consist of sands and sandy gravels separated by an aquitard layer of sandy clays

and silts. Where present, the upper unit of coarse-grained materials (Upper Zone) ranges in depth from eight to 33 feet below ground surface (bgs) and is saturated intermittently. The results of slug tests performed in the Upper Zone (when the Upper Zone was saturated) during previous investigations indicate hydraulic conductivities ranging from 1.1 to 17.7 feet per day (*James M. Montgomery [JMM], 1991*). The top of the lower coarse-grained unit (Lower Zone) varies from approximately 20 to 60 feet bgs and remains saturated year round; the elevation of the bottom of the Lower Zone is unknown over most of the site. Cross sections (presented in *HLA, 2000b*) also show that the alluvial units generally dip to the west-southwest.

A friable, deeply weathered siltstone, encountered between 10 and 20 feet bgs near the underground storage tank (UST) area at the Site, appears to underlie the Lower Zone and appears to dip to the west-southwest. The depth to the siltstone is greater than 50 feet bgs near former Monitoring Well 194-MW-005 and rises to about 40 feet bgs in former Well 194-MW-010.

Monitoring of the Lower Zone indicates that groundwater flow direction is northwesterly in the eastern portion of the site and turns to the south in the western portion of the site. Between Building 194 and Facility 95, groundwater flow generally follows surface topography; however, at Facility 95, where the surface topography becomes gentler the groundwater flow appears to turn towards the south, which is consistent with the regional direction of groundwater flow towards the San Antonio River (Figure 2-1).

Assuming an effective porosity of 25 percent and a measured hydraulic gradient of 0.015 feet per foot (ft/ft) between Well 194-PZ-12 and 194-MW-W11, the groundwater velocity was calculated to be between 0.06 and 1.04 feet per day, with an average of 0.55 feet per day during the first 2009 semiannual monitoring event.

2.3 Site Usage Previous Investigations and Regulatory History

Two sites, formerly used for vehicle maintenance or fueling, comprise the Site: a former refueling station at Building 194 and a former motor pool maintenance area at Facility 95 (Figure 2-1). A description of the previous site usages and groundwater investigations are presented in the following subsections.

2.3.1 UST Removals and Initial Groundwater Investigation

At Building 194, two 12,000-gallon USTs were installed in 1958. In 1981, a leak was discovered in one of the USTs, and that UST was replaced with a 12,000-gallon single-walled fiberglass UST. In 1992, the second 12,000-gallon UST was removed under the direction of Ecology and Environment, Inc. (E&E). It was noted at that time that excavated soils had strong hydrocarbon odors (*E&E, 1995*). Between 1996 and 1998, contaminated soil was excavated from areas where the former USTs and conveyance lines were

located, identified as Hot Spot 1 (southeast of Building 194) and Hot Spot 2 (northwest of Building 194) (Figure 2-1). Soil was removed from Hot Spot 2 in September 1996 (*Geofon, Inc., 1996*) and from Hot Spot 1 in June 1998 from the area southeast of Building 194 (*HLA, 1998*).

At Facility 95, northwest and downhill of Building 194, a 750-gallon waste oil UST was installed in 1964. The tank was used for vehicle maintenance prior to its removal in April 1991 under the guidance of the Monterey County Department of Health, Environmental Branch (MCDOH). In 1997, contaminated soil was excavated from the waste oil UST pit (Hot Spot 3, Figure 2-1) and confirmation samples indicated that soil concentrations following removal were below action levels.

In 1994 and 1995, E&E conducted two phases of a groundwater site investigations at the Building 194 Area. Quarterly monitoring of these wells indicated that the groundwater contained levels of benzene, toluene, ethylbenzene, and xylenes (BTEX), and lead above state and federal maximum contaminant levels (MCLs) (*E&E, 1995)*.

2.3.2 Corrective Action Plan

Following the tank removal and groundwater investigations described above, a CAP (*HLA, 1997*) was developed specifying MNA for groundwater as the Site remedy. The U. S. Environmental Protection Agency (EPA) MCLs were identified as the cleanup goals for groundwater.

As part of the CAP, a natural attenuation study was required to assess whether microorganisms were naturally degrading hydrocarbon compounds at the site. The results of this study and the subsequent enhanced natural attenuation implemented at the site are described in Section 2.3.4.

2.3.3 Groundwater Investigations 1998 to 2008

This section briefly summarizes groundwater investigations performed at the site between 1998 through 2008.

- Additional groundwater investigations conducted at the site by HLA between 1998 to 2000 indicated that two water-bearing zones were present in the Building 194 Area, separated by a clay layer approximately 5-feet thick. The contamination was primarily confined to the Lower Zone (*HLA, 1999)* and the downgradient extent of the benzene plume was determined to be Well 194-MW-016 (*HLA, 2000a and 2000c, Figure 2-4*);
- Routine quarterly groundwater monitoring was performed by HLA and Harding ESE between 2001 and 2003;

- The quarterly groundwater monitoring was reduced to a semi-annual monitoring beginning in 2004. MACTEC performed semiannual groundwater monitoring at the site from 2004 through 2007;
- Routine semi-annual groundwater monitoring was resumed by MACTEC in October 2008 and June 2009, ending a brief hiatus since the previous sampling event in January 2007;
- Routine quarterly groundwater monitoring was conducted by Ahtna Engineering Services (AES) beginning in November 2009; and
- Additional characterization of the Site was conducted by MACTEC from February to June 2010 and results are presented in the SC (*MACTEC, 2010c*).

2.3.4 Enhanced Natural Attenuation Studies

Enhanced natural attenuation studies performed at the Site as part of the CAP implementation consisted of the following activities summarized below.

HLA conducted a natural attenuation study in 1998 to assess whether microorganisms were naturally degrading hydrocarbon compounds. In March 2000, HLA published an evaluation of the effectiveness of natural attenuation at the Building 194 Area (*HLA, 2000b*). As a result of this evaluation, HLA concluded that natural attenuation, primarily bioactivity, was responsible for the observed decline in groundwater hydrocarbonsconcentrations in groundwater.

FHL submitted a work plan (WP) to the Regional Water Quality Control Board (RWQCB) in a letter dated January 10, 2000, describing a pilot study designed to assess if calculated decay rates could be enhanced by adding oxygen releasing compound (ORC™) to the groundwater (*HLA, 2000a, and 2000c*). The pilot study began during the last week of April 2000 and continued through the fourth quarter 2000. Based on results of the ORC™ pilot study, FHL proposed changing the oxygen conveyance system from ORC™ to hydrogen peroxide using a gravity drip system. The conversion allowed for the delivery of more hydrogen peroxide per unit of time resulting in a higher concentration of oxygen over a longer period than was possible with injection and dissolution of the ORC™. The conversion of the oxygen conveyance system was approved by the RWQCB in November 2000, and an injection point 194-NW-001 was subsequently installed. Coinciding with this pilot study, collection of natural attenuation parameters from 16 wells within the Building 194 monitoring network and five hydrogen peroxide injection area wells was initiated. From April 2000 to April 2004, the natural attenuation data was collected, reported, and evaluated from these 21 wells to determine if enhanced natural attenuation was occurring as a result of the hydrogen peroxide injections.

Based on the results of the first year of operation using the gravity drip system, FHL proposed installing two additional hydrogen peroxide delivery system wells downgradient of the original injection system. The oxygen delivery system expansion was subsequently approved by the RWQCB and the two new injection points were installed during the fourth quarter 2002. The hydrogen peroxide injections continued through approximately November 2006, when the hydrogen peroxide injection systems were taken offline. The enhanced natural attenuation using hydrogen peroxide helped to lower and maintain benzene and total petroleum hydrocarbon as gasoline range organics (TPH-GRO) concentrations at the Site, although a moderate rebound in both benzene and TPH-GRO concentrations was observed in some plume wells after the injections were discontinued. The rebound in contaminants in site wells following the halt to the injections indicate that the enhanced natural attenuation was not effective as a long term remedial solution for the site, and other remedial methods should be evaluated.

2.3.5 Conceptual Site Model

Based on review of the data obtained during the 2010 site characterization, a revised site conceptual model is presented below. The first section describes the potential sources and distribution of chemicals detected in groundwater and soil. The second section describes the contaminant transport model, and the third section describes the potential for complete human health pathways.

2.3.5.1 Potential Source Areas and Distribution of Chemicals

Based on the review of existing soil vapor, soil, and groundwater sampling data, and review of the quarterly groundwater monitoring conducted by AES from September 2009 through June 2010, the primary source of contamination was the former UST and fuel pump island areas at Building 194. Based on the soil vapor survey, there is residual contamination in the soil and soil vapor near the Building 194 area. A review of the soil vapor data collected adjacent to Building 95 did not indicate the presence of residual hydrocarbon source in the vicinity of the building. BTEX concentrations in the soil vapor sample collected near Building 95 were not elevated in comparison to the samples collected near Building 194 (*MACTEC, 2010c*).

Primary chemicals of concern at the site include BTEX, methyl tertiary butyl ether (MTBE), 1,2,-Dichloroethane (1,2-DCA), and lead. These chemicals are associated with the petroleum hydrocarbon release at the USTs. Benzene is used as the indicator chemical to define the extent of the hydrocarbon plume. A discussion of the distribution of the chemicals of concern (COCs) based on the historical data and the recently collected data is provided below.

Review of historical data suggests that two hydrostratigraphic units are present at the site, the Upper Zone and the Lower Zone. The Upper Zone appears to have connection with the Lower Zone in the Upgradient Area as evident at recently installed Monitoring Well 194-MW-018 where benzene was detected at 9,500 micrograms per liter (µg/L) in groundwater. A sand unit is present in the vicinity of the source area and dips toward the east and may act and have acted as a pathway for migration of contamination into the Lower Zone. Recent site characterization activities suggests that the highest concentrations of chemicals are present in the Lower Zone as seen in 194-MW-018 and 194-MW-022.

Recent data indicates that concentrations of benzene and TPH-GRO are elevated at concentrations downgradient of the source area north of Buildings 188 and 189 (194-MW-018). The concentrations detected in 194-MW-018 in June 2010 were in the range of historic high concentrations seen in piezometers 194-PZ-012 and -013. This suggests that the area of highest concentrations within the plume extends closer to the source area than previously identified. It should be noted that following completion of the source removal in 1998, overall benzene concentrations declined, particularly in the wells located closest to the former source areas (194-MW-001 and -003). The source removal actions also resulted in decreases in benzene concentrations in all other wells in the Building 194 Area, with the exception of Piezometers 194-PZ-012 and -013. Although the overall benzene concentrations have declined since removal of Hot Spots 1 and 2, the benzene concentrations increased in some wells between January 2007 and the October 2008 and June/July 2009 monitoring events suggesting a continuing source of petroleum hydrocarbons in soil, soil vapor, or groundwater at the site. The results of the site characterization also suggest the potential for a continuing source based on the soil vapor results, and the increase in benzene concentrations from non-detect to 93 µg/L in 194-MW-003 following the increasing water levels related to the spring precipitation.

2.3.5.2 Contaminant Transport Model

The primary source of petroleum hydrocarbon contamination was from former leaking USTs at Building 194. USTs, associated conveyance lines and contaminated soil were removed prior to the end of 1998. Prior to removal of the source, the petroleum hydrocarbons that leaked from the USTs appear to have migrated down to an impermeable siltstone that dips to the west and flowed along the siltstone contact in the Lower Zone, potentially in a well graded sand just above the siltstone, following the hydraulic gradient. After the surface topography flattens in the vicinity of Building 183, the groundwater flow direction turns towards the south following the regional groundwater gradient towards the San Antonio River. Figure 2-2 shows the current benzene plume.

Based on review of the historical data, the rebound in benzene concentrations since discontinuation of active enhanced natural attenuation program, the results of the soil vapor sampling, and recent groundwater monitoring, indicate that residual contamination exists in soil and soil vapor near the Building 194 area which may be mobilized to the groundwater during periods of high groundwater.

2.3.5.3 Analysis of Potential Receptors

A conceptual site exposure model was presented in the *Draft Site Characterization Report (MACTEC, 2010c, Figure 2-7).* As shown on the figure and discussed above, the primary source was likely a release of petroleum hydrocarbons to soil. The primary transport mechanisms include volatilization, and leaching. Exposure mechanisms include volitalization to air and contact with soil and groundwater. Potential onsite receptors are limited to construction workers and onsite workers. Contact with contaminated soil is not anticipated unless excavation of over 20 feet in the source areas occurs. Therefore, the soil exposure pathways are considered incomplete. The groundwater exposure pathways are also considered incomplete because the groundwater is not used by human receptors and no use of the shallow groundwater is expected in the future. Exposure to volatilized contaminants through inhalation due to intrusion of soil vapor into indoor air is potentially complete; however, a recent Army soil vapor intrusion investigation, suggest that the pathway is not complete; however, a recent Army soil vapor intrusion investigation, suggest that the pathway is not complete.

Although the groundwater pathway is not considered complete, the site will not be considered closed until cleanup goals specified in the CAP (*HLA, 1997*) are met.

3.0 LITHOLOGY, SOIL PHYSICAL TESTING AND CONTAMINANT MASS DISTRIBUTION

3.1 Lithologic Data

Lithologic data was collected during the 2010 site characterization and previous investigations indicates that subsurface deposits consist of silty sand, silt, and clay units, which are interbedded with sand and gravel units. Some of these units appear to be poorly cemented bedrock, especially in the vicinity of the source area and at depth in the mid plume and downgradient areas. As evident on the cross-sections, there are fine-grained units which appear to separate an Upper hydrostraticgraphic unit (Upper Zone) from a Lower hydrostratigraphic unit (Lower Zone) in the downgradient portions of the site. The thickness of the fine grained units separating the Upper and Lower Zone varies across the site and appears to thin near the source area in the vicinity of the recently installed monitoring well 194-MW-018. A review of the soil types mapped in the soil excavation sidewall conducted at the source areas (Hot Spots 1 and 2) indicated that the geologic units were dipping to the west. The westward dipping soil layers provide a pathway for contamination to migrate from the release area through the vadose soil and into the saturated Lower Zone present in the downgradient plume (*MACTEC, 2010c, Figure 2-2*). It should also be noted that the coarse and fine-grained units are not continuous throughout the area and that flow between the Upper and Lower Zones may occur in the vicinity of the source area.

3.2 Saturated Soil Analysis

During the 2010 SC, ten saturated soil samples were collected and submitted for chemical and physical analysis. Saturated soil samples were collected within one 2-inch diameter by 6-inch stainless steel tube. Saturated soil samples collected for chemical analysis were submitted to Curtis & Tomkins (C&T) in Berkeley, California, and samples for petrophysical analysis were submitted to PTS Laboratories (PTS) in Santa Fe Springs, California. Soil samples were analyzed for the following:

- Chemical Oxygen Demand (COD) by Standard Method (SM) 5220D submitted to C&T;
- Total Organic Carbon (TOC) by SM5310 submitted to C&T;
- Title 22 Metals by EPA Test Method 6000/7000 submitted to C&T;
- TRRP RG-36 Limited Site Assessment Physical Properties Format (intrinsic permeability/hydraulic conductivity, total porosity, air-filled porosity, dry bulk density, volumetric moisture content, and fraction organic carbon [FOC]) submitted to PTS; and

- X-Ray Diffraction Analysis (Mineralogical Analysis) submitted to PTS.

Laboratory analysis results reported by C&T indicated that detected COD in the mid-plume were below the laboratory reporting limit of 10 milligrams per kilogram (mg/kg), and varied from 11 mg/kg in 194-SB-0019 (source area), 26 mg/kg in 194-MW-020 (downgradient), and 28 mg/kg in 194-SB-019 (outside the plume). TOC analysis indicated minimal organic carbon with percentages ranging from non-detect (0.01%) to 0.02% (194-SB-003) in the collected samples. The low TOC percentages were also confirmed by the analytical results from PTS, which indicated a fractional organic carbon average of only 2.9×10^{-4} grams per grams (i.e., 0.029%).

Inorganic analysis indicated total iron to be the predominant metal detected in the submitted soil samples. Total iron concentrations ranged from 4,400 mg/kg in 194-SB-019 to 13,000 mg/kg (0.44 to 1.3% of sample) in monitoring well 194-MW-021. Chemical analytical results are presented in Table 3-1.

Physical analyses indicated consistent physical characteristics among all samples with the following average soil parameters:

- Dry bulk density: 1.52 grams/cubic centimeter (95.0 pounds per cubic foot)
- Total porosity: 40.5%
- Vertical hydraulic conductivity: 5.13×10^{-4} centimeters per second (1.45 feet per day)

Mineralogical x-ray diffraction analysis indicated that the majority of the mineral content in the submitted samples consist mainly of quartz (27% to 58%), plagioclase feldspar (12% to 32%), and montmorillonite (4% to 39%). The lack of organic carbon and ferro-magnesium minerals within the site's soil types indicates that the natural oxygen demand of soil is relatively low and that chemical oxidation is a viable technology for remediation of site COCs. The soil samples physical properties and mineralogical results are presented in Tables 3-2 and 3-3, respectively.

3.3 Contaminant Mass Distribution

The benzene plume presented in the *Draft Site Characterization Report* was used to calculate the soil and dissolved contaminant mass remaining at the Site. Due to the variability in detected soil and groundwater contaminant concentrations, the delineated benzene plume was divided into three separate treatment areas: 1) Area 1 – Source Area, 2) Area 2 – Mid-Plume, and 3) Area 3 – Downgradient Plume, (Figure 3-1). The soil mass and dissolved mass were calculated using the following assumptions:

- Estimated Plume Areas: Treatment Area 1 = 29,500 square feet (sf), Treatment Area 2 = 90,800 sf, and Treatment Area 3 = 109,000 sf
- Estimated affected soil areas in Treatment Areas 1 and 3 are localized to a 50 ft by 50 ft area
- Estimated affected soil area in Treatment Area 2 is the entire plume area
- Estimated thickness of affected soil in all Treatment Areas = 3 ft
- Estimated thickness of affected saturated zone = 10 ft
- Average soil porosity (40.5%) and dry bulk density (95 pounds [lbs]/cf) as reported in the physical analyses reports for all Treatment Areas (Table 3-2)

Mass calculations were conducted using the average concentration of reported total petroleum hydrocarbon – diesel range organics (TPH-DRO), TPH-GRO, and benzene reported in soil borings and monitoring wells located within each of the designated areas. These three contaminants were selected as they represent the three COCs with the highest detected concentrations during the characterization work and on-going groundwater sampling. Soil and dissolved mass calculations are presented in Table 3-4.

Calculated mass in place for each of the treatment areas are as follows:

AREA	Mass in Soil (lbs / kg)	Dissolved Mass (lbs / kg)	Total Mass (lbs / kg)
1	39.4 / 17.9	4.8 / 2.2	83.5 / 38.0
2	11.7 / 5.3	502.8 / 228.5	526.3 / 239.2
3	43.2 / 19.6	5.6 / 2.5	91.9 / 41.8

4.0 REMEDIAL DESIGN

This section describes the remedy selected to treat the groundwater hydrocarbon impacts at the Site.

4.1 In-Situ Chemical Oxidation

The selected remedial technologies for the Site is in-situ chemical oxidation (ISCO). ISCO is a proven and feasible remedial method capable of reducing current petroleum hydrocarbon and benzene concentrations in groundwater to below MCLs or to levels that can be effectively treated by natural attenuation. ISCO pilot treatability studies conducted in the Building 258 Area (approximately 0.68 miles southeast of the Site) indicated that the application of ISCO was effective in the reduction of dissolved hydrocarbon contamination in groundwater (*MACTEC, 2006*).

ISCO is based on the delivery of chemical oxidants to contaminated media in order to destroy the contaminants by converting them to innocuous compounds such as carbon dioxide (CO_2) and water (H_2O). The oxidants applied in this process are typically catalyzed hydrogen peroxide (H_2O_2), catalyzed sodium persulfate ($Na_2S_2O_8$), potassium permanganate ($KMnO_4$), or ozone (O_3). The oxidation of hydrocarbons, in the case of catalyzed hydrogen peroxide or sodium persulfate, is conducted by the formation of free radicals such as hydroxyl ion (OH•) or sulfate ion ($SO_4^{-\bullet}$) derived from the oxidant. Radicals are powerful oxidizing species, which non-selectively react with organic substrates via bond addition and hydrogen abstraction under suitable conditions. The reaction is exothermic and leads to the complete mineralization of organic substrates. In addition to the direct oxidation of hydrocarbons, an increase in dissolved oxygen concentrations occurs when peroxide based oxidant is supplied in quantities greater than necessary for the decomposition reaction. The increased dissolved oxygen can stimulate natural microbial activity to further degrade any residual contamination.

The RD focuses on the use of a catalyzed hydrogen peroxide as the oxidant of choice for the remediation of the site. A catalyzed hydrogen peroxide oxidant was selected based on the following:

- Only dissolved contaminants are present at the Site. Characterization work conducted in May 2010 did not indicate the presence of free product at the Site.
- A catalyzed hydrogen peroxide oxidant produces hydroxyl radicals (OH•) which have the highest standard oxidation potential (2.8 volts) when compared to sulfate radical (2.5 volts), ozone (2.1 volts), and permanganate (1.7 volts) (*Interstate Technology Regulatory Coucil [ITRC], 2005, Table 1-1*).

- Catalyzed hydrogen peroxide injection provides spot treatment and does not require installation of permanent treatment equipment or permanent access to utilities such as in the case of ozone injection.
- Oxidant in excess of the required decomposition reaction fosters increased microbial activity by increasing dissolved oxygen concentrations
- Commercial catalyzed hydrogen peroxide oxidant products such as RegenOx™ by Regenesis are readily available.

4.2 Catalyzed Hydrogen Peroxide Chemical Oxidation

Catalyzed hydrogen peroxide has been established as an effective oxidizing agent for the treatment of hydrocarbon contaminated groundwater. The process generates powerful hydroxyl radicals when the hydrogen peroxide reacts with an iron catalyst. The principal chemical reactions associated with the production of hydroxyl radicals and oxidation of hydrocarbons by hydrogen peroxide is as follows (*Peters, 2001*):

$$H_2O_{2\,(aq)} + Fe^{2+}_{(aq)} \Rightarrow OH\bullet_{(aq)} + OH^-_{(aq)} + Fe^{3+}_{(aq)}$$

$$OH\bullet_{(aq)} + C_xH_{y(l)} \Rightarrow H_2O_{(l)} + CO_{2(g)}$$

Where,

H_2O_2 = hydrogen peroxide, Fe^{2+} = ferrous ion, OH• = hydroxyl radicals, C_xH_y= hydrocarbon, CO_2 = carbon dioxide, H_2O = water; (aq) = aqueous, (l) = liquid, (g) = gaseous phase.

4.3 Remediation Treatment Areas Oxygen Demand and Radius of Influence

The oxygen demand required to mineralize the residual hydrocarbon mass was calculated using the estimated TPH-DRO, TPH-GRO, and benzene masses presented in Table 3-4 for each of the treatment areas. The stoichiometric contaminant oxygen demand was calculated as follows:

- The TPH-DRO oxygen demand was calculated using dodecane ($C_{12}H_{26}$) as an average for TPH-DRO. The theoretical chemical oxidation reaction of dodecane is given by:

DODECANE	+	oxygen →		carbon dioxide	+	water
$C_{12}H_{26}$	+	$18.5O_2$	→	$12CO_2$	+	$13H_2O$

- The TPH-GRO oxygen demand was calculated using octane (C_8H_{18}) as an average for TPH-GRO. The theoretical chemical oxidation reaction of octane is given by:

OCTANE	+	oxygen →		carbon dioxide	+	water
C_8H_{18}	+	$12.5O_2$	→	$8CO_2$	+	$9H_2O$

- The theoretical chemical oxidation reaction of benzene is given by:

BENZENE	+	oxygen →		carbon dioxide	+	water
C_6H_6	+	$7.5O_2$	→	$6CO_2$	+	$3H_2O$

Therefore, for every gram of octane or dodecane there is a requirement of approximately 3.5 grams of oxygen for complete oxidation and 3.1 grams of oxygen per gram of benzene. In addition to the contaminant oxygen demand, the saturated soil oxygen demand was calculated using the laboratory reported COD for collected soil samples.

Based on the calculated contaminant mass in soil, dissolved in groundwater and saturated soil COD; the oxygen demand at each treatment area, is approximately 308 lbs (140 kg), 1,976 lbs (898 kg), and 830 lbs (377 kg) for Treatments Area 1, Area 2 and Area 3, respectively, and totaling 3114 pounds (1,415 kg). The above calculation assumes a 100% oxidation efficiency.

The ability to disperse the oxidant evenly throughout the desired treatment zone is a limiting factor in application of ISCO. For the purposes of design a theoretical radius of influence (ROI) for the injected oxidant can be determined based on the desired injection interval is given by:

$$r = \sqrt{\frac{Qt}{n\pi H}} \quad (\textit{Bear, 1972})$$

Where	r	=	*radius of the treated soil cylinder (ft)*
	Q	=	*Volumetric injection rate (ft^3/min)*
	t	=	*elapsed time (min)*
	n	=	*soil porosity*
	H	=	*height of treated soil column (ft)*

Based on the calculated average total soil porosity of 40.5% and an estimated injection rate of 15 gallons per minute for approximately 90 minutes, an effective radius of influence of approximately 12 feet can be achieved with an injection interval of one foot. The estimated injection volume required to achieve the calculated l2 foot ROI is 1,350 gallons.

The oxygen demand and ROI calculations are presented in Table 4-1.

4.4 RegenOx™ Oxidant Amount

The RD is based on the use of RegenOx™ as the oxidant product for ISCO remediation of the Site. RegenOx™ is an advanced chemical oxidation technology that destroys contaminants through powerful, yet controlled chemical reactions and not through biological means. This product maximizes in situ performance while using a solid alkaline oxidant that employs a sodium percarbonate complex with a multi-part catalytic formula. RegenOx™ directly oxidizes contaminants while its unique catalytic component generates a range of highly oxidizing free radicals that rapidly and effectively destroy a range of target contaminants. RegenOx™ is manufactured and distributed by Regenesis of San Clemente, California.

The percent active oxygen was used to calculate the required amount of RegenOx™ necessary to supply the estimated oxygen demand for each treatment area. The percent active oxygen is the relative weight fraction of oxygen in the oxidant material that can contribute to the chemical oxidation reaction. Regenesis publicized percent active oxygen in their RegenOx™ product is 15.3% (*Regenesis, 2007*). The following calculated amounts of RegenOx™ were estimated for each treatment area:

Treatment Area	Calculated Oxygen Demand (lbs)	Calculated RegenOx™ required to supply oxygen demand based on 15.3% activate oxygen percentage (lbs) *RegenOx™ Amount = Oxygen Demand (lbs)/0.153*
1	308	2,011
2	1,976	12,913
3	830	5,426
TOTAL	**3,114**	**20,350**

5.0 REMEDIAL FIELD ACTIVITIES

This section describes the activities associated with the implementation of the proposed ISCO remedial action. To complete the ISCO treatability study, the proposed field activities will include the following:

- Permitting and clearance
- Mobilization and staging of oxidant injection material and mixing equipment
- Injection of oxidant solution in selected locations
- ISCO performance monitoring program

These tasks are described in detail in the following sections.

5.1 Permitting and Clearance

Prior to commencing injection activities, appropriate permits shall be obtained from the MCDOH and environmental clearance and a Directorate of Public Works Excavation Permit shall be obtained from FHL for all proposed injection locations. The proposed injection locations shall be cleared for the presence of underground utilities by a private utility subcontractor. Proposed injection locations conflicting with existing underground or above ground utilities shall be relocated within five to 10 feet from the original proposed location.

In addition, the private utility subcontractor shall mark in white paint all injection locations and shall provide notification to USA North in accordance with California Government Code 4216 requirements. USA North shall be notified at least two (2) working days before breaking ground to allow utility owners to identify their utilities at the property (if any). The USA ticket number shall be obtained at the time of notification and recorded in the field notes.

5.2 Oxidant Injections

As indicated in the *Draft Characterization Report*, two hydrostratigraphic units are present at the Site, the Upper Zone and the Lower Zone and seasonal groundwater elevation changes of greater than 20 feet have been observed at the Site. Observed fluctuations in contaminant concentrations in relation to groundwater elevations indicate that as groundwater levels increase, contaminant concentration increase at the source area and decrease in the mid-plume and downgradient plume, and vice-versa as groundwater levels

decrease. In order to target the contamination in both hydrostratigraphic units and take advantage of the seasonal groundwater elevation changes, the oxidant injections have been separated into two injection events – one during high groundwater elevation and one during low groundwater elevation. The proposed number of injection locations for each event and the required quantity of oxidant per injection point is as follows:

Treatment Area	Number of Injection Locations per Event	Injection Interval (ft)	RegenOx™ amount per injection location (lbs)	Injection Volume per location (gals)	Total Injection Volume per Treatment Area (gals)	Estimated Days to Complete Injection (@15 gpm/8 hr days)
1	18	1	112	1,350	24,300	4 days
2	33	1	391	1,350	44,550	7 days
3	29	1	187	1,350	39,150	6 days

The amount of oxidant per injection point was calculated by dividing the total amount of oxidant required to satisfy the calculated oxygen demand by the total number of proposed injection locations. The injection intervals and volumes are based on the calculated parameters to achieve the 12 ft ROI (Table 4-1). Proposed injection locations for each Treatment Area are presented in Figures 5-1 through 5-3.

RegenOx™ is delivered in powder form and should be prepared on site per the manufacturer's mixing instructions. The necessary water to mix the product will be supplied by an on-site source of clean water.

Oxidant injection will be accomplished by driving a one to 1.5-inch steel injection pipe with a disposable or retractable spray tip into the ground using a direct push drilling rig to a pre-determined depth. The injection pipe will then be retracted one foot to expose the targeted saturated formation intended for the oxidant solution. If necessary to establish injection flow paths within the formation, clean water will be initially injected using a high-pressure pump capable of 150 pounds per square inch (psi) of injection pressure up to a maximum of 55 gallons of water per injection point. After the injection flow paths have been established, the oxidant solution will be injected using a lower pressure (50 to 60 psi) corrosion-resistant pump. Once the selected volume and mass of oxidant has been injected, the injection pipe will be retracted from the ground and the injection borehole will be sealed immediately following the injection of the oxidant solution. The injection borehole will be sealed with bentonite chips or

cement/bentonite slurry to seal each injection hole to the surface. Significant groundwater mounding at the Site is not expected due to the oxidant injections; however, groundwater levels in nearby monitoring wells will be measured periodically to identify any changes in groundwater levels.

Injections conducted during high groundwater elevation will take place at a depth of three to five feet below the groundwater elevation measured in nearby groundwater monitoring wells in all three treatment areas. Similarly, during low groundwater elevation, oxidant injection depths will be conducted at three to five feet below groundwater elevations with the exception of injections between monitoring wells 194-MW-017 and 194-MW-022 in Treatment Area 3. Oxidant injections around wells 194-MW-017 and 194-MW-022 will be at a depth of 45 to 50 feet below ground surface to target elevated soil contaminant concentrations identified during the installation of monitoring well 194-MW-022.

As indicated in the table below, two injection events in each treatment area of equal magnitude and injection density are proposed for the remedial activities. However, if two injection events per treatment area are cost prohibiting, the the primary injection event is recommended as a minimum procedure.

Treatment Area	Primary Injection Event	Primary Injection Event Months	Secondary Injection Event	Secondary Injection Event Months
1	High Groundwater	March- May	Low Groundwater	November - January
2	Low Groundwater	November - January	High Groundwater	March- May
3	Low Groundwater	November - January	High Groundwater	March- May

The approximate target injection zones during high and low groundwater conditions are presented in cross-sections A-A’ and C-C’ (Figures 5-4 and 5-5).

6.0 REMEDIAL MONITORING AND SAMPLING PLAN

6.1 Pre-Injection and Post-Injection Groundwater Sampling Plan

Baseline and post oxidant injection groundwater samples will be collected to monitor the effectiveness of the remedial action and groundwater geochemical changes. Prior to injection of the oxidant solution, a baseline monitoring event will be performed and include monitoring wells 194-MW-001, -003, -004, -017, -018, -020, and -022. Post injection performance monitoring groundwater samplings will be conducted from all the baseline/performance monitoring wells at one, five, and 17 weeks after each injection event. Subsequent sampling events will be conducted under the regularly scheduled basewide groundwater monitoring program. Baseline and post-injection groundwater samples collected from all wells will be analyzed using the following test methods:

Baseline Sampling

- EPA 8015D for TPH-DRO (C10 to C28);
- EPA 8015D-V for TPH-GRO (C6 to C10);
- EPA 8021 for BTEX;
- CO_2 by Test Method RSK 175;
- Alkalinity by SM2320B;
- COD by SM5220D;
- Dissolved Oxygen (DO), pH, and oxidation reduction potential (ORP) by field instruments.

Post Oxidant Injection Sampling (one, five, and 17 weeks)

- EPA 8015D for TPH-DRO (C10 to C28);
- EPA 8015D-V for TPH-GRO (C6 to C10);
- EPA 8260C for volatile organic compounds (VOCs);
- Hexavalent Chromium by EPA Test Method 7196;
- CO_2 by Test Method RSK 175;
- Alkalinity by SM2320B;
- COD by SM5220D;
- DO, pH, and ORP by field instruments.

Quality Assuarance/Quality Control (QA/QC) limits and protocols are specified in the *Quality Assurance Project Plan* (*MACTEC, 2010b*). A sampling schedule is presented in Table 6-1.

6.2 Field Parameters Monitoring During Injections

Groundwater parameters will be monitored during the oxidant injection to record immediate groundwater geochemical and physical changes in selected groundwater wells. Groundwater parameters collected during the oxidant injection will include:

- Groundwater levels, DO, pH, and ORP by field instruments.

7.0 ADDITIONAL WELL INSTALLATIONS

7.1 Monitoring Well Installation/Development/Sampling

Three new monitoring wells (194-MW-023 through –025), are proposed for installation to (1) evaluate the extent of groundwater contamination in areas not already addressed by the existing monitoring well network, (2) further define the vertical extent of groundwater contamination in areas of the site already covered by the existing monitoring well network, (3) provide physical and chemical analyses of soil within the groundwater plume and background conditions, and (4) monitor the effects of the ISCO remediation. Two new groundwater wells are proposed in Treatment Area 2 and one new groundwater well in Treatment Area 3. Proposed new groundwater wells 194-MW-023 and 194-MW-024 locations are shown in Figures 5-2 and new groundwater well 194-MW-025 in Figure 5-3.

Installation, development, and sampling of the proposed groundwater wells will be in accordance to the methods presented in the *Final Remedial Work Plan* (*MACTEC, 2010a*) and *Quality Assurance Project Plan* (*MACTEC, 2010b*).

8.0 DECONTAMINATION AND MANAGEMENT OF IDW

It is expected that all the oxidant solution will be used during the injection event and no disposal of oxidant product will be necessary. Push rods and injection pumps used for the injection of oxidant material will be decontaminated by running clean water through the system at the last injection point or steam cleaned at the end of each working day.

Augers and drill bits will be steam cleaned between each groundwater well installation. Pumps, surge blocks, and bailers used for groundwater well development and sampling will be decontaminated by steam cleaning before use in each well. Sounders used for water level measurements will be decontaminated between wells by washing in a low phosphate soap solution and deionized water rinse. Decontamination rinsate will be contained in a trough and/or plastic buckets and then transferred to a polyethylene tank at the MACTEC yard at FHL. Purge water generated during development and sampling will be stored in a storage tank at the site. Soil cuttings generated during drilling will be stored in either 55-gallon Department of Transportation (DOT) drums or an onsite 10 or 20-cubic yard storage bin, sampled, and disposed offsite.

9.0 REFERENCES

Bear, J., 1972. *Dynamics of Fluids in Porous Materials, American Elsevier*.

Ecology and Environment, Inc. (E&E), 1995. *Draft Site Characterization Report Site Investigation of Underground Storage Tanks, Building 194 and Facility 95, Fort Hunter Liggett, California*. December.

Geofon, Inc., 1996. *Report for Site Remediation Excavation and Verification Sampling, Building 194, Fort Hunter Liggett, California, Contract Number DACA05-94-D-0015. Delivery Order 8*. December 3.

Harding Lawson Associates (HLA), 1997. *Draft Corrective Action Plan, Building 194 Site, Fort Hunter Liggett, California*. May 16.

_____, 1998. *Technical Memorandum, Hot Spot Removal, Building 194 Area, Fort Hunter Liggett, California*. December 15.

_____, 1999. *Final 1998 Annual Report, Basewide Water Quality Monitoring Program, Fort Hunter Liggett, California*. June 16.

_____, 2000a. *Quarterly Report, Fourth Quarter 1999, Building 194 Area, Water Quality Monitoring Program, Fort Hunter Liggett, California*. January 27.

_____, 2000b. *Final Monitored Natural Attenuation Evaluation, Building 194 Area, Fort Hunter Liggett, California*. March 29.

_____, 2000c. *Quarterly Report, Second Quarter 2000, Building 194 Area, Water Quality Monitoring Program, Fort Hunter Liggett, California*. July 20.

Interstate Technology Regulatory Council, 2005. *Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater, Second Edition*. January.

James M. Montgomery (JMM), 1991. *Preliminary Assessment/Site Investigation, Draft Site Investigation Report, Fort Ord and Fort Hunter Liggett, California*. January.

MACTEC Engineering and Consulting, Inc. (MACTEC), 2006. *Draft Technical Memorandum Report, Pilot Treatability Study, Building 258 Area, Fort Hunter Liggett, California*. August 31.

_____, 2010a. *Final Remedial Design Work Plan, Building 194 Area, Fort Hunter Liggett, California.* February 26.

_____, 2010b. *Quality Assurance Project Plan, Building 194 Groundwater Studies, Fort Hunter Liggett, California.* May.

_____, 2010c *Draft Site Characterization Report, Building 194 Area, Fort Hunter Liggett, California.* October 20.

Peters, Stuart M., Tai T. Wong, and John G. Agar, 2001. *A laboratory Study on the Degradation of Gasoline Contamination Using Fenton's Reagent, 54th Canadian Geotechnical Conference, Calgary*.

Regenesis, 2007. *Principles of Chemical Oxidation Technology for the Remediation of Groundwater and Soil.* March.

TABLES

Table 3-1 Analytical Results for Detected Inorganic Compounds - Soil

	Station Number:	**194-MW-018**		**194-MW-020**		**194-MW-021**		**194-MW-022**	
	Sample Date:	**05/21/10**		**05/21/10**		**05/25/10**		**05/21/10**	
	Sample Depth (feet):	**30**		**40.5**		**46**		**45**	
	Sample Number:	**1020F194013F**		**1020F194015F**		**1021F194021F**		**1020F194019F**	
	Lab Batch:	**220336**		**220336**		**220371**		**220336**	
Test Method/Analyte Name	Units	Value	Qual	Value	Qual	Value	Qual	Value	Qual
EPA6010C									
Iron	mg/kg	NT		NT		12,000.	A	NT	
EPA6020A									
Antimony	mg/kg	0.26	J-/J	0.17	J-/J	0.23	J-/J	0.14	J-/J
Arsenic	mg/kg	3.6	A	3.3	A	5.2	A	1.8	A
Barium	mg/kg	27.	J-	76.	J-	67.	J-	21.	J-
Beryllium	mg/kg	0.31	A	0.34	A	0.44	A	0.15	A/J
Cadmium	mg/kg	0.86	A	2.2	A	1.2	A	0.36	A
Chromium	mg/kg	5.9	J+	24.	J+	12.	J+	5.8	J+
Cobalt	mg/kg	2.3	A	3.5	A	4.8	A	1.5	A
Copper	mg/kg	6.3	A	6.9	A	9.1	A	3.0	A
Iron	mg/kg	8,500.	A	9,000.	A	13,000.	A	4,600.	A
Lead	mg/kg	3.8	A	3.7	A	4.5	A	1.5	A
Molybdenum	mg/kg	0.53	J-	1.9	J-	1.1	J-	0.53	J-
Nickel	mg/kg	6.3	A	20.	A	14.	A	5.0	A
Selenium	mg/kg	0.084	A/J	0.058	A/J	0.074	A/J	0.038	A/J
Silver	mg/kg	0.011	A/J	0.035	A/J	0.018	A/J	0.0087	A/J
Thallium	mg/kg	0.048	A/J	0.14	A/J	0.12	A/J	0.014	A/J
Vanadium	mg/kg	17.	A	20.	A	26.	A	8.7	A
Zinc	mg/kg	20.	J-	26.	J-	31.	J-	13.	J-
EPA7471A									
Mercury	mg/kg	0.011	A/J	0.03	A	0.011	A/J	0.015	A/J
SM5220D									
Chemical Oxygen Demand (Regular)	mg/kg	ND(10.)	A	26.	A	15.	A	ND(10.)	A

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 4/21/2011

Table 3-1 Analytical Results for Detected Inorganic Compounds - Soil

	Station Number:	**194-SB-001**		**194-SB-002**		**194-SB-003**		**194-SB-004**	
	Sample Date:	**05/21/10**		**05/21/10**		**05/21/10**		**05/21/10**	
	Sample Depth (feet):	**50**		**30.5**		**15.5**		**40.5**	
	Sample Number:	**1020F194010F**		**1020F194006F**		**1020F194001F**		**1020F194004F**	
	Lab Batch:	**220336**		**220336**		**220336**		**220336**	
Test Method/Analyte Name	Units	Value	Qual	Value	Qual	Value	Qual	Value	Qual
EPA6010C									
Iron	mg/kg	NT		NT		NT		NT	
EPA6020A									
Antimony	mg/kg	**0.16**	**J-/J**	**0.18**	**J-/J**	**0.19**	**J-/J**	**0.31**	**J-**
Arsenic	mg/kg	**2.6**	**A**	**4.5**	**A**	**4.0**	**A**	**5.0**	**A**
Barium	mg/kg	**25.**	**J-**	**50.**	**J-**	**66.**	**J-**	**74.**	**J-**
Beryllium	mg/kg	**0.16**	**A/J**	**0.53**	**A**	**0.35**	**A**	**0.54**	**A**
Cadmium	mg/kg	**2.0**	**A**	**0.80**	**A**	**1.1**	**A**	**2.3**	**A**
Chromium	mg/kg	**26.**	**J+**	**8.8**	**J+**	**14.**	**J+**	**11.**	**J+**
Cobalt	mg/kg	**1.8**	**A**	**6.2**	**A**	**3.7**	**A**	**2.6**	**A**
Copper	mg/kg	**3.6**	**A**	**7.8**	**A**	**8.9**	**A**	**8.2**	**A**
Iron	mg/kg	**5,900.**	**A**	**12,000.**	**A**	**12,000.**	**A**	**11,000.**	**A**
Lead	mg/kg	**2.3**	**A**	**4.4**	**A**	**4.5**	**A**	**4.2**	**A**
Molybdenum	mg/kg	**1.4**	**J-**	**0.56**	**J-**	**1.0**	**J-**	**1.7**	**J-**
Nickel	mg/kg	**5.6**	**A**	**11.**	**A**	**11.**	**A**	**19.**	**A**
Selenium	mg/kg	**0.078**	**A/J**	**0.11**	**A/J**	**0.086**	**A/J**	**0.15**	**A/J**
Silver	mg/kg	**0.011**	**A/J**	ND(0.30)	A	**0.014**	**A/J**	**0.018**	**A/J**
Thallium	mg/kg	**0.038**	**A/J**	**0.14**	**A/J**	**0.09**	**A/J**	**0.18**	**A/J**
Vanadium	mg/kg	**14.**	**A**	**21.**	**A**	**24.**	**A**	**27.**	**A**
Zinc	mg/kg	**15.**	**J-**	**36.**	**J-**	**41.**	**J-**	**38.**	**J-**
EPA7471A									
Mercury	mg/kg	**0.013**	**A/J**	**0.016**	**A/J**	**0.016**	**A/J**	**0.029**	**A**
SM5220D									
Chemical Oxygen Demand (Regular)	mg/kg	**11.**	**A**	ND(10.)	A	ND(10.)	A	ND(10.)	A

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 4/21/2011

Table 3-1 Analytical Results for Detected Inorganic Compounds - Soil

	Station Number:	**194-SB-005**		**194-SB-019**		**SOIL BIN 20 CY**	
	Sample Date:	**05/21/10**		**05/21/10**		**05/25/10**	
	Sample Depth (feet):	**40.5**		**30.5**			
	Sample Number:	**1020F194011F**		**1020F194017F**		**1021F194023F**	
	Lab Batch:	**220336**		**220336**		**220371**	
Test Method/Analyte Name	Units	Value	Qual	Value	Qual	Value	Qual
EPA6010C							
Iron	mg/kg	NT		NT		NT	
EPA6020A							
Antimony	mg/kg	**0.18**	**J-/J**	**0.15**	**J-/J**	**0.23**	**J-/J**
Arsenic	mg/kg	**2.6**	**A**	**2.2**	**A**	**4.1**	**A**
Barium	mg/kg	**23.**	**J-**	**12.**	**J-**	**59.**	**J-**
Beryllium	mg/kg	**0.19**	**A/J**	**0.11**	**A/J**	**0.47**	**A**
Cadmium	mg/kg	**1.3**	**A**	**0.75**	**A**	**1.1**	**A**
Chromium	mg/kg	**9.0**	**J+**	**4.0**	**J+**	**22.**	**J+**
Cobalt	mg/kg	**3.1**	**A**	**1.1**	**A**	**3.8**	**A**
Copper	mg/kg	**5.9**	**A**	**2.8**	**A**	**9.6**	**A**
Iron	mg/kg	**7,200.**	**A**	**4,400.**	**A**	NT	
Lead	mg/kg	**2.1**	**A**	**1.3**	**A**	**5.1**	**A**
Molybdenum	mg/kg	**0.67**	**J-**	**0.35**	**J-**	**0.99**	**J-**
Nickel	mg/kg	**12.**	**A**	**5.5**	**A**	**11.**	**A**
Selenium	mg/kg	**0.076**	**A/J**	**0.028**	**A/J**	**0.15**	**A/J**
Silver	mg/kg	**0.01**	**A/J**	**0.0058**	**A/J**	**0.029**	**A/J**
Thallium	mg/kg	**0.024**	**A/J**	**0.011**	**A/J**	**0.11**	**A/J**
Vanadium	mg/kg	**13.**	**A**	**10.**	**A**	**23.**	**A**
Zinc	mg/kg	**15.**	**J-**	**11.**	**J-**	**34.**	**J-**
EPA7471A							
Mercury	mg/kg	**0.014**	**A/J**	**0.0085**	**A/J**	**0.023**	**A**
SM5220D							
Chemical Oxygen Demand (Regular)	mg/kg	ND(10.)	A	**28.**	**A**	NT	

Checked: AA
Approved: WC

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 4/21/2011

Table 3-1 Analytical Results for Detected Inorganic Compounds - Soil

Summary of Analyte Qualifiers used in this Report

Type	Qualifier	Qualifier Description
MACTEC Validation Assigned Qualifiers		
Inorganic	A	Sample has undergone routine data validation.
Inorganic	J-	Data are qualified as estimated, with a low bias likely to occur. False possitives or false negatives are unlikely to have been reported.
Inorganic	J+	Data are qualified as estimated, with a high bias likely to occur. False possitives or false negatives are unlikely to have been reported.

Notes:
Where validation qualifiers are absent, data was used for screening purposes only.
Qualifiers are listed as validation qualifier / lab qualifier where applicable (e.g. B/R)

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 4/21/2011

Table 3-2. Physical Properties - Soil

PTS File No: 40356
Client: MACTEC

PTS Laboratories

PHYSICAL PROPERTIES DATA - TNRCC RG-36 RBCA SOIL PARAMETERS

PROJECT NAME: Fort Hunter Liggett Building 194
PROJECT NO: 4084096558 3.1.1

				METHODS:	API RP40	WALKLEY-BLACK	ASTM D2216/API RP40	API RP40		EPA 9100/API RP40	
										25 PSI CONFINING STRESS	
SAMPLE ID.	SAMPLING DATE	SAMPLE LOCATION	DEPTH, ft.	SAMPLE ORIENTATION (1)	DRY BULK DENSITY, g/cc	FRACTION ORGANIC CARBON, g/g	VOLUMETRIC MOISTURE CONTENT AS FRACTION OF Vb, cm^3/cm^3	AIR-FILLED POROSITY, % Vb	TOTAL POROSITY, % Vb	NATIVE PERMEABILITY TO WATER, cm^2	NATIVE HYDRAULIC CONDUCTIVITY, cm/s
1020F194001F	5/17/2010	194-SB-003 (background)	16	V	1.68	<1.00E-04	0.151	19.7	34.8	4.08E-10	4.25E-05
1020F194004F	5/17/2010	194-SB-004	40.5	V	1.26	6.10E-04	0.388	11.4	50.2	2.01E-11	2.09E-06
1020F194006F	5/18/2010	194-SB-002	31	V	1.52	2.70E-04	0.180	23.4	41.4	5.78E-11	6.07E-06
1020F194010F	5/18/2010	194-SB-001	50.5	V	1.67	<1.00E-04	0.232	12.7	35.9	3.34E-09	3.48E-04
1020F194011F	5/19/2010	194-SB-005	41	V	1.54	2.40E-04	0.222	16.9	39.1	1.22E-09	1.28E-04
1020F194013F	5/19/2010	194-MW-018	30.5	V	1.61	2.30E-04	0.279	10.2	38.0	3.13E-09	3.26E-04
1020F194015F	5/20/2010	194-MW-020	41	V	1.29	3.50E-04	0.300	19.0	49.1	1.13E-09	1.17E-04
1020F194017F	5/20/2010	194-SB-019	31	V	1.34	3.10E-04	0.287	15.9	44.6	2.54E-10	2.63E-05
1020F194019F	5/21/2010	194-MW-022	45.5	V	1.63	1.40E-04	0.130	24.2	37.2	3.94E-08	4.10E-03
1020F194021F	5/24/2010	194-MW-021	45.5	V	1.68	1.80E-04	0.224	12.6	35.0	3.48E-10	3.63E-05
				AVERAGE	**1.52**	**2.91E-04**	**0.239**	**16.6**	**40.5**	**4.93E-09**	**5.13E-04**
					95.0 lbs/cf						

Notes:
(1) Sample Orientation: H = Horizontal; V = Vertical; Vb = Bulk Volume

Checked: AA
Approved: WC

Table 3-3. X-Ray Diffraction Analysis - Soil

Client:	PTS Laboratories, Inc.	MI#:	10294; Page 2 of 2
Project:	194 FHL' Project #4084096558 3.1.1	Sample Type:	Unconsolidated Sediment
PO #	10-204 PTS File # 40356	Date:	06.25.10

X-Ray Diffraction Results

	MI Lab ID	10294-01	10294-02	10294-03	10294-04	10294-05	10294-06	10294-07	10294-08	10294-09	10294-10
Mineral	Sample ID: 1020F194...	001F	004F	006F	010F	011F	013F	015F	017F	019F	021F
Constituents	Chemical Formula	Relative Abundance (%)									
Quartz	SiO_2	48	27	30	52	48	58	45	44	43	32
Cristobalite	SiO_2		8	3			1	8	13	2	12
Tridymite	SiO_2		5					5	8	1	8
Plagioclase Feldspar	$(Na,Ca)AlSi_3O_8$	18	12	23	21	24	19	22	14	32	21
K-Feldspar	$KAlSi_3O_8$	10	7	10	22	23	17	11	16	16	15
Ferroan Dolomite	$Ca(Mg_{0.67}Fe_{0.33})(CO_3)_2$	1			trc						
Hornblende	$Ca_2(Mg,Fe)_5(Si,Al)_8O_{22}(OH)_6$	trc	trc		trc		trc	trc		trc	
Kaolinite	$Al_2Si_2O_5(OH)_4$	1	trc	1	trc			trc			1
Chlorite	$(Mg,Al)_6(Si,Al)_4O_{10}(OH)_8$		trc	trc	trc	trc			trc	trc	
Illite/Mica	$KAl_2(Si_3AlO_{10})(OH)_2$	1	2	1	1	trc	trc	1	trc	1	trc
Montmorillonite	$Na_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot xH_2O$	21	39	32	4	5	5	8	5	5	11
TOTAL		100	100	100	100	100	100	100	100	100	100

Note:
trc = trace

Checked: AA
Approved: WC

Table 3-4 - Mass-In-Place Estimate

AREA 1	29,500 sf

Mass In Soil

	Reported Concentrations (mg/Kg)		
Contaminant	194-SB-001 @ 20.5 ft	194-SB-001 @ 40 ft	Average
TPH-DRO	110	0.29	55
TPH-GRO	0.22	0.015	0.12

[TPH-DRO] mg/kg	Area ft^2	Thickness ft	Total Volume cf	Unit Weight lbs/cf	Weight lbs	Weight kg	TPH-DRO Mass kg
55	2,500	3	7500	95	712,500	323,864	17.859
(assumes 50 ft x 50 ft area)							**39.29 lbs**

[TPH-GRO] mg/kg	Area ft^2	Thickness ft	Total Volume cf	Unit Weight lbs/cf	Weight lbs	Weight kg	TPH-GRO Mass kg
0.12	2,500	3	7500	95	712,500	323,864	0.038
(assumes 50 ft x 50 ft area)							**.08 lbs**

Dissolved Mass

	Reported Concentrations (µg/L)			
Contaminant	194-MW-001	194-MW-002	194-MW-003	Average
TPH-DRO	320	23	180	174
TPH-GRO	910	25	220	385
Benzene	160	0.2	94	85

[TPH-DRO] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	TPH-DRO Mass kg
174	29,500	10	0.405	119,475	3,382,552	0.590
						1.3 lbs

[TPH-GRO] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	TPH-GRO Mass kg
385	29,500	10	0.405	119,475	3,382,552	1.302
						2.87 lbs

[Benzene] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	Benzene Mass kg
85	29,500	10	0.405	119,475	3,382,552	0.287
						.63 lbs

Table 3-4 - Mass-In-Place Estimate

AREA 2	90,800 sf

Mass In Soil

	Reported Concentrations (mg/Kg)			
Contaminant	194-SB-002 @ 45 ft	194-SB-005 @ 45.5 ft	194-MW-018 @ 25 ft	Average
TPH-DRO	0.37	---	---	0.37
TPH-GRO	0.024	0.016	0.21	0.08

[TPH-DRO] mg/kg	Area ft^2	Thickness ft	Total Volume cf	Unit Weight lbs/cf	Weight lbs	Weight kg	TPH-DRO Mass kg
0.37	90,800	3	272,400	95	25,878,000	11,762,727	4.352
							9.57 lbs

[TPH-GRO] mg/kg	Area ft^2	Thickness ft	Total Volume cf	Unit Weight lbs/cf	Weight lbs	Weight kg	TPH-GRO Mass kg
0.08	90,800	3	272,400	95	25,878,000	11,762,727	0.980
							2.16 lbs

Dissolved Mass

	Reported Concentrations (µg/L)		
Contaminant	194-MW-004	194-MW-018	Average
TPH-DRO	570	2,200	1,385
TPH-GRO	1600	30,000	15,800
Benzene	33	9,500	4,767

[TPH-DRO] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	TPH-DRO Mass kg
1,385	90,800	10	0.405	367,740	10,411,381	14.420
						31.72 lbs

[TPH-GRO] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	TPH-GRO Mass kg
15,800	90,800	10	0.405	367,740	10,411,381	164.500
						361.9 lbs

[Benzene] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	Benzene Mass kg
4,767	90,800	10	0.405	367,740	10,411,381	49.626
						109.18 lbs

Table 3-4 - Mass-In-Place Estimate

AREA 3 109,000 sf

Mass In Soil

	Reported Concentrations (mg/Kg)					
Contaminant	194-SB-004 @ 25 ft	194-SB-004 @ 46 ft	194-MW-020 @ 51 ft	194-MW-021 @ 50.5 ft	194-MW-022 @ 51 ft	Average
TPH-DRO	2.2	0.29	---	---	95	32.50
TPH-GRO	0.017	0.17	0.17	0.014	140	28.07

[TPH-DRO] mg/kg	Area ft^2	Thickness ft	Total Volume cf	Unit Weight lbs/cf	Weight lbs	Weight kg	TPH-DRO Mass kg
32.50	2,500	3	7,500	95	712,500	323,864	10.524
(assumes 50 ft x 50 ft area)							**23.15 lbs**

[TPH-GRO] mg/kg	Area ft^2	Thickness ft	Total Volume cf	Unit Weight lbs/cf	Weight lbs	Weight kg	TPH-GRO Mass kg
28.07	2,500	3	7,500	95	712,500	323,864	9.092
(assumes 50 ft x 50 ft area)							**20. lbs**

Dissolved Mass

	Reported Concentrations (µg/L)					
Contaminant	194-MW-011	194-MW-017	194-MW-020	194-MW-021	194-MW-022	Average
TPH-DRO	190	16	15	---	12	58
TPH-GRO	420	19	28	14	160	128
Benzene	52	6.6	2.9	---	2	16

[TPH-DRO] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	TPH-DRO Mass kg
58	109,000	10	0.405	441,450	12,498,244	0.728
						1.6 lbs

[TPH-GRO] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	TPH-GRO Mass kg
128	109,000	10	0.405	441,450	12,498,244	1.602
						3.53 lbs

[Benzene] µg/L	Area ft^2	Thickness ft	Total porosity --	Volume ft^3	Volume L	Benzene Mass kg
16	109,000	10	0.405	441,450	12,498,244	0.197
						.43 lbs

Table 3-4 - Mass-In-Place Estimate

AREA 1			**AREA 2**			**AREA 3**		
Soil Mass (assumed 50 ft by 50 ft Area)			Soil Mass (plume area)			Soil Mass (assumed 50 ft by 50 ft Area)		
TPH-DRO	39.3 lbs	17.9 kg	TPH-DRO	9.6 lbs	4.4 kg	TPH-DRO	23.2 lbs	10.5 kg
TPH-GRO	.1 lbs	.04 kg	TPH-GRO	2.2 lbs	1.0 kg	TPH-GRO	20.0 lbs	9.1 kg
Subtotal =	39.4 lbs	17.9 kg	Subtotal =	11.7 lbs	5.3 kg	Subtotal =	43.2 lbs	19.6 kg
Dissolved Mass (plume area)			Dissolved Mass (plume area)			Dissolved Mass (plume area)		
TPH-DRO	1.3 lbs	.6 kg	TPH-DRO	31.7 lbs	14.4 kg	TPH-DRO	1.6 lbs	.7 kg
TPH-GRO	2.9 lbs	1.3 kg	TPH-GRO	361.9 lbs	164.5 kg	TPH-GRO	3.5 lbs	1.6 kg
Benzene	.6 lbs	.3 kg	Benzene	109.2 lbs	49.6 kg	Benzene	.4 lbs	.2 kg
Subtotal =	4.8 lbs	2.2 kg	Subtotal =	502.8 lbs	228.5 kg	Subtotal =	5.6 lbs	2.5 kg
TOTAL MASS =	**83.5 lbs**	**38.0 kg**	**TOTAL MASS =**	**526.3 lbs**	**239.2 kg**	**TOTAL MASS =**	**91.9 lbs**	**41.8 kg**

Notes
All reported concentrations as presented in the MACTEC Draft Characterization Report October 2010 and Ahtna Groundwater Sampling June 2010
--- = reported concentration below method detection limit
B = benzene
TPH-GRO = total pretroleum hydrocarbons - gasoline range organic
TPH-DRO = total petroleum hydrocarbons - diesel range organic
μ g/L = micrograms per liter
mg/kg = milligrams per kilogram
1 kg = 2.2 lbs
1 cf = 28.32 liters = 7.43 gallons
Plume Volume = Area * Thickness * Porosity

Checked: AA
Approved: WC

Table 6-1. Sampling Schedule

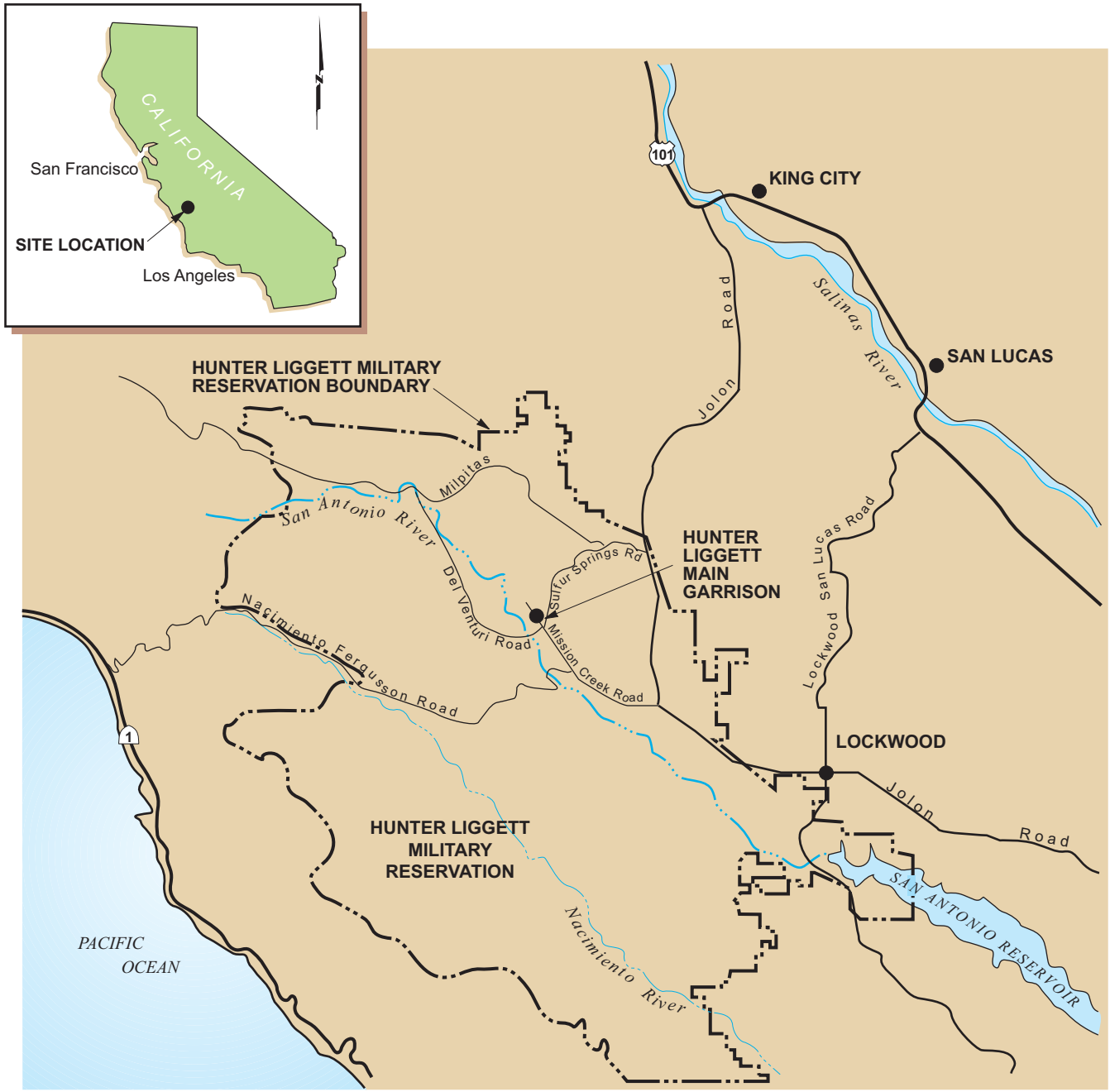
Monitoring Wells / Stations	TPH-DRO EPA 8015D	TPH-GRO EPA 8015D	VOCs EPA 8260C	Hexavalent Chromium EPA 7196	Dissolve Carbon Dioxide RSK 175	Alkalinity SM2320B	Chemical Oxygen Demand SM5220D	Dissolved Oxygen meter	pH meter	Oxidation/ Reduction (redox) Potential meter
Treatment Area 1										
194-MW-001	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS
194-MW-003	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS
Treatment Area 2										
194-MW-004	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS
194-MW-018	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS
Treatment Area 3										
194-MW-017	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS
194-MW-020	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS
194-MW-022	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS	BL/1W/5W/FS

Notes: Presented sampling schedule is for each injection event

BL	Baseline sampling
1W	One week after completion of oxidant injection
5W	Five weeks after completion of oxidant injection
FS	17 weeks after completion of oxidant injection
EPA	U.S. Environmental Protection Agency
TPH-DRO	Total Petroleum Hydrocarbons - Diesel Range Organics
TPH-GRO	Total Petroleum Hydrocarbons - Gasoline Range Organics
VOCs	Volatile organic compounds

Checked: AA
Approved: WC

FIGURES



0 4 8

SCALE IN MILES

Modified from USGS 1:250,000 Scale Series,
Monterey and San Luis Obispo Quadrangles.

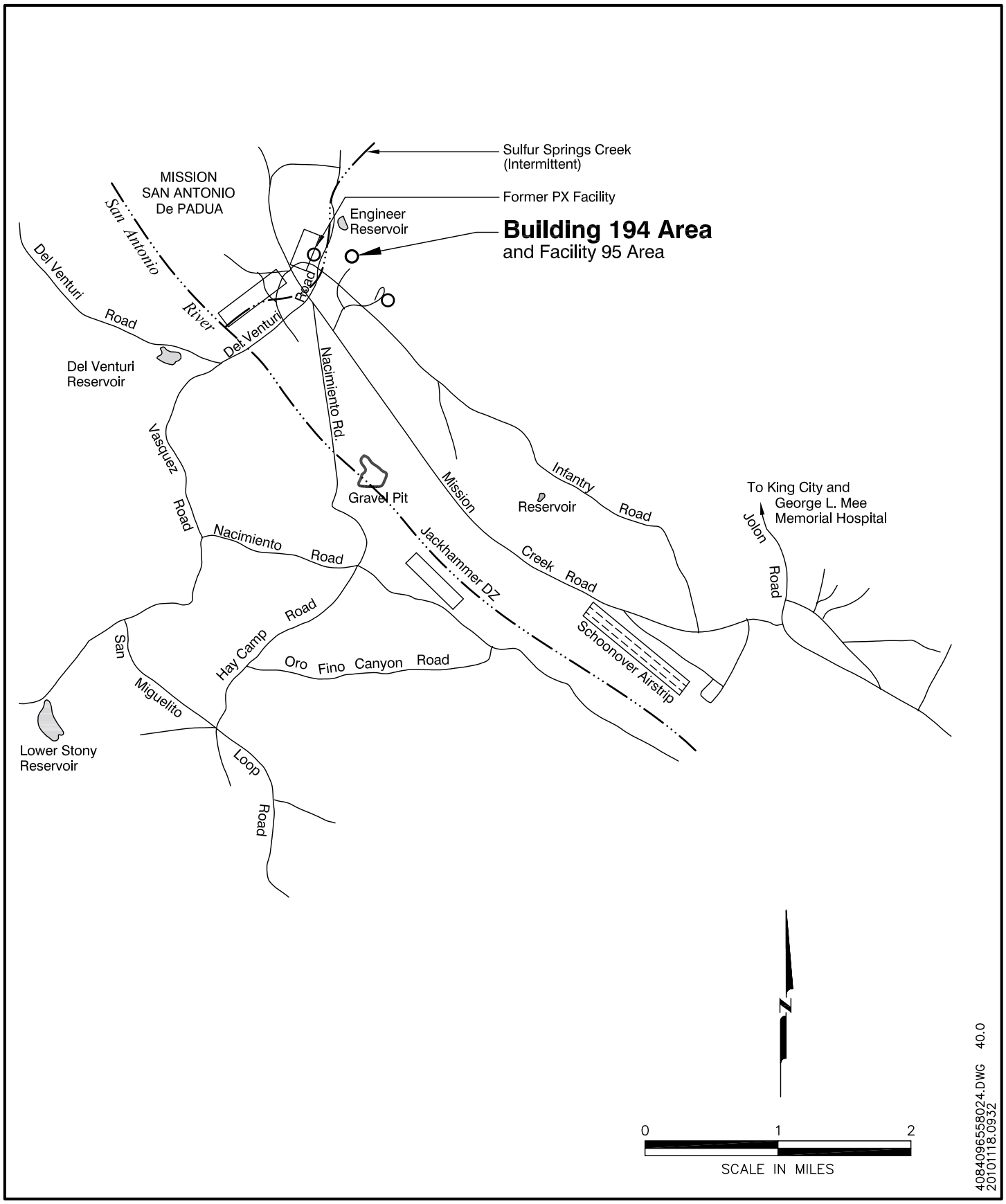
MACTEC

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT,
CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

Fort Hunter Liggett Location Map
Remedial Design
Building 194 Area
Fort Hunter Liggett, California

FIGURE
1-1

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084096558 3.3.6	AA	11/2010	BF	11/2010

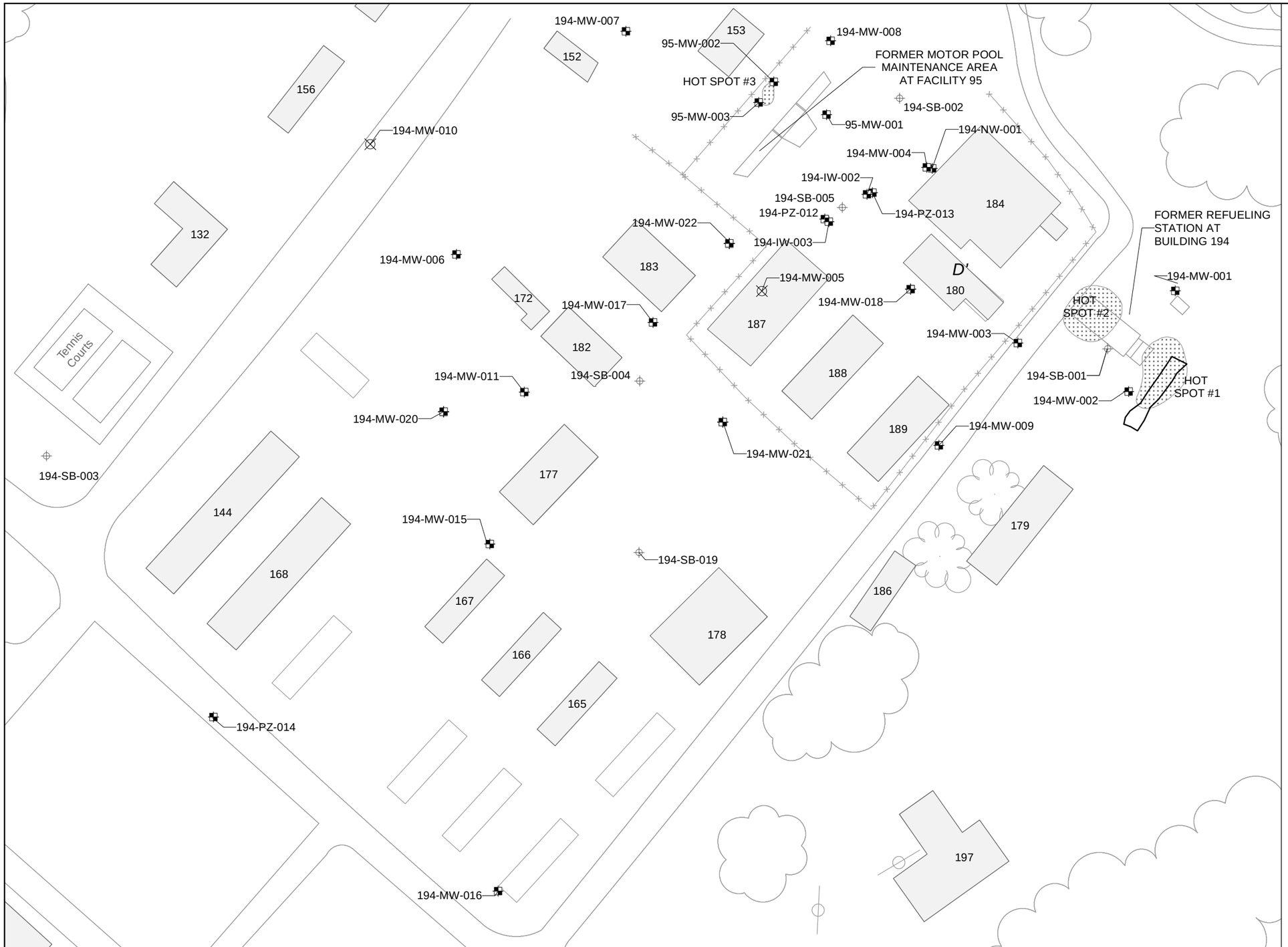


MACTEC

Site Plan
Remedial Design
Building 194 Area
Fort Hunter Liggett, California

FIGURE
1-2

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
TJH	4084096558 3.3.6	AA	11/2010	BPF	11/2010



EXPLANATION

- Existing Monitoring Well Location
- Abandoned Monitoring Well
- Soil Boring Location
- Approximate Building Location
- Approximate Fence Location
- Estimated Delineation of Former Soil Hot Spots

N

100 0 100 Feet

DRAWN: TJH	PROJECT NO: 4084096558 3.3.6		MACTEC	Remedial Design Building 194 Area Fort Hunter Liggett, California	Base Map and Monitoring Well Locations	FIGURE **2-1**
ENGINEER:	SCALE: AS SHOWN					
CHECKED: WJF	APPROVED: BF					
DATE: 11/2010	DATE: 11/2010					

November 16, 2010 5:35:36 PM
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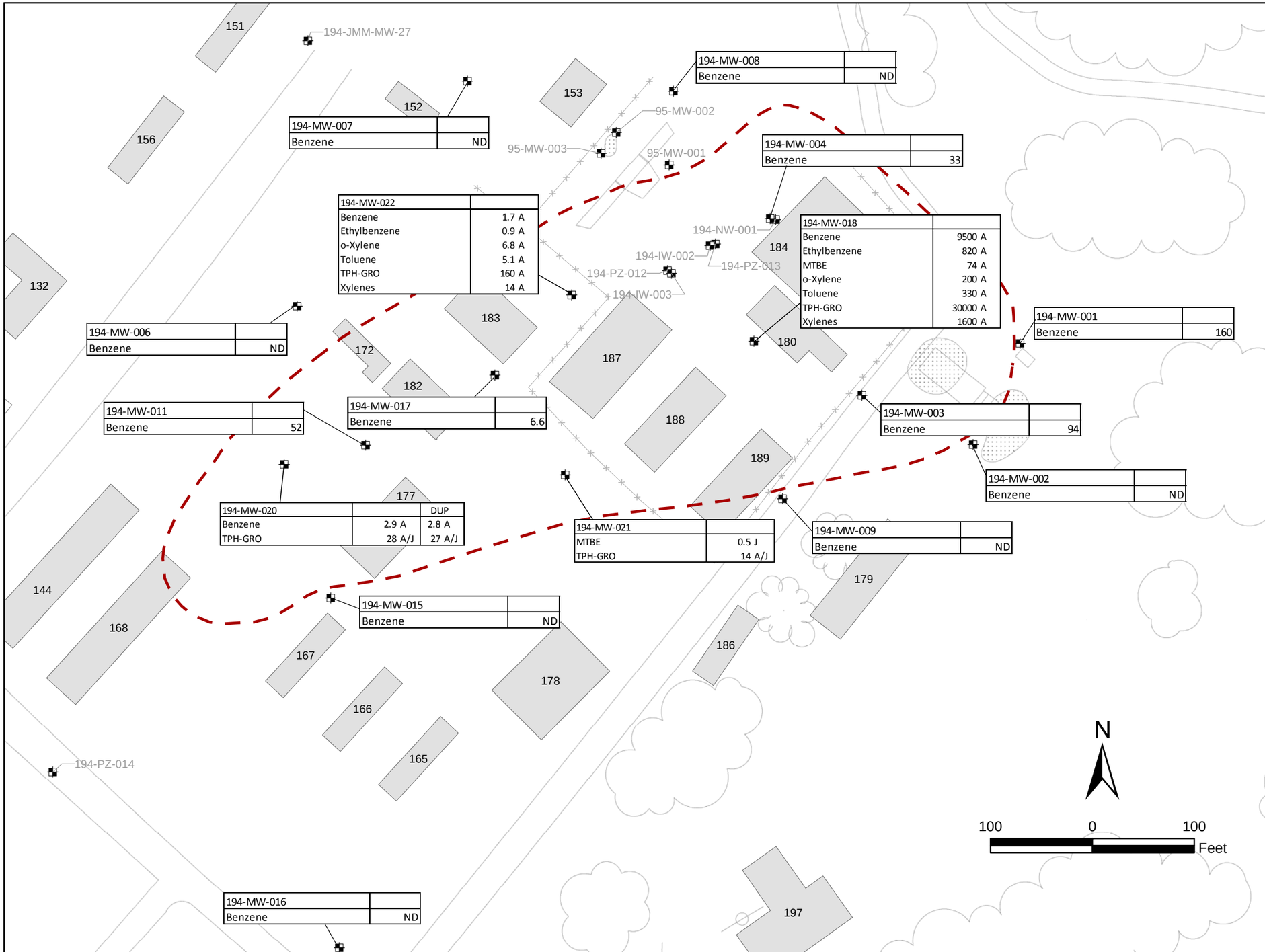

EXPLANATION

- Existing Monitoring Well Location
- Approximate Building Location
- Approximate Fence Location
- Estimated Delineation of Former Soil Hot Spots
- Approximate Extent of Benzene in Groundwater (at 1.0 ppb)

Well Name Changes

New Name	Old Name
95-MW-001	EE-95-MW-W1
95-MW-003	EE-95-MW-W3
194-MW-001	EE-194-MW-W1
194-MW-002	EE-194-MW-W2B
194-MW-003	EE-194-MW-W3
194-MW-004	EE-194-MW-W4
194-MW-006	EE-194-MW-W6
194-MW-007	EE-194-MW-W7
194-MW-008	EE-194-MW-W8
194-MW-009	194-MW-W9
194-MW-011	194-MW-W11
194-MW-015	194-MW-W15
194-MW-016	194-MW-W16
194-MW-017	194-MW-W17

Sample Station ID

194-MW-018	
Benzene	9,500

Analyte

Concentration, Micrograms per liter

A = Sample has undergone routine validation

MTBE = Methyl tert-butly ether
TPH-GRO = Total Petroleum Hydrocarbons as Gasoline Range Organics

ND = Not detected

DRAWN: TJH	PROJECT NO: 4084096558 3.3.6	MACTEC	Remedial Design Building 194 Area Fort Hunter Liggett, California
ENGINEER:	SCALE: AS SHOWN		
CHECKED: AA	APPROVED: BF		
DATE: 11/2010	DATE: 11/2010		

TPH-GRO, BTEX, and MTBE
Analytical Results
June 2010

FIGURE
2-2

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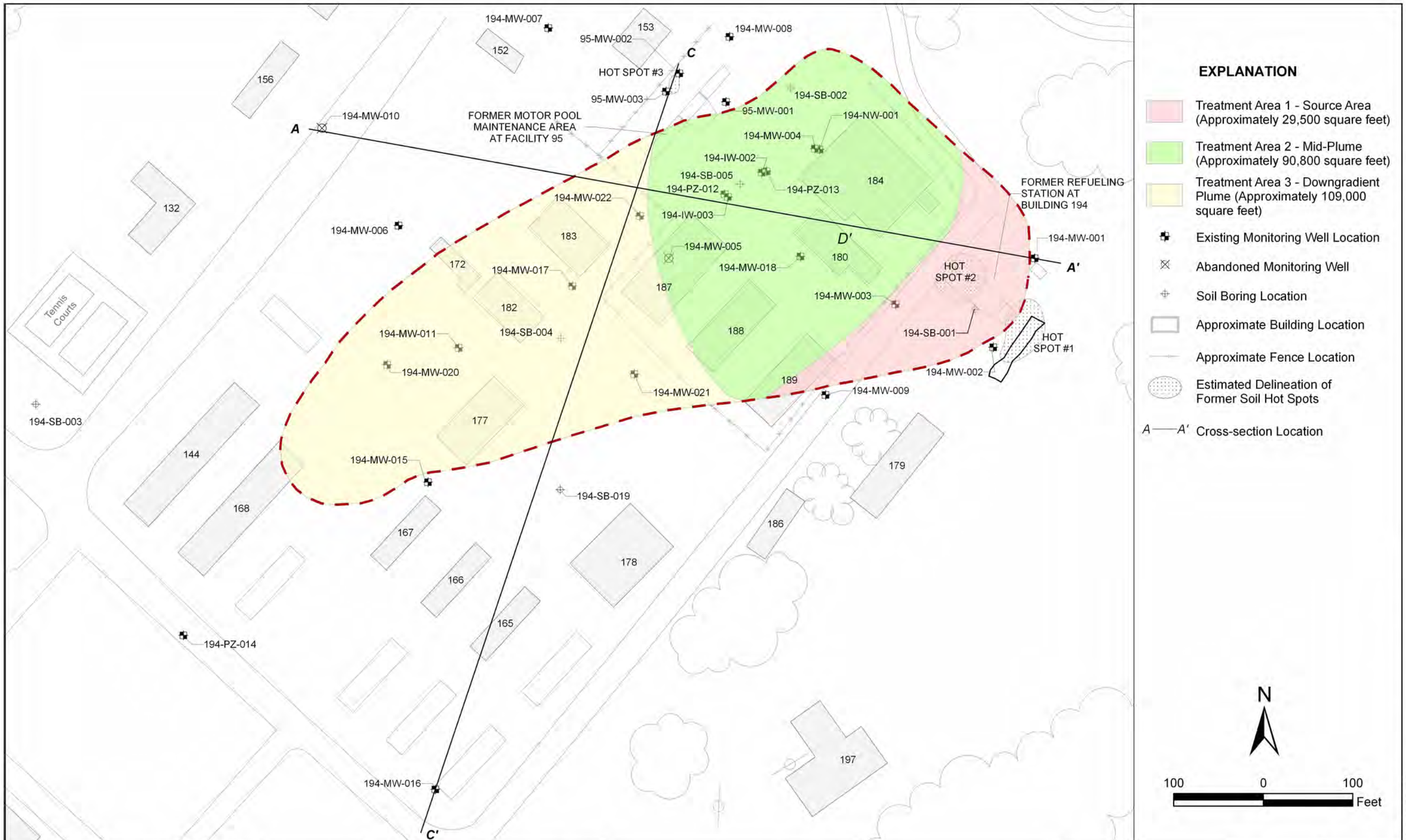

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ENGINEER:	SCALE: AS SHOWN				FIGURE
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DATE: 11/2010	DATE: 11/2010				

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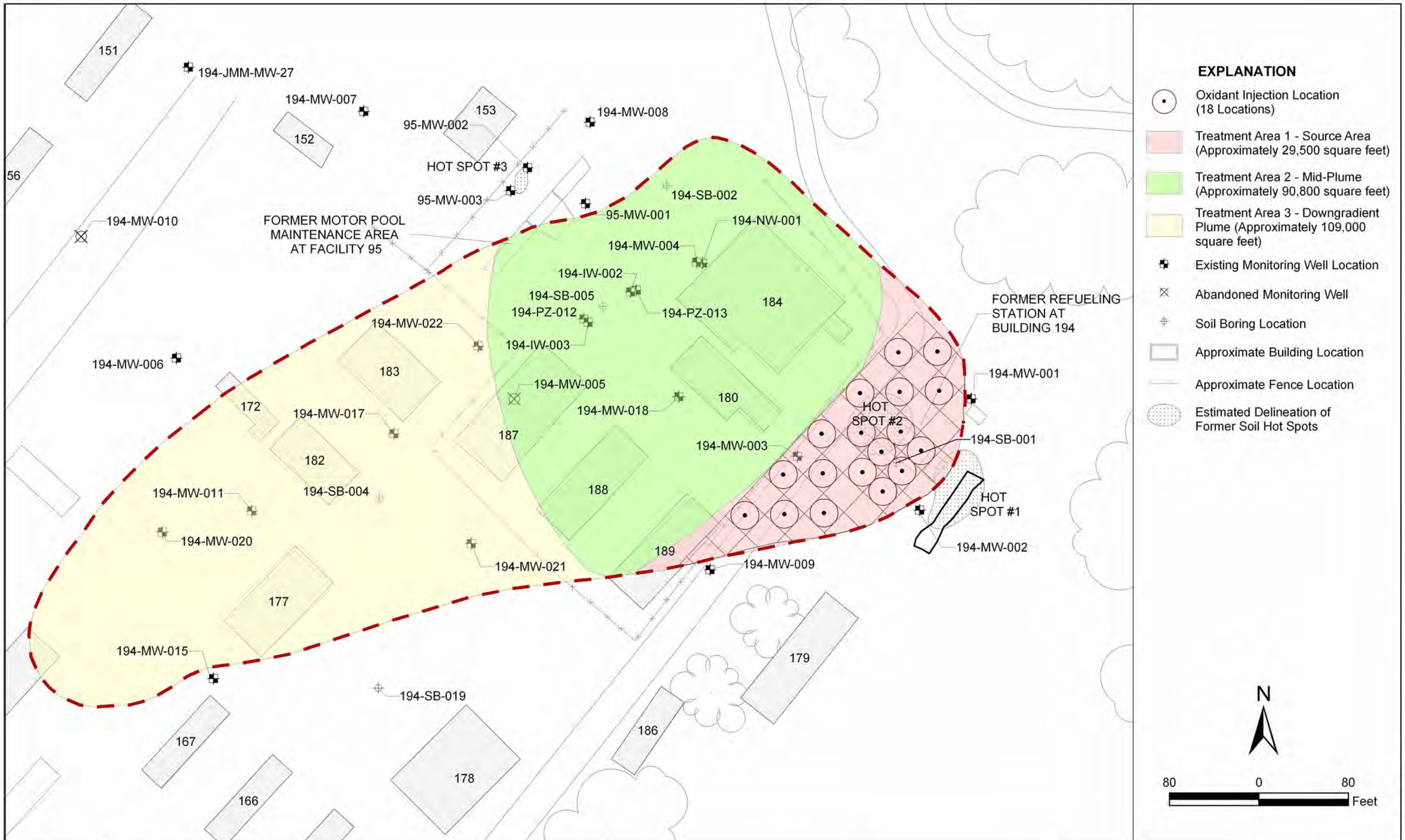

DRAWN: TJH	PROJECT NO: 4084096558 3.3.6	MACTEC	Remedial Design Building 194 Area Fort Hunter Liggett, California	Proposed Oxidant Injections Treatment Area 1	FIGURE 5-1
ENGINEER:	SCALE: AS SHOWN				
CHECKED: AA	APPROVED: BF				
DATE: 11/2010	DATE: 11/2010				

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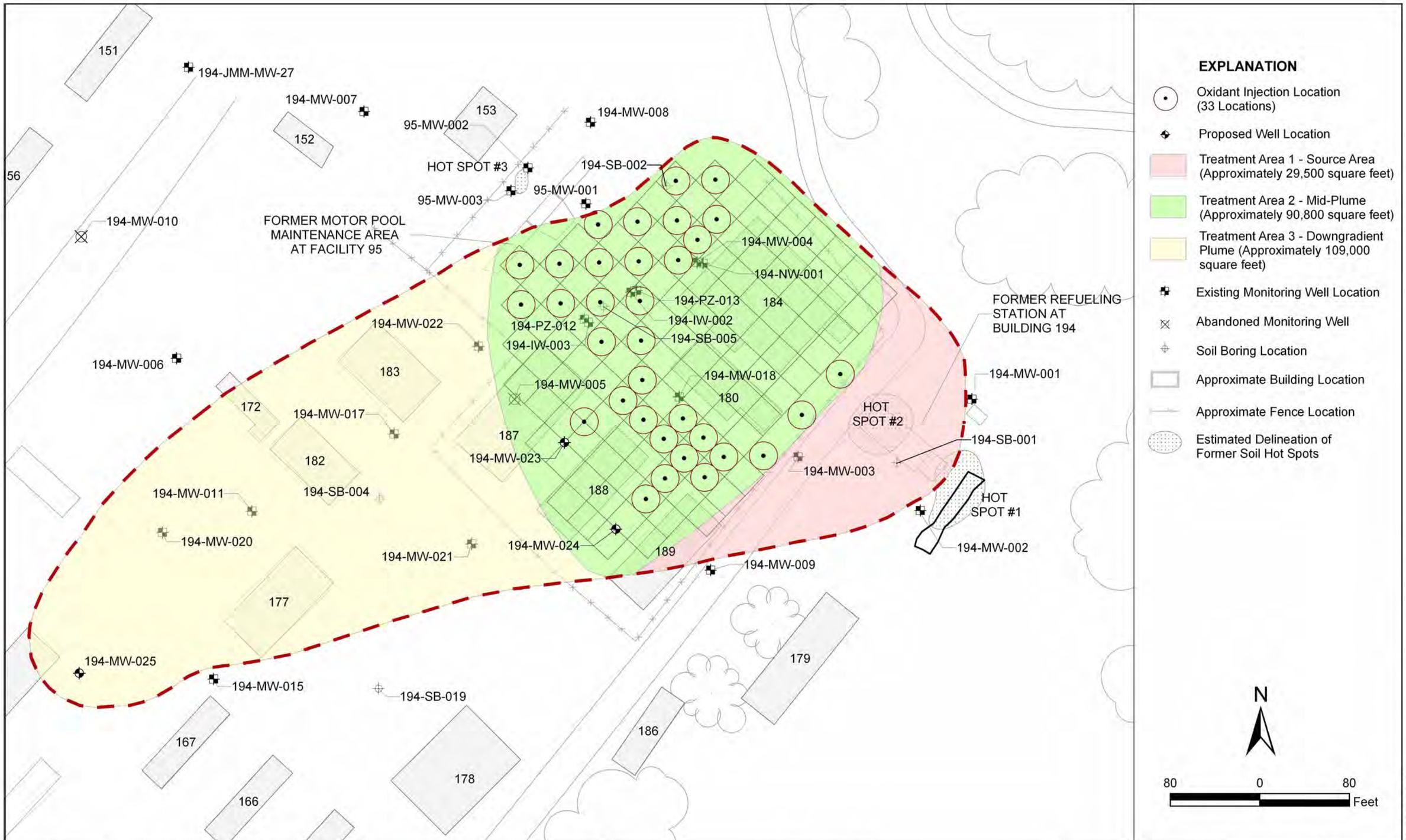

DRAWN: TJH	PROJECT NO: 4084096558 3.3.6		MACTEC	Remedial Design Building 194 Area Fort Hunter Liggett, California	Proposed Oxidant Injections Treatment Area 2	FIGURE
ENGINEER:	SCALE: AS SHOWN					5-2
CHECKED: AA	APPROVED: BF					
DATE: 11/2010	DATE: 11/2010					

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DRAWN: TJH	PROJECT NO: 4084096558 3.3.6		MACTEC	Remedial Design Building 194 Area Fort Hunter Liggett, California	Proposed Oxidant Injections Treatment Area 3	FIGURE 5-3
ENGINEER:	SCALE: AS SHOWN					
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DATE: 11/2010	DATE: 11/2010					

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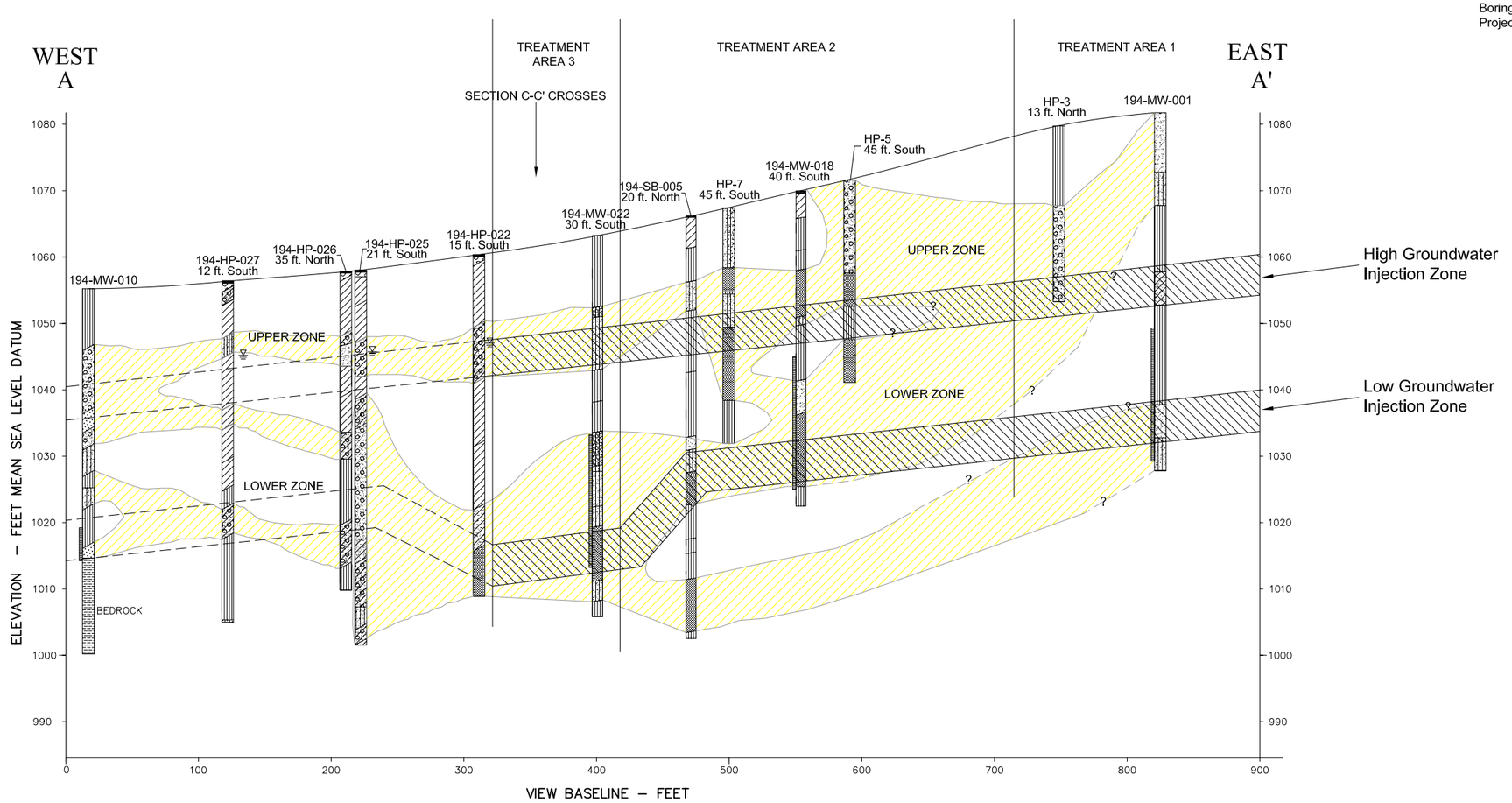
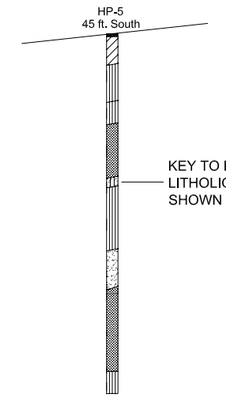


EXPLANATION

Boring or Well Number and
Projection Distance



KEY TO BORING LOG
LITHOLIGIC UNITS IS
SHOWN ON FIGURE 5-6

SAND AND GRAVEL

FINES (CLAY AND SILTS)

MONITORING WELL
SCREENED INTERVAL

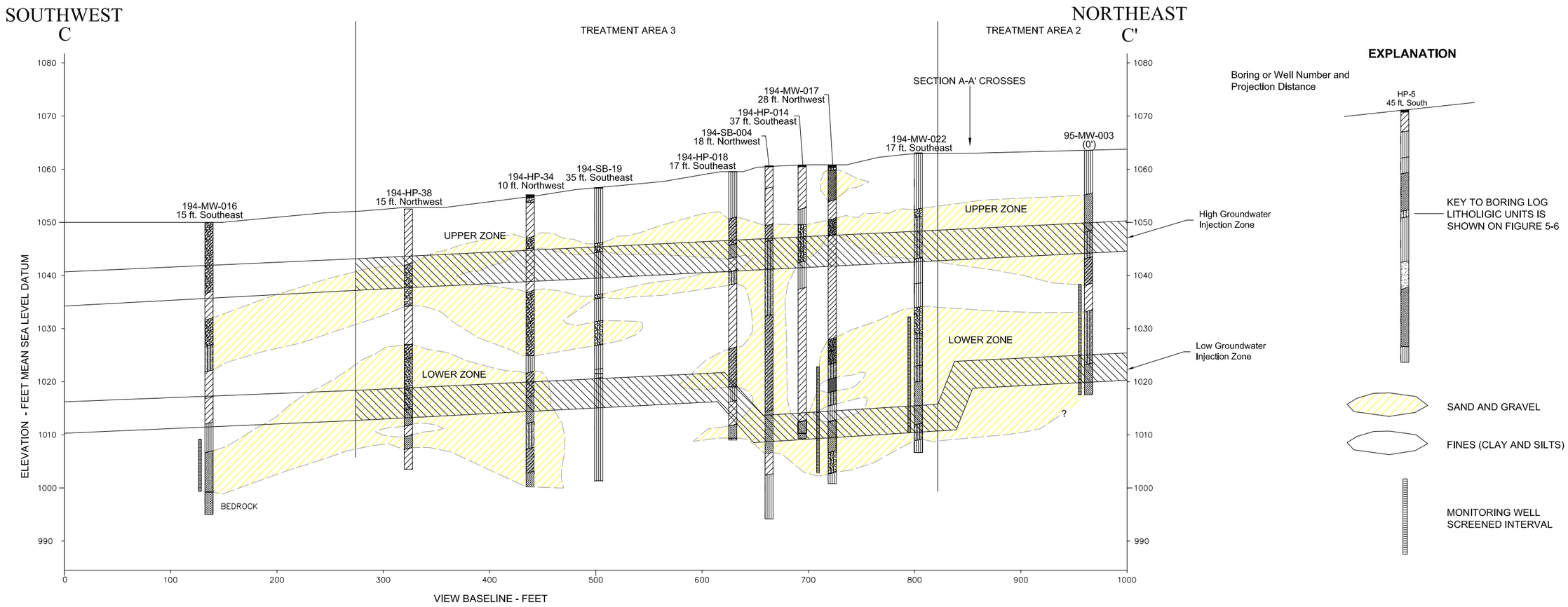
4084096558022.DWG 50.0
20101203.0922

MACTEC

Cross-Section A-A'
Oxidant Injection Zones
Remedial Design
Building 194 Area
Fort Hunter Liggett, California

FIGURE
5-4

DRAWN	JOB NUMBER	CHECKED	DATE	APPROVED	DATE
PCB	4084096558 3.3.6	AA	11/2010	BF	11/2010



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20101203.0915

MACTEC

Cross-Section C-C'
Oxidant Injection Zones
Remedial Design
Building 194 Area
Fort Hunter Liggett, California

FIGURE
5-5

DRAWN	JOB NUMBER	CHECKED	DATE	APPROVED	DATE
PCB	4084096558 3.3.6	AA	11/2010	BF	11/2010

MAJOR DIVISIONS			SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS OVER 50% > No.200 SIEVE SIZE	GRAVELS MORE THAN 1/2 OF COARSE FRACTION > No.4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW	Well-graded gravels or gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GRAVELS WITH OVER 15% FINES	GM	Silty gravels, gravel-sand mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS MORE THAN 1/2 OF COARSE FRACTION < No.4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES	SW	Well-graded sand or gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH OVER 15% FINES	SM	Silty sand, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS OVER 50% < No.200 SIEVE SIZE	SILTS & CLAYS LIQUID LIMIT 50% OR LESS		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS LIQUID LIMIT GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2488-93

☒	Bulk or classification sample
■	Sample preserved for possible laboratory analysis
□	No Recovery
▨	Hydropunch Sample
▽	First encountered groundwater
▼	Static groundwater level
(10YR 4/4)	Munsell Soil color 1990 edition
NA	Not Available
ND	Not Detected

CLASSIFICATION	RANGE OF GRAIN SIZES	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.75
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.75
SAND	No. 4 to No. 200	4.75 to 0.075
coarse	No. 4 to No. 10	4.75 to 2.00
medium	No. 10 to No. 40	2.00 to 0.425
fine	No. 40 to No. 200	0.425 to 0.075
SILT & CLAY	Below No. 200	Below 0.075

KEY TO TEST DATA*

Source: ASTM D 2488-93, based on Unified Soil Classification system
*. Not part of ASTM Classification System

SOIL_CLASS_GEOL_MACTEC FHL_BORING LOGS.GPJ GEOL.GDT 11/19/10

MACTEC

Soil Classification Chart and Key to Test Data FIGURE **5-6**

Remedial Design
Building 194 Area
Fort Hunter Liggett, California

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
PCB	4084096558 3.3.6	AA			

BUILDING 258 AREA SITE CHARACTERIZATION REPORT, 2012

Final
Building 258 Area
Site Characterization Report
Fort Hunter Liggett, California

Prepared for

Department of the Army
Sacramento District Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

AMEC Project No. 4084106586 03.2

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Final
Building 258 Area
Site Characterization Report
Fort Hunter Liggett, California

AMEC Project No. 4084106586 03.2

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C BORING LOGS/WELL COMPLETION DETAILS
D WELL DEVELOPMENT DATA
E DATA VALIDATION RESULTS

ACRONYM LIST

%Ds	percent differences
Accutest	Accutest laboratories
ADR	Automated Data Review
AES	Ahtna Engineering Services
AMEC	AMEC Environment & Infrastructure
Army	U.S. Department of the Army
bgs	below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CCRWQCB	Central Coast Regional Quality Water Control Board
COC	Chain of Custody
COD	Chemical Oxygen Demand
CSM	Conceptual site model
DOD ELAP	Department of Defense Environmental Laboratory Accreditation Program
EC	electrical conductivity
ECD	electron exchange detector
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
FHL	Fort Hunter Liggett
FID	flame ionization detector
FOC	fraction organic carbon
g/cc	grams per cubic centimeter
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HLA	Harding Lawson Associates
ISCO	in-situ chemical oxidation
LIF	Laser Inducted Fluoresence
LNAPL	Light Non-aqueous phase liquid
MACTEC	MACTEC Engineering and Consulting, Inc.
MCDOH	Monterey County Department of Environmental Health
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
µg/kg	micrograms per kilograms
mg/kg	milligrams per kilogram
MCL	Maximum contaminant level
MDL	Method Detection Limit
MIP	Membrane interface probe
MS	Matrix Spike
MSL	mean sea level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MTBE	Methyl tertiary butyl ether
NAPL	Non-aqueous Phase Liquid
NELAC	National Environmental Laboratory Accreditation Conference
PAHs	Polycyclic aromatic hydrocarbons
PDBs	passive diffusion bags
PID	photoionization detector
ppbv	parts per billion by volume

ppm	parts per million
ppmv	parts per million by volume
PQL	practical quantitation limit
PTS	Pilot treatability study
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
RE	reference emitter
RF	Radio Frequency
RL	reporting limit
RPDs	relative percent difference
Site	Building 258 Area
SM	Standard Method
SVE	soil vapor extraction
SVOCs	Semivolatile organic carbons
TBA	Tert-butyl alcohol
TD	total depth
TOC	Total Organic Carbon
TPH	Total petroleum hydrocarbon
TPH-d	Total petroleum hydrocarbon as diesel
TPH-DRO	Total petroleum hydrocarbon as diesel range organics
TPH-g	Total petroleum hydrocarbon as gasoline
TPH-GRO	Total petroleum hydrocarbons as gasoline range organics
TPH-mo	Total petroleum hydrocarbons as motor oil
U&A	Uribe and Associates
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
µV	microvolts
UVOST®	Ultraviolet Optical Screening Tool
VOCs	Volatile organic compounds
WDC	Water Development Corporation
w/sg	With silica gel cleanout

1.0 INTRODUCTION

This Site Characterization Report for the Building 258 area at Fort Hunter Liggett (FHL), California (Plate 1-1) was prepared by AMEC Environment & Infrastructure (AMEC) under the direction of the U.S. Army Corps of Engineers (USACE), Sacramento District, Contract No. W91278- 7-D-005 CM04. Work described in this report was performed according to the *Final Building 258 Site Investigation and Monitoring Well Installation Work Plan, Fort Hunter Liggett, California* (Work Plan) dated January 28, 2011(*Ahtna Engineering Services [AES], 2011*) and the *Final Building 258 Site Investigation, Technical Memorandum, Fort Hunter Liggett, California* (Tech Memo) dated July 12, 2011 (*MACTEC Engineering and Consulting, Inc. [MACTEC], 2011*). Any deviations from the Work Plan and Tech Memo are described in this report. Fieldwork conducted under the Work Plan was performed between January 31 through February 18, 2011 and June 7 to June 30, 2011, at the Building 258 Area (Site) (Plate 1-2). In addition to the data collected by MACTEC, groundwater quarterly monitoring data collected by AES was reviewed and evaluated as part of this report.

1.1 Objectives

The objective of this Site Characterization was to further delineate the vertical and horizontal extent of groundwater contamination, determine if there was a continuing source of contamination, determine if contamination was present within soil vapor, and further define the lithology and depth of bedrock units beneath the site. This information will be used to conduct a design analysis including evaluation of remedial alternatives, which will lead to development of plans for optimization of the site remediation.

1.2 Report Organization

This report is organized as follows: Section 2.0 presents background information regarding site location, geology and hydrogeology, site usage, previous investigations, distribution of chemicals, and soil vapor extraction. Section 3.0 presents the investigation objectives and identified data gaps. Section 4.0 presents a summary of the field investigation. Section 5.0 presents the results of the soil boring installation and discusses groundwater monitoring. Section 6.0 presents analytical results. Section 7.0 presents a Conceptual Site Model (CSM) based on the field investigation. Section 8.0 presents conclusions and recommendations. Section 9.0 presents references. Tables, Plates, and appended material are included in separate tabbed sections following the text.

2.0 BACKGROUND

This section presents a discussion of the site location and topography, geology and hydrogeology, previous investigations, and site usage.

2.1 Location and Topography

The Site (Plate 1.2) is located on a gentle slope on the northeast edge of a northwest-trending valley comprising the San Antonio River Flood plain. Building 258 is located in the Main Garrison Area of FHL and includes the former Main Fuel Depot and the area down gradient.

The elevation of the Site ranges from 1,060 feet (near Building 258) to approximately 1,030 feet above mean sea level (MSL) on the southwest side of Route Tampa. The surface of the site slopes gently down to the southwest. Surface runoff flows towards Route Tampa and then toward the San Antonio River.

2.2 Geology and Hydrogeology

Building 258 is located on a gentle slope on the northeast edge of a northwest-trending valley comprising the San Antonio River flood plain. The San Antonio River channel lies approximately 4,000 feet southwest of Building 258. Boring logs from previous investigations indicate the following:

- Between Building 258 and Route Tampa to the southwest, there are approximately 12 to 40 feet of clay and silt that overlies a water-bearing zone composed of silty sand, clayey gravel with sand, and sand with gravel. Groundwater was encountered at depths ranging from 12 to 45 feet below ground surface (bgs).

- Water-bearing sands and gravels are underlain by bedrock composed primarily of weathered and fractured siltstone and mudstone with minor sandstone and conglomerate.

- North of Route Tampa, water-bearing sediments appear to be confined to a relatively narrow bedrock channel, which runs roughly north to south. The depth to bedrock within the channel was deeper than the total depth (TD) of borings drilled within the channel during previous investigations, although bedrock was determined to be as shallow as 11 feet bgs approximately 70 feet away from the channel axis.

- Previous lithologic logs have shown a general decrease in the thickness of the overlying fine grained material and an increase in coarse-grained material between borings drilled on the north

side of Route Tampa and those drilled within the San Antonio River flood plain located on the southwest side of Route Tampa.

An updated geology and hydrology description using lithologic information obtained during this investigation is included in Section 5.0.

2.3 Previous Investigations

The Building 258 Area includes the former Main Fuel Depot and the area down gradient (Plate 2.1). A description of the previous site usages and investigations are presented below in the following subsections.

2.3.1 UST Removals

In late 1989, FHL personnel reported a gasoline spill at Building 258 resulting from an apparent leak in underground piping connecting a 10,000 gallon unleaded gasoline underground storage tank (UST) to a dispenser island. A strong hydrocarbon odor and fuel in a nearby drainage ditch were observed. The suspected cause of the leak was ground movement resulting from the October 17, 1989 Loma Prieta earthquake.

In November 1989, approximately 930 cubic yards of soil were removed to a depth of 22 feet in the vicinity of the product lines. Confirmation soil sampling following excavation showed concentrations of total petroleum hydrocarbons as gasoline (TPH-g) up to 1,000 milligrams per kilogram (mg/kg) and benzene up to 22 mg/kg (*Harding Lawson Associates [HLA], 1991*; Plate 2.1). In November 1998, four USTs were removed from the Building 258 Area by Geofon, Inc. from three excavations at Building 258. The four USTs were as follows:

- **Tank 258-T1:** 10,000-gallon single-walled steel tank used to store unleaded gasoline.
- **Tank 258-T2**: 10,000-gallon single-walled steel tank used to store diesel fuel.
- **Tank 258-T3**: 25,000-gallon single-walled steel tank used to store diesel fuel.
- **Tank 258-T4**: 10,000-gallon single-walled steel tank used to store diesel fuel.

Since the walls of the UST excavations were close to active underground utilities, the excavations were backfilled as the USTs were removed to prevent collapse of the backfill material supporting the utility

lines. As a consequence, excavation confirmation soil samples were not collected directly below the USTs. Instead, samples were collected at the ends of the USTs prior to removal of the USTs. Seven excavation confirmation soil samples were collected from 14 feet bgs, approximately two feet below the base of the UST excavations. One of the seven excavation confirmation samples contained TPH as diesel (TPH-d) at 2,000 mg/kg (*MACTEC, 2009*). Additional soil was subsequently excavated from that location and confirmation sampling indicated that total petroleum hydrocarbons (TPH) results were below the Monterey County Department of Health, Environmental Branch (MCDOH) cleanup levels of 100 mg/kg, and MCDOH approved closure of the site (*Uribe and Associates [U&A], 1999, and Geofon, Inc. 1999*).

2.3.2 HydroPunch™ Investigation and Well Installation

Following the UST removal activities, there were multiple phases of groundwater investigations performed at the Site to evaluate the presence and extent of petroleum hydrocarbons in groundwater. These investigations consisted of the installation and sampling of 58 HydroPunch™ borings and the installation of ten groundwater monitoring wells (258-NW-001 and 258-MW-002 through 258-MW-009 and 258-MW-010B), two injection wells (258-IN-011 and 258-IN-012), and two piezomters (258-PZ-001 and 258-PZ-002). One additional monitoring well (258-MW-014) was installed during a 2010 soil vapor extraction (SVE) well installation. MW-258-014 was first sampled in November 2010. One well (258-IN-011) was destroyed during a sewer line repair in 2007.

2.3.3 Groundwater Monitoring

Groundwater monitoring wells have been sampled quarterly or semiannually for TPH-g, TPH-d, volatile organic compounds (VOCs) including benzene, toluene, ethylbenzene, and total xylenes (BTEX), methyl tert butyl ether (MTBE), and tert-butyl alcohol (TBA) since 2002. Building 258 Area wells have also historically been sampled for dissolved lead, and natural attenuation parameters until these compounds were dropped from the monitoring program in November 2006.

Free product was found in the two wells installed immediately downgradient of the former USTs and product lines (258-NW-001 and 258-MW-002) at thicknesses ranging from a sheen to 3.45 feet prior to the implementation of the SVE pilot treatability study (pilot treatability study [PTS], Section 2.3.4). Product was bailed from the wells and passive recovery systems comprising product selective absorbent socks in stainless steel canisters and a product skimmer system were installed in the wells. These passive systems are no longer in use.

Previous investigations have indicated that contaminated groundwater appears to be confined within a relatively narrow bedrock channel that becomes wider as it encounters the San Antonio River flood plain. As groundwater moves into the flood plain, TPH-g and BTEX concentrations appear to attenuate as the channel becomes less confined both laterally and vertically. It appears that the plume bends to the south as it crosses Tampan Road, potentially influenced by the buried bedrock channel discussed in Section 2.2.

2.3.4 Soil Vapor Extraction

The SVE PTS was conducted in two phases between March 26 and November 25, 2007. Phase I was conducted to determine the effectiveness of SVE as a remedial alternative for the removal of petroleum hydrocarbons perched within the vadose zone, and Phase II was performed to obtain additional SVE system operational data over an extended period of time. Initially, three SVE wells were installed (258-SVE-001, 258-SVE-002, and 258-SVE-003). Two of the SVE wells were destroyed during excavation work associated with a damaged sanitary sewer line (258-SVE-001 and 258-SVE-002) and replaced with new wells (258-SVE-001A and 258-SVE-002A). The SVE PTS demonstrated that SVE was effective at removing petroleum hydrocarbons from the vadose zone and provided data necessary for design of a full-scale SVE system (*MACTEC, 2009*).

In November 2009, AES installed an SVE treatment unit and began SVE remediation utilizing the three existing SVE wells. Two additional SVE wells (258-SVE-004 and 258-SVE-005) were installed and connected to the existing SVE treatment system in February 2010 (Plate 2.1). The treatment system continued to operate until April 29, 2011.

A combined total of 183,999 pounds of TPH-g was removed during SVE operation, equivalent, using an average weight of 6.2 pounds per gallon of gasoline, to 29,677 gallons of gasoline.

2.3.5 Groundwater Pilot Studies

Between February and April 2006, an in-situ chemical oxidation (ISCO) PTS was conducted in two areas of the Site, at the source area near Building 258 and near well 258-MW-006, which is located in the mid plume area. The results of the ISCO PTS indicated that ISCO is effective in reducing groundwater hydrocarbon concentrations in the Building 258 Area. However, the removal of residual hydrocarbon contamination in the vadose zone in the vicinity of the source area was recommended prior to implementation of the full-scale groundwater remediation. The results of the ISCO PTS are presented in the PTS Technical Memorandum (*MACTEC, 2006*).

3.0 INVESTIGATION OBJECTIVES AND IDENTIFIED DATA GAPS

The investigation objectives of the site characterization were to define and implement a field investigation strategy that would provide sufficient information to conduct a design analysis including evaluation of remedial alternatives. To accomplish this objective, the following data gaps were addressed:

1. The horizontal extent of the groundwater plume has not been adequately defined (Data Gap 1).

2. The vertical profile of the chemicals of concern in the groundwater plume has not been adequately defined (Data Gap 2).

3. The possible presence of continuing source areas of contamination have not been adequately investigated (Data Gap 3).

4. The potential for contaminants to be present within soil vapor has not been adequately evaluated (Data Gap 4).

5. Saturated soil chemistry and physical parameters for the center of the groundwater plume and background conditions needed to determine the appropriate groundwater remediation methods (Data Gap 5).

6. The lithology of bedrock units beneath the site has not been adequately defined (Data Gap 6).

4.0 SUMMARY OF FIELD INVESTIGATION PROGRAM

This section describes the field investigation program performed during the site characterization. The soil sampling and analytical program is presented on Table 4.1 and the groundwater analytical program is presented on Table 4.2. The sampling programs for the Ultraviolet Optical Screening Tool (UVOST®) and membrane interface probe (MIP) surveys are described below, but not presented in tabular format. Locations of activities are shown on Plates 4.1 and 4.2. The following field tasks were performed:

- MIPS and a UVOST® investigation;
- Geophysical survey;
- Soil boring installation;
- Monitoring well installation; and
- Groundwater sampling.

4.1 MIP and UVOST® Investigation

4.1.1 UVOST® Investigation

Between January 31 and February 18, 2011, AES conducted a subsurface UVOST® investigation to delineate the depth and horizontal extent of free product and residual petroleum contamination at the Site (Data gaps 1 through 4). UVOST® is a Laser Induced Fluorescence (LIF) Non-Aqueous Phase Liquid (NAPL) detection tool that can be used to delineate the vertical and horizontal extent of free product and residual phase petroleum hydrocarbons in the subsurface. The tool uses a laser that sends pulses of monochromatic light through a fiber optic cable strung within direct push rods with a probe at the bottom. The light exits through a window on the side of the probe and fluoresces compounds containing polycyclic aromatic hydrocarbons (PAHs). The light emitted from the fluoresced compounds is transmitted up to the surface through another fiber optic cable that can be analyzed and measured. This emitted light indicates the presence of free product or residual phase petroleum hydrocarbons. Free product describes NAPL that is mobile, and residual phase describes NAPL that is immobile. The response to the light is identified as individual wavelengths and reported as a percentage of a known standard identified as the reference emitter (RE). In general, the higher the percent RE measured, the more likely the NAPL is free product and mobile. However, because the range of UVOST® data that

could represent NAPL that is either considered free product or residual phase is not well defined and can be difficult to interpret, detections of NAPL are herein referred to using the singular term of free/residual product.

The UVOST® investigation consisted of completing 21 of 39 proposed sample locations in the source area; five locations along transect 1; four locations along transect 2; and five locations along transect 3, which are downgradient of the source area (Plates 4.1 and 4.2). These locations were selected to better define the lateral and vertical extent of free product and residual phase product at the Site. The UVOST® data collected at each of the sample locations is presented and discussed in Section 6.1. Cross-sections A-A' (Plate 4.3), B-B' (Plate 4.4), and C-C' (Plate 4.5) present selected UVOST® profiling locations along with the depths of free/residual product detected as part of the survey.

4.1.2 MIP Investigation

Between February 7 and 18, 2011, AES conducted a MIP investigation in order to collect continuous VOC soil and groundwater data from the Site to better define the width and length of the groundwater plume (Data gaps 1, 2, and 4). The MIP technology uses a sensor detection system, which includes a photoionization detector (PID), a flame ionization detector (FID), and an electron capture detector (ECD). The ECD probe is primarily used to detect halogenated VOCs, which are not contaminants of concern at the Site; therefore, ECD results are not discussed. The PID and FID probes are more likely to identify petroleum-based VOCs such as benzene. The MIP also includes an integrated electrical conductivity (EC) probe to provide a general indication of soil particle size.

The MIP investigation consisted of completing two locations along transect 3, five along transect 4, six along transect 5, eight along transect 6, two along transect 7, two along transect 8, and one along transect 9 (Plate 4.2). These locations were selected to better define the lateral and vertical extent of dissolved phase product at the Site. The MIP data collected at each of the sample locations is presented in Section 6.2. Cross-sections A-A' (Plate 4.3), C-C' (Plate 4.5), D-D' (Plate 4.6), E-E' (Plate 4.7) and F-F' (Plate 4.8) present selected MIP profiling locations along with the depths of dissolved phase product detected as part of the survey. MIP logs are presented in Appendix B. MIP Transects were chosen as follows:

- Transect 3 was designed to better define the width of the plume and confirm there are no additional unknown flow paths with impacted groundwater.

- Transect 4 was designed to better define the width of the plume where the plume appears to turn from a southwesterly path to a southerly direction, and expands both to the east and west based on historical HydroPunch™ data.

- Transect 5 is downgradient of monitoring well 258-MW-006 and was designed to better define the width of the plume and to confirm there are no additional flow paths with impacted groundwater.

- Transect 6 extends downgradient of monitoring well 258-MW-006 to 258-MW-008. The transect was selected to better define the length of the plume.

- Transect 7 extends downgradient of transect 5 to monitoring well 258-MW-005. MIP measurements were collected to define the flow paths east of what appears to be a bedrock high identified during a previous HydroPunch™ investigation (*Harding ESE, 2002*).

- Transect 8 extends downgradient in the southern area of the plume to further define the flow paths and potential bedrock high between wells 258-MW-005 and 258-MW-008.

- Transect 9 extends perpendicular towards the east from the midpoint of transect 7, and was designed to further define the southeastern extent of the plume.

4.2 Geophysical Survey

A geophysical investigation to locate potential remaining sources of petroleum products, such as USTs or associated pipelines and other possible contamination flow paths in the Building 258 Area, was performed by a California registered geophysicist using an integrated approach that included multiple surveys using Electromagnetic (EM) terrain conductivity, EM metal detecting, Ground Penetrating Radar (GPR), and Radio Frequency (RF) pipe and cable locating instrumentation (Data Gap 3).

The investigation proceeded in two phases: a utility mapping phase and an EM survey phase. Utility mapping was used to locate any backfilled utility burial trenches that might serve as underground flow pathways. Additionally, the resulting utility maps aided the interpretation of the subsequent EM survey data by facilitating the identification of EM responses associated with known utilities.

4.2.1 Utility Mapping

As-built utility drawings were gathered and referenced for the utility mapping phase. The geophysical investigation searched for additional utilities not shown on the drawings using a combination of RF utility locating, GPR, and EM metal detection. The data was analyzed in the field and the locations of detected utilities were marked.

4.2.2 EM Surveys

Two types of EM surveys were performed: a metal-detecting survey using a Geonics EM61 to look for buried metal representing possible UST locations, and a terrain conductivity survey using a Geonics EM31 to assess changes in the electrical properties of the soil indicative of potential groundwater flow paths. Horizontal positioning information for the EM datasets was obtained using a Trimble Pro-XR mapping-grade Global Positioning System (GPS). The EM data was evaluated in the field so any EM anomalies identified could be further evaluated with GPR. GPR was used, but no anomalies indicating the presence of an additional UST were discovered.

4.3 Soil Borings

Five new soil borings (258-SB-001 through 258-SB-005) were drilled and installed between June 7 and June 21, 2011 by Water Development Corporation (WDC) under the supervision of an AMEC geologist. The borings were installed to (1) provide physical and chemical analyses of soil within the groundwater plume and background conditions (2) determine the bedrock units beneath the Site; and (3) identify, and potentially establish, a correlation between the MIP and UVOST® data and lithology. The data will be used to develop the remedial design (Data Gaps 5 and 6 identified in Section 3.0).

The following soil borings were installed at the locations shown on Plates 4.1 and 4.2:

- 258-SB-001 was drilled near MIP location 6-1 to establish a correlation between MIP data and lithology (MIP location 6-1 contained elevated MIP concentrations between 36 and 59 feet bgs). The boring was advanced into bedrock in order to determine the depth of the bedrock channel down gradient from well 258-MW-006.

- 258-SB-002 was installed based on results from MIP locations 5-1 and 5-3 to further investigate the potential for contamination on the southwestern side of the plume at a depth greater than the total depth of HydroPunch™ location 258-HP-035. The boring was not advanced into bedrock.

- 258-SB-003 was installed to establish a correlation between MIP data and lithology. This boring was drilled into bedrock at a location selected due to high MIP concentrations detected at MIP location 4-3.

- 258-SB-004 was installed to establish a correlation between UVOST® data and lithology. This boring was drilled into bedrock at a location selected due to high UVOST® concentrations detected at UVOST® location 1-5.

- 258-SB-005 was installed to establish a correlation between MIP data and lithology. This location was originally proposed in the source are, but due to the proximity between the proposed location and 258-MW-002D, this boring was moved to be adjacent to UVOST® location 3-3.

Drilling procedures consisted of clearing the borings using private utility locator, hand augering or using an air-knife to clear the top five feet, drilling the boring using sonic drilling methods, logging the soil and collecting pertinent soil samples for laboratory analysis, and backfilling the borehole using portland cement grout when complete.

4.4 Monitoring Well Installation

Six new monitoring wells (258-MW-002D, 258-MW-004D, 258-MW-005D, 258-MW-006D, 258-MW-008D, and 258-MW-015) were drilled and installed between June 15 and June 29, 2011 by WDC under the supervision of AES and an AMEC geologist. Drilling procedures consisted of clearing the borings using a private utility locator, hand augering or using an air-knife to clear the top five feet, drilling the boring using sonic drilling methods, logging the soil and collecting pertinent soil samples for laboratory analysis, and installing either 2 or 4-inch polyvinyl chloride (PVC) monitoring wells. Details of the well installation procedures are provided in AES's Well Completion Report (October 2011).

The monitoring wells were installed to (1) evaluate the extent of groundwater contamination in areas not already addressed by the existing monitoring well network, (2) further define the vertical extent of groundwater contamination in areas of the site already covered by the existing monitoring well network, and (3) provide physical and chemical analyses of soil within the groundwater plume. The data will be used to develop the remedial design (Data Gaps 1, 2, 3, and 5 identified in Section 3.0).

The following new monitoring wells were installed at the locations shown on Plate 4.9:

- 258-MW-002D was installed to assess groundwater quality in the lower zone between 65 and 85 feet bgs. The screen interval corresponds to the bottom of alluvial deposits and the top of weathered bedrock. Adjacent well 258-MW-002 is screened from 34 to 54 feet bgs.

- 258-MW-004D was installed to monitor the zone beneath the bottom of the screen at 258-MW-004 (49 feet bgs) and 70 feet. The well was screened within the bedrock and will be used to evaluate the potential for contamination to be present in the bedrock at the mid plume area.

- 258-MW-005D was installed to determine the limits of contamination between the bottom of the screen interval at 258-MW-005 (43 feet bgs) and the top of the bedrock at approximately 55 feet bgs, and to provide information on vertical hydraulic gradients.

- 258-MW-006D was installed to determine the limits of contamination between the bottom of the screen interval at 258-MW-006 (42 feet bgs) and the top of the bedrock and to provide information on vertical hydraulic gradients.

- 258-MW-008D was selected for installation adjacent to monitoring well 258-MW-008 to verify the limits of groundwater contamination below the screen depth of 258-MW-008 (22 to 37 feet bgs) and to provide information on potential vertical gradients between the upper and lower portions of the unit.

- 258-MW-0015 was installed to collect information in the area between the free product and the dissolved contamination portions of the plume (south of Route Tampa). The screen interval was selected to cover the high water levels to bedrock.

Drilling procedures consisted of clearing the borings using private utility locator, hand augering or using an air-knife to clear the top five feet, drilling the boring using sonic drilling methods, logging the soil and collecting pertinent soil samples for laboratory analysis, and installing the wells based on the soil lithology, depth to bedrock, and the screen depth of nearby wells (if any). Lithologic logs with the well construction details are included in Appendix D.

4.5 Groundwater Sampling

4.5.1 Vertical Profiling

Groundwater sampling was performed using the following procedures:

Five previously existing monitoring wells were profiled by AES for selected VOCs to evaluate the potential for a vertical distribution of groundwater contamination, in an effort to insure that existing and proposed well locations were screened at intervals that will provide the best representation of groundwater contaminant conditions (Data Gap 2). Collected groundwater samples were submitted to Accutest laboratories (Accutest) in San Jose, California for analysis. A sixth monitoring well (258-MW-003) was planned for vertical profiling; however the passive diffusion bags (PDBs) ruptured while being removed from the well. Monitoring wells used for vertical profiling using PDBs are as follows:

258-MW-002 – This monitoring well was selected for profiling because it is located in the source area and intermittently contains free product. Three PDBs were used to profile the 20 foot screen interval. The bags were placed at 36 feet to monitor the lean clay unit at the top of the screen interval; 42 feet to monitor the well-graded sand unit underlying the clay; and at 48 feet to monitor a well-graded gravel unit underlying a 3-foot thick silt unit.

258-MW-004 – This well was selected for profiling because it is located within the middle of the plume. Four PDBs were used to profile the 20-foot screen interval. The PDBs were placed at 32 feet to monitor a lean clay unit at the top of the screen interval; 37 feet to monitor a clayey sand with gravel unit underlying the clay unit; 42 feet to monitor a silty sand unit underlying the clayey sand with gravel; and 48 feet to monitor a well-graded sand unit located at the bottom of the well screen.

258-MW-006 – This well was selected for profiling because it is the most downgradient plume well with consistent detections of BTEX. The PDBs were used to profile the 15-foot screen interval and were placed at 32 feet to monitor a clayey sand with gravel unit at the top of the screen, and at 36 and 41 feet to monitor a well graded sand unit underlying the clayey sand with gravel.

258-MW-007 – This well was selected for profiling because intermittent maximum contaminant level (MCL) exceedances have been observed. Three PDBs were used to profile the 15-foot screen interval. The bags were placed at 30 feet bgs to monitor the approximate contact with between a clayey sand with gravel and a clayey gravel near the top of the screen interval, at 34 feet bgs to monitor the top of a well graded sand unit; and 40 feet bgs to monitor a well graded sand unit at the bottom of the screen interval.

258-MW-008 – This well was selected because it is the most downgradient Building 258 Area well. Three PDBs were used to profile the 15 foot screen interval. The bags were placed at 25 feet bgs to monitor a clayey sand at the top of the screen interval; at 30 feet bgs to monitor a well graded sand with

gravel underlying the clayey sand at the top of the screen interval; and 35 feet bgs to monitor a well graded sand unit at the bottom of the screen interval.

Profile samples were collected from the PDBs on January 27th, 2011. Sample collection followed the methodology specified in the FHL Quality Assurance Project Plan (QAPP) (*AES, 2010a*) and the Site Characterization work plan (*AES, 2011)*. The only deviation from the work resulted when the PDBs from 258-MW-003 were damaged. The results of the sampling are presented in the 2011 First Quarter Groundwater Monitoring Report, Building 258 Area (*AES, 2011b)*.

4.5.2 Groundwater Sampling

The six newly installed wells (258-MW-002D, 258-MW-004D, 258-MW-005D, 258-MW-006D, 258-MW-008D, and 258-MW-015) and 14 existing wells or piezometers were sampled between July 12 and 14, 2011 by AES. The samples were collected to provide baseline data for future sampling events, to further delineate the lateral and vertical extent of the groundwater plume, and to further define and characterize existing source areas (Data Gaps 1 and 3). Well screen intervals, top of casing elevations, and northings and eastings for all new and existing Site wells are presented on Table 4.3.

Collected groundwater samples were submitted to Accutest for analyzes. Groundwater samples were analyzed for the following:

- Total petroleum hydrocarbons as gasoline range organics (TPH-GRO)/VOCs by U.S. Environmental Protection Agency (EPA) Test Method 8015D/8260B; and
- Total petroleum hydrocarbon as diesel range organics (TPH-DRO) by EPA Test Method 8015B M.

The list of VOCs analyzed during the site characterization is provided in Table 4.4.

4.5.3 Groundwater Sampling Procedures

Groundwater sampling was performed using the procedures described in the FHL QAPP (*AES, 2010a*).

4.6 Soil Sampling

Eleven soil samples were collected for one or more organic parameters, nine primary and one duplicate soil sample were collected for inorganic parameters, and saturated soil samples were collected for

physical properties from five borings and two monitoring wells on June 7 through 29, 2011. Sample depths from each borehole were selected in the field based on drilling conditions and PID readings.

Soil samples submitted for chemical analyses were collected within one 2.5-inch diameter by 6-inch stainless steel tube and Encore® sampling devices hand driven into 4-inch diameter sonic cores. Collected soil boring samples were submitted to Accutest in San Jose, California for analyzes. The soils were analyzed for the following:

- TPH-GRO (C6-C10)/BTEX and MTBE by EPA Test Method 8260B;
- TPH-DRO (C10-C28) with silica gel cleanout (w/sg) by EPA Test Method 8015B-M;
- Total petroleum hydrocarbons as motor oil (TPH-mo) (C28-C40) by EPA Test Method 8260B-M;
- Chemical Oxygen Demand (COD) by Standard Method (SM) 5220C-M;
- Total Organic Carbon (TOC) by EPA Test Method 9060A-M;
- Total Iron by EPA Test Method 6010B; and
- Title 22 Metals by EPA Test Method 6010B/7471A.

Saturated soil samples submitted for physical parameters were collected by placing undisturbed 4-inch diameter sonic core between two sections of 4-inch diameter PVC pipe ripped lengthwise and secured for transport. Collected saturated soil samples were submitted to PTS Laboratory in Santa Fe Springs, California for one or more of the following analyses:

- TRRP RG-36 Limited Site Assessment Physical Properties Format (intrinsic permeability/hydraulic conductivity, total porosity, air-filled porosity, dry bulk density, volumetric moisture content, and fraction organic carbon [FOC]);
- X-Ray Diffraction Analysis (Mineralogical Analysis); and
- Water/Light Non-aqueous Phase Liquid (LNAPL) Relative Permeability.

Stockpiled soil was sampled as a 4-point composite sample collected by hand into stainless steel tubes from approximately 1-foot beneath the surface at each quadrant of the soil bin. The analytical laboratory

was instructed to composite four tubes into one sample. Stockpile samples were submitted to Accutest for analyzes. The stockpiles soil was analyzed for the following:

- TPH-g (C6-C10)/BTEX and MTBE by EPA Test Method 8260B;
- TPH-d (C10-C28) w/sg by EPA Test Method 8015B-M;
- Luft Metals by EPA Test Method 6010B; and
- Percent Moisture.

4.7 Well Development

The six newly installed monitoring wells were developed by AES in June 2011. Details on the development methods are provided in Appendix D.

5.0 SUMMARY OF SOIL BORING AND GROUNDWATER MONITORING RESULTS

This section presents the results of the soil boring program and groundwater monitoring performed by MACTEC and AES during 2011. Tables 5.1 and 5.2 present a summary of the soil boring and monitoring well installation results. This information is the basis for the discussions provided in Section 5.1 and expanded upon in Section 6.0.

5.1 Lithologic Data

Eleven soil borings were drilled and logged as part of the site characterization. Six of the borings were completed as monitoring wells (258-MW-002D, 258-MW-004D, 258-MW-005D, 258-MW-006D, 258-MW-008D, and 258-MW-15). The boring logs and well completion details are provided in Appendix C. Cross sections A-A', B-B', C-C', D-D', E-E' and F-F' were updated with the lithologic information collected during the site characterization (Plates 4-3 through 4-8). Cross section A-A' was prepared to present lithologic information down the center of the plume. Cross-Section B-B' presents lithologic information cross-gradient through the source area, and cross sections C-C' and D-D' present lithologic information across the plume width in the center and near the down gradient portion of the plume. Cross-sections E-E' and F-F' present information from the downgradient portions of the plume.

Review of the lithologic data indicates that subsurface deposits consist of unconsolidated, silts and clays that are interbedded with sand and gravels. The unconsolidated deposits are present in an incised bedrock channel and comprise the primary water bearing zone at the site. The sand and gravel deposits appear to be locally continuous in both the lateral and vertical directions and likely represent braided conditions due to suspected deposition within the bedrock channel during storm wash events. There appears to be less vertical and lateral connection of the coarse grained deposits in and near the source area where the bedrock channel is narrower. The water bearing zone comprised of the unconsolidated sands and gravels varies from about 60 feet thick in the source and along the axis of the channel to less than 20 feet thick along the edges of the channel. (Plates 4.3 through 4.8). A bedrock high appears to be present just south of 258-MW-006. The formation is finer grained in the shallow parts of the upper portions of the channel (near the source area) and becomes coarser grained; therefore, it is more likely to be hydraulically connected to the south.

5.2 Water Level Data

Water-level measurements collected between 2002 and 2011 were compared to historical benzene concentration to evaluate the potential impact of water-level variations on the migration of TPH and BTEX within the plume. Rainfall data from 1980 to 2011 was also reviewed to identify years with drought conditions and elevated precipitation. Rainfall data from 2002 through 2010 was compared to water level data to evaluate the impact of seasonal variations in rainfall on water levels and the potential impact that drought may have had on water levels and contaminant migration. The period from 2002 through 2010 was selected because the first monitoring wells at the site were installed in 2002.

The data show that groundwater levels decrease following months of little to no rainfall, while groundwater levels increase following periods of increased rainfall. Plates 5.1 and 5.2 present hydrographs of the water levels measured between 2002 and 2010 plotted against monthly and yearly rainfall totals. In addition to the season variations, variation in water levels related to yearly precipitation is also evident. Plate 5.2 shows the yearly precipitation and water levels for 258-MW-002, 258-MW-004, 258-MW-005, 258-MW-006 and 258-MW-008 between 2002 and 2010. This graph illustrates the changes in water levels related to overall yearly precipitation. This graph indicates that water levels can be up to 10 feet lower throughout the year during drought years.

Review of the precipitation data from 1980 through 1998 (when the USTs were removed), indicates that during the time the USTs were in use (1982 until 1998), the highest yearly rainfall occurred in 1983 (26.41 inches) and the lowest rainfall year was in 1989 (5.03 inches). The large fluctuations in rainfall during the 1980s likely resulted in large fluctuations in water levels related to yearly differences in precipitation. These large fluctuations likely resulted in the transport of contaminants both vertically and horizontally during the 1980s and 1990s. As is evident in the 11 to 16 foot variation in water levels measured on a quarterly basis between 2002 and 2010; it is possible that even greater fluctuations occurred in the 1980s which could have led to even greater vertical and horizontal transport of contaminants throughout the lithologic unit. It should be noted that water levels were not collected between February 2009 and November 2010, which represented the end of a dry period with only 4.3, 9.39, and 8.80 inches of rainfall measured in 2007, 2008, and 2009 respectively, so it is possible that very low water levels also occurred in the late 2000s.

To evaluate the hydraulic connection between the upper and lower portions of the water bearing zone within the bedrock channel, AES collected water level measurements in deep monitoring wells installed

adjacent to existing shallow monitoring wells within the bedrock channel and the downgradient portions of the plume where the bedrock channel is less defined. Vertical gradients between the five shallow and deep well pairs, 258-MW-002 and 258-MW-002D; 258-MW-004 and 258-MW-004D; 258-MW-005 and 258-MW-005D; 258-MW-006 and 258-MW-006D; and 258-MW-008 and 258-MW-008D are presented in Table 5-1. The vertical gradients indicate a slight upward gradient at the source area and in the far downgradient wells, and no vertical gradient in the 258-MW-006 and 258-MW-006D pair. The vertical gradient results suggest hydraulic connection between the upper and lower portions of the channel deposits that comprise the upper water bearing zone. Review of the vertical gradient in well pair 258-MW-004 and 258-MW-004D suggests less connection between the unconsolidated deposits water bearing zone and well 258-MW-004D, which is screened in the weathered bedrock below the channel deposits.

Seasonal and annual water-level fluctuations are observed in all wells, which are often mirrored by increases in the benzene concentration following periods of water-level increases and benzene decreases, following periods of water-level decreases (258-MW-002 and 258-MW-004; Plates 5.3 and 5.4).

Monitoring Well 258-MW-006, located in the downgradient part of the Plume, also show seasonal variations in water levels; however, benzene concentrations tend to decrease with increasing water levels possibly due to increases in water levels within the Lower Zone, which provides a dilution of the contamination (Plates 5.3 through 5.5).

Piezometric surface contours (Plate 5.6) show that groundwater flows to the southwest toward Route Tampa. Groundwater flows to the south after crossing Route Tampa.

6.0 ANALYTICAL RESULTS

This section summarizes the investigation results. Section 6.1 presents the UVOST® results and Section 6.2 presents the MIP results. Vertical groundwater contaminant profiling results are presented in Section 6.3. Section 6.4 presents the analytical results for soil sampling, and Section 6.5 presents the groundwater analytical results. Section 6.6 presents the results of the physical test analyses.

6.1 UVOST® Results

The UVOST® profile results for the Source Area and the Downgradient Area are presented below.

6.1.1 Source Area Results

UVOST® locations in the source area were drilled to maximum depths ranging from 42 to 58 feet bgs (Appendix A). UVOST® boring locations are presented on Plate 4.2. UVOST® analytical results are presented on Table 6.1 UVOST® survey locations U-1 and U-4 are located north of the source area. No detections of free/residual product were detected during profiling of these locations, indicating that the extent of free/residual product is defined and is not present to the north of the source area. The UVOST® profile locations in the far east-northeast portion of the source area (U-33, U-37, and U-39) also did not show evidence of free/residual product, indicating that the extent of free/residual product is defined and not present to the east of the source area.

UVOST® locations U-24, U-26, U-32, and U-34 showed evidence of residual product in limited zones, primarily located between 28 and 30 feet bgs and between 27 and 39 feet bgs.

All of the UVOST® locations south and west of 258-NW-001 and 258-MW-10B had detections of free/residual product. The free/residual product in this area typically was found in multiple zones and ranged in depth from about 15 to 55 feet. Free/residual product zones south of 258-NW-001 and 258-MW-10B indicated free/residual product was present in the unsaturated zone (16 to 17 feet bgs, and 22 to 28 feet bgs), the smear zone (27 to 43 feet bgs), and below the lowest measured water levels (45 to 50 feet bgs).

Comparison of the lithologic log of 258-MW-002D with adjacent UVOST® location U-23 shows that the high UVOST® signal readings between 25 and 27 feet correspond to a sandy lean clay and the high UVOST® readings between 37 and 45 feet correspond to a well-graded sand. PID readings ranged from 3,443 to 4.450 parts per million (ppm) within the well-graded sand. (Plate 6.1).

6.1.2 Downgradient Results

The UVOST® locations along transect 1 (U-1-2 through U-1-6) had detections of free/residual product within the center of the plume, with the highest detections (percent RE up to 65%) identified in locations U-1-3 and U-1-5. Free/residual product was detected both at the water table (approximately 30 feet bgs) and between 45 and 50 feet bgs in U-1-3, U-1-5, and U-1-6. Low detections of free/residual product (up to 8% RE) were detected in U-1-4 at the water table and at 50 feet bgs. No free/residual product was identified in U-1-2. Comparison of the lithologic log of 258-SB-004 with adjacent UVOST® location U-1-5 shows that the highest UVOST® signal readings, between 32 and 35 feet bgs correspond to a sandy lean clay (Plate 6.2). A UVOST® reading spike at 37 feet corresponds to a silty sand, and a smaller spike at 43 to 45 feet bgs corresponds to a well-graded sand (Plate 6.2).

UVOST® locations along transect 2 (U-2-3 through U-2-6) were drilled to further define the extent of free/residual product downgradient of transect 1. Free/residual product was detected below 20% RE at the water table in U-2-4 and U-2-5. No free/residual product was identified in U-2-3 or U-2-6, or in the lower part of the water bearing zone in the locations surveyed on transect 2.

UVOST® locations along transect 3 (U-3-2 through U-3-6) had detections of free/residual product in locations U-3-3 and U-3-4, at the water table in U-3-4, and below the water table in U-3-3. Review of the lithologic log from 258-SB-005, installed adjacent to UVOST® location U-3-3 shows a correlation of elevated UVOST® readings at 38 to 42 feet bgs with a lean clay and sandy lean clay. An additional spike in the UVOST® readings correlate with a sandy silt at 46.5 feet (Plate 6.3).

In summary, the UVOST® data collected from 1-2, 2-3, 2-6, 3-2, and 3-5 did not indicate the presence of free/residual product. These results likely represent the locations of the edges of the plume, and also correspond to the edges of the bedrock channel previously identified at the Site (*Harding ESE, 2002*).

6.2 MIP Results

AES conducted a MIP investigation in order to collect continuous VOC soil and groundwater data from the Site to better define the width and length of the groundwater plume. Boring Locations are presented on Plate 2.4 and analytical results are presented on Table 6.2.

The MIP logs present PID and FID readings interpreted to be above background conditions, with readings above background, likely representing the presence of VOCs in either groundwater or soil. PID readings varied from less than 0.15 microvolts (μV) (which appears to represent background conditions within the

borings) to over 11 μV x10^6. The FID readings ranged from less than 0.15 to over 9 μV x10^6. The higher readings likely represent areas with higher VOC concentrations, and the lower readings likely represent areas with lower VOC concentrations. A brief summary of the results is presented below.

Transect 3 was designed to better define the width of the plume and confirm there are no additional unknown flow paths with impacted groundwater. MIP locations M-3-1 and M-3-8 identified the edges of the bedrock channel. Location M-3-1 had minor PID and FID readings of 0.31 and 0.34 μV x10^6, respectively, at 12 feet bgs. The location was terminated at 14 feet bgs, which may be the point of contact with bedrock. Location M-3-8 did not have any detections of VOCs above PID and FID background readings within the boring.

Transect 4 was designed to better define the width of the plume where the plume appears to turn from a southwesterly path to a southerly direction, and expands both to the east and west based on historical HydroPunch™ data. Location M-4-1 had minor PID and FID readings (0.31 and 0.26 μV x10^6) at 10.5 feet bgs, from 48 to 50 feet bgs, and below 56 feet bgs. Location M-4-3 had moderate PID and FID readings of 5.61 and 4.81 μV x10^6, respectively, from 17 to 28 feet bgs, and high PID and FID readings at maximum detections of 11 and 9.6 μV x10^6, respectively, from 31 to 35 feet bgs and 45 to 50 feet bgs. The EC reading associated with the moderate and high PID and FID detections in M-4-3 was lower for these borings, indicating more coarse-grained materials were present in these locations. Locations M-4-8, M-4-12, and M-4-14 had minor FID and PID readings when compared to background within the boring. The MIP results indicate that VOCs are present both at the water table and below the water table within the lower portion of the hydrostratigraphic unit in the vicinity of transect 4. Review of the lithologic log for 258-SB-003 shows that the highest PID and FID readings detected at M-4-3 during the MIP survey correspond to a well-graded sand with clay at 31 to 33 feet. Elevated MIP readings at about 44 feet correspond to a sility sand and well graded sand with clay (Plate 6.4).

Transect 5 is downgradient of monitoring well 258-MW-006 and was designed to better define the width of the plume and to confirm there are no additional flow paths with impacted groundwater. Location M-5-6 had moderate PID and FID readings of 2.8 and 1.03 μV x10^6, respectively, from 44 to 47 feet bgs, which was the maximum depth of the boring at this location. Location M-5-9 had PID and FID detections of 0.85 and 0.89 μV x10^6, respectively, from 51 to 53 feet bgs, the maximum depth of the of the boring at this location. The EC reading associated with the PID and FID detections in M-5-6 and M-5-9 was lower, indicating more coarse-grained materials were present in these locations. Locations M-5-1, M-5-3, M-5-12, and M-5-14 had minor FID and PID readings; primarily near the bottom of the

borings. The MIP results confirm that the highest VOC concentrations are in the center of the plume, and that VOCs are likely to be present in the center and on the edges of the plume within the lower portion of the water bearing zone.

Transect 6 extends downgradient of monitoring well 258-MW-006 to 258-MW-008. The transect was selected to better define the length of the plume. Location M-6-1 had moderate PID and FID detections at a maximum detection of 5.56 and 4.16 μV x10^6, respectively, from 36 to 59 feet bgs, the maximum depth of the boring at this location. Location M-6-5 had moderate PID and FID detections with maximum detections of 3.11 and 10.82 μV x10^6, respectively, from 31 to 33 feet bgs. Location M-6-4 had maximum PID and FID detections of 0.70 and 0.79 μV x10^6, respectively, between 40 feet and 46 feet bgs; location M-6-6 had maximum detections of 1.42 and.82 μV x10^6, respectively, at 29 feet bgs; and location M-6-7 had maximum detections of 0.48 and 0.49 μV x10^6, respectively at 32 feet bgs. The EC readings associated with the PID and FID detections were lower for these locations, indicating more coarse-grained materials were present. Locations M-6-8, M-6-10, and M-6-12 had minor PID detections. Based on the maximum depths that could be achieved before refusal along transect 6, a bedrock high appears to be located in the area of M-6-6 through M-6-8. The MIP results indicate that VOCs are present in both upper and lower portions of the water bearing zone along transect 6. Soil boring 258-SB-001 was drilled adjacent to MIP location 6-1 to correlate MIP results with lithology and to further evaluate the potential for contamination downgradient of 258-MW-006. Review of the MIP log and the lithologic log indicate that the elevated MIP readings correlate with a well-graded sand unit. A spike in the MIP results at 50 feet appears to correlate with grayish green clay nodules present at 50 feet bgs. PID readings taken from soil samples during drilling were elevated between 45 and 50 feet which corresponds to a moderate increase in the MIP readings (Plate 6.5).

Transect 7 extends downgradient of transect 5 to monitoring well 258-MW-005. MIP measurements were collected to define the flow paths east of what appears to be a bedrock high identified during a previous HydroPunch™ investigation (*Harding ESE, 2002*). Locations M-7-1 and M-7-4 had PID and FID detections from 51 to 54 feet bgs and 44 to 45 feet bgs, respectively, the maximum depths of these two borings. The EC readings associated with the PID and FID detections in M-7-1 and M-7-4 were lower, indicating more coarse-grained materials were present in this location. The MIP results indicate that VOCs are likely to be present in the lower portion of the hydrostratigraphic unit on the eastern side of the plume. Based on review of comparison of MIP location M-7-4 with 258-MW-005D, the elevated MIP reading at 38.5 feet corresponded to a silty sand and the elevated reading at 45 feet corresponded to a well-graded sand (Plate 6.6).

Transect 8 extends downgradient in the southern part of the plume to further define the flow paths and potential bedrock high between wells 258-MW-005 and 258-MW-008. Location M-8-1 had minor elevated PID and FID readings between 23 and 31 feet bgs. PID and FID readings at location M-8-3 did not indicate the presence of VOCs above background readings within the boring. The maximum depths of these locations were 32 and 33 feet bgs, respectively, which likely indicates a bedrock high in this area of the Site.

Transect 9 extends perpendicular towards the east from the midpoint of transect 7, and was designed to further define the southeastern extent of the plume. The MIP data collected from Location M-9-2 indicates the potential presence of VOCs from 52 to 58 feet bgs.

6.3 Vertical Groundwater Profiling Results

6.3.1 Vertical Groundwater Profiling Analytical Results

Vertical profile groundwater samples were collected by AES from five previously existing monitoring wells and analyzed for BTEX to determine if there is a vertical distribution to groundwater contamination and to insure that existing and proposed wells are screened at intervals that will provide an accurate representation of groundwater contaminant conditions.

Table 6-3 presents the vertical profiling BTEX analytical results. Wells 258-MW-002, 258-MW-004, 258-MW-006, 258-MW-007, and 258-MW-008 were all sampled on January 27, 2011. None of the BTEX compound were detected above laboratory reporting limits in samples collected from 258-MW-007 and 258-MW-008. Benzene results for the remaining three wells were as follows:

- **258-MW-002** – Benzene was detected at 6,510 micrograms per Liter (µg/L) in the shallowest sample (36 feet), 29,600 µg/L in the 42 feet sample, and 24,800 µg/L in the 48 feet sample.

- **258-MW-004 –** Benzene was detected at 3,880 µg/L in the shallowest sample (32 feet), 4,020 µg/L in the 37 feet sample, 3,900 µg/L in the 42 feet sample, and 3,900 µg/L in the 48 feet sample.

- **258-MW-006 –** Benzene was detected at 6,480 µg/L in the shallowest sample (32 feet), 11,400 µg/L in the 37 feet sample, and 12,800 µg/L in the deepest sample (42 feet).

6.3.2 Vertical Profiling Conclusions

The vertical profiling data indicate that the highest benzene concentrations are present in the deeper portion of the screen interval in monitoring wells 258-MW-002 and 258-MW-006. Benzene concentrations in 258-MW-004 show only minor variations across the monitored screen interval. Review of the detected concentration with geology of the screened material showed lower concentrations in samples collected from fine-grained portions of the screened interval in 258-MW-002, 258-MW-004, and 258-MW-006. The highest concentrations were detected in samples taken from the deeper coarser grained material (well-graded sands and gravels).

6.4 Soil Sampling Results

Eleven soil samples were collected and analyzed for one or more organic parameters, nine primary and one duplicate soil samples were collected and analyzed for inorganic parameters. Saturated soil samples were collected tested for physical properties from five borings and two monitoring wells. Analytical results from the soil samples are presented on Table 6.4. Soil sample analytical results for organic and inorganic parameters were subject to a Level 3 data review as designated in the QAPP. The Level 3 data review included a cursory review for compliance with laboratory reporting limits, evidence of contamination, and compliance with minimum laboratory QC limits. Ten percent of the samples were subject to a Level 4 data review. All data was considered usable. Section 6.4.2 summarizes the details of the data validation. No quality issues were identified during the data review.

6.4.1 Organic Soil Results

Analytical results for organic parameters (select VOCs [BTEX, MTBE, and TBA], TPH-GRO, TPH-DRO, and TPH-MO) for soil samples collected in soil borings and monitoring wells are presented in Table 6-4 and discussed below.

6.4.1.1 TPH-GRO, TPH-DRO, and TPH-MO Soil Analytical Results

Eleven soil samples were collected, one each from 258-SB-002, 258-SB-004, 258-SB-005, and 258-MW-004D, two from 258-SB-001 and 258-MW-002D, and three from 258-SB-001. Soil samples from borings, 258-SB-001 through 258-SB-005, and 258-MW-002D and 258-MW-004D were analyzed for TPH-GRO and selected VOCs. One sample collected at 78 feet bgs in 258-SB-001 was also analyzed for TPH-DRO, and TPH-MO. The results are described below:

- TPH-GRO was detected in seven of the 11 soil samples. The highest concentration was detected in the 41 foot sample from 258-MW-002D at 2,890 mg/kg. The lowest concentration was detected at 0.133 mg/kg in the 76 feet bgs sample from 258-SB-003. TPH GRO was detected above 100 mg/kg in 258-SB-003 (39 feet bgs), 258-SB-004 (54 feet), 258-SB-005 (41 feet), 258-MW-002D (27 feet bgs), and 258-MW-004D (37 feet bgs):

- TPH-DRO was not detected in the 78 foot sample at 258-SB-001 (only sample analyzed for TPH DRO); and

- TPH-MO was below the laboratory reporting level of 20 mg/kg in the one soil sample it was collected (258-SB-001: 78-feet).

6.4.1.2 VOCs (BTEX, MTBE, and TBA) Soil Analytical Results

Five of the eight soil samples analyzed for BTEX, TBA, and MTBE had one or more compound detected. BTEX, MTBE, and TBA were below the laboratory reporting limits in the soil samples collected from 258-SB-001, 258-SB-002, and the 27-feet sample from 258-MW-002D (Table 6.4). VOC compounds were detected in the following samples:

- 258-SB-003 (39-feet) – Ethylbenzene was detected at an estimated concentration of 4,410 micrograms per kilogram (µg/kg).

- 258-SB-004 (54-feet) – Toluene, ethylbenzene, and total xylenes were detected at 1,870; 14,200; and 84,300 µg/kg respectively.

- 258-SB-005 (41-feet) – Benzene, toluene, ethylbenzene, and total xylenes were detected at 2,820; 15,900; 25,800; and 145,000 µg/kg, respectively.

- 258-MW-002D (27-feet) – BTEX was not detected in this sample; however the detection limits were raised due to elevated TPH-GRO concentrations.

- 258-MW-002D (41-feet) – Toluene, ethylbenzene, and xylenes were detected at 11,900; 73,400; and 391,000 µg/kg, respectively.

- 258-MW-004D (35.5-feet) – Toluene, ethylbenzene, and total xylenes were detected at 4,900; 4,220; and 22,500 µg/kg, respectively.

6.4.1.3 Soil Organic Analyses Conclusions

The analytical results indicate TPH-GRO is present within soil in the source area both above the water table (258-MW-002D at 27 feet), and below the water table (258-MW-002D at 41 feet). TPH-GRO is present in soil below the water table downgradient of the source area at depths ranging from 39 feet bgs at 258-SB-003 (1,290 mg/kg) to 54 feet bgs at 258-SB-004 (754 mg/kg). The highest concentrations were detected in well-graded sands; however, TPH-GRO was also detected at 1,290 mg/kg within a clay sample at 41 feet bgs in 258-SB-005 (just west of Route Tampa). TPH-GRO was not detected in the 258-SB-001 or 258-SB-002 (two furthest downgradient samples). TPH GRO was detected at 0.133 mg/kg within the siltstone bedrock at 76 feet 258-SB-003.

Toluene, ethylbenzene, and xylenes were detected in 258-MW-002D, 258-MW-004D, 258-SB-004, and 258-SB-005. Benzene was detected in one sample from 258-SB-005 (within clay). Only ethylbenzene was detected in 258-SB-003; however, the detection limits were raised for the other VOCs.

The results suggest that hydrocarbons are generally present below the average water table depth downgradient of the source area and extend from about 38 feet to almost 60 feet bgs in samples collected northeast of Route Tampa. Organic compounds were not detected in soil samples collected south of 258-MW-006.

6.4.2 Inorganic Soil Results

Sampling for inorganic parameters, TOC, COD, and Title 22 metals, was performed to support the preparation of the remedial design. Results are summarized below, and presented in Table 6.5.

- **TOC** - Detected at 1,080 mg/kg in 258-MW-2D at 41 feet, and at 7,450 mg/kg in 258-SB-001. It was not detected in samples from 258-SB003, 258-SB-004, and 258-SB-005.

- **COD** - Detected in nine of ten samples at concentrations ranging from 282 to 1,280 mg/kg. The highest COD was measured in 258-MS-002D.

- **Title 22 Metals** - Twelve metals were detected in three samples; 11 metals were detected in one sample, 10 metals were detected in five samples; and eight metals were detected in one sample. The highest detected concentration for each metal was as follows:

    - **Arsenic** – 6.8 mg/kg in 258-SB-004 (54-feet);

- **Barium -** 160 mg/kg in 258-SB-001 (64-feet);
- **Cadmium** – 4.0 mg/kg in 258-SB-003 (46-feet);
- **Chromium** – 30.7 mg/kg in 258 –SB-001 (64-feet);
- **Cobalt** – 3.5 mg/kg in 258-MW-002D (27-feet);
- **Copper -** 9.6 mg/kg in 258—SB-001 (64-feet);
- **Iron** – 9,550 mg/kg in 258-SB-004 (54 feet);
- **Lead** – 10.4 mg/kg in 258-SB-004 (37 feet);
- **Molybdenum** – 5.6 mg/kg in 258-SB-001 (64-feet);
- **Nickel** – 15.6 mg/kg in 258-SB-003) (46-feet);
- **Vanadium** – 29.5 mg/kg in SB-258-003 (46-feet);
- **Zinc –** 31.3 mg/kg in 258-MW-002D (27-feet); and
- **Mercury –** 0.096 mg/kg in 258-MW-002D (27-feet).

Ten soil samples were tested for physical properties, which included intrinsic permeability, hydraulic conductivity, total porosity, air-filled porosity, dry bulk density, volumetric moisture content, and fraction organic carbon. In addition, two soil samples were also analyzed by X-Ray diffraction analyses and Water/LNAPL relative permeability Physical testing results are presented in Table 6.6 and summarized in Section 6.6.

6.4.2.1 Soil Inorganic Analyses Conclusions

The results of the inorganic analyses in conjunction with the organic analyses and other data will be used in evaluation of the remedial design. The metals data were all at or below background values with the exception of barium and molybdenum which were detected at concentrations of 160 and 5.8 mg/kg, respectively in the 64 feet sample in boring 258-SB-001, which is above the San Antonio River Basin Eastern Flank background levels of 150 and non detect at 0.83 mg/kg (Background threshold estimated as

minimum detection limit), respectively (*Appendix B, HLA, 1995*). The metals data does not suggest additional sources at the site.

6.4.3 Summary of Soil Data Quality Assessment

The equivalent of an EPA Level III data review was performed on 100% of the sample results and the equivalent of an EPA Level IV data review was performed on approximately 10% of the sample results. Soil samples were collected between June 7th and June 29th, 2011 as part of the Fort Hunter Liggett Building 258 Site Investigation, and submitted under chain of custody (COC) to Accutest. Data validation was performed to confirm the integrity and reliability of the field and laboratory data generated during this sampling event. The equivalent of an EPA Level III data review was performed on 100% of the sample results and the equivalent of an EPA Level IV raw data review was performed on approximately 13% of the sample results. Level III and IV data review was performed in accordance with the following guidelines:

- *The Quality Assurance Project Plan Building 194 Groundwater Studies, Fort Hunter Liggett California* (MACTEC, 2010).
- The principles presented in the USACE *Guidance for Evaluation Performance Based Chemical Data*, June 30, 2005.
- Individual analysis methods: SW-846 Methods 8260B, 8015B and 6010B.

The Level III review was performed using Laboratory Data Consultants, Inc.'s Automated Data Review (ADR) program, with manual review of initial and continuing calibration files for each test method. Accutest has been certified through the Department of Defense Environmental Laboratory Accreditation Program (DOD ELAP) and maintains accreditation through the State of California for the National Environmental Laboratory Accreditation Conference (NELAC). Appendix E of this report presents a Quality Control Summary Report (QCSR) for the monitoring period. The following is a summary of the data validation findings.

6.4.3.1 Level III and IV Validation Results

The Level III and Level IV data validation of sample results identified the following data quality issues:

- TPH-GRO by EPA Test Method 8260B - The data review revealed that project samples and quality control (QC) parameters met acceptance criteria.

- BTEX, MTBE and TBA by EPA Test Method 8260B- The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:

  - The recovery of the surrogate 4-bromofluorobenzene in sample 11235G258005F was below the 85-120% acceptance criteria at 82%. The results for TPH-GRO in this sample was qualified as estimated (J-) with a possible low bias.

  - TBA had a RL of 40 ug/kg with results reported down to a MDL of 10 ug/kg. The RL and MDL were both above the practical quantitation limit (PQL) limit of 5 ug/kg specified in the QAPP. Non-detect results for TBA do not support the PQL specified in the QAPP.

- TPH-DRO and TPH-MO by EPA Test Method 8015B (mod) - The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:

  - TPH-DRO had a reporting limit of 10 mg/kg with results reported down to a MDL of 5 mg/kg. The RL and MDL were both above the PQL limit of 1 mg/kg specified in the QAPP. Non-detect results for TPH-DRO do not support the PQL specified in the QAPP.

- Title 22 Metals by EPA Test Method 6010B/7471A and Total Iron by EPA Test Method 6010B - The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:

  - The recoveries for antimony in matrix spike/matrix spike duplicate (MS/MSD) sample pair C16487-1 MS/MSD were below the 80-120% acceptance range at 51/51% and the MS recoveries for barium and silver were below the acceptance ranges at 76% and 78%, respectively. Associated samples were reported as non-detect for antimony and silver, therefore the results for these analytes in samples 11235G258001F, 11235G258002F, 1123SG258008F and 1123SG258009F were qualified as estimated (UJ). Detected results for barium in samples 11235G258001F, 11235G258002F, 1123SG258008F and 1123SG258009F were qualified as estimated (J-) with a possible low bias.

  - The recoveries for antimony in MS/MSD sample pair C16486-1MS/MSD were below the 80-120% acceptance range at 52/48%. Associated samples were reported as non-detect for

antimony, therefore the antimony results for samples 1123SG258013D, 1123SG258013F and 1123SG258015F were qualified as estimated (UJ).

- The recoveries for antimony in MS/MSD sample pair C16562-1MS/MSD were below the 80-120% acceptance range at 34/33% and the MS recovery for molybdenum was below the acceptance range at 79.8%. Associated samples were reported as non-detect for antimony and molybdenum, therefore the results for these analytes in samples 1124SG258017F and 1124SG258019F were qualified as estimated (UJ).

- The recoveries for mercury in MS/MSD sample pair C16562-1 were outside of the 80-120% acceptance range at 75/124%. The relative percent difference (RPD) between the MS and MSD was above the 20% acceptance criteria at 35%. Therefore the results for mercury in associated samples 1224SG258017F and 1124SG258019F were qualified as estimated, (J) and (UJ) respectively.

- Serial dilution sample MP-3597SD1 had a percent difference (%D) for molybdenum above the 0-10%D control limit at 15.2%. Associated non-detect results for molybdenum for samples 11235G258001F, 11235G258002F and 1123SG258008F were qualified as estimated (UJ).

- The RPD for the field duplicate samples collected from 1123SG258013F did not meet the 30% RPD acceptance criterion for the following detected analytes:

Sample ID	Analyte	Primary	Duplicate	Units	RPD	RPD Limit
1123SG258013F	Chromium	5.5	7.9	mg/kg	**36**	30
	Lead	10.4	3.4	mg/kg	**101**	30
	Nickel	5.3	7.4	mg/kg	**33**	30

The analysis of the field duplicate samples is a measure of both field and analytical precision. Since the effect on the quality of the data is unknown, data have not been qualified as a result of high RPDs in the field duplicates.

- The following laboratory RLs do not support the PQLs specified in the QAPP:

Analyte	RL	QAPP PQL	Units
Antimony	2	0.5	mg/kg
Arsenic	2	0.25	mg/kg
Barium	20	0.25	mg/kg
Beryllium	1	0.1	mg/kg

Analyte	RL	QAPP PQL	Units
Cadmium	1	0.25	mg/kg
Chromium	1	0.25	mg/kg
Cobalt	1	0.25	mg/kg
Copper	2.5	0.25	mg/kg
Lead	2	0.25	mg/kg
Molybdenum	2	0.25	mg/kg
Nickel	1	0.25	mg/kg
Selenium	2	0.5	mg/kg
Silver	1	0.25	mg/kg
Thallium	2	0.5	mg/kg
Vanadium	1	0.25	mg/kg
Zinc	2	1	mg/kg
Mercury	0.042	0.02	mg/kg

Non-detect results for the analytes listed above do not support the PQL specified in the QAPP. Sample results were not qualified based on the raised reporting limits.

- COD by SM19 5220C (mod) - The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:
  - COD had a reporting limit of 200 mg/kg. The RL was above the PQL limit of 10 mg/kg specified in the QAPP. Non-detect results for the analytes listed above do not support the PQL specified in the QAPP. Sample results were not qualified based on the raised reporting limits.
  - The RPD for the field duplicate samples collected from 1123SG258013F did not meet the 30% RPD acceptance criterion for COD:

Sample ID	Analyte	Primary	Duplicate	Units	RPD	RPD Limit
1123SG258013F	COD	367	570	mg/kg	**43**	30

The imprecision in the results between field duplicate pairs may be due to the sample matrix, sampling or laboratory technique, or method defects. Since the effect on the quality of the data is not known, data is not qualified for field duplicate failures.

- Total Organic Carbon by EPA Test Method 9060A (mod) - The data review revealed that project samples and QC parameters met acceptance criteria.

6.4.3.2 Data Validation Summary

Non-detect results for TBA by EPA Test Method 8260B, Metals by EPA Test Method 6010B and 7471A, TPH-DRO by EPA Test Method 8015B (mod), and COD by SM19 5220C (mod) were reported at RLs that do not support the PQLs specified in the QAPP. Although the results did not meet the PQLs specified in the QAPP, the data meet the requirements for use of the data to develop a remedial design. Sample results were not qualified based on the raised reporting limits.

Data validation qualification of results reported by the laboratory were required for multiple metal analytes of nine samples due to MS/MSD outliers, for the COD results of two samples due to MS/MSD outliers, for the TPH-GRO result of one sample due to surrogate recovery outliers and for the molybdenum result of three samples due to serial dilution outliers. Estimated sample results (J/UJ) are usable, as qualified for limited purposes only. Based upon the Level III and Level IV data validation, the data are considered usable as reported by the laboratory with qualifiers applied as described in this report.

6.5 Groundwater Sampling Results

The six newly installed wells (258-MW-002D, 258-MW-004D, 258-MW-005D, 258-MW-006D, 258-MW-008D, and 258-MW-015), and 14 existing wells and piezometers were sampled by AES between July 12 and 14, 2011. The samples were collected and analyzed to provide baseline data for future sampling events, provide data for further delineation of the extent of the groundwater plume, and to further define and characterize existing source areas. The samples were analyzed for organic parameters (TPH-GRO, TPH-DRO and BTEX, TBA, and MTBE).

6.5.1 Groundwater Results

Analytical results for groundwater samples collected by AES in July from the 14 existing monitoring wells and six new monitoring wells are presented in Table 6.5; Detected benzene concentrations are presented on Plate 6.7.

6.5.1.1 TPH-GRO and TPH-DRO Groundwater Analytical Results

TPH-GRO was detected in samples from 12 of the 20 monitoring wells at concentrations ranging from 106 µg/L (258-MW-004D) to 119,000 µg/L (258-MW-002).

TPH-DRO was detected in 10 of the 20 monitoring wells at concentrations of 221 µg/L (258-PZ-002) to 237,000 µg/L (258-NW-001)

6.5.1.2 VOCs Groundwater Analytical Results

Groundwater samples from 13 of the monitoring wells had one or more VOC compound detected. VOCs were not detected in 258-MW-003 (furthest upgradient well), 258-MW-005, 258-MW-005D, and, 258-MW-008 (downgradient sentinel wells), 258-MW-10B (source area bedrock well), 258-MW-007 (cross-gradient well) and, 258-MW-002D (deep source area well). Detected benzene concentrations summarized below. Benzene is considered an indicator chemical at the Site.

Existing Monitoring Wells With Benzene Detections

- **258-NW-001** – Benzene was detected at 7,090 µg/L. Toluene, ethylbenzene, and total xylenes were also detected.
- **258-MW-002** – Benzene was detected as 38,900 µg/L. Toluene, ethylbenzene and total xylenes were also detected.
- **258-MW-004** – Benzene was detected at 3,820 µg/L. Toluene, ethylbenzene and total xylenes were also detected.
- **258-MW-006** – Benzene was detected at 613 µg/L. Toluene, ethylbenzene, and total xylenes were also detected.
- **258-MW-009** – Benzene was detected at an estimated concentration of 0.94 µg/L. Toluene, ethylbenzene, and total xylenes were also detected.
- **258-MW-014** – Benzene was detected at 6,050 µg/L. Toluene, ethylbenzene, and xylenes were also detected.
- **258-PZ-001** –Benzene was detected at 1,030 µg/L. Toluene, ethylbenzene, and total xylenes were also detected.
- **258-PZ-002** – Benzene was detected at 490 µg/L. Toluene, ethylbenzene, and total xylenes were also detected.

- **258-IN-012** – Benzene was detected at 8,400 µg/L. Toluene, ethylbenzene, and total xylenes were also detected.

New Monitoring Wells With Benzene Detections

- **258-MW-004D –** Benzene was detected at a concentration of 0.49 µg/L; MTBE and TBA were detected at 52.8 and 129 µg/L, respectively. Ethylbenzene was detected at an estimated concentration of 0.39 µg/L.

- **258-MW-006D –** Benzene was detected at 1,420 µg/L. Toluene, ethylbenzene, and total xylenes were also detected.

- **258-MW-008D –** Total xylenes were detected at an estimated 0.75 µg/L.

- **258-MW-015 - Benzene** was detected at 3,980 µg/L Toluene, ethylbenzene, and total xylenes were detected.

6.5.1.3 VOC Groundwater Analytical Conclusions

The results of the sampling conducted in July 2011 indicate the following:

- Groundwater sampling in the source area confirm the historic data that bounded the source area in the upgradient direction by 258-MW-003 (non-detect for VOCs), that the highest BTEX concentrations are found near Building 258 (258-NW-001 and 258-MW-002) and that bedrock (258-MW-10B) is not impacted in the source area.

- Analytical results from 258-MW-002D were non detect for BTEX, suggesting the in the source area, contamination is present in groundwater above the 258-MW-002D screen interval (65 to 85 feet bgs).

- Elevated BTEX is present in wells installed along the axis of the plume downgradient to 258-MW-006.

- Non-detect results, with the exception of a total xylenes detection at less than 1 µg/L in 258-MW-008D, indicate that the hydrocarbons attenuate between 258-MW-006 and the sentinel wells (258-MW-005, 258-MW-005D, 258-MW-007, 258-MW-008, and 258-MW-008D).

- Groundwater samples collected from 258-MW-004D (screened within the fractured bedrock) had detections of TPH-GRO, benzene, ethylbenzene, MTBE, and TBA indicating possible impacts to shallow bedrock downgradient of the source area.

- Groundwater samples collected from 258-MW-006D suggest that the hydrocarbon contamination extends below the screen interval of 258-MW-006 and that concentrations are higher in the deeper portion of the unit (258-MW-006D screen interval).

6.6 Physical Testing Results

Physical testing results for soil samples collected from soil borings and monitoring wells are presented in Table 6.6 and are summarized below.

- **Dry Bulk Density** – Ranged from 0.81 grams per cubic centimeter (g/cc) to 1.84 g/cc. The highest bulk densities were measured for silty sands. The lowest bulk densities were measured in clays.

- **Fraction Organic Carbon** – The fraction organic carbon ranged from non-detect at 0.0001 grams per gram (g/g) to 00172 g/g. The highest fraction organic carbon was measured in a clay.

- **Volumetric Moisture Content –** The volumetric moisture content varied from 0.109 to 0.486 cubic centimeters per cubic centimeter ($cm^3/cm^{3)}$. The highest moisture content was measured in 258-SB-001 in a clay collected at 62 feet bgs.

- **Total Porosity - Total** porosity varied from 33.7% measured in 258-SB-003 within a well graded sand with clay to 65.9% measured in 258-SB-001 in a clay.

- **Native Hydraulic Conductivity to Water –** Hydraulic conductivity was measured from 4.50 x 10^{-3} centimeters per second (cm/s) within 258-SB-003 (well-graded sand) to 1.44 x10^{-6} cm/s within 258-MW-004D (clay).

Samples logged as well graded sands with clay or silt had hydraulic conductivities in the 10^{-5} range.

The measured hydraulic conductivity values are lower than typically expected for sands and likely result from the poorly sorted nature of the deposit. The hydraulic conductivity of the deposits along with the other physical test data are important parameters for evaluation of the feasibility of remedial alternatives

including injection and extraction technologies. Injection and extraction technologies are generally less effective in low permeability zones.

The hydraulic conductivity results and other physical testing results will be used in conjunction with the other site characterization data in evaluating the remedial alternatives.

6.7 Geophysical Survey Results

The geophysical survey results are discussed below in two sections.

Underground Utilities

Underground utilities for water, electrical, communication/fiber optic, sanitary sewer, unknown lines, and possible product lines were all successfully located at Building 258. Anomalies found during EM61 survey near the old USTs were determined to be rebar from reinforced concrete, which blocked view in the area. No USTs were visible to GPR.

EM Surveys

EM61 found anomalies in five sections located near and along the path of the old USTs at Building 258. The GPR later determined the anomalies were rebar from reinforced concrete. EM31 found coarser grained soil indicative of potential groundwater flow paths in two sections northeast of Building 258 and the old UST locations.

7.0 SITE CONCEPTUAL MODEL

Based on review of the data obtained during this site characterization and further review of existing data, the site conceptual model has been modified and is presented below. The first section describes the potential sources and distribution of chemicals detected in groundwater and soil. The second section describes the contaminant transport model, and the third section describes the potential for complete human health pathways.

7.1 Potential Source Areas and Distribution of Chemicals

Past activities at the Site resulted in a release of gasoline (measured in this investigation as TPH-GRO) and associated VOCs, which include BTEX and MTBE, into the soil (vadose zone) and groundwater. TPH-GRO and VOCs are the chemicals of concern at the Site.

The groundwater monitored at this Site is not used as a drinking water source; however, according to the Basin Plan of the Central Coast Regional Water Quality Control Board (CCRWQCB), all groundwater must be considered to have an actual or potential beneficial use. Therefore, the detected concentrations are compared to State of California and Federal MCLs, and any MCL exceedances are considered relative to ongoing monitoring and remedial decisions (*California Department of Public Health, 2008*). VOCs are present in groundwater at concentrations above the MCLs for drinking water. Benzene in groundwater at Building 258 ranges in concentration from non-detect to approximately 39,900 µg/L and TPH-GRO ranges from non-detect to approximately 69,000 µg/L. In February 2011, PDB sampling was employed in six wells at the Site in order to determine if there were VOC concentration changes at depth. In monitoring wells 258-MW-002 and 258-MW-006, benzene concentrations increased with depth, and the concentrations of benzene in monitoring well 258-MW-004 remained consistent. Benzene was not detected in the remaining wells located at the plume boundaries.

Concentrations of the chemicals of concern in the vadose zone indicate a significant source of contamination to groundwater remains at and near the Source. VOCs measured in soil gas from the SVE system well sampling ports located near Building 258 (Source Area, Plate 4.2) ranged in concentration from approximately 5,000 parts per billion by volume (ppbv) to 50,000 ppbv for benzene, and approximately 2,000 parts per million by volume (ppmv) to 7,000 ppmv for TPH-g. VOCs measured in soil gas at five feet bgs during a recent Army investigation at the Site ranged in concentration from

approximately 0.087 micrograms per cubic meter (µg/m^3) to 0.71 µg/m^3 (approximately 0.283 to 2.31 ppbv) for benzene.

As discussed in Section 6.1 and presented in Appendix A, the UVOST® data show there is free/residual product present at multiple depths at the Source Area ranging from 20 to at least 53 feet bgs. The free/residual product is present both at the source area and up to 800 feet downgradient of the source area. The MIP data discussed in Section 6.2 and presented in Appendix B, show similar patterns as the UVOST® data, indicating dissolved phase hydrocarbons are present at multiple depths downgradient from the free/residual product. PID readings indicating the presence of VOCs were recorded at multiple depths ranging from 10 to 59 feet bgs.

Analytical results from the soil boring program confirm the presence of VOCs and TPH-GRO in soil at depths of 27 feet (TPH GRO within a clay) and 41 feet (TPH GRO and ethylbenzene, toluene, and xylenes within a well-graded sand) at 258-MW-002D. In addition, the highest PID readings (greater than 4,000 ppm) measured during drilling are between 37 feet and 52 in Source Area boring 258-MW-002D suggesting the presence of VOCs to a depth of at least 52 feet. PID measurements from 258-MW-002D decrease from 322 ppm at 54 feet to 5.9 ppm at 57 feet. The highest PID readings correspond to well-graded sands, and clayey sands. These results suggest that VOC and TPH-GRO contamination drops off below 54 feet bgs.

Soil samples collected downgradient of the source area, and northeast of Route Tampa also contain TPH-GRO and BTEX in samples collected at 37, 41, and 54 feet bgs. The highest concentrations were detected in clay at 41 feet at 258-SB-005. These detections confirm the presence of TPH-GRO and associated BTEX within both the fine-grained silt and clay and coarse-grained sand and gravel and to depths of between about 35 and 55 feet bgs.

South and west of Route Tampa, TPH-GRO and ethylbenzene were detected at 1,290 and 4.41 mg/kg respectively, in a soil sample collected at 39 feet bgs. These results are consistent with the MIP results collected along transect line 4 and suggest potential for free/residual product as far south as MIP transect line 4. Soil samples collected south of 258-MW-006 did not have detections of BTEX or TPH-GRO indicating that source remaining in the soil decreases rapidly south of Route Tampa.

The results of the most recent groundwater sampling event, July 2011, did not detect TPH-GRO or BTEX within the 258-MW-010B (deep bedrock well at the source area); however, TPH-GRO, benzene, TBA, and MTBE were detected in 258-MW-004D, which is screened within the weathered bedrock on the edge

of the channel about 700 feet downgradient from the source area, suggesting the possibility that low concentrations of BTEX, MTBE, TBA, and TPH-GRO could be present in areas where the bedrock shallows and is in contact with the impacted unconsolidated channel deposits. It is anticipated that the contamination within the bedrock is limited laterally and vertically due to the low permeability of the unit.

7.2 Contaminant Transport Model

The primary source of petroleum hydrocarbon contamination is from former leaking USTs or conveyance piping at the Site. USTs, associated conveyance lines, and contaminated soil were removed prior to the end of 1998. Petroleum hydrocarbons were present in soil following removal of the USTs and are still present in the vadose zone as free/residual product, in soil gas, and on the surface of and below the water table as free/residual product. The presence of free/residual product below the water table is likely due to relatively large fluctuations in groundwater elevations (greater than 20 feet) that occurred during a number of drought periods that occurred between 1982, when the tanks were installed, and 2009. Review of precipitation data from King City from 1980 through 2010 shows annual rainfall ranging from a low of 4.1 inches in 1990 to a high of 26.41 inches in 1983. The gasoline UST was installed in 1982 and in use between 1982 and 1989, when it was removed following the Loma Prieta Earthquake. Although water level information is not available for the period that the UST was in use, 1982 though 1998, it is expected that the water level changes seen between 2002 and 2010 (Plate 5-2) were similar to those that may have occurred in the 1980s. The high precipitation in 1983 may have resulted in transport of leaked gasoline, as both free/residual product and dissolved phase to downgradient portions of the site.

Following the transport downgradient of the source area, decreases in groundwater levels could have allowed the free/residual product to migrate to the deeper coarse-grained zones, explaining the detections of free/residual product and PID/FID readings indicating the presence of VOCs up to 900 feet downgradient of the source area. Once dissolved into the groundwater, the movement of free/residual product is likely confined primarily to the coarser material within the bedrock channel. Although the downgradient transport of dissolved phase TPH is primarily within the sand and gravel deposits, the presence of TPH-GRO and BTEX as residual product in the finer grained silts and clays and within the sand and gravel deposits in the source area and north of Route Tampa represents a significant continuing source.

Vertical gradients were calculated between well pairs installed within the source area. The vertical gradients indicate a slight upward gradient at the source area and in the far downgradient wells, with no

measured vertical gradient in the 258-MW-006 -258-MW-006D well pair. The vertical gradient results suggest hydraulic connection between the upper and lower portions of the water bearing unconsolidated deposits. Review of vertical gradient in well pair 258-MW-004 and 258-MW-004D suggests less connection between the water bearing unconsolidated deposits and the bedrock. 258-MW-004D is screened in the weathered bedrock below the channel deposits. The water bearing unconsolidated deposits are underlain by bedrock predominantly composed of weathered and fractured siltstone and mudstone with minor sandstone and conglomerate. North of Route Tampa, geophysical survey and soil boring data suggest that the water-bearing deposits are confined to a relatively narrow bedrock channel that runs roughly north to south (*Harding ESE, 2002*). South of Route Tampa, groundwater levels become shallower toward the San Antonio flood plain, following the topographic slope. Geophysical survey and soil boring data indicate the bedrock channel deepens, and groundwater flow gradients flatten out in the flood plain and split due to a bedrock high between monitoring wells 258-MW-005 and 258-MW-008.

7.3 Analysis of Potential Receptors

The primary source of groundwater contamination at the Site was likely a release of petroleum hydrocarbons to soil. The primary transport mechanisms include volatilization, and leaching to groundwater. Exposure mechanisms include air, contact with soil, and groundwater. Potential onsite receptors are limited to construction workers and onsite workers. As described in Section 3.2, the USTs and contaminated soil were removed at the identified locations. Contact with contaminated soil is not anticipated unless excavation activities in the source areas occur; therefore, the soil exposure pathways are considered incomplete. Groundwater exposure pathways are also considered incomplete because the groundwater is not used by human receptors and no use of this shallow groundwater is expected in the future. The soil vapor exposure pathway through inhalation of indoor air containing contaminants could potentially be considered complete; however, in December 2010 a vapor intrusion study and risk evaluation were conducted at the Site that indicated unacceptable cancer risks and non-cancer hazards associated with exposure to COCs in the samples collected as part of the study are not expected for either the residential land use exposure scenario or lesser-exposed scenarios (workers, visitors, part-time occupants, trespassers, etc.) (*USACE, 2011*).

8.0 CONCLUSIONS AND RECOMMENDATIONS

Section 8.1 presents the conclusions and recommendations related to the site characterization; Section 8.2 identifies aspects of the results that may impact the remedial design.

8.1 Conclusions and Recommendations

8.1.1 UVOST® and MIPS

Conclusions

- UVOST® locations in the source area and downgradient portion of the plume indicate the presence of free/residual product below the water table. Comparison of UVOST® results with lithologic logs indicates that above the water table and in the shallow portion of the water bearing unit, elevated UVOST® results correlate with clays and silts. Within the deeper portion of the unit, the elevated UVOST® results generally correlate with well-graded sands.

- MIP locations at the downgradient portion of the plume identified elevated PID and FID readings in lithologic units that are deeper than the screened intervals of network monitoring wells. Review of soil boring logs and corresponding PID readings indicated that the lateral and vertical extent of VOCs in the downgradient portion of the plume did extend below the screened interval of the previously existing network monitoring wells. This was also confirmed by the detection of benzene and TPH-GRO in groundwater samples collected from 258-MW-006D, which is screened from 47 to 57 feet bgs, Review of MIP results, soil boring logs and soil analytical results indicates that soil is impacted down to a maximum of about 60 feet bgs. Correlations of the UVOST® and MIP results with lithology were evaluated based on comparison of the UVOST® and MIP results to the soil borings. In general, free/residual product zones correspond to finer grained units; however, free/residual product was also detected below 40 feet in a well-graded sand. In general, MIP results compared to soil borings indicate the highest PID and FID readings correspond to well-graded sands.

Recommendations

Collect additional hydraulic conductivity data primarily north of Route Tampa to compare to MIP and UVOST® data to determine the impacts of hydraulic conductivity on the distribution of free/residual product and to aide in preparation of a remedial design.

8.1.2 Groundwater Sampling- Vertical Profile Results

Conclusion

The groundwater profile results indicate the following:

- The highest benzene concentrations were detected in the deeper portion of the screen interval in monitoring wells 258-MW-002 and 258-MW-006 and correspond to well-graded sand intervals.
- Benzene concentrations in 258-MW-004 show only minor variations across the monitored screen interval.
- Groundwater samples collected from upper portions of the screen intervals, generally associated with fine-grained material in 258-MW-002, 258-MW-004, and 258-MW-006 had lower detections of benzene.
- The highest concentrations were detected in samples taken from the coarse-grained material (Well-graded sands and gravels).

Recommendation

- It is recommended that the newly installed monitoring wells also be profiled using PDBs to evaluate the possible stratification of contaminants with depth and lithology in deeper portions of the water bearing zone.
- The pump intake should be placed appropriately based on vertical profiling results during future sampling events.

8.1.3 Soil Sampling

Conclusions

Soil sampling results indicate the following:

- TPH-GRO is present within soil in the source area both above the water table (258-MW-002D at 27 feet; 176 mg/kg), and below the water table (258-MW-002D at 41 feet; 2,890 mg/kg).
- TPH-GRO is present in soil below the water table downgradient of the source area at depths ranging from 39 feet bgs at 258-SB-003 (1,290 mg/kg) to 54 feet bgs at 258-SB-004 (754 mg/kg).

- The highest TPH-GRO concentrations were detected in well-graded sands; however, TPH-GRO was also detected at 1,290 mg/kg within a clay sample at 41 feet bgs in 258-SB-005 (just west of Route Tampa).

- TPH GRO was not detected in the 258-SB-001 or 258-SB-002 (two furthest downgradient samples).

- Toluene, ethylbenzene, and xylenes were detected in 258-MW-002D, 258-MW-004D, 258-SB-004, and 258-SB-005. Benzene was detected in one sample from 258-SB-005 (within clay). Only ethylbenzene was detected in 258-SB-003; however, the detection limits were raised for the other VOCs.

- TPH GRO was detected at 0.133 mg/kg within the siltstone bedrock at 76 feet 258-SB-003.

- Results of the Title 22 metals sampling indicate metals are generally at or below background concentrations.

The results suggest that hydrocarbons are generally present below the average water table downgradient of the source area and extend from about 38 feet to almost 60 feet bgs in samples collected northeast of Route Tampa. Organic compounds were not detected in soil samples collected south of 258-MW-006 which is just south of Route Tampa. No additional sources above or below Route Tampa are indicated based on the data.

Recommendations

No further soil investigation is recommended at this time.

8.1.4 Groundwater Sampling

Conclusions

Groundwater samples were collected by AES between November 2010 and July 2011. This discussion relies primarily on the results of sampling completed in the last nine months.

- Results of groundwater sampling in the source area, confirm that the source area in the upgradient area is bounded by 258-MW-003 (non-detect for VOCs), and that the highest BTEX

concentrations are found near Building 258 (258-NW-001, and 258-MW-002). Based on sampling results, from258-MW-10B (Bedrock Well) is not impacted in the source area.

- Analytical results from 258-MW-002D were non-detect for BTEX and TPH GRO, indicating contamination is present in groundwater above the 258-MW-002D screen interval (65 to 85 feet bgs).

- Elevated BTEX is present in monitoring wells installed along the axis of the plume downgradient to 258-MW-006 (about 200 feet southwest of Route Tampa).

- Non-detect results, with the exception of total xylenes detected at less than 1 µg/L, indicated that the plume attenuates southwest of Route Tampa between 258-MW-006 and the sentinel wells (258-MW-005, 258-MW-005D, 258-MW-007, 258-MW-008, and 258-MW-008D).

- Groundwater samples collected from 258-MW-004D (screened within the fractured bedrock) had detections of TPH GRO, benzene, ethylbenzene, MTBE, and TBA indicating possible impacts to shallow bedrock downgradient of the source area.

- Groundwater samples collected from 258-MW-006D suggest that the groundwater contamination extends to at least 52 feet bgs (mid-point of the screen interval).

- The plume appears to be well defined in the upgradient portions where confined to the bedrock channel. The flow direction and limits of the plume in the southeastern portion, just south of Route Tampa and east of 258-MW-006, may require further definition based on 2002 HydroPunch™ investigations and MIP investigation.

Recommendations

- It is recommended that an additional monitoring well be installed to monitor the plume boundary east of 258-MW-006. This recommendation is based on the results of the MIP investigation and HydroPunch™ investigation that indicate that the plume width may be wider in this location.

- Continue quarterly monitoring of the monitoring wells for an additional year to evaluate the impact of seasonal variations on the newly installed wells. Continue quarterly monitoring at 258-MW-004D to further evaluate the potential for groundwater contamination in bedrock in the mid-plume area.

8.2 Technology Screening Considerations

The following information from the site characterization should be considered during the technology screening and development of the remedial alternatives:

- Free/residual product is present in soil as far south as Route Tampa based on the UVOST® results. It appears to be present in isolated pockets primarily between 25 and 50 feet bgs. Based on PID readings measured during sampling of soil borings, free/residual product may extend to 60 feet bgs.

- Free/residual product is present up to 20 feet below the water table in the source area and south to at least Route Tampa.

- Comparison of UVOST® logs with soil borings drilled adjacent to UVOST® logs indicates presence of free/residual product in the source area and just south of the source area primarily in clays and silts. Further downgradient, elevated UVOST® results generally correlate to well-graded sand units.

- Dissolved phase contamination is present in groundwater at up to 55 feet bgs at 258-MW-006D.

- TPH-GRO and BTEX was detected in soil samples collected from well-graded sand, silty sand, and clay units.

- The subsurface deposits near Building 258 are alluvial silty sand and clay interbedded with well-graded sand and gravel units. The alluvial material was deposited within an incised bedrock channel, which confines the flow of contamination to within the channel. The complexity of the subsurface deposits makes interpretation of the geology and the connection between the fine and coarse-grained material difficult.

- The petroleum contamination appears to be well defined and localized at the site with limited continued movement downgradient of Route Tampa.

- Low hydraulic conductivities are present within the fine-grained deposits. Hydraulic conductivities within the coarser-grained deposits showed large variations.

9.0 REFERENCES

Ahtna Engineering (AES), 2010a. Quality Assurance Project Plan Building 194 Area Groundwater Monitoring, Building 258 Soil Vapor Extraction and Groundwater Monitoring, and Landfill Post-Closure Monitoring (QAPP), Fort Hunter Liggett, California. October

_____, 2010b. Draft Quality Assurance Project Plan, Building 258 Groundwater Well Installation (QAPP Addendum), Fort Hunter Liggett, California. November.

_____, 2011a. *Final Building 258 Site Investigation and Monitoring Well Installation Work Plan, Fort Hunter Liggett, California.* January 28.

_____, 2011b. *2011 First Quarter Groundwater Monitoring Report, Building 258 Area, Fort Hunter Liggett, California*. April 15.

California Department of Public Health, 2008. *Chemicals and Contaminants in Groundwater, Maximum Contaminant Levels and Regulatory Dates for Drinking Water, U.S. EPA vs. California*. http://www.cdph.ca.gov/certlic/drinkingwater/pages/chemicalcontaminants.aspx

Geofon, 1999. Facsimile to Mary Jo Heassler, HLA, Buildings 176 and 258 Tables. June 29.

Harding ESE, 2002. *Technical Memorandum and Work Plan, Groundwater Investigation and Groundwater Monitoring Well Installation, Building 258 Area, Fort Hunter Liggett, California*. February 21.

Harding Lawson Associates (HLA), 1991. *Building 258 Gasoline Spill Investigation, Fort Hunter Liggett, California*. February 22.

_____, 1995. *Investigation of Eight Sites, Fort Hunter Liggett, California, Volume II,* March 24.

MACTEC Engineering and Consulting Inc. (MACTEC), 2006. *Draft Technical Memorandum Report, Pilot Treatability Study, Building 258 Area, Fort Hunter Liggett, California*. August 31.

_____, 2009. *Technical Memorandum Report, Soil Vapor Extraction Pilot Treatability Study, Building 258 Area, Fort Hunter Liggett, California*. January 26.

_____, 2010. The Quality Assurance Project Plan, Building 194 Groundwater Studies, Fort Hunter Liggett, California, California. May 5.

_____, 2011. *Building 258 Site Investigation, Technical Memorandum, Fort Hunter Liggett, California.* April 25.

United States Army Corps of Engineers (USACE), 2005. Guidance for Evaluation of Performance Based Chemical Performance.

_____, 2011. *Vapor Intrusion Study, Fort Hunter-Liggett, Monterey County, California*. Final. February.

Uribe and Associates (U&A), 1999. *Observations during UST Removals, Building 258, Fort Hunter Liggett, California*. January 19.

Weather Source, 2011. Weather Station Data King City, California, All Available Data. August 17. http://weathersource.com

TABLES

Table 4.1 Sampling and Analysis Plan, Soil

Stations	Matrix	Depth	VOCs	TPH-g	TPH-d w/sg	TPH-mo	Water/LNAPL Relative Permeability	X-Ray Diffraction Annalysis	COD	TOC	Total Iron	Percent Moisture	Luft Metals	Title 22 Metals	TCEQ/TNRCC Package
															Intrinsic permiability
															Hydraulic conductivity
															Total porosity
														EPA 6000 7000	Air-filled porosity
															Dry bulk density
															Volumetric moisture content
															Fraction organic carbon
			EPA 8260	EPA 8260	EPA 8015	EPA 8015		Mineralogical Analysis	5220D	5310C	6010				
IDW Soil			X	X	X							X	X	X	
IDW Water			X	X										X	
Soil boring Samples															
258-SB-001	soil	46	X	X					X	X	X			X	X
258-SB-001	soil	62													X
258-SB-001	soil	64							X	X	X			X	
258-SB-001	soil	78		X	X	X									
258-SB-002	soil	54	X	X											
258-SB-003	soil	39	X	X					X	X	X			X	
258-SB-003	soil	42													X
258-SB-003	soil	46							X	X	X			X	
258-SB-003	soil	50													X
258-SB-003	soil	76		X											
258-SB-003	soil	88		X											
258-SB-004	soil	37							X	X	X			X	X
258-SB-004	soil	54	X	X			X	X	X	X	X			X	X
258-SB-005	soil	41	X	X											
Monitoring Well Samples															
258-MW-002D	soil	27	X	X					X	X	X			X	X
258-MW-002D	soil	36					X	X							X
258-MW-002D	soil	41	X	X					X	X	X			X	
258-MW-004D	soil	35													X
258-MW-004D	soil	35.5	X	X					X	X	X			X	
258-MW-004D	soil	38													X
Field Duplicate (258-SB-004)	soil	37							X	X	X			X	

Abbreviations:

COD	Chemical oxygen demand
LNAPL	Light non-aqueous phase liquids
TOC	Total organic carbon
TPH-GRO	Total petroleum hydrocarbons, gasoline-range organics
VOCs	Volatile organic compounds
w/sg	With silica gel cleanout

Checked By: WJF
Approved By: BPF

Table 4.2 Sampling and Analysis Program, Groundwater

Well I.D.	Analyte	TPH-GRO, BTEX, MTBE, and TBA	TPH-DRO
	Test Method	EPA 8260	EPA 8015
258-NW-001		**Quarterly**	**Quarterly**
258-MW-002		**Quarterly, PDBs Q1**	**Quarterly**
258-MW-003		**Quarterly, PDBs Q1**	**Quarterly**
258-MW-004		**Quarterly, PDBs Q1**	**Quarterly**
258-MW-005		**Quarterly**	**Quarterly**
258-MW-006		**Quarterly, PDBs Q1**	**Quarterly**
258-MW-007		**Quarterly, PDBs Q1**	**Quarterly**
258-MW-008		**Quarterly, PDBs Q1**	**Quarterly**
258-MW-009		**Quarterly**	**Quarterly**
258-MW-010B		**Quarterly**	**Quarterly**
258-MW-014		**Quarterly**	**Quarterly**
258-IN-012		**Quarterly**	**Quarterly**
258-PZ-001		**Quarterly**	**Quarterly**
258-PZ-002		**Quarterly**	**Quarterly**
258-MW-002D		**Quarterly beginning July 2011**	**Quarterly beginning July 2011**
258-MW-004D		**Quarterly beginning July 2011**	**Quarterly beginning July 2011**
258-MW-005D		**Quarterly beginning July 2011**	**Quarterly beginning July 2011**
258-MW-006D		**Quarterly beginning July 2011**	**Quarterly beginning July 2011**
258-MW-008D		**Quarterly beginning July 2011**	**Quarterly beginning July 2011**
258-MW-015		**Quarterly beginning July 2011**	**Quarterly beginning July 2011**

Checked By: WJF
Approved By: BPF

Table 4.3 Well Screen Intervals, Casing Elevations, and Coordinates

Well Name	Well Casing Diameter (inches)	Total Depth of Well (feet bgs)	Completion	Top of Casing Elevation (feet msl)	Ground Surface Elevation (feet msl)	Screen Interval (feet bgs)	Mid-Screen Depth (feet bgs)	Well Type
258-NW-001	2	54	Below grade	1057.72	1058.56	34-54	44	Plume Well
258-MW-002	4	54	Below grade	1057.64	1057.86	34-54	44	Plume Well
258-MW-002D	4	85	Below grade	1057.89	1057.89	65-85	75	Plume Well
258-MW-003	2	55	Below grade	1060.88	1061.33	33-55	44	Upgradient Well
258-MW-004	4	49	Above grade	1044.78	1043.95	29-49	39	Plume Well
258-MW-004D	4	70.5	Above grade	1045.99	1043.39	55.5-70.5	63	Bedrock Well
258-MW-005	2	43	Below grade	1028.08	1028.31	28-43	35.5	Perimeter Well
258-MW-005D	4	55	Above grade	1030.88	1028.45	45-55	50	Perimeter Well
258-MW-006	4	42	Above grade	1033.55	1031.96	27-42	34.5	Plume Well
258-MW-006D	4	57	Above grade	1034.42	1031.89	47-57	52	Plume Well
258-MW-007	2	41	Above grade	1031.44	1029.73	26-41	33.5	Perimeter Well
258-MW-008	4	37	Below grade	1020.06	1020.39	22-37	29.5	Perimeter Well
258-MW-008D	2	45	Above grade	1022.95	1020.55	35-45	40	Perimeter Well
258-MW-009	6	97	Below grade	1058.19	1057.89	38-78	58	Aquifer Test Well
258-MW-010B	2	117.5	Below grade	1058.03	1057.65	102-117	109.5	Bedrock Well
258-MW-014	4	53	Below grade	1054.84	1054.84	33-53	43	Plume Well
258-MW-015	2	58	Above grade	1039.09	1036.72	23-58	40.5	Plume Well
258-IN-011	4	50	Below grade	1059.1	1059.68	40-50	45	Pilot Injection Well
258-IN-012	4	49.2	Above grade	1033.16	1031.75	39-49	44	Pilot Injection Well
258-PZ-001	2	40	Below grade	1031.14	1031.5	30-40	35	Pilot Piezometer
258-PZ-002	2	40	Below grade	1031.44	1031.72	30-40	35	Pilot Piezometer

Abbreviations:

bgs	Below ground surface
msl	Mean sea level
-	Surveying to be performed

Checked: WJF
Approved: BPF

Table 4.4 Volatile Organic Compound Analyte List

Analyte	Matrix
Benzene	Soil and Groundwater
Ethylbenzene	Soil and Groundwater
Methyl t-butyl ether	Soil and Groundwater
Total Xylenes	Soil and Groundwater
Tert-butyl alcohol	Soil and Groundwater
Toluene	Soil and Groundwater

Checked: WJF
Approved: BPF

Table 5.1 Summary Soil Boring Results

Proposed Soil Boring	Total Depth (feet bgs)	Comments
258-SB-001	105	Bedrock was encountered at 70 feet bgs. The highest PID reading (33 ppm) was detected at 46 feet. Soil sample collected from 46 feet was non-detect for BTEX and TPH Gasoline. A Soil sample was also collected from 78 feet (within bedrock). Sample was non-detect for TPH gasoline, diesel, and motor oil. No correlation between MIP M 6-1 and 258-SB-001 is evident.
258-SB-002	65	Bedrock was not encountered in this boring. No elevated PID readings were detected in this boring. No color changes in soil were noted to indicate petroleum hydrocarbon contamination. Results of chemical analysis of a soil sample collected at 54 feet were non-detect for BTEX and TPH Gasoline. This boring was selected due to the MIP results from 5-1 and 5-3 and to further investigate the potential for contamination in a deeper zone on the southwestern side of the plume because 258-HP-035 did not extend deep enough to encounter contamination in the lower zone, if present. This location was drilled to approximately 65 feet bgs.
258-SB-003	105	Bedrock was encountered at between 65 and 70 feet bgs. PID readings began increasing at 37 feet bgs, The highest PID reading was 646 ppm at 39 feet bgs. Elevated PID readings were also detected to about 55 feet bgs. This boring was selected due to high MIP concentrations from 18 - 32 and 44 - 51 feet bgs in MIP location 4-3. Review of the PID readings indicate that contaminated soil/groundwater is present from about 32 feet to 55 feet. Variation in PID readings was noted across the interval. A color change from brown to gray was noted at about 35 feet. Analytical samples were collected within the bedrock due to hydrocarbon odors. A sample was collected from 76 feet about 12 hours after coring. Gasoline was detected at 0.133 ppm. An additional bedrock sample was collected at 88 feet. TPH gasoline was non-detect.
258-SB-004	75	PID readings between 3.8 and 18.4 ppm were detected above 30 feet bgs. A sandy lean clay was encountered at 30 feet bgs. PID readings varied between 29.8 and 73.5 at the base of the clay unit at 34.5 feet. PID readings from 35 to 52 ft bgs ranged from 1,101 to 2149 ppm . A PID reading of 862 ppm was detected at 54 feet bgs. Below 55 feet PID readings ranged from 4.4 to 19.2 ppm. This boring location was selected due to high UVOST results from 30 - 38, 43 - 44, and 53 feet bgs in UVOST location 1-5. This boring location was used to establish a correlation between UVOST data and lithology. The highest UVOST signal readings were detected at 30 to 35 feet which corresponds to a sandy lean clay and clayey sand (PID readings of 29.8 to 73.5 ppm). The highest PID readings correspond to a Well-graded sand.
258-SB-005	90	The location of this boring was moved adjacent to UVOST location U-3-3. Monitoring Well 258-MW-002D was drilled and installed within 5 feet of the proposed 258-SB-005. This boring location was selected due to high UVOST results from 40 to 44 feet bgs in UVOST location 3-3. This boring location was used to establish a correlation between UVOST data and lithology in the mid plume area. The elevated UVOST results correlate with a lean clay and sandy lean clay present from 38 to 42 feet bgs. An additional spike in the UVOST results from 3-3 appears to correlate with a sandy silt at 46.5 feet bgs. High PID readings were identified within the clay and within well graded sand and gravel units present at 42 to 55 feet bgs. PID readings drop to below 1 ppm below 55 feet. Bedrock was encountered at between 75 and 80 feet bgs.

Abbreviations:

bgs = Below ground surface.
MIP = Membrane Interface Probe
ppm = parts per million
UVOST = Ultraviolet Optical Screening Tool

Checked By: WJF
Approved By: BPF

Table 5.2 Summary of Monitoring Well Installation Results

Monitoring Well	Depth (feet bgs)	Screen Interval (feet bgs)	Review of Lithologic Data, Field Screening and Analytical Data
258-MW-002D	85	Lower (65-85)	This monitoring well will be used to collect information in the lower zone between 65 and 85 feet bgs. The screen interval corresponds to bottom of alluvial deposits and top of weathered bedrock. MW-002 shallow is screened from 34 to 54 feet. Within the screen interval, PID readings ranged from 0.7 ppm at 85 feet to 31.2 ppm at 67 feet. These represent a significant drop from 4509 ppm at 52 feet and 322.3 feet at 54 feet. Comparison of the lithologic log to UVOST U-23 shows that the high UVOST signal readings between 37 and 45 correspond to a well graded sand unit where PID readings ranged from 3443 to 4450 ppm. The high UVOST readings from 25 to 27 feet correspond to a sandy lean clay.
258-MW-008D	70	Lower (35-45)	This monitoring well was selected for installation adjacent to 258-MW-008 in order to verify the limits of contamination below the screen depth of 258-MW-008 and to provide information on potential vertical gradients between the upper and lower portions of the unit. The well was installed across a well graded sand unit. It was not installed below 45 due to the presence of clay and silt units (possible weathered bedrock) below 45 feet. No elevated PID readings were measured below 45 feet.
258-MW-005D	65	Lower (45-55)	This monitoring well will be used to collect information on the limits of contamination between the bottom of the screen interval at 258-MW-005 (43 feet) and the top of the bedrock estimated at about 55 feet bgs. This well will also provide information on vertical hydraulic gradients. The well was screened from 45 to 55 feet bgs. The highest PID reading measured in this boring was 1.8 ppm at 37 feet. Elevated PID readings were not detected below 40 feet.
258-MW-006D	65	Lower (47-57)	This monitoring well will be used to collect information on the limits of contamination between the bottom of the screen interval at 258-MW-002 and the top of the bedrock and to provide information on vertical hydraulic gradients. The highest PID reading measured was 593 ppm at 40 feet. PID readings declined to 25.9 ppm at 50 feet and to 7.9 ppm at 53 feet. PID reading were measured at below 1 ppm below greater than 57 feet.
258-MW-015	63	(23 to 58)	This monitoring well will be used to collect information in the area between the free product and the dissolved contamination area. The screen interval was selected to cover the high water levels to bedrock. The highest PID readings were detected at 42 feet bgs. Elevated readings were detected between 37 and 55 feet bgs. An approximately 2 foot thick sandy lean clay was detected between 37.5 and 39.5 feet bgs. A PID reading of 515 ppm was measured within the sandy lean clay.
258-MW-004D	75	Lower (55.5 to 70.5)	This monitoring well will be used to monitor the zone beneath the bottom of the screen at 258-MW-004 (49 feet) and 70 feet. The highest PID readings were measured between 37 and 42 feet bgs. PID readings dropped to 9.9 at 43 feet. PID readings were less than 1 ppm below 55 feet. This well is screened within the bedrock and will be used to evaluate the potential for contamination to be present in the bedrock in the mid plume area.

Abbreviations:
bgs = Below ground surface.

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Approved By: BPF

Table 5.3 Vertical Gradient Calculations

Well Pairs	TOC Elevation (feet msl)	Distance Between Mid Screen Elevations* (feet)	DTW Elevation July 2011	Distance Between Lower/Higher DTW Elevations (feet)	Gradient (feet)	Direction of Gradient Up/Down
258-MW-002	1057.64	31	1025.19	-0.30	-9.6774E-03	Downward
258-MW-002D	1057.89		1025.49			
258-MW-004	1044.78	24.56	1017.48	2.25	9.1612E-02	Upwards
258-MW-004D	1045.99		1015.23			
258-MW-005	1028.08	14.36	1000.15	-5.00	-3.4819E-01	Upwards
258-MW-005D	1030.88		1005.15			
258-MW-006	1033.55	17.57	1006.2	0.00	0.0000E+00	None
258-MW-006D	1034.42		1006.2			
258-MW-008	1020.06	10.34	1003.84	-0.09	-8.7041E-03	Upwards
258-MW-008D	1022.95		1003.93			

Abbreviations:

*	Screen elevations calculated from depth below ground surface.
DTW	Depth to water
msl	Mean sea level
TOC	Top of casing

Checked By: WJF
Approved By: BPF

Table 6.1 Ultraviolet Optical Screening Tools (UVOST®) Results

UVOST® Location	Depth Interval (ft)	Percent of RE	Total Depth (ft)	Comments
U-01	33-34	3	54	Minor to not present
U-04	NA	0.9	46.4	No elevated readings/FP not detected
U-08	22-28	13	54	
	45-53	73.7		
U-09	30-35	16.5	56	
	38-41	6		
	46-48	8		
U-11	16-17	8	45.5	
	29.5-30	5		
	37-44	8.6		
U-12	27-43	52.7	51	
	48-50	24		
U-14	20-25	48.5	50	
	27-31	35		
U-15	30-40	231.7	54	
	45-50	45		
U-17	34-36	88.3	45.7	
	37-42.5	5		
U-18	34-42	298.8	50	
	45-50	25		
U-19	36-38	7	46	
	43-44	9.7		
U-20	36-37	6	58	
	48-52	45		
	57.5	6		
U-22	24-25.5	9	46	
	28-46	59		
U-23	25-27	65	44.3	
	35-44	194		
U-24	37-43.5	26.4	50	
	48	3		Minor
U-26	29-30.5	9	42	
	38-39.5	9.4		

Table 6.1 Ultraviolet Optical Screening Tools (UVOST®) Results

UVOST® Location	Depth Interval (ft)	Percent of RE	Total Depth (ft)	Comments
U-32	30-44.5	7.9	50	
U-33	45.5-46	3.1	50	Minor
U-34	28-34	31.7	46	
U-37	29.5-35.5	3.7	46	Minor
U-39	0-5	2.4	47	Minor to not present
U-1-2	35.5-36	2.7	47.5	Minor to not present
U-1-3	31-33.5	6	50	
	42-45	16		
	46-50	44		
U-1-4	27-33	5	51	
	49-51	6.6		
U-1-5	30-38.5	132.5	58	
	43-47	22		
	53-54	5		
U-1-6	31.5-43	14	48.4	
	47-48	17.7		
U-2-3	22	3.1	41	
U-2-4	26-27.5	16.6	58	
U-2-5	20.5	9.4	58	
	27-29	3.5		Minor to not present
U-2-6	38.5-39.5	2.1	50	
U-3-2	NA	1	23.8	No elevated readings/FP not detected
U-3-3	38-39	5	58.4	
	41-46	15		
U-3-4	28-31	12.1	58.5	
U-3-5	NA	2	58.2	No elevated readings/FP not detected

Abbreviations:
ft = feet
RE = Reference Emitter
UVOST® = Ultraviolet Optical Scanning Tools

Checked By: WJF
Approved By: BPF

Table 6.2 Membrane Interface Probe (MIP) Results

MIP Location	Depth Interval (ft)	PID/FID Reading (µVx10-6)	Total Depth (ft)	Comments
M-3-1	12	.34/.34	14	Above Water Table
M-3-8	NA	<0.2	30	Appears just background readings
M-4-1	10-12	0.26/0.31	57	Above Water Table
	49-51	0.2/0.26		Variable readings over depth
	58	0.26/0.24		Variable readings over depth
M-4-3	31-33	9.62/>11.07	57	
	44-51	5/9		Variable readings over depth
M-4-8	18	0.29/0.27	38	Above Water Table
M-4-12	NA	<0.22	27	Appears just background readings
M-4-14	NA	<0.21	28	Appears just background readings
M-5-1	23-25	0.26/0.22	55	Variable readings over depth
	54	0.27/0.22		Variable readings over depth
M-5-3	11	0.31/0.25	57	
	22	0.25/0.25		Variable readings over depth
	43-57	0.25/0.25		Variable readings over depth
M-5-6	23-29	0.25/0.25	46	
	44-46	0.51-1.03/0.7-2.8		variable readings over depth, at TD
M-5-9	23	0.2/0.2	52	Small reading just above background
	47-51	0.9/0.85		at TD
M-5-12	18	0.26/0.27	55	above Water Table
	53-55	0.25/0.2		Variable readings over depth
M-5-14	23	0.23/0.21	24	At TD
M-6-1	36-59	2-4.16/2-5.56	59	variable readings over depth, at TD
M-6-4	42	0.3/0.4	48	
	43-47	0.8/0.7		variable readings over depth, at TD
M-6-5	30-32	3.11/10.82	40	Variable readings over depth
	38	0.4/0.4		At TD
M-6-6	28	1.4/0.8	33	
M-6-7	32	0.48/0.49	34	
M-6-8	28-32	0.29/0.18	34	

Table 6.2 Membrane Interface Probe (MIP) Results

MIP Location	Depth Interval (ft)	PID/FID Reading (µVx10-6)	Total Depth (ft)	Comments
M-6-10	42-43-4	0.33/0.20	43	
M-6-12	12	0.25/0.27	44	Above Water Table
	34-39	0.31/0.5		varibale readings over depth
M-7-1	12	0.28/0.22	54	Just above background readings
	51-53	0.28/0.31		Still present at TD, variable 51-53
M-7-4	37	0.31/0.25	46	
	45-46	0.57/0.38		Variable readings over depth
M-8-1	14	0.23/0.22	32	
	23	0.2/0.2		Slight change from background
M-8-3	NA	0.16/0.2	33	Appears just background readings
M-9-2	48	0.2/NA	57	
	52-57	0.29/0.26		variable readings over depth, at TD

Abbreviations:
ft = feet
MIP = membrane interphase probe
TD = total depth

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Approved By: BPF

Table 6.3. Groundwater Vertical Profiling Analytical Results

Well	Depth	Benzene (ppb)	Toluene (ppb)	Ethyl-benzene (ppb)	Total Xylenes (ppb)
258-MW-002	36	6,510	6,150	371J	5,530
258-MW-002	42	29,600	31,200	2,140	1,440
258-MW-002	48	24,800	21,200	1,440	1,560
258-MW-002	48 (Dup)	ND(0.5)	ND(0.5)	9,810	10,500
258-MW-004	32	3,880	10,300	1,610	8,380
258-MW-004	37	4,020	10,700	1,770	8,420
258-MW-004	42	3,900	10,500	1,650	7,020
258-MW-004	48	3,900	10,500	1,690	7,040
258-MW-006	32	6,480	9,310	772	3,020
258-MW-006	36	11,400	14,800	1,410	5,370
258-MW-006	41	12,800	11,900	1,280	4,660
258-MW-006	41 (Dup)	12,700	11,600	1,220	4,390
258-MW-007	30	ND(0.3)	ND(0.5)	ND(0.3)	ND(0.7)
258-MW-007	34	ND(0.3)	ND(0.5)	ND(0.3)	ND(0.7)
258-MW-007	40	ND(0.3)	ND(0.5)	ND(0.3)	ND(0.7)
258-MW-008	25	ND(0.3)	ND(0.5)	ND(0.3)	ND(0.7)
258-MW-008	30	ND (0.3)	ND(0.5)	ND(0.3)	ND(0.7)
258-MW-008	35	ND(0.3)	ND(0.5)	ND(0.3)	ND(0.7)

ND(0.5) = Not detected above laboratory reporting limit shown.
Dup = Duplicate.

Checked: WJF
Approved: BPF

Table 6.4 - Soil Analytical Results
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

	Station Number:	258-MW-2D		258-MW-2D		258-MW-4D		258-SB-001	
	Sample Date:	06/15/11		06/15/11		06/29/11		06/09/11	
	Sample Depth (feet):	27		41				46	
	Sample Number:	1124SG258017F		1124SG258019F		1126SG258023F		1123SG258008F	
	Lab Batch:	C16562		C16562		C16776		C16487	
Test Method/Analyte Name	Units	Value	Qual	Value	Qual	Value	Qual	Value	Qual
EPA6010B									
Arsenic	mg/kg	2.6	A	2.6	A	2.6	A	2.0	A
Barium	mg/kg	67.5	A	36.2	A	61.	A	90.8	J-
Cadmium	mg/kg	1.2	A	ND(0.99)	A/U	1.5	A	1.4	A
Chromium	mg/kg	13.7	A	5.1	A	8.9	A	12.5	A
Cobalt	mg/kg	3.5	A	1.5	A	1.9	A	2.8	A
Copper	mg/kg	8.6	A	3.7	A	5.8	A	8.8	A
Iron	mg/kg	9,270.	A	6,050.	A	7,730.	A	8,350.	A
Lead	mg/kg	4.7	A	2.5	A	2.8	A	ND(2.0)	A/U
Molybdenum	mg/kg	ND(1.9)	UJ/U	ND(2.0)	UJ/U	ND(1.8)	A/U	ND(2.0)	UJ/U
Nickel	mg/kg	13.1	A	4.2	A	8.3	A	9.9	A
Vanadium	mg/kg	25.	A	14.5	A	22.1	A	19.7	A
Zinc	mg/kg	31.3	A	15.6	A	21.5	A	22.3	A
EPA7471A									
Mercury	mg/kg	0.096	J	ND(0.037)	UJ/U	0.061	A	ND(0.04)	A/U
EPA8260B									
Benzene	mg/kg	ND(0.98)	A/U	ND(22)	A/U	ND(2.3)	A/U	ND(0.0051)	A/U
Ethylbenzene	mg/kg	ND(0.98)	A/U	73.4	A	4.22	A	ND(0.0051)	A/U
Toluene	mg/kg	ND(0.98)	A/U	11.9	A/J	4.99	A	ND(0.0051)	A/U
TPH-Gasoline C6-C10	mg/kg	176	A	2890	A	218	A	ND(0.1)	A/U
Xylenes	mg/kg	ND(2)	A/U	391	A	22.5	A	ND(0.01)	A/U
EPA9060A-MOD									
Total Organic Carbon	mg/kg	ND(1,000.)	A/U	1,080.	A	ND(1,000.)	A/U	ND(1,000.)	A/U
SM5220C-M									
Chemical Oxygen Demand (Regular)	mg/kg	628.	J+	1,280.	J+	325.	A	280.	A

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 10/7/2011

Table 6.4 - Soil Analytical Results
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

	Station Number:	258-SB-001		258-SB-001		258-SB-002		258-SB-003	
	Sample Date:	06/09/11		06/09/11		06/08/11		06/07/11	
	Sample Depth (feet):	64		78		54		39	
	Sample Number:	1123SG258009F		1123SG258012F		1123SG258007F		1123SG258001F	
	Lab Batch:	C16487		C16487		C16441		C16441	
Test Method/Analyte Name	Units	Value	Qual	Value	Qual	Value	Qual	Value	Qual
EPA6010B									
Arsenic	mg/kg	**3.1**	**A**	NT		NT		ND(2.0)	A/U
Barium	mg/kg	**160.**	**J-**	NT		NT		**23.8**	**J-**
Cadmium	mg/kg	**3.2**	**A**	NT		NT		ND(0.98)	A/U
Chromium	mg/kg	**30.7**	**A**	NT		NT		**5.9**	**A**
Cobalt	mg/kg	**1.6**	**A**	NT		NT		**1.7**	**A**
Copper	mg/kg	**9.6**	**A**	NT		NT		**4.4**	**A**
Iron	mg/kg	**6,560.**	**A**	NT		NT		**5,300.**	**A**
Lead	mg/kg	**2.0**	**A**	NT		NT		ND(2.0)	A/U
Molybdenum	mg/kg	**5.8**	**A**	NT		NT		ND(2.0)	UJ/U
Nickel	mg/kg	**13.6**	**A**	NT		NT		**3.7**	**A**
Vanadium	mg/kg	**21.2**	**A**	NT		NT		**11.4**	**A**
Zinc	mg/kg	**28.8**	**A**	NT		NT		**12.1**	**A**
EPA7471A									
Mercury	mg/kg	ND(0.038)	A/U	NT		NT		ND(0.04)	A/U
EPA8260B									
Benzene	mg/kg	NT		NT		ND(0.0057)	A/U	ND(7.8)	A/U
Ethylbenzene	mg/kg	NT		NT		ND(0.0057)	A/U	**4.41**	**A/J**
Toluene	mg/kg	NT		NT		ND(0.0057)	A/U	ND(7.8)	A/U
TPH-Gasoline C6-C10	mg/kg	NT		ND(0.098)	A/U	ND(0.11)	A/U	**1290**	**A**
Xylenes	mg/kg	NT		NT		ND(0.011)	A/U	ND(16)	A/U
EPA9060A-MOD									
Total Organic Carbon	mg/kg	**7,450.**	**A**	NT		NT		ND(1,000.)	A/U
SM5220C-M									
Chemical Oxygen Demand (Regular)	mg/kg	**706.**	**A**	NT		NT		**532.**	**A**

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 10/7/2011

Table 6.4 - Soil Analytical Results
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

	Station Number:	258-SB-003		258-SB-003		258-SB-003		258-SB-004	
	Sample Date:	06/07/11		06/08/11		06/08/11		06/10/11	
	Sample Depth (feet):	46		76		88		37	
	Sample Number:	1123SG258002F		1123SG258005F		1123SG258006F		1123SG258013D	
	Lab Batch:	C16441		C16441		C16441		C16486	
Test Method/Analyte Name	Units	Value	Qual	Value	Qual	Value	Qual	Value	Qual
EPA6010B									
Arsenic	mg/kg	**3.0**	**A**	NT		NT		**3.9**	**A**
Barium	mg/kg	**113.**	**J-**	NT		NT		**47.3**	**A**
Cadmium	mg/kg	**4.0**	**A**	NT		NT		ND(0.95)	A/U
Chromium	mg/kg	**13.6**	**A**	NT		NT		**7.9**	**A**
Cobalt	mg/kg	**2.1**	**A**	NT		NT		**2.2**	**A**
Copper	mg/kg	**7.2**	**A**	NT		NT		**4.8**	**A**
Iron	mg/kg	**5,470.**	**A**	NT		NT		**7,240.**	**A**
Lead	mg/kg	**2.6**	**A**	NT		NT		**3.4**	**A**
Molybdenum	mg/kg	ND(2.0)	UJ/U	NT		NT		ND(1.9)	A/U
Nickel	mg/kg	**15.6**	**A**	NT		NT		**7.4**	**A**
Vanadium	mg/kg	**29.5**	**A**	NT		NT		**19.6**	**A**
Zinc	mg/kg	**22.5**	**A**	NT		NT		**18.9**	**A**
EPA7471A									
Mercury	mg/kg	ND(0.038)	A/U	NT		NT		ND(0.042)	A/U
EPA8260B									
Benzene	mg/kg	NT		NT		NT		NT	
Ethylbenzene	mg/kg	NT		NT		NT		NT	
Toluene	mg/kg	NT		NT		NT		NT	
TPH-Gasoline C6-C10	mg/kg	NT		**0.133**	**J-**	ND(0.15)	A/U	NT	
Xylenes	mg/kg	NT		NT		NT		NT	
EPA9060A-MOD									
Total Organic Carbon	mg/kg	ND(1,000.)	A/U	NT		NT		ND(1,000.)	A/U
SM5220C-M									
Chemical Oxygen Demand (Regular)	mg/kg	ND(200.)	A/U	NT		NT		**570.**	**A**

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 10/7/2011

Table 6.4 - Soil Analytical Results
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

	Station Number:	258-SB-004		258-SB-004		258-SB-005	
	Sample Date:	06/10/11		06/10/11		06/21/11	
	Sample Depth (feet):	37		54		41	
	Sample Number:	1123SG258013F		1123SG258015F		1125SG258021F	
	Lab Batch:	C16486		C16486		C16666	
Test Method/Analyte Name	Units	Value	Qual	Value	Qual	Value	Qual
EPA6010B							
Arsenic	mg/kg	**4.4**	**A**	**6.8**	**A**	NT	
Barium	mg/kg	**41.5**	**A**	**62.2**	**A**	NT	
Cadmium	mg/kg	ND(1.0)	A/U	ND(0.99)	A/U	NT	
Chromium	mg/kg	**5.5**	**A**	**11.3**	**A**	NT	
Cobalt	mg/kg	**1.9**	**A**	**1.2**	**A**	NT	
Copper	mg/kg	**3.7**	**A**	**6.8**	**A**	NT	
Iron	mg/kg	**6,020.**	**A**	**9,550.**	**A**	NT	
Lead	mg/kg	**10.4**	**A**	**6.5**	**A**	NT	
Molybdenum	mg/kg	ND(2.0)	A/U	ND(2.0)	A/U	NT	
Nickel	mg/kg	**5.3**	**A**	**5.2**	**A**	NT	
Vanadium	mg/kg	**16.1**	**A**	**23.5**	**A**	NT	
Zinc	mg/kg	**16.1**	**A**	**24.1**	**A**	NT	
EPA7471A							
Mercury	mg/kg	ND(0.037)	A/U	ND(0.041)	A/U	NT	
EPA8260B							
Benzene	mg/kg	NT		ND(4.2)	A/U	**2.82**	**A/J**
Ethylbenzene	mg/kg	NT		**14.2**	**A**	**25.8**	**A**
Toluene	mg/kg	NT		**1.87**	**A/J**	**15.9**	**A**
TPH-Gasoline C6-C10	mg/kg	NT		**754**	**A**	**1370**	**A**
Xylenes	mg/kg	NT		**84.3**	**A**	**145**	**A**
EPA9060A-MOD							
Total Organic Carbon	mg/kg	ND(1,000.)	A/U	ND(1,000.)	A/U	NT	
SM5220C-M							
Chemical Oxygen Demand (Regular)	mg/kg	**367.**	**A**	**380.**	**A**	NT	

ND = Not Detected at the specific reporting level in parentheses
NT = Not Tested
SQLRpt1 10/7/2011

Table 6.4 – Soil Analytical Results
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

Summary of Analyte Qualifiers Used in this Report

Type	Qualifier	Qualifier Description	Qualifiers are listed as validation qualifier / lab qualifier where applicable (e.g. A/J)
Laboratory Assigned Qualifiers			
	J	Result is detected below the reporting limit or is an estimated concentration.	
	U	Compound was analyzed for but not detected.	
Validation Assigned Qualifiers			
	J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. A minus sign (-) indicates the numerical value has a low bias. A plus sign (+) indicated the numerical value has a high bias	
	U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit	
	A	Sample has undergone routine data validation.	

Table 6.5 Groundwater Analytical Results

Project:	Fort Hunter Ligget, Building 258 3Q11 Results																					
Sample ID:		1128BM258002F	1128BM258004F	1128BM258005F	1128BM258006F	1128BM258007F	1128BM258008F	1128BM258009F	1128BM258011F	1128BM258012F	1128BM258013F	1128BM258014F	1128BM258015F	1128BM258016F	1128BM258017F	1128BM258019F	1128BM258021F	1128BM258022F	1128BM258023F	1128BM258025F	1128BM258026F
Well ID:		258-MW-005	258-MW-007	258-PZ-002	258-MW-010B	258-MW-008	258-MW-003	258-MW-014	258-MW-009	258-MW-004	258-MW-006	258-PZ-001	258-IN-012	258-MW-008D	258-MW-005D	258-MW-006D	258-MW-015	258-MW-004D	258-MW-002D	258-MW-002	258-NW-001
Date Sampled:		7/11/2011	7/11/2011	7/11/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/12/2011	7/14/2011	7/14/2011	7/14/2011	7/14/2011	7/14/2011
Depth to Water (feet below top of casing)																						
DTW	FT BTOC	22.93	24.65	25.40	32.27	16.22	34.00	30.30	32.48	27.30	27.35	25.05	26.98	19.02	25.73	28.22	29.10	30.76	32.40	32.45	32.10
GC/MS Volatiles (SW846 8260B)																						
Benzene	µg/l	ND (0.30)	ND (0.30)	490	ND (0.30)	ND (0.30)	ND (0.30)	6050	0.94 J	3820	613	1030	8400	ND (0.30)	ND (0.30)	1420	3980	0.49 J	ND (0.30)	38900	7090
Ethylbenzene	µg/l	ND (0.30)	ND (0.30)	189	ND (0.30)	ND (0.30)	ND (0.30)	363	1.4	2500	368	403	2950	ND (0.30)	ND (0.30)	913	2330	0.39 J	ND (0.30)	3990	1630
Methyl Tert Butyl Ether	µg/l	ND (0.50)	ND (0.50)	ND (5.0)	ND (0.50)	ND (0.50)	ND (0.50)	ND (50)	ND (0.50)	ND (50)	ND (25)	ND (25)	ND (50)	ND (0.50)	ND (0.50)	ND (10)	ND (50)	52.8	ND (0.50)	ND (250)	ND (100)
Tert-Butyl Alcohol	µg/l	ND (5.0)	ND (5.0)	ND (50)	ND (5.0)	ND (5.0)	ND (5.0)	ND (500)	ND (5.0)	ND (500)	ND (250)	ND (250)	ND (500)	ND (5.0)	ND (5.0)	ND (100)	ND (500)	129	ND (5.0)	ND (2500)	ND (1000)
Toluene	µg/l	ND (0.50)	ND (0.50)	687	ND (0.50)	ND (0.50)	ND (0.50)	4660	0.81 J	8560	574	837	9980	ND (0.50)	ND (0.50)	455	590	ND (0.50)	ND (0.50)	24400	10700
Xylene (total)	µg/l	ND (0.70)	ND (0.70)	508	ND (0.70)	ND (0.70)	ND (0.70)	1730	9.7	11000	1640	1520	10300	0.75 J	ND (0.70)	770	1330	ND (0.70)	ND (0.70)	21200	18500
TPH-GRO (C6-C10)	µg/l	ND (25)	ND (25)	5630	ND (25)	ND (25)	ND (25)	31800	375	69200	10200	11200	79100	ND (25)	ND (25)	10300	17300	108	ND (25)	119000	54200
GC Semi-volatiles (SW846 8015B M)																						
TPH-DRO (C10-C28)	mg/l	ND (0.048)	ND (0.048)	0.221	ND (0.049)	ND (0.047)	ND (0.049)	0.551	ND (0.047)	0.638	0.402	1.06	1.79	ND (0.048)	ND (0.048)	0.235	0.512	ND (0.049)	ND (0.048)	1.79	237

Abbreviations:

Samples collected by AES
DTW = depth to water
FT BTOC = feet below top of casing
GC/MS = gas chromatograph/mass spectrometer
GC = gas chromatograph
ND (0.5) = not detected at concentration shown in parentheses
TPH-GRO = total petroleum hydrocarbons gasoline range organics
TPH-DRO = total petroleum hydrocarbons diesel range organics
ug/l = micrograms/liter

Checked: WJF
Approved: BPF

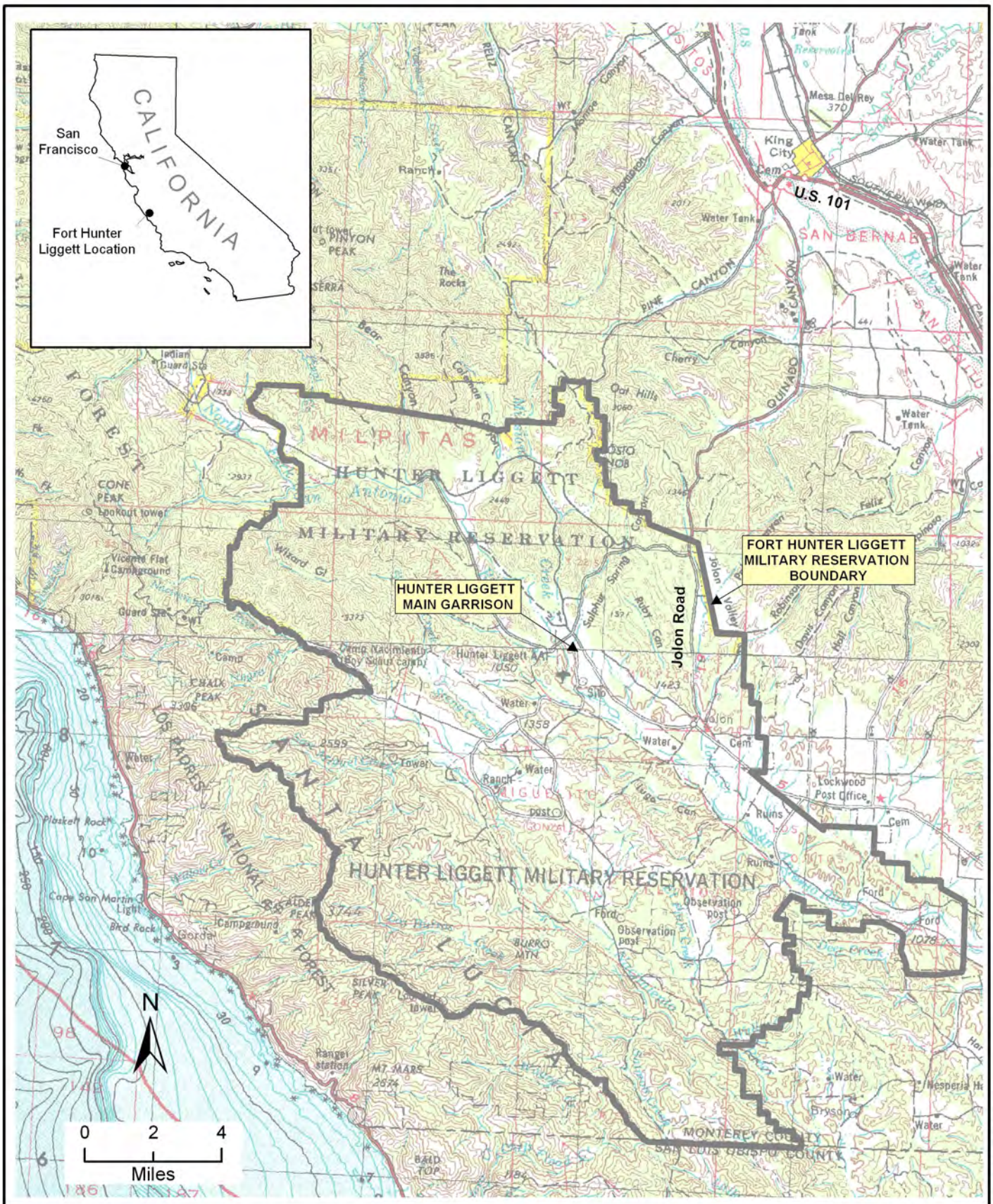
Table 6.6 Physical Properties Testing Results

Sample Location	Sample Depth (ft)	Logged Soil Type (field log)	Sample ID	Sample Orientation	Dry Bulk Density (API RP 40)	Fraction Organic Carbon (Walkey-Black)	Volumetric Moisture Content as Fraction of Vb (ASTM D2216/API RP 40)	Air Filled Porosity % Vb (API RP 40)	Total Porosity % Vb	Native Permeability to Water	Native Hydraulic Conductivity
Units				NA	g/cc	g/g	cm^3/cm^3	%Vb	%Vb	cm^2	cm/s
258-SB-003	42	SW	1123SG258003F	V	1.50	$1.7x10^{-4}$	0.192	24.9	44.0	$4.51x10^{-8}$	$4.50x10^{-3}$
258-SB-003	50	SW-SC	1123SG258004F	V	1.72	$<1.00x10^{-4}$	0.253	8.4	33.7	$5.99x10^{-10}$	$5.98x10^{-5}$
258-SB-001	46	SW-SM	1123SG258010F	V	1.37	$1.40x10^{-4}$	0.362	12.0	48.2	$3.90x10^{-10}$	$3.92x10^{-5}$
258-SB-001	62	CL	1123SG258011F	V	0.81	$1.72x10^{-4}$	0.486	17.2	65.8	$2.17x10^{-11}$	$2.18x10^{-6}$
258-SB-004	37	SM	1123SG258014F	V	1.60	$<1.00x10^{-4}$	0.265	12.3	38.9	$2.45x10^{-11}$	$2.46x10^{-6}$
258-SB-004	54	SM	1123SG258016F	V	1.84	$2.10x10^{-4}$	0.225	7.3	29.8	$2.65x10^{-11}$	$2.66x10^{-6}$
258-MW-002D	27	CL	1123SG258018F	V	1.55	$4.30x10^{-4}$	0.260	14.9	40.8	$2.33x10^{-11}$	$2.30x10^{-6}$
258-MW-002D	36	SW-SM	1123SG258020F	V	1.49	$2.10x10^{-4}$	0.109	32.4	43.3	$1.32x10^{-10}$	$1.29x10^{-5}$
258-MW-004D	38	SW-SC	1123SG258025F	V	1.52	$<1.00x10^{-4}$	0.232	17.9	41.2	$3.18x10^{-11}$	$3.16x10^{-6}$
258-MW-004D	35	CL	1123SG258024F	V	1.34	$2.50x10^{-4}$	0.387	8.8	47.5	$1.44x10^{-11}$	$1.44x10^{-6}$

Abbreviations:
%Vb = percentage of bulk volume
cm^2 = square centimeter
cm/s = centimenters per second
ft = feet
g/cc = grams per cubic centimeter
g/g = grams/gram
V = vertical

Checked: WJF
Approved: BPF

PLATES



MACTEC

Fort Hunter Liggett Location Map

Building 258 Investigation Area
Site Characterization Report
Fort Hunter Liggett, California

PLATE **1.1**

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084105686 01.1	NAM	9/2011	BPF	9/2011

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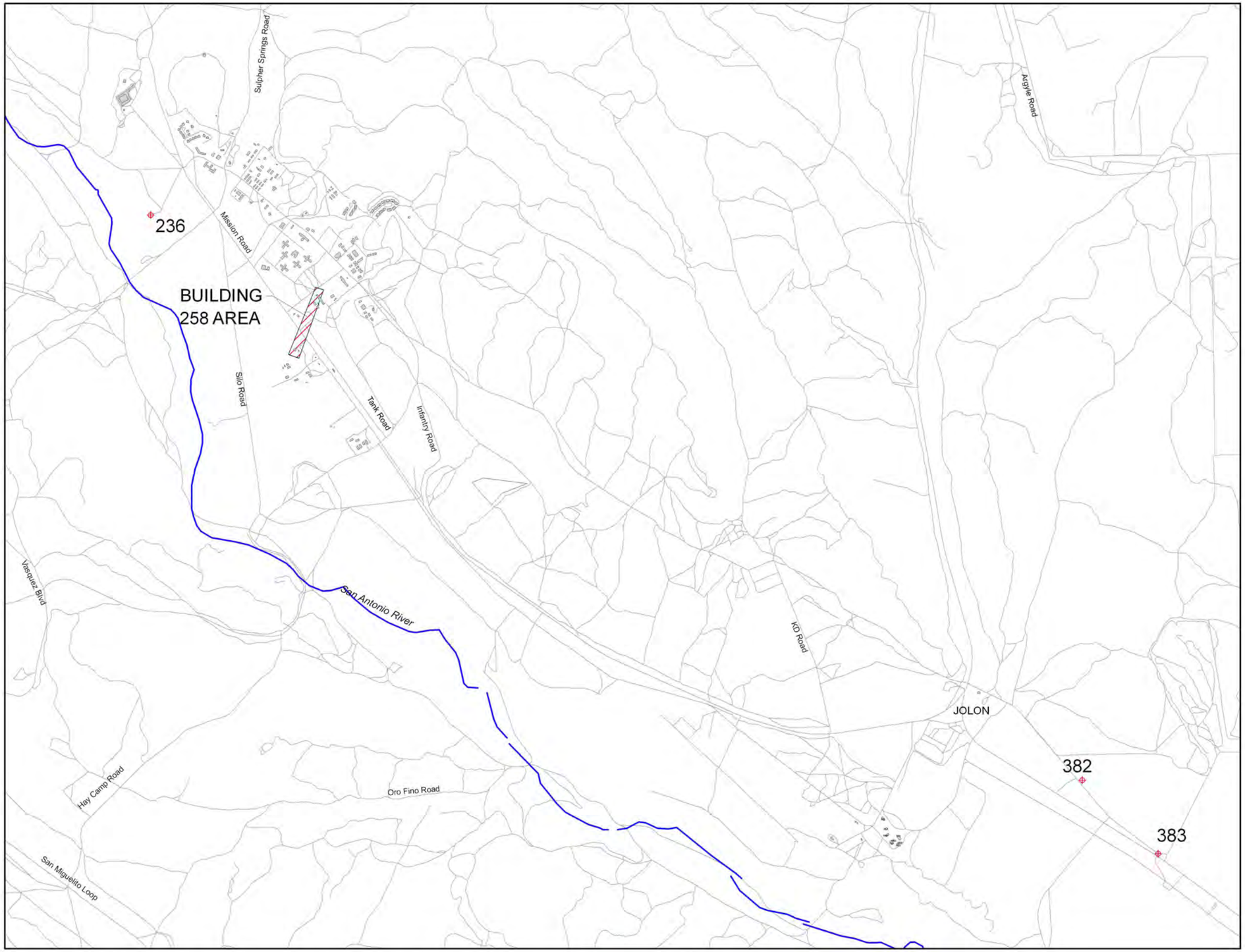

EXPLANATION

236 WATER SUPPLY WELL WITH WELL NUMBER

N

0 0.5 1 Miles

DRAWN: TJH	PROJECT NO: 4084106586 03	amec	Building 258 Investigation Site Characterization Report Fort Hunter Liggett	Building 258 Location Map	PLATE 1.2
ENGINEER:	SCALE: AS SHOWN				
CHECKED: NAM	APPROVED: BPF				
DATE: 9/2011	DATE: 9/2011				

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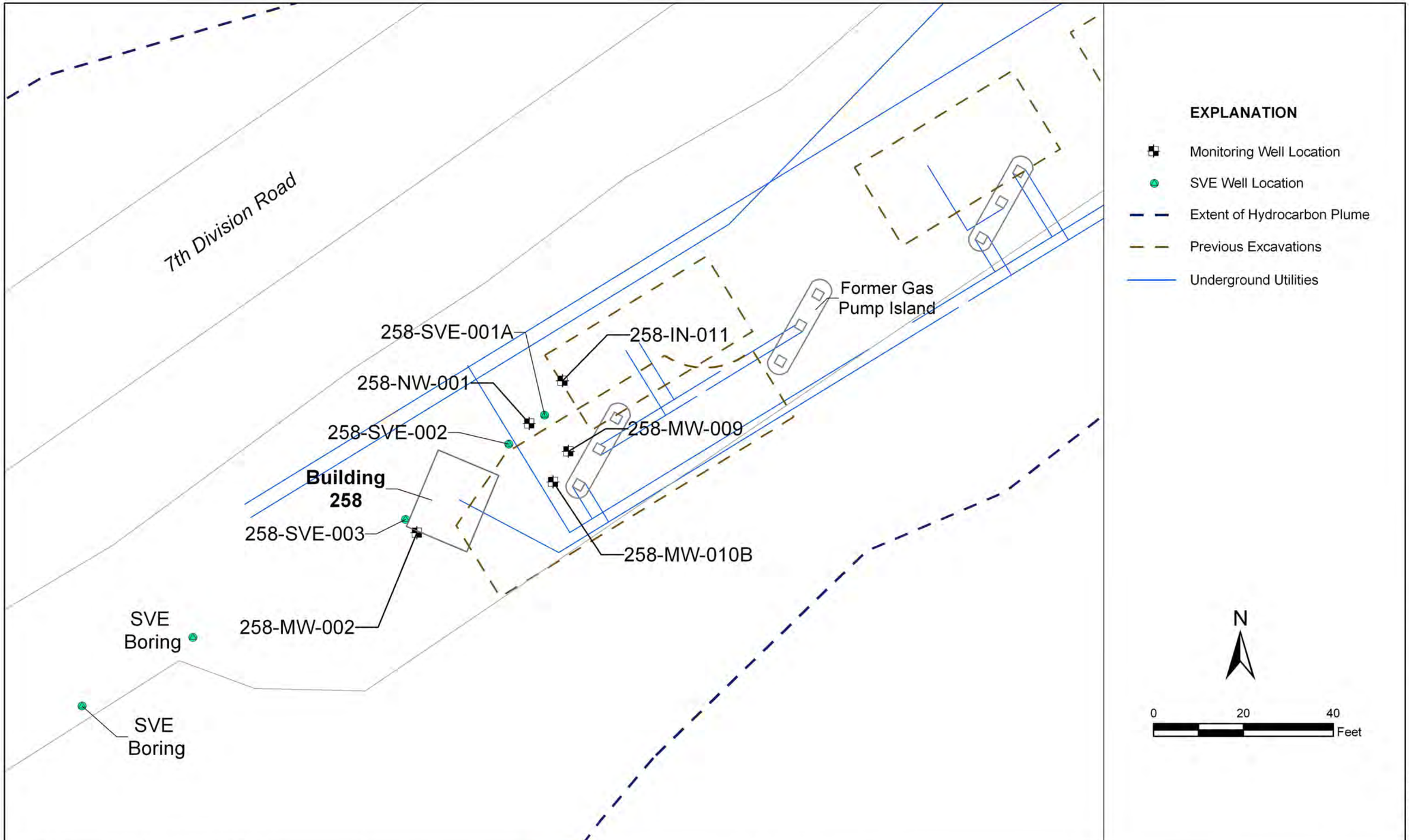

DRAWN: TJH	PROJECT NO: 4084106586 03.1		amec	Building 258 Investigation Site Charaterization Report Fort Hunter Liggett	Building 258 UST Excavtion Areas and Former Pump Island Locations	PLATE
ENGINEER:	SCALE: AS SHOWN					2.1
CHECKED: NAM	APPROVED: BPF					
DATE: 9/2011	DATE: 9/2011					

September 30, 2011 1:20:04 PM
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EXPLANATION

- Completed MIP
- Proposed MIP Location (Not completed)
- Completed UVOST
- Proposed UVOST Location (Not completed)
- Existing Monitoring Well Location
- New Monitoring Well Location
- Soil Boring Location
- SVE Well Location
- Extent of Hydrocarbon Plume, January 2011
- 3 Transect Number
- A A' Cross-Section Location

N

300 0 300 Feet

Aerial Photo Source: DigitalGlobe, June 2009

DRAWN: TJH	PROJECT NO. 4084106578 03.1	amec	Building 258 Investigation Site Characterization Report Fort Hunter Liggett	Plume Area Investigation Map Downgradient of Source Area	PLATE 4.1
ENGINEER:	SCALE: AS SHOWN				
CHECKED: NAM	APPROVED: BPF				
DATE: 9/2011	DATE: 9/2011				

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DRAWN: TJH	PROJECT NO: 4084106586 03.1		Building 258 Investigation Site Characterization Report Fort Hunter Liggett	Source Area Investigation Map	PLATE **4.2**
ENGINEER:	SCALE: AS SHOWN				
CHECKED: NAM	APPROVED: BPF				
DATE: 9/2011	DATE: 9/2011				

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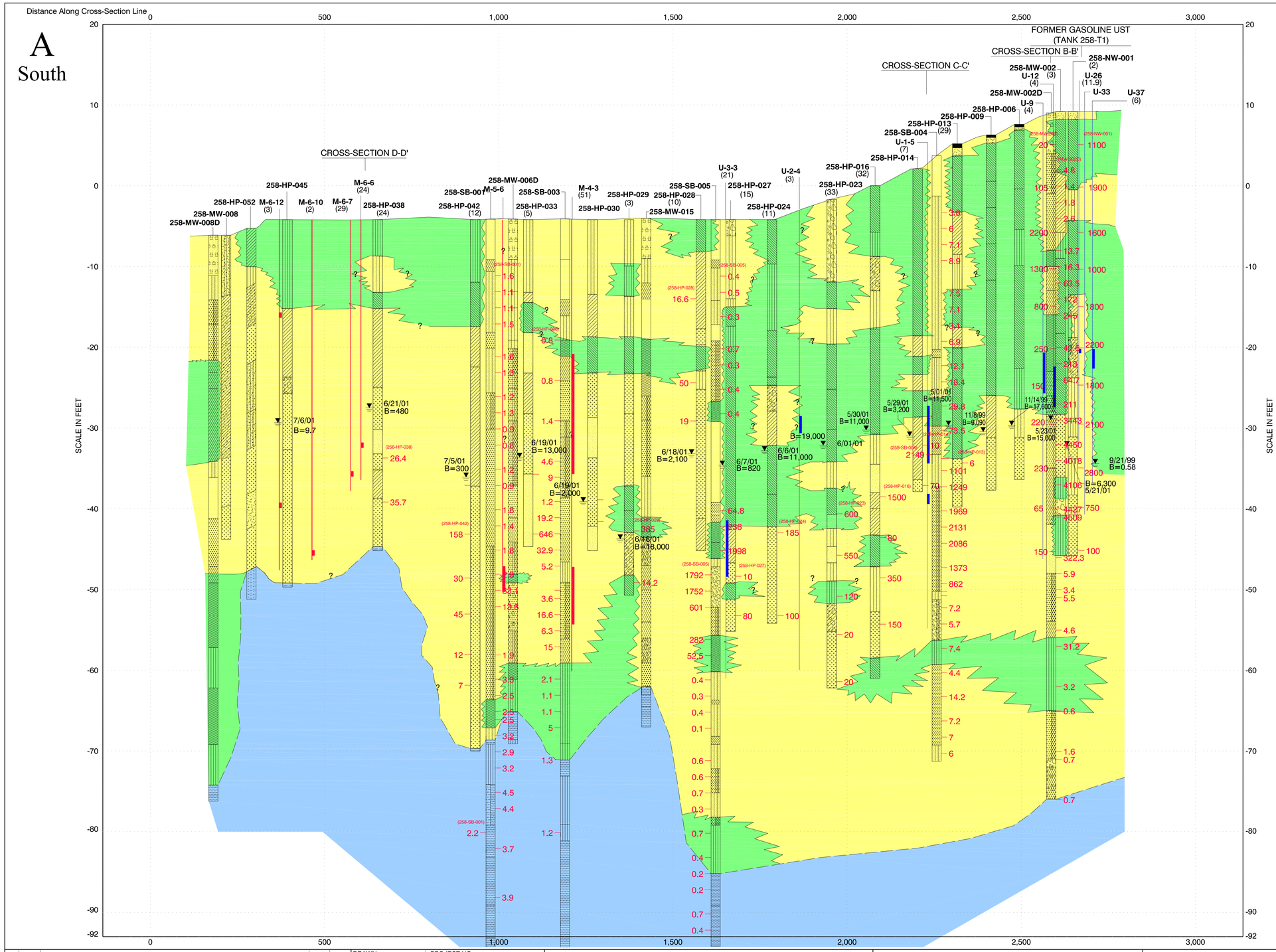


EXPLANATION

?	CONTACT BETWEEN UNITS; QUERIED WHERE UNCERTAIN
258-NW-001 (2)	WELL OR BORING ID WITH APPROXIMATE OFFSET DISTANCE FROM CROSS-SECTION LINE
5/21/01	APPROXIMATE GROUNDWATER LEVEL AND DATE MEASURED IN BOREHOLE
B=33,100	CONCENTRATION OF BENZENE IN MICROGRAMS PER LITER IN GROUNDWATER SAMPLE COLLECTED FROM OPEN BOREHOLE
ND	NOT DETECTED
100	PID READING IN ppm
	UVOST -- FREE PRODUCT
	MIP -- PID DETECTION
	CLAY AND SILT: sandy silt, silt with sand, clay with sand, sandy clay, gravelly clay, clay, silt
	SAND AND GRAVEL: Clayey sand with gravel, silty sand, clayey sand, clayey gravel with sand, silty sand with gravel, well graded sand with gravel, well graded sand, silty gravel
	BEDROCK: Mudstone

NOTES:

1. SURFACE ELEVATIONS ARE APPROXIMATE
2. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 4.1

40841005600 DWG 1.0
2011/05/11 (1:40)

NO.	DATE	REVISIONS	BY	CHK

DRAWN: TJH	PROJECT NO: 40841005686 01.1
ENGINEER:	SCALE:
CHECKED: NAM	APPROVED: BPF
DATE: 3/2011	DATE: 3/2011

amec

Building 258 Investigation

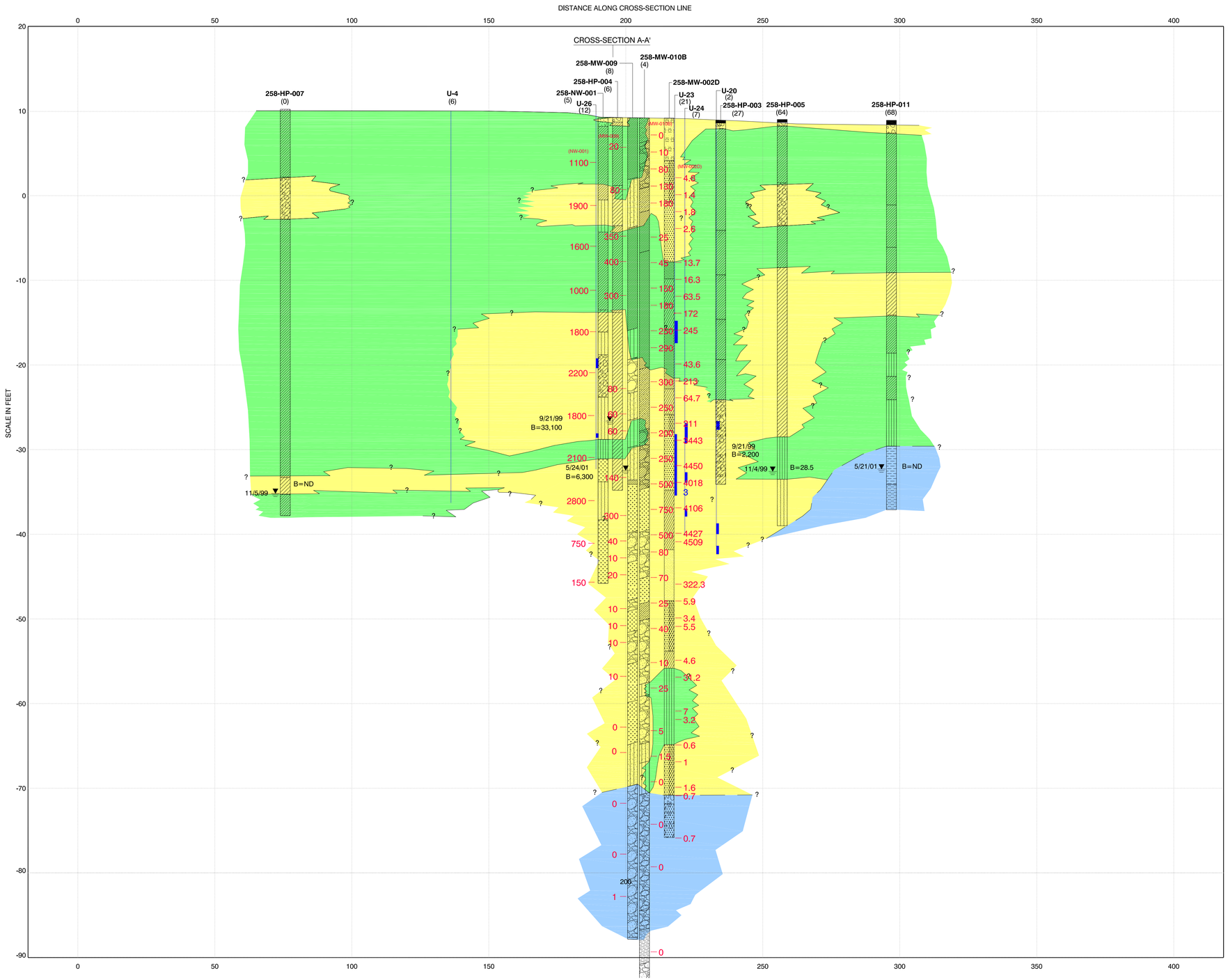
Site Characterization Report
Fort Hunter Liggett, California

Representative Cross-Section A-A'

PLATE: **4.3**
SHEET: OF
REVISION NUMBER: 0
DATE: 9/2011

B
Northwest

B'
Southeast



SCALE IN FEET

10
0
SCALE IN FEET
0
25

EXPLANATION

?	CONTACT BETWEEN UNITS; QUERIED WHERE UNCERTAIN
258-MW-009 (8)	WELL OR BORING ID WITH APPROXIMATE OFFSET DISTANCE FROM CROSS-SECTION LINE
5/21/01	APPROXIMATE GROUNDWATER LEVEL AND DATE MEASURED IN BOREHOLE
B=33,100	CONCENTRATION OF BENZENE IN MICROGRAMS PER LITER IN GROUNDWATER SAMPLE COLLECTED FROM OPEN BOREHOLE
ND	NOT DETECTED
100	PID READING IN ppm
I	UVOST -- FREE PRODUCT
	CLAY AND SILT: sandy silt, silt with sand, clay with sand, sandy clay, gravelly clay, clay, silt
	SAND AND GRAVEL: Clayey sand with gravel, silty sand, clayey sand, clayey gravel with sand, silty sand with gravel, well graded sand with gravel, well graded sand, silty gravel
	BEDROCK: Mudstone/Conglomerate

NOTES:

1. SURFACE ELEVATIONS ARE APPROXIMATE
2. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 4.1

4084106586GN.DWG 1-0
2011/02/03/05

NO.	DATE	REVISIONS	BY	CHK

DRAWN: PCB	PROJECT NO: 4084106586 03.1
ENGINEER:	SCALE:
CHECKED: NAM	APPROVED: BPF
DATE: 3/2011	DATE: 3/2011

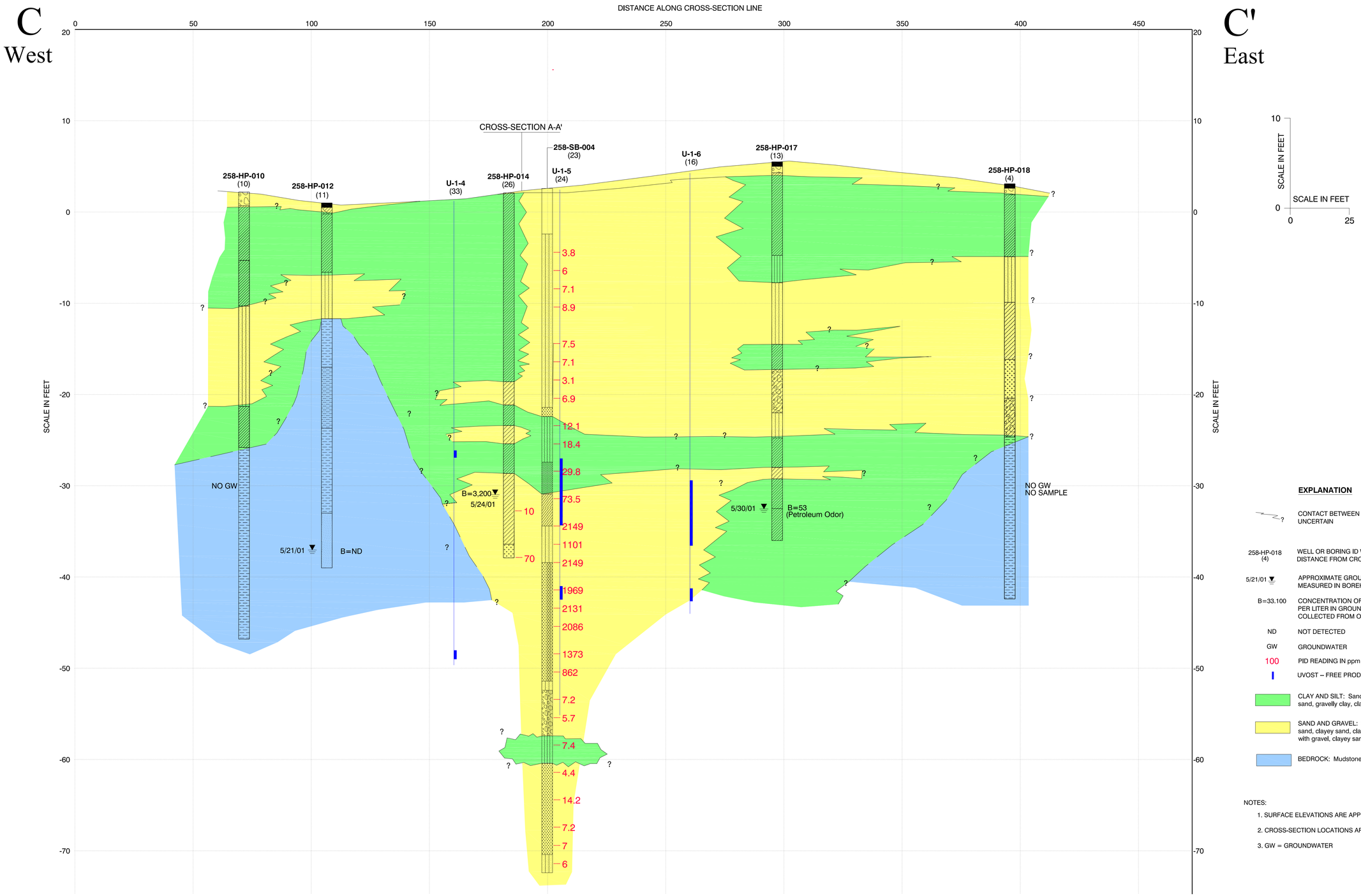
amec

Building 258 Investigation

Site Characterization Report
Fort Hunter Liggett, California

Representative Cross-Section B-B'

PLATE: **4.4**
SHEET: **1** OF **1**
REVISION NUMBER: 0
DATE: 9/2011



NO.	DATE	REVISIONS	BY	CHK

DRAWN: PCB	PROJECT NO: 4084106586 03.1
ENGINEER:	SCALE:
CHECKED: NAM	APPROVED: BPF
DATE: 3/2011	DATE: 3/2011

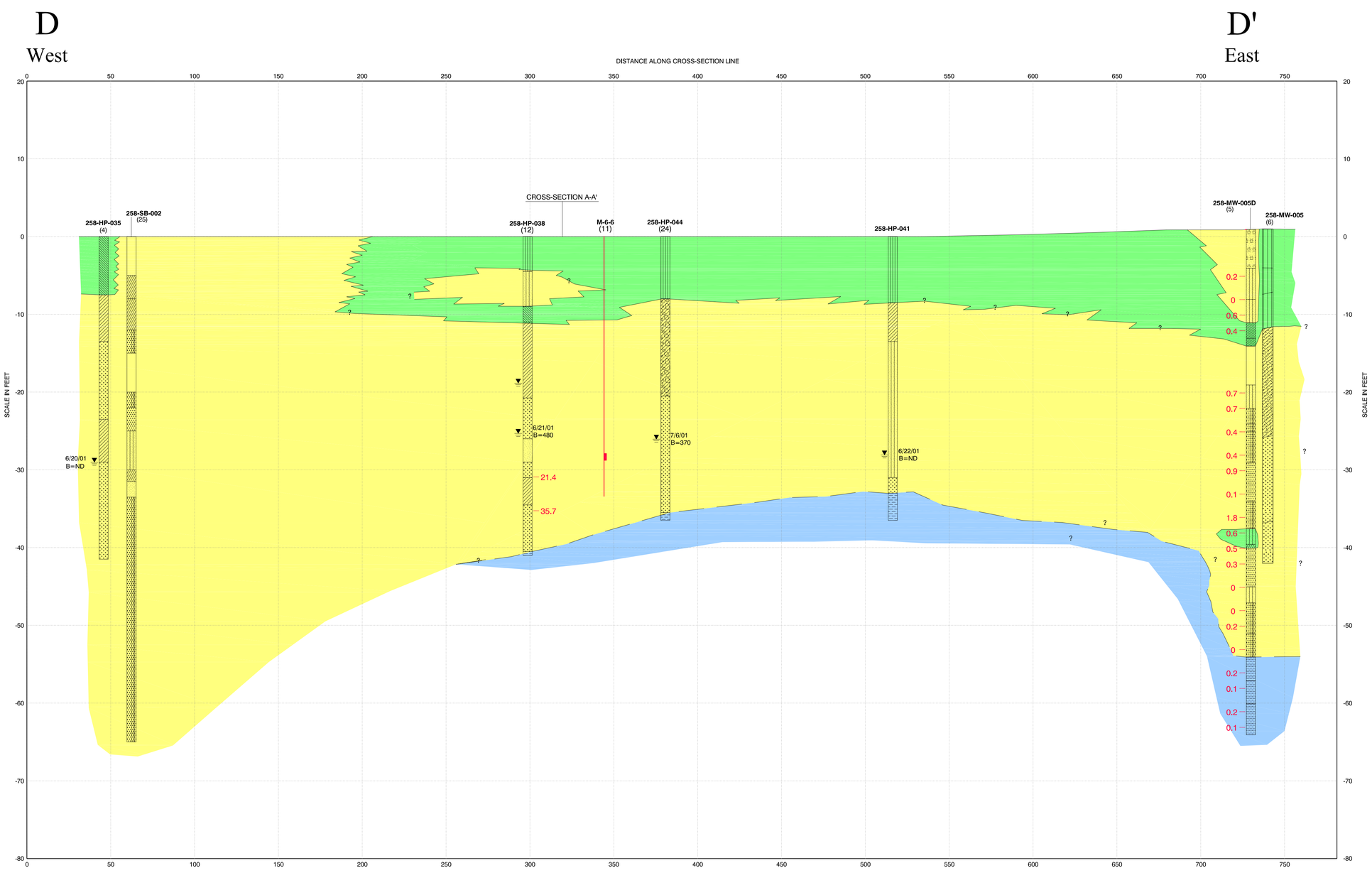
amec

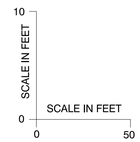
Building 258 Investigation

Site Characterization Report
Fort Hunter Liggett, California

Representative Cross-Section C-C'

PLATE:	4.5
SHEET:	1 OF 1
REVISION NUMBER:	0
DATE:	9/2011





EXPLANATION

?	CONTACT BETWEEN UNITS; QUERIED WHERE UNCERTAIN
258-MW-005 (6)	WELL OR BORING ID WITH APPROXIMATE OFFSET DISTANCE FROM CROSS-SECTION LINE
5/21/01	APPROXIMATE GROUNDWATER LEVEL AND DATE MEASURED IN BOREHOLE
B=33,100	CONCENTRATION OF BENZENE IN MICROGRAMS PER LITER IN GROUNDWATER SAMPLE COLLECTED FROM OPEN BOREHOLE
ND	NOT DETECTED
21.4	PID READING IN ppm
	MIP – PID DETECTION
	CLAY AND SILT: sandy silt, silt with sand, clay with sand, sandy clay, gravelly clay, clay, silt
	SAND AND GRAVEL: Clayey sand with gravel, silty sand, clayey sand, clayey gravel with sand, silty sand with gravel, well graded sand with gravel, well graded sand, silty gravel
	BEDROCK: Mudstone

NOTES:

1. SURFACE ELEVATIONS ARE APPROXIMATE
2. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 4.1

4084106586D12.DWG 1.0
20110505:0913

NO.	DATE	REVISIONS	BY	CHK

DRAWN: PCB	PROJECT NO: 4084106586 03.1
ENGINEER:	SCALE:
CHECKED: NAM	APPROVED: BPF
DATE: 3/2011	DATE: 3/2011

amec

Building 258 Investigation

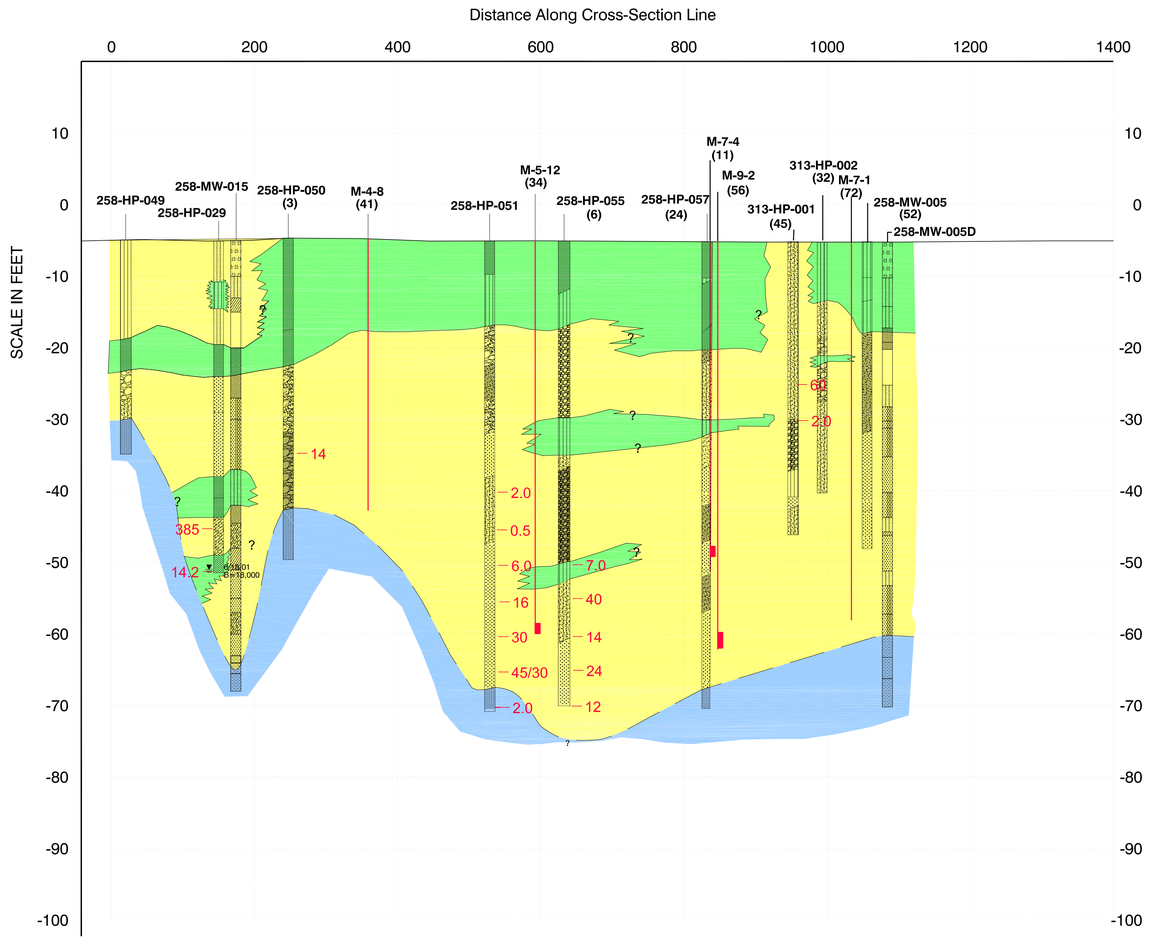
Site Characterization Investigation
Fort Hunter Liggett, California

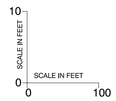
Representative Cross-Section D-D'

PLATE:	4.6
SHEET:	1 OF 1
REVISION NUMBER:	0
DATE:	9/2011

E
Northwest

E'
Southeast





EXPLANATION

?	CONTACT BETWEEN UNITS; QUERIED WHERE UNCERTAIN
258-MW-005 (52)	WELL OR BORING ID WITH APPROXIMATE OFFSET DISTANCE FROM CROSS-SECTION LINE
5/21/01	APPROXIMATE GROUNDWATER LEVEL AND DATE MEASURED IN BOREHOLE
B=33,100	CONCENTRATION OF BENZENE IN MICROGRAMS PER LITER IN GROUNDWATER SAMPLE COLLECTED FROM OPEN BOREHOLE
ND	NOT DETECTED
100	PID READING IN ppm
	MIP -- PID DETECTION
	CLAY AND SILT: sandy silt, silt with sand, clay with sand, sandy clay, gravelly clay, clay, silt
	SAND AND GRAVEL: Clayey sand with gravel, silty sand, clayey sand, clayey gravel with sand, silty sand with gravel, well graded sand with gravel, well graded sand, silty gravel
	BEDROCK: Mudstone

NOTES:

1. SURFACE ELEVATIONS ARE APPROXIMATE
2. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 4.1

4084106586SOLDWG 1.0
20110025.TXT

NO.	DATE	REVISIONS	BY	CHK

DRAWN: PCB	PROJECT NO: 4084106586 03.1
ENGINEER:	SCALE:
CHECKED: NAM	APPROVED: BPF
DATE: 3/2011	DATE: 3/2011

amec

Building 258 Investigation

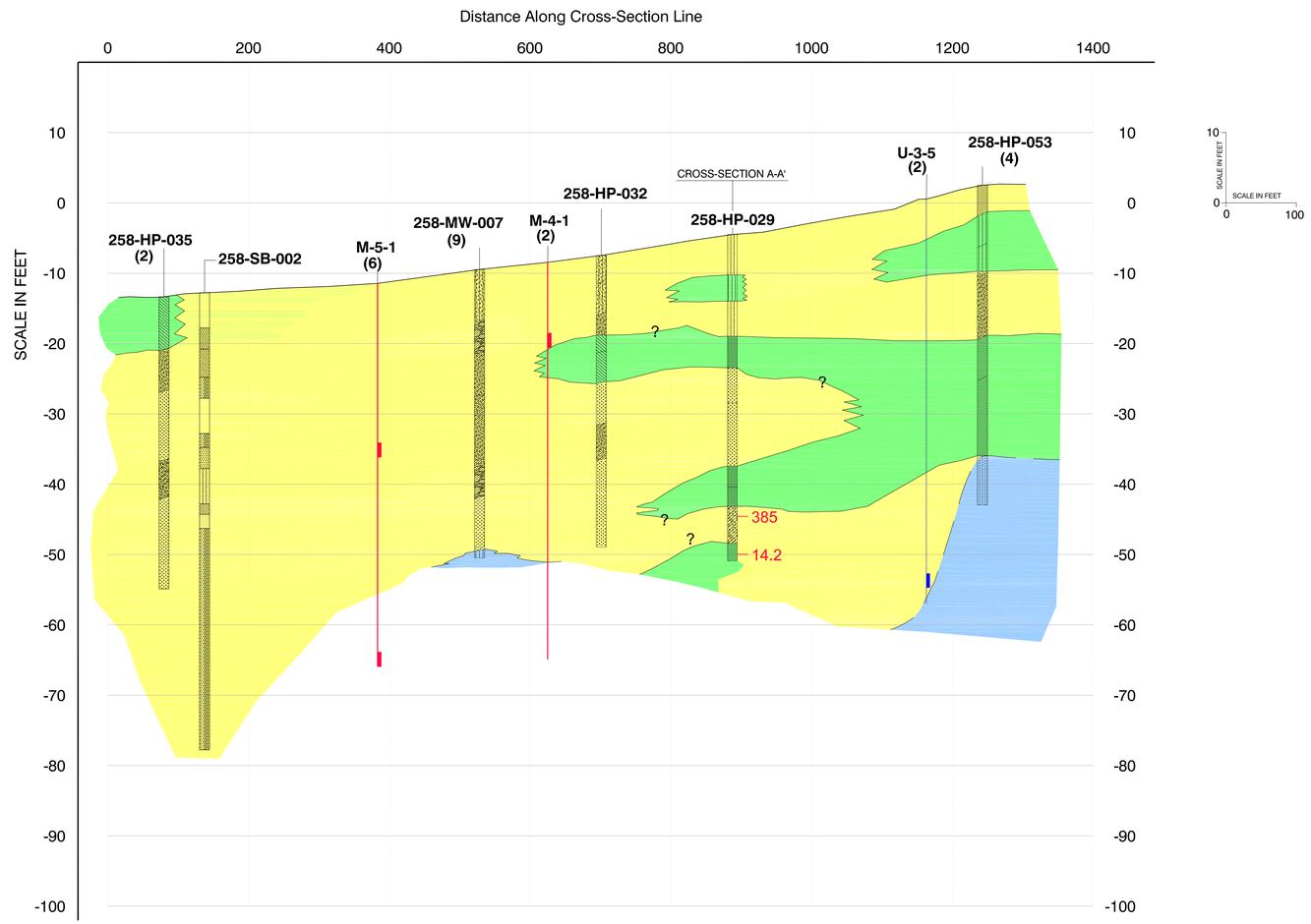
Site Investigation Report
Fort Hunter Liggett, California

Representative Cross-Section E-E'

PLATE:	4.7
SHEET:	1 OF 1
REVISION NUMBER:	0
DATE:	9/2011

F — Southwest

F' — Northeast



EXPLANATION

?	CONTACT BETWEEN UNITS; QUERIED WHERE UNCERTAIN
258-HP-053 (4)	WELL OR BORING ID WITH APPROXIMATE OFFSET DISTANCE FROM CROSS-SECTION LINE
5/21/01 ▼	APPROXIMATE GROUNDWATER LEVEL AND DATE MEASURED IN BOREHOLE
B=33,100	CONCENTRATION OF BENZENE IN MICROGRAMS PER LITER IN GROUNDWATER SAMPLE COLLECTED FROM OPEN BOREHOLE
ND	NOT DETECTED
100	PID READING IN ppm
	UVOST -- FREE PRODUCT
	MIP -- PID DETECTION
	CLAY AND SILT: sandy silt, silt with sand, clay with sand, sandy clay, gravelly clay, clay, silt
	SAND AND GRAVEL: Clayey sand with gravel, silty sand, clayey sand, clayey gravel with sand, silty sand with gravel, well graded sand with gravel, well graded sand, silty gravel
	BEDROCK: Mudstone

NOTES:

1. SURFACE ELEVATIONS ARE APPROXIMATE
2. CROSS-SECTION LOCATIONS ARE SHOWN ON PLATE 4.1

4084106586G1.DWG 1.0
2011/02/24 SAG

NO.	DATE	REVISIONS	BY	CHK

DRAWN: PCB	PROJECT NO: 4084106586 03.1
ENGINEER:	SCALE:
CHECKED: NAM	APPROVED: BPF
DATE: 3/2011	DATE: 3/2011

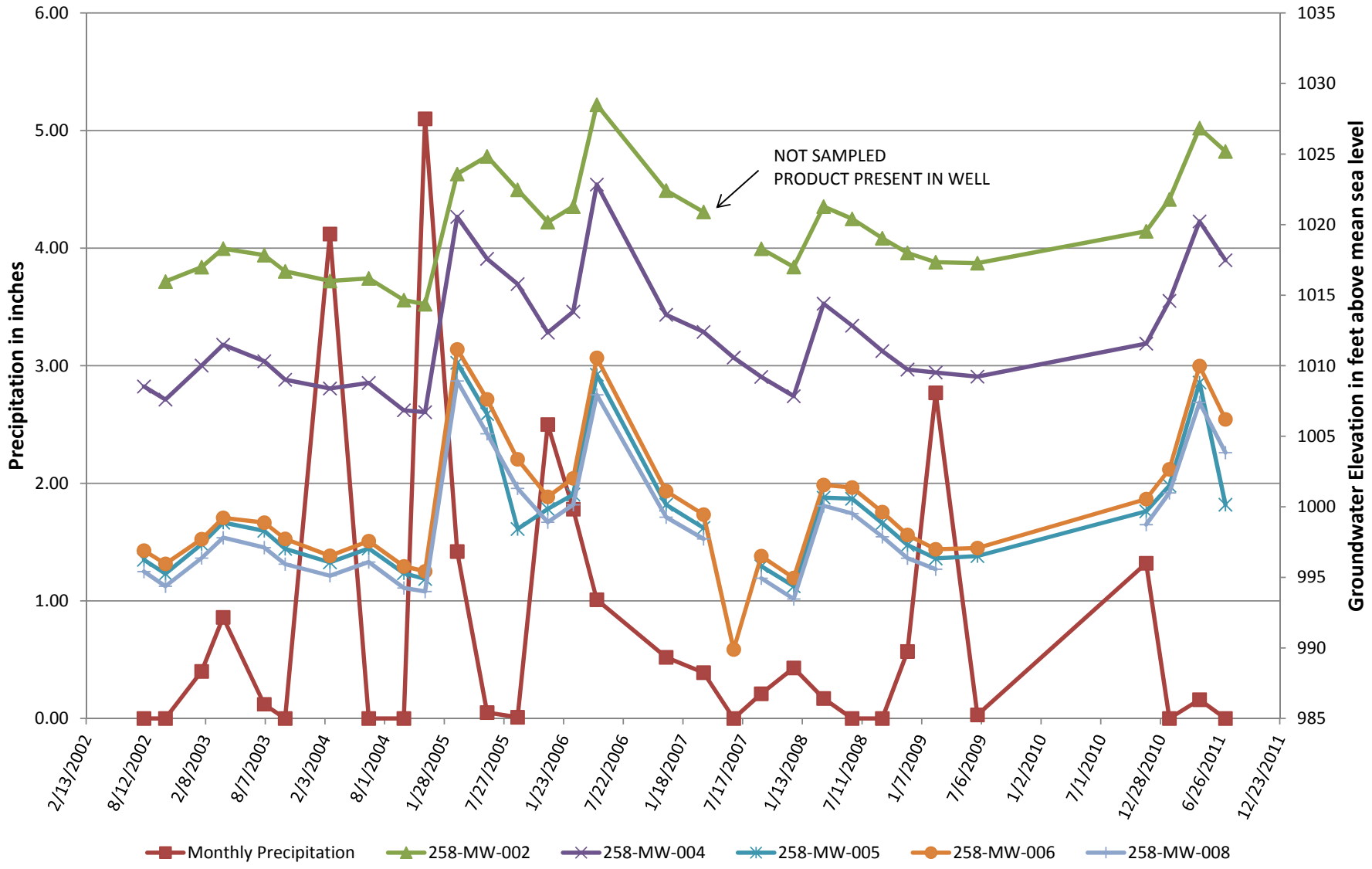
amec

Building 258 Investigation

Site Investigation Report
Fort Hunter Liggett, California

Representative Cross-Section F-F'

PLATE: **4.8**
SHEET: **1** OF **1**
REVISION NUMBER: 0
DATE: 9/2011



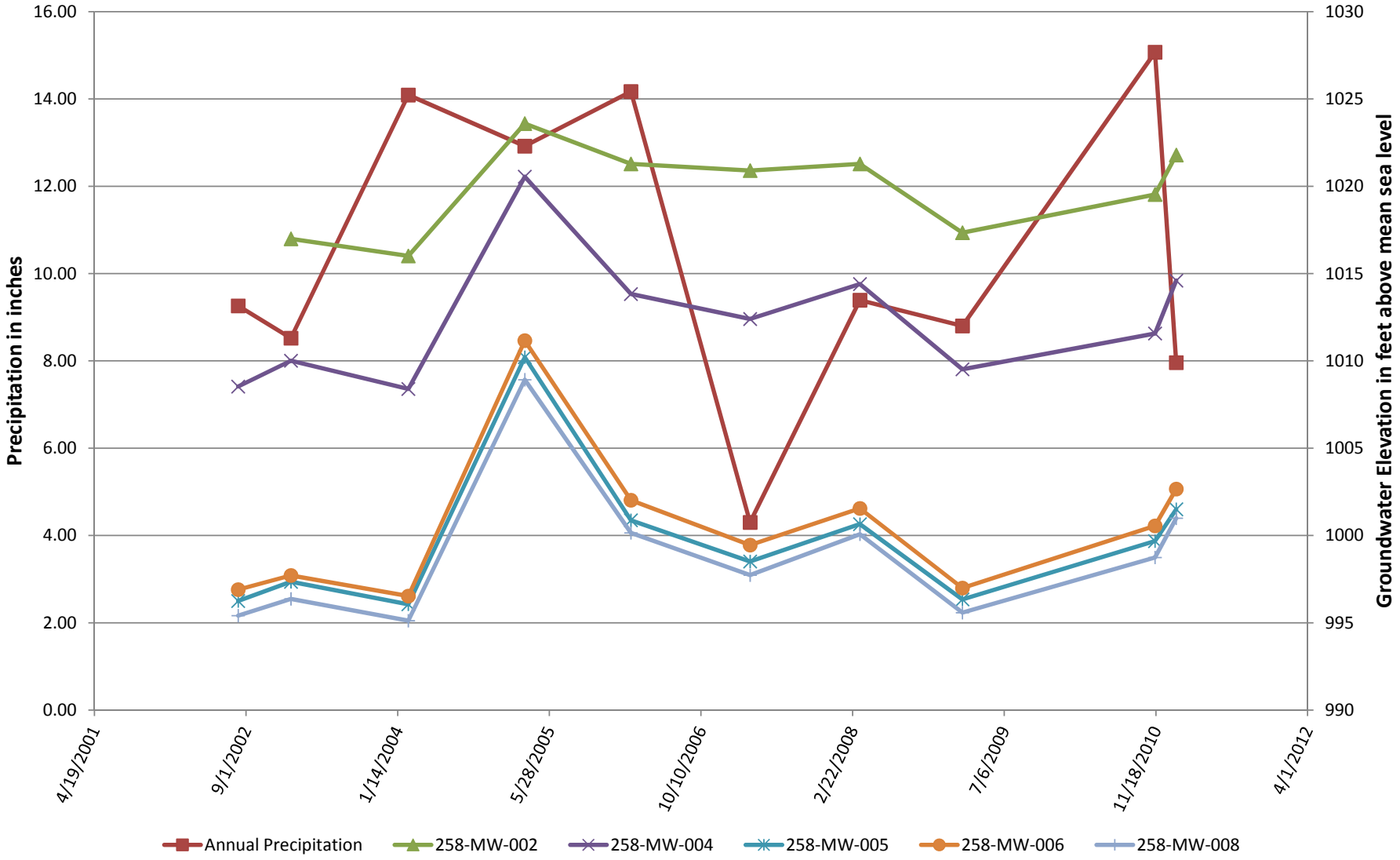
amec

Monthly Precipitation and Water Level vs Time

2002 through 2011
Fort Hunter Liggett Building 258
Fort Hunter Liggett, California

Plate **5.1**

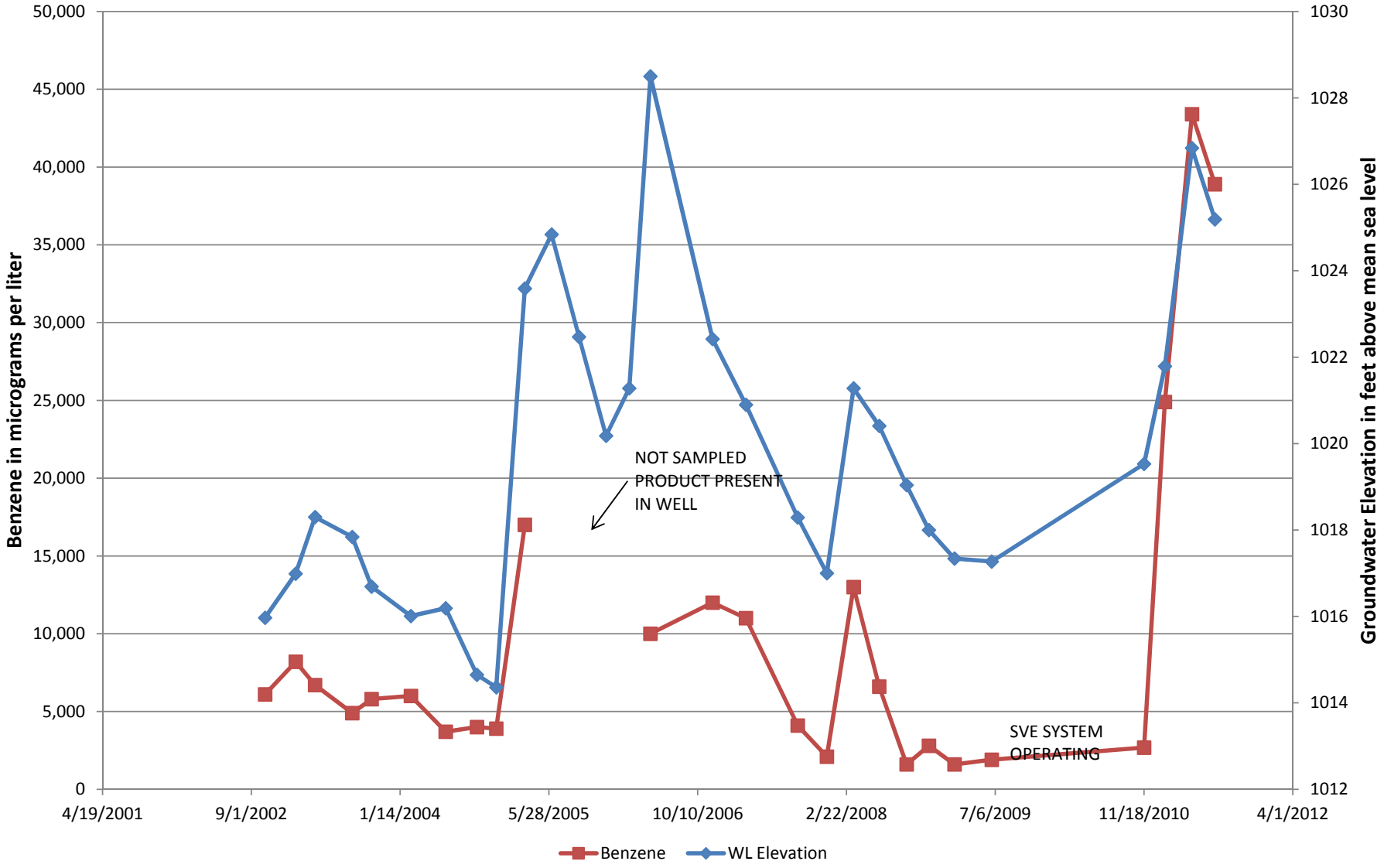
DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
NAM	4084106586 03.1	WJF	3/2011	BPF	3/2011



** Annual Precipitation amounts were compared to the groundwater elevations in the earliest recorded month in each year

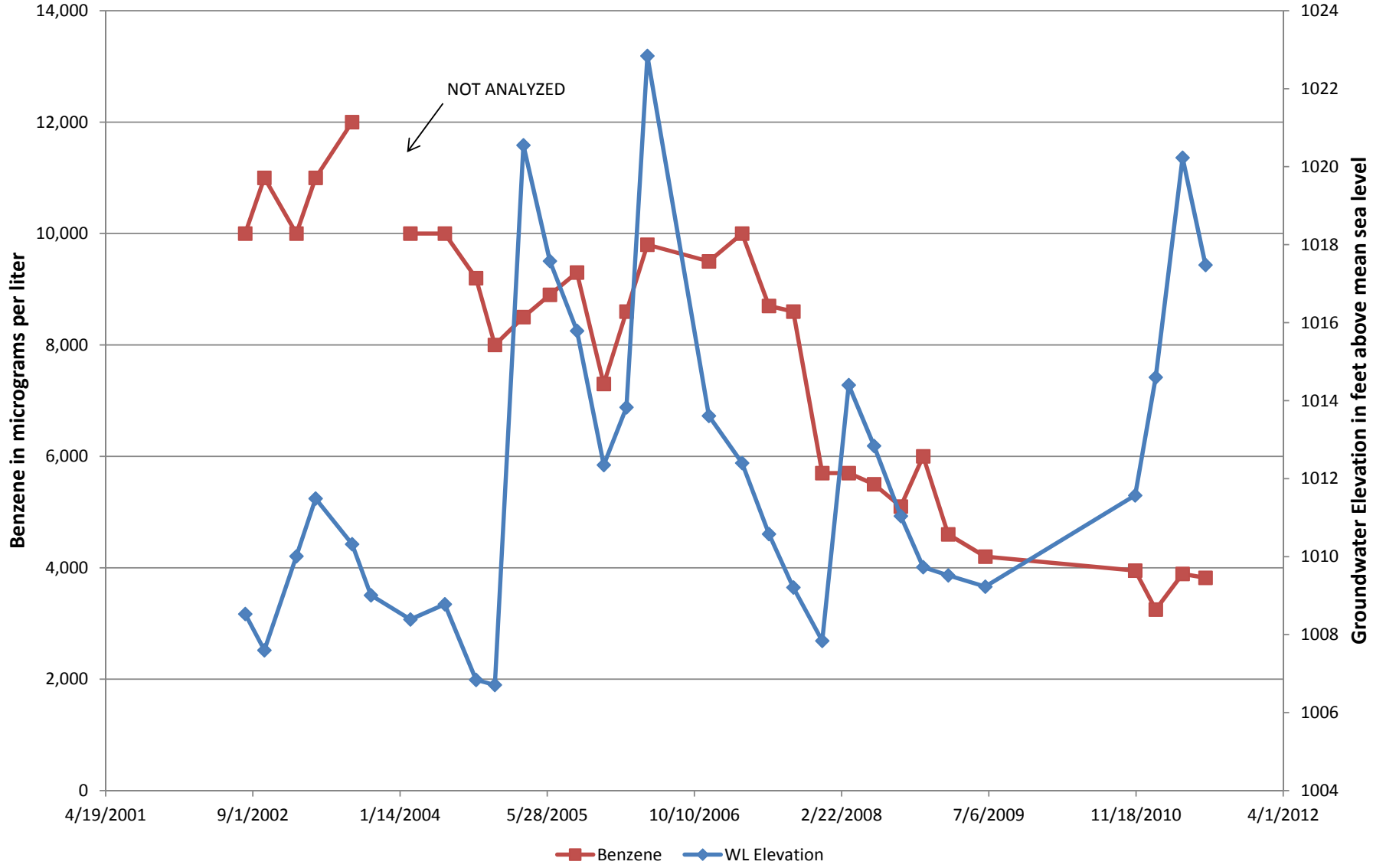
amec	Annual Precipitation and Water Level vs Time 2002 through 2011 Fort Hunter Liggett Building 258 Fort Hunter Liggett, California	Plate **5.2**

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
NAM	4084106586 03.1	WJF	3/2011	BPF	3/2011



amec	Benzene and Water Level vs Time 258-MW-002 2002 through 2011 Fort Hunter Liggett Building 258 Fort Hunter Liggett, California	Plate **5.3**

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
NAM	4084106586 03.1	WJF	3/2011	BPF	3/2011



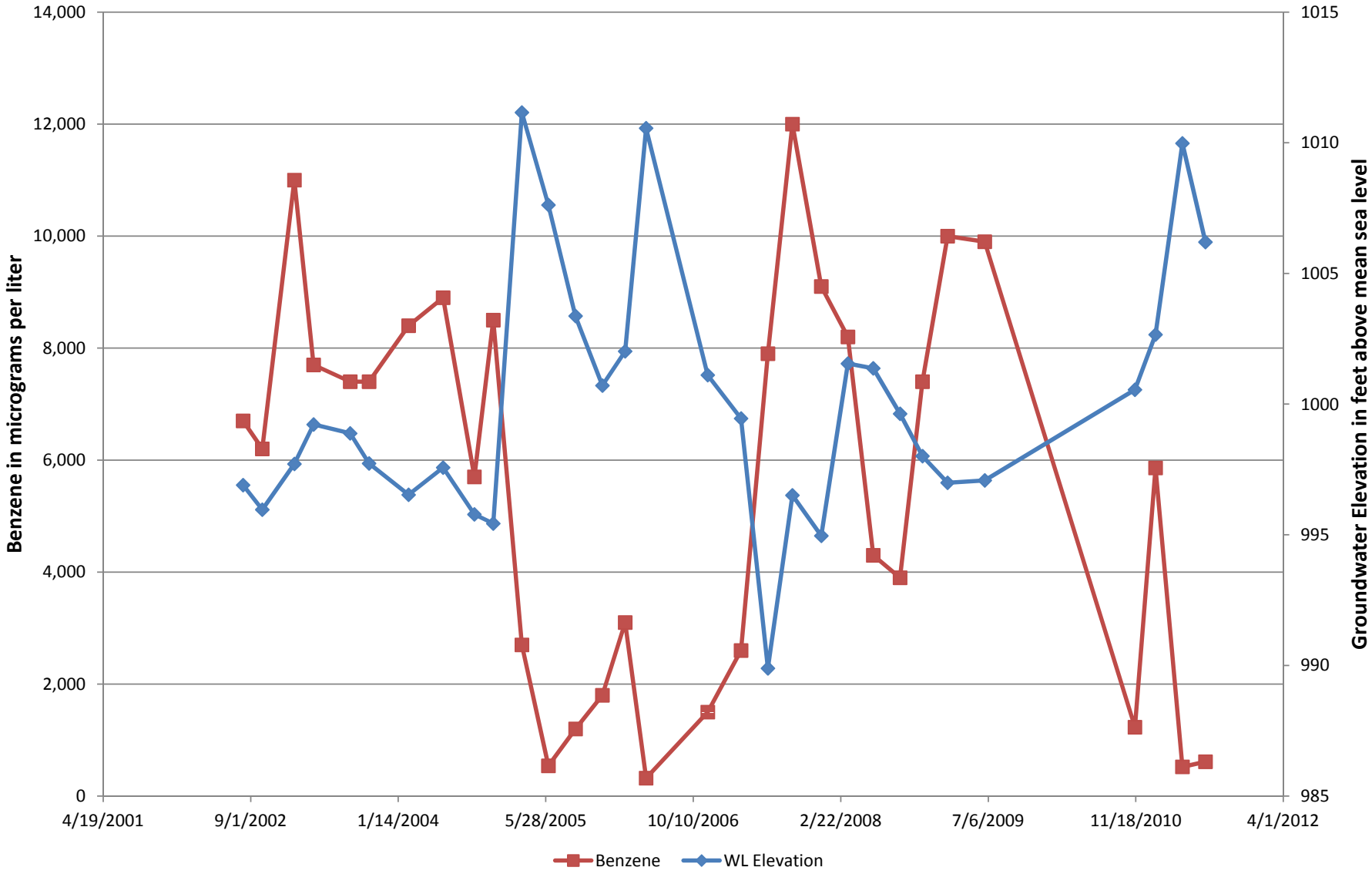
amec

Benzene and Water Level vs Time
258-MW-004
2002 through 2011
Fort Hunter Liggett Building 258
Fort Hunter Liggett, California

Plate

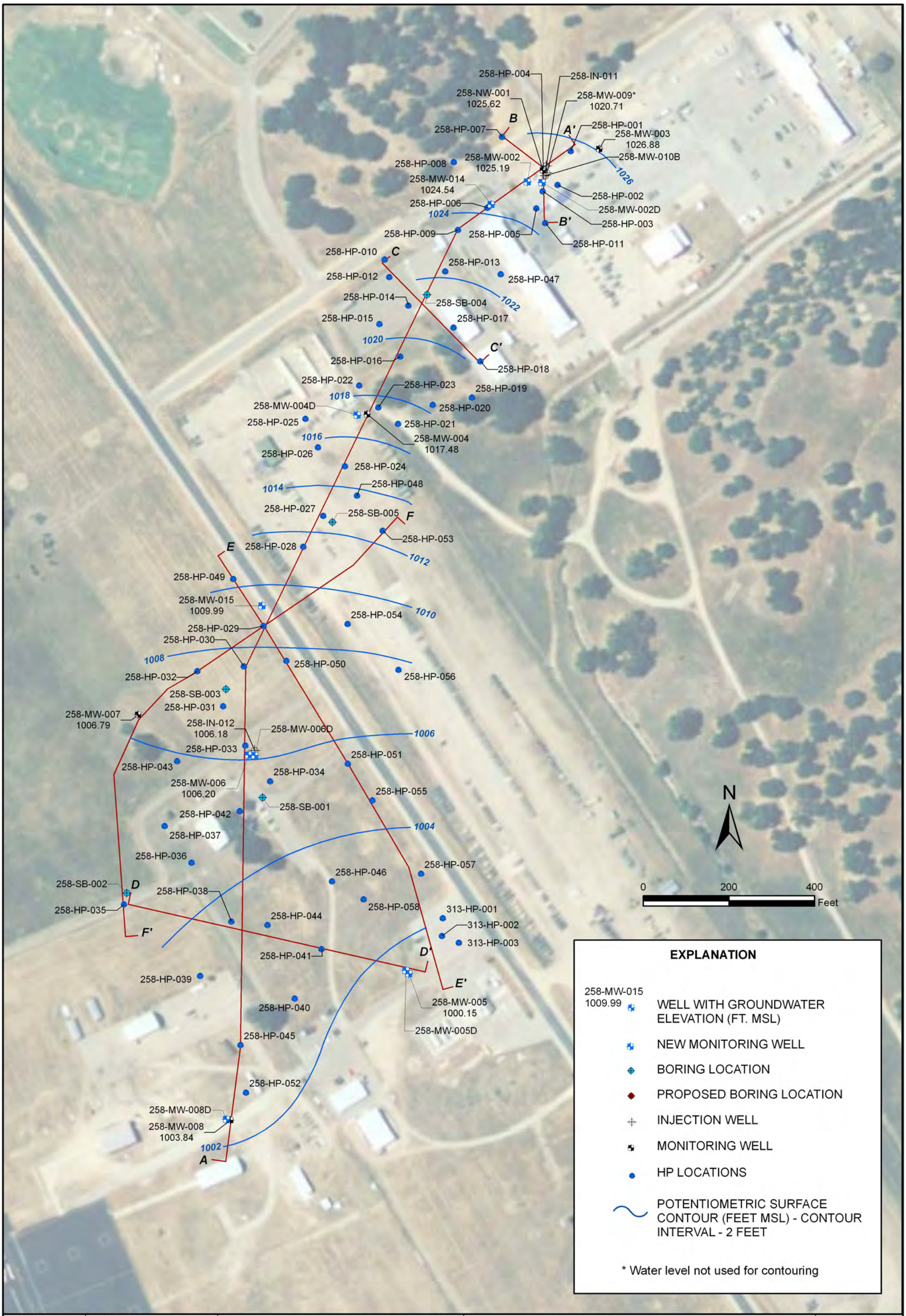
5.4

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
NAM	4084106586 03.1	WJF	3/2011	BPF	3/2011



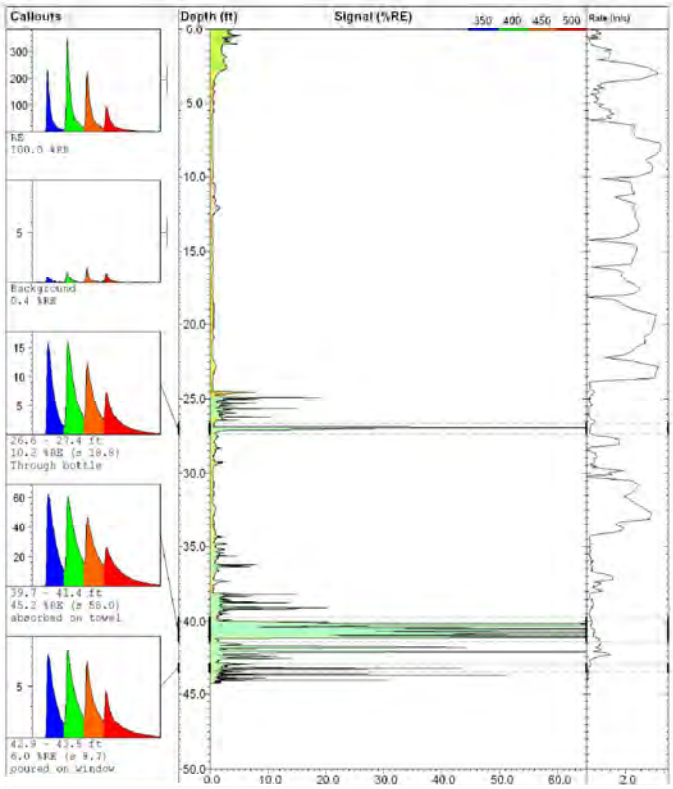
amec	Benzene and Water Level vs Time 258-MW-006 2002 through 2011 Fort Hunter Liggett Building 258 Fort Hunter Liggett, California	Plate **5.5**

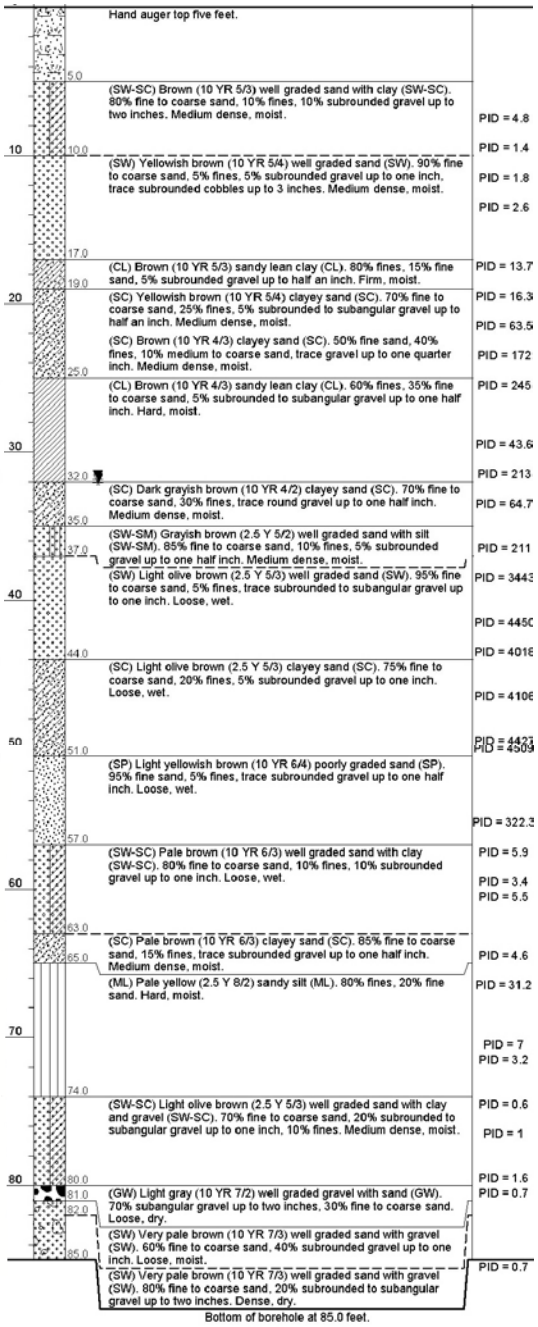
DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
NAM	4084106586 03.1	WJF	3/2011	BPF	3/2011



DRAWN: TJH	PROJECT NO: 4084106586 03.1	amec	**Potentiometric Surface Map** Building 258 Investigation Site Characterization Report Fort Hunter Liggett	PLATE **5.6**
ENGINEER:	SCALE: AS SHOWN			
CHECKED: NAM	DATE: 9/2011			
APPROVED: BPF	DATE:			

Monday, September 26, 2011 2:37:45 PM
P:\4084\106586_FHL258\GIS\Projects\CharacterizationReport\WaterLevels.mxd





ROP = Rate of Penetration
%RE = Percentage of Reference Emitter

MIP log prepared by Columbia Technologies
Boring log prepared by AES

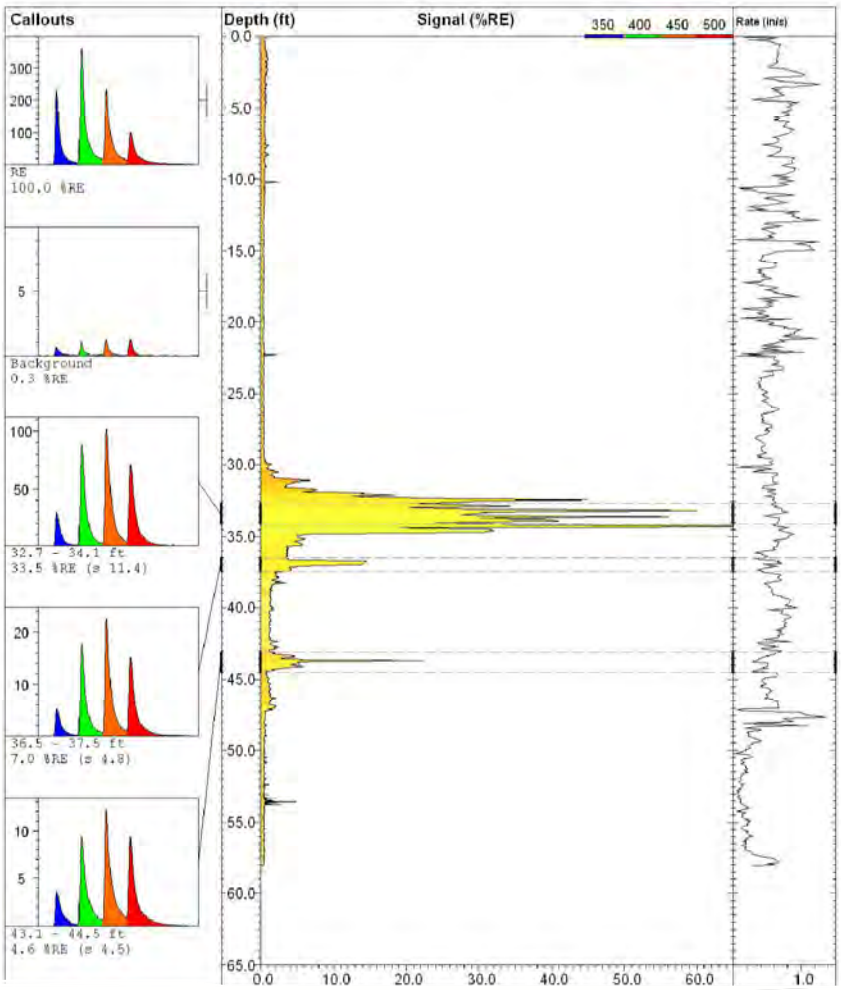
4084106586014.DWG 500
20110926.183

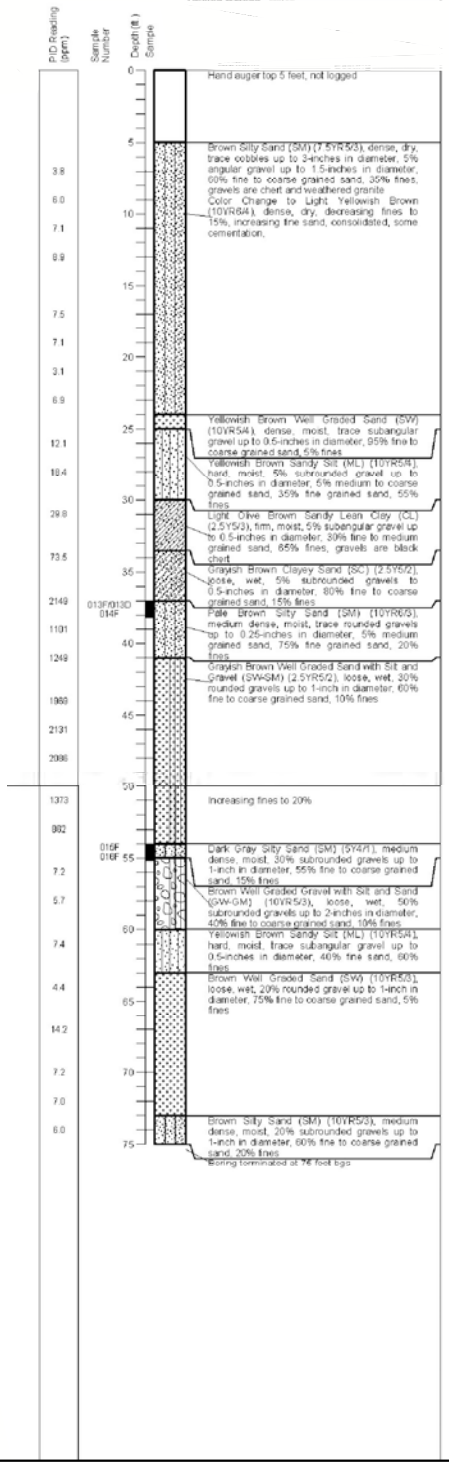
amec

258-MW-002D Boring Log and UVOST U-23
Building 258 Investigation
Site Characterization Report
Fort Hunter Liggett, California

PLATE
6.1

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084106586 03.1	NAM	9/2011	BPF	9/2011





ROP = Rate of Penetration
%RE = Percentage of Reference Emitter

MIP log prepared by Columbia Technologies
Boring log prepared by AMEC

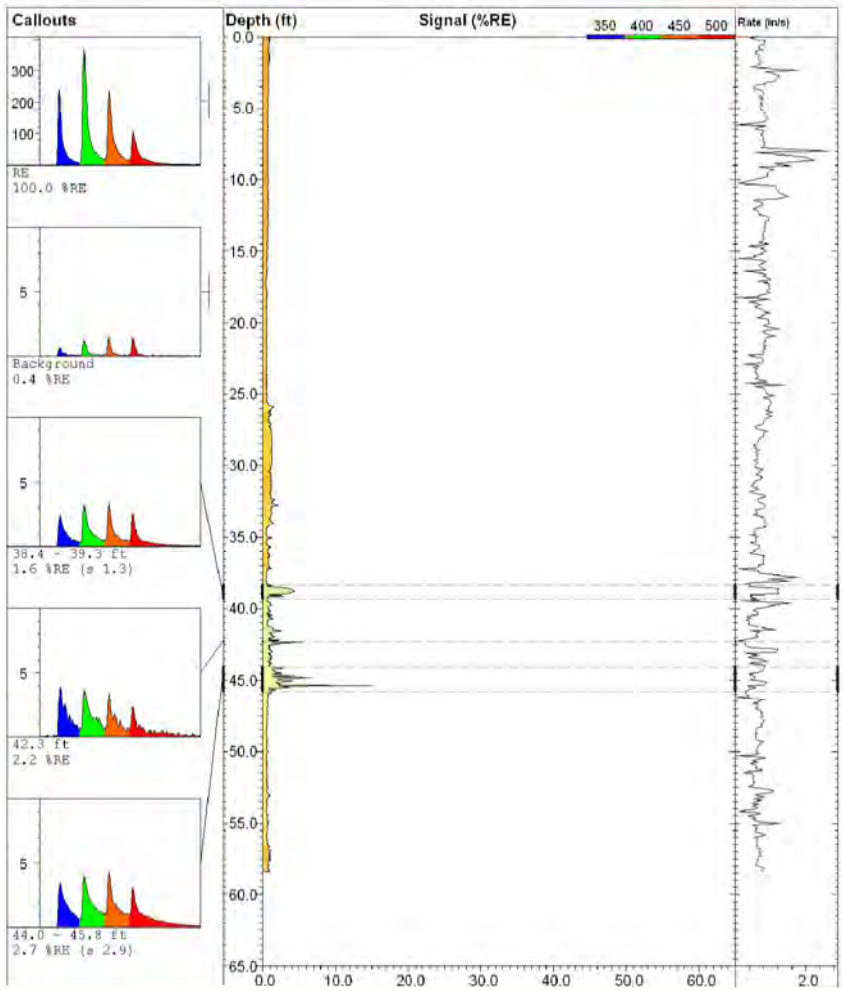
4084106586015.DWG 500
20110926.1839

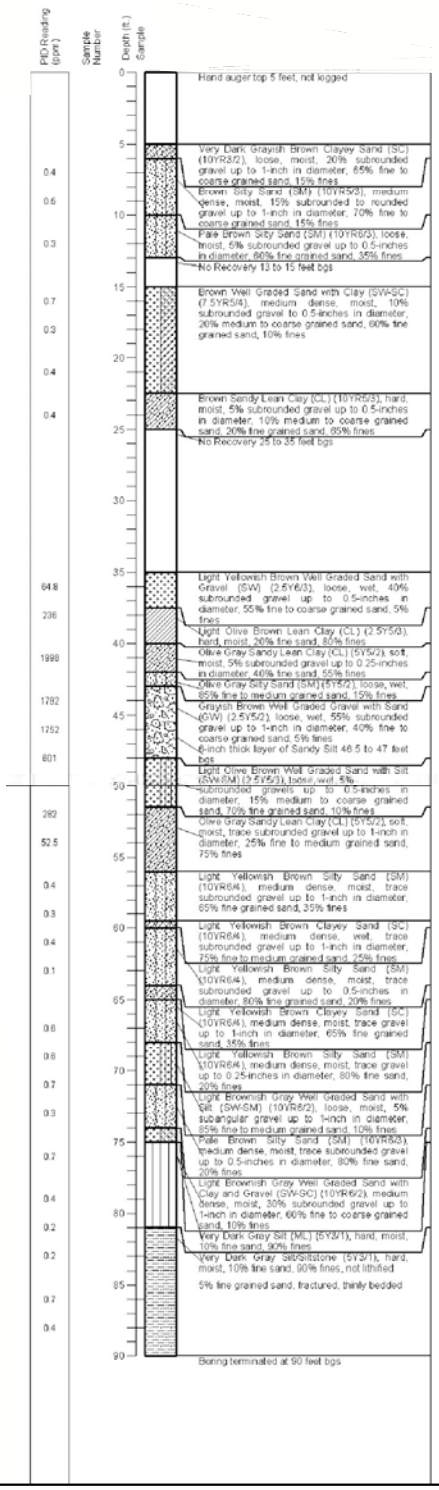
amec

258-SB-004 Boring Log and UVOST U-1-5
Building 258 Investigation
Site Characterization Report
Fort Hunter Liggett, California

PLATE
6.2

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084106586 03.1	NAM	9/2011	BPF	9/2011





ROP = Rate of Penetration
%RE = Percentage of Reference Emitter

MIP log prepared by Columbia Technologies
Boring log prepared by AMEC

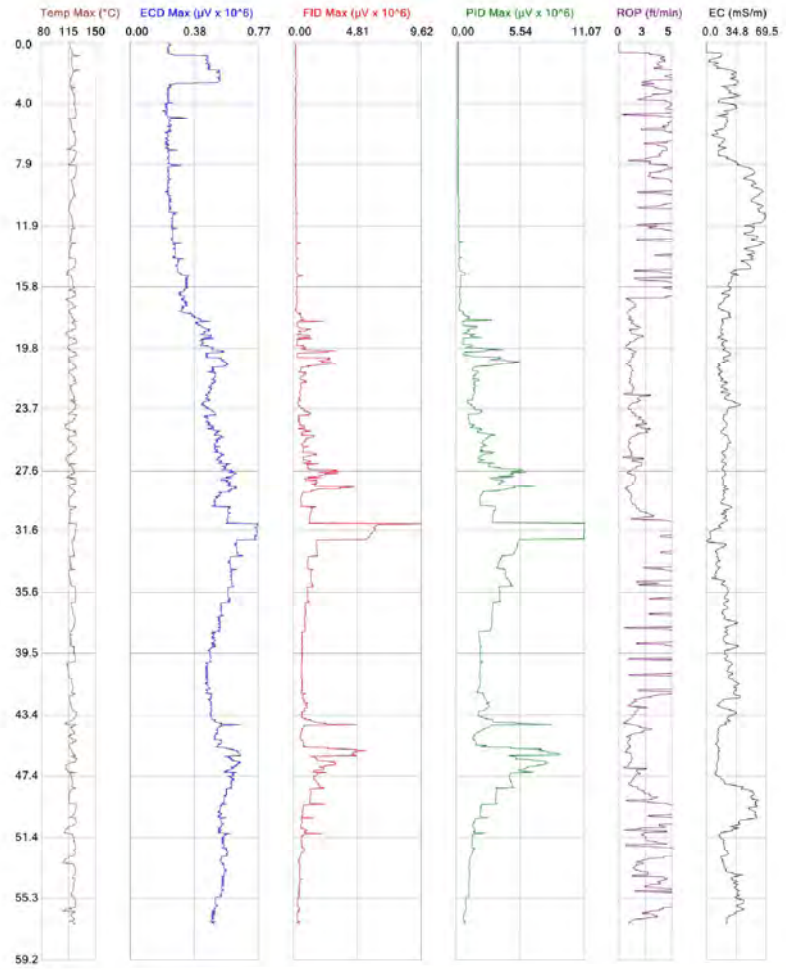
4084106586016.DWG 500
20110926.1843

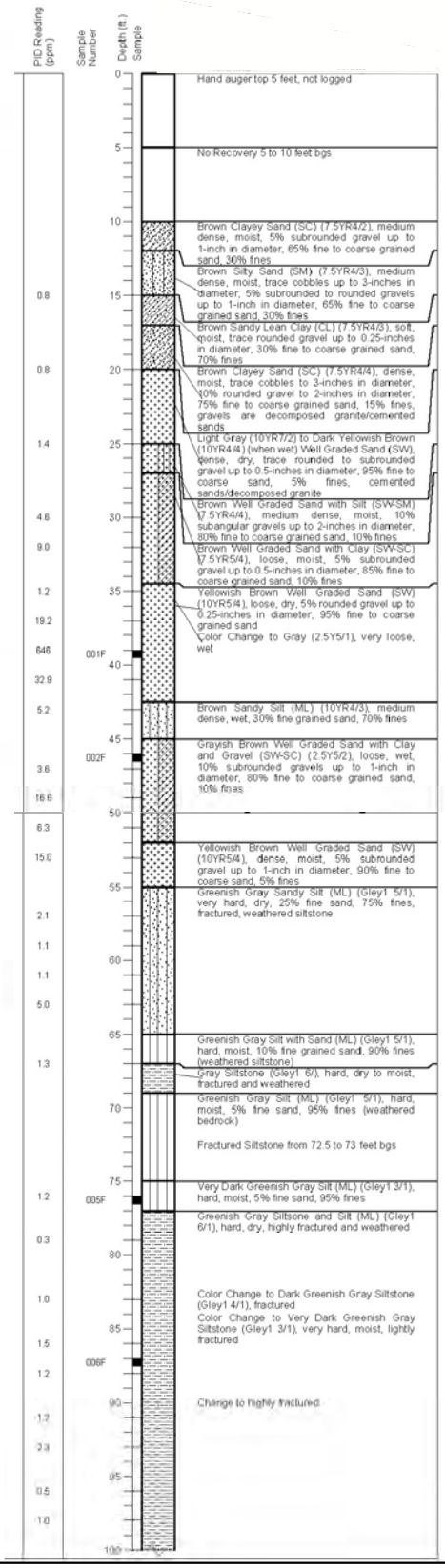
amec

258-SB-005 Boring Log and UVOST U-3-3
Building 258 Investigation
Site Characterization Report
Fort Hunter Liggett, California

PLATE
6.3

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084106586 03.1	NAM	9/2011	BPF	9/2011





ECD = Electron Capture Detector
PID = Photoionization Detector
FID = Flame Ionization Detector
ROP = Rate of Penetration
EC = Electrical Conductivity

MIP log prepared by Columbia Technologies
Boring log prepared by AMEC

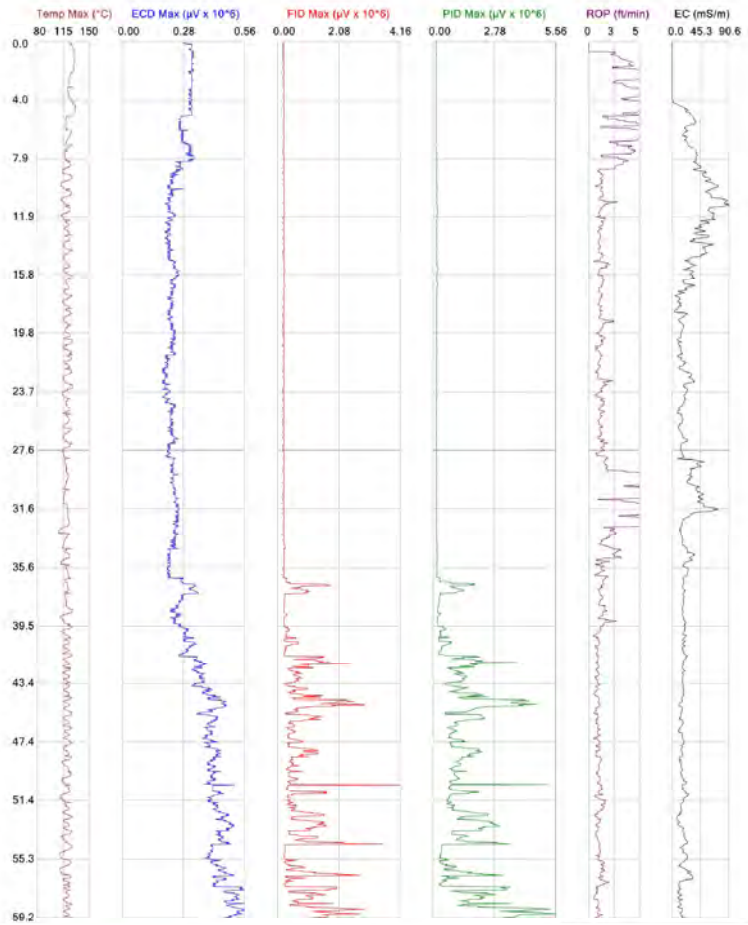
4084106586017.DWG 500
20110926.1845

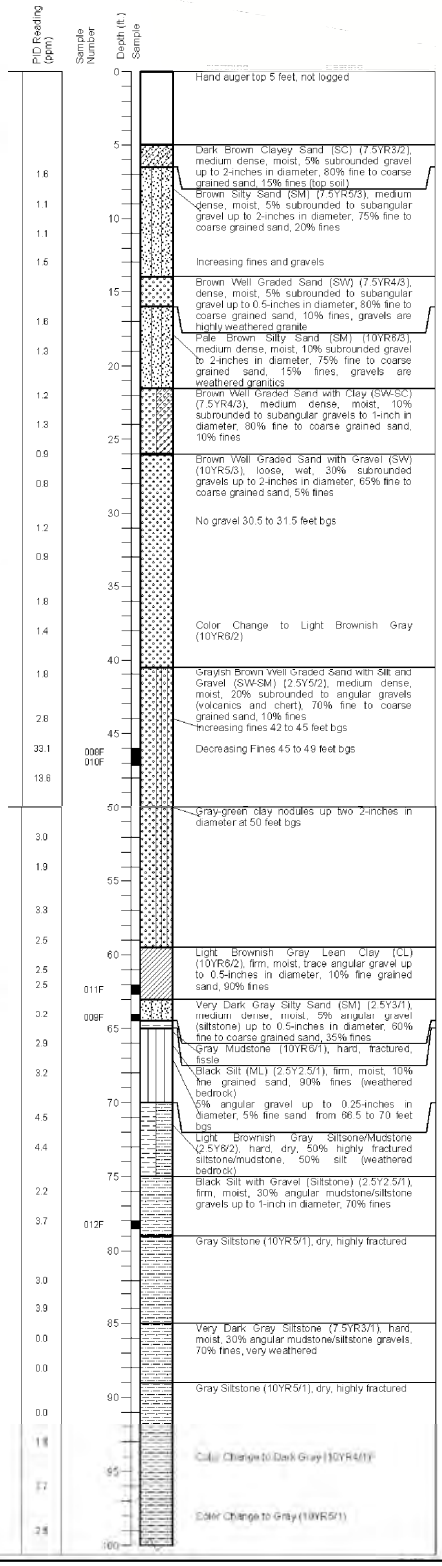
amec

258-SB-003 Boring Log and MIP M-4-3
Building 258 Investigation
Site Characterization Report
Fort Hunter Liggett, California

PLATE
6.4

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084106586 03.1	NAM	9/2011	BPF	9/2011





ECD = Electron Capture Detector
PID = Photoionization Detector
FID = Flame Ionization Detector
ROP = Rate of Penetration
EC = Electrical Conductivity

MIP log prepared by Columbia Technologies
Boring log prepared by AMEC

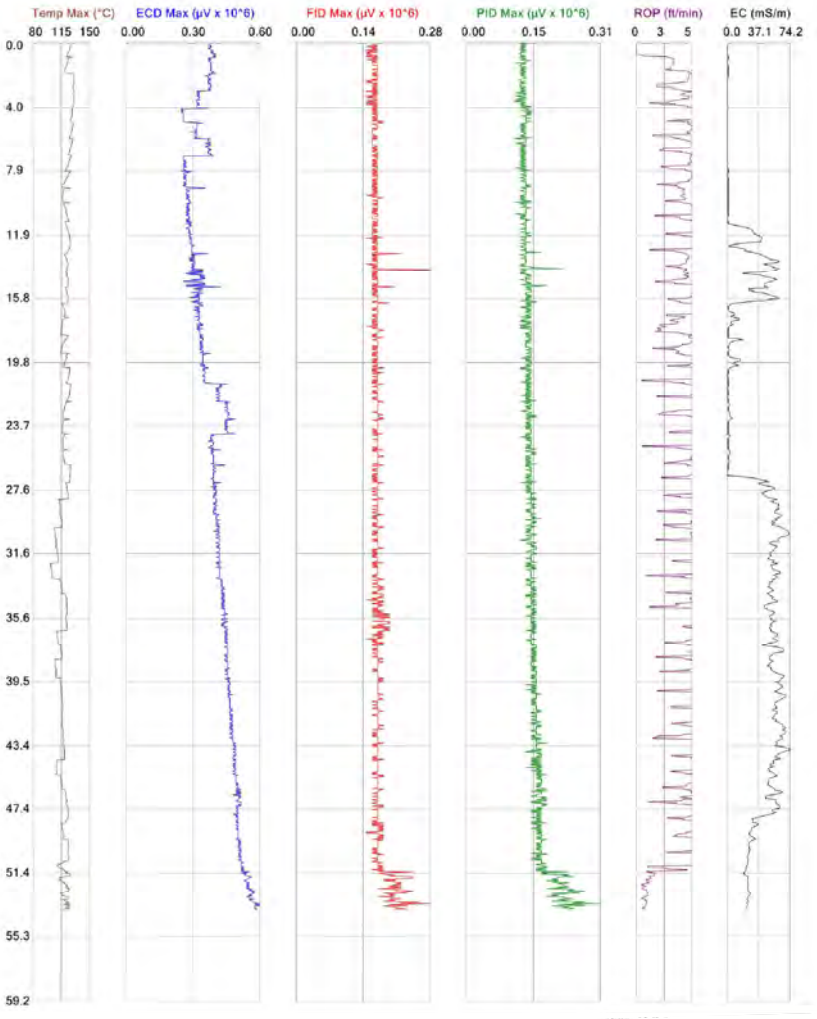
4084106586013.DWG 500
20110926.1711

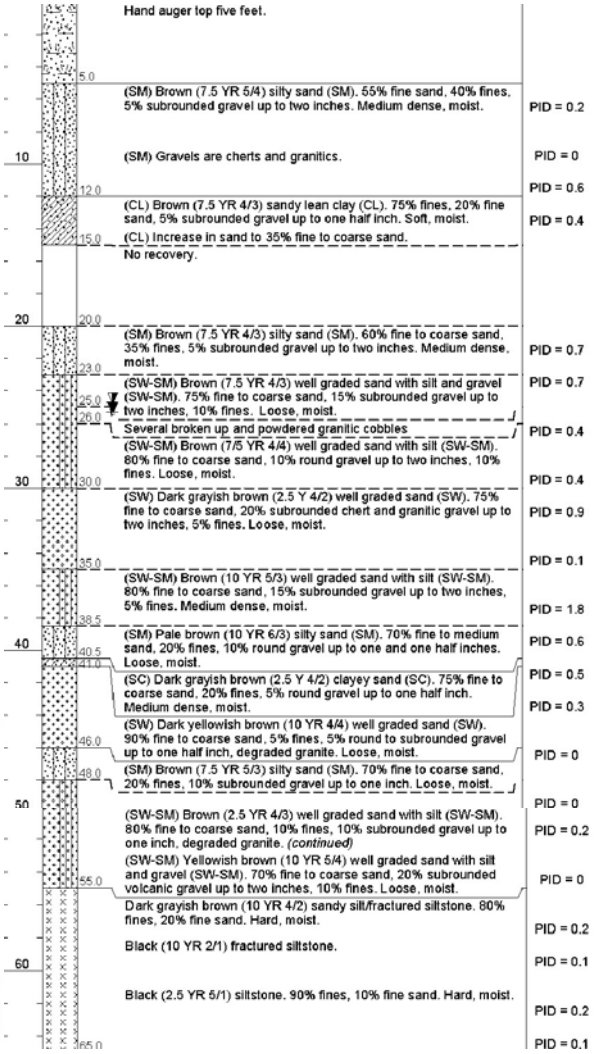
amec

258-SB-001 Boring Log and MIP M-6-1
Building 258 Investigation
Site Characterization Report
Fort Hunter Liggett, California

PLATE
6.5

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084106586	NAM	9/2011	BPF	9/2011





ECD = Electron Capture Detector
PID = Photoionization Detector
FID = Flame Ionization Detector
ROP = Rate of Penetration
EC = Electrical Conductivity

MIP log prepared by Columbia Technologies
Boring log prepared by AES

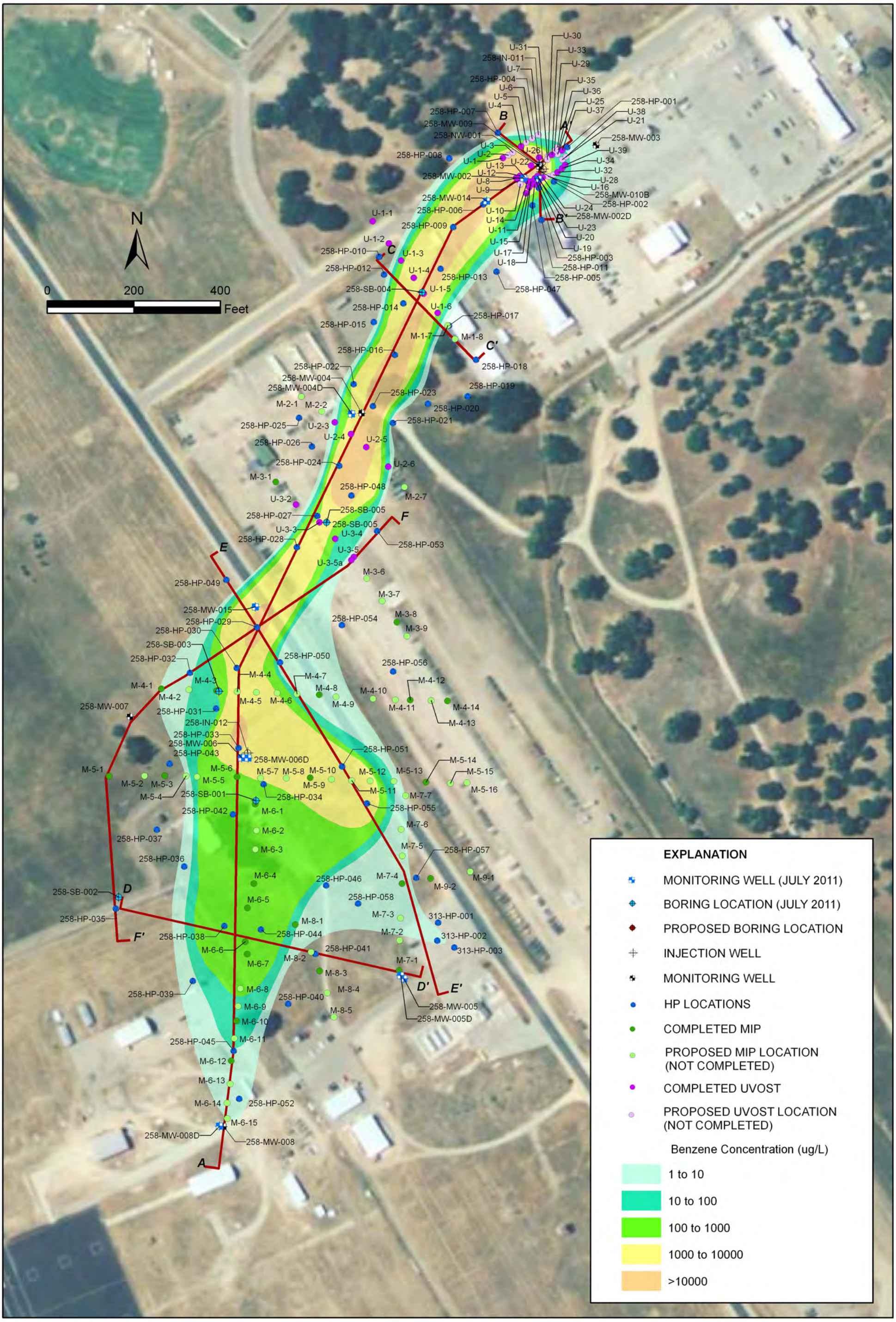
4084106586018.DWG 500
20110926.1849

amec

258-SB-005D Boring Log and UVOST M-7-1
Building 258 Investigation
Site Characterization Report
Fort Hunter Liggett, California

PLATE
6.6

DRAWN	JOB NUMBER	CHECKED	CHECKED DATE	APPROVED	APPROVED DATE
TJH	4084106586 03.1	NAM	9/2011	BPF	9/2011

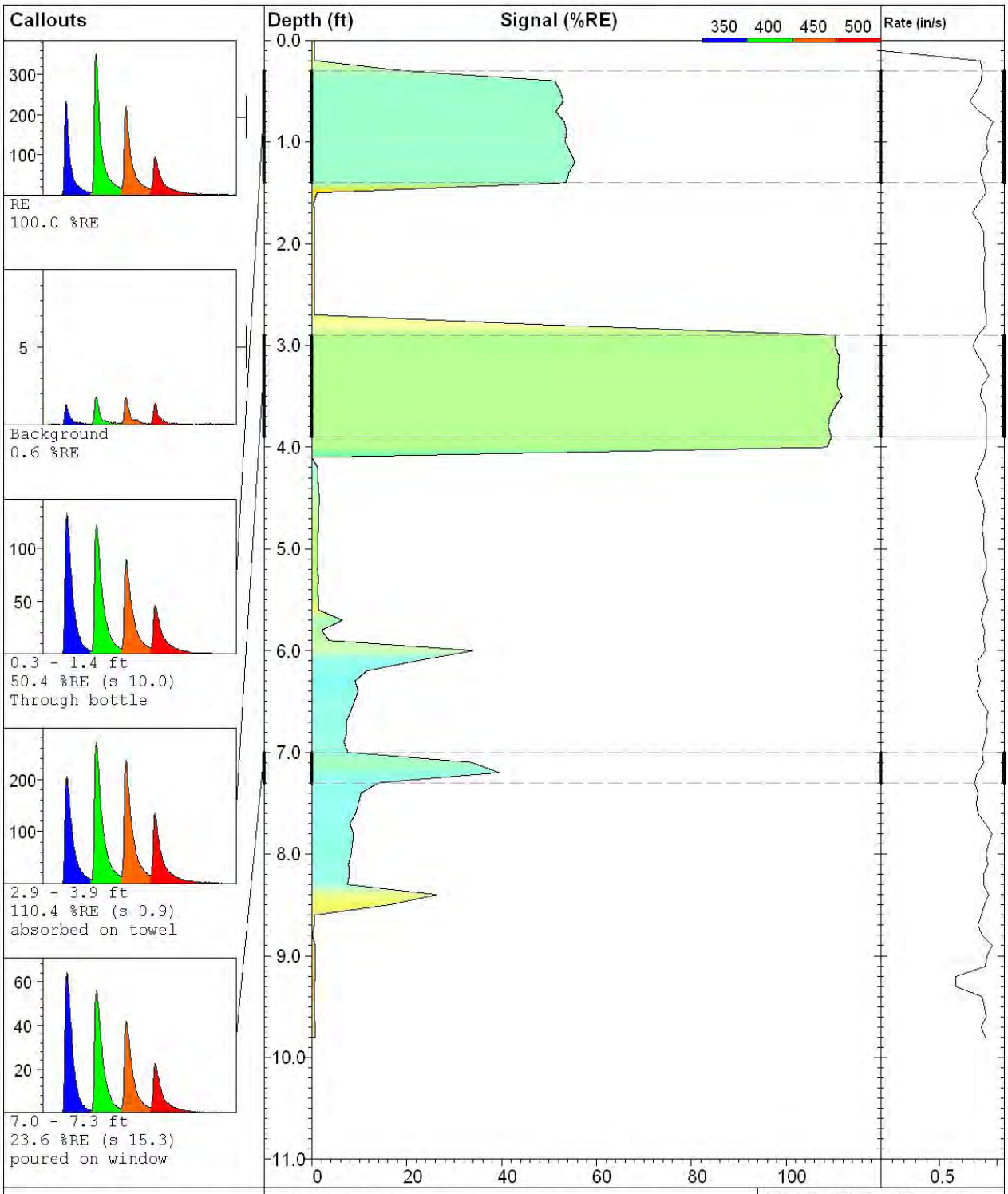


DRAWN: TJH	PROJECT NO: 4084106586 03.1	amec	**Benzene Concentrations in Groundwater** Building 258 Investigation Site Characterization Report Fort Hunter Liggett	PLATE **6.7**
ENGINEER:	SCALE: AS SHOWN			
CHECKED: NAM	DATE: 9/2011			
APPROVED: BPF	DATE:			

October 7, 2011 1:44:13 PM
P:\4084\106586_FHL258\GIS\Projects\CharacterizationReport\Figure6-7-PlumeMap2011.mxd

APPENDIX A

UVOST® Results



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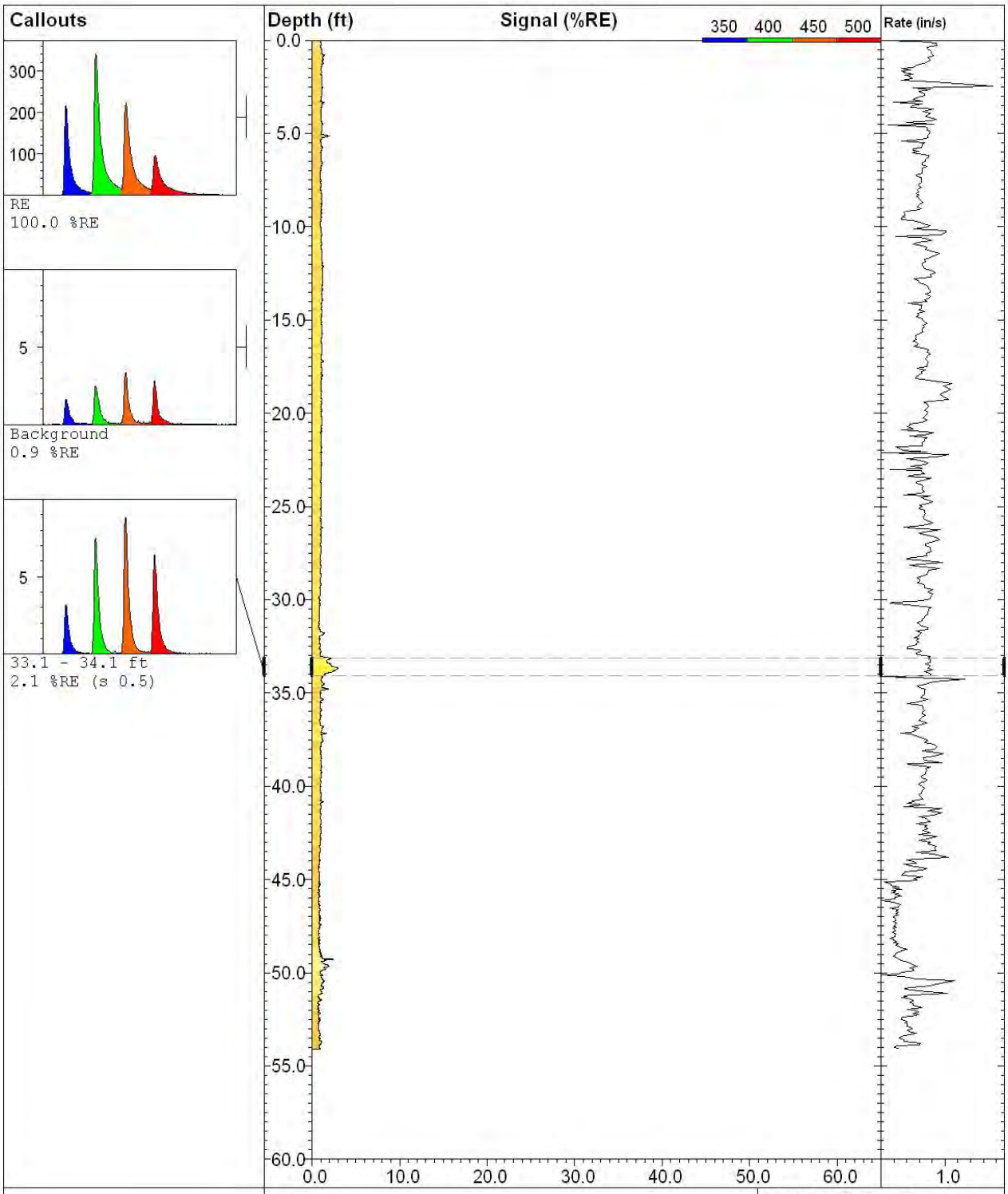
Baltimore, MD 888-344-2704
www.columbiatechnologies.com

NW001 Free Product

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **9.80 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **111.8 % @ 3.50 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-01-31 13:33 EST**



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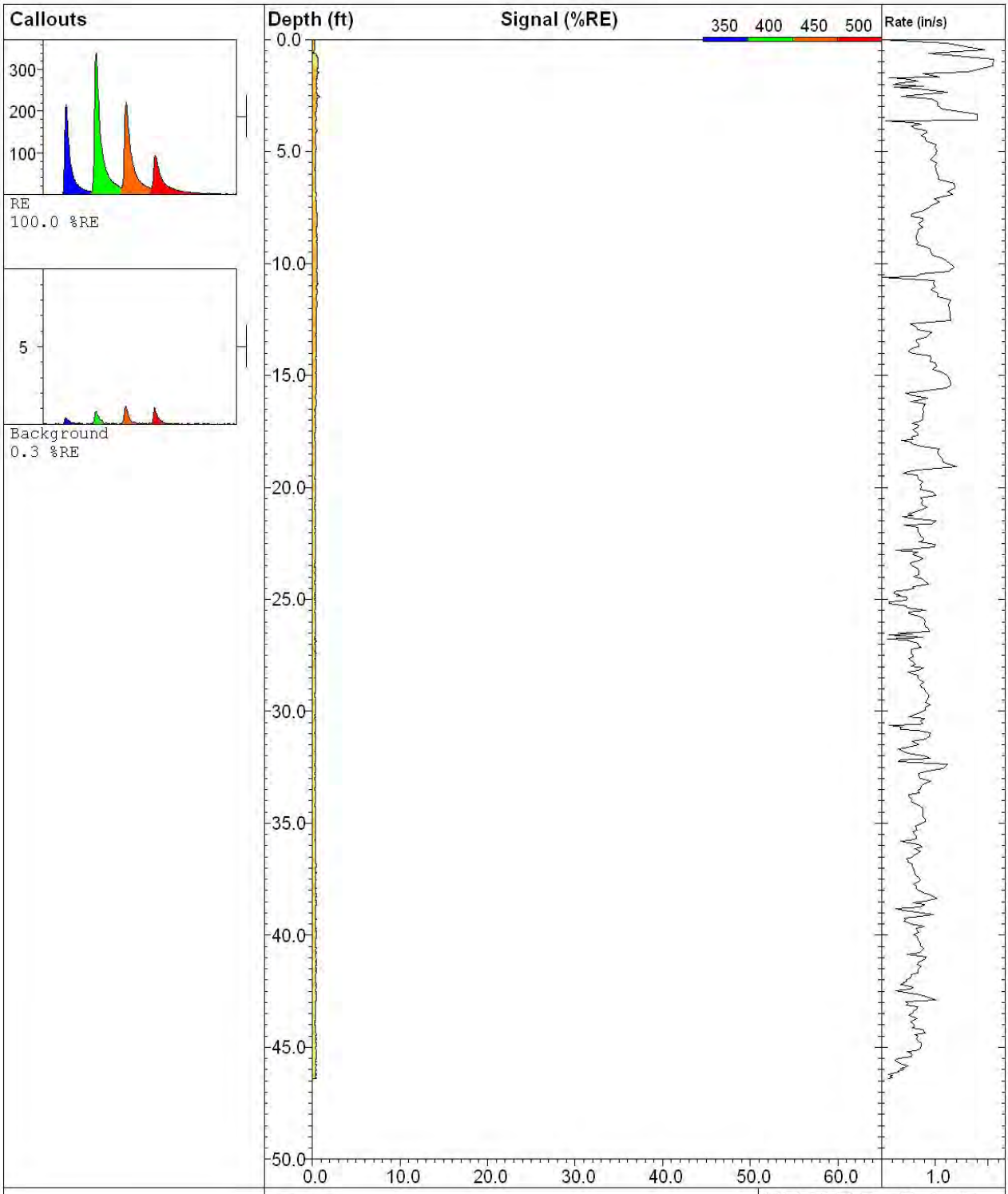
U-01

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **54.09 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **3.0 % @ 33.65 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-01 15:44 PST**



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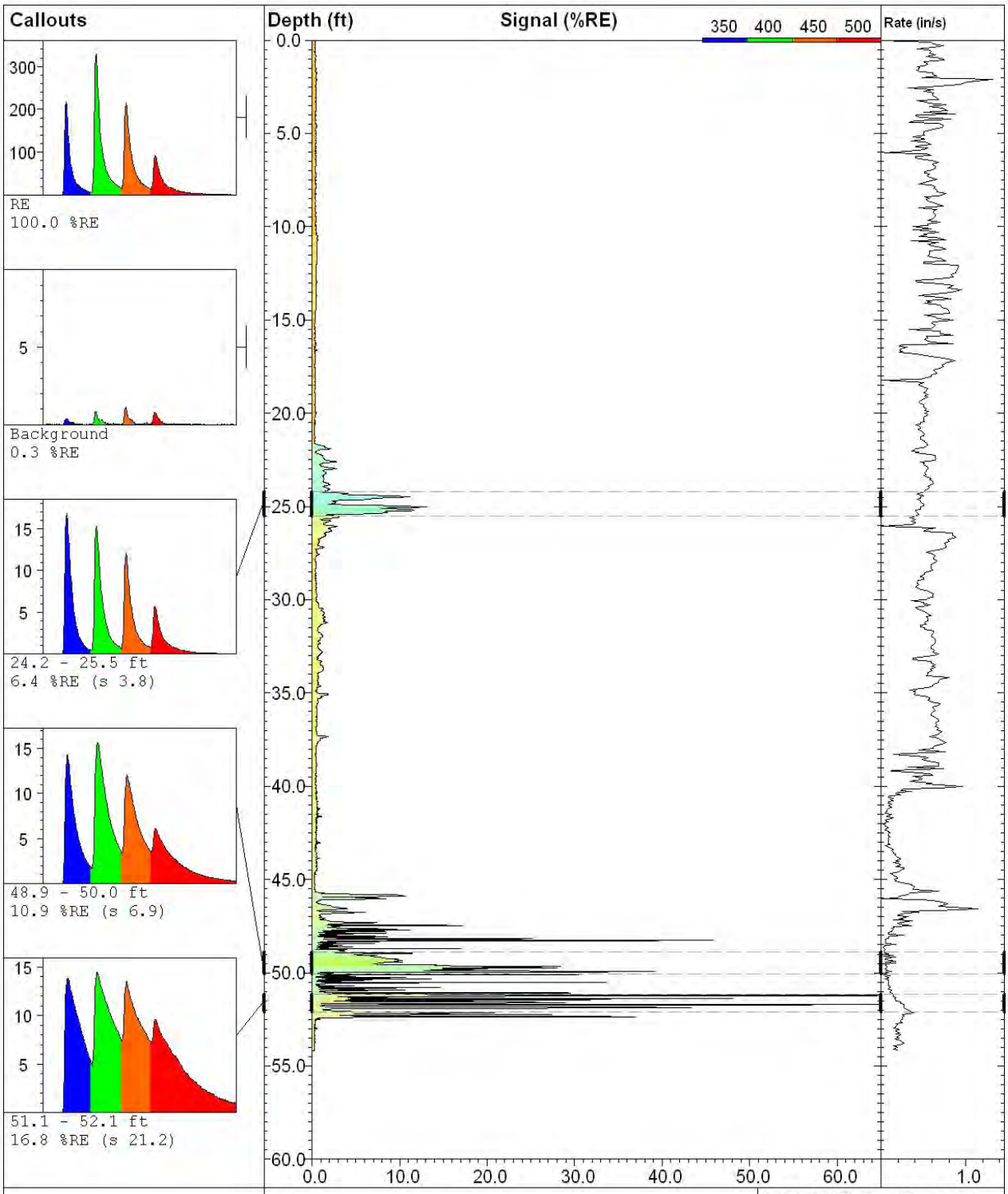
U-04

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **46.41 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **0.9 % @ 2.55 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-02 16:20 PST**



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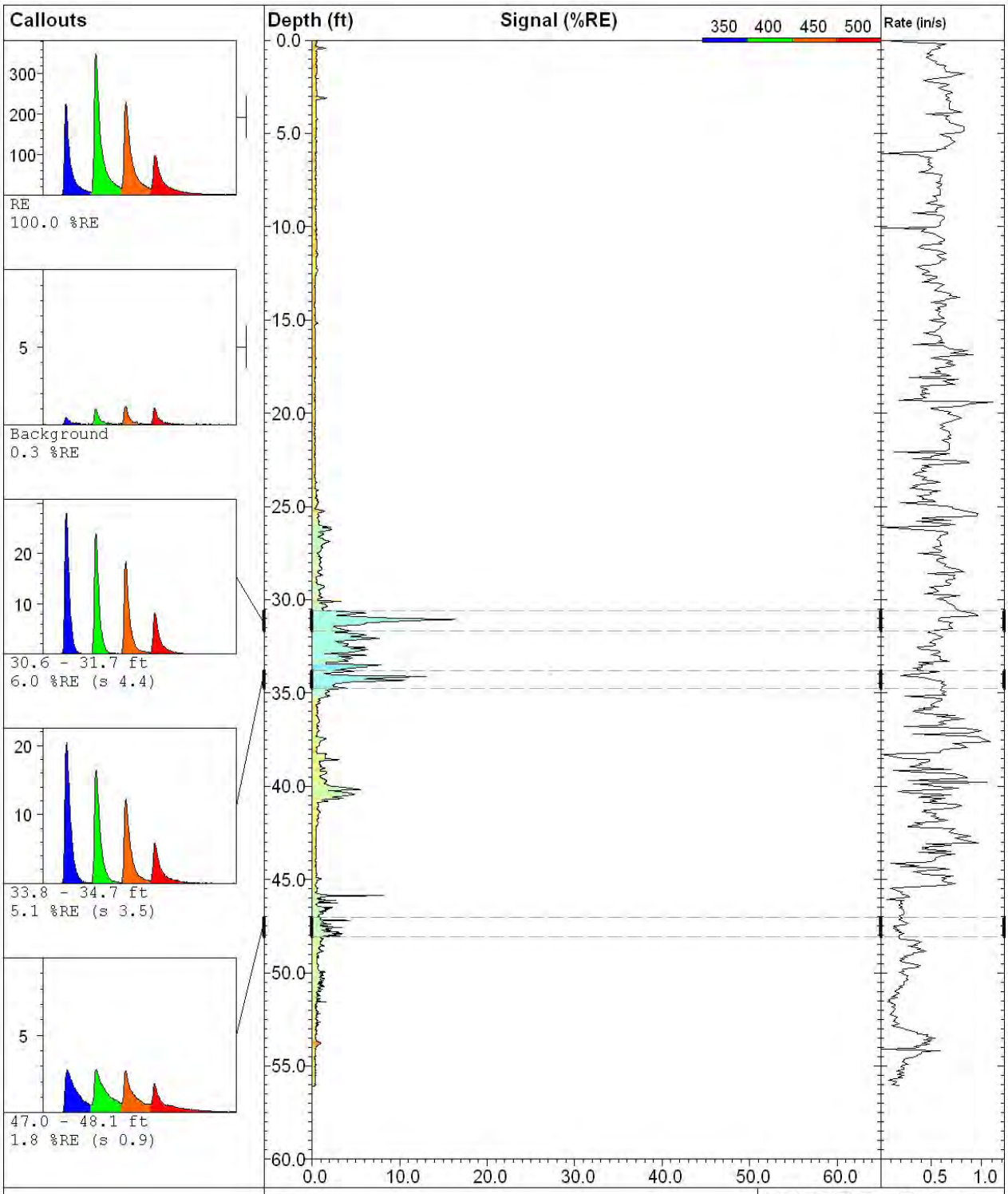
U-08

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **54.18 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **73.7 % @ 51.71 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-03 08:31 PST**



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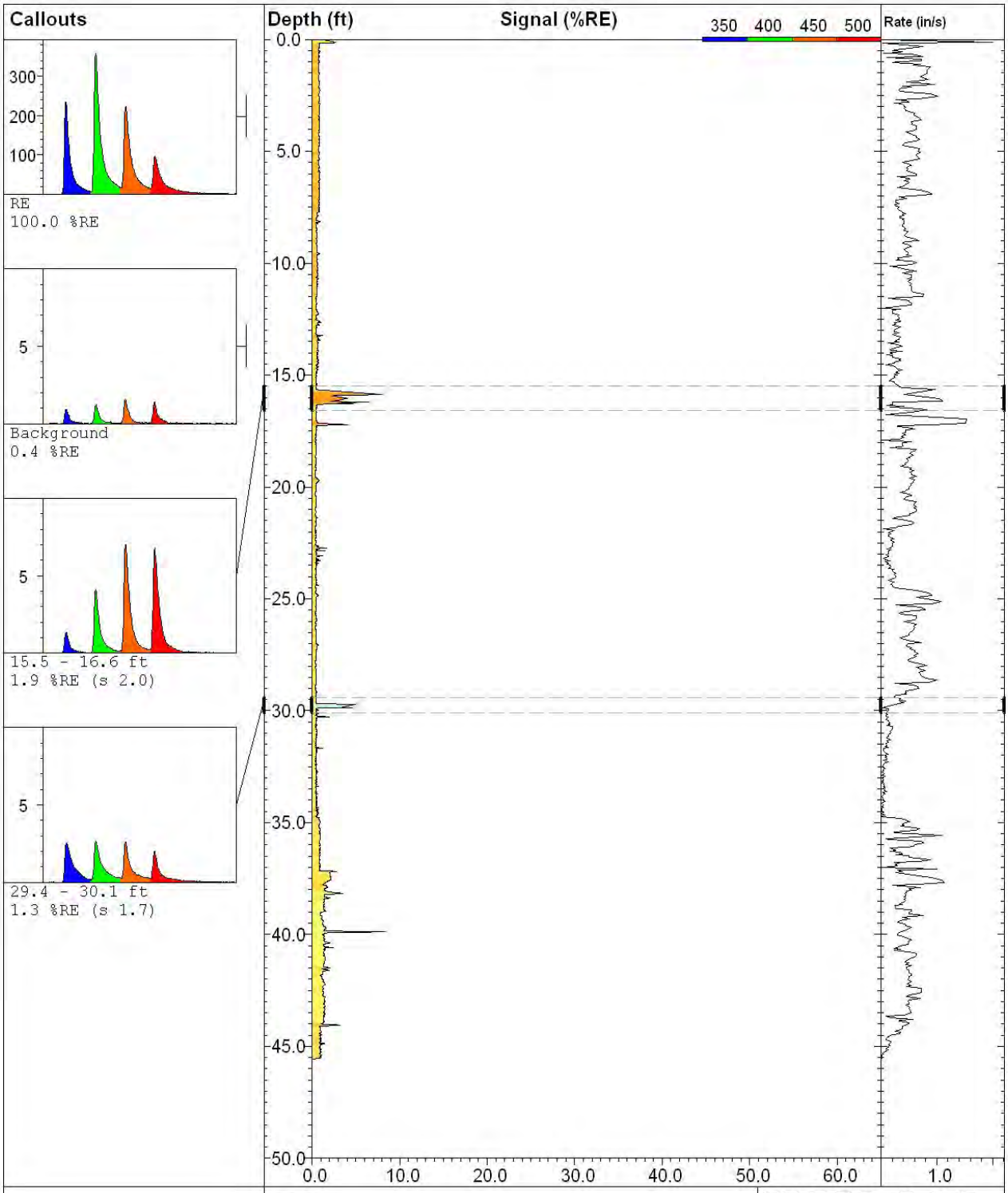
U-09

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **56.07 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **16.5 % @ 31.05 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-03 10:29 PST**



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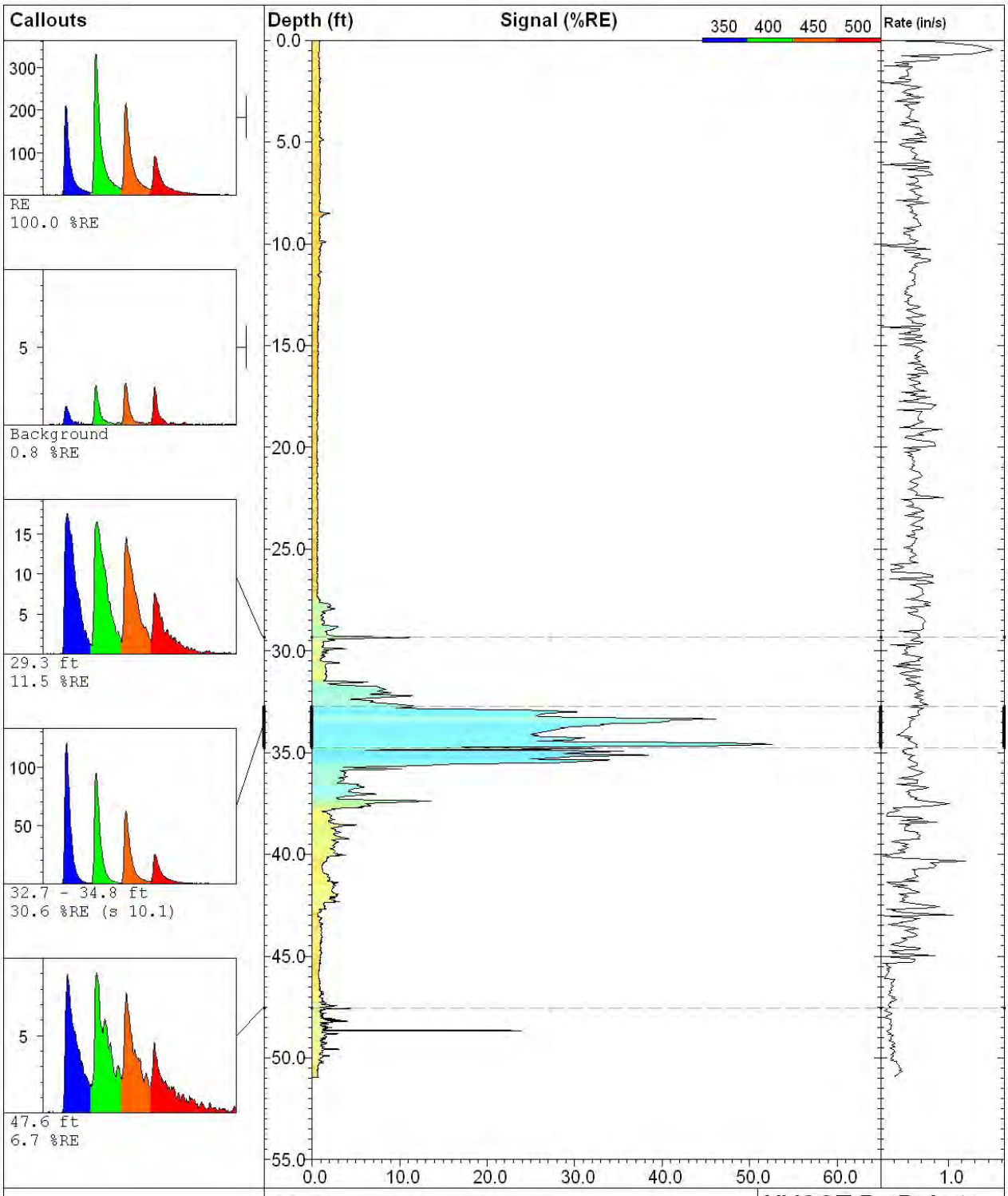
U-11

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **45.55 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **8.5 % @ 39.88 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-01-31 14:25 PST**



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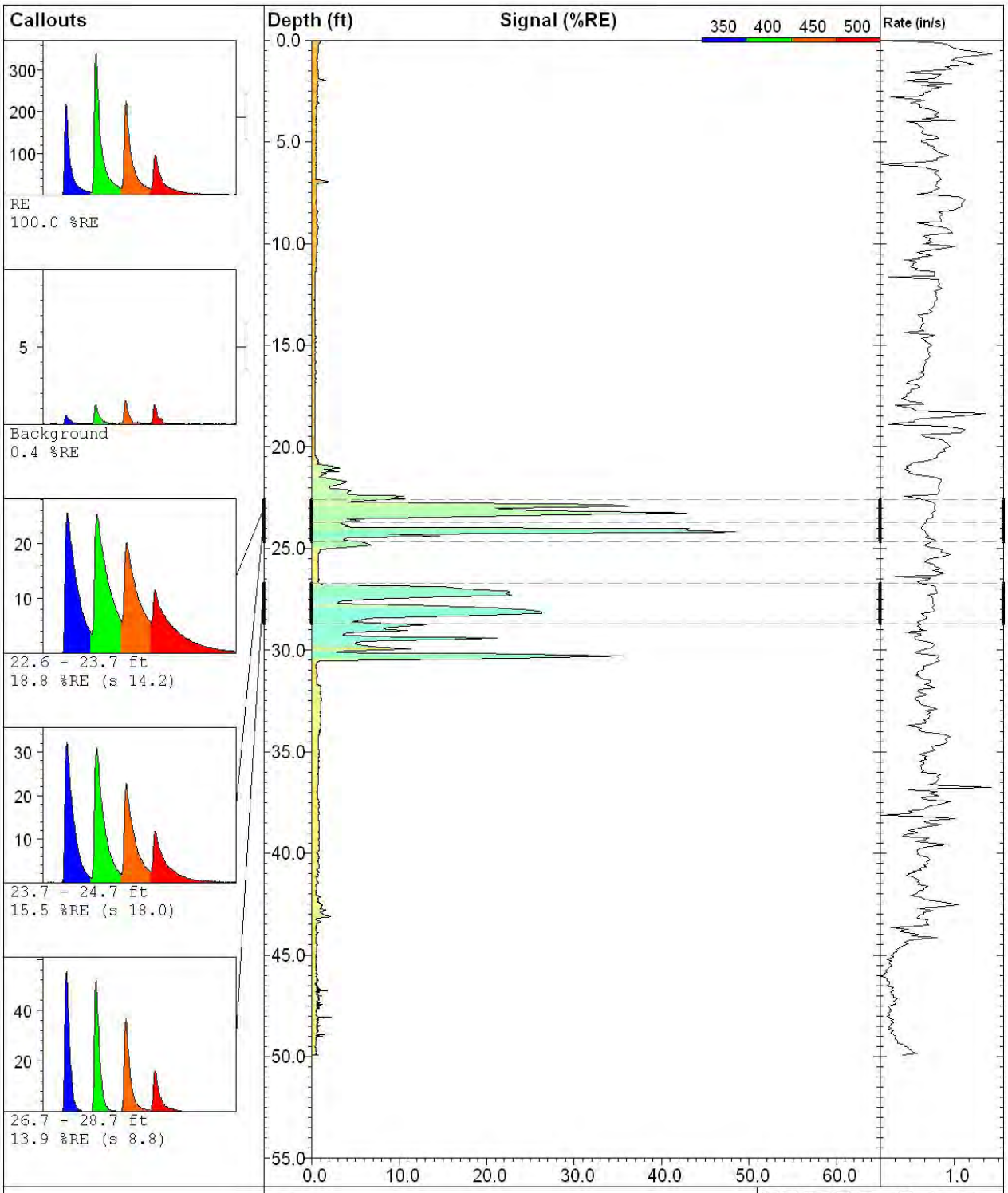
U-12

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **50.94 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **52.7 % @ 34.59 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-01 13:50 PST**



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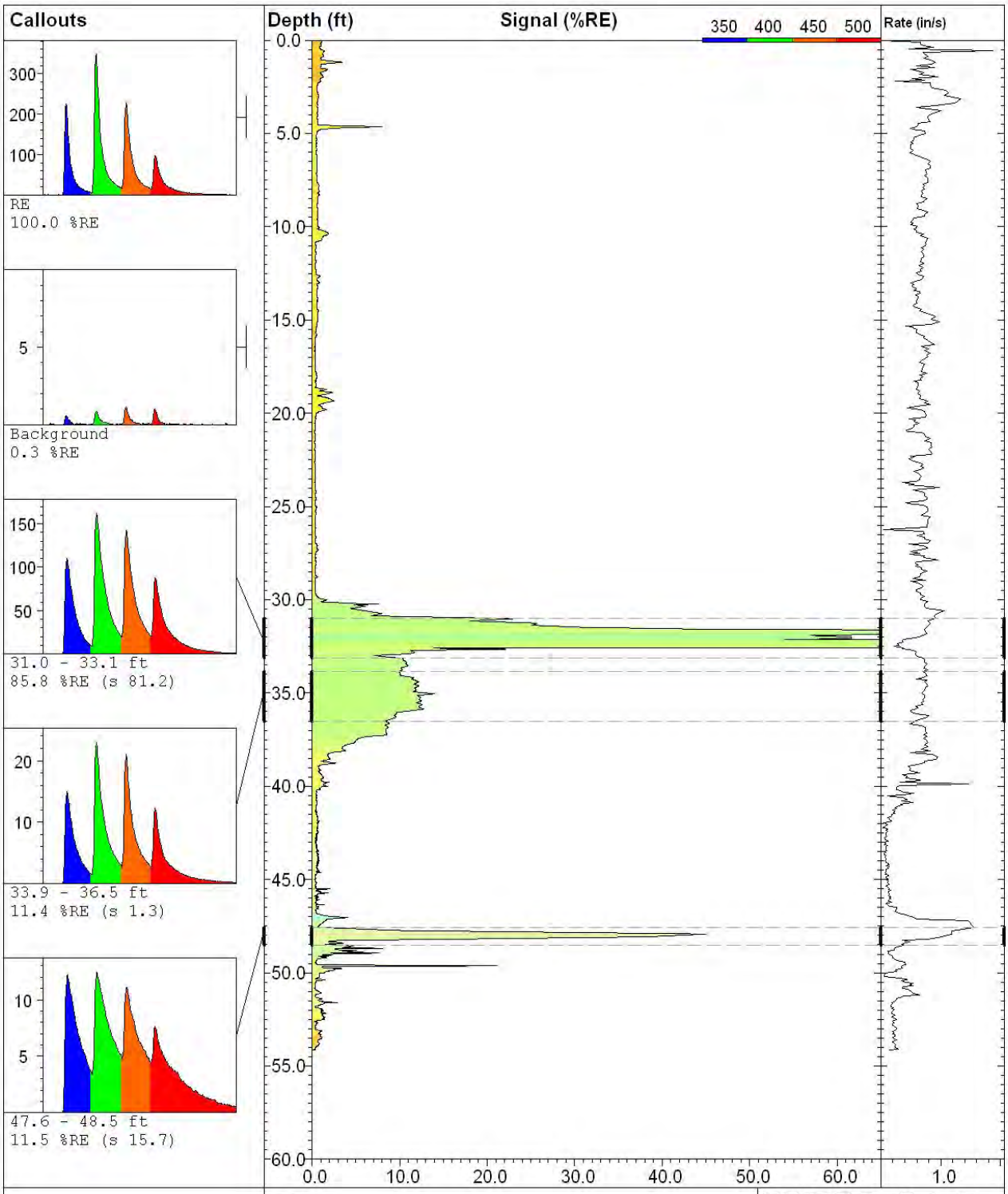
www.columbiatechnologies.com

U-14

UVOST By Dakota
www.DakotaTechnologies.com

Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **49.93 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **48.5 % @ 24.19 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-04 13:40 PST**



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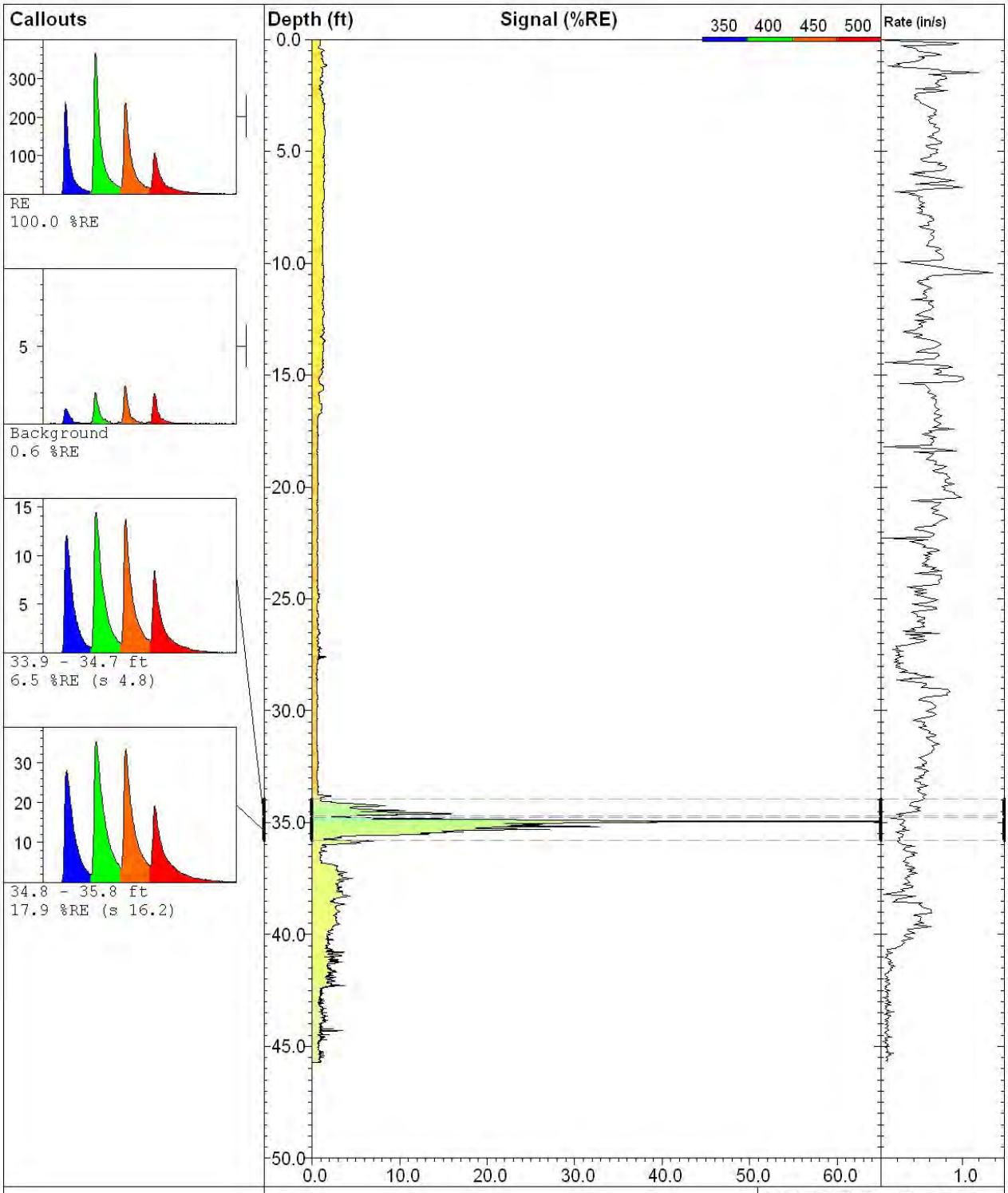
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **54.14 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **231.7 % @ 32.33 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-03 15:18 PST**



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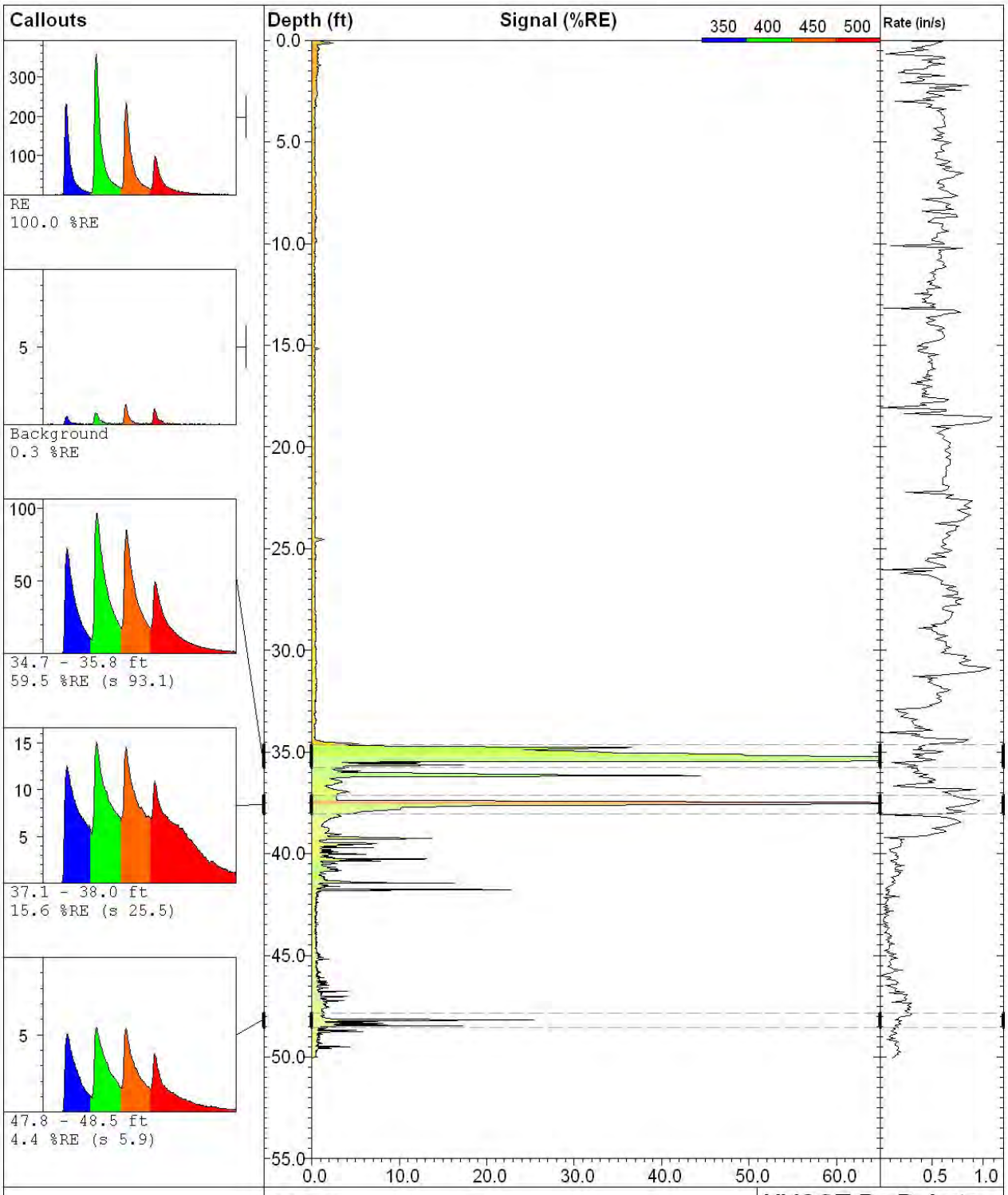
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **45.72 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **88.3 % @ 34.94 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-01 09:04 PST**



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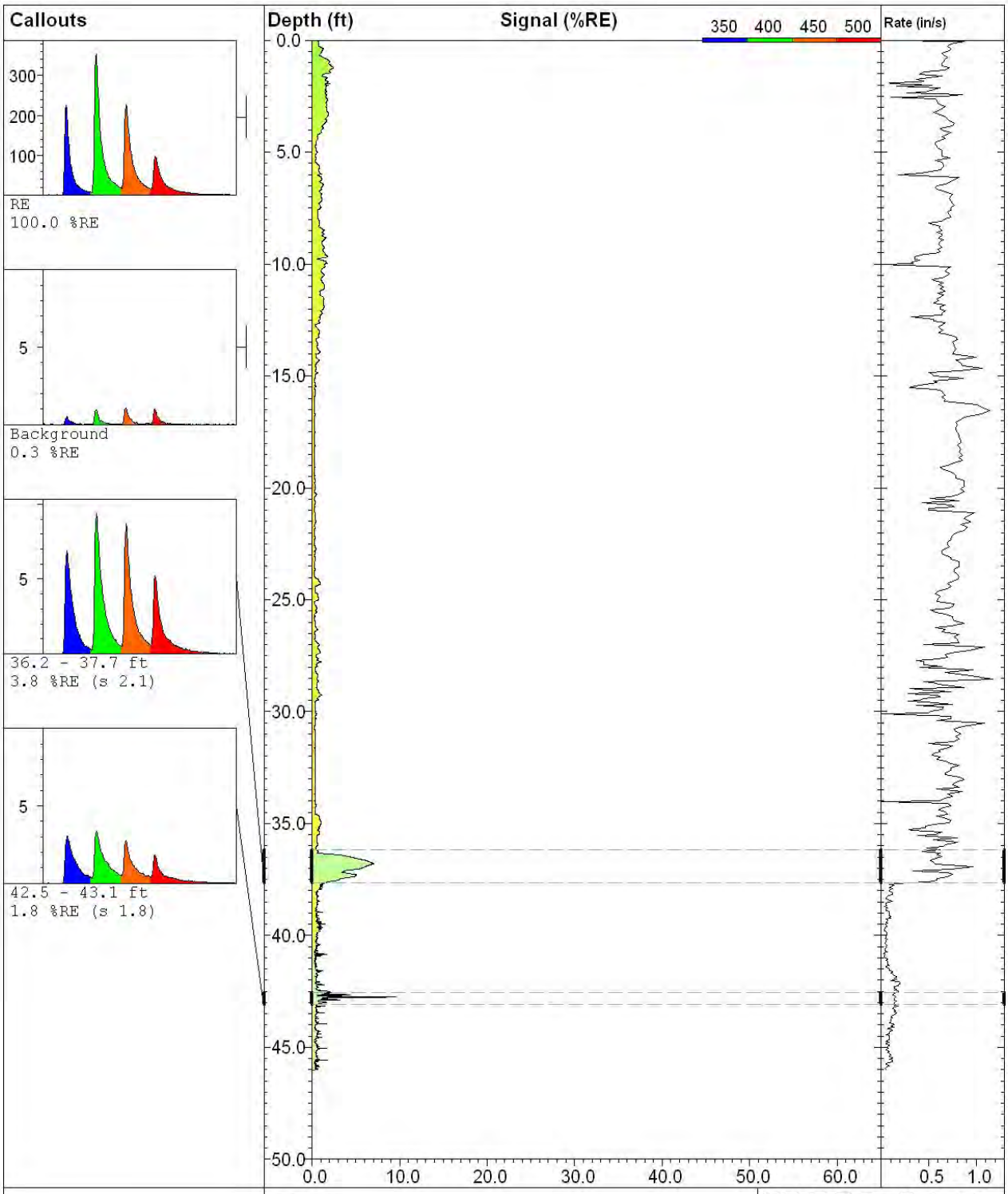
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **50.03 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **298.8 % @ 35.32 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-03 13:10 PST**



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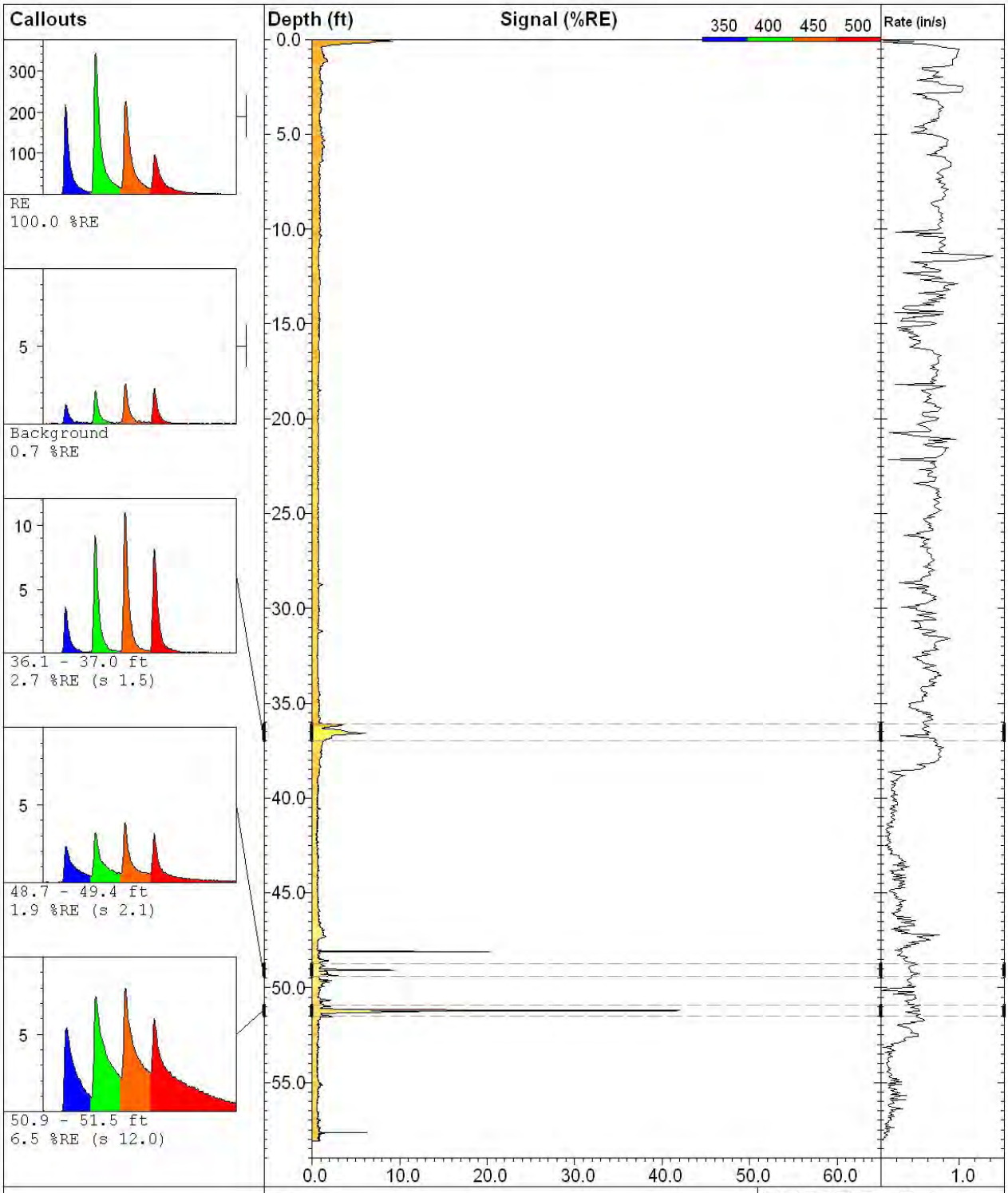
U-19		UVOST By Dakota www.DakotaTechnologies.com
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **46.01 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **9.7 % @ 42.76 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-04 11:29 PST**



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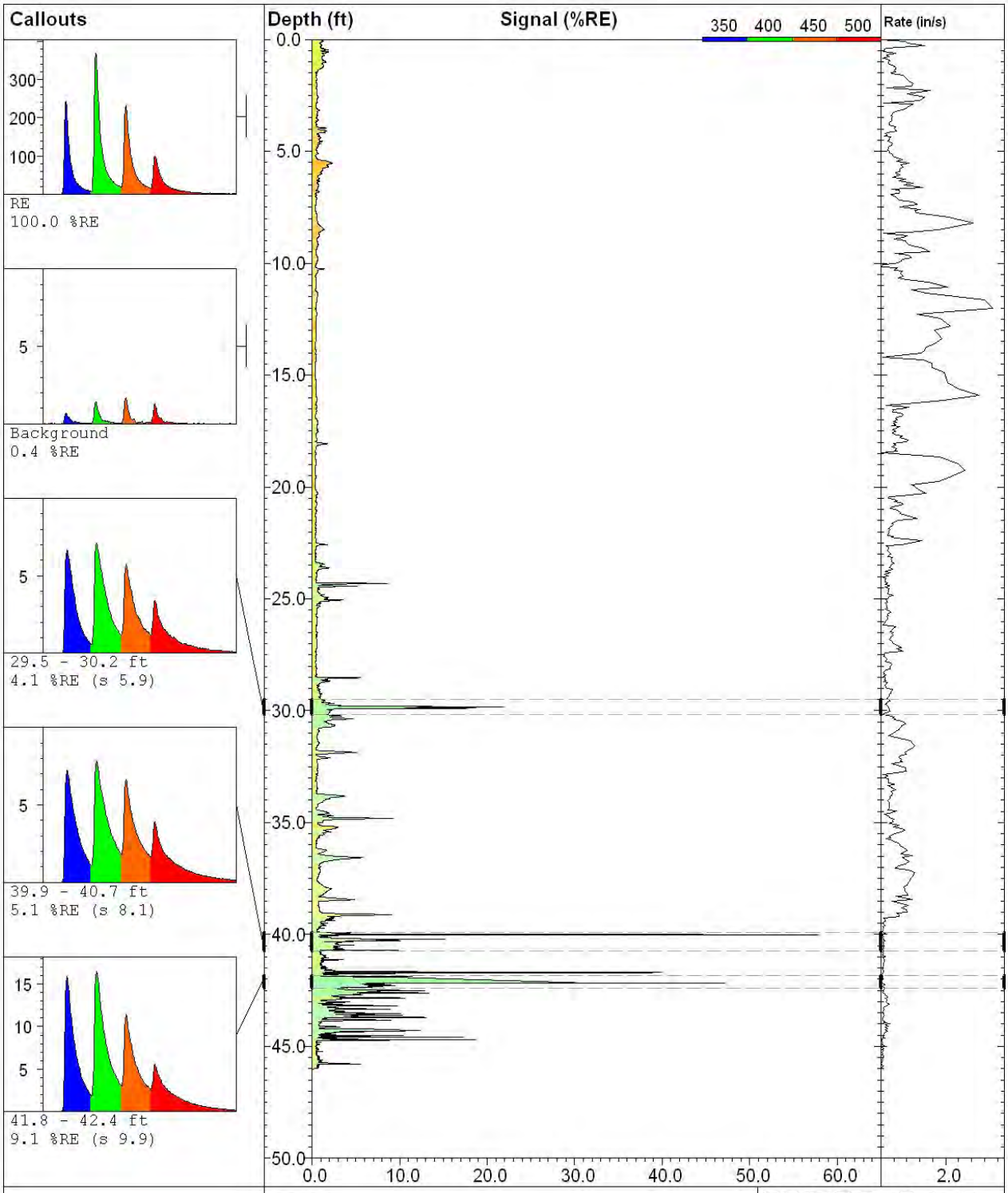
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **58.08 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **44.9 % @ 51.21 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-01 10:56 PST**



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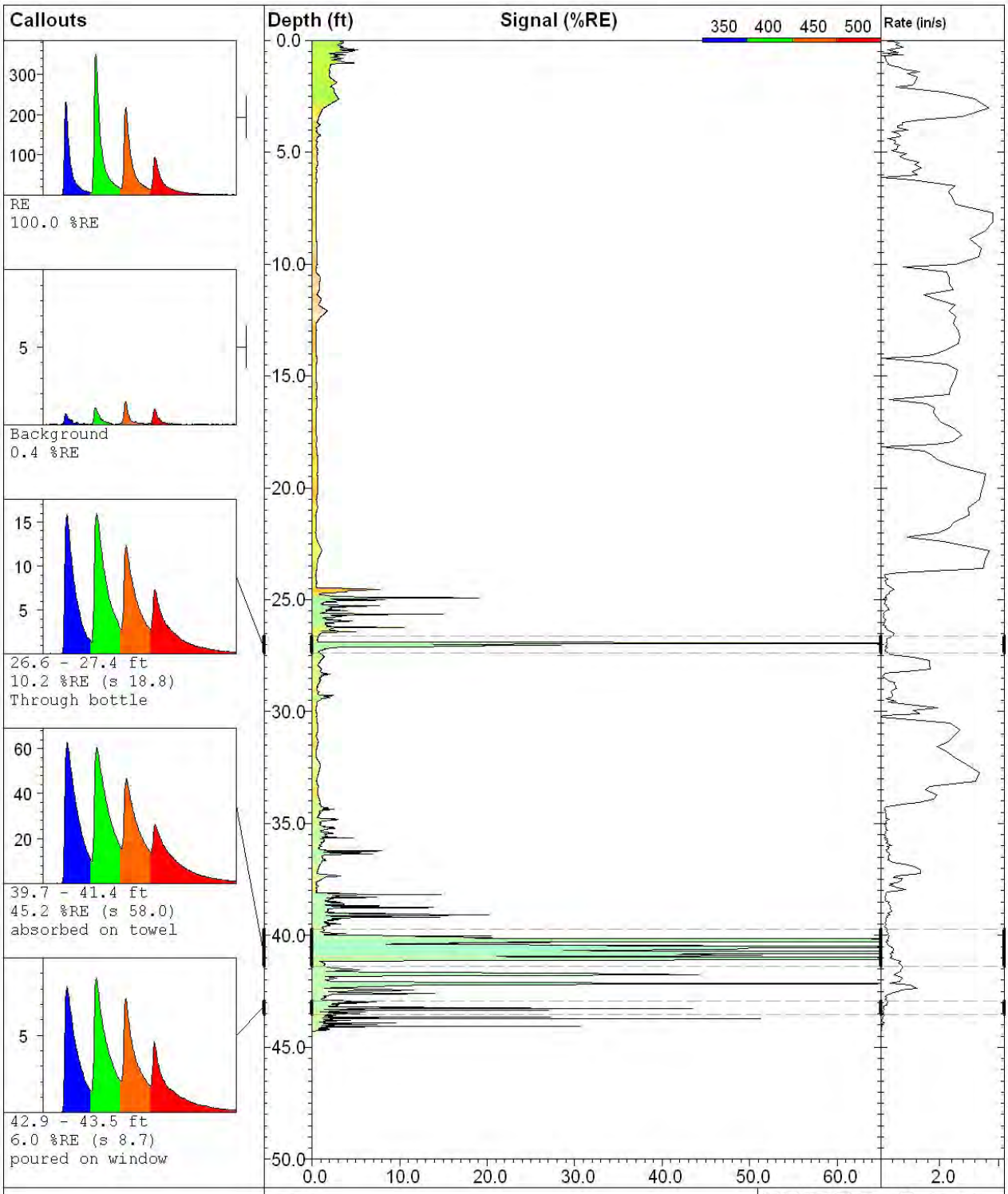
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **46.01 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **59.1 % @ 40.01 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-01-31 11:58 EST**



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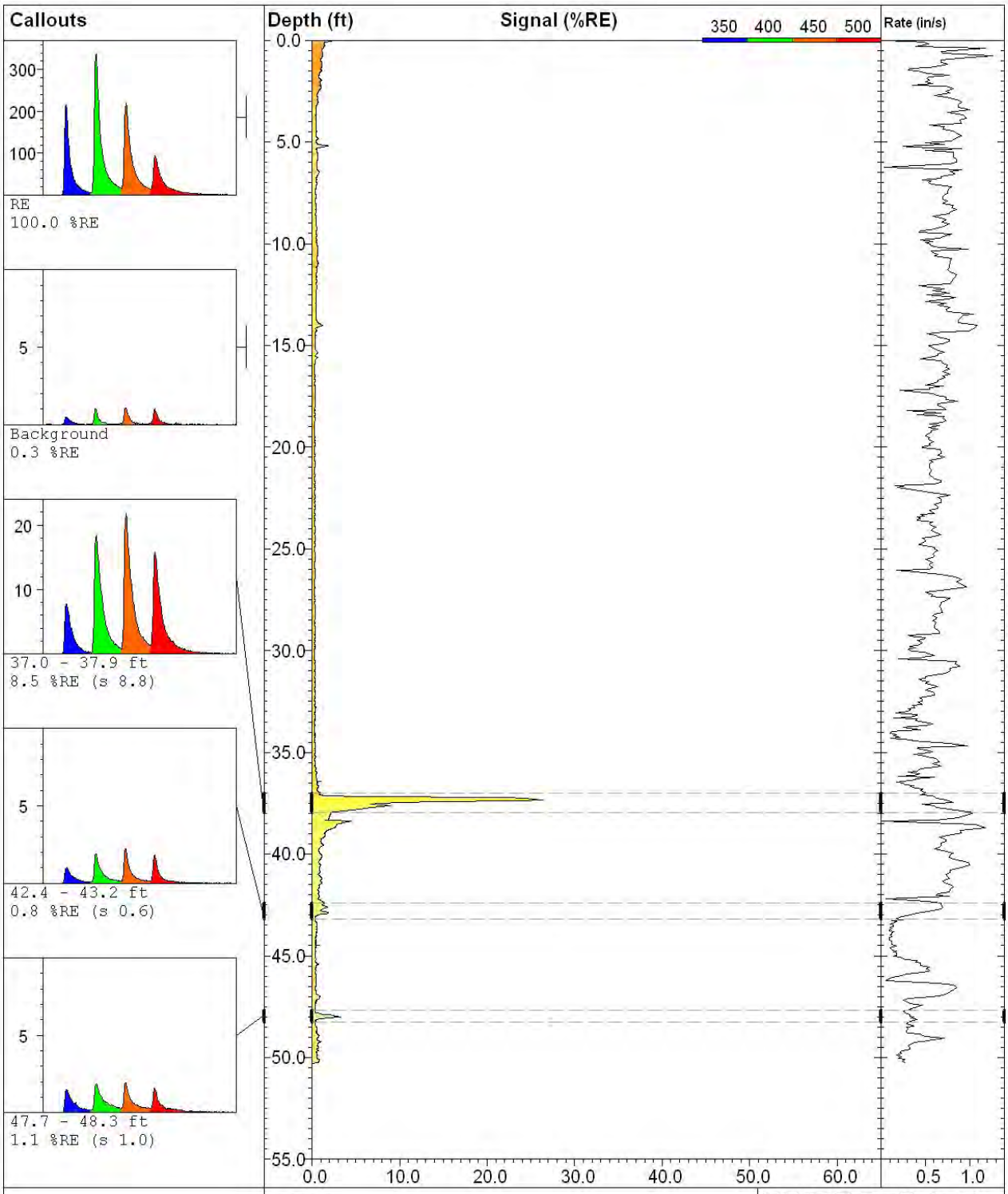
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **44.27 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **194.1 % @ 40.22 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-01-31 13:50 EST**



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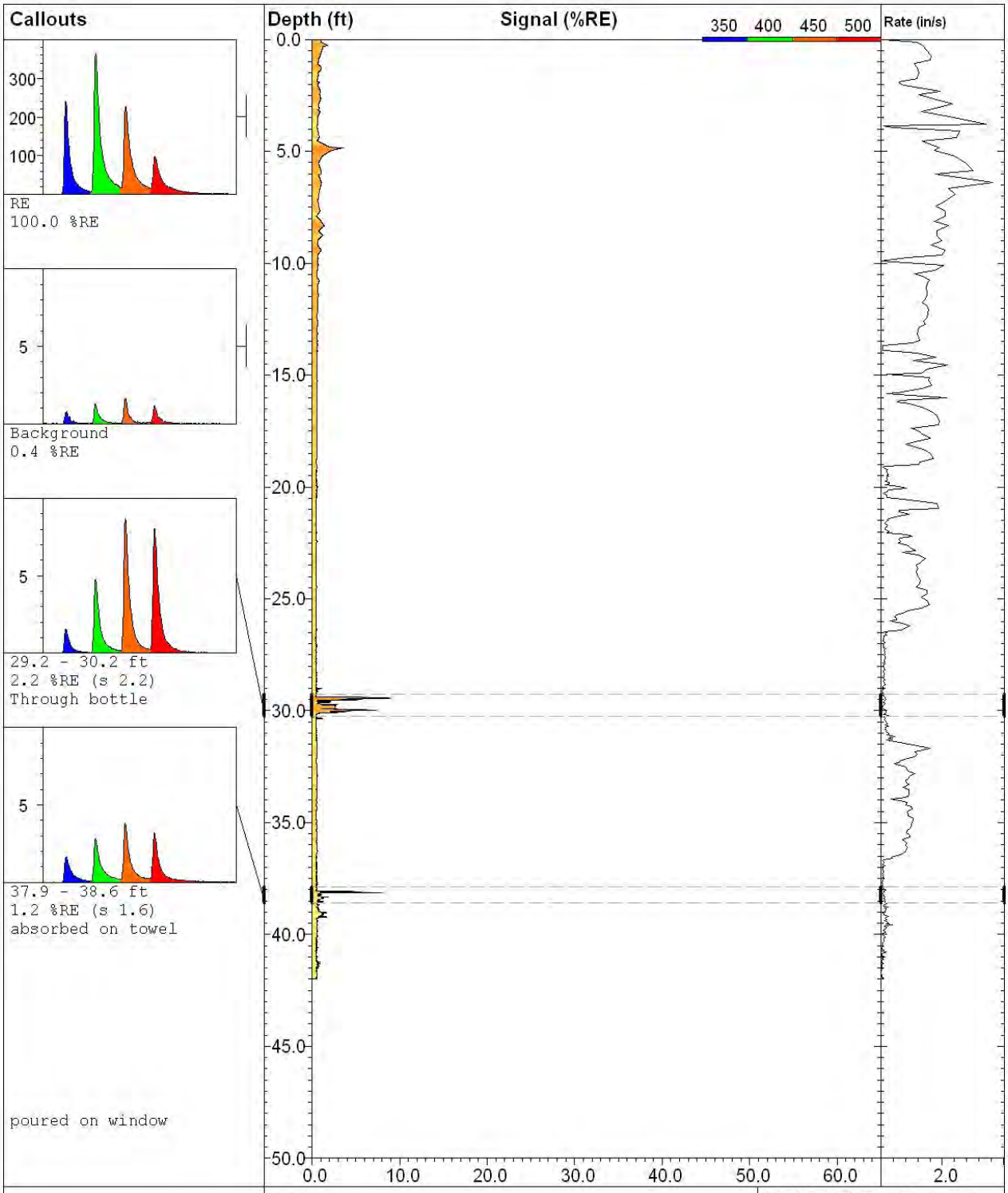
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **50.27 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **26.4 % @ 37.35 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-04 09:58 PST**



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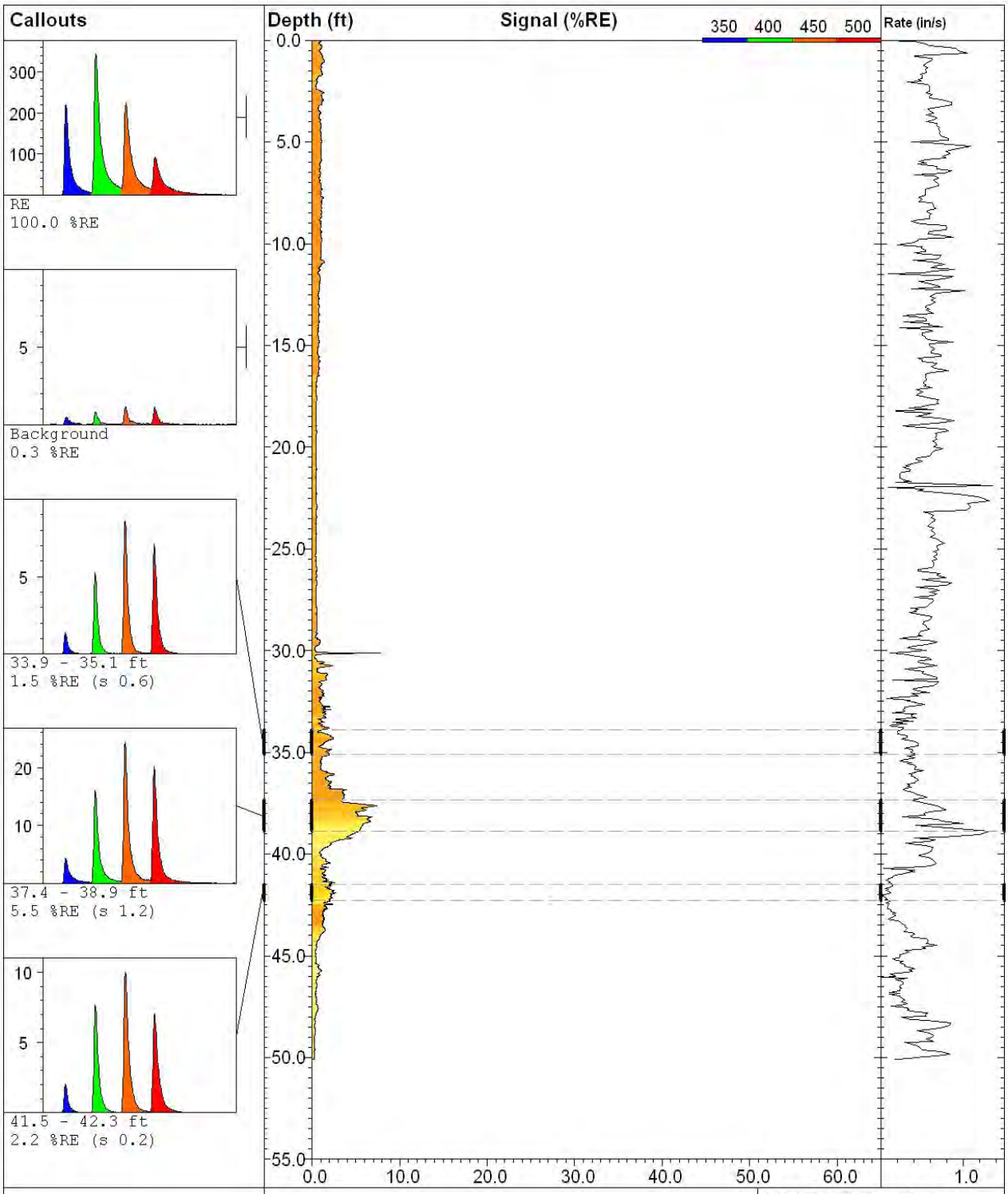
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **42.00 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **9.4 % @ 38.14 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-01-31 12:51 PST**



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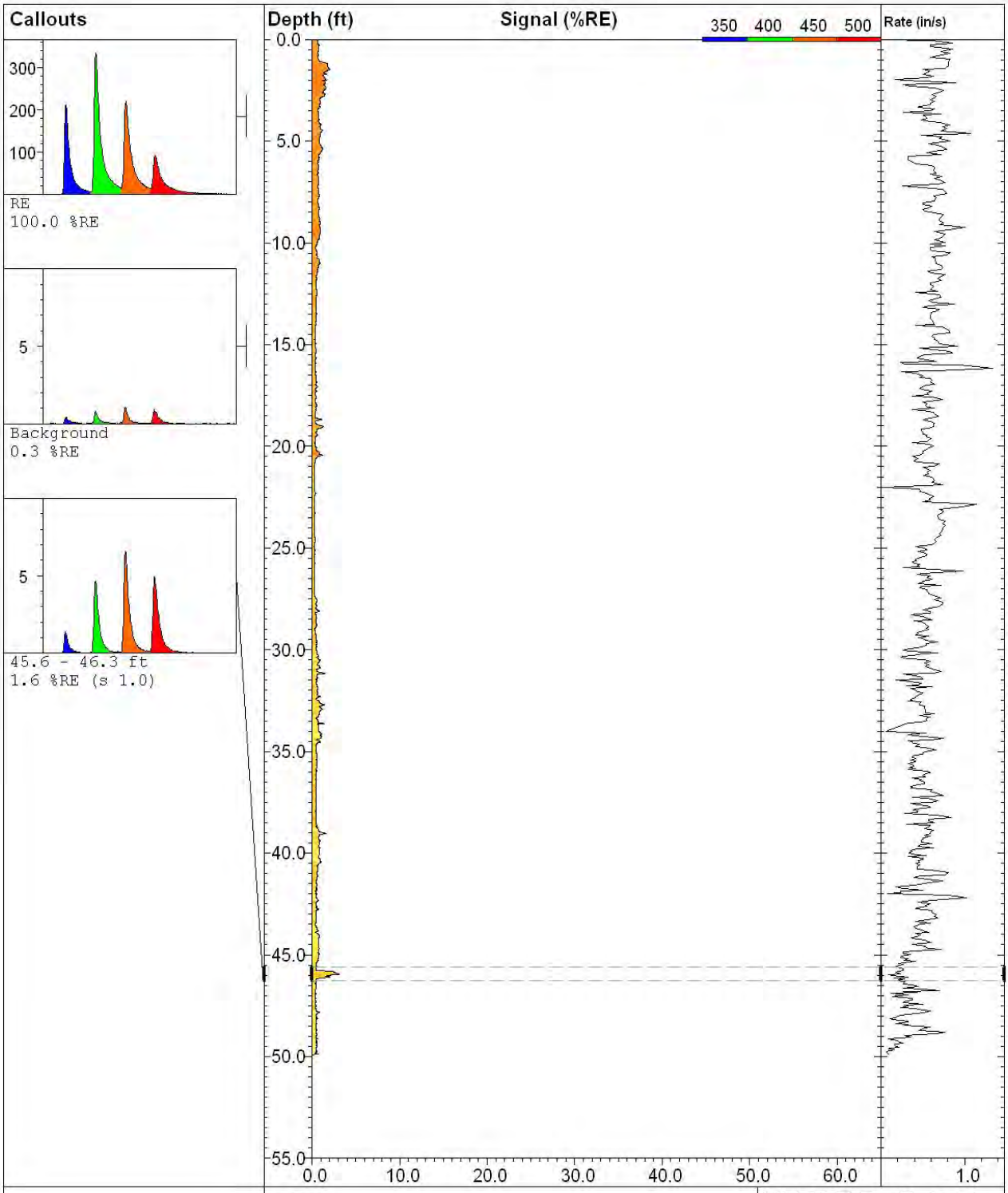
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **50.09 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **7.9 % @ 30.12 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-02 08:46 PST**



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UVOST By Dakota
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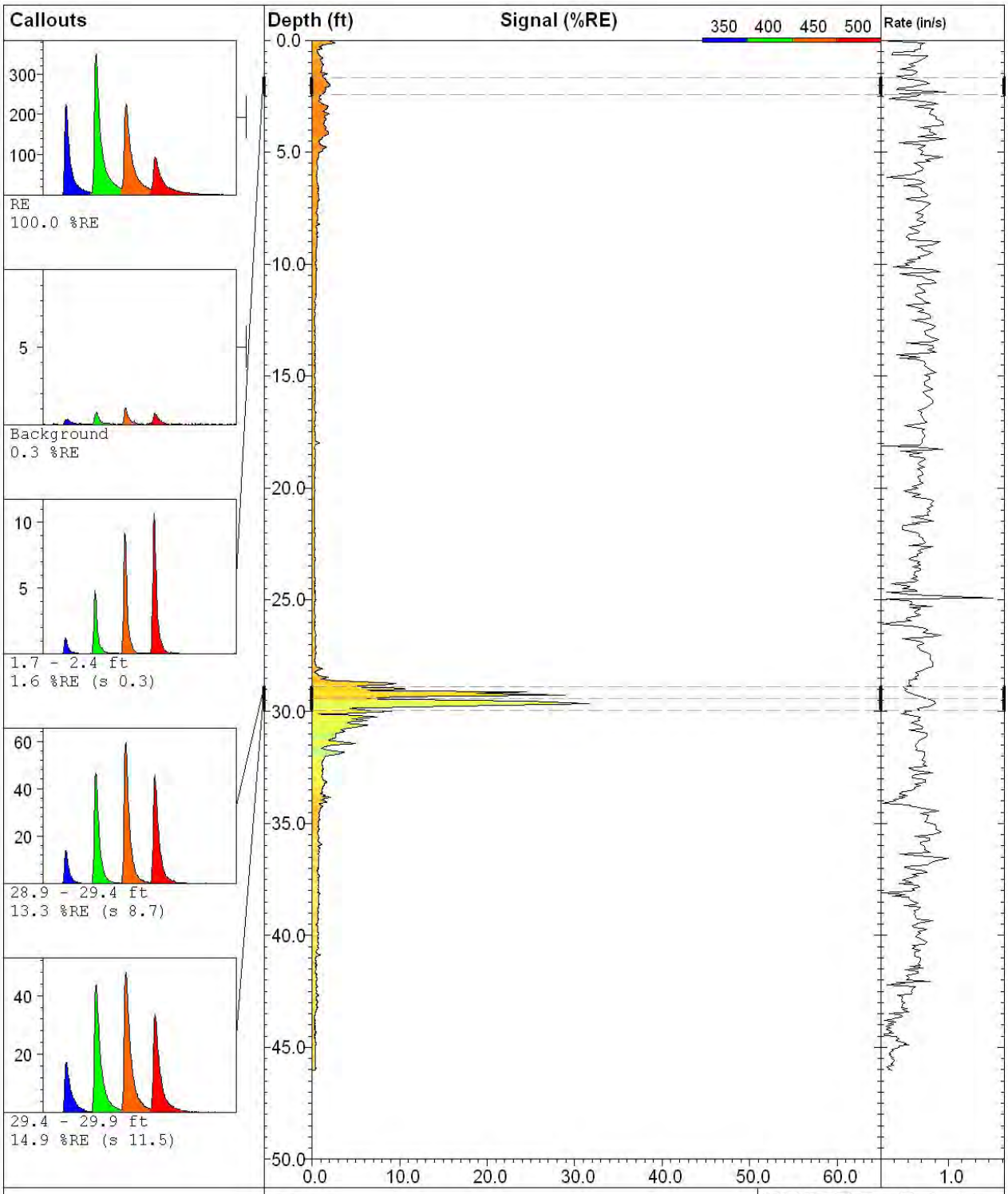
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **49.90 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **3.1 % @ 45.96 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-02 10:20 PST**



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UVOST By Dakota
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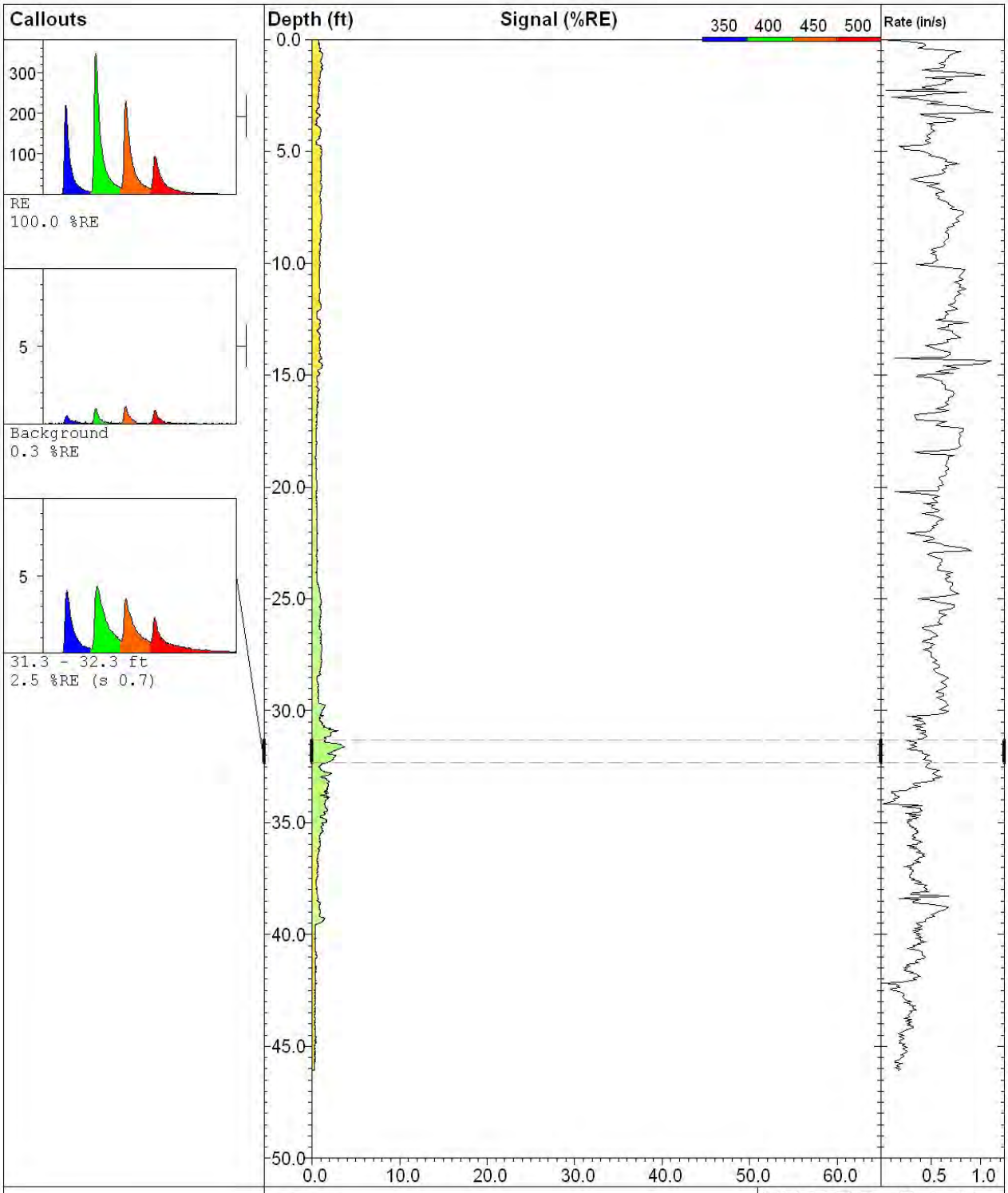
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **46.03 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **31.7 % @ 29.65 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-02 14:36 PST**



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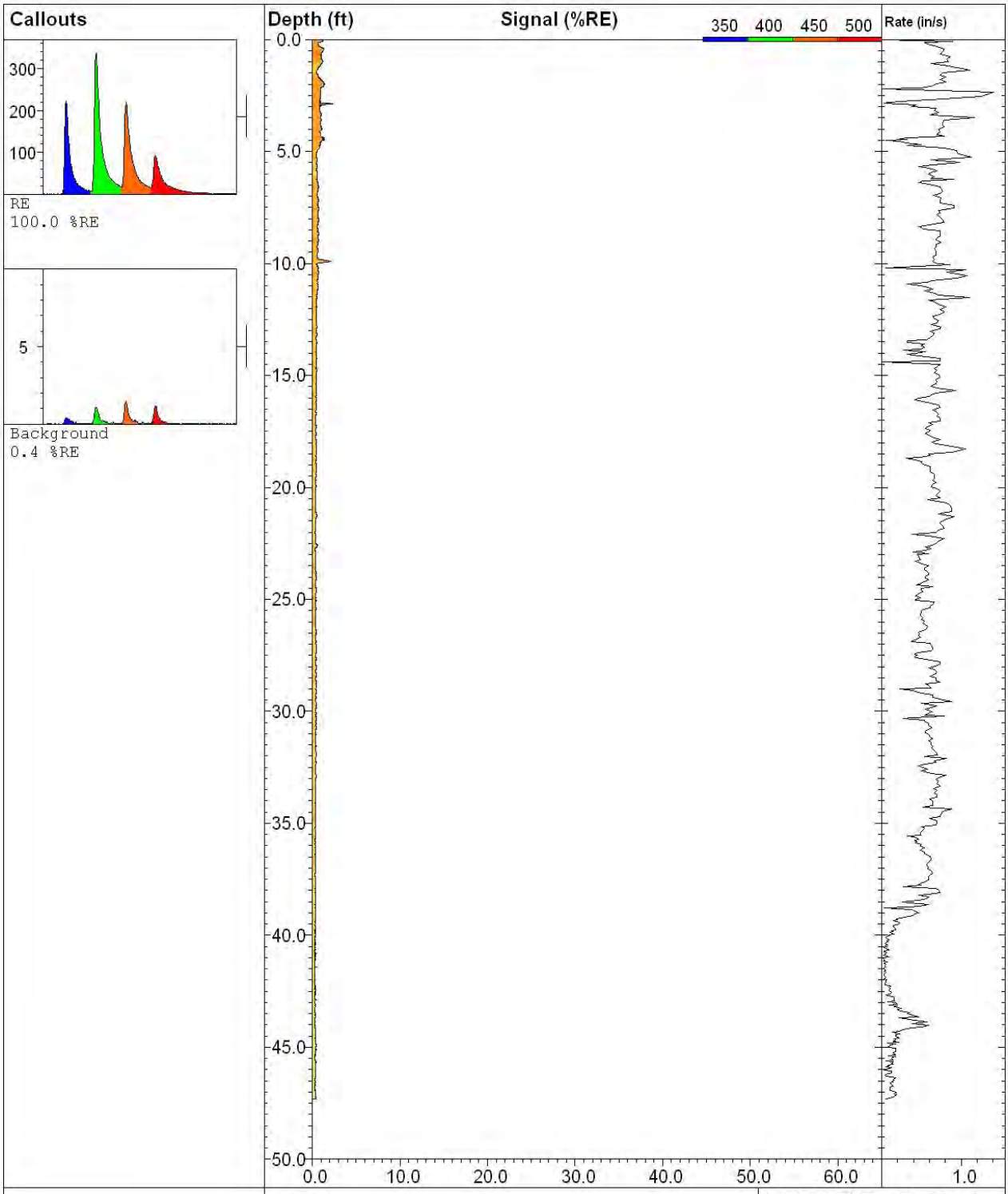
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **46.05 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **3.7 % @ 31.63 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-02 12:53 PST**



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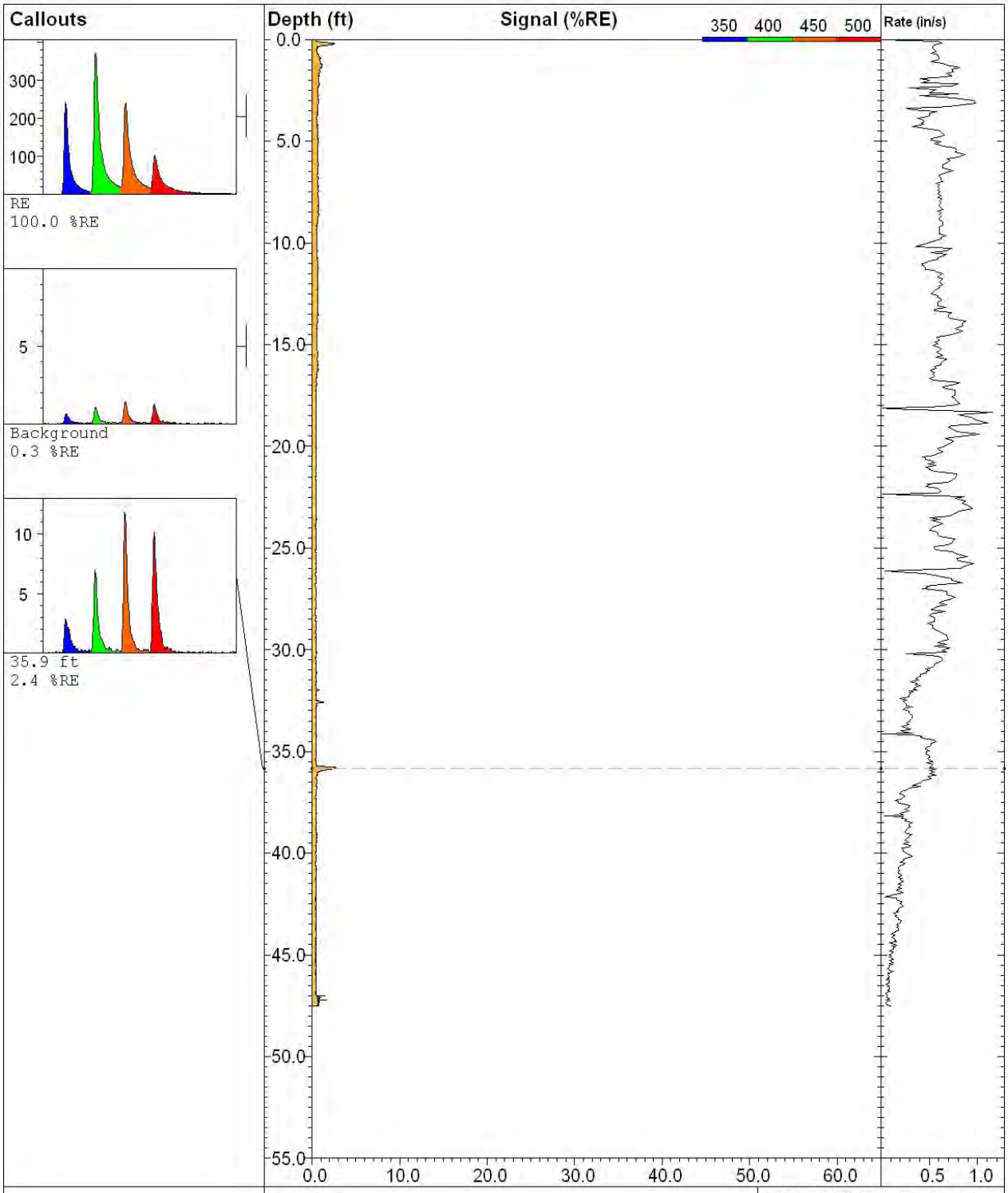
Site: **FHL Bldg 258**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **47.29 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **2.4 % @ 2.87 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-04 08:19 PST**



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U-1-2

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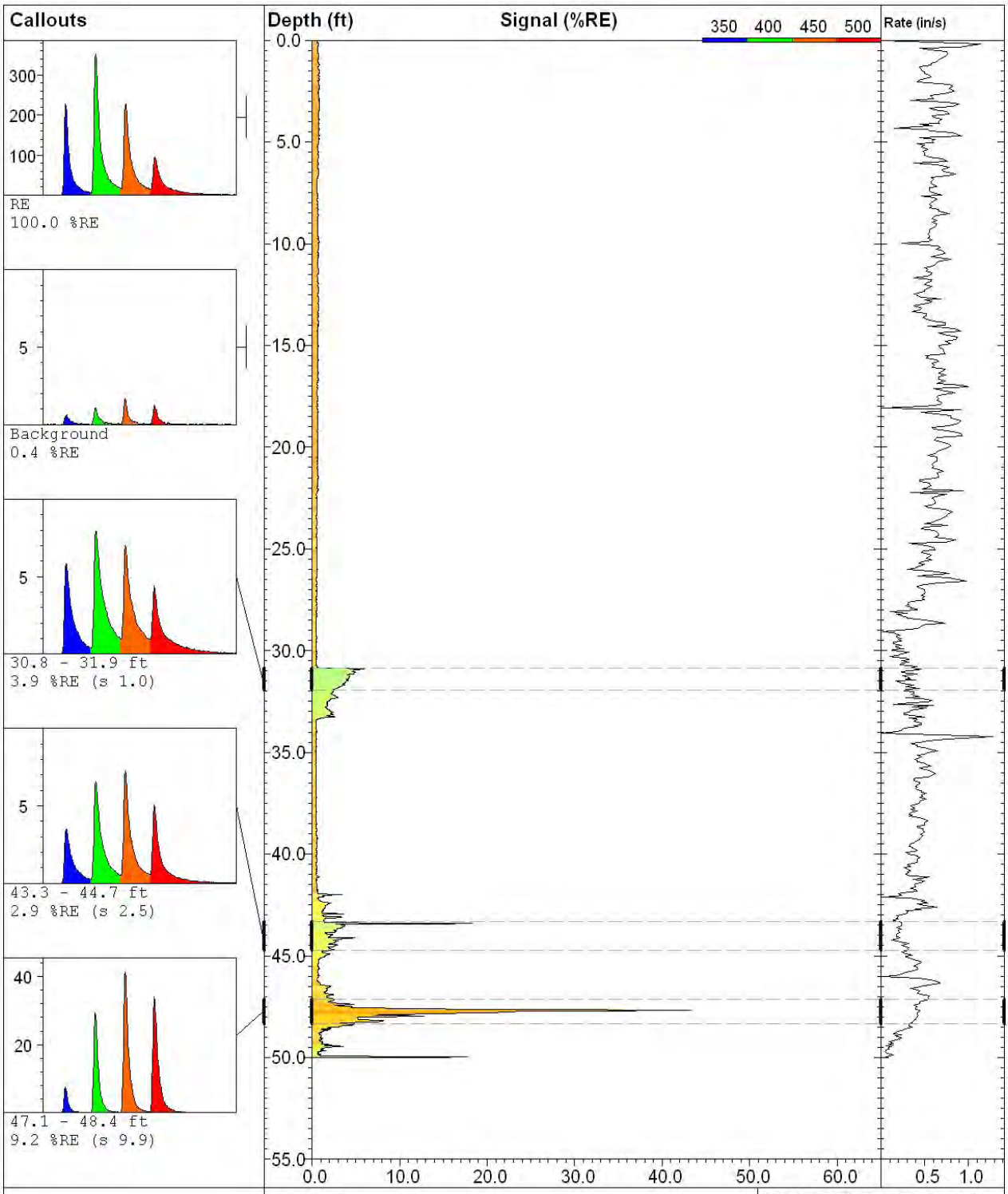
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **47.53 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **2.7 % @ 35.79 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-09 16:43 PST**



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U-1-3

UVOST By Dakota
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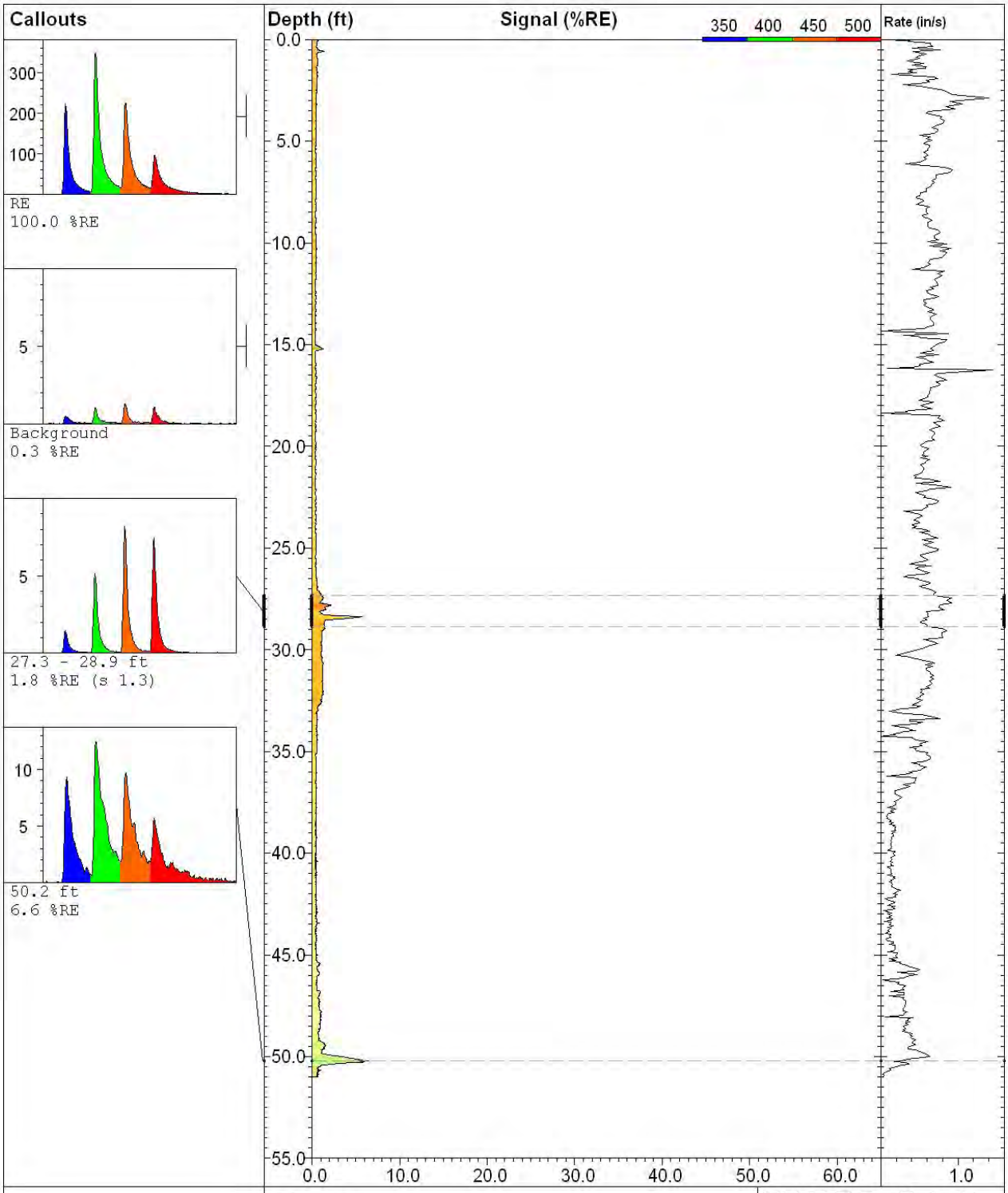
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **50.01 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **44.2 % @ 47.68 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-09 12:43 PST**



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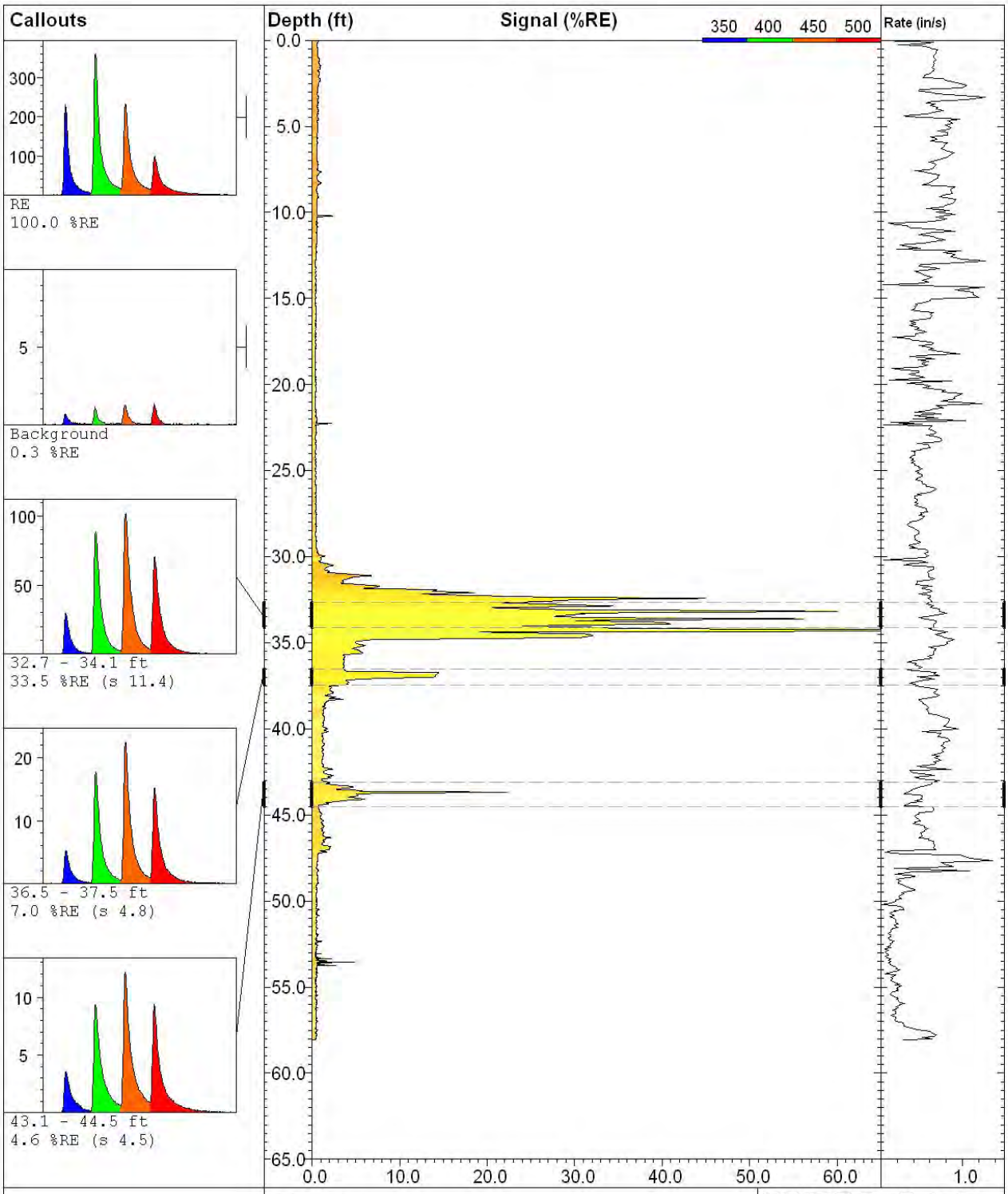
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **51.01 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **6.6 % @ 50.22 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-09 10:53 PST**



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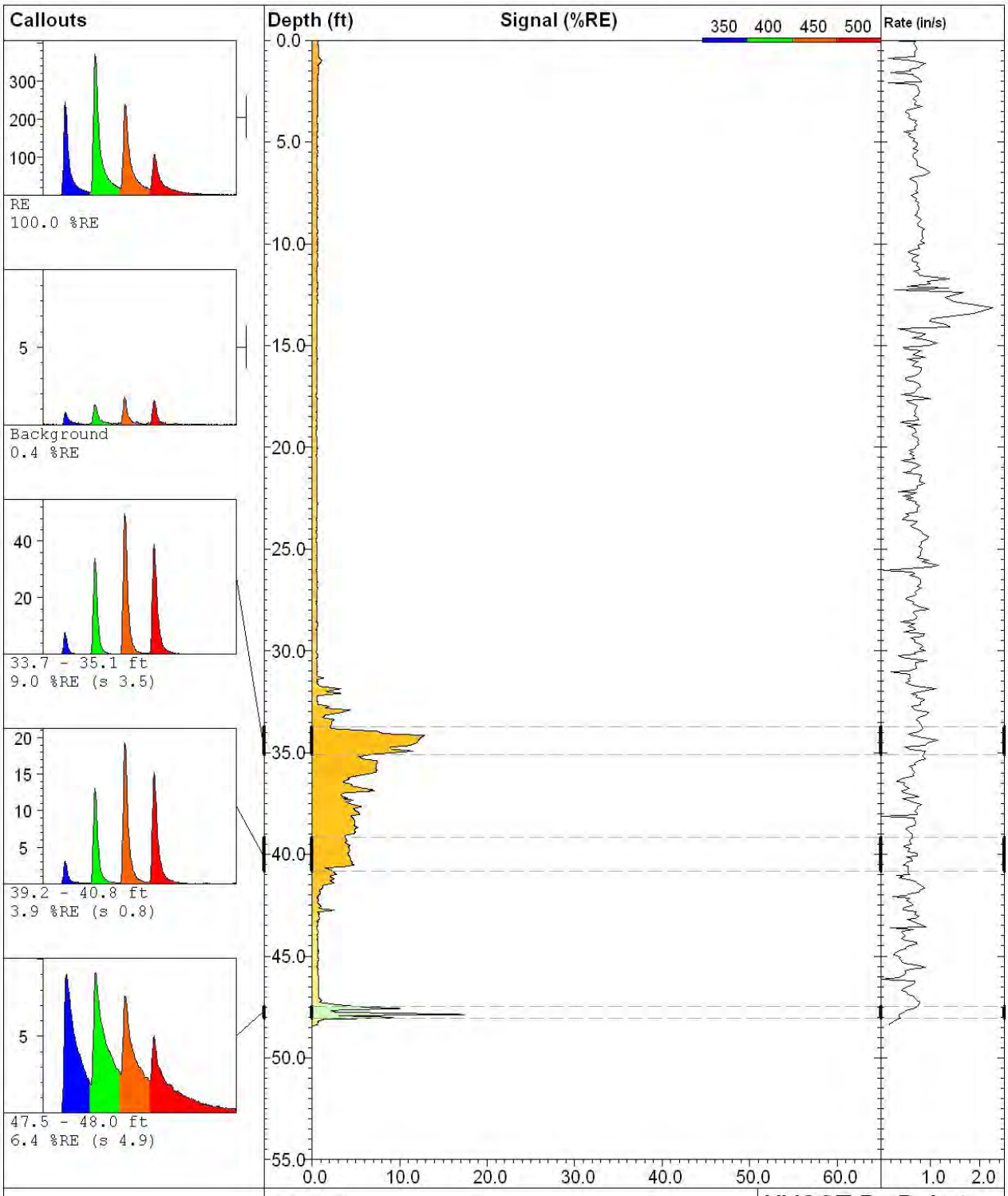
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **58.07 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **132.5 % @ 34.26 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-09 14:37 PST**



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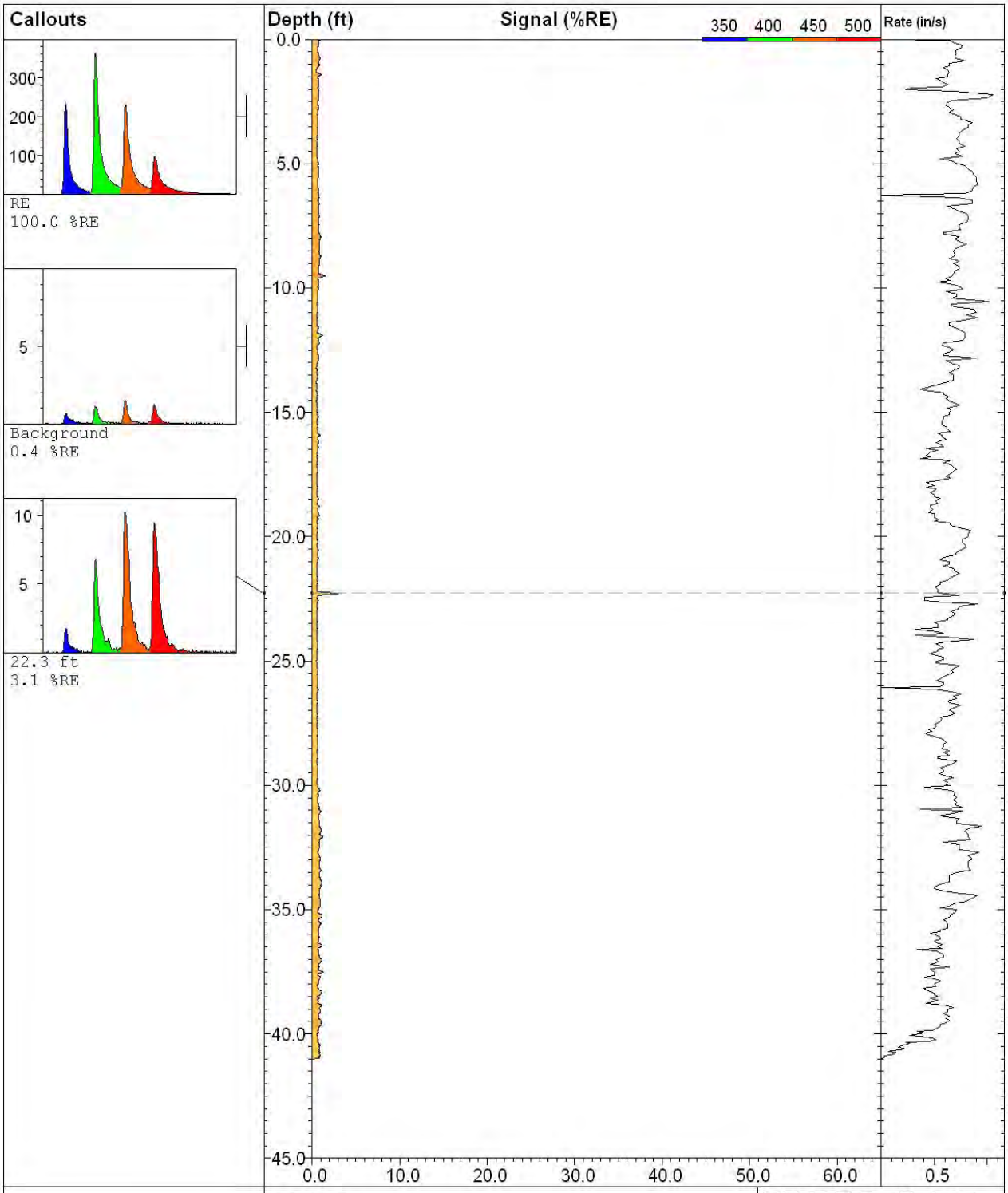
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **48.40 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **17.7 % @ 47.87 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-18 11:20 PST**



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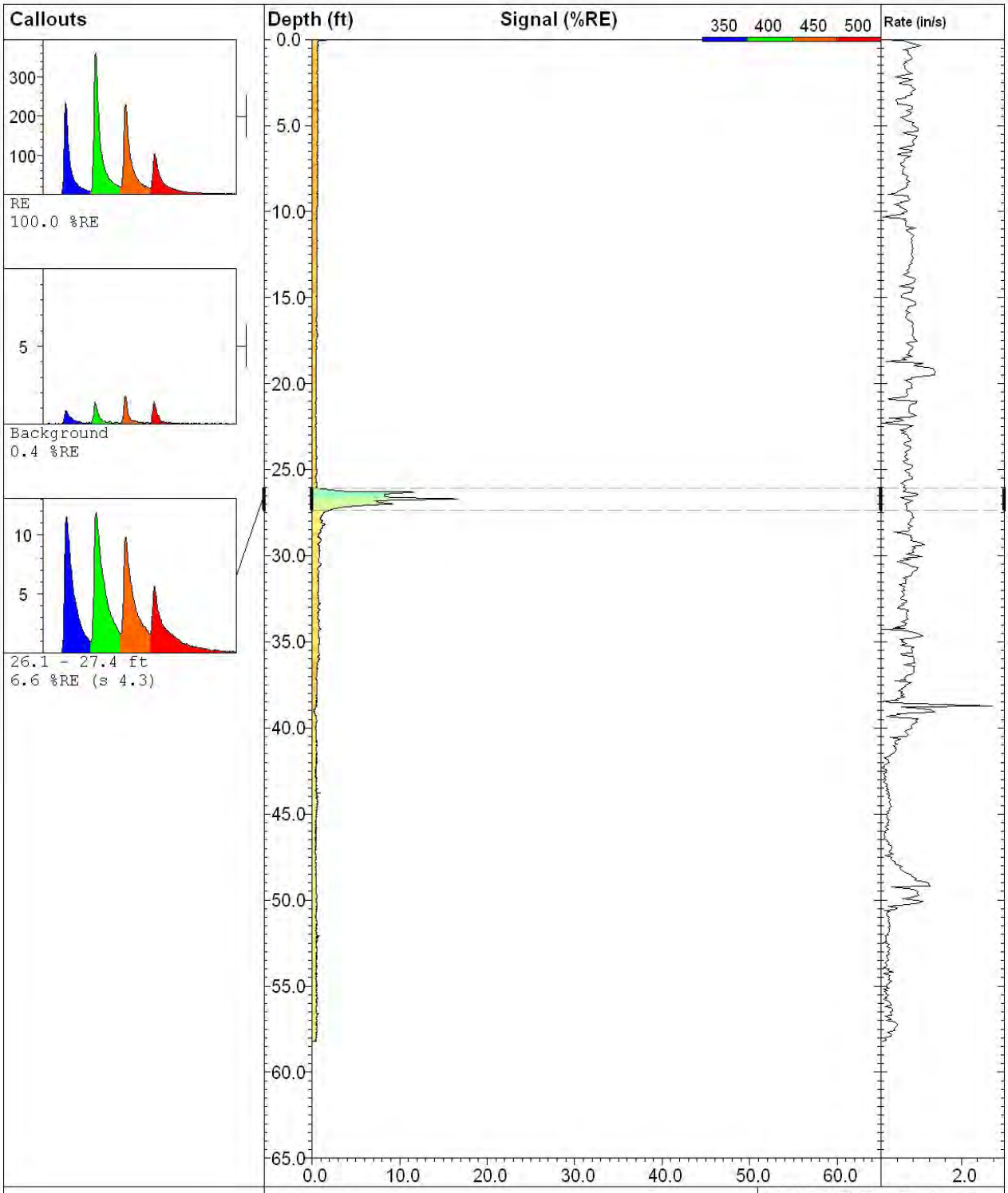
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **41.00 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **3.1 % @ 22.27 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-11 10:14 PST**



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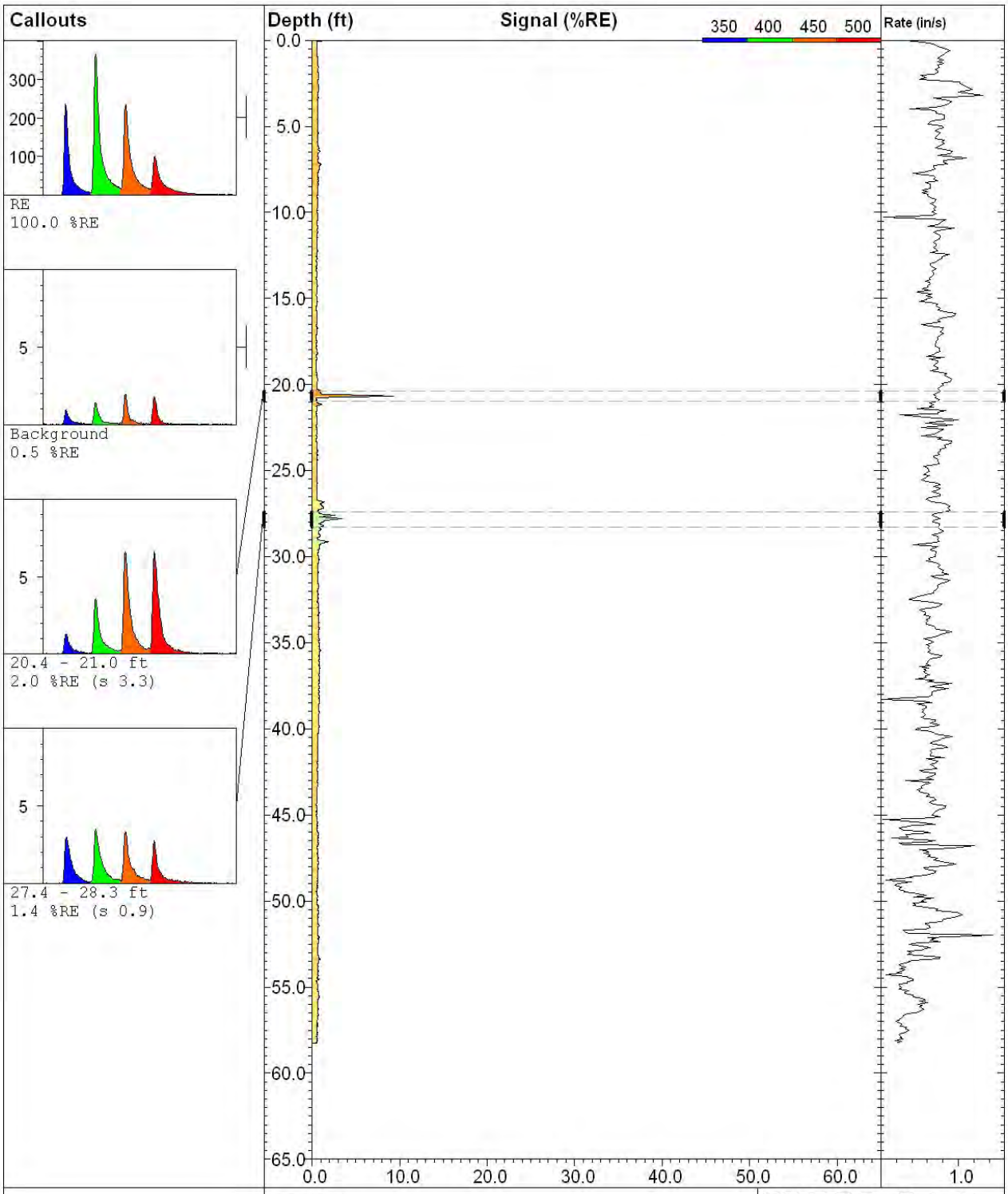
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **58.21 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **16.6 % @ 26.69 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-11 08:30 PST**



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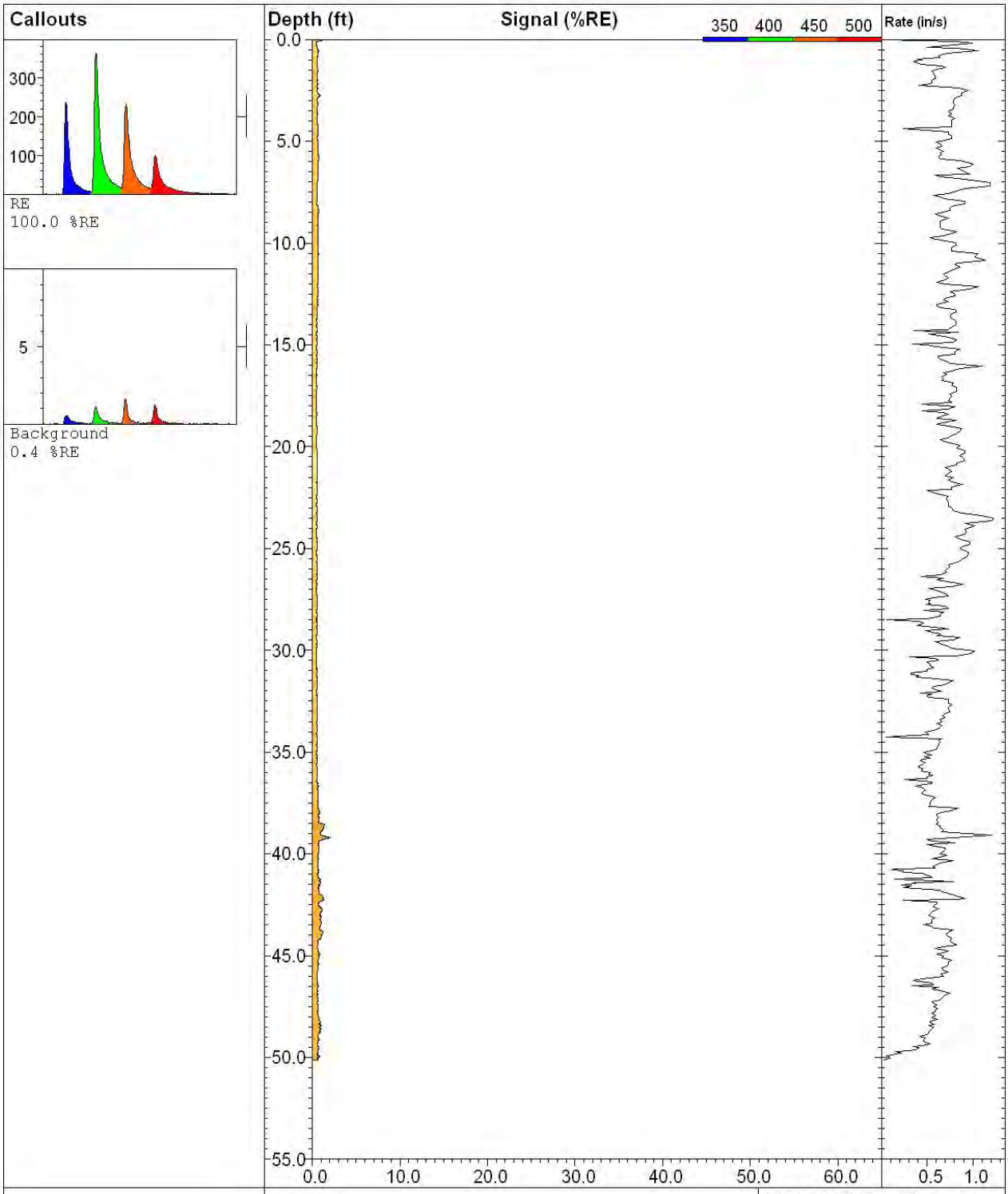
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **58.26 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **9.4 % @ 20.67 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-11 11:33 PST**



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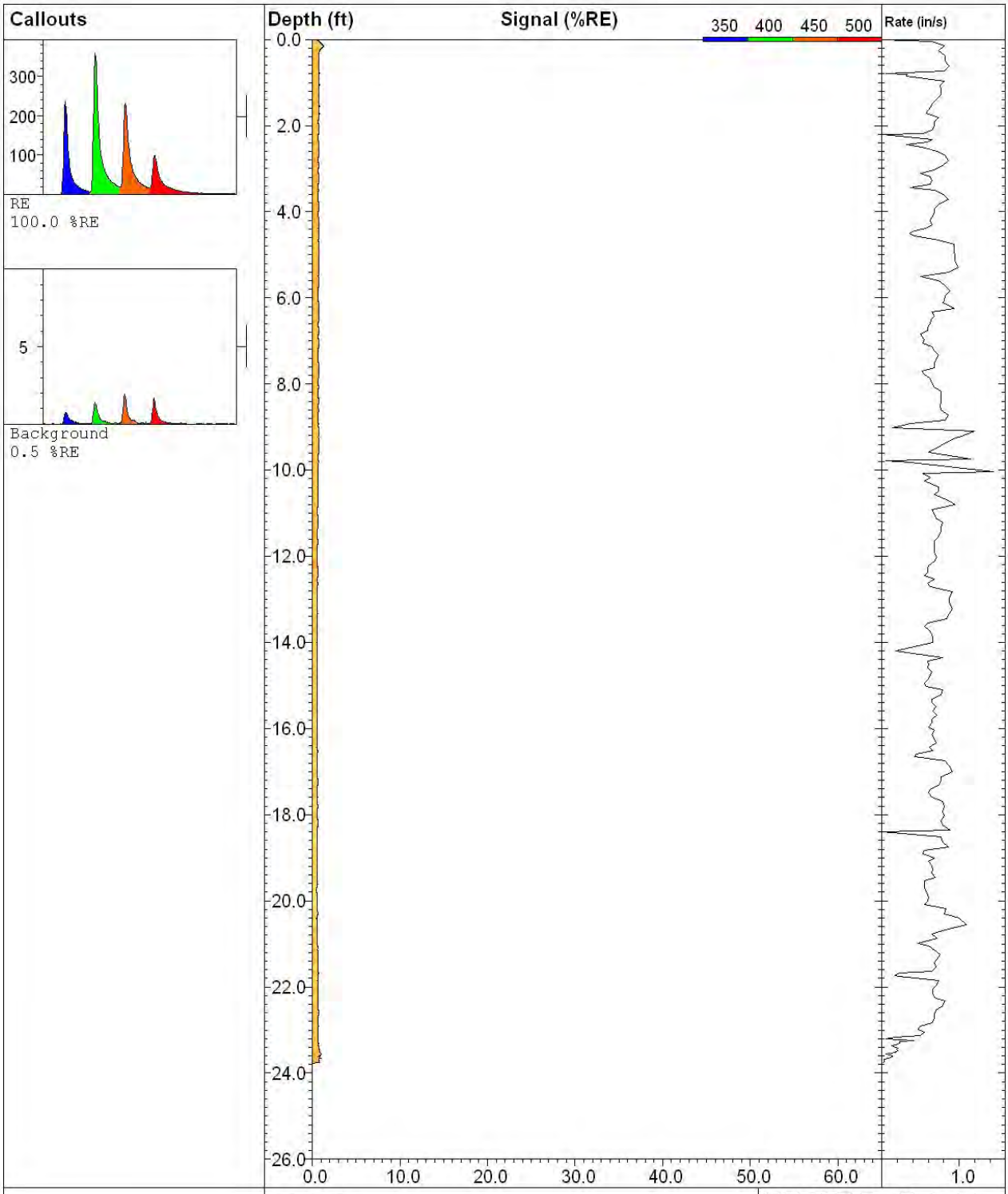
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **50.13 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **2.1 % @ 39.21 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-11 13:59 PST**



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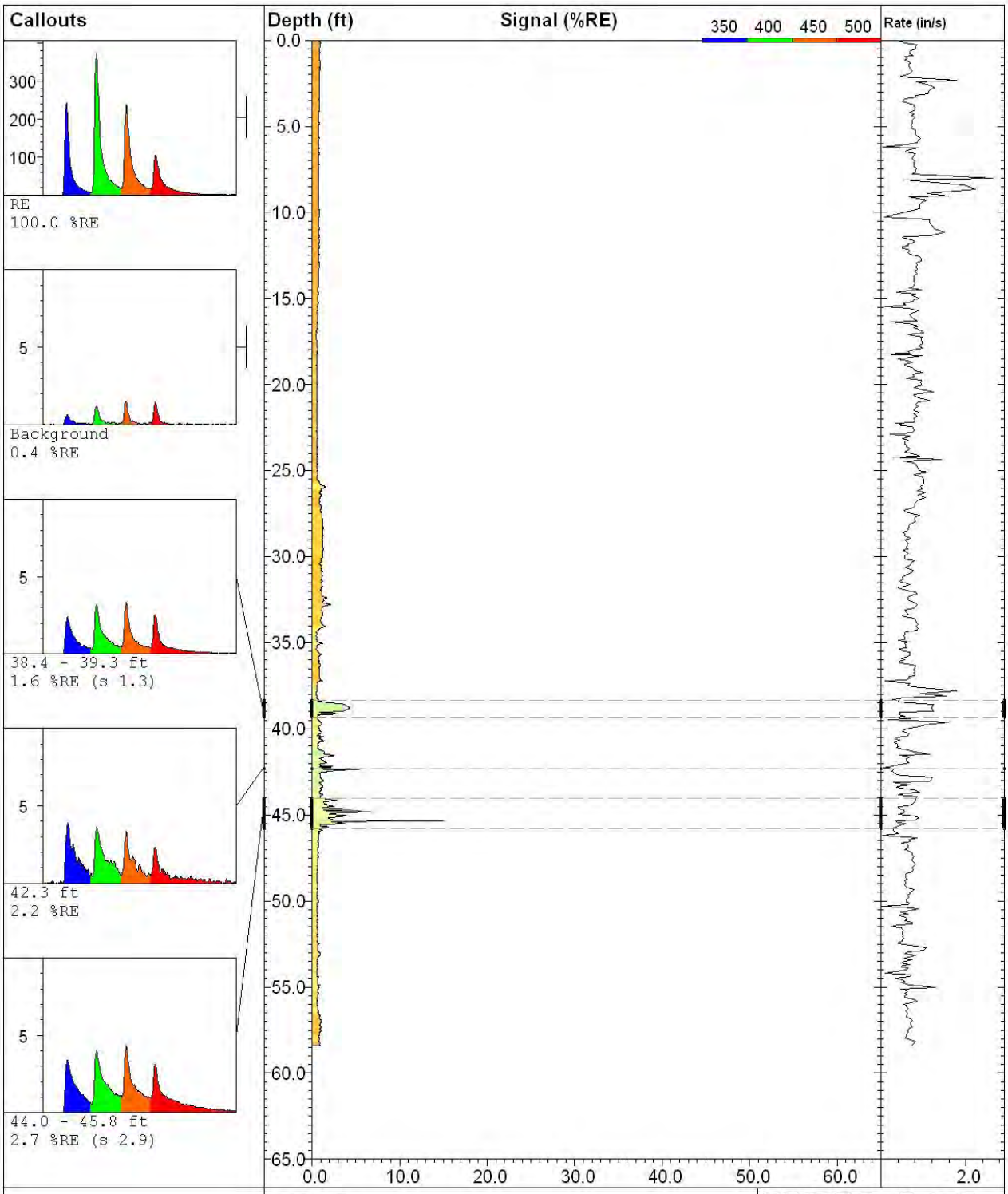
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **23.77 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **1.3 % @ 0.15 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-18 09:54 PST**



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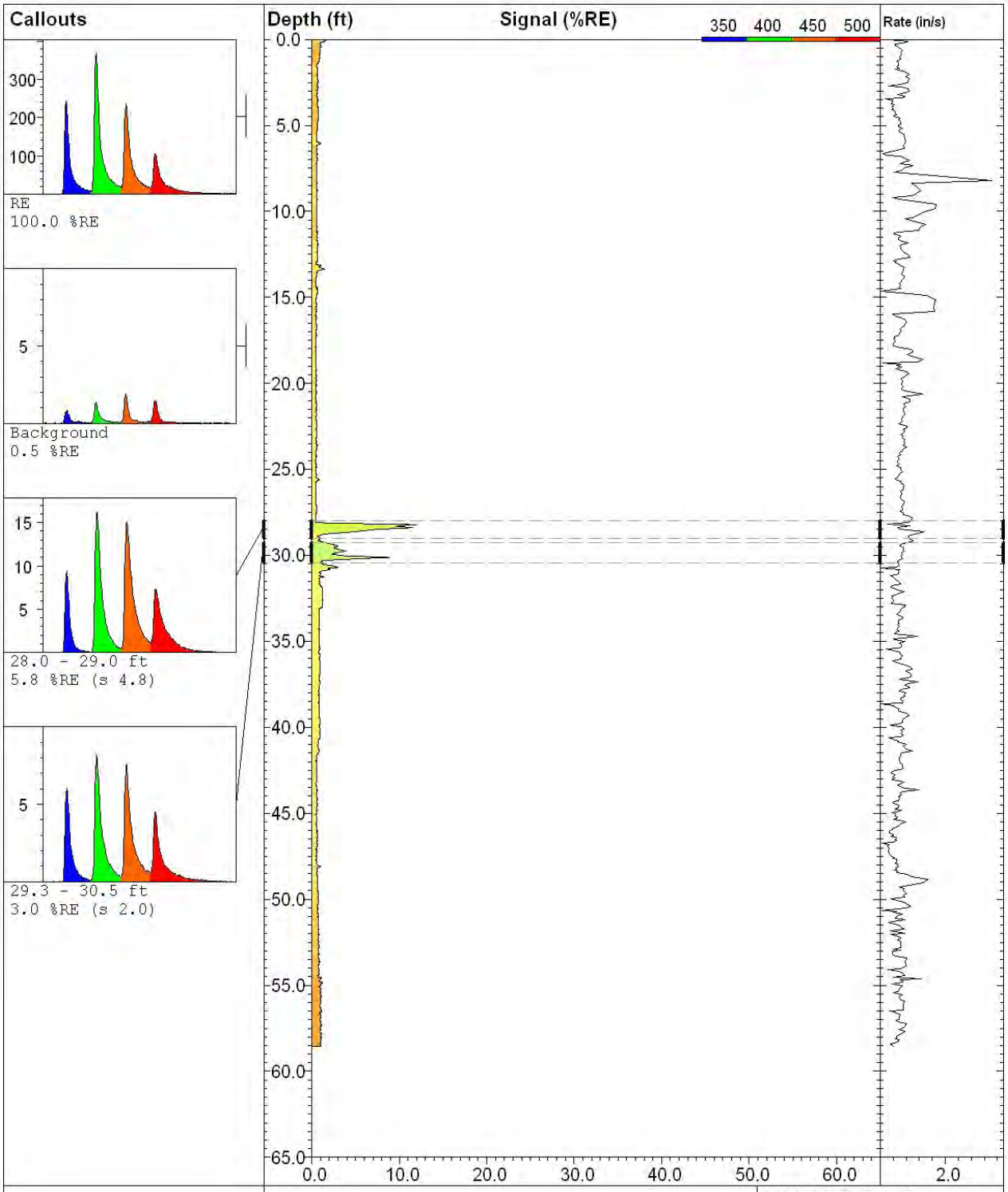
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **58.40 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **15.0 % @ 45.36 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-17 16:18 PST**



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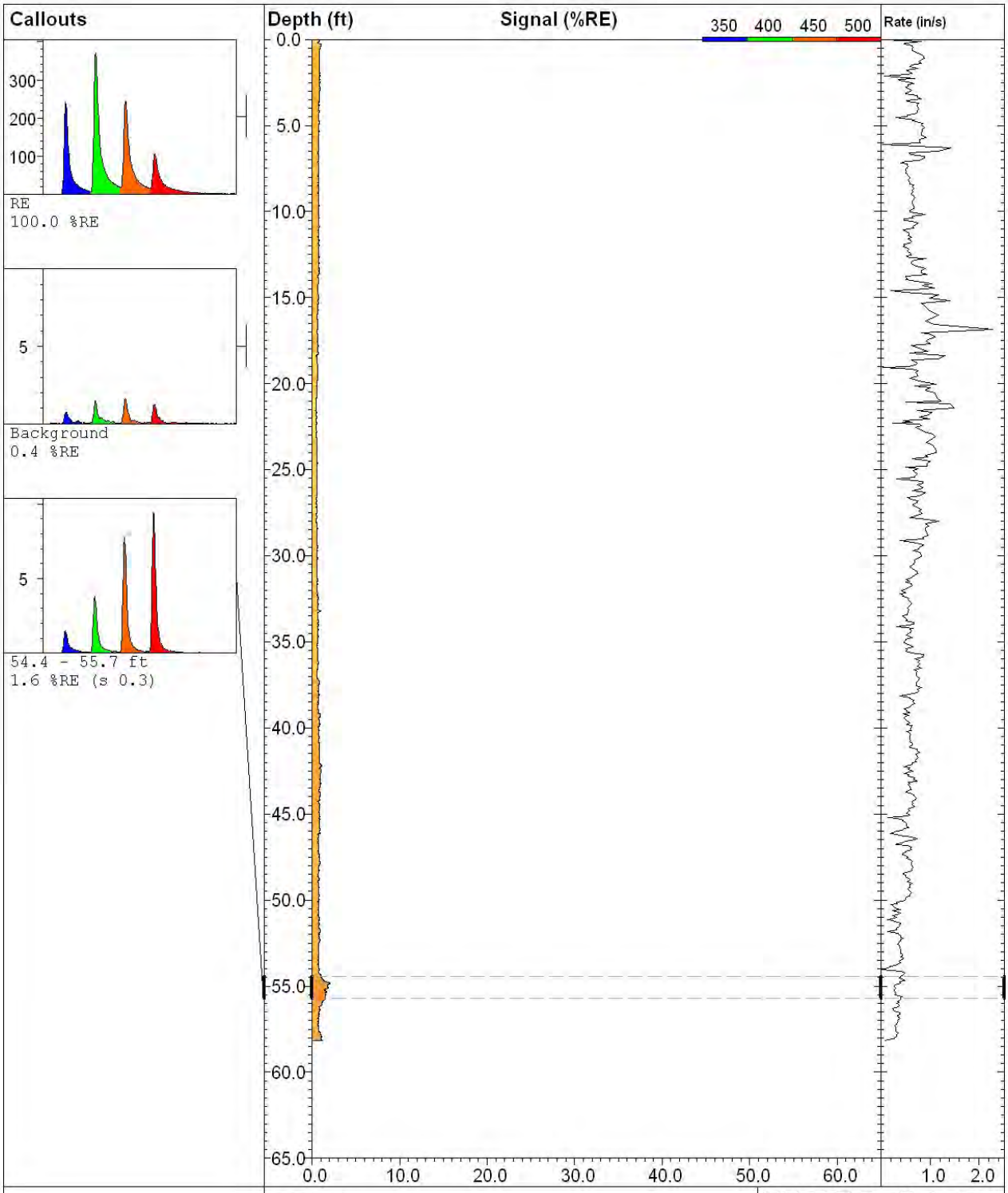
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **58.54 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **12.1 % @ 28.20 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-17 14:45 PST**



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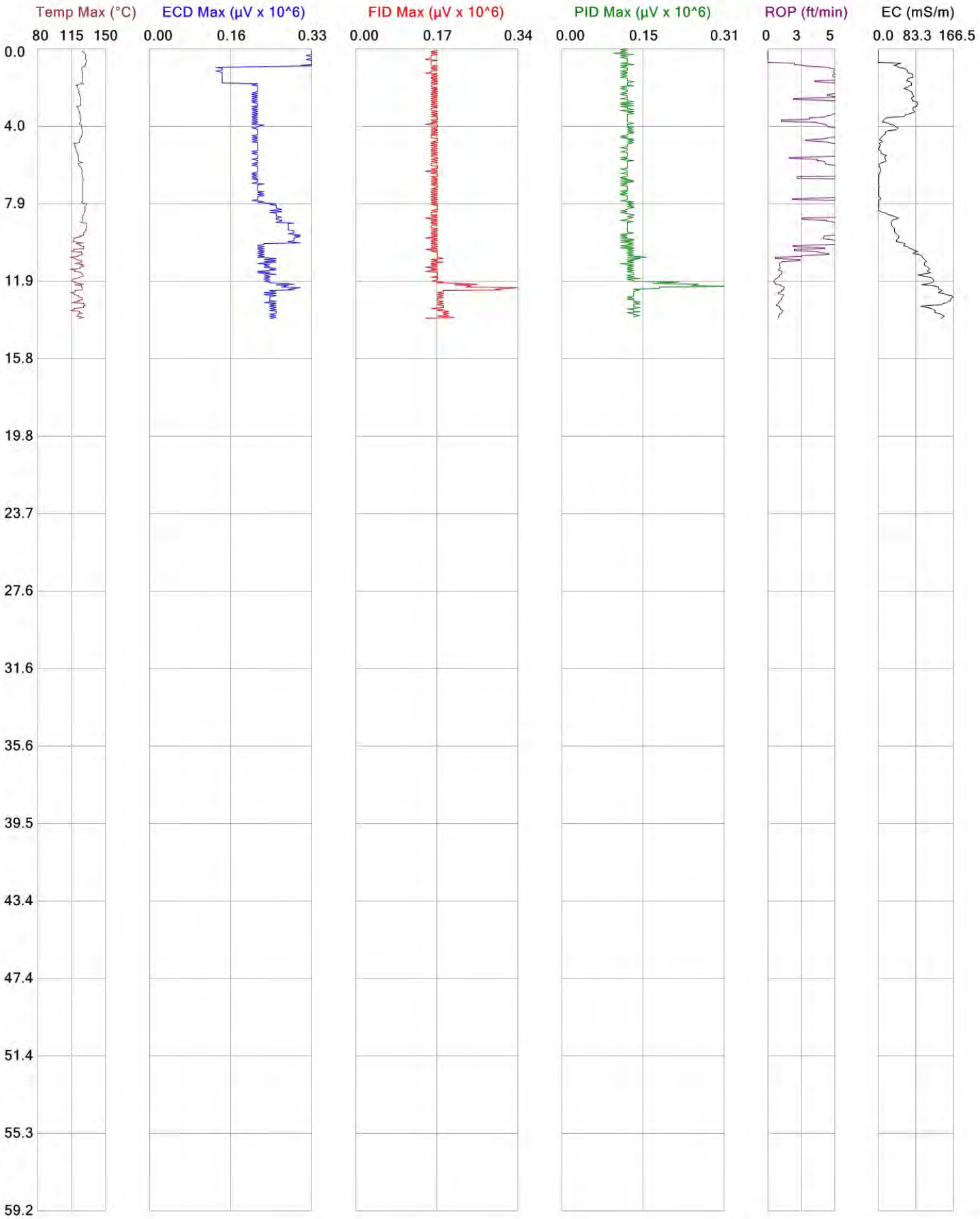
Site: **Fort Hunter Liggett**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **58.17 ft**
Client: **AHTNA**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **2.1 % @ 54.85 ft**
Job:	*Operator/Unit:* **Heicher/UVOST1005**	*Date & Time:* **2011-02-18 08:28 PST**

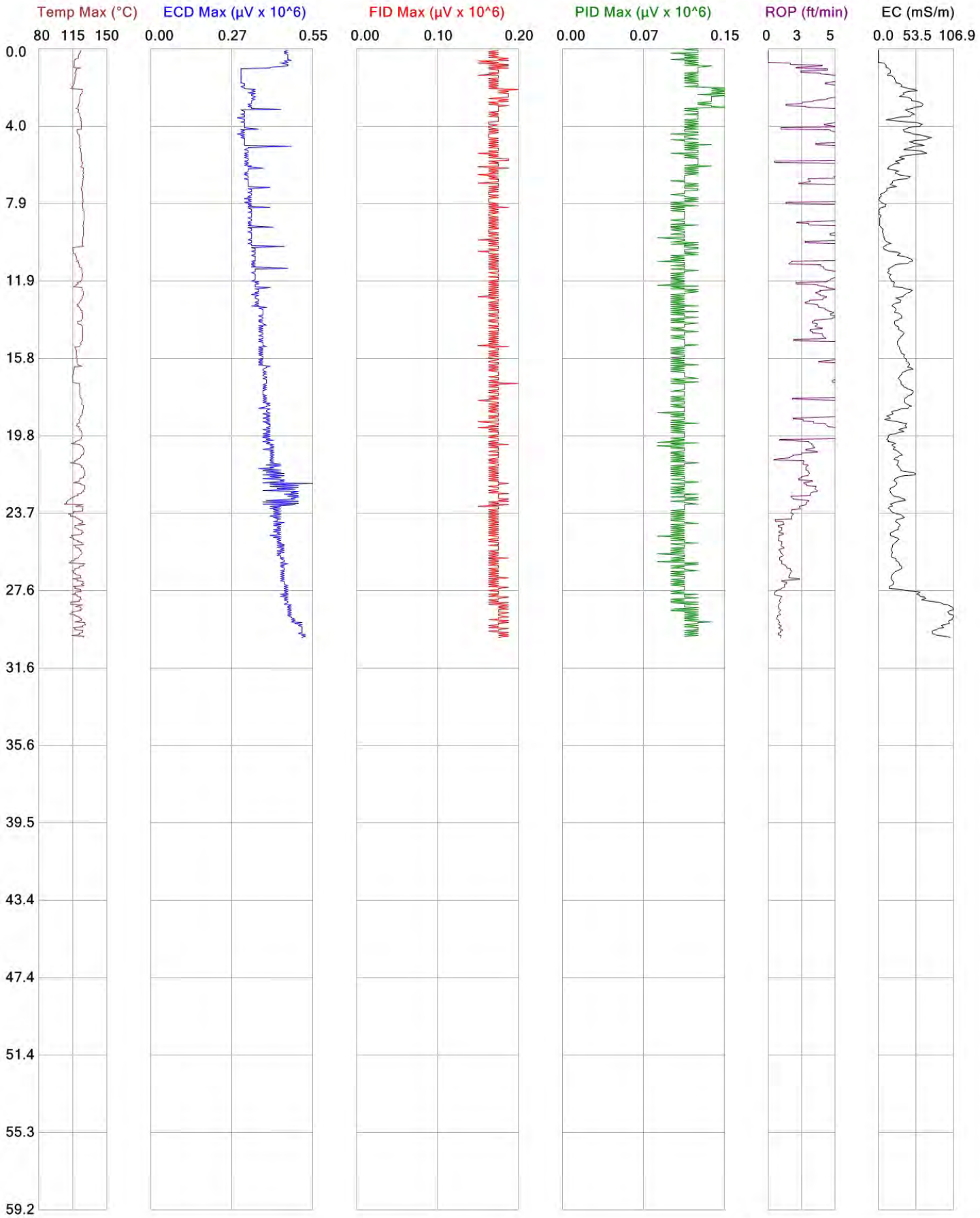
APPENDIX B

MIPS Results



	File: M-3-1
Client: Ahtna Engineering Services, LLC	Date: 2/17/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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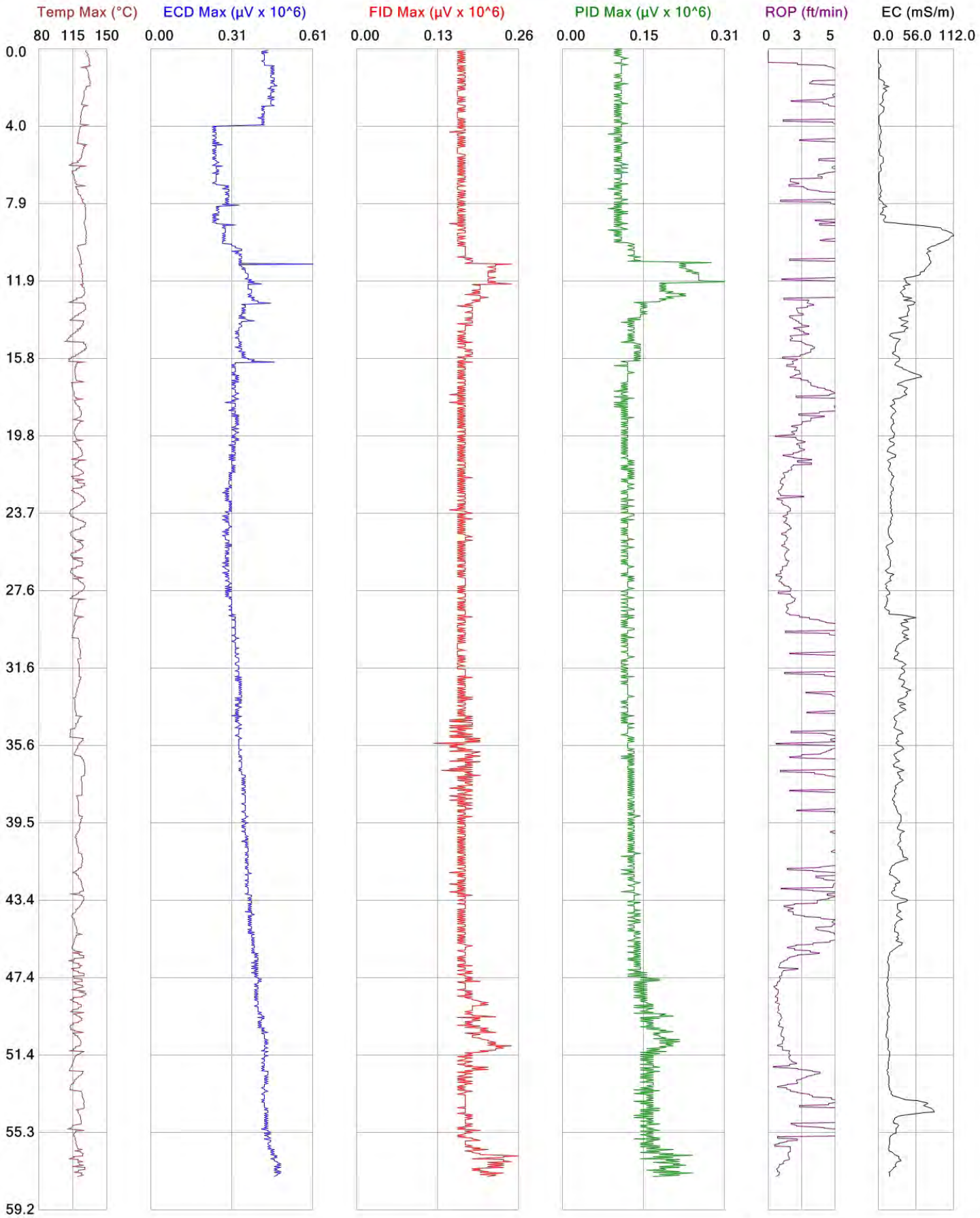
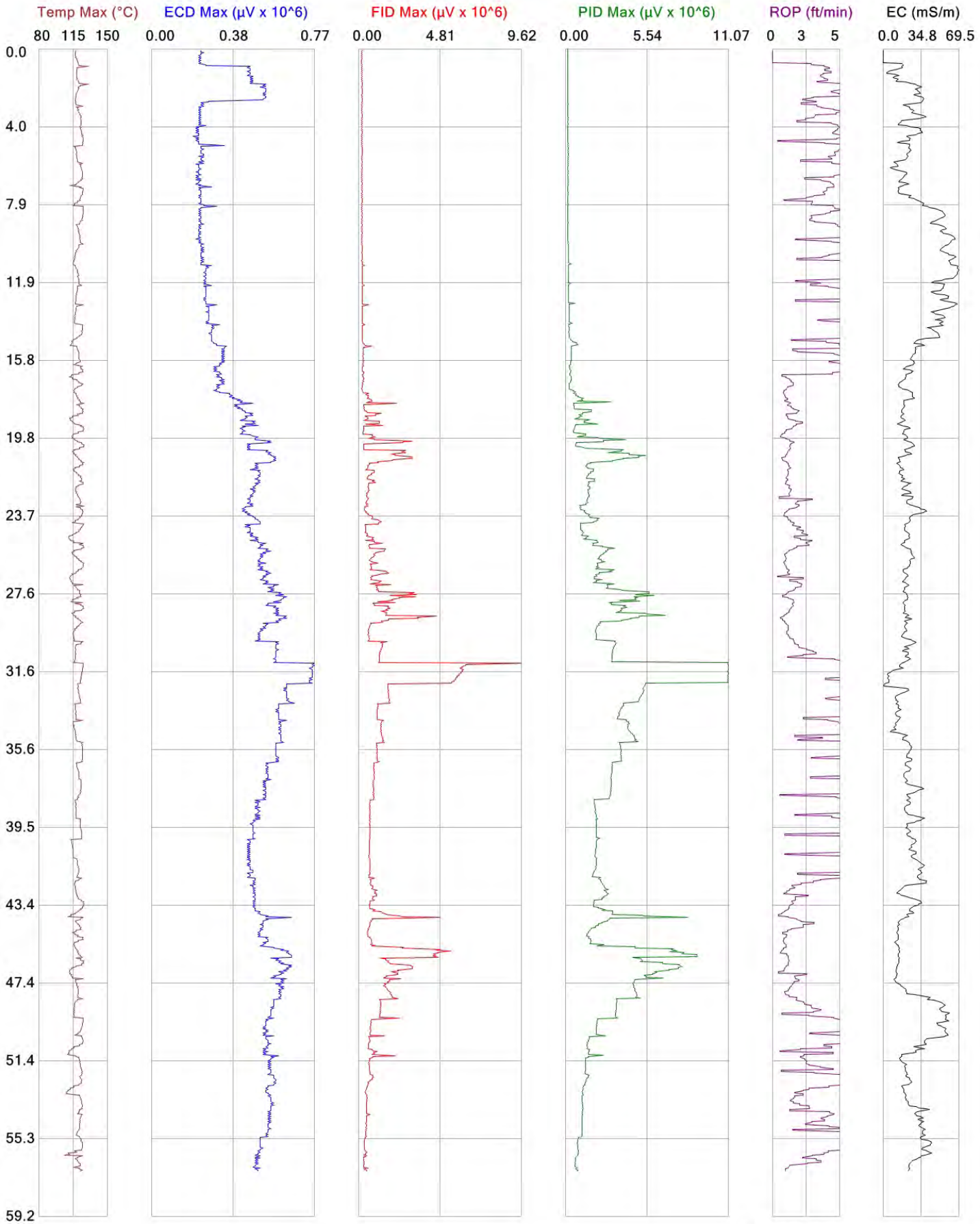
Client: Ahtna Engineering Services, LLC	Date: 2/17/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



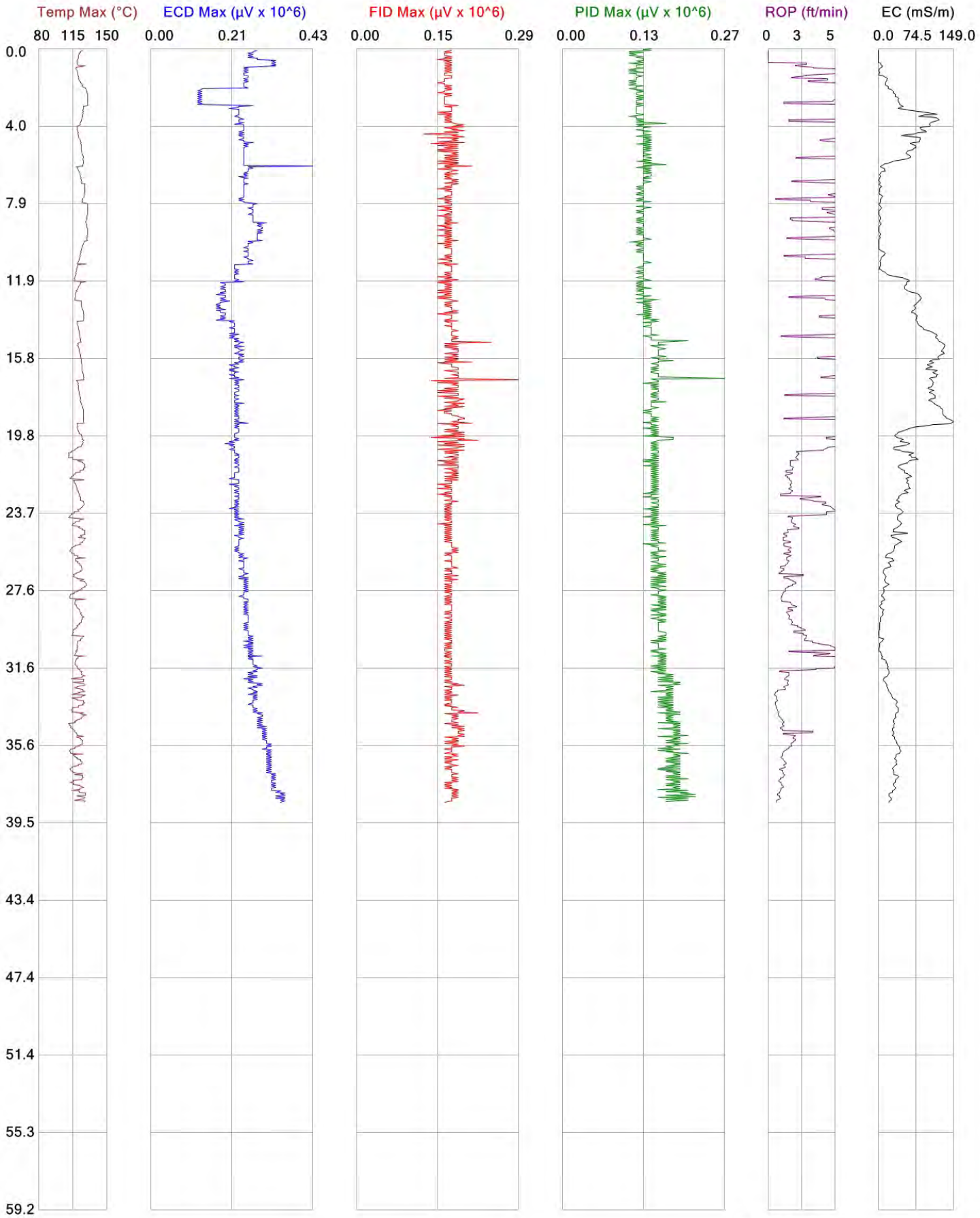
	File: M-4-1
Client: Ahtna Engineering Services, LLC	Date: 2/15/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



	File: M-4-3
Client: Ahtna Engineering Services, LLC	Date: 2/15/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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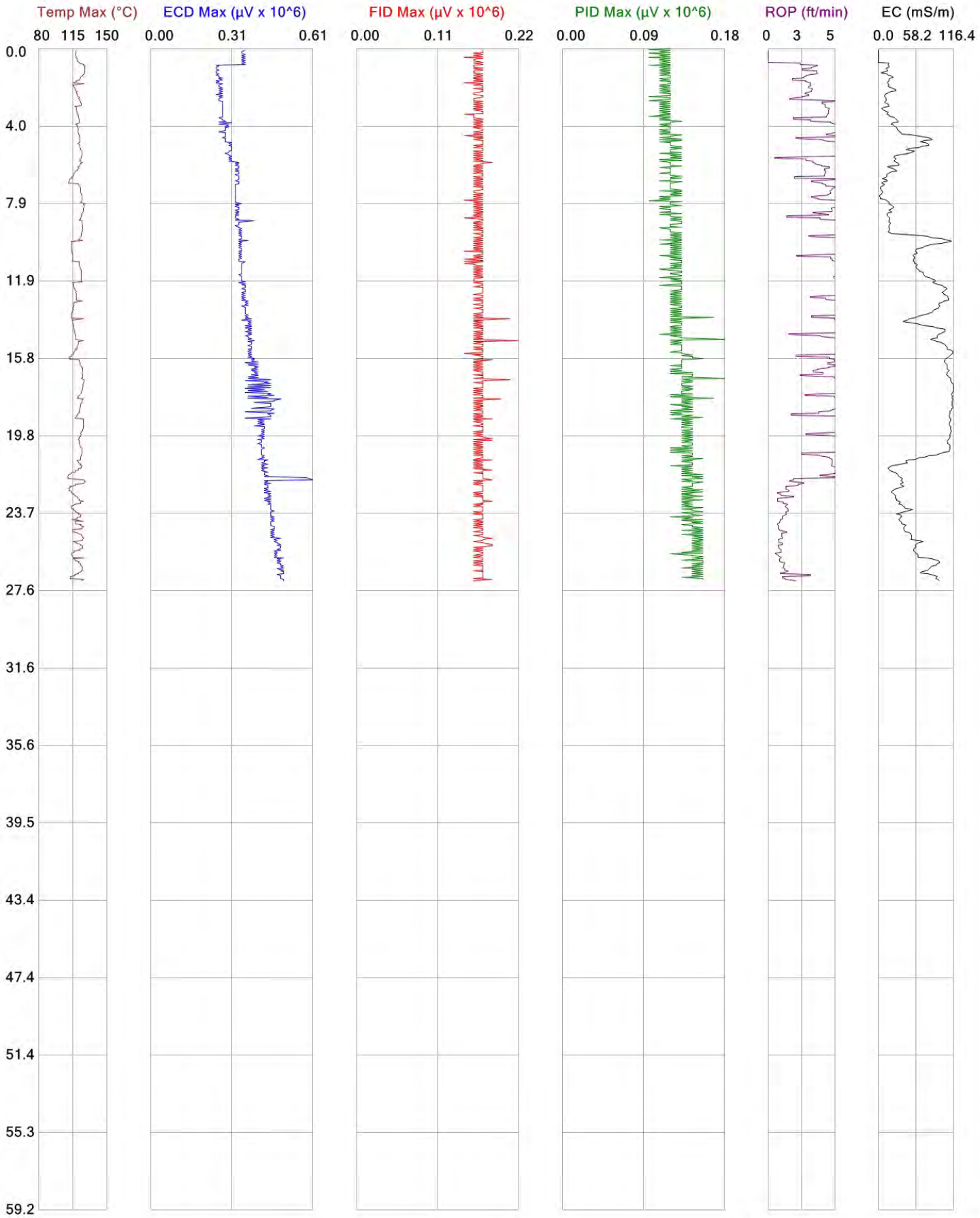
Client: Ahtna Engineering Services, LLC	Date: 2/15/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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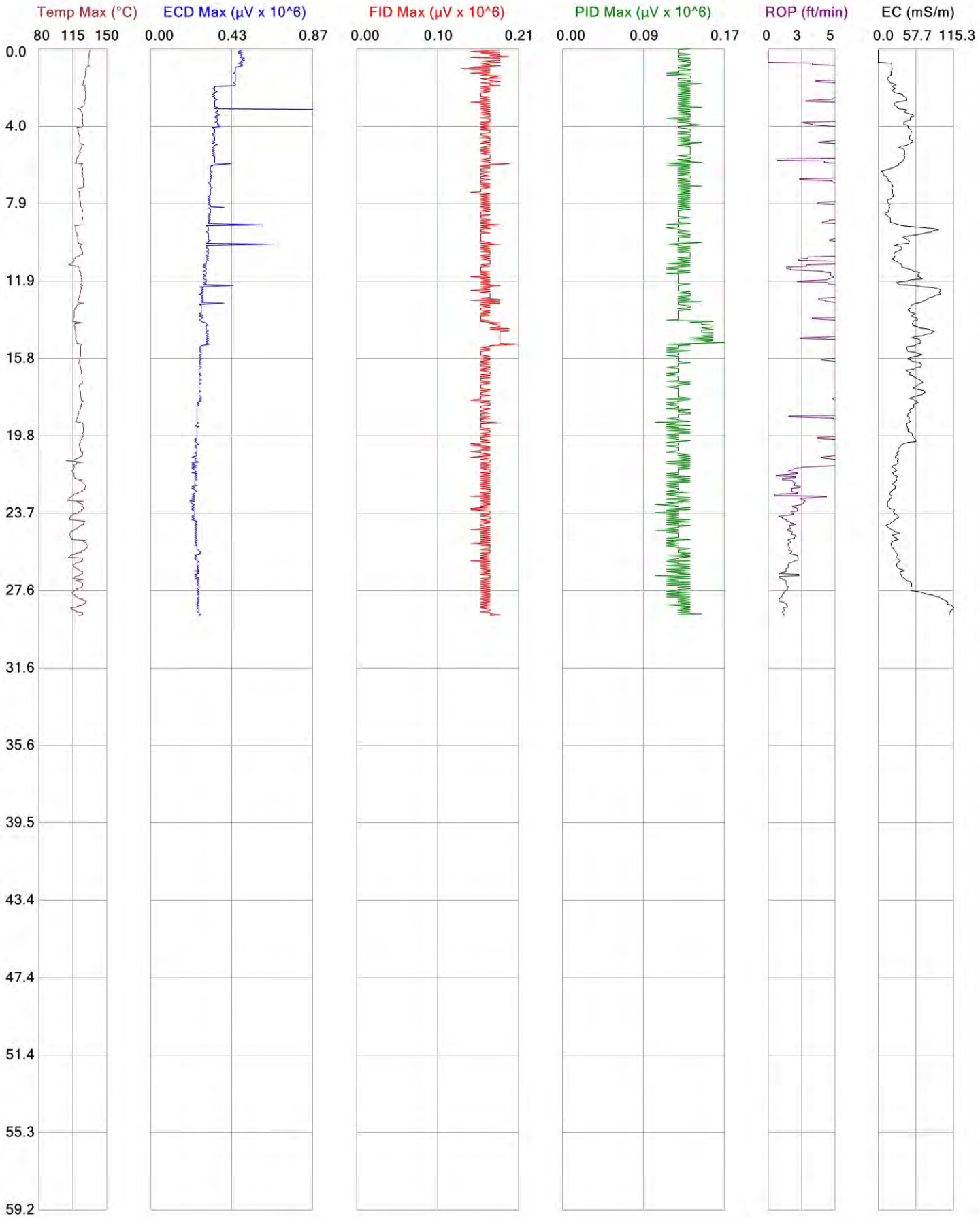
Client: Ahtna Engineering Services, LLC	Date: 2/16/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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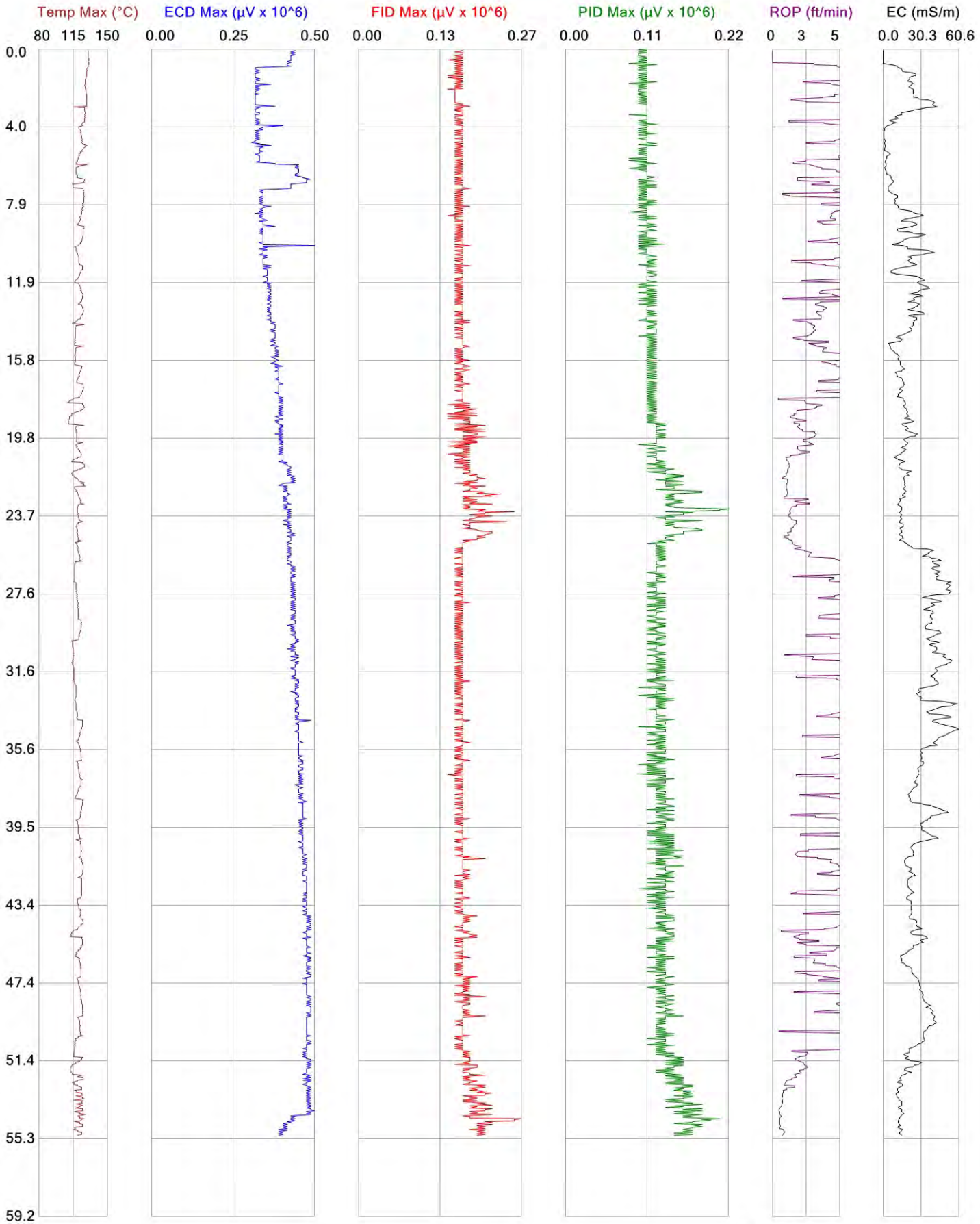
Client: Ahtna Engineering Services, LLC	Date: 2/16/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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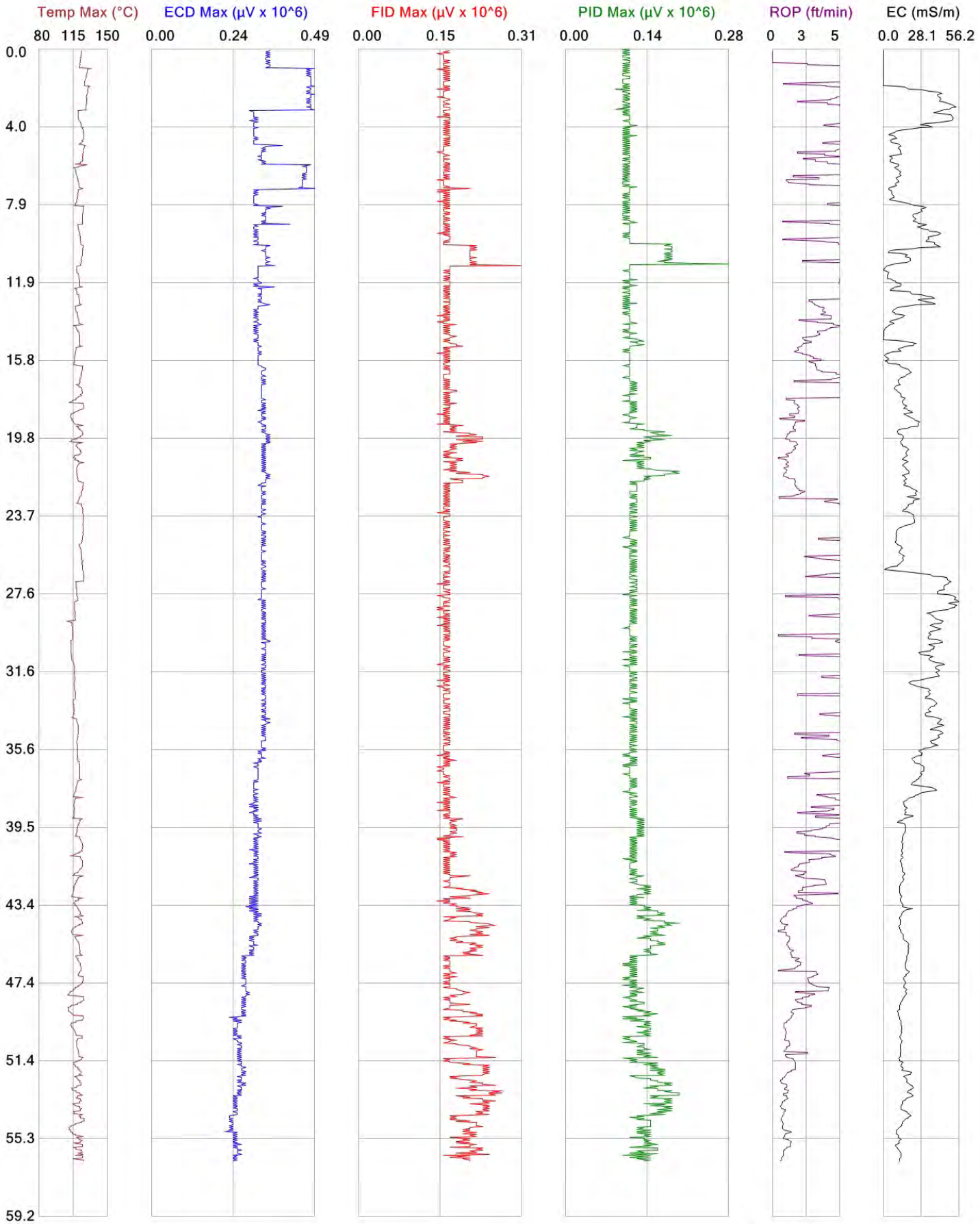
Client: Ahtna Engineering Services, LLC	Date: 2/14/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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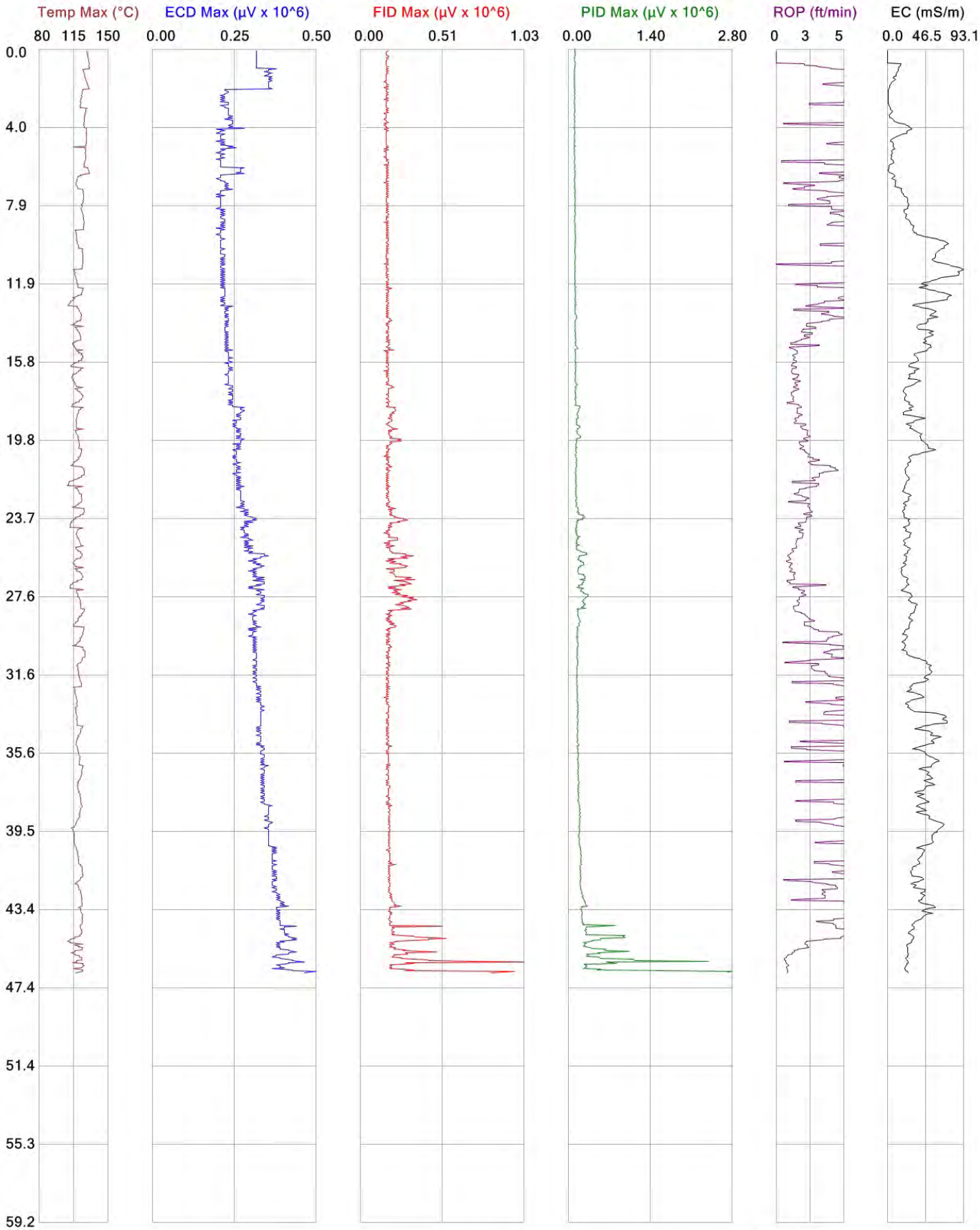
Client: Ahtna Engineering Services, LLC	Date: 2/14/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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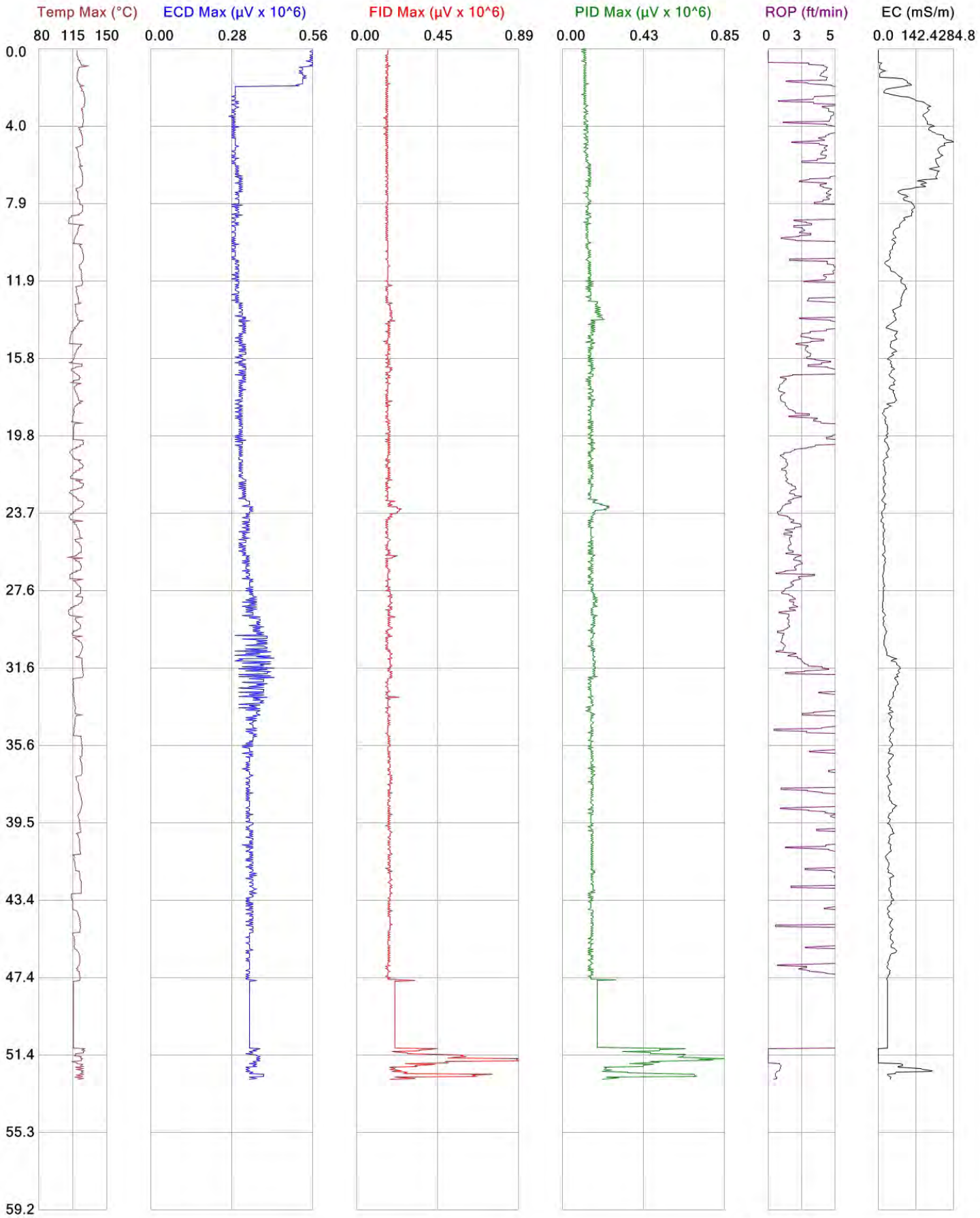
Client: Ahtna Engineering Services, LLC	Date: 2/14/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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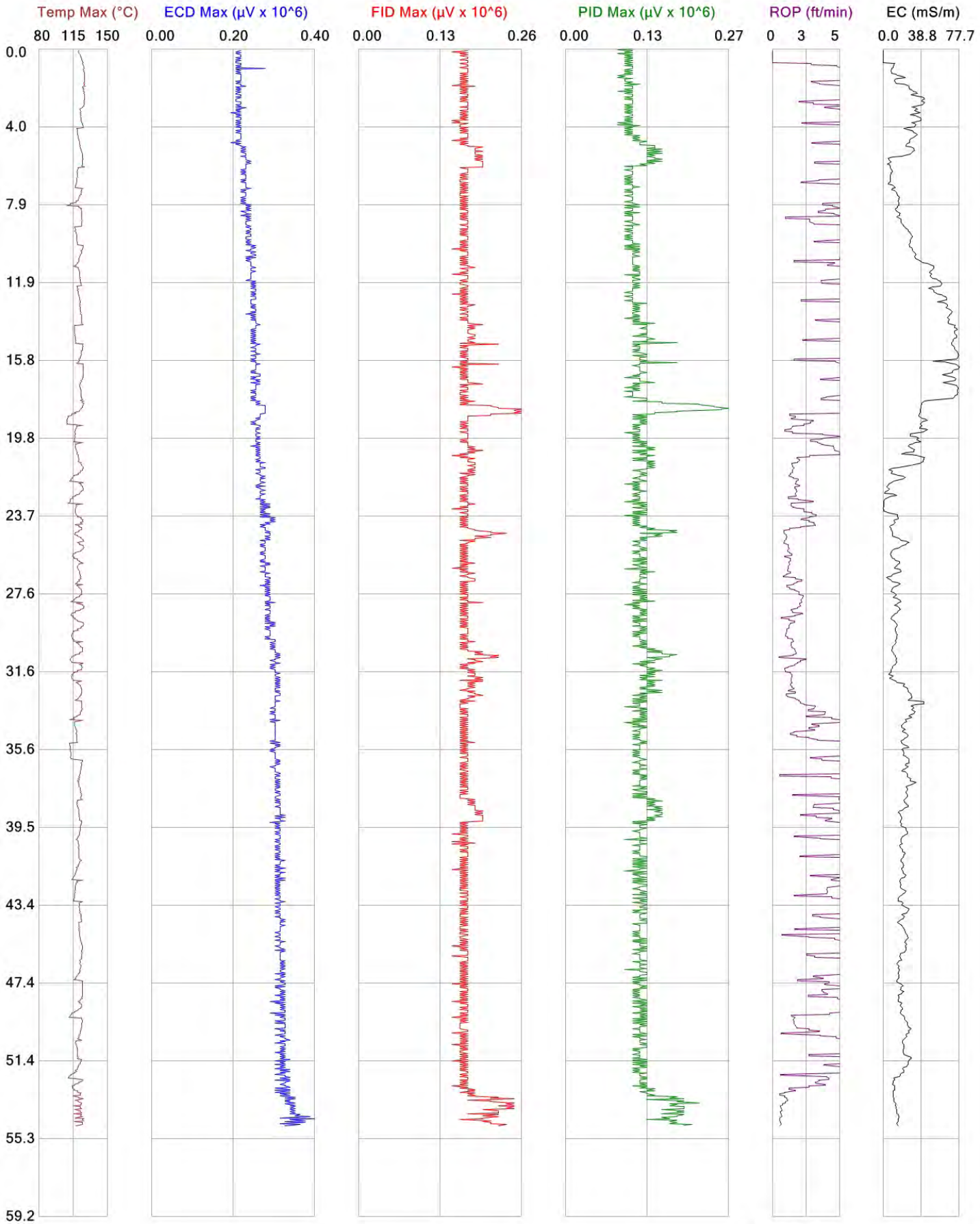
Client: Ahtna Engineering Services, LLC	Date: 2/15/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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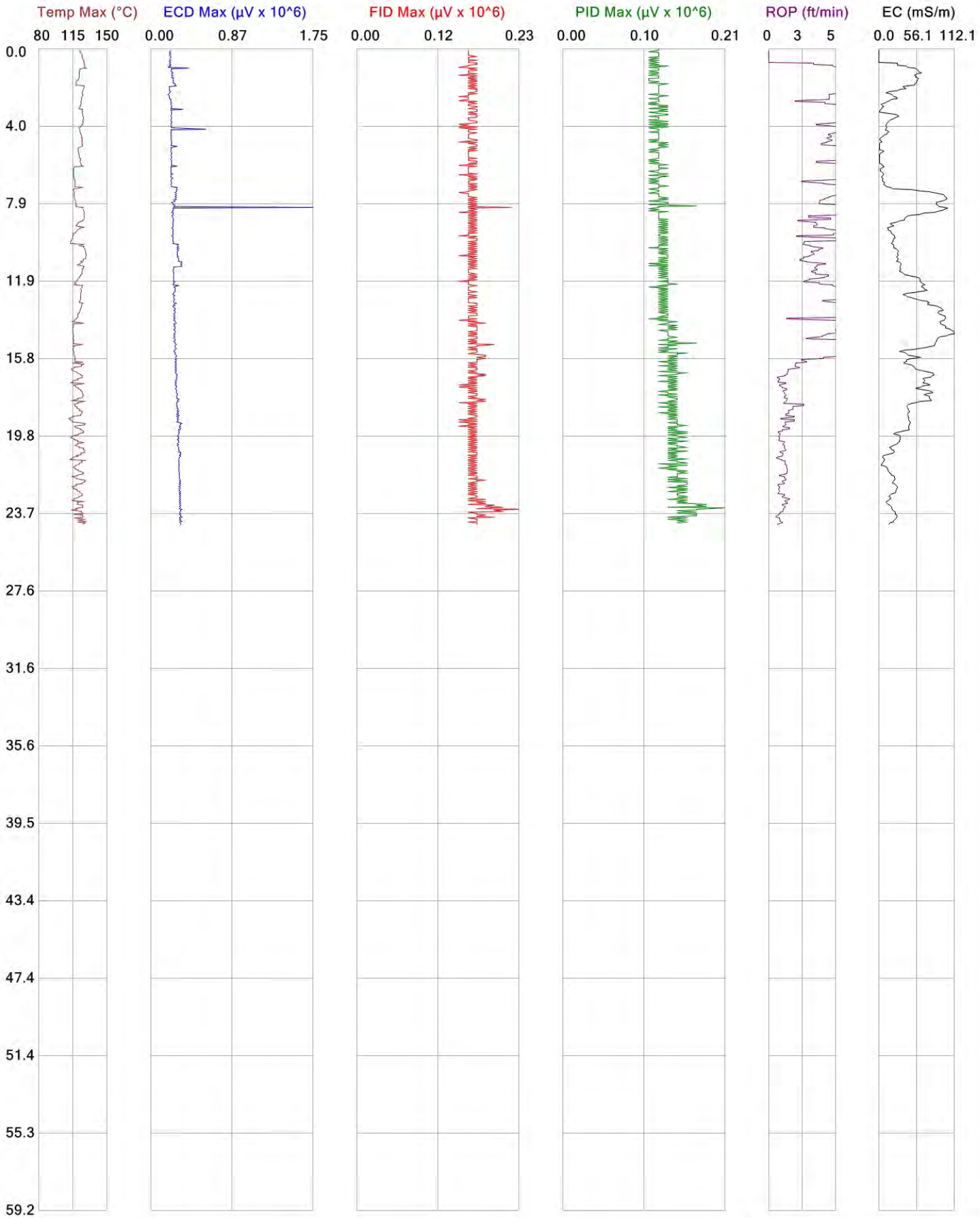
Client: Ahtna Engineering Services, LLC	Date: 2/14/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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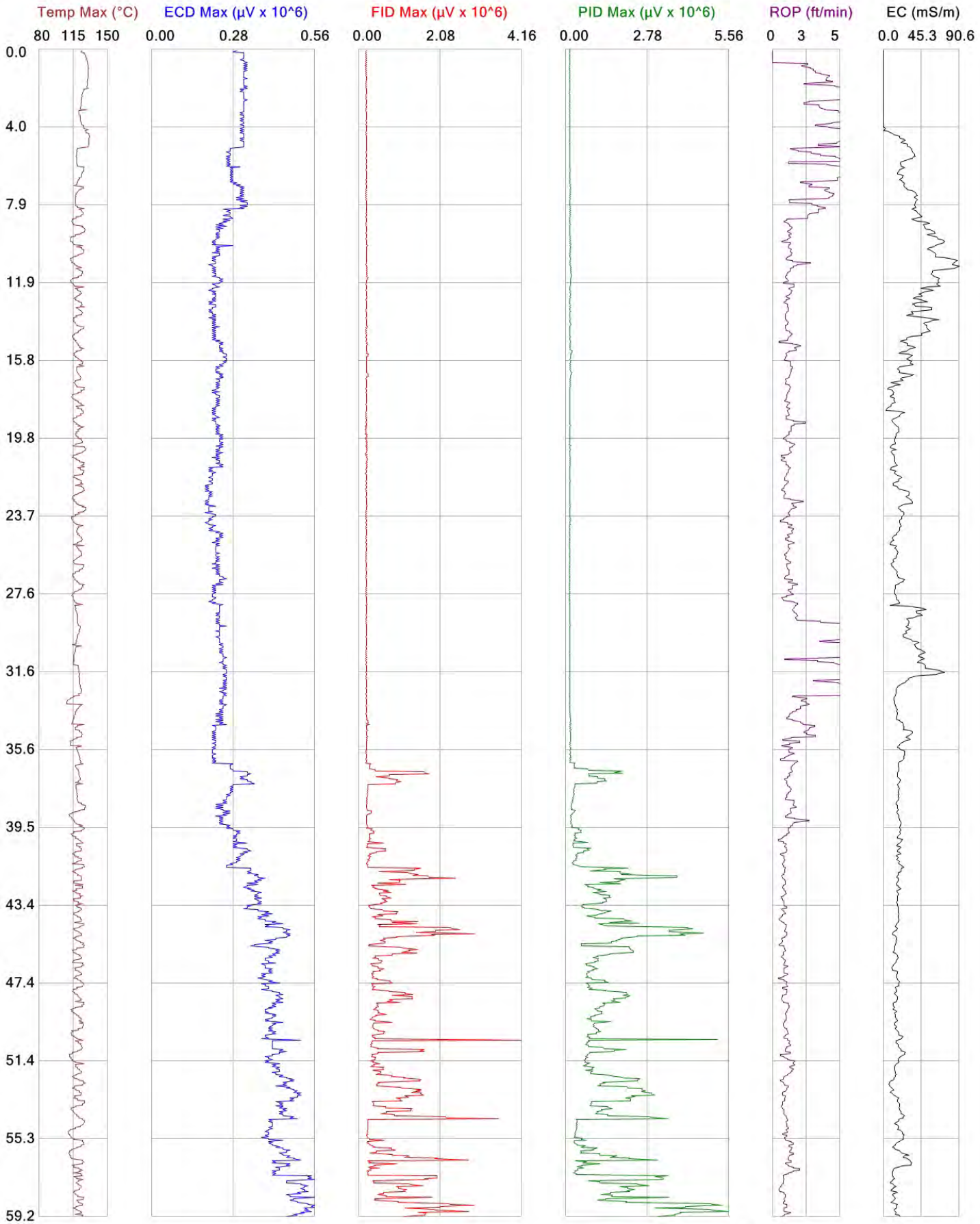
Client: Ahtna Engineering Services, LLC	Date: 2/16/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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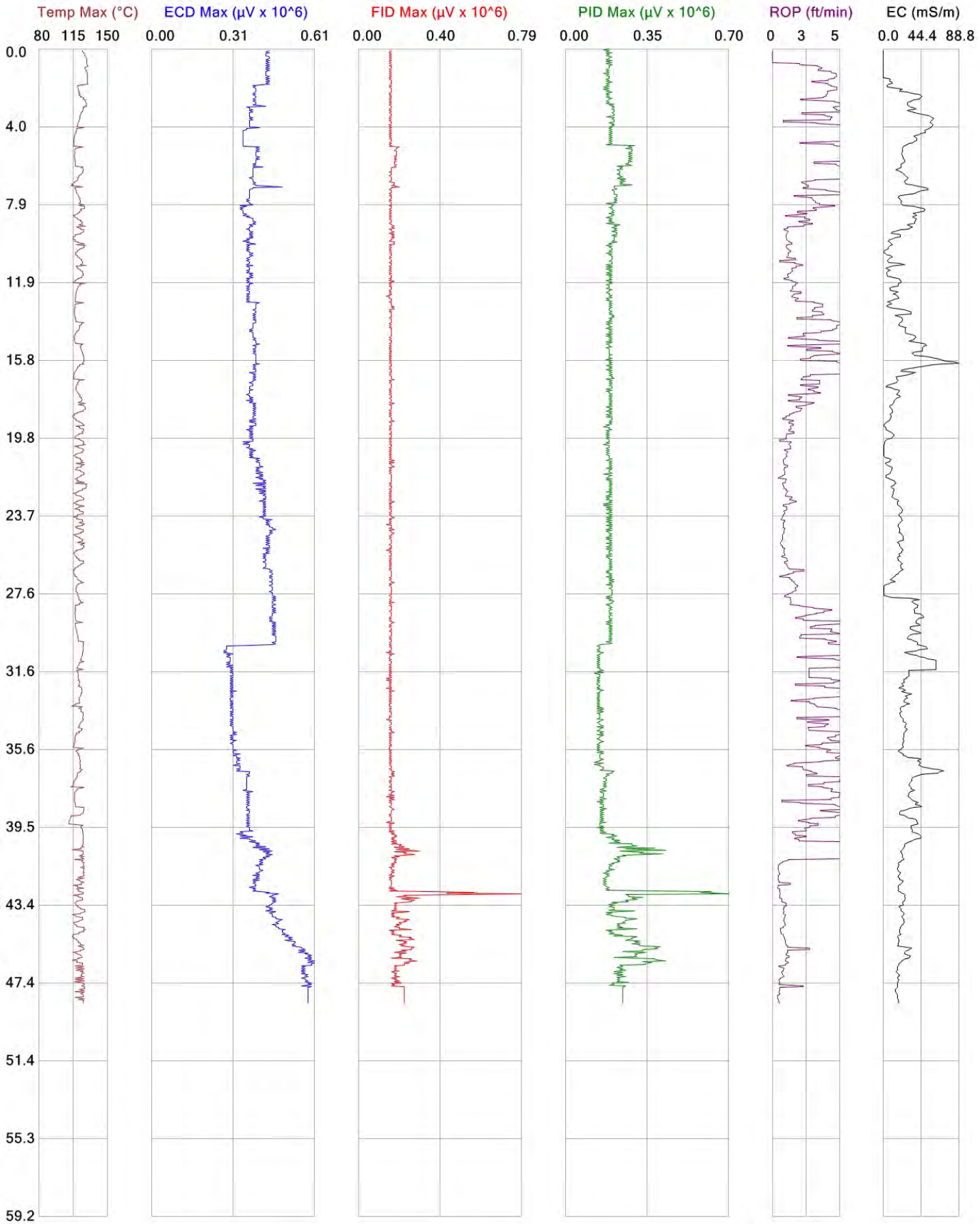
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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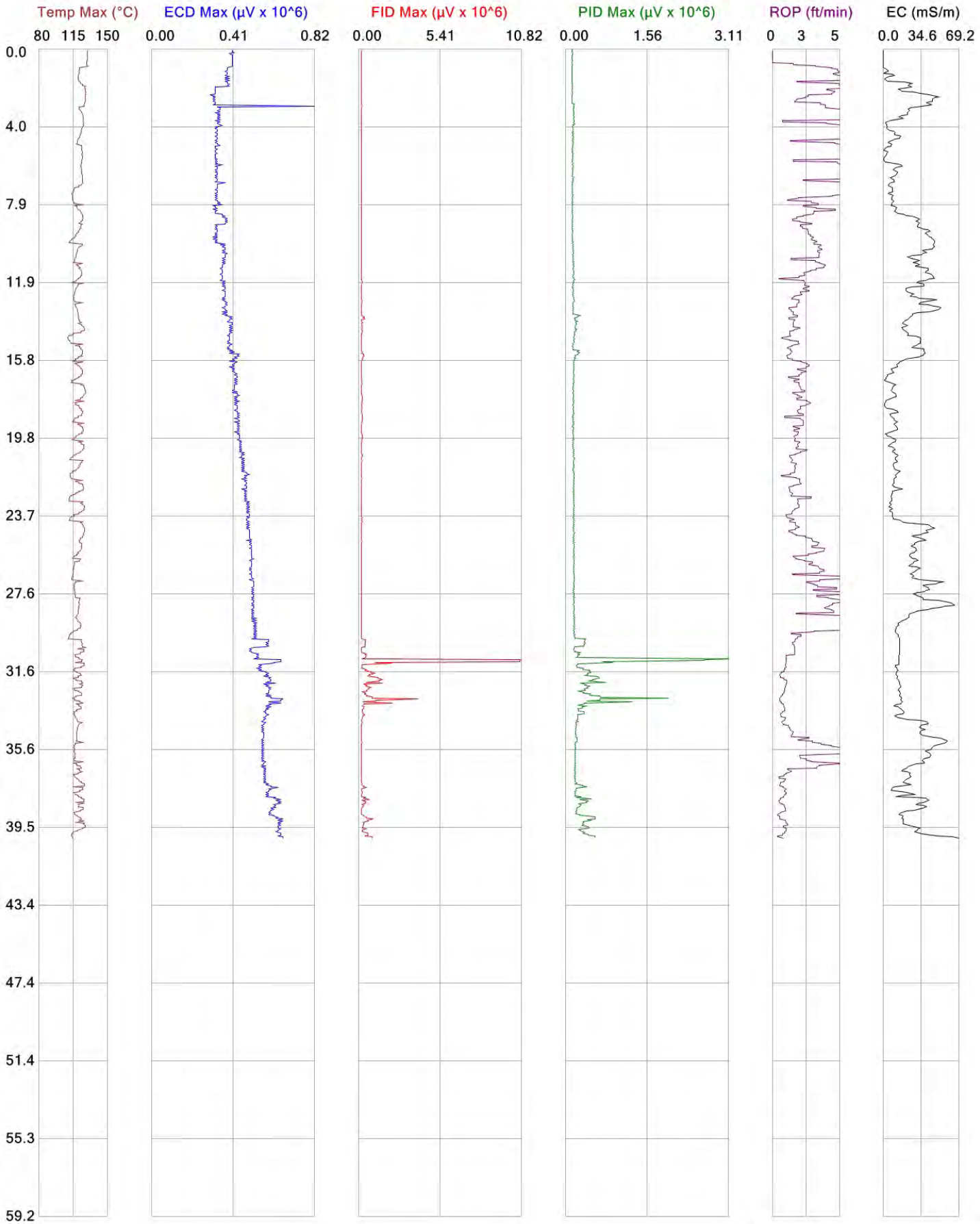
Client: Ahtna Engineering Services, LLC	Date: 2/7/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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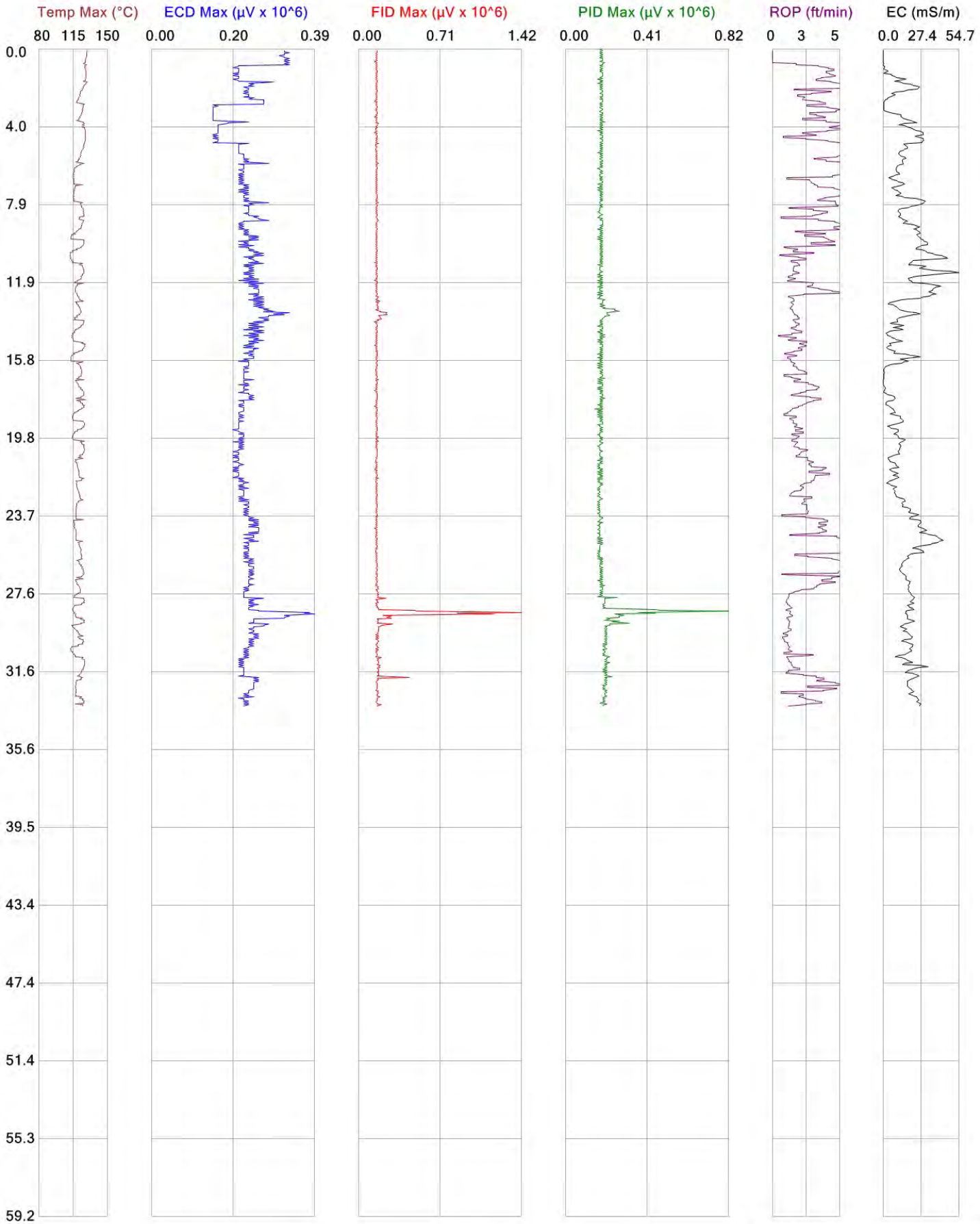
Client: Ahtna Engineering Services, LLC	Date: 2/8/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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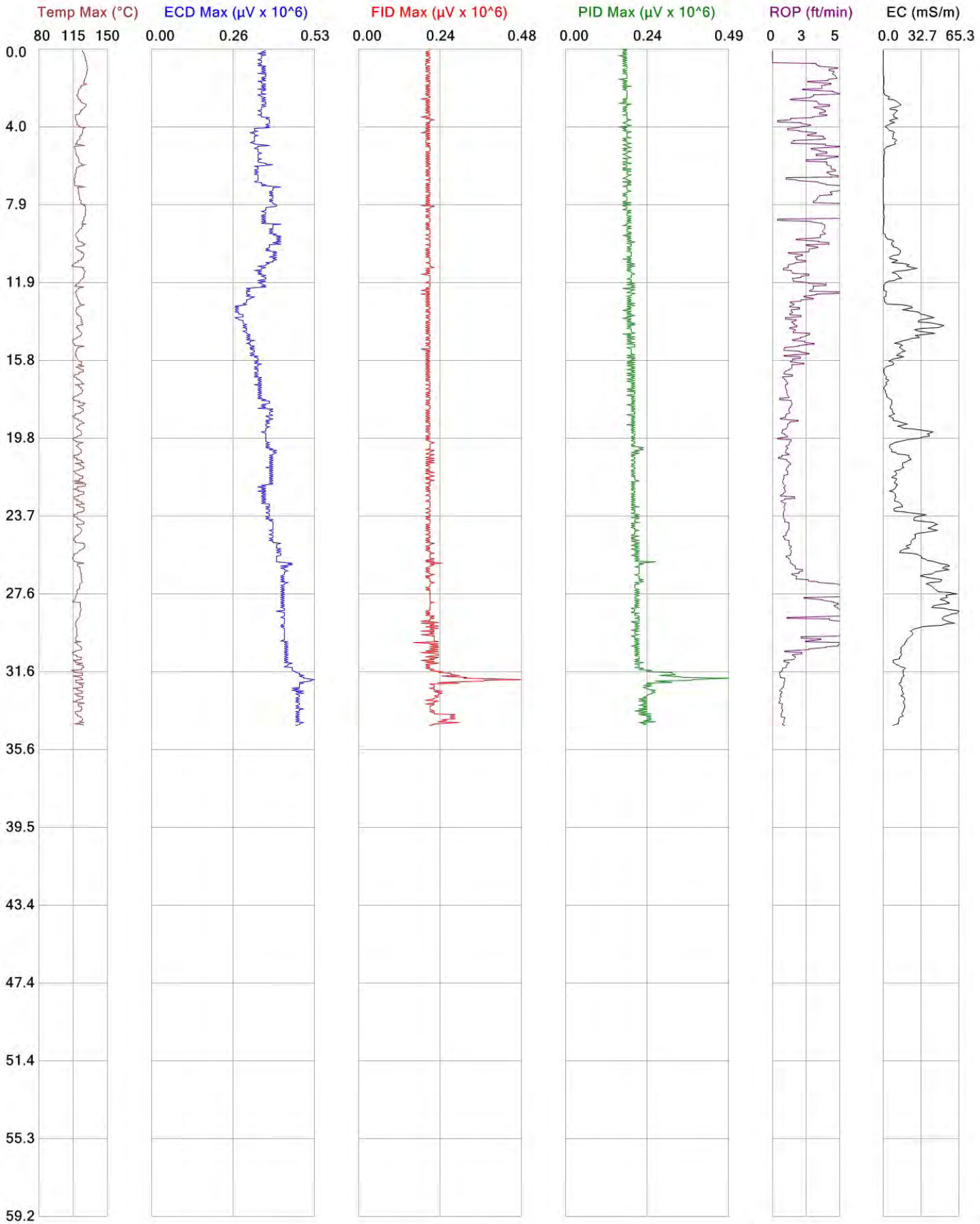
Client: Ahtna Engineering Services, LLC	Date: 2/7/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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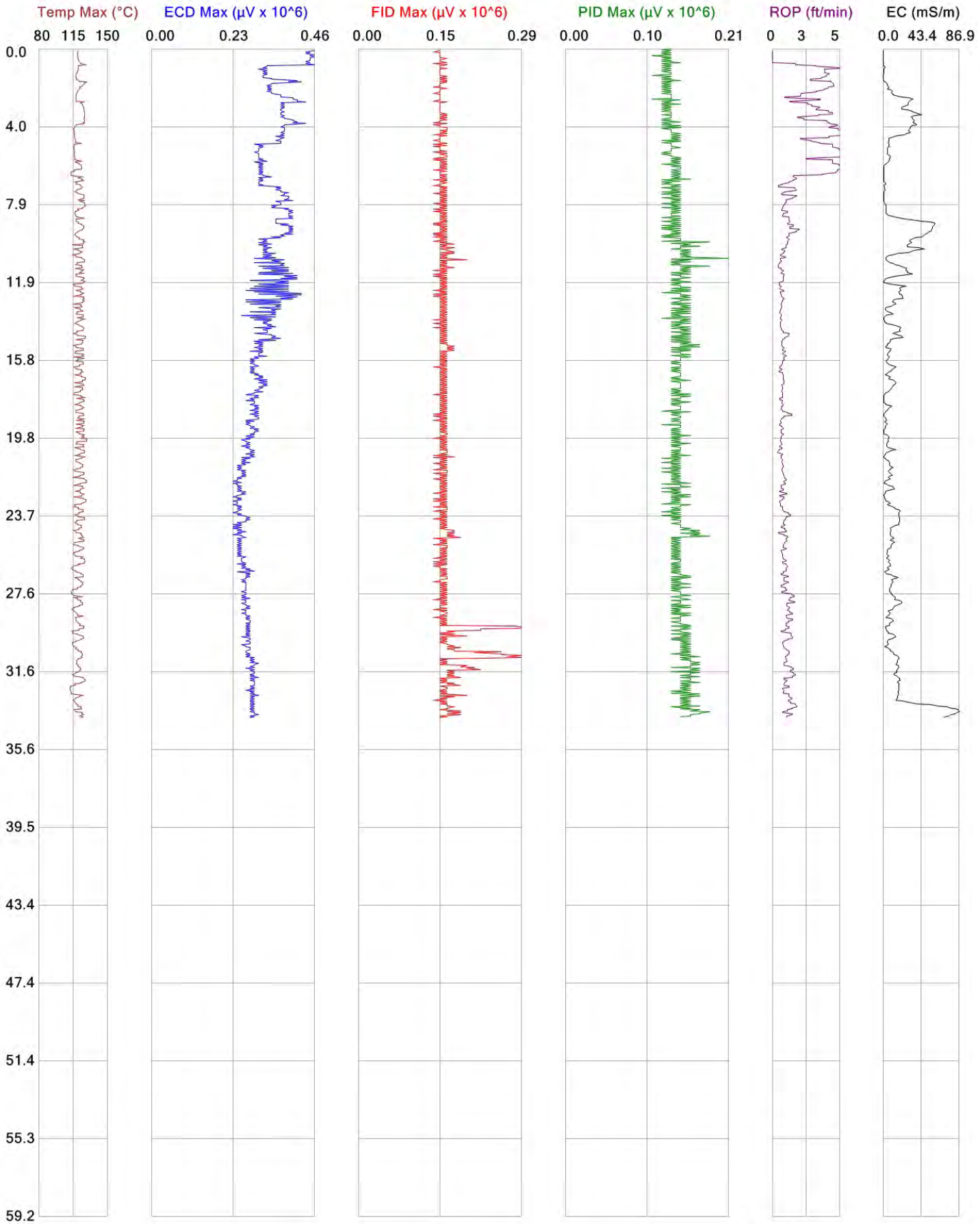
Client: Ahtna Engineering Services, LLC	Date: 2/8/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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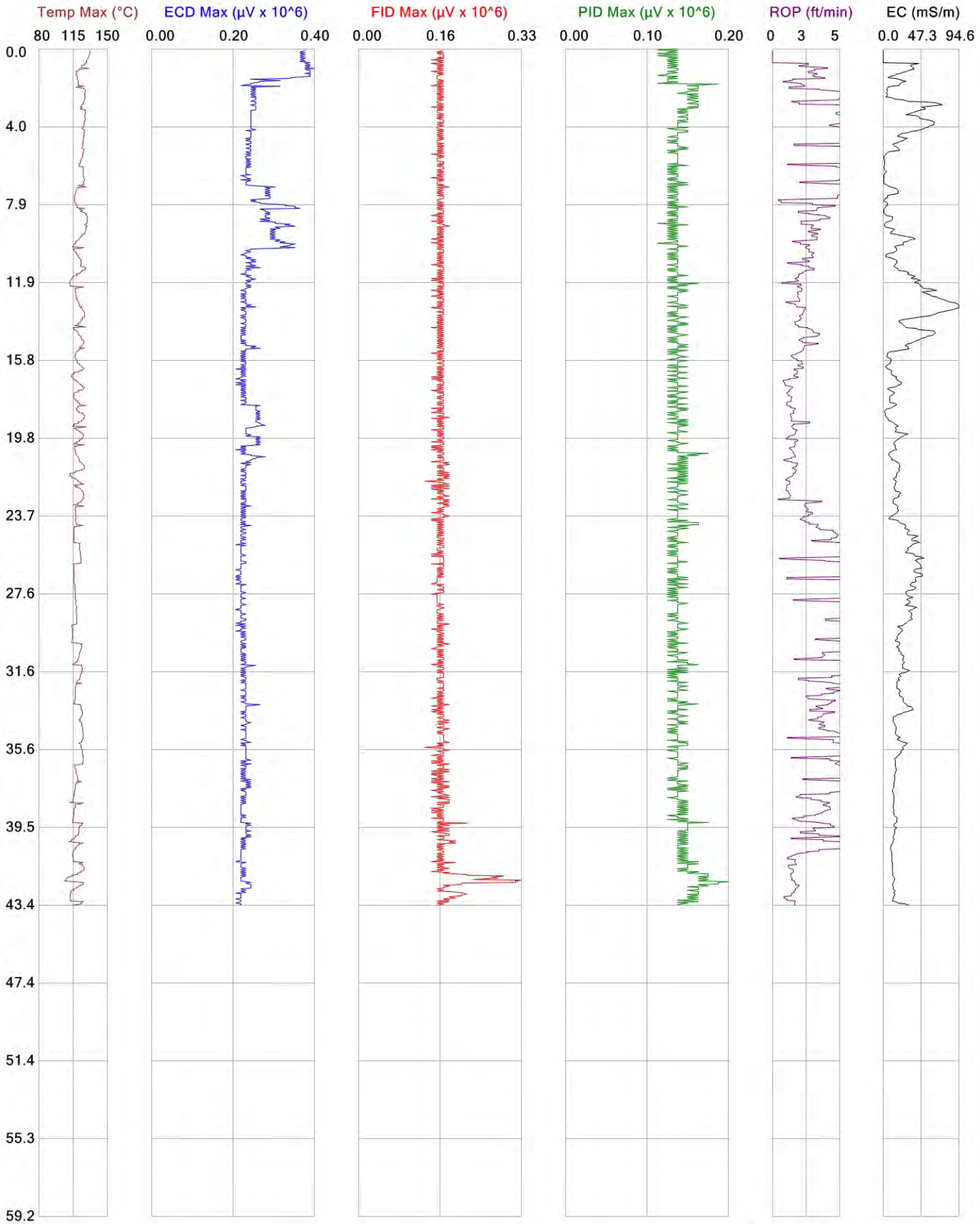
Client: Ahtna Engineering Services, LLC	Date: 2/7/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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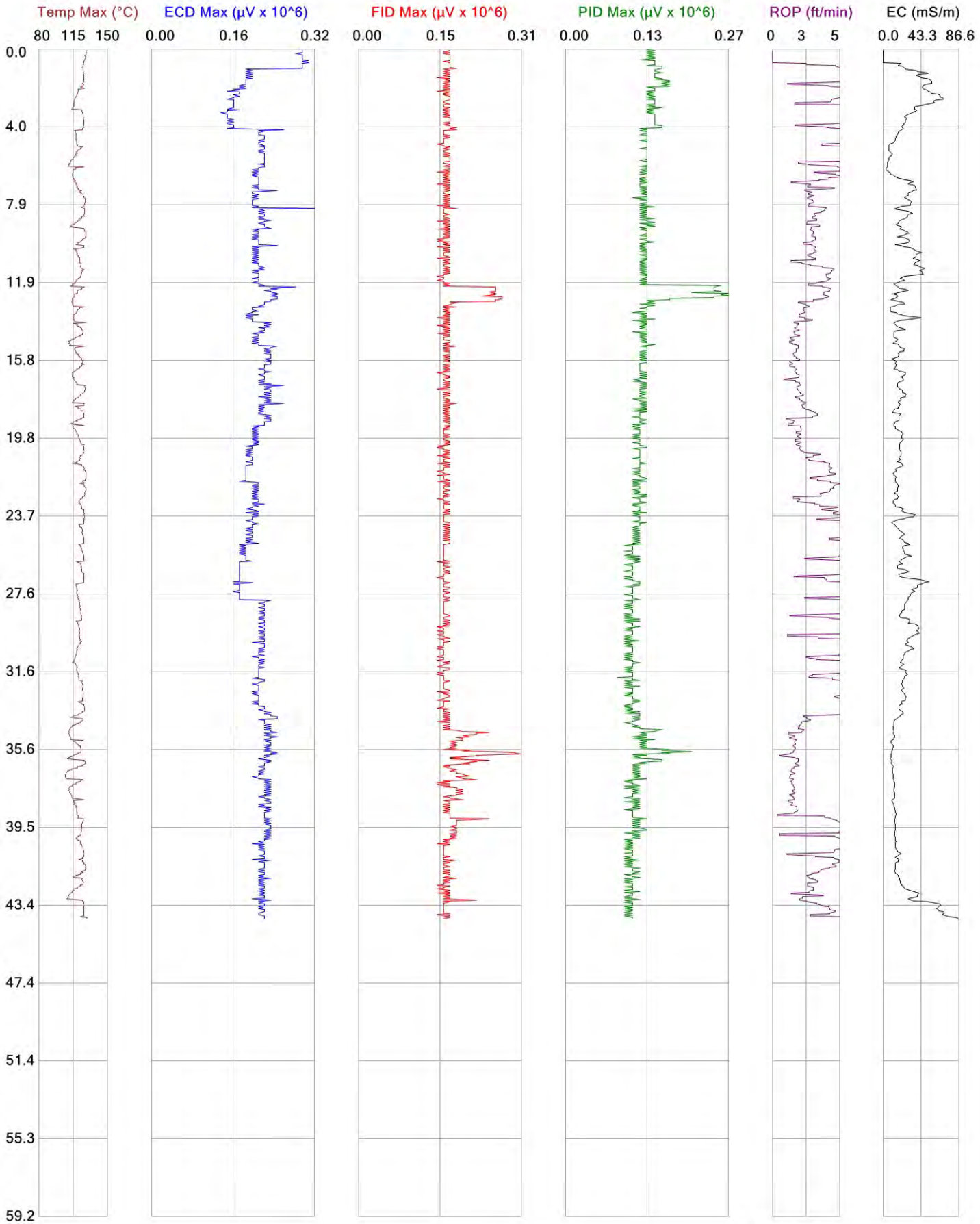
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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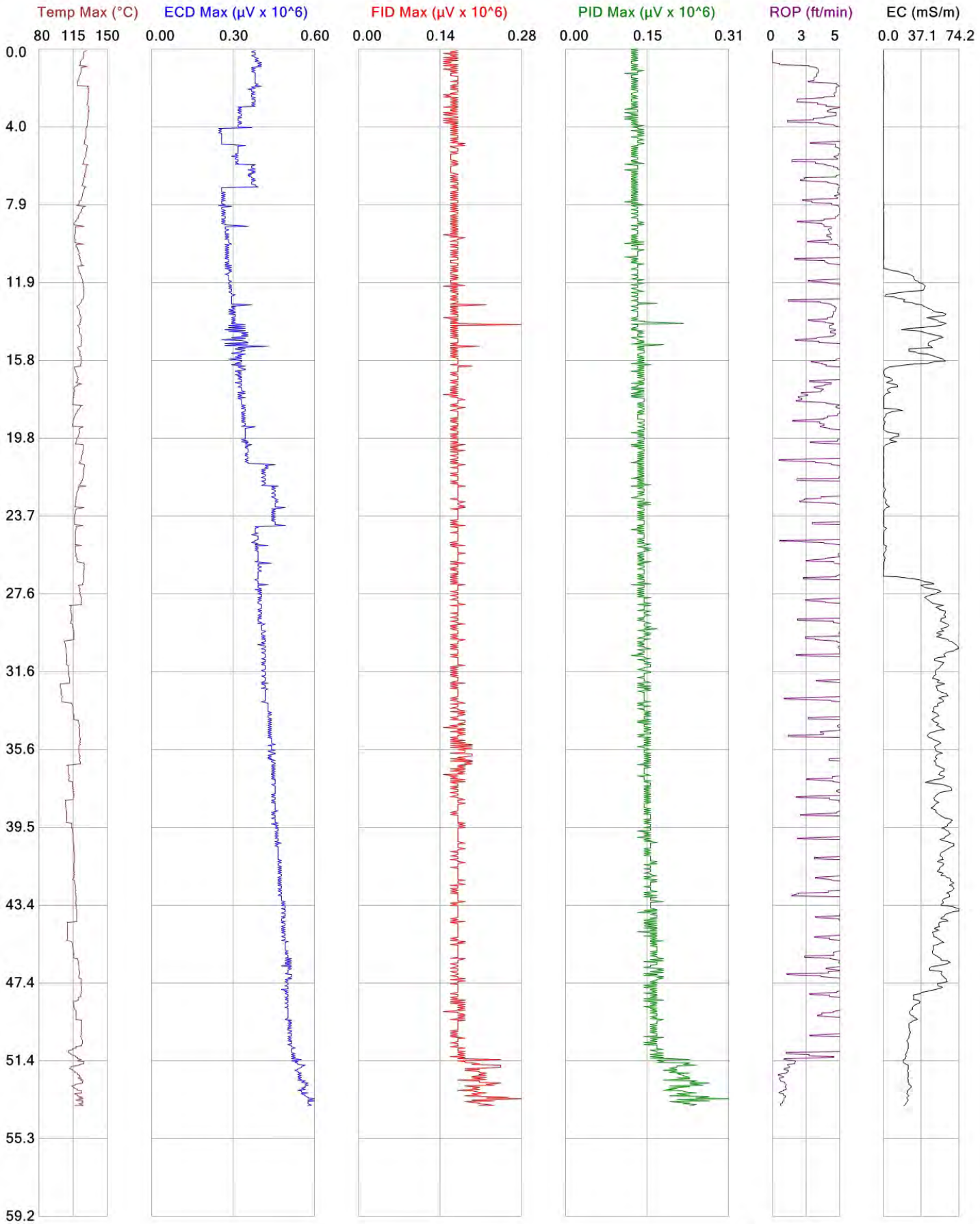
Client: Ahtna Engineering Services, LLC	Date: 2/18/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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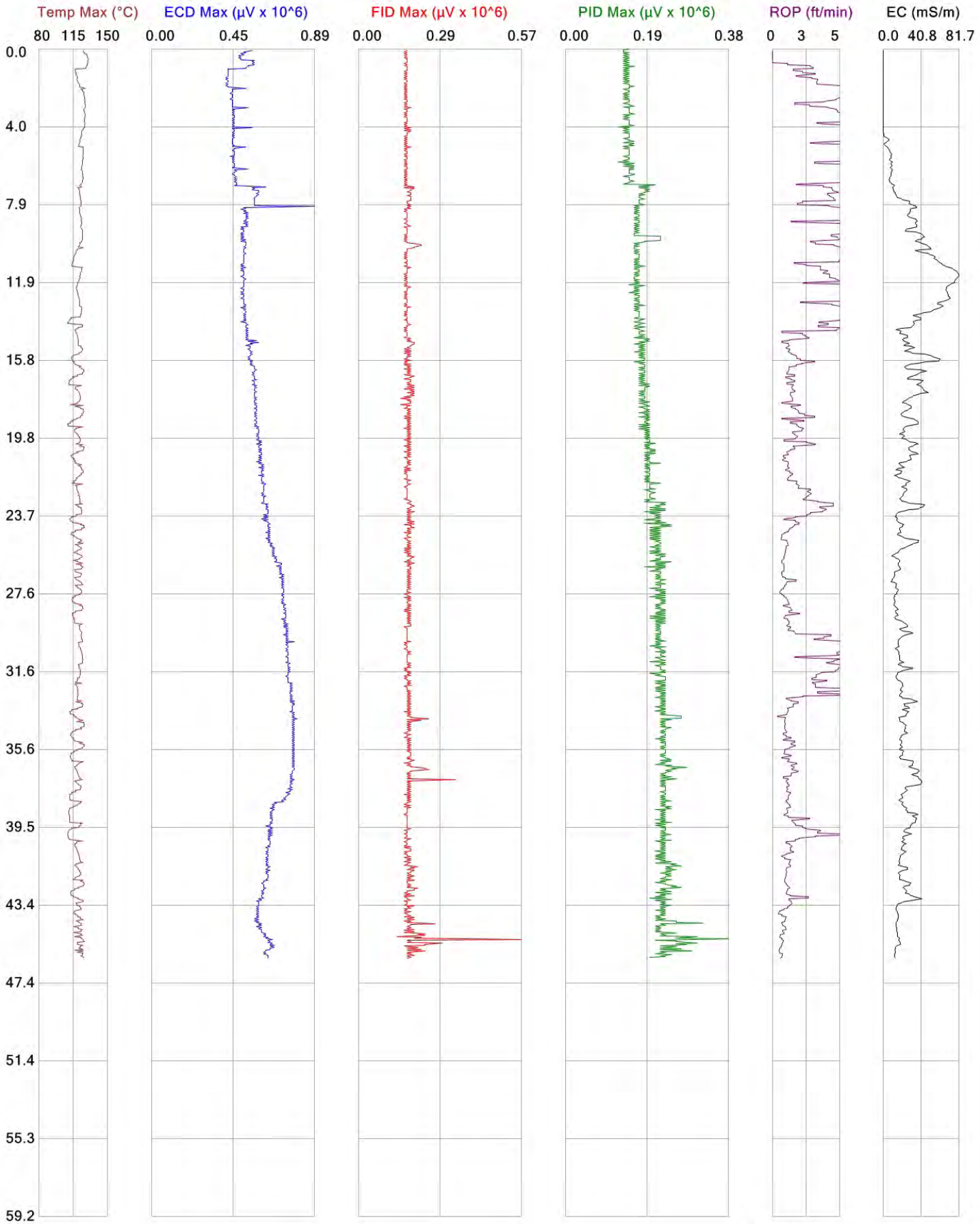
Client: Ahtna Engineering Services, LLC	Date: 2/10/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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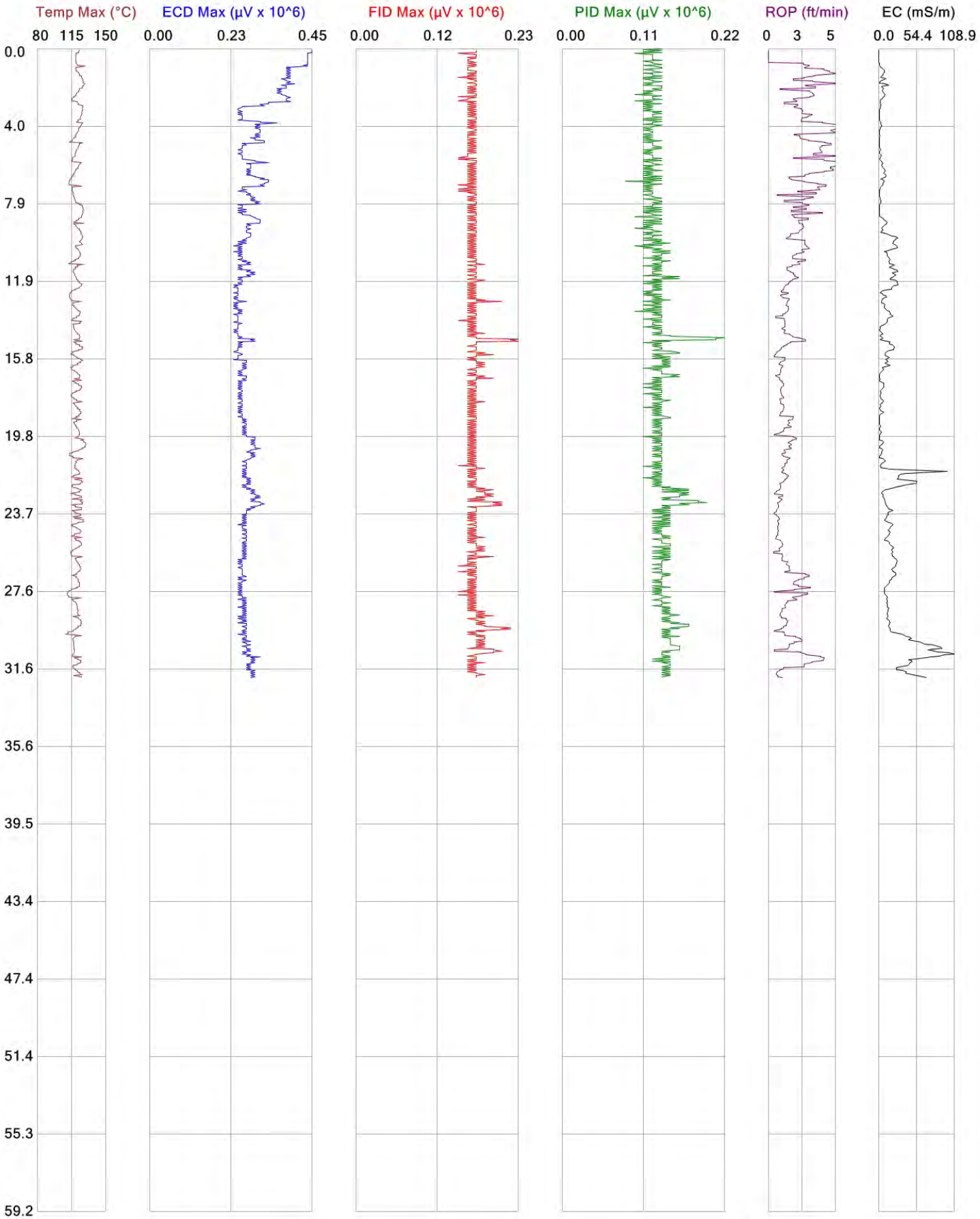
Client: Ahtna Engineering Services, LLC	Date: 2/9/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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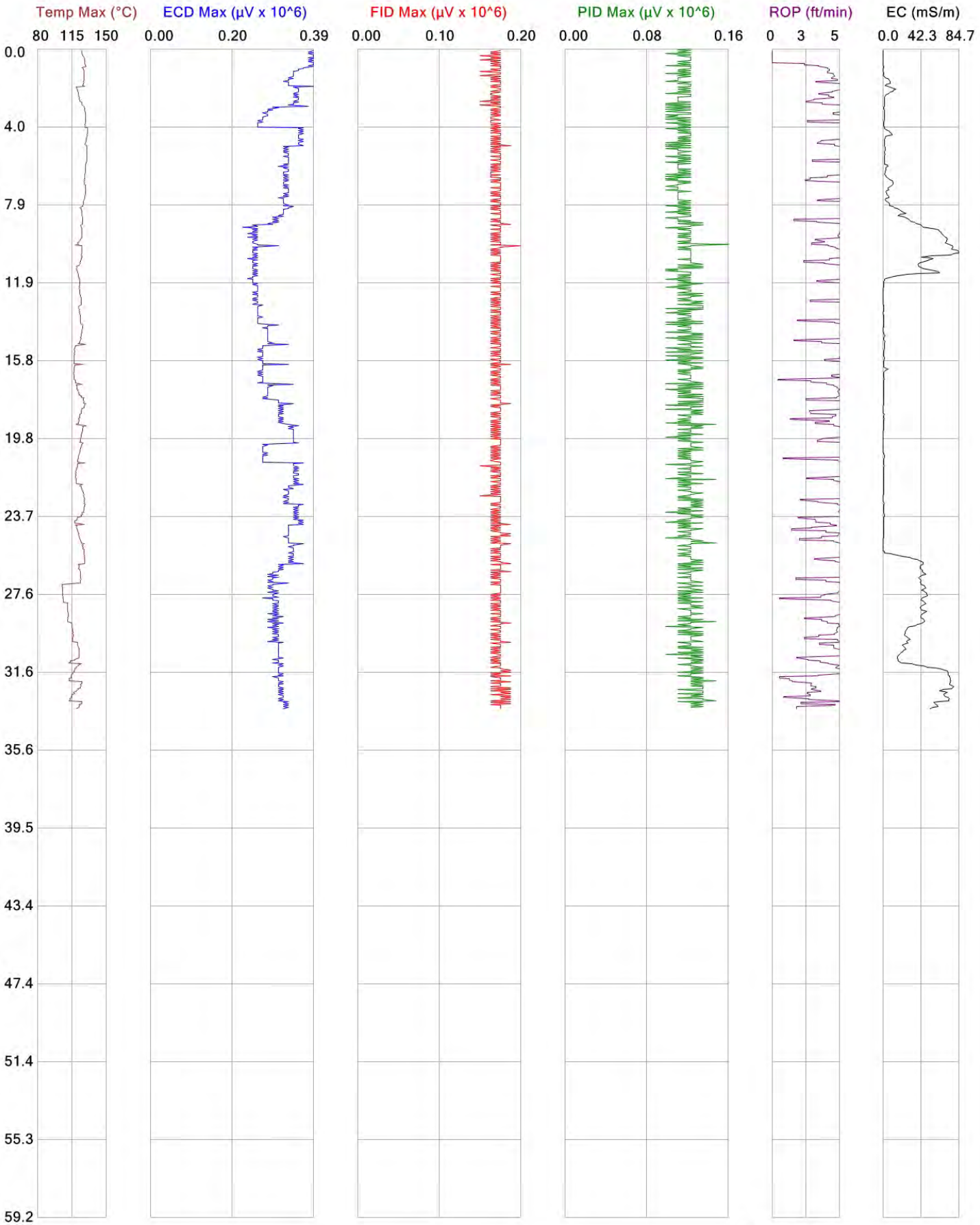
Client: Ahtna Engineering Services, LLC	Date: 2/10/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



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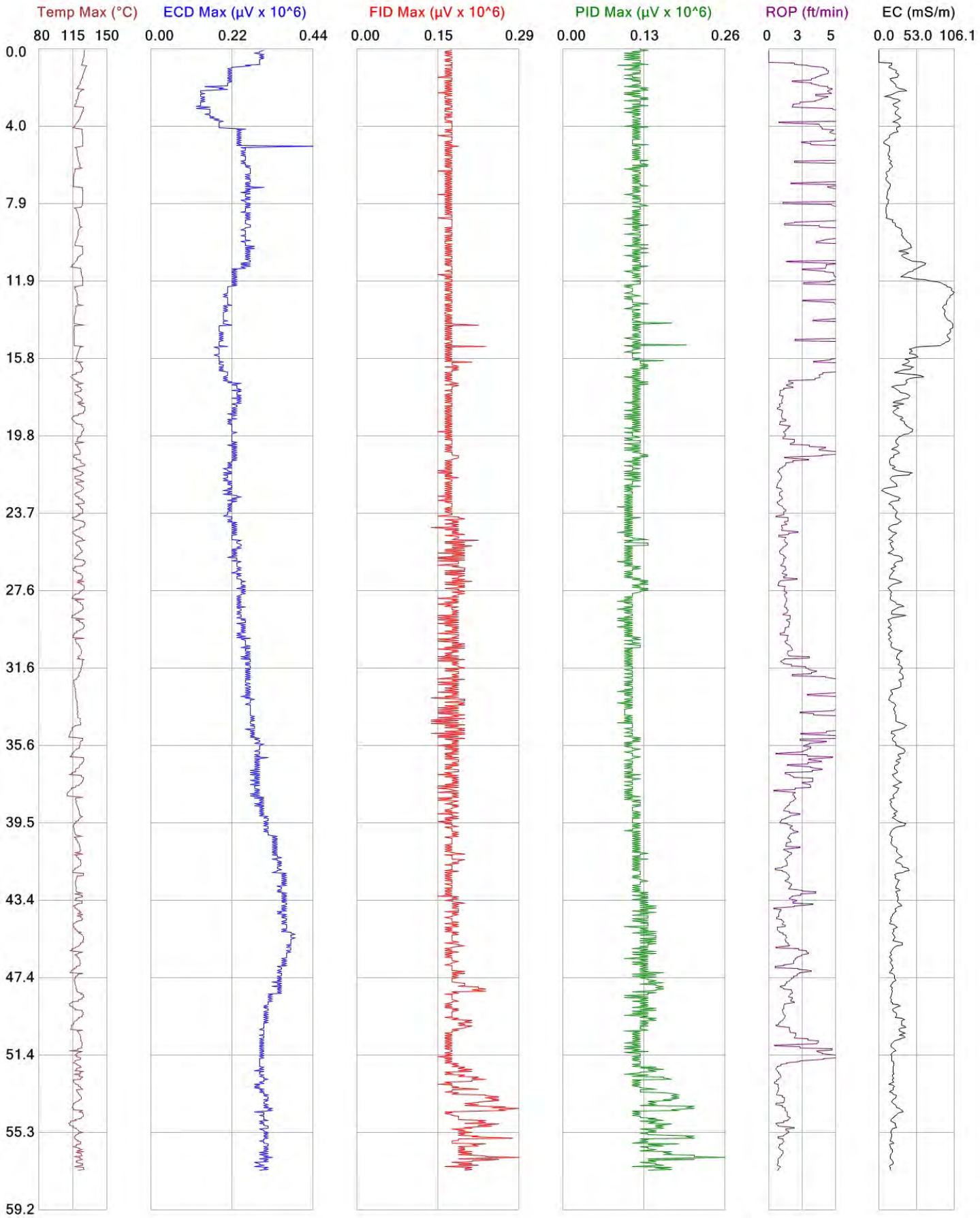
Client: Ahtna Engineering Services, LLC	Date: 2/10/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES



	File: M-9-2
Client: Ahtna Engineering Services, LLC	Date: 2/10/2011
Project ID: Building 258, Fort Hunter Liggett	Location:

COLUMBIA TECHNOLOGIES

APPENDIX C

BORING LOG AND WELL COMPLETION DETAILS

Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

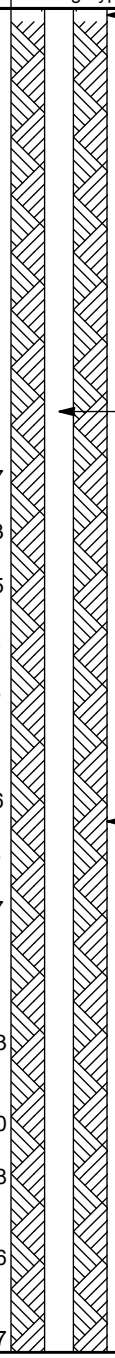
WELL NUMBER 258-MW-002D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California
DATE STARTED 6/15/11 **COMPLETED** 6/16/11
GROUND ELEVATION 1058.117 ft **HOLE SIZE** 8
DRILLING CONTRACTOR WDC Exploration & Wells
GROUND WATER LEVELS:
DRILLING METHOD Rotosonic
AT TIME OF DRILLING --- Not Measured
LOGGED BY S. Graham **CHECKED BY** B. Clark
AT END OF DRILLING 31.83 ft / Elev 1026.29 ft
NOTES TOC N:1891209.632 E:5901203.646 NAD 83 Elev:1057.892 NGVD 29
AFTER DRILLING 32.08 ft / Elev 1026.04 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
0		Hand auger top five feet.	
5.0		(SW-SC) Brown (10 YR 5/3) well graded sand with clay (SW-SC). 80% fine to coarse sand, 10% fines, 10% subrounded gravel up to two inches. Medium dense, moist.	PID = 4.8
10	10.0		PID = 1.4
		(SW) Yellowish brown (10 YR 5/4) well graded sand (SW). 90% fine to coarse sand, 5% fines, 5% subrounded gravel up to one inch, trace subrounded cobbles up to 3 inches. Medium dense, moist.	PID = 1.8 PID = 2.6
17.0		(CL) Brown (10 YR 5/3) sandy lean clay (CL). 80% fines, 15% fine sand, 5% subrounded gravel up to half an inch. Firm, moist.	PID = 13.7
19.0		(SC) Yellowish brown (10 YR 5/4) clayey sand (SC). 70% fine to coarse sand, 25% fines, 5% subrounded to subangular gravel up to half an inch. Medium dense, moist.	PID = 16.3 PID = 63.5
20		(SC) Brown (10 YR 4/3) clayey sand (SC). 50% fine sand, 40% fines, 10% medium to coarse sand, trace gravel up to one quarter inch. Medium dense, moist.	PID = 172
25.0		(CL) Brown (10 YR 4/3) sandy lean clay (CL). 60% fines, 35% fine to coarse sand, 5% subrounded to subangular gravel up to one half inch. Hard, moist.	PID = 245
30			PID = 43.6
32.0			PID = 213
		(SC) Dark grayish brown (10 YR 4/2) clayey sand (SC). 70% fine to coarse sand, 30% fines, trace round gravel up to one half inch. Medium dense, moist.	PID = 64.7
35.0		(SW-SM) Grayish brown (2.5 Y 5/2) well graded sand with silt (SW-SM). 85% fine to coarse sand, 10% fines, 5% subrounded gravel up to one half inch. Medium dense, moist.	PID = 211
37.0		(SW) Light olive brown (2.5 Y 5/3) well graded sand (SW). 95% fine to coarse sand, 5% fines, trace subrounded to subangular gravel up to one inch. Loose, wet.	PID = 3443
40			PID = 4450
44.0			PID = 4018
		(SC) Light olive brown (2.5 Y 5/3) clayey sand (SC). 75% fine to coarse sand, 20% fines, 5% subrounded gravel up to one inch. Loose, wet.	PID = 4106
50			PID = 4427

WELL DIAGRAM

Casing Type: 4" Schedule 40 PVC Blank Casing



GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:55 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

(Continued Next Page)

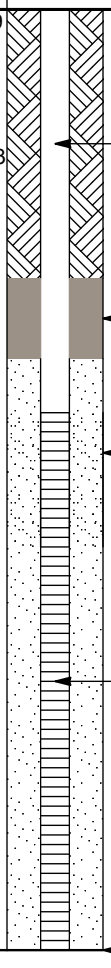
Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-002D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California

DEPTH (ft)	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
50		
51.0	(SP) Light yellowish brown (10 YR 6/4) poorly graded sand (SP). 95% fine sand, 5% fines, trace subrounded gravel up to one half inch. Loose, wet.	PID = 4509
		PID = 322.3
57.0	(SW-SC) Pale brown (10 YR 6/3) well graded sand with clay (SW-SC). 80% fine to coarse sand, 10% fines, 10% subrounded gravel up to one inch. Loose, wet.	PID = 5.9
60		PID = 3.4
		PID = 5.5
63.0	(SC) Pale brown (10 YR 6/3) clayey sand (SC). 85% fine to coarse sand, 15% fines, trace subrounded gravel up to one half inch. Medium dense, moist.	PID = 4.6
65.0	(ML) Pale yellow (2.5 Y 8/2) sandy silt (ML). 80% fines, 20% fine sand. Hard, moist.	PID = 31.2
70		PID = 7
		PID = 3.2
74.0	(SW-SC) Light olive brown (2.5 Y 5/3) well graded sand with clay and gravel (SW-SC). 70% fine to coarse sand, 20% subrounded to subangular gravel up to one inch, 10% fines. Medium dense, moist.	PID = 0.6
		PID = 1
80		PID = 1.6
80.0		PID = 0.7
81.0	(GW) Light gray (10 YR 7/2) well graded gravel with sand (GW). 70% subangular gravel up to two inches, 30% fine to coarse sand. Loose, dry.	
82.0	(SW) Very pale brown (10 YR 7/3) well graded sand with gravel (SW). 60% fine to coarse sand, 40% subrounded gravel up to one inch. Loose, moist.	
85.0		PID = 0.7
	(SW) Very pale brown (10 YR 7/3) well graded sand with gravel (SW). 80% fine to coarse sand, 20% subrounded to subangular gravel up to two inches. Dense, dry.	

Bottom of borehole at 85.0 feet.



GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:55 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-004D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California
DATE STARTED 6/23/11 **COMPLETED** 6/29/11
GROUND ELEVATION 1043.386 ft **HOLE SIZE** 8
DRILLING CONTRACTOR WDC Exploration & Wells
GROUND WATER LEVELS:
DRILLING METHOD Rotosonic
AT TIME OF DRILLING --- Not Measured
LOGGED BY S. Graham **CHECKED BY** B. Clark
AT END OF DRILLING --- Not Measured
NOTES TOC N:1890667.391 E:5900772.747 NAD 83 Elev:1045.989 NGVD 29 ▼ **AFTER DRILLING** 22.63 ft / Elev 1020.76 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
0		(SM) Brown (10 YR 5/3) silty sand (SM). 60% fine to coarse sand, 30% fines, 10% subrounded to subangular gravel up to one inch. Hard, moist. Airknifed top five feet, logged from cuttings.	
		5.0 (ML) Brown (10 YR 5/3) sandy silt (ML). 70% fines, 20% fine sand, 10% subrounded gravel up to one inch. Dense, dry. Dropped and logged from a mixed bucket.	
10		11.0 (CL) Pale yellow (2.5 Y 7/3) lean clay (CL). 85% fines, 10% fine sand, 5% subrounded gravel up to one half inch. Very hard, dry.	PID = 0.3
		15.0 (CL) Light yellowish brown (10 YR 6/4) sandy lean clay (CL). 75% fines, 20% fine sand, 5% subangular gravel up to one quarter inch. Very hard, dry.	PID = 0.4
20			PID = 0.1
		21.0 (CL) Light yellowish brown (10 YR 6/4) lean clay (CL). 95% fines, 5% fine sand. Very hard, dry.	PID = 0.2
		23.0 ▼ 24.0 (CL) Yellowish brown (10 YR 5/4) sandy lean clay (CL). 60% fines, 35% fine sand, 5% subrounded gravel up to one half inch. Very hard, moist.	PID = 0.1
		25.0 (CL) Brown (10 YR 5/3) sandy lean clay with gravel (CL). 60% fines, 20% fine sand, 20% subrounded gravel up to one half inch. Hard, moist.	PID = 0.2
30		(CL) Brown (7.5 YR 4/3) sandy lean clay (CL). 70% fines, 20% fine sand, 10% subrounded gravel up to two inches. Hard, moist.	PID = 0.2
		31.0 (CL) Brown (7.5 YR 5/4) sandy lean clay (CL). 55% fines, 30% fine sand, 15% subrounded gravel up to one and one half inches. Hard, moist.	PID = 0.3
		35.0 (SC) Grayish brown (2.5 Y 5/4) clayey sand (SC). 60% fine to coarse sand, 35% fines, 5% subrounded gravel up to one quarter inch. Dense, moist.	PID = 0.5
		36.0 (SC) Grayish brown (2.5 Y 5/4) clayey sand (SC). 75% fine to coarse sand, 15% fines, 10% subrounded gravel up to two inches. Dense, moist.	PID = 2093
40		40.0 (CL) Pale olive (5 Y 6/3) sandy clay (CL). 80% fines, 20% fine sand. Firm, moist.	PID = 1158
		(SW-SC) Grayish brown (2.5 Y 5/2) well graded sand with gravel and clay (SW-SC). 70% fine to coarse sand, 20% subrounded gravel up to one inch, 10% fines. Loose, wet.	PID = 300
		(ML) Light greenish gray (G6 Y 17/1) silt (ML). 100% fines, trace fine sand. Hard, moist.	PID = 9.9
			PID = 3.7
50			PID = 1.9

WELL DIAGRAM

Casing Type: 4" Schedule 40 PVC Blank Casing

- Stickup with monument and bollards
- 4" Schedule 40 PVC blank casing
- Bentonite/cement grout, 0 to 51.5 feet bgs

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:56 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

(Continued Next Page)

Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-004D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA	WELL DIAGRAM
50		(ML) Light greenish gray (G6 Y 17/1) silt (ML). 100% fines, trace fine sand. Hard, moist. *(continued)*	PID = 2.3	
			PID = 0.31	Bentonite chips, 51.5 to 54.5 feet bgs
		(ML) Dark greenish gray (G6 Y 14/1) silt (ML). 100% fines. Very hard, moist.	PID = 0.2	
60			PID = 0.4	4" diameter Schedule 40 PVC 0.020 slot screen, 55.5 to 70.5 feet bgs
			PID = 0.5	No. 3 Monterey sand pack, 54.5 to 70.5 feet bgs
			PID = 0.3	
			PID = 0.2	
70			PID = 0.1	End Cap, TD = 70.5 ft bgs
			PID = 0.1	Silt slough, 70.5 to 72 feet bgs
		75.0	PID = 0.2	Bentonite chips, 72 to 75 feet bgs

Bottom of borehole at 75.0 feet.

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:56 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

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296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-005D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California
DATE STARTED 6/20/11 **COMPLETED** 6/21/11
GROUND ELEVATION 1028.447 ft **HOLE SIZE** 8
DRILLING CONTRACTOR WDC Exploration & Wells
GROUND WATER LEVELS:
DRILLING METHOD Rotosonic
AT TIME OF DRILLING --- Not Measured
LOGGED BY S. Graham **CHECKED BY** B. Clark
AT END OF DRILLING 25.31 ft / Elev 1003.13 ft
NOTES TOC N:1889371.675 E:5900886.024 NAD 83 Elev:1030.876 NGVD 29
AFTER DRILLING 24.72 ft / Elev 1003.73 ft

DEPTH (ft)	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
0	Hand auger top five feet.	
5.0	(SM) Brown (7.5 YR 5/4) silty sand (SM). 55% fine sand, 40% fines, 5% subrounded gravel up to two inches. Medium dense, moist.	PID = 0.2
10	(SM) Gravels are cherts and granitics.	PID = 0
12.0	(CL) Brown (7.5 YR 4/3) sandy lean clay (CL). 75% fines, 20% fine sand, 5% subrounded gravel up to one half inch. Soft, moist.	PID = 0.6
15.0	(CL) Increase in sand to 35% fine to coarse sand.	PID = 0.4
	No recovery.	
20.0		
20	(SM) Brown (7.5 YR 4/3) silty sand (SM). 60% fine to coarse sand, 35% fines, 5% subrounded gravel up to two inches. Medium dense, moist.	PID = 0.7
23.0	(SW-SM) Brown (7.5 YR 4/3) well graded sand with silt and gravel (SW-SM). 75% fine to coarse sand, 15% subrounded gravel up to two inches, 10% fines. Loose, moist.	PID = 0.7
25.0		
26.0	Several broken up and powdered granitic cobbles	PID = 0.4
	(SW-SM) Brown (7/5 YR 4/4) well graded sand with silt (SW-SM). 80% fine to coarse sand, 10% round gravel up to two inches, 10% fines. Loose, moist.	
30		PID = 0.4
30.0	(SW) Dark grayish brown (2.5 Y 4/2) well graded sand (SW). 75% fine to coarse sand, 20% subrounded chert and granitic gravel up to two inches, 5% fines. Loose, moist.	PID = 0.9
35.0		PID = 0.1
	(SW-SM) Brown (10 YR 5/3) well graded sand with silt (SW-SM). 80% fine to coarse sand, 15% subrounded gravel up to two inches, 5% fines. Medium dense, moist.	PID = 1.8
38.5	(SM) Pale brown (10 YR 6/3) silty sand (SM). 70% fine to medium sand, 20% fines, 10% round gravel up to one and one half inches. Loose, moist.	PID = 0.6
40		
40.5		
41.0	(SC) Dark grayish brown (2.5 Y 4/2) clayey sand (SC). 75% fine to coarse sand, 20% fines, 5% round gravel up to one half inch. Medium dense, moist.	PID = 0.5
		PID = 0.3
46.0	(SW) Dark yellowish brown (10 YR 4/4) well graded sand (SW). 90% fine to coarse sand, 5% fines, 5% round to subrounded gravel up to one half inch, degraded granite. Loose, moist.	PID = 0
48.0	(SM) Brown (7.5 YR 5/3) silty sand (SM). 70% fine to coarse sand, 20% fines, 10% subrounded gravel up to one inch. Loose, moist.	
50		PID = 0

WELL DIAGRAM

Casing Type: 4" Schedule 40 PVC Blank Casing

- Stickup with monument and bollards
- 4" Schedule 40 PVC blank casing
- Bentonite/cement grout, 0 to 40 feet bgs
- Bentonite chips, 40 to 43 feet bgs
- No. 3 Monterey sand pack, 43 to 56 feet bgs

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:57 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

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Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-005D

CLIENT US Army Corps of Engineers **PROJECT NAME** Building 258 Monitoring Well

PROJECT NUMBER 20049.017 **PROJECT LOCATION** Fort Hunter Liggett, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA	WELL DIAGRAM
50		(SW-SM) Brown (2.5 YR 4/3) well graded sand with silt (SW-SM). 80% fine to coarse sand, 10% fines, 10% subrounded gravel up to one inch, degraded granite. *(continued)*	PID = 0.2	4" diameter Schedule 40 PVC 0.020 slot screen, 45 to 55 feet bgs
		(SW-SM) Yellowish brown (10 YR 5/4) well graded sand with silt and gravel (SW-SM). 70% fine to coarse sand, 20% subrounded volcanic gravel up to two inches, 10% fines. Loose, moist.	PID = 0	End Cap, TD = 55 ft bgs
	55.0	Dark grayish brown (10 YR 4/2) sandy silt/fractured siltstone. 80% fines, 20% fine sand. Hard, moist.	PID = 0.2	
60		Black (10 YR 2/1) fractured siltstone.	PID = 0.1	Bentonite chips, 56 to 65 feet bgs
		Black (2.5 YR 5/1) siltstone. 90% fines, 10% fine sand. Hard, moist.	PID = 0.2	
	65.0		PID = 0.1	

Bottom of borehole at 65.0 feet.

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Ahtna Engineering Services
296 12th Street
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Telephone: (831) 384-3735
Fax: (831) 384-3930

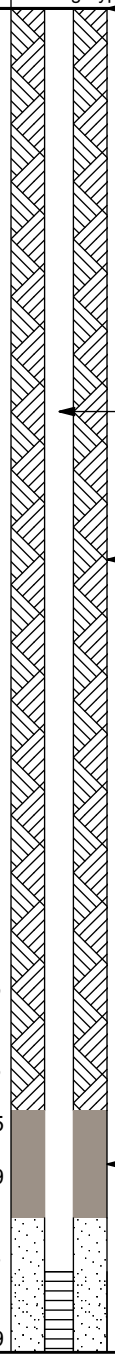
WELL NUMBER 258-MW-006D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California
DATE STARTED 6/16/11 **COMPLETED** 6/20/11
GROUND ELEVATION 1031.894 ft **HOLE SIZE** 8
DRILLING CONTRACTOR WDC Exploration & Wells
GROUND WATER LEVELS:
DRILLING METHOD Rotosonic
AT TIME OF DRILLING --- Not Measured
LOGGED BY S. Graham **CHECKED BY** B. Clark
AT END OF DRILLING 25.00 ft / Elev 1006.89 ft
NOTES TOC N:1889873.631 E:5900533.793 NAD 83 Elev:1034.416 NGVD 29
AFTER DRILLING 24.81 ft / Elev 1007.09 ft

DEPTH (ft)	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
0	Hand auger top five feet.	
5.0	(SM) Dark brown (7.5 YR 3/2) silty sand (SM). 75% fine to coarse sand, 20% fines, 5% subangular gravel up to one half inch. Loose, moist.	PID = 0.3
10	(SM) Brown (7.5 YR 4/2) silty sand (SM). 70% fine to coarse sand, 15% fines, 15% subangular gravel up to one inch. Medium dense, moist.	PID = 0.5
	(SM) Brown (7.5 YR 4/3) silty sand (SM). 65% fine to coarse sand, 20% subrounded gravel up to one and one half inch, 15% fines. Medium dense, moist.	PID = 0.4
16.0	(SM) Brown (10 YR 5/3) silty sand (SM). 80% fine to medium sand, 20% fines, trace round gravel up to one quarter inch. Medium dense, moist.	PID = 3.5
19.0	(SW-SC) Brown (7.5 YR 4/3) well graded sand with clay (SW-SC). 90% fine to coarse sand, 10% fines, trace subangular gravel up to one half inch. Dense, moist.	PID = 1.8
20	(SW-SM) Light yellowish brown (10 YR 6/4) well graded sand with silt (SW-SM). 85% fine to coarse sand, 10% fines, 5% subrounded gravel up to two inches. Dense, dry.	PID = 0.9
25.0	(SW-SM) Dark grayish brown (10 YR 4/2) well graded sand with silt (SW-SM). 80% fine to coarse sand, 10% fines, 10% subrounded gravel up to one inch, one subrounded cobble up to three inches. Hard, moist.	PID = 1.5
	(SW-SC) Brown (10 YR 5/3) well graded sand with clay (SW-SC). 80% fine to coarse sand, 10% fines, 10% round to subrounded gravel up to two inches. Loose, wet.	PID = 1.5
30		PID = 0.4
		PID = 0.7
33.0		PID = 0.3
	(SW) Grayish brown (2.5 Y 5/2) well graded sand (SW). 85% fine to coarse sand, 10% round gravel up to one inch, 5% fines. Loose, wet.	PID = 1.3
	(SW) Trace subrounded cobble up to three inches.	PID = 105
40		PID = 593
40.0	(SW-SM) Dark grayish brown (2.5 Y 4/2) well graded sand with silt (SW-SM). 85% fine to coarse sand, 10% fines, 5% subrounded gravel up to two inches. Loose, moist.	PID = 71.5
44.0		PID = 94.9
45.0	(CL) Light brownish gray (2.5 Y 6/2) sandy lean clay (CL). 55% fines, 45% fine sand, trace round gravel up to one half inch. Soft, moist.	PID = 104
50	(SW) Olive gray (5 Y 5/2) well graded sand with gravel (SW). 65% fine to coarse sand, 30% subrounded gravel up to two inches, 5% fines. Loose, wet.	PID = 25.9

WELL DIAGRAM

Casing Type: 4" Schedule 40 PVC Blank Casing



- Stickup with monument and bollards
- 4" Schedule 40 PVC blank casing
- Bentonite/cement grout, 0 to 41 feet bgs
- Bentonite chips, 41 to 45 feet bgs

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/8/11 16:45 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

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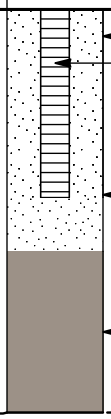
Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-006D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
50			
		51.0	
		(SW-SM) Dark greenish gray (G6 Y 14/1) well graded sand with silt (SW-SM). 70% fine to coarse sand, 20% subrounded gravel up to two inches, 10% fines. Medium dense, moist.	PID = 3.8 PID = 7.9
		55.0	
		(CL) Light brownish gray (2.5 Y 6/2) sandy lean clay (CL). 65% fines, 30% fine sand, 5% subrounded gravel up to one half inch. Firm, moist.	
		57.0	PID = 0.9
		(ML) Very dark gray (2.5 Y 3/1) sandy silt (ML). 80% fines, 20% fine sand. Hard, moist.	PID = 0.4
60		61.0	
		Light gray to dark gray pulverized siltstone/mudstone. Dry.	PID = 0.8
		64.5	
		65.0	PID = 0.8
		(ML) Black (2.5 Y 5/1) sandy silt (ML). 80% fines, 20% fine sand. Firm to soft, moist.	

Bottom of borehole at 65.0 feet.



GENERAL BH / TP / WELL - GINT STD US.GDT - 8/8/11 16:45 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-008D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California
DATE STARTED 6/23/11 **COMPLETED** 6/28/11
GROUND ELEVATION 1020.548 ft **HOLE SIZE** 6
DRILLING CONTRACTOR WDC Exploration & Wells
GROUND WATER LEVELS:
DRILLING METHOD Rotosonic
AT TIME OF DRILLING --- Not Measured
LOGGED BY S. Graham **CHECKED BY** B. Clark
AT END OF DRILLING 13.80 ft / Elev 1006.75 ft
NOTES TOC N:1889024.379 E:5900467.783 NAD 83 Elev:1022.945 NGVD 29
AFTER DRILLING 13.70 ft / Elev 1006.85 ft

DEPTH (ft)	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
0	Airknifed top five feet.	
5.0	(SM) Brown (7.5 YR 4/2) silty sand (SM). 70% fine to coarse sand, 20% fines, 10% subrounded gravel up to one inch. Dense, moist.	PID = 0.5
8.0	(SW-SC) Yellowish brown (10 YR 5/4) well graded sand with clay (SW-SC). 85% fine to coarse sand, 10% fines, 5% subangular granitic gravel up to one inch. Dense, moist.	PID = 3.1 PID = 1.1
10		
11.0	(SW-SM) Brown (7.5 YR 5/4) well graded sand with silt (SW-SC). 85% fine to coarse sand, 10% fines, 5% subrounded chert and granitic gravel up to two inches. Dense, moist.	PID = 0.4 PID = 0.7
15.5	(SC) Brown (7.5 YR 4/2) clayey sand (SC). 75% fine to coarse sand, 20% fines, 5% subrounded gravel up to one half inch. Dense, moist.	PID = 0.2
	(SC) Light olive brown (2.5 Y 5/3) clayey sand (SC). 65% fine to medium sand, 25% fines, 10% subrounded gravel up to one half inch. Dense, moist.	PID = 0.6
20	(SC) Yellowish brown (10 YR 5/4) clayey sand (SC). 75% fine to coarse sand, 15% fines, 10% subrounded gravel up to two inches, trace subrounded cobbles up to five inches. Medium dense, moist.	PID = 0.4 PID = 0.2
28.0		PID = 0.4
30.0	(SM) Yellowish brown (10 YR 5/4) silty sand (SM). 80% fine to coarse sand, 20% fines, decomposed granite, trace subrounded gravel up to one quarter inch. Medium dense, moist.	PID = 0.2
30	No recovery.	
35.0	(SW) Pale brown (10 YR 6/3) well graded sand (SW). 90% fine to coarse sand (60% medium), 5% fines, 5% subrounded gravel up to two and one half inches. Loose, wet.	PID = 0.4
40		PID = 0.1
41.0	(SC) Dark yellowish brown (10 YR 4/6) clayey sand (SC). 60% fine sand, 40% fines. Medium dense, wet.	PID = 0.3
43.0	(CL) Pale yellow (2.5 Y 7/3) lean clay (CL). 90% fines, 10% fine sand, orange mottling throughout. Soft, moist.	PID = 0.3 PID = 0 PID = 0.3
50		

WELL DIAGRAM

Casing Type: 2" Schedule 40 PVC Blank Casing

- Stickup with monument and bollards
- 2" Schedule 40 PVC blank casing
- Bentonite/cement grout, 0 to 30 feet bgs
- Bentonite chips, 30 to 33 feet bgs
- 2" diameter Schedule 40 PVC 0.020 slot screen, 35 to 45 feet bgs
- No. 3 Monterey sand pack, 33 to 47 feet bgs
- End Cap, TD = 45 ft bgs

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:57 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

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Telephone: (831) 384-3735
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WELL NUMBER 258-MW-008D

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA	WELL DIAGRAM
50				
		51.0		
		(ML) Pale yellow (5 Y 8/3) silt (ML). 90% fines, 10% fine sand. Hard, moist.	PID = 0.3	
			PID = 0.1	
		56.0		
		(CL) Pale olive (5 Y 6/3) lean clay (CL). 65% clay, 35% silt/siltstone gravel up to one inch. Soft, moist.	PID = 0	◄ Bentonite chips, 47 to 70 feet bgs
60			PID = 0.3	
			PID = 0	
		63.0		
		(ML) Light yellowish brown (8.5 Y 6/4) silt (ML). 95% fines, 5% fine sand. Hard, moist.	PID = 0.2	
		68.0		
		Biofractured silt/siltstone		
70		70.0	PID = 0	

Bottom of borehole at 70.0 feet.

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:57 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

Ahtna Engineering Services
296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-015

CLIENT US Army Corps of Engineers
PROJECT NAME Building 258 Monitoring Well
PROJECT NUMBER 20049.017
PROJECT LOCATION Fort Hunter Liggett, California
DATE STARTED 6/22/11 **COMPLETED** 6/27/11
GROUND ELEVATION 1036.721 ft **HOLE SIZE** 8
DRILLING CONTRACTOR WDC Exploration & Wells
GROUND WATER LEVELS:
DRILLING METHOD Rotosonic
AT TIME OF DRILLING --- Not Measured
LOGGED BY S. Graham **CHECKED BY** B. Clark
AT END OF DRILLING 26.00 ft / Elev 1010.72 ft
NOTES TOC N:1890222.318 E:5900550.495 NAD 83 Elev:1039.088 NGVD 29
AFTER DRILLING 26.02 ft / Elev 1010.70 ft

DEPTH (ft)	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
0	Airknifed top five feet.	
5.0	(SM) Brown (7.5 YR 4/3) silty sand (SM). 75% fine to coarse sand, 15% fines, 10% subrounded gravel up to one half inch. Loose, moist.	PID = 0.7
8.0	(SC) Brown (7.5 YR 5/4) clayey sand (SC). 65% fine to coarse sand, 20% subrounded cherts and volcanics gravel up to two inches, 15% fines. Loose, moist.	PID = 0.5
10		
10.0	No recovery.	
15.0	(CL) Brown (7.5 YR 4/3) sandy clay (CL). 70% fines, 20% fine sand, 10% subrounded gravel up to one half inch. Soft, moist.	PID = 0.6
20		PID = 0.5
22.0	(SW-SM) Pale brown (10 YR 6/3) well graded sand with silt (SW-SM). 85% fine to coarse sand, 10% fines, 5% subrounded gravel up to one half inch, cemented sand/degraded granite. Dense, dry.	PID = 1.5
	(SW-SM) Brown (7.5 YR 4/4) well graded sand with silt (SW-SM). 65% fine sand, 20% medium to coarse sand, 15% fines. Loose, moist.	PID = 0.4
		PID = 0.3
30		PID = 0.4
32.0	(SM) Yellowish brown (10 YR 5/4) silty sand (SM). 50% fine sand, 25% medium to coarse sand, 15% fines, 10% subrounded gravel up to two inches. Loose, moist.	PID = 0.3
37.0	(CL) Brown (7.5 YR 5/4) sandy lean clay (CL). 85% fines, 15% fine sand, trace subrounded gravel up to one inch. Soft, moist.	PID = 0.6
39.5	(GC) Brown (10 YR 5/3) clayey gravel with sand (GC). 40% subrounded gravel up to one inch, 30% fine to coarse sand, 30% fines. Medium dense, moist.	PID = 90.6
40		PID = 515
43.0	(SC) Light brownish gray (10 YR 6/2) clayey sand (SC). 75% fine to medium sand, 25% fines, trace subrounded gravel to one half inch. Medium dense, moist.	PID = 2339
46.0	(SW) Greenish gray (G6 Y 15/1) well graded sand (SW). 80% fine to coarse sand, 15% subrounded gravel up to one inch, 5% fines. Loose, wet.	PID = 757
50		PID = 161
		PID = 24.2

WELL DIAGRAM

Casing Type: 4" Schedule 40 PVC Blank Casing

- Stickup with monument and bollards
- Bentonite/cement grout, 0 to 18 feet bgs
- 4" Schedule 40 PVC blank casing
- Bentonite chips, 18 to 21 feet bgs
- 4" diameter Schedule 40 PVC 0.020 slot screen, 23 to 58 feet bgs
- No. 3 Monterey sand pack, 21 to 59 feet bgs

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:59 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

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296 12th Street
Marina, CA 93933
Telephone: (831) 384-3735
Fax: (831) 384-3930

WELL NUMBER 258-MW-015

CLIENT US Army Corps of Engineers **PROJECT NAME** Building 258 Monitoring Well

PROJECT NUMBER 20049.017 **PROJECT LOCATION** Fort Hunter Liggett, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA	WELL DIAGRAM
50				
		52.0	PID = 12.9	
		(GC) Pale brown (10 YR 6/3) clayey gravel with sand (GC). 40% subangular gravel/siltstone up to two inches, 35% fine to coarse sand, 25% fines. Dense, moist.	PID = 28.6	
		55.0		
		(SW) Light brownish gray (10 YR 6/2) well graded sand (SW). 75% fine to coarse sand, 20% subrounded gravel up to one inch, 5% fines. Loose, wet.	PID = 6.1	End Cap, TD = 58 ft bgs
		58.0		
		Light gray (2.5 Y 7/1) pulverized siltstone/mudstone.		
60		Light olive brown (2.5 Y 5/3) siltstone. 90% fines, 10% fine sand. Hard, moist.	PID = 1.4	
		Light gray (2.5 Y 7/1) pulverized siltstone/mudstone.	PID = 2.8	Bentonite chips, 59 to 63 feet bgs
		63.0		

Bottom of borehole at 63.0 feet.

GENERAL BH / TP / WELL - GINT STD US.GDT - 8/10/11 12:59 - C:\PROGRAM FILES\GINT\FHL 258 NEW WELLS.GPJ

Date 6/9/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

GROUND SURFACE	PID Reading (ppm)	Sample Number	Depth (ft.)	Sample	
			0		Hand auger top 5 feet, not logged
			5		Dark Brown Clayey Sand (SC) (7.5YR3/2), medium dense, moist, 5% subrounded gravel up to 2-inches in diameter, 80% fine to coarse grained sand, 15% fines (top soil)
	1.6				Brown Silty Sand (SM) (7.5YR5/3), medium dense, moist, 5% subrounded to subangular gravel up to 2-inches in diameter, 75% fine to coarse grained sand, 20% fines
	1.1		10		
	1.1				
	1.5				Increasing fines and gravels
			15		Brown Well Graded Sand (SW) (7.5YR4/3), dense, moist, 5% subrounded to subangular gravel up to 0.5-inches in diameter, 80% fine to coarse grained sand, 10% fines, gravels are highly weathered granite
	1.6				Pale Brown Silty Sand (SM) (10YR6/3), medium dense, moist, 10% subrounded gravel to 2-inches in diameter, 75% fine to coarse grained sand, 15% fines, gravels are weathered granitics
	1.3		20		
	1.2				Brown Well Graded Sand with Clay (SW-SC) (7.5YR4/3), medium dense, moist, 10% subrounded to subangular gravels to 1-inch in diameter, 80% fine to coarse grained sand, 10% fines
	1.3		25		
	0.9				Brown Well Graded Sand with Gravel (SW) (10YR5/3), loose, wet, 30% subrounded gravels up to 2-inches in diameter, 65% fine to coarse grained sand, 5% fines
	0.8				
			30		No gravel 30.5 to 31.5 feet bgs
	1.2				
	0.9				
			35		
	1.8				
	1.4				Color Change to Light Brownish Gray (10YR6/2)
			40		
	1.8				Grayish Brown Well Graded Sand with Silt and Gravel (SW-SM) (2.5Y5/2), medium dense, moist, 20% subrounded to angular gravels (volcanics and chert), 70% fine to coarse grained sand, 10% fines
	2.8				Increasing fines 42 to 45 feet bgs
			45		
	33.1	008F 010F			Decreasing Fines 45 to 49 feet bgs
	13.6				
			50		

BORING_WELL2_AMEC FHL_SB-001.GPJ GEOL.GDT 7/25/11

PLATE

Log of Boring 258-SB-001

Fort Hunter Liggett
Bldg. 258, Jolon, CA

C-1

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/9/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

PID Reading (ppm)	Sample Number	Depth (ft.)	Description
		50	Gray-green clay nodules up two 2-inches in diameter at 50 feet bgs
3.0			
1.9		55	
3.3			
2.5		60	Light Brownish Gray Lean Clay (CL) (10YR6/2), firm, moist, trace angular gravel up to 0.5-inches in diameter, 10% fine grained sand, 90% fines
2.5			
2.5	011F		
3.2	009F	65	Very Dark Gray Silty Sand (SM) (2.5Y3/1), medium dense, moist, 5% angular gravel (siltstone) up to 0.5-inches in diameter, 60% fine to coarse grained sand, 35% fines
2.9			Gray Mudstone (10YR6/1), hard, fractured, fissle
3.2			Black Silt (ML) (2.5Y2.5/1), firm, moist, 10% fine grained sand, 90% fines (weathered bedrock)
4.5		70	5% angular gravel up to 0.25-inches in diameter, 5% fine sand from 66.5 to 70 feet bgs
4.4			Light Brownish Gray Siltsone/Mudstone (2.5Y6/2), hard, dry, 50% highly fractured siltstone/mudstone, 50% silt (weathered bedrock)
2.2		75	Black Silt with Gravel (Siltstone) (2.5Y2.5/1), firm, moist, 30% angular mudstone/siltstone gravels up to 1-inch in diameter, 70% fines
3.7	012F		
		80	Gray Siltstone (10YR5/1), dry, highly fractured
3.0			
3.9		85	Very Dark Gray Siltstone (7.5YR3/1), hard, moist, 30% angular mudstone/siltstone gravels, 70% fines, very weathered
0.0			
0.0			Gray Siltstone (10YR5/1), dry, highly fractured
		90	
0.0			
1.3			Color Change to Dark Gray (10YR4/1)
		95	
3.7			Color Change to Gray (10YR5/1)
2.5		100	

BORING_WELL2_AMEC FHL_SB-001.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-001

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-1

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/9/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

PID Reading (ppm)	Sample Number	Depth (ft.)	Sample	
		100		
2.3				
3.6				
		105		Boring terminated at 105 feet bgs

BORING_WELL2_AMEC FHL_SB-001.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-001

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-1

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/8/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

GROUND SURFACE

PID Reading (ppm)	Sample Number	Depth (ft.)	Description
		0	Hand auger top 5 feet, not logged
0.8		5	Brown Clayey Sand (SC) (7.5YR5/4), medium dense, moist, 5% subrounded gravel up to 1-inch in diameter, 75% fine to coarse grained sand, 20% fines (top soil)
0.6			Brown Clayey Sand (SC) (7.5YR4/3), medium dense, moist, trace subrounded gravel up to 0.5-inches in diameter, 85% fine to coarse grained sand, 15% fines, decreasing fines and gravels with depth
0.5		10	
0.9			Brown Well Graded Sand with Silt (SW-SM) (10YR4/3), loose, moist, trace subrounded gravel up to 1-inch in diameter, 90% fine to coarse grained sand, 10% fines, gravels are highly weathered granite/cemented sandstone
		15	No Recovery 15 to 20 feet bgs
		20	Dark Grayish Brown Well Graded Sand with Silt and Gravel (SW-SM) (10YR4/2), loose, moist, 15% subangular gravel to 0.5-inches in diameter, 75% fine to coarse grained sand, 10% fines
2.6			
1.4			Brown Well Graded Sand with Gravel (SW) (10YR5/3), dense, dry, 30% subrounded to subangular gravels up to 1-inch in diameter, 65% fine to coarse grained sands, 5% fines, well cemented
		25	Dark Grayish Brown Silty Sand (SM) (10YR4/2), loose, moist, trace subangular gravels up to 0.25-inches in diameter, 85% fine to coarse grained sand, 15% fines
2.2			
1.7		30	Brown Clayey Sand (SC) (10YR4/3), loose, moist, 5% subrounded gravel up to 1-inch in diameter, 80% fine to coarse grained sand, 15% fines
1.5			
1.7			Yellowish Brown Poorly Graded Sand (SP) (10YR5/4), dense, moist, 10% rounded gravel up to 1-inch in diameter, 80% medium grained sand, 10% fine and coarse sand, trace fines
		35	Brown Well Graded Sand with Silt (SW-SM) (10YR4/3), medium dense to dense, moist, 5% subrounded gravel up to 2-inches in diameter, 85% fine to coarse sand 10% fines
2.3			
2.1			Increasing fines (15%) and decreasing sand (80%)
		40	
1.9			Increasing Silt
1.7		45	Color Change to Brown (10YR5/3), 10% subrounded gravel to 1-inch in diameter, 90% fine to coarse grained sand, trace fines
1.7			
1.6		50	

BORING_WELL2_AMEC FHL_SB-002.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-002

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-2

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/8/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

PID Reading (ppm)	Sample Number	Depth (ft.)	Sample	
		50		Gravels to 2-inches in diameter
1.5				
1.6	007F			
		55		
1.5				
1.5				
		60		
1.4				Increase to 15% fines
1.5				
		65		Boring terminated at 65 feet bgs

BORING_WELL2_AMEC FHL_SB-002.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-002

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-2

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/7/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

GROUND SURFACE

PID Reading (ppm)	Sample Number	Depth (ft.)	Description
		0	Hand auger top 5 feet, not logged
		5	No Recovery 5 to 10 feet bgs
		10	Brown Clayey Sand (SC) (7.5YR4/2), medium dense, moist, 5% subrounded gravel up to 1-inch in diameter, 65% fine to coarse grained sand, 30% fines
			Brown Silty Sand (SM) (7.5YR4/3), medium dense, moist, trace cobbles up to 3-inches in diameter, 5% subrounded to rounded gravels up to 1-inch in diameter, 65% fine to coarse grained sand, 30% fines
0.8		15	Brown Sandy Lean Clay (CL) (7.5YR4/3), soft, moist, trace rounded gravel up to 0.25-inches in diameter, 30% fine to coarse grained sand, 70% fines
0.8		20	Brown Clayey Sand (SC) (7.5YR4/4), dense, moist, trace cobbles to 3-inches in diameter, 10% rounded gravel to 2-inches in diameter, 75% fine to coarse grained sand, 15% fines, gravels are decomposed granite/cemented sands
1.4		25	Light Gray (10YR7/2) to Dark Yellowish Brown (10YR4/4) (when wet) Well Graded Sand (SW), dense, dry, trace rounded to subrounded gravel up to 0.5-inches in diameter, 95% fine to coarse sand, 5% fines, cemented sands/decomposed granite
4.6		30	Brown Well Graded Sand with Silt (SW-SM) (7.5YR4/4), medium dense, moist, 10% subangular gravels up to 2-inches in diameter, 80% fine to coarse grained sand, 10% fines
9.0			Brown Well Graded Sand with Clay (SW-SC) (7.5YR5/4), loose, moist, 5% subrounded gravel up to 0.5-inches in diameter, 85% fine to coarse grained sand, 10% fines
1.2		35	Yellowish Brown Well Graded Sand (SW) (10YR5/4), loose, dry, 5% rounded gravel up to 0.25-inches in diameter, 95% fine to coarse grained sand
19.2			Color Change to Gray (2.5Y5/1), very loose, wet
646	001F		
32.9		40	
5.2			Brown Sandy Silt (ML) (10YR4/3), medium dense, wet, 30% fine grained sand, 70% fines
		45	Grayish Brown Well Graded Sand with Clay and Gravel (SW-SC) (2.5Y5/2), loose, wet, 10% subrounded gravels up to 1-inch in diameter, 80% fine to coarse grained sand, 10% fines
3.6	002F		
16.6		50	

BORING_WELL2_AMEC FHL_SB-003.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-003

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-3

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/7/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

PID Reading (ppm)	Sample Number	Depth (ft.)	Description
6.3		50	
15.0			Yellowish Brown Well Graded Sand (SW) (10YR5/4), dense, moist, 5% subrounded gravel up to 1-inch in diameter, 90% fine to coarse sand, 5% fines
		55	Greenish Gray Sandy Silt (ML) (Gley1 5/1), very hard, dry, 25% fine sand, 75% fines, fractured, weathered siltstone
2.1			
1.1		60	
1.1			
5.0			
		65	Greenish Gray Silt with Sand (ML) (Gley1 5/1), hard, moist, 10% fine grained sand, 90% fines (weathered siltstone)
1.3			Gray Siltstone (Gley1 6/), hard, dry to moist, fractured and weathered
		70	Greenish Gray Silt (ML) (Gley1 5/1), hard, moist, 5% fine sand, 95% fines (weathered bedrock)
			Fractured Siltstone from 72.5 to 73 feet bgs
		75	Very Dark Greenish Gray Silt (ML) (Gley1 3/1), hard, moist, 5% fine sand, 95% fines
1.2	005F		
			Greenish Gray Siltsone and Silt (ML) (Gley1 6/1), hard, dry, highly fractured and weathered
0.3		80	
1.0			Color Change to Dark Greenish Gray Siltstone (Gley1 4/1), fractured
		85	Color Change to Very Dark Greenish Gray Siltstone (Gley1 3/1), very hard, moist, lightly fractured
1.5	006F		
1.2			
		90	Change to highly fractured
1.2			
2.3			
		95	
0.5			
1.0			
		100	

BORING_WELL2_AMEC FHL_SB-003.GPJ GEOL.GDT 7/25/11

PLATE

Log of Boring 258-SB-003

Fort Hunter Liggett
Bldg. 258, Jolon, CA

C-3

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/7/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

PID Reading (ppm)	Sample Number	Depth (ft.)	Sample
2.7		100	
1.2			
1.4			
		105	

Boring Terminated at 105 feet bgs

BORING_WELL2_AMEC FHL_SB-003.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-003

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-3

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/10/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

GROUND SURFACE	PID Reading (ppm)	Sample Number	Depth (ft.)	Sample	
			0		Hand auger top 5 feet, not logged
			5		Brown Silty Sand (SM) (7.5YR5/3), dense, dry, trace cobbles up to 3-inches in diameter, 5% angular gravel up to 1.5-inches in diameter, 60% fine to coarse grained sand, 35% fines, gravels are chert and weathered granite
	3.8				
	6.0		10		Color Change to Light Yellowish Brown (10YR6/4), dense, dry, decreasing fines to 15%, increasing fine sand, consolidated, some cementation,
	7.1				
	8.9		15		
	7.5				
	7.1		20		
	3.1				
	6.9				
			25		Yellowish Brown Well Graded Sand (SW) (10YR5/4), dense, moist, trace subangular gravel up to 0.5-inches in diameter, 95% fine to coarse grained sand, 5% fines
	12.1				Yellowish Brown Sandy Silt (ML) (10YR5/4), hard, moist, 5% subrounded gravel up to 0.5-inches in diameter, 5% medium to coarse grained sand, 35% fine grained sand, 55% fines
	18.4		30		
	29.8				Light Olive Brown Sandy Lean Clay (CL) (2.5Y5/3), firm, moist, 5% subangular gravel up to 0.5-inches in diameter, 30% fine to medium grained sand, 65% fines, gravels are black chert
	73.5		35		Grayish Brown Clayey Sand (SC) (2.5Y5/2), loose, wet, 5% subrounded gravels to 0.5-inches in diameter, 80% fine to coarse grained sand, 15% fines
	2149	013F/013D 014F			
	1101		40		Pale Brown Silty Sand (SM) (10YR6/3), medium dense, moist, trace rounded gravels up to 0.25-inches in diameter, 5% medium grained sand, 75% fine grained sand, 20% fines
	1249				Grayish Brown Well Graded Sand with Silt and Gravel (SW-SM) (2.5YR5/2), loose, wet, 30% rounded gravels up to 1-inch in diameter, 60% fine to coarse grained sand, 10% fines
	1969		45		
	2131				
	2086		50		

BORING_WELL2_AMEC FHL_SB-004.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-004

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-4

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/10/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

PID Reading (ppm)	Sample Number	Depth (ft.)	Sample	Description
1373		50		Increasing fines to 20%
862				
	015F 016F	55		Dark Gray Silty Sand (SM) (5Y4/1), medium dense, moist, 30% subrounded gravels up to 1-inch in diameter, 55% fine to coarse grained sand, 15% fines
7.2				Brown Well Graded Gravel with Silt and Sand (GW-GM) (10YR5/3), loose, wet, 50% subrounded gravels up to 2-inches in diameter, 40% fine to coarse grained sand, 10% fines
5.7				
		60		Yellowish Brown Sandy Silt (ML) (10YR5/4), hard, moist, trace subangular gravel up to 0.5-inches in diameter, 40% fine sand, 60% fines
7.4				
				Brown Well Graded Sand (SW) (10YR5/3), loose, wet, 20% rounded gravel up to 1-inch in diameter, 75% fine to coarse grained sand, 5% fines
4.4		65		
14.2				
7.2		70		
7.0				
6.0				Brown Silty Sand (SM) (10YR5/3), medium dense, moist, 20% subrounded gravels up to 1-inch in diameter, 60% fine to coarse grained sand, 20% fines
		75		Boring terminated at 75 feet bgs

BORING_WELL2_AMEC FHL_SB-004.GPJ GEOL.GDT 7/25/11

PLATE

Log of Boring 258-SB-004

Fort Hunter Liggett
Bldg. 258, Jolon, CA

C-4

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/21/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

GROUND SURFACE	PID Reading (ppm)	Sample Number	Depth (ft.)	Sample	
			0		Hand auger top 5 feet, not logged
	0.4		5		Very Dark Grayish Brown Clayey Sand (SC) (10YR3/2), loose, moist, 20% subrounded gravel up to 1-inch in diameter, 65% fine to coarse grained sand, 15% fines
	0.5				Brown Silty Sand (SM) (10YR5/3), medium dense, moist, 15% subrounded to rounded gravel up to 1-inch in diameter, 70% fine to coarse grained sand, 15% fines
	0.3		10		Pale Brown Silty Sand (SM) (10YR6/3), loose, moist, 5% subrounded gravel up to 0.5-inches in diameter, 60% fine grained sand, 35% fines
					No Recovery 13 to 15 feet bgs
	0.7		15		Brown Well Graded Sand with Clay (SW-SC) (7.5YR5/4), medium dense, moist, 10% subrounded gravel to 0.5-inches in diameter, 20% medium to coarse grained sand, 60% fine grained sand, 10% fines
	0.3				
	0.4		20		
	0.4				Brown Sandy Lean Clay (CL) (10YR5/3), hard, moist, 5% subrounded gravel up to 0.5-inches in diameter, 10% medium to coarse grained sand, 20% fine grained sand, 65% fines
			25		No Recovery 25 to 35 feet bgs
			30		
	64.8		35		Light Yellowish Brown Well Graded Sand with Gravel (SW) (2.5Y6/3), loose, wet, 40% subrounded gravel up to 0.5-inches in diameter, 55% fine to coarse grained sand, 5% fines
	236				Light Olive Brown Lean Clay (CL) (2.5Y5/3), hard, moist, 20% fine sand, 80% fines
	1998		40		Olive Gray Sandy Lean Clay (CL) (5Y5/2), soft, moist, 5% subrounded gravel up to 0.25-inches in diameter, 40% fine sand, 55% fines
					Olive Gray Silty Sand (SM) (5Y5/2), loose, wet, 85% fine to medium grained sand, 15% fines
	1792		45		Grayish Brown Well Graded Gravel with Sand (GW) (2.5Y5/2), loose, wet, 55% subrounded gravel up to 1-inch in diameter, 40% fine to coarse grained sand, 5% fines
	1752				6-inch thick layer of Sandy Silt 46.5 to 47 feet bgs
	601		50		Light Olive Brown Well Graded Sand with Silt (SW-SM) (2.5Y5/3), loose, wet, 5%

BORING_WELL2_AMEC FHL_SB-005.GPJ GEOL.GDT 7/25/11

PLATE

Log of Boring 258-SB-005

Fort Hunter Liggett
Bldg. 258, Jolon, CA

C-5

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

Date 6/21/11
Driller
Drilling Method Sonic
Sampler
Hammer Weight **Drop**
Logged by SRG **Datum**
Surface Elevation **Hole Dia.** 6-inch
Northing **Easting**

PID Reading (ppm)	Sample Number	Depth (ft.)	Sample	
		50		subrounded gravels up to 0.5-inches in diameter, 15% medium to coarse grained sand, 70% fine grained sand, 10% fines
282				Olive Gray Sandy Lean Clay (CL) (5Y5/2), soft, moist, trace subrounded gravel up to 1-inch in diameter, 25% fine to medium grained sand, 75% fines
52.5		55		
0.4				Light Yellowish Brown Silty Sand (SM) (10YR6/4), medium dense, moist, trace subrounded gravel up to 1-inch in diameter, 65% fine grained sand, 35% fines
0.3				
		60		Light Yellowish Brown Clayey Sand (SC) (10YR6/4), medium dense, wet, trace subrounded gravel up to 1-inch in diameter, 75% fine to medium grained sand, 25% fines
0.4				
0.1				Light Yellowish Brown Silty Sand (SM) (10YR6/4), medium dense, moist, trace subrounded gravel up to 0.5-inches in diameter, 80% fine grained sand, 20% fines
		65		Light Yellowish Brown Clayey Sand (SC) (10YR6/4), medium dense, moist, trace gravel up to 1-inch in diameter, 65% fine grained sand, 35% fines
0.6				
0.6				Light Yellowish Brown Silty Sand (SM) (10YR6/4), medium dense, moist, trace gravel up to 0.25-inches in diameter, 80% fine sand, 20% fines
		70		
0.7				Light Brownish Gray Well Graded Sand with Silt (SW-SM) (10YR6/2), loose, moist, 5% subangular gravel up to 1-inch in diameter, 85% fine to medium grained sand, 10% fines
0.3				
		75		Pale Brown Silty Sand (SM) (10YR6/3), medium dense, moist, trace subrounded gravel up to 0.5-inches in diameter, 80% fine sand, 20% fines
0.7				
				Light Brownish Gray Well Graded Sand with Clay and Gravel (SW-SC) (10YR6/2), medium dense, moist, 30% subrounded gravel up to 1-inch in diameter, 60% fine to coarse grained sand, 10% fines
0.4				
		80		
0.2				Very Dark Gray Silt (ML) (5Y3/1), hard, moist, 10% fine sand, 90% fines
0.2				Very Dark Gray Silt/Siltstone (5Y3/1), hard, moist, 10% fine sand, 90% fines, not lithified
		85		5% fine grained sand, fractured, thinly bedded
0.7				
0.4				
		90		Boring terminated at 90 feet bgs

BORING_WELL2_AMEC FHL_SB-005.GPJ GEOL.GDT 7/25/11

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Log of Boring 258-SB-005

Fort Hunter Liggett
Bldg. 258, Jolon, CA

PLATE
C-5

DRAWN	JOB NUMBER	CHECKED	CHCK'D DATE	APPROVED	APPRV'D DATE
SRG	4084106586.02.3				

APPENDIX D

WELL DEVELOPMENT DATA

Table D-1: Well Completion and Installation Data

Well	258-MW-002D	258-MW-004D	258-MW-005D	258-MW-006D	258-MW-008D	258-MW-0015
Begin Date	6/15/2011	6/29/2011	6/20/2011	6/16/2011	6/28/2011	6/27/2011
Finish Date	6/15/2011	6/29/2011	6/20/2011	6/17/2011	6/28/2011	6/27/2011
Screen Interval (ft bgs)	65-85	55.5-70.5	45-55	47-57	35-45	23-58
Borehole TD (ft bgs)*	85	74	58	60	48	61
Borehole Diam (in)	8	8	8	8	6	8
Nominal Casing Diam (in)†	4	4	4	4	2	4
Development Date	6/23/2011	7/1/2011	6/24/2011	6/24/2011	6/30/2011	6/30/2011
Gallons Purged	240	45	260	220	95	260
Depth to Water (ft btoc)	31.85	25.23	24.93	27.33	18.5	28.39
Well TD (ft btoc)	84.63	73.36	57.24	59.96	47.76	60.71

Notes:

ft: Feet

bgs: Below Ground Surface

btoc: Below Top Of Casing

in: Inches

TD : Total Depth

*: Estimated during well installation

† Schedule 40 PVC

Ahtna Engineering

Table 2: Monitoring Well Survey Data

Well	258-MW-002D	258-MW-004D	258-MW-005D	258-MW-006D	258-MW-008D	258-MW-014	258-MW-015
Latitude (N)*	36.0011411	35.9996245	35.9960734	35.9974294	35.9950929	36.0009928	35.9983880
Longitude (West)*	-121.2329456	-121.2343593	-121.2338746	-121.2351044	-121.2352607	-121.2333438	-121.2350754
Northing*	1891209.632	1890667.391	1889371.675	1889873.631	1889024.379	1891158.400	1890222.318
Easting*	5901203.646	5900772.747	5900886.024	5900533.793	5900467.783	5901084.645	5900550.495
Elevation (NAVD 1988)*	1060.78	1048.88	1033.77	1037.31	1025.84	1057.73	1041.98
Elevation (NGVD 29)*	1057.892	1045.989	1030.876	1034.416	1022.945	1054.841	1039.088

Notes:

Coordinate System: US State Plane 1983

Zone: California Zone 4 0404

Project Datum: NAD 1983 (Conus)

Vertical Datum: NAVD 88

Coordinate Units: US survey feet

Distance Units: US survey feet

Elevation Units: US survey feet

Subtract 2.89 feet from NAVD 1988 elevation to obtain NGVD 29 elevation. The elevation datum was converted to NGVD 29 to match historical wells survey data.

* Measurement taken from top of casing

APPENDIX E

DATA VALIDATION RESULTS

4.0 SUMMARY OF DATA QUALITY ASSESSMENT

Soil samples were collected between June 7th and June 29th, 2011as part of the Fort Hunter Liggett Building 258 Site Investigation, and submitted and submitted under chain of custody (COC) to Accutest Laboratories, located in San Jose, California. Data validation was performed on the data to confirm the integrity and reliability of the field and laboratory data generated during this sampling event. The equivalent of a United States Environmental Protection Agency (USEPA) Level III data review was performed on 100% of the sample results and the equivalent of a USEPA Level IV raw data review was performed on approximately 13% of the sample results. Level III and IV data review was performed in accordance with the following guidelines:

- *The Quality Assurance Project Plan Building 194 Groundwater Studies, Fort Hunter Liggett California*, May 5, 2010.
- The principles presented in the U.S. Army Corps of Engineers (USACE) *Guidance for Evaluation Performance Based Chemical Data*, June 30, 2005.
- Individual analysis methods: SW-846 Methods 8260B, 8015B and 6010B

The Level III review was performed using Laboratory Data Consultants, Inc.'s Automated Data Review (ADR) program, with manual review of initial and continuing calibration files for each test method. Accutest has been certified through the Department of Defense Environmental Laboratory Accreditation Program (DOD ELAP) and maintains accreditation through the State of California for the National Environmental Laboratory Accreditation Conference (NELAC). Appendix C of this report presents a Quality Control Summary Report (QCSR) for the monitoring period. The following is a summary of the data validation findings.

4.1 Level III and IV Validation Results

The Level III and Level IV data validation of sample results identified the following data quality issues:

- Total Petroleum Hydrocarbons (Gasoline Range Organics) (TPH-GRO) by USEPA Test Method 8260B - The data review revealed that project samples and QC parameters met acceptance criteria.
- Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), Methyl tert-butyl ether (MTBE) and tert-Butyl Alcohol (TBA) by USEPA Test Method 8260B- The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:
    - The recovery of the surrogate 4-bromofluorobenzene in sample 11235G258005F was below the 85-120% acceptance criteria at 82%. The results for TPH-g in this sample was qualified as estimated (J-) with a possible low bias.
    - TBA had a reporting limit of 40 ug/kg with results reported down to a Method Detection Limit (MDL) of 10 ug/kg. The RL and MDL were both above the PQL limit of 5 ug/kg specified in the QAPP. Non-detect results for TBA do not support the PQL specified in the QAPP.

- Total Petroleum Hydrocarbons (Diesel Range Organics) (TPH-DRO) and Total Petroleum Hydrocarbons (Motor Oil) (TPH-mo) by USEPA Test Method 8015B (mod) - The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:

  - TPH-d had a reporting limit of 10 mg/kg with results reported down to a Method Detection Limit (MDL) of 5 mg/kg. The RL and MDL were both above the PQL limit of 1 mg/kg specified in the QAPP. Non-detect results for TPH-d do not support the PQL specified in the QAPP.

- Title 22 Metals by USEPA Test Method 6010B/7471A and Total Iron by USEPA Test Method 6010B - The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:

  - The recoveries for antimony in matrix spike/matrix spike duplicate (MS/MSD) sample pair C16487-1MS/MSD were below the 80-120% acceptance range at 51/51% and the MS recoveries for barium and silver were below the acceptance ranges at 76% and 78%, respectively. Associated samples were reported as non-detect for antimony and silver, therefore the results for these analytes in samples 11235G258001F, 11235G258002F, 1123SG258008F and 1123SG258009F were qualified as estimated (UJ). Detected results for barium in samples 11235G258001F, 11235G258002F, 1123SG258008F and 1123SG258009F were qualified as estimated (J-) with a possible low bias.

  - The recoveries for antimony in MS/MSD sample pair C16486-1MS/MSD were below the 80-120% acceptance range at 52/48%. Associated samples were reported as non-detect for antimony, therefore the antimony results for samples 1123SG258013D, 1123SG258013F and 1123SG258015F were qualified as estimated (UJ).

  - The recoveries for antimony in MS/MSD sample pair C16562-1MS/MSD were below the 80-120% acceptance range at 34/33% and the MS recovery for molybdenum was below the acceptance range at 79.8%. Associated samples were reported as non-detect for antimony and molybdenum, therefore the results for these analytes in samples 1124SG258017F and 1124SG258019F were qualified as estimated (UJ).

  - The recoveries for mercury in MS/MSD sample pair C16562-1 were outside of the 80-120% acceptance range at 75/124%. The RPD between the MS and MSD was above the 20% acceptance criteria at 35%. Therefore the results for mercury in associated samples 1224SG258017F and 1124SG258019F were qualified as estimated, (J) and (UJ) respectively.

  - Serial dilution sample MP-3597SD1 had a %D for molybdenum above the 0-10%D control limit at 15.2%. Associated non-detect results for molybdenum for samples 11235G258001F, 11235G258002F and 1123SG258008F were qualified as estimated (UJ).

  - The RPD for the field duplicate samples collected from 1123SG258013F did not meet the 30% RPD acceptance criterion for the following detected analytes:

Sample ID	Analyte	Primary	Duplicate	Units	RPD	RPD Limit
1123SG258013F	Chromium	5.5	7.9	mg/kg	**36**	30
	Lead	10.4	3.4	mg/kg	**101**	30
	Nickel	5.3	7.4	mg/kg	**33**	30

The analysis of the field duplicate samples is a measure of both field and analytical precision. Since the effect on the quality of the data is unknown, data have not been qualified as a result of high RPDs in the field duplicates.

- The following laboratory RLs do not support the PQLs specified in the QAPP:

Analyte	RL	QAPP PQL	Units
Antimony	2	0.5	mg/kg
Arsenic	2	0.25	mg/kg
Barium	20	0.25	mg/kg
Beryllium	1	0.1	mg/kg
Cadmium	1	0.25	mg/kg
Chromium	1	0.25	mg/kg
Cobalt	1	0.25	mg/kg
Copper	2.5	0.25	mg/kg
Lead	2	0.25	mg/kg
Molybdenum	2	0.25	mg/kg
Nickel	1	0.25	mg/kg
Selenium	2	0.5	mg/kg
Silver	1	0.25	mg/kg
Thallium	2	0.5	mg/kg
Vanadium	1	0.25	mg/kg
Zinc	2	1	mg/kg
Mercury	0.042	0.02	mg/kg

Non-detect results for the analytes listed above do not support the PQL specified in the QAPP. Sample results were not qualified based on the raised reporting limits.

- Chemical Oxygen Demand by SM19 5220C (mod) - The data review revealed that project samples and QC parameters met acceptance criteria, with the exception of the following:

  - COD had a reporting limit of 200 mg/kg. The RL was above the PQL limit of 10 mg/kg specified in the QAPP. Non-detect results for the analytes listed above do not support the PQL specified in the QAPP. Sample results were not qualified based on the raised reporting limits.

  - The RPD for the field duplicate samples collected from 1123SG258013F did not meet the 30% RPD acceptance criterion for COD:

Sample ID	Analyte	Primary	Duplicate	Units	RPD	RPD Limit
1123SG258013F	COD	367	570	mg/kg	**43**	30

The imprecision in the results between field duplicate pairs may be due to the sample matrix, sampling or laboratory technique, or method defects. Since the effect on the quality of the data is not known, data is not qualified for field duplicate failures.

- Total Organic Carbon by USEPA Test Method 9060A (mod) - The data review revealed that project samples and QC parameters met acceptance criteria.

4.2 Data Validation Summary

Non-detect results for TBA by USEPA Test Method 8260B, Metals by USEPA Test Method 6010B and 7471A, TPH-d by USEPA Test Method 8015B (mod) and COD by SM19 5220C (mod) were reported at RLs that do not support the PQLs specified in the QAPP. Sample results were not qualified based on the raised reporting limits.

Data validation qualification of results reported by the laboratory wererequired for multiple metal analytes of nine samples due to MS/MSD outliers, for the COD results of two samples due to MS/MSD outliers, for the TPH-g result of one sample due to surrogate recovery outliers and for the molybdenum result of three samples due to serial dilution outliers. Estimated sample results (J/UJ) are usable, as qualified for limited purposes only. Based upon the Level III and Level IV data validation, the data are considered usable as reported by the laboratory with qualifiers applied as described in this report.

APPENDIX E

QUALITY CONTROL SUMMARY REPORT

APPENDIX E

QUALITY CONTROL SUMMARY REPORT

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E1.0 INTRODUCTION

This quality control summary report (QCSR) presents Level III and IV data validation results for samples collected as part of the June 2011Fort Hunter Liggett Building 258 Site Investigation sampling event. AMEC performed Level III and IV data validation on analytical results generated by Accutest Laboratories Inc., in San Jose, California.

Level III and IV data review was performed in accordance with the following guidelines:

- *The Quality Assurance Project Plan Building 194 Groundwater Studies, Fort Hunter Liggett California*, May 5, 2010.
- The principles presented in the U.S. Army Corps of Engineers (USACE) *Guidance for Evaluation Performance Based Chemical Data*, June 30, 2005.
- Individual analysis methods: SW-846 Methods 8260B, 8015B and 6010B.

The Level III review was performed using Laboratory Data Consultants, Inc.'s Automated Data Review (ADR) program, with manual review of initial and continuing calibration files for each test method. The Level III review performed on 100% of analytical results included the following:

- Evaluation of the quality of the data with respect to the quality control (QC) criteria specified in the QAPP.
    - This evaluation is based on a review of spike recoveries from the laboratory control sample (LCS), surrogate spike recoveries, internal standard recoveries, initial and continuing calibration verification (CCV) standards, a review of field duplicate sample results, and laboratory, trip blank results, and a review of laboratory compliance with analytical holding times.
- Identification of data quality issues and application of data qualification as a result of QC exceedances.
- Overall Data quality assessment
    - This assessment is based on a review of the data precision, accuracy, representativeness, and completeness of the reported results.
- Review of sample preparation logs and instrument logs
    - The review is performed to confirm that field samples were prepared and analyzed correctly and that instruments were calibrated at the proper frequency. The review also confirms that QC samples were prepared and analyzed at the proper frequency.
- Review of internal standards (gas chromatography/mass spectrometry only)
    - Internal standards (IS) are organic compounds that have similar retention times to target analytes. IS are added to samples and calibration standards to establish relative response factors for target analytes, and to establish initial and continuing calibration curves. The

review is performed to document that internal standard area counts and retention times agree within their respective acceptance criteria.

- Review of instrument performance
  - A review of the instrument tune results is performed to show that the tune standard was run at the proper frequency and that the relative ion abundance ratios were reproducible and within acceptance criteria.

An additional Level IV raw data review was performed on approximately 13% of analytical results and included the elements of the Level III review plus the following:

- Review of sample chromatographic patterns for target compound identification – (TPH-g analysis only)
  - Target compounds identification through comparison of the pattern of the target analyte found in the project samples to the associated continuing calibration standards.
- Evaluation of the raw data and re-calculation of sample results.

E2.0 ANALYTICAL SUMMARY

During the June 2011 sampling event, 15 soil samples were collected from Fort Hunter Liggett Building 258 and submitted to Accutest Laboratories Inc., in San Jose, California for analysis. Table C1 identifies the samples collected during the June 2011 sampling period. The following test methods were performed, however not all test methods were requested for all of the samples.

Test Methods:

- Total Petroleum Hydrocarbons (Gasoline Range Organics) (TPH-GRO) by USEPA Test Method 8260B
- Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX), Methyl tert-butyl ether (MTBE) and tert-Butyl Alcohol (TBA) by USEPA Test Method 8260B
- Total Petroleum Hydrocarbons (Diesel Range Organics) (TPH-DRO) and Total Petroleum Hydrocarbons (Motor Oil) (TPH-mo) by USEPA Test Method 8015B (mod)
- Title 22 Metals by USEPA Test Method 6010B/7471A and Total Iron by USEPA Test Method 6010B
- Chemical Oxygen Demand by SM19 5220C (mod)
- Total Organic Carbon by USEPA Test Method 9060A (mod)

E3.0 DATA VALIDATION RESULTS

This section provides a discussion of Level III and Level IV data validation results for the June 2011 Fort Hunter Liggett Building 258 Site Investigation sampling event. The discussion in this section is limited to results that were outside acceptance criteria, and the data qualifiers that were applied as a result of control limit exceedances. Potential impacts, if any, on data usability are also included in this discussion. Table C2 presents a summary of data qualifiers applied as a result of the exceedances described below.

E3.1 TPH-GRO by USEPA Test Method 8260B

A surrogate recovery outside the QAPP QC acceptance criteria of 85-120% was observed for 4-bromofluorobenzene in sample 11235G258005F at 82%. The detected result for TPH-g in this sample was qualified as estimated (J-) with a possible low bias.

E3.2 BTEX, MTBE and TBA by USEPA Test Method 8260B

An LCS recovery outside of the QAPP QC acceptance criteria of 65-130% was observed for tert-butyl alcohol (TBA) in one LCS sample at 138%. Qualification was not necessary, as the associated project sample was non-detect for TBA.

E3.3 TPH-DRO and TPH-MO by USEPA Test Method 8015B (mod)

The data validation revealed that project samples and QC parameters met the acceptance criteria.

E3.4 Title 22 Metals by USEPA Test Method 6010B/7471A and Total Iron by USEPA Test Method 6010B

The recoveries for antimony in matrix spike/matrix spike duplicate (MS/MSD) sample pair C16487-1MS/MSD were below the 80-120% acceptance range at 51/51% and the MS recoveries for barium and silver were below the acceptance ranges at 76% and 78%, respectively. Associated samples were reported as non-detect for antimony and silver, therefore the results for these analytes in samples 11235G258001F, 11235G258002F, 1123SG258008F and 1123SG258009F were qualified as estimated (UJ). Detected results for barium in samples 11235G258001F, 11235G258002F, 1123SG258008F and 1123SG258009F were qualified as estimated (J-) with a possible low bias.

The recoveries for antimony in MS/MSD sample pair C16486-1MS/MSD were below the 80-120% acceptance range at 52/48%. Associated samples were reported as non-detect for antimony, therefore the antimony results for samples 1123SG258013D, 1123SG258013F and 1123SG258015F were qualified as estimated (UJ).

The recoveries in MS/MSD sample pairs C16486-1MS/MSD and C16487-1MS/MSD were not useful for iron, as the concentration of the analyte in the parent samples exceeded the spike concentrations by a factor of greater than four. The associated sample results were accepted based on the LCS recoveries and qualification was not necessary.

The recoveries for antimony in MS/MSD sample pair C16562-1MS/MSD were below the 80-120% acceptance range at 34/33% and the MS recovery for molybdenum was below the acceptance range at 79.8%. Associated samples were reported as non-detect for antimony and molybdenum, therefore the

results for these analytes in samples 1124SG258017F and 1124SG258019F were qualified as estimated (UJ).

The recoveries for antimony in MS/MSD sample pair C16782-5 were below the 80-120% acceptance range at 35/31%. The parent sample used for the MS/MSD was not related to project samples and the results are not considered relevant. The associated sample results were accepted based on the LCS recoveries.

The recoveries for mercury in MS/MSD sample pair C16562-1 were outside of the 80-120% acceptance range at 75/124%. The RPD between the MS and MSD was above the 20% acceptance criteria at 35%. Therefore the results for mercury in associated samples 1224SG258017F and 1124SG258019F were qualified as estimated, (J) and (UJ) respectively.

Serial dilution sample MP-3597SD1 had a %D for molybdenum above the 0-10%D control limit at 15.2%. Associated non-detect results for molybdenum for samples 11235G258001F, 11235G258002F and 1123SG258008F were qualified as estimated (UJ).

E3.5 Chemical Oxygen Demand by SM19 5220C (mod)

The recoveries for COD in MS/MSD sample pair F83261-4MS/MSD were below the 80-120% acceptance range at 35/35%. The parent sample used for the MS/MSD was not related to project samples and the results are not considered relevant. The associated sample results were accepted based on the LCS recoveries, and qualification was not necessary.

The MS recovery for COD in MS/MSD sample pair C16562-1MS/MSD was above the 80-120% acceptance range at 186%. Therefore the COD results for associated samples 1124SG258017F and 1124SG258019F were qualified as estimated (J+) with a possible high bias.

E3.6 Total Organic Carbon by USEPA Test Method 9060A (mod)

The data validation revealed that project samples and QC parameters met the acceptance criteria.

E4.0 DATA QUALITY

This section presents a discussion of the precision, accuracy, representativeness, and completeness of the June 2011 Fort Hunter Liggett Building 258 Site Investigation sampling event. Conclusions and recommendations regarding data use and interpretation presented in Section C5.0 have taken into consideration the data quality issues raised in this QCSR.

E4.1 Precision and Accuracy

Precision and accuracy were evaluated during data validation by review of the LCS recoveries, MS/MSDs recoveries and relative percent differences (RPDs), field duplicate and laboratory QC RPDs, surrogate compound recoveries, internal standards, initial calibration and continuing calibration verification (CCV) standards relative response factors (RRFs), relative standard deviations (RSDs) and percent differences (%Ds). In addition, the results of laboratory blanks, and trip blanks were reviewed for evidence of contamination.

As described in the previous sections, the Level III and Level IV data validation identified the following data quality issues for the June 2011 Fort Hunter Liggett Building 258 Site Investigation soil samples:

- TPH-g by USEPA Test Method 8260B: The result for TPH-g in one project sample was qualified as estimated (J-) with a possible low bias due to a surrogate recovery outside of acceptance limits.

- Title 22 Metals by USEPA Test Method 6010B/7471A and Total Iron by USEPA Test Method 6010B: Multiple metal analytes in nine project samples were qualified as estimated (UJ/J-) due to MS/MSD outliers and for the non-detect molybdenum results of three samples due to serial dilution outliers.

- Chemical Oxygen Demand by SM19 5220C (mod): The COD results of two project samples were qualified as estimated (J+) with a possible high bias due to MS/MSD outliers.

Field duplicate accuracy was evaluated by calculating the relative percent difference (RPD) between detected results in the primary sample and the associated duplicate. One sample was collected in duplicate for the June 2011 sampling event. The RPDs met the QAPP specified percent precision control limit requirements for detected results, with the exceptions noted in bold:

Primary Sample ID	Analyte	Primary Result	Duplicate Result	Units	RPD	RPD Limit
1123SG258013F	Arsenic	4.4	3.9	mg/kg	12	30
	Barium	41.5	47.3	mg/kg	13	30
	Chromium	5.5	7.9	mg/kg	**36**	30
	Cobalt	1.9	2.2	mg/kg	15	30
	Copper	3.7	4.8	mg/kg	26	30
	Iron	6020	7240	mg/kg	18	30
	Lead	10.4	3.4	mg/kg	**101**	30
	Nickel	5.3	7.4	mg/kg	**33**	30
	Vanadium	16.1	19.6	mg/kg	20	30
	Zinc	16.1	18.9	mg/kg	16	30
1123SG258013F	COD	367	570	mg/kg	**43**	30

The analysis of the field duplicate samples is a measure of both field and analytical precision. The imprecision in the results between field duplicate pairs may be due to the sample matrix, sampling or laboratory technique, or method defects. Since the effect on the quality of the data is not known, data is not qualified for field duplicate failures.

E4.2 Representativeness

Representativeness is a parameter that provides the data user with a degree of assurance that samples were collected and handled using appropriate procedures, and therefore were representative of site conditions. Based on the review of the chain of custody information, it appears that the correct sample handling and preservation procedures were followed.

E4.3 Analytical Completeness

Analytical completeness is defined as the ratio of the number of acceptable analytical results obtained to the total number of analytical results reported. An analytical result is a reported value for an analyte expressed either as a detected concentration or non-detected concentration at the reporting limit. The QC parameters that are evaluated in determining the analytical completeness are: analytical holding times, initial and continuing calibrations, surrogate recoveries, LCS spike recoveries and RPDs, and laboratory duplicate RPDs. The completeness requirement for the project is 90 percent. An analytical result is considered unacceptable in the completeness evaluation if either of the following apply:

- The analytical results in a sample for which the holding time criterion was not met are unacceptable in the analytical completeness calculation. These analytical results receive UJ qualifiers in the data validation.

- The analytical results in a sample that were qualified as rejected are unacceptable in the analytical completeness calculation. These analytical results receive R-qualifiers in the data validation.

The calculated analytical completeness results for the June 2011 Fort Hunter Liggett Building 258 Site Investigation sampling event was 100%

E5.0 CONCLUSIONS AND RECOMMENDATIONS FOR CORRECTIVE ACTION

E5.1 Conclusions

The Level III and IV data validation findings indicate that the laboratory performance and overall data quality met the analytical data quality objectives for the project. A review of the data precision, accuracy, representativeness, and completeness of the reported results showed that the overall data quality was high, and sample results, as qualified are considered suitable for supporting project decisions.

E5.2 Recommendations for Corrective Action

This section presents recommended corrective actions for the laboratory to address specific data quality issues identified in this QCSR. Non-detect results for TBA by USEPA Test Method 8260B, Metals by USEPA Test Method 6010B and 7471A, TPH-d by USEPA Test Method 8015B (mod) and COD by SM19 5220C (mod) were reported at RLs that do not support the PQLs specified in the QAPP. It is recommended for future sampling events, that the laboratory reporting limits meet the PQLs specified in the QAPP.

APPENDIX E

TABLES

Table E1. Sample Cross Reference Table
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

AMEC Sample Number	Sample Location	Depth	Matrix	Sample Type	Laboratory Sample Number	Date Sampled	Analysis Performed	Validation Level
1123SG258007F	258-SB-002	54	Soil	Primary	C16440-1	6/8/2011	TPH-g, BTEX + MTBE & TBA	III
1123SG258001F	258-SB-003	39	Soil	Primary	C16441-1	6/7/2011	TPH-g, BTEX + MTBE & TBA, COD, TOC, Total Iron, Title 22 Metals	III
1123SG258002F	258-SB-003	46	Soil	Primary	C16441-2	6/7/2011	COD, TOC, Total Iron, Title 22 Metals	III
1123SG258005F	258-SB-003	76	Soil	Primary	C16441-3	6/8/2011	TPH-g	III
1123SG258006F	258-SB-003	88	Soil	Primary	C16441-4	6/8/2011	TPH-g	III
1123SG258013F	258-SB-004	37	Soil	Primary	C16486-1	6/10/2011	COD, TOC, Total Iron, Title 22 Metals	III
1123SG258013D	258-SB-004	37	Soil	Field Duplicate	C16486-2	6/10/2011	COD, TOC, Total Iron, Title 22 Metals	III
1123SG258015F	258-SB-004	54	Soil	Primary	C16486-3	6/10/2011	TPH-g, BTEX + MTBE & TBA, COD, TOC, Total Iron, Title 22 Metals	III
1123SG258008F	258-SB-001	46	Soil	Primary	C16487-1	6/9/2011	TPH-g, BTEX + MTBE & TBA, COD, TOC, Total Iron, Title 22 Metals	III
1123SG258009F	258-SB-001	64	Soil	Primary	C16487-2	6/9/2011	COD, TOC, Total Iron, Title 22 Metals	III
1123SG258012F	258-SB-001	78	Soil	Primary	C16487-3	6/9/2011	TPH-g, TPH-d, TPH-mo	III
1124SG258017F	258-MW-2D	27	Soil	Primary	C16562-1	6/15/2011	TPH-g, BTEX + MTBE & TBA, COD, TOC, Total Iron, Title 22 Metals	IV
1124SG258019F	258-MW-2D	41	Soil	Primary	C16562-2	6/15/2011	TPH-g, BTEX + MTBE & TBA, COD, TOC, Total Iron, Title 22 Metals	IV
1125SG258021F	258-SB-005	41	Soil	Primary	C16666-1	6/21/2011	TPH-g, BTEX + MTBE & TBA	III
1126SG258023F	258-MW-4D	-	Soil	Primary	C16776-1	6/29/2011	TPH-g, BTEX + MTBE & TBA, COD, TOC, Total Iron, Title 22 Metals	III

Table E1. Sample Cross Reference Table
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

Notes:

TPH-g	Total Petroleum Hydrocarbons (Gasoline) by EPA Method 8260B
BTEX + MTBE & TBA	Benzene, Toluene, Ethylbenzene, and Xylenes plus Methyl tert-butyl ether and tert-Butyl Alcohol by EPA Method 8260B
COD	Chemical Oxygen Demand by SM19 5220C (Mod)
TOC	Total Organic Carbon by EPA method 9060A (mod)
Total Iron	Total Iron by EPA Method 6010B
Title 22 Metals	Metals by EPA Method 6010B/7471A
TPH-d	Total Petroleum Hydrocarbons (Diesel) by EPA Method 8015B (mod)
TPH-mo	Total Petroleum Hydrocarbons (Motor Oil) by EPA Method 8015B (mod)

Table E2. Summary of Applied Data Qualifiers
Building 258 Soil Boring
June 2011
Fort Hunter Liggett, California

Sample Number	Lab Sample ID	Test Method	Analyte	Result	Units	Validation Qualifier	Reason
11235G258001F	C16441-1	6010B	Antimony	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
11235G258001F	C16441-1	6010B	Barium	23.8	mg/kg	J-	MS/MSD recovery outlier.
11235G258001F	C16441-1	6010B	Molybdenum	ND(2)	mg/kg	UJ	Serial dilution outlier.
11235G258001F	C16441-1	6010B	Silver	ND(0.98)	mg/kg	UJ	MS/MSD recovery outlier.
11235G258002F	C16441-2	6010B	Antimony	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
11235G258002F	C16441-2	6010B	Barium	113	mg/kg	J-	MS/MSD recovery outlier.
11235G258002F	C16441-2	6010B	Molybdenum	ND(2)	mg/kg	UJ	Serial dilution outlier.
11235G258002F	C16441-2	6010B	Silver	ND(0.99)	mg/kg	UJ	MS/MSD recovery outlier.
11235G258005F	C16441-3	8260B	TPH-g	133	ug/kg	J-	Surrogate recovery outlier.
1123SG258013D	C16486-1	6010B	Antimony	ND(1.9)	mg/kg	UJ	MS/MSD recovery outlier.
1123SG258013F	C16486-2	6010B	Antimony	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
1123SG258015F	C16486-3	6010B	Antimony	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
1123SG258008F	C16487-1	6010B	Antimony	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
1123SG258008F	C16487-1	6010B	Barium	90.8	mg/kg	J-	MS/MSD recovery outlier.
1123SG258008F	C16487-1	6010B	Molybdenum	ND(2)	mg/kg	UJ	Serial dilution outlier.
1123SG258008F	C16487-1	6010B	Silver	ND(0.98)	mg/kg	UJ	MS/MSD recovery outlier.
1123SG258009F	C16487-2	6010B	Antimony	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
1123SG258009F	C16487-2	6010B	Barium	160	mg/kg	J-	MS/MSD recovery outlier.
1123SG258009F	C16487-2	6010B	Silver	ND(0.98)	mg/kg	UJ	MS/MSD recovery outlier.
1124SG258017F	C16562-1	6010B	Antimony	ND(1.9)	mg/kg	UJ	MS/MSD recovery outlier.
1124SG258017F	C16562-1	6010B	Molybdenum	ND(1.9)	mg/kg	UJ	MS/MSD recovery outlier.
1124SG258017F	C16562-1	7471A	Mercury	0.096	mg/kg	J	MS/MSD recovery outlier.
1124SG258017F	C16562-1	SM19 522C M	COD	628	mg/kg	J+	MS/MSD recovery outlier.
1124SG258019F	C16562-2	6010B	Antimony	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
1124SG258019F	C16562-2	6010B	Molybdenum	ND(2)	mg/kg	UJ	MS/MSD recovery outlier.
1124SG258019F	C16562-2	7471A	Mercury	ND(0.037)	mg/kg	UJ	MS/MSD recovery outlier.
1124SG258019F	C16562-2	SM19 522C M	COD	1280	mg/kg	J+	MS/MSD recovery outlier.

MAPS AND FIGURES

MONTEREY COUNTY ZONING ORDINANCE - TITLE 21

Chapter 21.08

ESTABLISHMENT AND

DESIGNATION OF ZONING DISTRICTS

Sections:

21.08.010	Designation of Districts.
21.08.020	Combining Regulations.
21.08.030	Establishment of Districts.
21.08.080	Effect of Establishment of Districts.
21.08.050	Index to Sectional District Maps.
21.08.060	Sectional District Maps.

21.08.010 DESIGNATION OF DISTRICTS.

The districts established and into which the County is divided are designated as follows and shall not be used as combining districts.

Designation	*District Name*
HDR	High Density Residential
MDR	Medium Density Residential
LDR	Low Density Residential
RDR	Rural Density Residential
LC	Light Commercial
HC	Heavy Commercial
VO	Visitor Serving/Office
AI	Agricultural Industrial
LI	Light Industrial
HI	Heavy Industrial
F	Farmlands
RG	Rural Grazing
PG	Permanent Grazing
RC	Resource Conservation
PQP	Public/Quasi-P

B

21.08.020 COMBINING REGULATIONS.

In addition to the districts mentioned in Section 21.06.010, certain combining districts are established and are designated as follows:

Designation	*District Name*
B	Building Site District
D	Design Control District
S	Site Plan Review District
VS	Visual Sensitivity District
A	Limited Agricultural District
UR	Urban Reserve District
RAZ	Residential Allocation District
HR	Historical Resources District
Z	Street Improvements District
RES	Regulations for Parking and Use of Major Recreational Equipment Storage in Seaward Zone

21.08.030 ESTABLISHMENT OF DISTRICTS.

A. The designations, locations, and boundaries of districts are set forth on the Sectional District Maps showing the Zoning Plan.

B. The districts and certain combinations are established as the designation. The locations, and boundaries thereof are set forth and indicated on Sectional District Maps. Section 20.06.050 is the Index to the Sectional District Maps, each of which is designated by the number 21, followed by a dash and numeral. Each Sectional District Map shows the designations, locations, and

boundaries of certain of districts. The maps and all notations, references, data, and other information shown on the maps are a part of this Title.

C. Where uncertainty exists as to the boundaries of any of the aforesaid districts as shown on a Sectional District Map or Maps, the Planning Commission, upon written application or upon its own motion, shall determine the location of such boundaries.

21.08.040 EFFECT OF ESTABLISHMENT OF DISTRICTS.

A. Except as otherwise provided in this Title:

1. No structure shall be erected and no existing structure shall be moved, altered, added to or enlarged, nor shall any land, structure, or premises be used, designated or intended to be used for any purpose, or in any manner other than is included among the uses hereinafter listed as permitted in the district in which such structure, land, or premises is located;

2. No structure shall be erected, reconstructed or structurally altered to exceed in height the limit herein after designated for the districts in which such structure is located;

3. No structure shall be erected, altered, enlarged, or rebuilt, except in conformity to the setback, building site area and structure location regulations hereinafter designated for the district in which such structure is located;

4. No setback or other space provided about any structure for the purpose of complying with provisions of this Title shall be considered as providing a setback for a structure on any other building site;

5. No use shall be established, expanded, altered, changed or otherwise modified except as provided for in the terms of this Title.

B. No governmental unit whether City, County, District, State or Federal shall be exempt from the provisions of this Title.

21.08.050 INDEX TO SECTIONAL DISTRICT MAPS.

This Section consists of an Index Map to Sectional District Maps which show the Zoning Plan, being parts of this Title under the provisions of Section 21.08.030 and shall constitute Section 21.08.050 of this Title.

21.08.060 SECTIONAL DISTRICT MAPS.

This Section shall consist of a series

of Sectional District Maps which show the Zoning Plan, being parts of this Title under the provisions of Section 21.08.030, and are for example designated Sections 21-10, 21-2, etc.

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Monterey County, California

AsA—Arroyo Seco gravelly sandy loam, 0 to 2 percent slopes

Map Unit Setting

Elevation: 100 to 3,000 feet
Mean annual precipitation: 12 to 30 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 210 to 260 days

Map Unit Composition

Arroyo seco and similar soils: 85 percent
Minor components: 15 percent

Description of Arroyo Seco

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy and gravelly alluvium derived from igneous rock

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability (nonirrigated): 4s

Typical profile

0 to 42 inches: Gravelly sandy loam
42 to 60 inches: Very gravelly coarse sandy loam

Minor Components

Danville

Percent of map unit: 3 percent

Gorgonio

Percent of map unit: 3 percent

Chualar

Percent of map unit: 3 percent

Hanford
Percent of map unit: 2 percent

Tujunga
Percent of map unit: 2 percent

Mocho
Percent of map unit: 2 percent

Data Source Information

Soil Survey Area: Monterey County, California
Survey Area Data: Version 9, Apr 14, 2009

Soil Map—Monterey County, California
(Soils of Preferred Alternative1)

Map Scale: 1:4,170 if printed on A size (8.5" x 11") sheet.

N

Meters
0 40 80 160 240

Feet
0 150 300 600 900

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Gully

Short Steep Slope

Other

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

MAP INFORMATION

Map Scale: 1:4,170 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Monterey County, California
Survey Area Data: Version 9, Apr 14, 2009

Date(s) aerial images were photographed: 6/28/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Monterey County, California (CA053)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AsA	Arroyo Seco gravelly sandy loam, 0 to 2 percent slopes	36.4	90.3%
AsB	Arroyo Seco gravelly sandy loam, 2 to 5 percent slopes	3.9	9.7%
Totals for Area of Interest		**40.3**	**100.0%**

CH2MHILL TELEPHONE CONVERSATION RECORD

Call To: California Coastal Commission Central Coast District Office

Phone No.: **(831) 427-4863** **Date:** April 4, 2012

Call From: Grant Koster **Time:** 13:32 p.m. (EST)

Message Taken By: Grant Koster

Subject: California Coastal Management Zone Maps/Boundary for Orange County, California, specifically Fort Hunter Liggett, California

Project No.: **426649**

Katie Butler, a Coastal Planner in the Central Coast District Office of the California Coastal Commission said that the coastal management zone (CMZ) boundary is seaward of Fort Hunter Liggett (FHL). It was indicated that the boundary of the CMZ ends at the top of the mountain ridge located west of FHL.

http://www.co.monterey.ca.us/building/zoning1.asp

File Edit View Favorites Tools Help

Monterey County
Resource Management Agency

Monterey County Planning and Building, PO Box 1208 Salinas California 93902 (831)755-5025 for Salinas and (831)883-7500 for Marina

rtment

., 2nd Floor, Salinas, CA 93901
Marina, CA 93933
(831) 755-5025 Salinas Office, (831) 883-7500 Marina Office

Zoning Look-Up for Parcels in the Unincorporated Area of Monterey County

(enter an Assessor's Parcel Number in the form below and click submit to retrieve the zoning for the parcel.)

Back to Building Home

Frequently Asked Questions

- Where can I find my Assessor's Parcel Number (APN)?
- What does the zoning designation mean?
- Why is there no location shown for the parcel?
- What should I do if my parcel is not found?

Important Note Regarding Zoning:
The zoning designation of a property is only one of many factors that can influence the development potential of a property. **It is important that you contact Planning & Building staff before you make a significant investment in your proposed project.** If you have a project in mind you can start the development process using the online questionnaire.

Enter 12 digit APN: 000-000-000-000

Submit Query | Reset

Assessor Parcel Number	Zoning	Location
201-021-004-000	PQP &PQP-HR	

3:17 PM
3/14/2012

SPECIAL REPORT 201

RADON POTENTIAL IN MONTEREY COUNTY

2007

CALIFORNIA GEOLOGICAL SURVEY
Department of Conservation

STATE OF CALIFORNIA
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GOVERNOR

THE RESOURCES AGENCY
MIKE CHRISMAN
SECRETARY FOR RESOURCES

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SPECIAL REPORT 201

RADON POTENTIAL IN MONTEREY COUNTY

By

Ronald K. Churchill

2007

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EXECUTIVE SUMMARY

During winter 2006, the Department of Health Services-Radon Program conducted an indoor-radon survey of 1,059 residences in Monterey County using short-term charcoal detectors. In Zip Code area 93924 (Carmel Valley), 24.5 percent of the residences had radon levels at or above 4 picocuries per liter, the U.S. EPA recommended action level. In two other Zip Code areas, 93905 (Salinas) and 93923 (Carmel), 9.5 and 5.3 percent of the residences measured at or above 4 picocuries per liter respectively. Based on survey results, not weighted for location, an estimated 15,668* individuals out of 401,754 (3.9 percent) live in residences with radon levels at or above 4 picocuries per liter in Monterey County

Through a cooperative agreement with the Department of Health Services Radon Program, the California Geological Survey compared the radon survey data with available geology, soil and uranium geochemical information for Monterey County. Portions of Monterey County having either high, moderate or low potential for residences with radon levels at or above 4 picocuries per liter were identified during this activity. These radon potential ―zones" are shown on the 1:100,000-scale (1 inch = 1.58 miles) maps of western and eastern Monterey County included as Plate 1 and Plate 2 of this report.

High radon potential zone areas relate to a group of Monterey Formation geologic units and adjacent related alluvial units covering 10.9 percent of the county (361 square miles total). Survey results suggest 25.0 percent of residences in the high potential zone have radon levels at or above 4 picocuries per liter. An estimated 2,828 individuals live in residences in this zone with radon levels at or above 4 picocuries per liter, 549 of which may live in residences with radon levels exceeding 20 pCi/l. Moderate radon potential areas are related to certain portions of Monterey Formation geologic units, middle Pleistocene fluvial terrace deposits, and the Paso Robles Formation and cover approximately 20.2 percent of the county (671 square miles total). Survey results suggest 6.0 percent of residences in the moderate potential zone have radon levels at or above 4 picocuries per liter. An estimated 3,950 individuals live in residences with radon levels at or above 4 picocuries per liter within moderate zone areas. Low radon potential areas cover about 68.9 percent of the county (2,290 square miles total) and are comprised of a number of different geologic units. Survey results suggest 1.2 percent of residences in the low potential zone have radon levels at or above 4 picocuries per liter. An estimated 3,895 individuals live in residences with radon levels at or above 4 picocuries per liter within low zone areas. Using the radon potential zone population estimates, 10,683 individuals out of 401,754 (2.66 percent) are estimated to live in residences with indoor radon levels at or above 4 picocuries per liter in Monterey County.

*All population figures are based on 2000 census data.

The only way to identify buildings with indoor radon levels exceeding 4 picocuries per liter is through testing. The map of radon potential zones for Monterey County in this report can be used as a guide to prioritize areas for public education on radon and for targeting additional indoor radon testing activities. This report includes the data and information utilized and describes the approach taken to develop the radon potential zone map for Monterey County. It also identifies radon data gaps for Monterey County that could be addressed in the future if resources become available.

INTRODUCTION

Purpose

This report documents the procedures used by the California Department of Conservation, California Geological Survey (CGS), to produce the 2007 radon potential map of Monterey County for the California Department of Public Health (CDPH). This report also describes radon potentials for geologic formations in Monterey County. Only minimal background information on radon and radon health issues is included, and radon testing and remediation practices are not discussed. The following websites contain information about radon and health issues, testing and remediation:
http://www.cdph.ca.gov/healthinfo/environhealth/Pages/Radon.aspx and
http://www.epa.gov/iaq/radon/pubs.

Background Information on Radon and Health

Radon gas is a naturally occurring radioactive gas that is odorless and colorless. It forms from the radioactive decay of small amounts of uranium and thorium naturally present in rocks and soils. Typical concentrations of uranium and thorium for many rocks and soils are on the order of a few parts-per-million (ppm). The average uranium content for the earth's continental crust is about 2.5-2.8 ppm. Certain rock types, such as organic-rich shales, some granitic rocks, and rhyolites may have uranium and thorium present at levels of tens to hundreds of ppm. While all buildings have some potential for elevated indoor-radon levels, buildings located on rocks and associated soils containing higher concentrations of uranium will have an increased likelihood of elevated indoor radon levels.

Radon gas readily moves through rock and soil along micro-fractures and through pore-spaces between mineral grains. Radon movement away from its site of origin is typically limited to a few meters to tens of meters because of the relatively short half-lives of radon isotopes (3.8 days for radon-222, 55.6 seconds for radon-220 and 3.96 seconds for radon-210), but movement may be hundreds of meters in some cases. Additional conditions, such as soil moisture content, also affect how far radon can move in the subsurface. Because radon-222 (a radioactive-decay product uranium-238) has the longest half-life of the several radon isotopes, it is usually the predominant radon isotope in indoor air.

Radon gas moves from the soil into buildings in various ways. It can move through cracks in slabs or basement walls, pores and cracks in concrete blocks, through-going floor-to-wall joints, and openings around pipes. Radon enters buildings from the soil when air pressure inside the buildings is lower than air pressure in the soil. When exhaust fans are used, inside air is heated, or wind is blowing across a building, the building's internal air pressure is lowered. Because radon enters buildings from the adjacent soil, radon levels are typically

highest in basements and ground floor rooms. Radon can also enter a building in water from private wells. All ground water contains some dissolved radon gas. The travel time of water from an aquifer to a home in a private well is usually too short for much radon decay so radon is available to be released in the house during water usage, for example through use of a bathroom shower. However, radon gas from water typically accounts for only about 5 percent of the total radon in indoor air (WRRTC, 1997).

Breathing air with an elevated level of radon gas results in an increased risk of developing lung cancer. Not everyone exposed to radon will develop lung cancer. However, the estimated annual number of lung cancer deaths in the United States attributable to radon is 15,000 to 22,000 according to the U.S. Environmental Protection Agency (U.S. EPA) (U.S. EPA, 2002). The average radon concentration for indoor air in American homes is about 1.3 pCi/l, (picocuries per liter) based on a 1991 national survey (U.S. EPA, 1992). The average radon concentration in outdoor air is about 0.4 pCi/l. The U.S. EPA recommends that individuals avoid long-term exposures to radon concentrations ≥ 4.0 pCi/l. Based on long-term radon test statistics, the U.S. EPA estimates that more than 6 million houses (about 1 out of 15) in the United States have radon levels ≥ 4.0 pCi/l and more than 60,000 homes have radon levels above 20 pCi/l (U.S. EPA, 1992).

Although radon levels are used as a guide for acceptable levels of exposure and for action levels, it is primarily the inhalation of two radon daughter elements polonium-218 and polonium-214 that leads to lung cancer. These elements have very short half-lives and when they enter the lungs they attach to lung tissue or trapped dust particles and quickly undergo radioactive decay. This is in contrast to the longer-lived radon-222 that is mostly exhaled before it undergoes radioactive decay. The alpha particles emitted during decay of polonium-218 and polonium-214 are thought to cause cancer by damaging the DNA (deoxyribonucleic acid) in lung tissue cells, resulting in abnormal or tumorous cell growth (Brookins, 1990).

The most common radon testing methods utilize either charcoal or alpha-track type detectors. These detectors are exposed to the air in a building according to the manufacturer's instructions and then sent to a laboratory for analysis. Charcoal detectors are usually exposed for a few days under closed building conditions (a short-term test), while alpha-track detectors are typically exposed for periods of weeks or months to as long as a year under normal building conditions (a long-term test). These tests are simple and inexpensive and homeowners can do this testing themselves. Test results are reported in units of picocuries per liter (pCi/l). Longer-duration measurements (alpha-track detector measurements) have an advantage because they ~~a~~average out" short-term fluctuations in radon levels that relate to factors such as weather changes. Consequently, long-term measurements should be more representative of long-

term average radon levels. However, short-term measurements are more common because of the shorter time required.

Use and Limitations of Radon Potential Maps

Radon potential maps are maps that identify areas where geologic conditions are more likely to contribute to excessive indoor radon levels. They are intended to assist federal, state and local government agencies and private organizations in targeting their radon program activities and resources. These maps are not intended for determining which buildings have excessive indoor radon levels. In addition to geology, local variability in soil permeability and climatic conditions, and factors such as building design, construction, condition, and usage may influence indoor radon levels. Consequently, radon levels for a specific building can only be determined by indoor radon testing of that building, regardless of what radon zone it is located within.

DEVELOPMENT OF THE MONTEREY COUNTY RADON POTENTIAL MAP

Radon Mapping Overview

The CGS-CDPH Radon Program radon potential maps show areas, called radon potential zones, where residences have relatively high, moderate or low probability for indoor-air with ≥ 4.0 pCi/l radon levels. Since 2005 (Churchill, 2005 and 2006), radon zones for these maps have been broadly defined on the basis of short-term indoor radon tests as follows:

High Zone—20 percent or more ≥ 4.0 pCi/l indoor-measurements
Moderate Zone—5 to 19.9 percent ≥ 4.0 pCi/l indoor-measurements
Low Zone—less than 5 percent ≥ 4.0 pCi/l indoor-measurements

These definitions make it easier to compare the radon zones between counties. For example, the highest zones in Counties A, B and C might have 25 percent, 35 percent and 8 percent ≥ 4.0 pCi/l indoor-measurements respectively. Using the above definitions, the highest zones in Counties A and B would be classified as having high radon potential while the highest zone in County C would have moderate radon potential. In the previous approach, qualitative ranking of zones on a county by county basis, sometimes resulted in situations where zone classification in one county would have dramatically different ≥ 4.0 pCi/l percentage than the same zone classification in an another county. For the example cited here, this alternative approach would have classified the highest zone for County C in the high radon potential category as for Counties A and B, even though the County C high zone has a much lower percentage of ≥ 4.0 pCi/l indoor-measurements.

Development of radon zones involves the following steps and considerations:

1) Indoor-radon data are grouped by geologic unit, or geologic unit and soil unit (where appropriate digital soil maps are available)

2) The different geologic unit or geologic unit-soil unit areas are classified as having high, moderate or low indoor-radon potential based on their percentage of ≥ 4.0 pCi/l measurements. Units with 20% or more indoor measurements ≥ 4.0 pCi/l are classified "high" potential, units with 5 to 19.9% ≥ 4.0 pCi/l measurements are classified "moderate" potential, and units with < 5% ≥ 4.0 pCi/l measurements or no measurements are classified low potential unless other information is available supporting a higher classification status (see item 3).

3) Indoor-radon measurements from about 25 to 30 different sites, distributed over the areal extent of a unit, are considered necessary for a reliable assessment of the unit's radon potential. A provisional "Moderate" or "High" radon potential may be assigned some units having less than 25 measurements (if many or all of the available indoor measurements exceed ≥ 4.0 pCi/l, if several measurements exceed 10 or 20 pCi/l, if the same unit elsewhere in California is known to have moderate or high radon potential, or if other data such as airborne or ground gamma-ray spectrometry or uranium data from soil or sediment samples suggest elevated indoor-radon potential for the unit).

4) The final high-potential and moderate-potential radon zone areas are the aggregate of high potential unit occurrences and moderate potential unit occurrences respectively, each with an added 0.2 mile wide buffer zone. If high and moderate potential buffer zones overlap, the high potential buffer zone takes precedence. Where sufficient indoor-radon data and soil unit data are present, these data may support modification of the final high and moderate zone boundaries by restricting high or moderate zone boundaries to certain soil unit boundaries or using geologic unit boundaries, without a 0.2 mile wide buffer zone, as the high or moderate zone boundaries. All areas not classified as high or moderate radon potential are considered low radon potential.

5) Finally, indoor-radon data populations for the high, moderate and low potential zones are statistically compared using a difference of mean t-test or a Mann-Whitney Rank Sum test, as appropriate, to confirm that the zones are statistically different in radon potential. If the zones differ statistically, the radon potential zone development process is complete and the final potential zone areas are plotted on a 1:100,000-scale base map. If zones do not differ statistically, classification boundary adjustments may be made, or a radon potential zone category may be

added or dropped so that the radon potential zones indicated on the final map are statistically different.

Faults and shear zones are not indicated on 1:100,000-scale radon potential maps. Portions of radon zone areas underlain by faults and shear zones may have increased potential for elevated indoor-radon because such features provide pathways for radon flow. However, faults and shear zones are not identified separately on the 1:100,000-scale radon potential maps because the minimum fault or shear zone width that can be depicted by a map line at this scale is about 150-200 feet while fractures of an inch width or less can be significant pathways for radon movement to a buildings foundation. Soil and alluvium may obscure fault and shear zones from recognition or prevent their precise location on geologic maps except where detailed site-specific investigations have been conducted. Consequently, at 1:100,000-scale mapping, it is better to base priority for indoor testing on zone designation rather than attempt to target fault and shear zone locations. It must be kept in mind that the only way to determine the radon concentration it a particular building is to do an indoor radon test, irrespective of geologic or soil information. All radon zone categories will have some buildings with indoor radon levels ≥ 4 pCi/l. Where situations require a local detailed investigation of indoor radon and fault or shear zone relationships, accurate fault or shear zone maps of 1:24,000 or more detailed scale should be used or developed to guide testing.

MONTEREY COUNTY SHORT-TERM INDOOR-RADON SURVEY RESULTS

Overview

A survey of 1,059 Monterey County homes conducted by the California Department of Public Health--Radon Program between January 10 and May 12, 2006 generated the indoor-radon data for this project. The CDPH Radon Program solicited participation in this survey via direct mailing to 34,958 homeowners in Monterey County. Three percent of homeowners (1,059) agreed to participate. The survey participants received a free charcoal detector, which they placed and exposed according to instructions, and subsequently mailed to the Radon Program contract lab for measurement.

Figure 1 shows the distribution of CDPH radon survey locations in Monterey County. Forty-one locations had results that equaled or exceeded 4.0 pCi/l and these are shown in *Figure 2.* The data range from 0.2 pCi/l (the detection limit) to 25.1 pCi/l. *Table 1* summarizes survey results by Zip Code Zone.

Radon Survey Data Exposure Information and Quality

Most residents (81.5%) exposed their detector kits for 48 hours (Appendix A). Eighty-nine duplicate tests were made during the survey and the results are listed in Appendix B. For 20 sites below 1 pCi/l, 78.4 % of the test pairs differ by 0.3 pCi/l or less with an overall range of 0.0 to 0.8 pCi/l. For 51 sites with measurements between 1 and 10 pCi/l, 50% of test pairs differ by 0.6 pCi/l or less with an overall range of 0.1 to 1.2 pCi/l. For the one site above 10 pCi/l the test pair results were 25.1 pCi/l and 8.3 pCi/l. The placement of these two detectors with respect to each other at this site is not known and may be a factor here. A single charcoal detector previously placed at this site tested 16.5 pCi/l.

Follow-up Testing

Twenty-five radon survey sites had follow-up indoor radon tests (Appendix C). The period between the initial site test and follow-up testing ranged from 3 days to 57 days. Eighty-four percent of retested sites did not change in status from the initial test with regard to being ≥ 4 pCi/l or < 4 pCi/l. Of 12 sites initially testing > 4 pCi/l, 8 retested ≥ 4 pCi/l and 4 sites retested < 4 pCi/l. One site initially testing 22.1 pCi/l retested 19.2 pCi/l 49 days later.

Two sites initially testing of 44.9 and 28.4 pCi/l were retested with 4 detectors 39 days later and 2 detectors 29 days later respectively. The 6 follow-up detectors ranged from 0.2 (detection limit) to 0.8 pCi/l. These two sites are located within the Qe geologic unit (Eolian deposits, i.e., coastal dunes) on BbC (Baywood) soil. As is reported in Table 3 below, 142 additional sites on this geologic unit and soil were tested during the Monterey County indoor-radon survey and all results were less than 2.5 pCi/l. Three of the 142 sites are within 200 and 400 feet of these

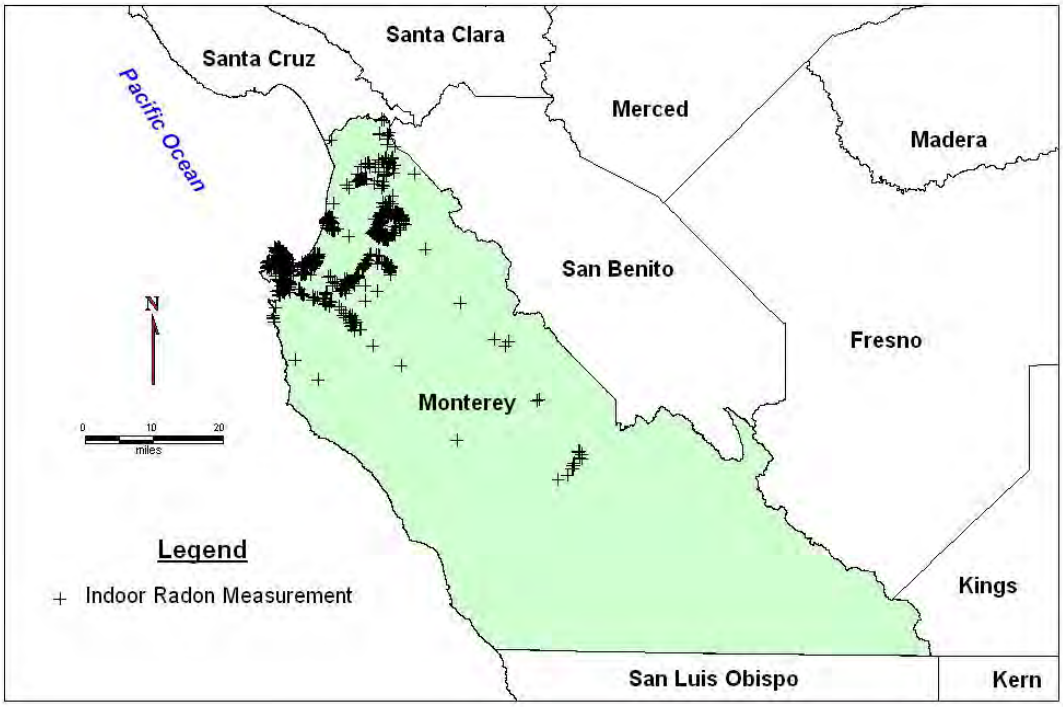

Figure 1. CDPH Short-Term Radon Tests for Monterey County

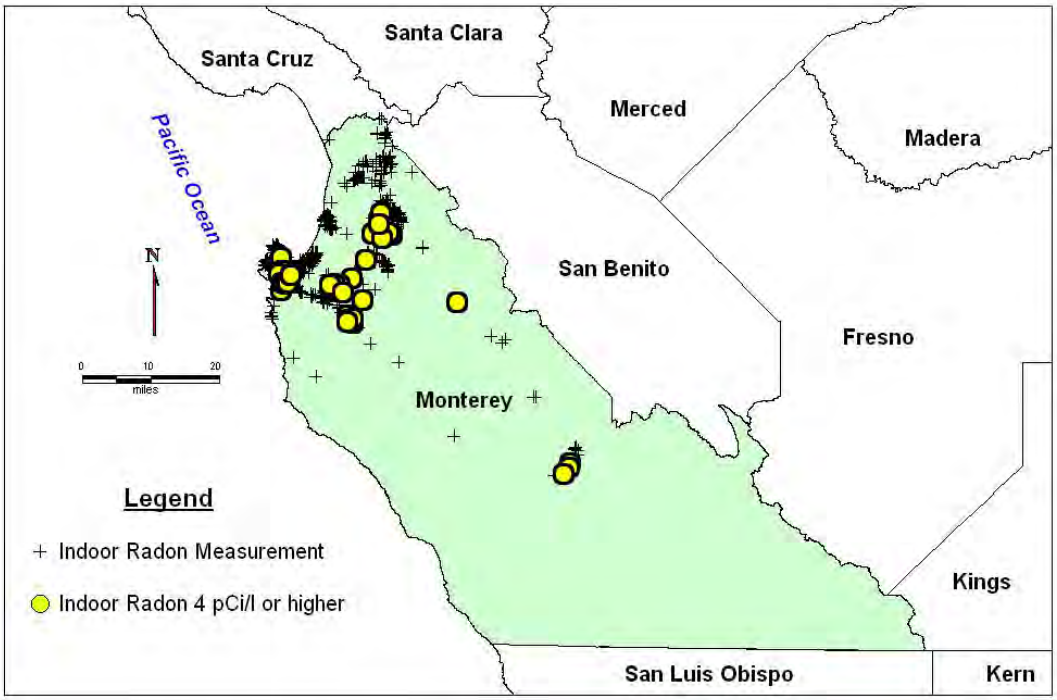

Figure 2. CDPH Short-Term Radon Test Results—4.0 pCi/l or Greater

Zip Code	City/Region	Number of Measurements	Measurements ≥ 4.0 pCi/l	Percent ≥ 4.0 pCi/l
93426	Bradley	0*	--	--
93451	San Miguel	0*	--	--
93901	Salinas	91	4	4.4
93902	Salinas	0*	--	--
93905	Salinas	21	2	9.5
93906	Salinas	85	2	2.4
93907	Salinas	80	1	1.3
93908	Salinas	98	3	3.1
93920	Big Sur	0*		
93921	Carmel	1	0	0
93922	Carmel	0*		
93923	Carmel	100	5	5.3
93924	Carmel Valley	53	13	24.5
93925	Chualar	0*	--	--
93926	Gonzales	1	1	100
93927	Greenfield	3	0	0
93930	King City	15	3	20
93932	Lockwood	0*	--	--
93933	Marina	55	0	0
93940	Monterey	178	6	3.4
93950	Pacific Grove	138	0	0
93953	Pebble Beach	56	1	1.8
93955	Seaside	62	0	0
93960	Solidad	3	0	0
93962	Spreckels or Salinas	0*	--	--
95004	Aromas	14	0	0
95012	Castroville	4	0	0
95039	Moss Landing	1	0	0
95076**	Watsonville**	0*	--	--
	total	*1,059*	*41*	*3.9*

*No respondents to CDPH Indoor-Radon testing solicitation.
**Portion of Zip Code area in Monterey County

Table 1. CDPH Indoor-radon Short-term Test Results for Monterey County by Zip Code Zone.

two sites and tested 0.2, 0.4, and 0.6 pCi/l. On the basis of site retest results and results from the 142 sites with the same geologic and soil units present, the initial test results at these two sites were considered in error and were replaced with the retest results in the Monterey County survey database.

The two other sites with ≥ 4 pCi/l initial tests and < 4 pCi/l follow-up tests had test results of 5.2 and 3.6 (17 days apart) and 5.0 and 3.3 (36 days apart).

Of 13 sites testing < 4 pCi/l, all retested < 4 pCi/l (i.e., no sites initially testing < 4 pCi/l retested > 4 pCi/l). Retesting at these sites occurred between 3 and 35 days after initial testing.

Monterey County Geologic/Soil Unit Radon Potentials

Indoor-radon data from the CDPH Radon Program 2006 survey of Monterey County residences are tabulated by geologic unit in Appendix D, and by geologic unit and soil unit in Appendix E. The 1:100,000-scale digital geologic map by Rosenberg (2001) was used to determine the geologic unit present at radon measurement locations. The NRCS digital soil map for Monterey County (NRCS, 2007) was used to determine soil type at each measurement location and is available for downloading at:
http://soildatamart.nrcs.usda.gov/Survey.aspx?County=CA053date

Table 2 lists six geologic units, with their associated soil types, likely to have high and moderate radon potential based in indoor-radon measurement results. The status of four of these units is provisional (indicated by ―High?" or ―Moderate?")—less certain because they have few associated indoor-radon measurements. Other data (airborne radiometric data, uranium data from soil samples and sediment samples, and soil property data) were reviewed to see if they supported either high or moderate designations for the provisional units in Table 2, and to identify additional geologic units that may have elevated radon potential but lack indoor-radon measurements. Following sections of this report discuss these data and their ramifications. Table 3 lists combinations of geologic and soil units having 25 or more indoor radon measurements and few or no measurements ≥ 4.0 pCi/l (i.e., units with sufficient radon measurement data to statistically support their low radon potential classification).

Geologic Unit (From Rosenberg, 2001)	**Soil Type (from NRCS)**	**Incidence Rate (R) of CDPH Indoor-Radon Measurements ≥ 4 pCi/l, in percent**	**Radon Potential Designation**
Tm-Monterey Formation (siliceous mudstone, Miocene)	**SfE, SfF, Sg (Santa Lucia)**	**R=21.1%,** N=38 N ≥4.0 = 8 Maximum = 25.1 pCi/l	**High** R ≥ 20%
Tmdi-Monterey Formation (diatomite, Miocene)	**SfE, SfF, Sg (Santa Lucia)**	**R uncertain (*too few data*),** N=4 N ≥4.0 = 3 Maximum = 22.1 pCi/l	**High?** Max=22.1 pCi/l Apparent R > 20% Unit similar to other high potential units in California
Tml-Monterey Formation (semi-siliceous mudstone, middle Miocene)	**SfE, SfF (Santa Lucia)**	**R uncertain (*too few data*),** N=6 N ≥4.0 = 1 Maximum = 8.2 pCi/l	**High or Moderate?** Apparent R > 5% Unit similar to other high and moderate potential units in California
Qt-Fluvial terrace deposits (undifferentiated, Pleistocene and Holocene)– those Qt areas adjacent to or surrounded by Monterey Fm.	**LeC (Lockwood)** and **SfE, SfF, Sg (Santa Lucia)**	**R uncertain (*too few data*),** n=9 N ≥4.0 = 3 Maximum = 11.2 pCi/l	**High?** Apparent R > 20%
Qal-Alluvial deposits (undifferentiated, Holocene)-- those Qal areas adjacent to or surrounded by Monterey Formation areas)	**RaA (Rincon)** and **SfF, Sg (Santa Lucia)**	**R= uncertain (*too few data*)** N=7 N ≥4.0 = 2 Maximum = 7.5 pCi/l	**High?** Apparent R > 20%
Qtmp-Fluvial terrace deposits (middle Pleistocene)	**AeA and AeC (Antioch) and CnA and CnC Cropley**	**R = 8%** N=36 Data ≥4.0 = 3 Maximum = 7 pCi/l	**Moderate** R ≥ 5 % and < 20%

*N=the number of CDPH indoor-radon data available from houses located on the geologic unit indicated in the first column of the table.

Table 2. High and Moderate Radon Potential Geologic and Soil Units in Monterey County Based on 2006 CDPH Short-term Indoor Radon Data

Geologic Unit (Rosenberg, 2001)	**Soil Type** (NRCS)	**Incidence Rate (R) of CDPH Indoor-Radon Measurements ≥ 4 pCi/l, in percent**	**Radon Potential Designation**
Kgdm-Porphyritic granodiorite of Monterey	**NcC (Narlon)**	**R=2.4%** N=41 N ≥4.0 = 1 Maximum = 8.1 pCi/l	**Low** R < 5 %
Qa-Aromas Sand, undifferentiated (Pleistocene)	**AkD, AkF (Arnold)**	**R=0%** N=64 Maximum = 2.6 pCi/l	**Low** R < 5 %
Qct-Coastal terraces, undifferentiated (Pleistocene)	**BbC (Baywood)** **NcC (Narlon)**	**R=0%** N=32 Maximum = 2 pCi/l **R=0%** N=115 Maximum = 2.4 pCi/l	**Low** R < 5 % **Low** R < 5 %
Qe-Eolian Deposits, undifferentiated (Pleistocene)	**BbC (Baywood)** **TaC (Tangoir)**	**R=0%** N=142 Maximum = 2.4 **R=0%** N=28 Maximum = 1.2 pCi/l	**Low** R < 5 % **Low** R < 5 %
Qfp-Flood-plain deposits, undifferentiated (Holocene)	**GkB (Gorgonio)** **SbA (Salinas)**	**R=3.1%** N=32 N ≥4.0 = 1 Maximum=5.2 pCi/l **R=4.4%** N=68 N ≥4.0 = 3 Maximum = 5.5 pCi/l	**Low** R < 5 % **Low** R < 5 %
Qfpl-Alluvial fans (late Pleistocene)	**CbA (Chualar)**	**R=2.0** N=50 N ≥4.0 = 1 Maximum = 5.2 pCi/l	**Low** R < 5 %

Table 3. Low Radon Potential Geologic and Soil Units in Monterey County Based on 2006 CDPH Short-term Indoor Radon Data (with more than 25 measurements)

NURE DATA REVIEW

Background

During the 1970s and early 1980s, the federal government funded the National Uranium Resource Evaluation Project (NURE). The goal of NURE was to identify new domestic sources (ore deposits) of uranium for energy and national defense. NURE uranium exploration activities included airborne gamma-ray spectral surveys that estimated the uranium content of soils and rocks along a grid of flight-lines, and (in some parts of California) the collection and analysis of soil and stream sediment samples for uranium. Locations with unusually high uranium levels were targets for additional work to see if economically recoverable uranium deposits were present.

Because radon is a radioactive decay product of uranium, areas with higher natural background uranium are more likely to have higher quantities of radon in the subsurface. Buildings in these areas have a greater potential for indoor-radon problems. Consequently, NURE uranium data uranium data for rock units, soils and sediments are valuable in radon mapping projects, particularly where indoor-radon measurements are sparse or lacking.

Airborne Radiometric Data

Figure 3. shows the approximately 1,387 miles of flight lines flown within Monterey County during the 1980 NURE airborne radiometric surveys and uranium anomaly locations. About 999 miles of flight lines were part of the NURE Santa Cruz 1X2 degree quadrangle survey and about 338 miles were part of the NURE San Luis Obispo 1X2 degree survey. The flight-line grid pattern consists of east-west flight- lines, 3-6 miles apart, and north-south flight-lines, 12 miles apart. Along the flight lines a specially equipped helicopter recorded approximately 57,000 gamma-ray spectral measurements. Data collection occurred at an average flight speed of 86 miles per hour and an average altitude of 336 feet. Such measurements typically represent uranium content within the upper 18 inches of surficial material over an area of approximately 48,000 square feet (High-Life Helicopters, 1981a). Gamma-ray spectral data were collected for bismuth-214, a radioactive daughter product of uranium-238 (and the immediate daughter of radon-222); the bismuth-214 data were was used to estimate of the soil-rock uranium content in parts-per-million (ppm) at each of the 57,000 measurement locations. Because the uranium values are calculated from bismuth-214 data they are referred to as equivalent uranium (eU) data to distinguish them from uranium data determined by direct chemical methods (i.e., typical laboratory determinations for rock and soil samples by delayed neutron activation or fluorescence). eU data can be impacted by soil moisture (Grasty, R.L., 1997), atmospheric inversion and other conditions, so eU data are treated in this study as a qualitative to semi-quantitative indicator of areas with increased uranium in rock or soil.

A problem with the NURE airborne radiometric survey digital files for the Santa Cruz 1X2 degree quadrangle prevented the creation of a digital data layer of flight-line uranium data for comparison, using GIS methods, with geologic units from the 1:100,000-scale map used in this radon mapping project. Consequently, the 1981 NURE report (High Life Helicopters, Inc., 1981b) for this quadrangle was reviewed for information on the uranium content of geologic formations and the locations and geologic characteristics of flight-line segments with anomalously high uranium. Information summarizing flight-line uranium data for geologic units from this 1981 report is provided in Appendix F. A list of flight-line uranium anomalies from this 1981 report for the Monterey County portion of the Santa Cruz 1X2 degree quadrangle is provided in Appendix G. Airborne radiometric data for the San Luis Obispo 1X2 degree quadrangle portion of Monterey County were suitable for creation of a digital layer for detailed comparison with the 1:100,000-scale map geologic units by GIS methods. Results of this comparison are summarized in Appendix H. Airborne equivalent uranium anomalies used in this study are defined as follows:

1) For Santa Cruz quadrangle data--*by 1X2 degree quadrangle geologic map unit (using the definition from the 1980 NURE report, High Life Helicopters, Inc., 1981b*) two consecutive averaged eU samples each being two or more standard deviations above the mean or three consecutive average eU samples, one of which is two or more standard deviations above the mean and two of which are one or more standard deviations above the mean. For example, for Monterey Formation units the anomaly thresholds would be about 6 to 10.4 ppm eU.

2) For the San Luis Obispo data (<u>from the NURE flight-line digital database</u>)—eU data equal to or exceeding 7.5 ppm (3 times the average uranium content of the earth's crust and within the range of anomaly thresholds for Monterey Formation units in the 1980 NURE report).

The frequency of airborne uranium (eU) anomaly associations for particular geologic units, shown in Appendix G and Appendix H, suggests the most likely geologic units to have areas with elevated radon potentials are:

- Tm-Monterey Formation;
- Tml-Monterey Formation, semi-siliceous mudstone;
- Other Monterey Formation units-Tmdi (diatomite),Tmc (clay shale) Tmd (Devilwater member)
- QTp-Paso Robles Formation
- Tpo-- Pancho Rico Formation, diatomaceous mudstone;
- Kqdj-Quartz diorite-granodiorite of Johnson Canyon
- Tvd-Intrusive dacitic felsite
- Tvp-Pinnacles Formation-dacitic breccia and tuff breccia

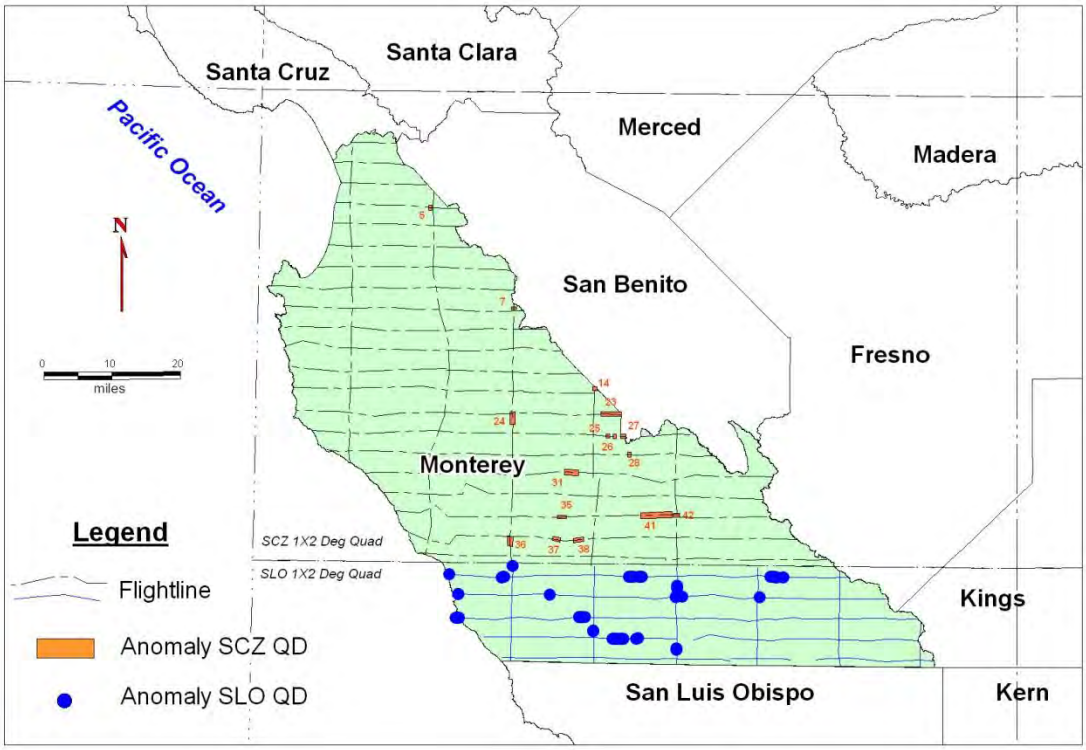

Figure 3. NURE Project Flight lines and Equivalent Uranium Anomalies
Blue flight lines and anomalies are from the San Luis Obispo 1X2 degree quadrangle NURE study, black flight lines and orange anomalies are from the Santa Cruz 1X2 degree quadrangle NURE study. Geologic information for the numbered anomalies is provided in Appendix G.

Uranium in Soil, Stream Sediment and Talus Samples

NURE activities in Monterey County also resulted in the collection and analysis of 134 soil samples, 415 stream sediment, and 26 talus samples for total uranium. The distribution of the soil, stream sediment and talus samples in Monterey County are shown in Figure 4. Figure 5 shows those samples (24 percent) that equal or exceed 5.0 ppm total uranium (i.e., approximately twice the average uranium content of the earth's crust).

Uranium data for the samples, grouped by the geologic unit present at the sample collection site, are listed in Appendix I. Seventy-four geologic units have NURE uranium data available. Four units have 25 or more associated NURE samples, the Tm (Monterey Formation)- stream sediment, Qal (Alluvial deposits)- stream sediment, Qfp (Flood-plain deposits)- stream sediment and soil, and QTp (Paso Robles Formation)-stream sediment. Median value of Uranium in stream sediment associated with Tm is 6.3 ppm, significantly higher than median uranium values for stream sediment and soil associated with Qal, Qfp or QTp which range from 2.2 to 3.6 ppm. The highest individual uranium analyses for these units, in order from high to low, are as follows: Qal—stream sediment,

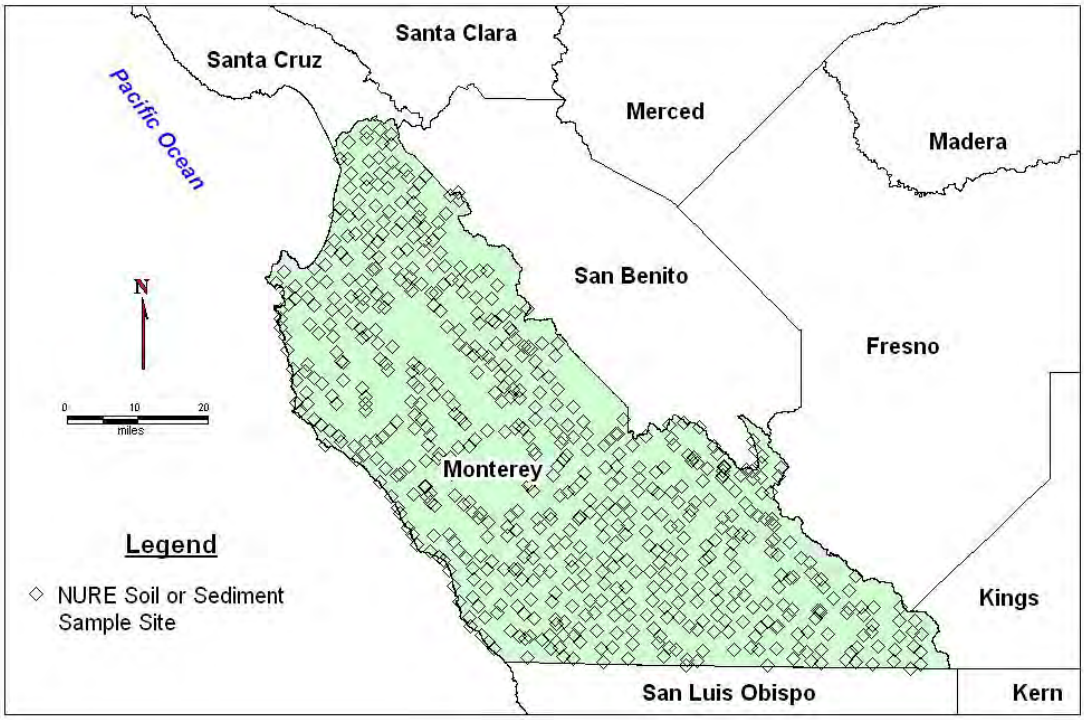

Figure 4. NURE Soil, Stream Sediment and Talus Sample Locations

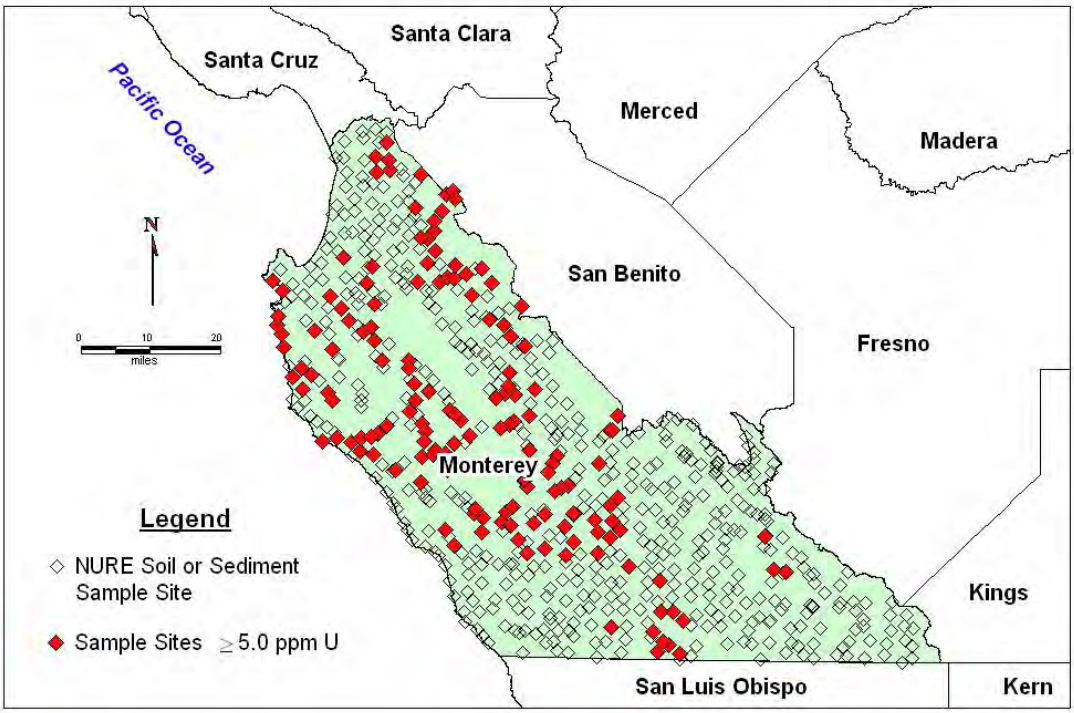

Figure 5. NURE Soil, Stream Sediment and Talus Locations with ≥ 5.0 ppm Uranium

21.9 ppm; Tm—stream sediment, 12.2 ppm; Qfp-soil, 7.2 ppm; Qfp-stream sediment, 6.3; and QTp-stream sediment, 4.32 ppm. The remaining 70 units have too few uranium data to reliably determine their uranium population characteristics. However, 17 geologic units (besides Qal and Tm, previously mentioned) have at least one associated NURE uranium analysis exceeding 10 ppm, suggesting that at least small areas within these units may have higher radon potential (see Table 4 and Appendix I). These high uranium sample sites

Geologic Unit and NURE sample type	**Highest NURE U analysis (ppm)**	**Geologic Unit and NURE sample type**	**Highest NURE U analysis (ppm)**
Kqmf-stream sed	51.2	pKqf-soil	12.3
pKm-soil	33.9	Tm-stream sed	12.2
Qal-stream sed	21.9	Tss-talus	12.1
Qc-stream sed	20.7	Kqmp-stream sed	11.8
Qhf-stream sed	20.1	pKqf-stream sed	11.3
Kqds-stream sed	18.2	Kqdj-talus	10.9
Qhf-soil	17.8	pKg-stream sed	10.9
Tm-talus	15.4	pKc-soil	10.7
Kgdn-stream sed	13.5	pKg-stream sed	10.2
Qls-talus	13.2		

Table 4. Geologic Units with One or More NURE Uranium Analyses Exceeding 10 ppm (see Appendix D for unit names)

are located in sparsely populated rural portions of Monterey County. Using 5 ppm uranium (twice the average crustal uranium content) as a screening boundary between geologic units with higher and lower radon potential, NURE uranium data for stream sediment, soil and talus samples suggest the most likely geologic units to have areas with elevated radon potentials in Monterey County are:

- Tm-Monterey Formation
- Kqmf-Quartz Monzonite of Brickmore Canyon
- Kqds-Hornblende-biotite diorite of Soberanes Point
- Kqdj-Quartz diorite-granodiorite of Johnson Canyon
- pKqf-Quartzofeldspathic rocks-gneiss, granofels, quartzite, minor schist
- Tss-Unnamed marine sandstone (Paleocene)
- Qhf-Alluvial fan deposits (Holocene)

Note that both the NURE airborne radiometric data and the soil-stream sediment-talus data support increased radon potential status for the following geologic units:

- Tm-Monterey Formation
- Kqdj-Quartz diorite-granodiorite of Johnson Canyon

The sediment-soil-talus data do not support the increased radon potential for Tpo and QTp implied by the airborne radiometric surveys, but the data are too few to be conclusive. Little can be concluded about the status of Tml (Monterey Formation, semi-siliceous mudstone) with only two uranium analyses of sediment available.

Figure 6 shows locations of anomalous airborne equivalent uranium data and anomalous sediment-soil-talus uranium data within Monterey County. These groups appear to be somewhat mutually exclusive in location with the many of the sediment-soil-talus anomalies being in areas of granitic or metamorphic rocks while the airborne equivalent uranium anomalies appear more closely associated with areas of Cenozoic marine and non-marine sediments. One possibility for this pattern is that radon emanation from granitic and metamorphic rocks in Monterey County is lower than from the Cenozoic sediments. Radon emanation is the percent of radon that escapes from minerals where it formed into surrounding pore spaces and fractures. If true, this suggests that higher total uranium in granitic and metamorphic rocks in Monterey County may be less a problem for elevated indoor-radon than lower moderate total uranium levels in Cenozoic sediments. Additional research is required to confirm or reject this possibility.

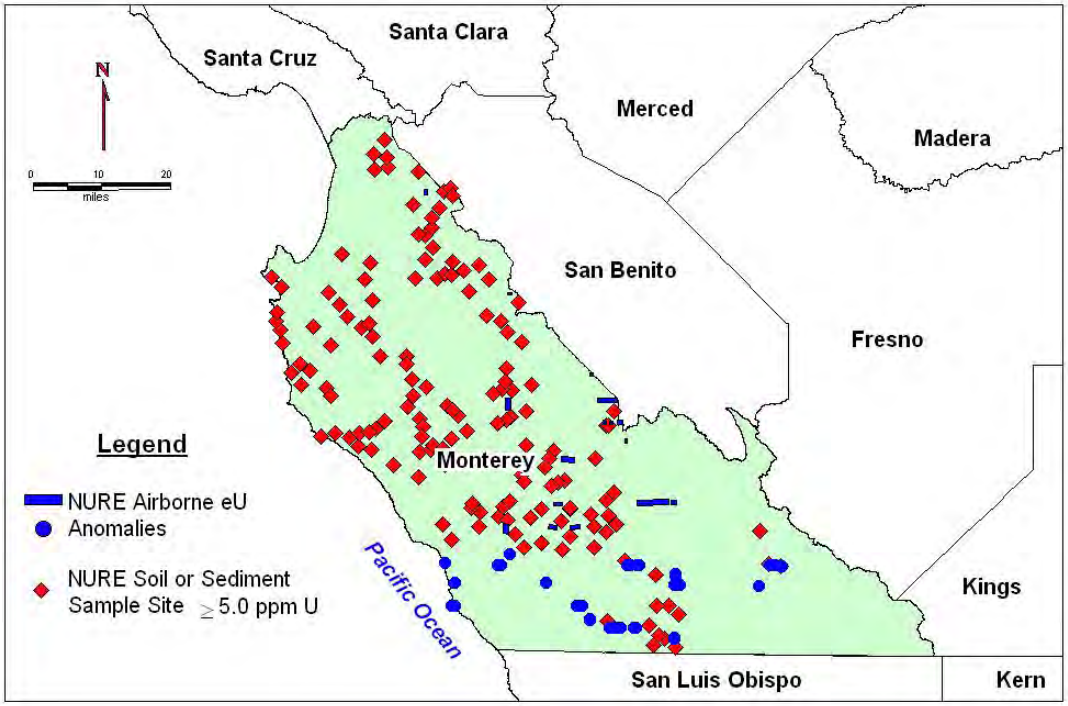

Figure 6. Comparison of NURE Airborne Survey eU Anomaly Locations with NURE Soil and Sediment Sample U Anomaly Locations

NRCS SOIL DATA

Soil Properties and Indoor-Radon

The few relatively high uranium analyses for geologic units other than the Monterey Formation, listed in Table 4 and Appendix I, suggest that small areas of uranium concentration with increased radon potential occur within these other units. Whether or not these areas of uranium concentration have increased radon potential depends, in part, on the permeability and other characteristics of the soils units present. Interconnected voids between mineral grains and fractures formed during drying of swelling clays are the primary forms of soil permeability and pathways for radon between its source and a building. Although not ideal, soil permeability data for water and shrink-swell behavior provides a qualitative gauge of soil permeability for radon gas (e.g., Brookins, 1990, Figure 7.2, p. 128).

Soil related to the Paso Robles Formation provides an example of how soil shrinkage fractures may facilitate radon transport to a foundation. A study by Fierer and others (2005) contains information on radon in the upper two meters of soil in Santa Barbara County related to the Paso Robles Formation. They found samples at 2 meters depth at 6 sites had soil gas radon levels ranging from about 500 pCi/l to 1,600 pCi/l. Shrinkage fractures 3 to 4 meters deep have been noted in soil associated with the Paso Robles Formation (Rosenberg, County of San Luis Obispo, written communication, 2007). Thus, soil fractures can be significant pathways for radon gas moving to a building's foundation. Swelling clays may also cause cracks in foundations and slabs, facilitating radon entry into buildings.

Appendix J lists representative permeability and shrink-swell properties of Monterey County soils associated with at least one indoor-radon measurement ≥ 4 pCi/l. From the information in Appendix J, Monterey County soils with horizons with the following characteristics appear more likely to be associated ≥ 4 pCi/l indoor air sites than soils with other combinations of permeability and shrink/swell characteristics:

- Moderate permeability and moderate or low shrink/swell
- Moderately-slow permeability and moderate or low shrink/swell
- Slow permeability and high shrink/swell
- Very-slow permeability and high shrink/swell

Of the 41 ≥ 4 pCi/l sites, 39 have soils with horizons with these characteristics (note that some soils have multiple horizons with different characteristics). The Santa Lucia soil is an example of a moderate permeability and low shrink/swell soil, associated with the Monterey Formation. Eight of the 41 home sites with 4 pCi/l or higher indoor-data in Monterey County are on Santa Lucia soil. Additional factors connecting Santa Lucia soil to elevated radon sites may be its

thickness and the physical condition of the underlying Monterey Formation. The representative Santa Lucia soil profile is only 24 inches thick and the soil rests on hard fractured Monterey (Formation) shale (Cook, 1978, p. 70). If this thickness and the fracturing are typical, radon should have numerous short and easy pathways available to move from its point of generation, within the Monterey Formation or the Santa Lucia soil, to the foundation of an overlying building.

Moderately-rapid, rapid or very rapid permeability soils appear less likely to be associated with ≥ 4 pCi/l indoor air sites. Only 9 of 41 of the ≥ 4 pCi/l sites have soils with at least one moderately-rapid, rapid or very rapid soil horizon. In Table 3, listing low-radon potential geologic and soil units based on indoor radon test results, note that Arnold, Baywood, Gorgonio and Tangoir soils have only moderately-rapid to rapid permeability and low shrink-swell soil horizons. NURE soil and stream sediment data for the geologic units in Table 3 are not abnormally low for the geologic units listed in Table 3, ranging from 2.1 ppm (slightly below the crustal uranium average) to 9.9 (almost 4 times the crustal uranium average). However, no information is available on the emanation efficiencies (the percent of radon that escapes from minerals and rocks) for these geologic units. Consequently, it remains uncertain if lower indoor-radon levels result from higher soil permeability, perhaps by facilitating dilution of soil gas in the subsurface by low radon atmospheric air or facilitating the flow of radon around buildings instead into buildings, or from low radon emanation efficiencies for these geologic units and soils

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RADON POTENTIAL ZONES

Final Monterey County Geologic Unit Radon Potentials

Monterey County high and moderate radon potential zones are based on locations of geologic units classified as having high or moderate radon potential. As discussed in previous sections and summarized in Table 5, indoor radon measurements, NURE airborne gamma-ray survey and stream sediment, soil and talus uranium data, and NRCS soil data, support the high potential zone for Monterey County being based on the distribution of Monterey Formation occurrences in the county. Because of similarities in uranium content and soil properties, characteristics and geologic origin, other Monterey Formation subunits—Tml, Tmdi, Tmc and Tmd, will be treated as having high radon potential at this time. Geologic units Qtmp and QTp are classified as having moderate radon potential based on currently available indoor-radon data. While no indoor data are currently available for QTp in Monterey County, review of QTp associated indoor-data for San Luis Obispo County Data suggest ≥ 4 pCi/l rate of about 6 to 8 percent and, consequently, a moderate radon potential classification. A moderate zone classification for QTp is also supported by NURE Airborne Survey data and soil permeability-shrink/swell data. There are insufficient data to reliably classify the remaining geologic units listed in Table 5

Geologic Unit	Indoor Radon Survey Data	NURE Project Airborne Survey Data for eU	NURE Project Stream Sediment, Soil and Talus Sample data for U	NRCS Soil Permeability and Shrink-Swell Data
Tm-Monterey Formation	XX	x	X	X
Qtmp-Fluvial terrace deposits (middle Pleistocene)	X			X
Tml-Monterey Formation Siltstone	x	x		X
Tmdi-Monterey Formation Diatomite	x	x		X
Qt-Fluvial terrace deposits (those assoc. w Monterey Fm units)	x			
Qal-Alluvial deposits (those assoc. w Monterey Fm units	x			
Tmc-Monterey Formation clay shale	ND	x		X
Tmd-Monterey Formation Devil Water member	ND	x		X
QTp-Paso Robles Formation	+	x		X
Tpo-Pancho Rico Formation	ND	x		X
Kqdj-Quartz diorite-granodiorite of Johnson Canyon	ND	x	x	
Tvd-Intrusive dacite felsite	ND	x		
Tvp-Pinnacles Formation-dacitic breccia and tuff breccia	ND	x		
Kqmf	ND		x	
Kqds	ND		x	
pKqf	ND		x	
Tss	ND		x	
Qhf	ND		x	

Table 5. Monterey County Geologic Units and Strength of Supporting Data for Increased Radon Potential.

XX = more than 25 indoor radon measurements with ≥ 20% at 4 pCi/l or greater)
X = more than 25 indoor radon measurements (with ≥ 5% and < 20% at 4pCi/l or greater); or uranium analyses (with median ≥ 5 ppm U); or strong association with soils facilitating radon migration
x = less than 25 indoor radon measurements (with ≥ 5 at 4 pCi/l or greater); or units with NURE airborne survey eU anomalies; or uranium analyses with median ≥ 5 ppm
+ = more than 25 indoor radon measurements on geologic unit in an adjacent county with ≥ 5% and < 20% at 4 pCi/l or greater)
ND = no indoor-radon data

as having moderate or high radon potential. Future studies to obtain indoor radon measurements related to these geologic units should be considered and may result in reclassification of some units to Moderate or High radon potential status. All other geologic units in Monterey County are assigned low radon potential at this time based on currently available data.

Radon Potential Zone Boundaries

Monterey Formation unit areas(Tm, Tml, Tmdi, Tmd, and Tmc) and immediately adjacent alluvial areas within a 0.2 mile wide buffer having Santa Lucia or Lockwood soils are classified as high radon potential. Monterey Formation/buffer areas with other soil types are classified as moderate radon potential.

Paso Robles Formation areas and associated 0.2 mile wide buffer areas are classified as moderate radon potential. A buffer zone is used here because no indoor-radon data are available for the Paso Robles Formation in Monterey County and the majority of associated soils are not included in Appendix J.

Note that buffer zones were not created for areas of Monterey Formation units or Paso Robles Formation areas having a width less than 0.2 miles unless these occurrences were less than 0.2 miles apart.

Middle Pleistocene fluvial terrace deposit (QTmp) areas with Antioch or Salinas soils are classified as moderate radon potential. Soil data and available indoor radon data did not support use of a buffer zone in this case.

Sometimes high or moderate potential geologic units are close enough that their buffer zones overlap each other. When this situation occurs high zone buffer areas receive priority over moderate zone buffer areas. Figure 7 shows the radon zone locations and Figure 8 shows the radon zones in relationship to anomalous NURE data and ≥ 4 pCi/l indoor measurements.

All portions of Monterey County not classified as High or Moderate radon potential areas, as defined above, are considered to have Low radon potential at this time.

Table 6a and Table 6b contain information about the radon data characteristics for each radon zone. Table 7a and Table 7b provide information about the incidence rates of ≥ 4 pCi/l indoor measurements and the density of indoor-radon survey measurements per radon zone.

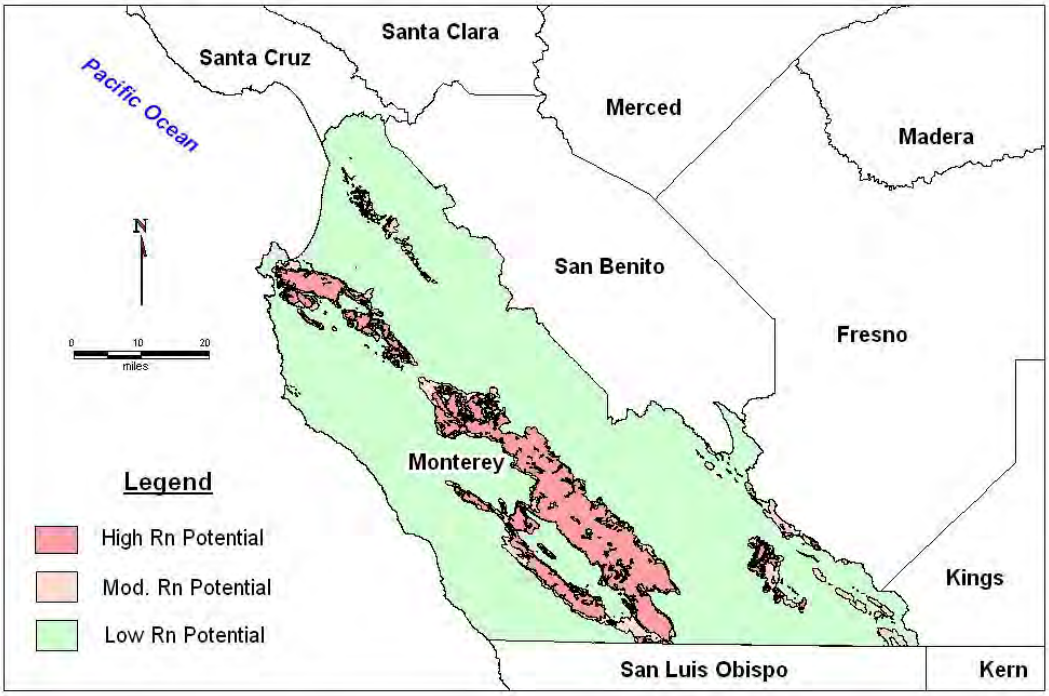

Figure 7. Radon Potential Zones for Monterey County.

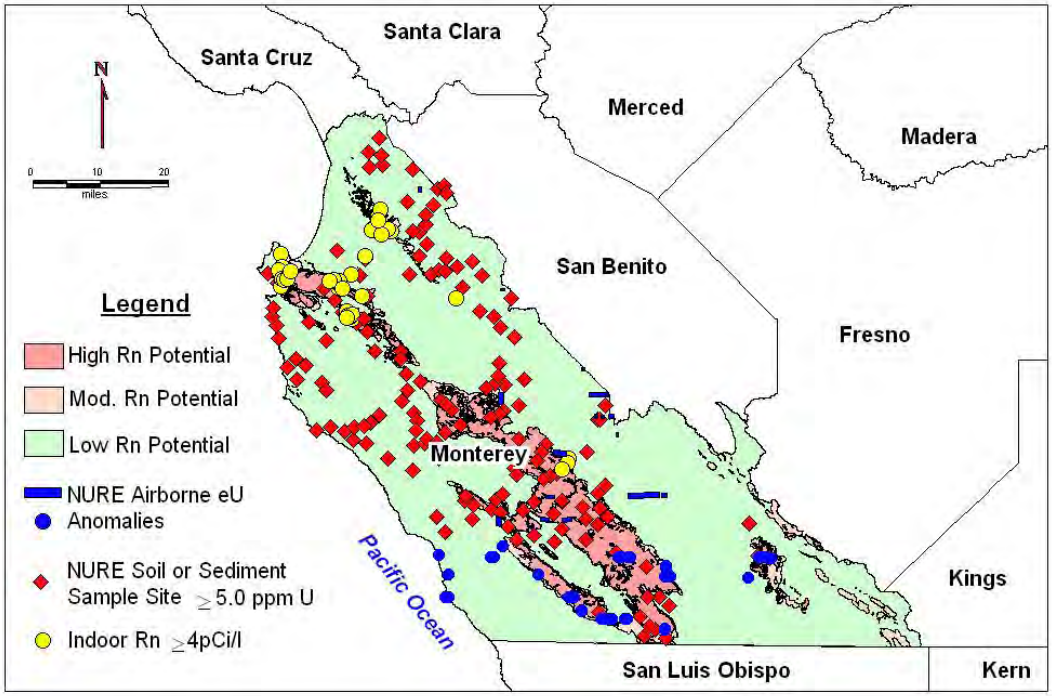

Figure 8. Comparison of Radon Potential Zones, Anomalous NURE Data and Indoor Radon Data ≥ 4 pCi/l.

Zone	n	Median pCi/l	pCi/l at 25%	pCi/l at 75%	Min pCi/l	Max pCi/l
High	84	1.65	0.6	3.85	0.2	25.1
Moderate	166	0.85	0.3	1.6	0.2	7.0
Low	809	0.6	0.2	1.1	0.2	8.7
All	1059	0.6	0.2	1.2	0.2	25.1

Table 6a. Radon Zone Data Characteristics

Zone	n	n ≥ 4.0 pCi/l data	% data ≥ 4.0 pCi/l	N ≥ 10.0 pCi/l data	% data ≥ 10.0 pCi/l	N ≥ 20.0 pCi/l data	% data ≥ 20.0 pCi/l	Area (sq-mi)
High	84	21	25.0	7	8.3	4	4.8	361
Moderate	166	10	6.0	0	0	0	0	671
Low	809	10	1.2	0	0	0	0	2290
All	1059	41	3.9	7	0.7	4	0.4	3322

Table 6b. ≥ 4.0 pCi/l Incidence per Radon Potential Zone

Zone	% of all ≥ 4.0 pCi/l measurements	% of all ≥ 10.0 pCi/l measurements	% of all ≥ 20.0 pCi/l measurements	% Area	Cumulative % of n ≥ 4.0 pCi/l measurements	Cumulative % of Monterey County Area
High	51.2	100	100	10.9	51.2	10.9
Moderate	24.4	0	0	20.2	73.2	31.1
Low	24.4	0	0	68.9	100.0	100.0
All	100.0	100.0	100.0	100.0		

Table 7a. ≥ 4.0 pCi/l Incidence Rates for Monterey County by Radon Potential Zone

Zone	Average Rate: n ≥ 4.0 pCi/l measurements per square mile	Average Rate: All measurements per square mile
High	0.058	0.23
Moderate	0.015	0.25
Low	0.004	0.35
All	0.012	0.32

Table 7b. Radon Data Distribution by Radon Potential Zone

RADON POTENTIAL ZONE STATISTICS

Indoor-Radon Measurement Data Characteristics

The statistical characteristics of the untransformed and log(10) transformed CDPH indoor radon data for Monterey County radon potential zones are provided in Appendix K and Appendix L).

Indoor-Radon Measurement Frequency Distributions

Frequency distributions of trace elements, such as uranium and radon, in rocks and soils are often approximated using the lognormal distribution. However, because of the variety of geologic units and complex history of processes affecting them, geochemical data such as radon data cannot always be fitted to a specific frequency distribution (Rose and others, 1979, p. 33). The indoor radon data for Monterey County are an example of this. Taken as a whole, the indoor radon test data from CDPH fail the Kolmogorov-Smirnov normality test in both untransformed and log-transformed modes (Table 8). Consequently, the data are neither normally nor lognormally distributed. A non-normal frequency distribution may be because the data are a combination of samples from several different populations—each rock unit radon population having its own unique distribution. On an individual basis, the rock unit radon populations may be lognormal, but the aggregate population is not lognormal.

Data non-normality has important implications for certain statistical operations. For example, T-test comparisons should not be used for comparing non-normal (non-parametric) populations. For this reason, the Mann-Whitney rank sum test is used for comparisons of sub-populations of the indoor-radon test data by radon zone in this study and the results are discussed in a following section. Non-normality may also have negative consequences for predictions of percentages of homes with indoor radon levels exceeding 4.0 pCi/l if the predictions assumed a lognormal population distribution for the radon data.

Statistical Comparison of Indoor Radon Data by Radon Potential Zone

The results of the statistical comparisons of indoor-radon data for the Monterey County radon potential zones are listed in Table 9. The indoor-radon data population for each radon potential zone is statistically distinct according to the Mann-Whitney rank sum test.

Data	N	K-S Distribution	P	Result
All Data—Untransformed	1059	0.311	<0.001	Failed
All Data—Log (10) Transformed	1059	0.151	<0.001	Failed
High Zone—Untransformed	84	0.263	>0.001	Failed
High Zone—Log(10) Transformed	84	0.113	=0.010	Failed
Moderate Zone—Untransformed	166	0.221	<0.001	Failed
Moderate Zone—Log(10) Transformed	166	0.121	<0.010	Failed
Low Zone—Untransformed	809	0.233	<0.001	Failed
Low Zone—Log(10) Transformed	809	0.172	<0.001	Failed

Table 8. Results of the Kolmogorov-Smirnov Normality Test for Untransformed and Log(10) Transformed Indoor-Radon Data, by Radon Potential Zone

A test that fails indicates that the data varies significantly from the pattern expected if the data were drawn from a population with a normal distribution. A test that passes indicates that the data matches the pattern expected if the data were drawn from a population with a normal distribution

Mann-Whitney Rank Sum Test					
Group	*N*	*Missing*	*Median*	*25%*	*75%*
High Zone	84	0	1.65	0.6	3.85
Moderate Zone	166	0	0.85	0.3	1.6
Result	T = 12567.000 n(small)=84 n(big)=166 (P=<0.001) The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P=<0.001)				
High Zone	84	0	1.65	0.6	3.85
Low Zone	809	0	0.60	0.2	1.1
Result	T = 52312.000 n(small)=84 n(big)=809 (P=<0.001) The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P=<0.001)				
Moderate Zone	166	0	0.85	0.30	1.6
Low Zone	809	0	0.60	0.20	1.1
Result	T = 93382.500 n(small)=166 n(big)=809 (P=<0.001) The difference in the median values between the two groups is greater than would be expected by chance; there is a statistically significant difference (P=<0.001)				

Table 9. Mann-Whitney Rank Sum Test Comparisons of Indoor-Radon Data by Radon Potential Zone

Estimated Population Exposed to 4.0 pCi/l Radon or Greater Indoor Air in Monterey County

Population estimates for each radon potential zone were obtained by overlaying the Monterey County radon potential zones with 2000 census tract data. For census tracts not completely within a radon potential zone, a portion of census tract population proportional to the percent area of the census tract falling within the radon potential zone was used as the population contribution of that census tract to the total population of the radon potential zone. The estimated populations for the different radon potential zones are listed in Table 10.

Radon Potential Zone	Estimated Total Population within Zone—2000 Census Statistics	Estimated Total Houses within Zone—2000 Census Statistics
High	11,351	4,918
Moderate	65,834	19,917
Low	324,569	106,876
All Monterey County	401,754	131,711

Table 10. Population Estimates for Monterey County Radon Zones Areas (based on 2000 U.S. Census Data).

Table 11 shows the estimated populations of residents for each radon potential zone and the estimated number of residences exposed to different radon levels. These estimates are based on the estimated population for each zone multiplied by the ≥4.0 pCi/l percentages for each zone from Table 6b.

Potential Radon Impacts on the Population of Monterey County

The High and Moderate radon potential zones contain 31.1 percent of the Monterey County area and 19.21 percent of the county population. These two zones also contain:

- 63.54% of the Monterey County population estimated to live in residences with indoor radon levels of ≥ 4.0 pCi/l

- Available data suggest most or all of the Monterey County residences with indoor radon levels ≥ 10.0 pCi/l area are within the High Zone

These results indicate that geology based radon potential zones can target areas within Monterey County where excessive indoor radon levels are more likely to be found (i.e., where the highest percentages of buildings with excessive indoor radon levels are expected to occur). Such information is helpful for government agencies and non-profit organizations involved in public health by indicating where the greatest benefit may be obtained from radon testing programs and public awareness efforts. However, the results also show that buildings with excessive indoor radon levels occur in all zones in Monterey County. Factors other than geology, such as soil permeability, building condition, design and usage also have important impacts on indoor radon levels. Therefore, anyone concerned about possible exposure to radon in his or her residence should test, regardless of location.–The U.S. EPA recommends testing of all residences regardless of location.

Radon Potential Zone	Estimated Total Population* for Zone	Estimated Population* at ≥ 4.0 pCi/l Conditions	Estimated Population* at ≥ 10.0 pCi/l Conditions	Estimated Population* at ≥ 20.0 pCi/l Conditions	Percent Area/Square Miles
High	11,351[1] 2.83%[2]	2,838 26.57% 25.0% rate[3]	942 100.00% 8.3% rate	549 100.00% 4.8% rate	10.9% 361 mi^2
Moderate	65,834 16.39%	3,950 36.97% 6.0% rate	0 0.00% 0.0% rate	0 0.00% 0.0% rate	20.2% 671 mi^2
Low	324,569 80.79%	3,895 36.46% 1.2% rate	0 0.00% 0.0% rate	0 0.00% 0.0% rate	68.9% 2,290 mi^2
Population Estimates Weighted by Radon Zone					
Totals (weighted by zone)	401,754 100.00%	10,683 100.00% 2.66% rate	942 100.00% 0.23% rate	549 100.00% 0.14% rate	100.00% 3,322 mi^2
Population Estimates by Radon Level Without Regard to Data Location or Zone					
All Monterey County (not weighted by zone)**	401,754	15,668 3.9% rate	2,812 0.7% rate	1,607 0.4% rate	100.00% 3,322 mi^2

Table 11. Estimates of Monterey County Population Exposed to 4.0 pCi/l or Greater Indoor Radon Levels in Residences (based on 2000 U.S. Census Data)

*Information listed vertically in the population column cells: 1) Population; 2) Percent of the total county population; 3) percent of ≥ 4.0 pCi/l measurements

**Based only on radon test results, not weighted for location

SUMMARY

Mapping Procedures and Results

Short-term indoor radon test data from CDPH, NURE project airborne radiometric data, and NURE soil, stream sediment and talus uranium data, were used to identify geologic units with relatively higher or lower radon potential in Monterey County. Geologic units were classified as having high, moderate or low radon potential based on the percentage of 4.0 pCi/l or higher indoor-radon data and the presence of airborne radiometric uranium anomalies and the presence of soil, stream sediment and talus uranium data exceeding 5.0 ppm.

High radon potential zones on the Monterey County radon potential map correspond to the locations of high radon potential geologic units. Moderate radon potential zones correspond to the locations of moderate radon potential units. Low radon potential zones are composed of the remaining geologic units, which may have either low radon potential or an unknown, but likely low, radon potential.

Buffer zones, 0.2 miles wide were added to the boundaries of Monterey Formation unit areas and the Paso Robles Formation to establish the final high and moderate radon zone boundaries. Buffer zones were not added to individual occurrences of these units where the smallest horizontal dimension is about 0.2 miles or smaller. Buffer zones were not used with middle Pleistocene fluvial terrace deposits to establish associated moderate potential zone areas because available indoor-radon data and soil data did not support their use in this case.

The final radon potential zones have the following characteristics:

High Radon Potential Zone: this zone comprises 10.9 percent (361 square miles) of Monterey County and contains 51.2 percent of ≥4.0 pCi/l short-term radon data in the CDPH database.

Moderate Radon Potential Zone: this zone comprises 20.2 percent (671 square miles) of Monterey County and contains 24.4 percent of ≥4.0 pCi/l short-term radon data in the CDPH database.

Low Radon Potential Zone: this zone comprises 68.9 percent (2290 square miles) of Monterey County and contains 24.4 percent of ≥4.0 pCi/l short-term radon data in the CDPH database.

All three radon potential zones contain short-term indoor-radon measurements above 4.0 pCi/l. The maximum measurement for each zone is: High, 25.1 pCi/l; Moderate, 7.0 pCi/l; and Low, 8.7 pCi/l.

Statistical comparison of the indoor radon data populations for the three radon potential zones, using the Mann-Whitney rank sum test, shows that the zones are statistically different from each other (note the P values, the probability of being wrong in concluding that there is a true difference in the two groups, listed in Table 9 are less than 0.001)

An estimated 2,838 individuals within High Radon Potential Zone areas and 3,950 individuals within Moderate Radon Potential Zone areas live in residences likely to measure ≥4.0 pCi/l in short-term tests. An additional 3,895 individuals are estimated to live in residences likely to measure ≥4.0 pCi/l in short-term tests within the Low Radon Potential Zone area (i.e., scattered through 68.9 percent of the Monterey County area. An estimated 549 individuals live in dwellings with indoor-radon levels measuring ≥ 20 pCi/l on short-term tests in Monterey County. Available data suggest that ≥ 20 pCi/l dwellings may be confined to High Radon Potential Zone areas.

Recommendations for Future Studies

Indoor radon data are lacking or minimal for Big Sur, Bradley, portions of Carmel (Zip Codes 93921, 93922), Castroville, Chualar, Gonzales, Greenfield, Lockwood, Moss Landing, portions of Salinas (Zip Code 93902), San Miguel, Solidad, Spreckels and Watsonville (portion of Zip Code 95076 in Monterey County). Future radon testing efforts should consider targeting these communities. The rural southern half of Monterey County also lacks indoor-radon measurements and future activities to encourage testing residences there should be considered.

Priority geologic units for additional indoor-radon testing should be: Monterey Formation-siltstone, Monterey Formation-diatomite, Monterey Formation-clay shale, Monterey Formation-Devil Water member, Paso Robles Formation, Pancho Rico Formation, and Quartz Diorite-granodiorite of Johnson Canyon. Acquisition of additional indoor-radon data for associated houses and schools would allow better evaluation of the radon potential status of these geologic units.

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REFERENCES

Brookins, D.G., 1990, The Indoor Radon Problem; Columbia University Press, New York, 229 p.

Churchill, R.K, 2006, Radon Potential in Ventura County-2006 Update; California Geological Survey Special Report 194, 42 p. and map.

Churchill, R.K., 2005, Radon Potential in Southern Los Angeles County; California Geological Survey Special Report 182, 52 p. and map.

Cook, Terry D., 1978, Soil Survey of Monterey County, California; United States Department of Agriculture, Soil Conservation Service, 228p with maps.

Duval, L.S., 2000, Aerial Gamma-Ray Surveys of the conterminous United States and Alaska: Aerial Gamma-Ray Surveys of California and Oregon; U.S. Geological Survey Open-File Report 99-562-K, CD-Rom.

Fierer, N., Chadwick, O.A., and Trumbore, S.E., 2005, Production of CO_2 in Soil Profiles of a California Annual Grassland; Ecosystems, v. 8, pp. 412-429.

Grasty, R.L., 1997, Radon emanation and soil moisture effects on airborne gamma-ray measurements; Geophysics, v. 62, no. 5 (September-October 1997), pp. 1379-1385.

High Life Helicopters, Inc., 1981b, Airborne Gamma-Ray Spectrometer and Magnetometer Survey, Santa Cruz Quadrangle (California), Final Report Volume II; High Life Helicopters, Inc., Puyallup, Washington/QEB, Inc., Lakewood, Colorado, Prepared for the U.S. Department of Energy, Grand Junction, Colorado, Subcontract No. DE-AC13-79GJO1692, 139 p.

NRCS, 2007, Soil Survey Geographic (SSURGO) database for Monterey County, California; U.S. Department of Agriculture, Natural Resources Conservation Service, Online_Linkage: http://soildatamart.nrcs.usda.gov/Metadata.aspx?Survey=CA053&UseState=CA

Rose, A.W., Hawkes, H.E., and Webb, J.S., 1979, Geochemistry in Mineral Exploration, second edition; Academic Press Inc., New York, 657 p.

Rosenberg, Lewis, I., 2001, Digital geologic map of Monterey County, California, in Rosenberg, Lewis I., Geologic resources and constraints, Monterey County, California: a technical report for the Monterey County 21st Century General Plan update program: scale 1:250,000, 1 CD-ROM, ESRI shape file format. *Note: this map was compiled from 1:24,000 and 1:62,500 scale geologic maps and the author has indicated that the digital file are accurate for use at 1:100,000-scale (Rosenberg, 2007, written communication).*

APPENDIX A

Charcoal Detector Exposure

Detector exposure	Number of detectors	Percent of detectors
1 day	32	2.4
2 days	1,078	81.5
3 days	190	14.4
4 days	22	1.7
total	*1,322**	*100*

* 1059 sites were tested but multiple detectors were placed at some sites

APPENDIX B

Indoor-Measurement Field Duplicate Results

Differences between field duplicate indoor-measurements for the Monterey County radon survey, January to May 2006.

High (pCi/l)	Low (pCi/l)	Difference (pCi/l)	%* Difference	Comment
1.0	0.8	0.2	20	
1.6	1.3	0.3	18.8	
0.8	0.5	0.3	37.5	
0.6	0.4	0.2	33.3	
0.7	0.6	0.1	14.3	
1.0	0.2	0.8	80	
0.2	0.2	0.0	0	No difference. Both tests at or below detection limit
0.5	0.2	0.3	60	
6.3	5.4	0.9	14.3	Difference above 10%**
2.1	0.6	1.5	71.4	0.6 lab measurement @ 6 days, 2.1 lab measurement @ 4 days
1.2	0.2	1.0	83.3	
0.9	0.5	0.4	44.4	
0.4	0.3	0.1	25	
0.8	0.6	0.2	25	
0.2	0.2	0.0	0	No difference. Both tests at or below detection limit
0.4	0.2	0.2	50	
4.4	3.2	1.2	27.3	Difference above 10%; Measurements above and below 4.0 pCi/l
1.3	0.9	0.4	30.8	
1.1	0.8	0.3	27.3	
0.3	0.2	0.1	33.3	
1.4	0.9	0.5	35.7	
1.6	1.4	0.2	12.5	

1.0	0.8	0.2	20	1.0 lab measurement @ 7 days, 0.8 lab measurement @ 5 days
0.5	0.5	0.0	0	No Difference
0.2	0.2	0.0	0	Both tests at or below detection limit
0.4	0.3	0.1	25	
0.7	0.3	0.4	57.1	
1.4	0.4	1.0	71.4	
0.3	0.2	0.1	33.3	
0.4	0.4	0.0	0	No difference
1.2	0.5	0.7	58.3	
0.2	0.2	0.0	0	Both tests at or below detection limit
1.1	0.4	0.7	63.6	
1.3	1.1	0.2	15.4	
0.9	0.5	0.4	44.4	
1.6	1.0	0.6	37.5	
0.8	0.3	0.5	62.5	
0.5	0.2	0.3	60	
2.0	1.1	0.9	45	2.0 lab measurement @ 5 days, 1.1 lab measurement @ 8 days
4.6	0.7	3.9	84.8	Same exposure and lab measurement days
0.4	0.2	0.2	50	
6.8	6.0	0.8	11.8	Difference slightly above 10%**
0.6	0.5	0.1	16.7	
25.1	8.3	16.8	66.9	Difference above 10%**; Same exposure and lab measurement days
9.5	8.3	1.2	13.0	Difference slightly above 10%**
1.5	0.6	0.9	40	
1.3	0.5	0.8	61.5	
0.5	0.2	0.3	60	
0.6	0.4	0.2	33.3	
0.7	0.6	0.1	14.3	
0.4	0.2	0.2	50	
0.7	0.4	0.3	42.9	
3.4	3.0	0.4	11.8	3.4 lab measurement @ 4 days; 3.0 lab measurement @ 5 days
0.5	0.3	0.2	40	
0.4	0.2	0.2	50	0.4 lab measurement @ 3 days, 0.2 lab measurement @ 7 days
0.2	0.2	0.0	0	No difference. Both tests at or below detection limit
1.2	0.8	0.4	33.3	1.2 lab measurement @ 5 days, 0.8 lab measurement @ 4 days
0.5	0.2	0.3	60	
6.2	4.8	1.2	19.4	Difference above 10%**; 6.2 lab measurement @ 6 days, 4.8 lab measurement @ 5 days
1.5	0.6	0.9	60	
0.2	0.2	0.0	0	No difference. One lab measurement @

				5 days, one @ 4 days: Both tests at or below detection limit
7.5	6.3	1.2	16.0	Difference above 10%**
1.2	1.1	0.1	8.3	
1.4	1.3	0.1	7.1	
0.2	0.2	0.0	0	No difference. Both tests at or below detection limit
0.9	0.2	0.7	77.8	
0.9	0.2	0.7	77.8	
2.3	1.9	0.4	17.4	
3.3	2.1	1.2	36.4	3.3 lab measurement @ 7 days, 2.1 lab measurement @ 4 days
0.2	0.2	0.0	0	No difference. Both tests at or below detection limit
0.9	0.2	0.7	77.8	0.9 lab measurement @ 3 days, 0.2 lab measurement @ 13 days
2.6	1.9	0.7	26.9	
1.4	1.2	0.2	14.2	
1.1	0.9	0.2	18.2	
0.2	0.2	0	0	No difference. One lab measurement @ 8 days, one @ 4 days; Both tests at or below detection limit
1.2	0.2	1.0	83.3	
0.4	0.2	0.2	50	
0.6	0.5	0.1	16.7	
1.1	1.0	0.1	9.1	
5.3	5.1	0.2	3.8	Difference less than 10%**
0.2	0.2	0.0	0.0	No difference. Both tests at or below detection limit
0.9	0.5	0.4	44.4	
1.0	0.7	0.3	30	
0.6	0.2	0.4	66.7	
1.0	1.0	0	0	
1.2	0.8	0.4	33.3	
0.9	0.8	0.1	11.1	
0.6	0.2	0.4	66.7	
		54.5 N=87 0.63 pCi/l average difference	**2,994.8 N=87 34.4% average difference**	Overall Differences for Field Duplicates- All sample pairs <u>except</u> 25.1 and 8.3 pCi/l
		11.0 total N=51 0.22 pCi/l average difference	**1,661.0 total N=51 32.6% average difference**	Overall Differences when <u>both</u> measurements are LE 1 pCi/l; range in pair differences is 0 to 0.8; 78.4% of pairs have 0.3 pCi/l difference or less

		11.5 total N=20 0.58 pCi/l average difference	**366 total N=20 18.3 % average difference**	Overall Differences when both measurements are GT 1 pCi/l and LE 10 pCi/l; range of pair differences is 0.1 to 1.2 pCi/l with 50 % of pairs have 0.6 pCi/l difference or less

* % Difference = (high-low)/high X 100

** 6 pairs are above 4 pCi/l with an average difference = 7.2 % and a range of differences from % differences = 3.8 to 19.4%. The Western Regional Radon Training Center course manual indicates the expected precision for short-term radon tests above 4.0 pCi/l is 10%. One of the six pairs differed by less than 10%, the other five differed by between 11.8% and 27.3%.)

APPENDIX C

Comparison of Original and Follow-up Indoor Radon Measurements

Test 1	Test 2	Difference	Days Apart	Comments	Site
5.2	3.6	1.4	17	Change in Status from ≥ 4pCi/l to ≤ 4 pCi/l	1
0.2	0.2	0	6	Maintained status ≤ 4 pCi/l (at or below detection limit)	2
1.3	0.5	0.8	25	Maintained status ≤ 4 pCi/l	3
22.1	19.2	2.9	49	Maintained status-high	4
6.2	4.6	1.6	33	Maintained status-high	5
6.2	6.2	0	33	Maintained status-high	5
1.3	1.1	0.2	6	Maintained status ≤ 4 pCi/l	6
6.6	6.7	0.1	11	Maintained status-high	7
28.4	0.8	27.6	29	Change in Status-high to low	8
28.4	0.3	28.1	29	Change in Status-high to low	8
0.8	0.2	0.6	4	Maintained status ≤ 4 pCi/l (Test 2 at or below detection limit)	9
0.3	0.2	0.1	4	Maintained status ≤ 4 pCi/l (Test 2 at or below detection limit)	9
0.3	1.0	0.7	35	Maintained status ≤ 4 pCi/l	10
11.6	7.6	4.0	39	Maintained status-high	11
15.2	6.0	9.2	15	Maintained status-high	12
15.2	6.8	8.4	15	Maintained status-high	12
16.5	9.5	7.0	18	Maintained status-high	13
16.5	25.1	8.6	18	Maintained status-high	13
16.5	8.3	8.2	18	Maintained status-high	13
3.6	1.1	2.5	29	Maintained status ≤ 4 pCi/l	14
1.0	0.9	0.1	2	Maintained status ≤ 4 pCi/l	15
44.9	0.4	44.5	39	Change in Status-high to ≤ 4 pCi/l	16
44.9	0.2	44.7	39	Change in Status-high to ≤ 4 pCi/l (Test 2 at or below detection limit)	16
44.9	0.2	44.7	39	Change in Status-high to ≤ 4 pCi/l (Test 2 at or below detection limit)	16
44.9	0.2	44.7	39	Change in Status-high to ≤ 4 pCi/l (Test 2 at or below detection limit)	16
0.2	0.5	0.3	3	Maintained status ≤ 4 pCi/l (Test 1 at or below detection limit)	17
2.6	2.3	0.3	4	Maintained status ≤ 4 pCi/l	18
0.9	0.2	0.7	4	Maintained status ≤ 4 pCi/l (Test 2 at or below detection limit)	19
1.5	1.4	0.1	5	Maintained status ≤ 4 pCi/l	20
5.1	5.7	0.6	34	Maintained status-high	21
5.0	3.3	2.7	36	Change in Status-high to ≤ 4 pCi/l	22
5.5	4.0	1.5	57	Maintained status-high	23
0.6	0.2	0.4	20	Maintained status ≤ 4 pCi/l (Test 2 at or below detection limit)	24

0.9	0.5	0.4	29	Maintained status ≤ 4 pCi/l	25
	Totals	**Detectors**		**Status Category**	**# Sites**
		8		Change in Status-high to ≤ 4 pCi/l	4
		0		Change in Status-low to high	0
		12		Maintained Status-high	8
		14		Maintained Status-≤ 4 pCi/l	13
		34			
				84 % of sites did not change their initial site status during retesting. For this study, follow-up tests were always < 4pCi/l if the initial test was < 4 pCi/l for these data.	

APPENDIX D

Geologic Map Units (Rosenberg, 2001) and Indoor Radon Data for Monterey County

Geologic Unit	Description	N	N GE 4 pCi/l	R %	Low pCi/l	High pCi/l
Kgdc	Granodiorite of Cachagua	4	0			1.0
Kgdm	Porphyritic granodiorite of Monterey	73	1	1.37	0.2	8.7
Kgds	Porphyritic granodiorite of Sand Creek	1	0		0.2	1.2
Kqds	Hornblende-biotite quartz diorite of Soberanes Point	3	0		0.2	2
Kqmg	Garnetiferous quartz monzonite of Pine Canyon	1	0			0.7
Qa	Aromas Sand, undifferentiated (Pleistocene)	40	0		0.2	2.6
Qal	Alluvial deposits, undifferentiated (Holocene)	31	2	6.45	0.2	7.5
Qb	Basin deposits (Holocene)	13	0		0.2	3
Qc	Colluvium (Holocene)	11	0		0.2	2.9
Qct	Coastal terraces, undifferentiated (Pleistocene)	201	0		0.2	2.4
Qd	Dune deposits (Holocene)	6	0		0.2	0.6
Qe	Eolian deposits, undifferentiated (Pleistocene)	206	0		0.2	2.4
Qfp	Flood-plain deposits, undifferentiated (Holocene)	161	6	3.73	0.2	7.5
Qfpl	Alluvial fans (late Pleistocene)	68	2	2.94	0.2	5.2
Qfpm	Alluvial fans (middle Pleistocene)	18	0		0.2	1.9
Qhf	Alluvial fan deposits, undifferentiated (Holocene)	8	0		0.2	1.8
Qls	Landslide deposits (Quaternary)	16	4	25.0	0.2	11.6
Qt	Fluvial terrace deposits, undifferentiated (Pleistocene and Holocene)	50	8	16.0	0.2	11.2
QTc	Continental deposits, undifferentiated (Pleistocene-Pliocene?)	19	1	5.26	0.2	5.6
Qtmp	Fluvial terrace deposits (middle Pleistocene)	50	4	8.00	0.2	7
Tm	Monterey Formation, siliceous mudstone (Miocene)	47	9	19.15	0.2	25.1
Tmdi	Monterey Formation, diatomite (Miocene)	5	3	60.0	0.2	22.1
Tml	Monterey Formation, siltstone (Miocene)	14	1	7.14	0.2	8.2

Tms	Unnamed marine sandstone (late and middle Miocene)	4	0		0.2	0.9
Tsm	Santa Margarita Sandstone (late Miocene)	1	0			1.6
Tts	Marine sandstone (middle Miocene	8	0		0.2	1.2
Totals		***1,059***	***41***	***3.87***	***0.2***	***25.1***

APPENDIX E

Geologic Units (Rosenberg, 2001), Soil Units (NRCS) and Indoor-Radon Data

Geologic Unit	Geologic Unit Name	Soil Unit	Soil Unit Name	N	N GE 4 pCi/l	R %	Low pCi/l	High pCi/l
Kgdc	Granodiorite of Cachagua	CcG	Cieneba	1	0			1.0
		SoE	Sheridan	2	0		0.2	0.3
		SoG	Sheridan	1	0			0.2
Kgdm	Porphyritic granodiorite of Monterey	GfF	Gazos	1	0			3.6
		NcC	Narlon	41	1	2.44	0.2	8.1
		NcE	Narlon	6	0		0.2	0.7
		ScG	San Andreas	3	0		0.2	0.3
		SfF	Santa Lucia	1	0			0.5
		SoD	Sheridan	16	0		0.2	1.2
		SoE	Sheridan	5	0		0.2	0.4
Kgds	Porphyritic granodiorite of Sand Creek	SoG	Sheridan	1	0		0.2	1.2
Kqds	Hornblende-biotite quartz diorite of Soberanes Point	JbG	Junipero	2	0		0.4	2
		LkG	Los Gatos	1	0			0.2
Kqmg	Garnetiferous quartz monzonite of Pine Canyon	AsB	Arroyo Seco	1	0			0.7
Qa	Aromas Sand, undifferentiated (Pleistocene)	AkD	Arnold	40	0		0.2	2.6
		AkF	Arnold	24	0		0.2	1.9
		Ar	Arnold	5	0		0.2	1.8
		EeD	Elkhorn	1	0			0.9
		EeE	Elkhorn	2	0		0.4	0.6
		PnE	Placentia	1	0			1.1
		ShC	San Andreas	1	0			0.2

Qal	Alluvial deposits, undifferentiated (Holocene)	Af	Aquic Zerofluvents	2	0		0.3	0.5
		AkD	Arnold	2	0		0.5	0.9
		AvA	Arroyo Seco	2	0		0.2	0.7
		EaA	Elkhorn	4	0		0.5	1.6
		GkB	Gorgonio	3	0		0.2	2.8
		MnA	Mocho	1	0			1.1
		NcC	Narlon	5	0		0.2	1.4
		PnA	Placentia	1	0			0.5
		PnC	Placentia	1	0			0.8
		RaA	Rincon	3	1	33.3	2.6	4.4
		SfF	Santa Lucia	2	1	50.0	1.6	7.5
		Sg	Santa Lucia	2	0		0.2	3.0
		ShE	Santa Ynez	2	0		0.2	0.3
		TaC	Tangoir	1	0			0.4
Qb	Basin deposits (Holocene)	Cg	Clear Lake	13	0		0.2	3
		CnA	Cropley	11	0		0.7	3
Qc	Colluvium (Holocene)	AkD	Arnold	5	0		0.2	2.9
		AkF	Arnold	3	0		0.2	0.4
		ShE	Santa Ynez	2	0		0.5	1.1
		W	--	1	0			1.0
Qct	Coastal terraces, undifferentiated (Pleistocene)	BbC	Baywood	32	0		0.2	2
		CaD	Chamise	14	0		0.2	1.5
		CaE	Chamise	4	0		0.2	0.9
		NcC	Narlon	115	0		0.2	2.4
		NcE	Narlon	7	0		0.2	1.4
		OaD	Oceano	3	0		0.5	1.3
		PdC	Pfeiffer	2	0		0.2	0.5
		ScG	San Andreas	1	0			0.8
		SfD	Santa Lucia	3	0		0.2	1.7
		SfE	Santa Lucia	2	0		0.3	0.3

		ShD	Santa Ynez	6	0		0.2	2.4
		SoD	Sheridan	4	0		0.2	1.2
		SoG	Sheridan	2	0		0.2	2.1
		Xc	Xerothents, loamy	3	0		0.2	0.4
Qd	Dune deposits (Holocene)	BbC	Baywood	1	0			0.2
		Df	Dune land	5	0		0.2	0.6
Qe	Eolian deposits, undifferentiated (Pleistocene)	AkF	Arnold	1	0			0.4
		Ar	Arnold	1	0			0.6
		BbC	Baywood	142	0		0.2	2.4
		CaD	Chamise	1	0			1.2
		EdC	Elkhorn	2	0		0.2	0.8
		EeD	Elkhorn	5	0		0.2	1.0
		EeE	Elkhorn	2	0		1.1	1.1
		NcC	Narlon	2	0		0.2	0.7
		OaD	Oceano	17	0		0.2	0.9
		ShC	Santa Ynez	1	0			0.4
		ShE	Santa Ynez	1	0			0.2
		SoD	Sheridan	3	0		0.2	0.2
		TaC	Tangoir	28	0		0.2	1.2
Qfp	Flood-plain deposits, undifferentiated (Holocene)	AvA	Arroyo Seco	1	0			1.0
		AvB	Arroyo Seco	1	0			2.9
		CbA	Chualar	1	0			0.9
		CnA	Cropley	13	1	7.7	0.5	5.0
		EaA	Elder	2	0		0.2	1.8
		EbC	Elder	6	0		0.2	1.5
		Fa	Fluvents, stony	3	0		0.4	0.8
		GkB	Gorgonio	32	1	3.1	0.2	5.2
		LeC	Lockwood	3	0		1.0	2.8
		MnA	Mocho	3	0		0.2	0.9
		MoA	Mocho	4	0		0.7	2.5

		Pa	Pacheco	5	0		0.2	1.2
		Pf	Pico	9	0		0.2	3.6
		Pr	Psamments and Fluvents, occasionally flooded	1	0			0.8
		Ps	Psamments and Fluvents, frequently flooded	1	0			0.3
		RaA	Rincon	3	1	33.3	0.2	7.5
		SbA	Salinas	68	3	4.4	0.2	5.5
		TbB	Tujunga	4	0		0.7	0.2
		Xc	Xerothents, loamy	1	0			0.4
Qfpl	Alluvial fans (late Pleistocene)	AsA	Arroyo Seco	2	0		1.2	1.3
		AsB	Arroyo Seco	1	0			1.2
		CbA	Chualar	50	1	2.0	0.2	5.2
		DaA	Danville	2	1	50.0	0.7	4.4
		EaA	Elder	2	0		0.4	0.9
		HbB	Hanford	3	0		0.2	2.6
		PnA	Placentia	4	0		0.2	1.3
		Xb	Xerothents, sandy	4	0		0.9	2.7
Qfpm	Alluvial fans (middle Pleistocene)	AeC	Antioch	1	0			0.9
		CbA	Chualar	6	0		0.4	1.4
		CbB	Chualar	3	0		0.2	1.9
		CbC	Chualar	2	0		0.6	0.6
		GhC	Gloria	1	0			1.4
		PnA	Placentia	3	0		0.8	1.7
		PnC	Placentia	2	0		0.4	0.8
Qhf	Alluvial fan deposits, undifferentiated (Holocene)	AsB	Arroyo Seco	1	0			0.2
		CbA	Chualar	1	0			0.5
		EaA	Elder	3	0		0.3	1.6
		HbB	Hanford	3	0		1.8	0.2

Qls	Landslide deposits (Quaternary)	EaA	Elder	1	0			0.3
		EbC	Elder	1	0			0.8
		Jc	Junipero	1	0			0.7
		NcE	Narlon	4	2	50.0	4.1	6.7
		PnD	Placentia	2	0		0.2	0.2
		ScG	San Andreas	1	0			1.4
		SfE	Santa Lucia	2	1	50.0	3.5	11.0
		Sg	Santa Lucia	4	1	25.0	0.2	11.6
Qt	Fluvial terrace deposits, undifferentiated (Pleistocene and Holocene)	AeC	Antioch	6	0		0.2	0.6
		AsB	Arroyo Seco	2	0		1.7	1.9
		AvB	Arroyo Seco	4	0		0.3	2.9
		CaD	Chamise	4	0		0.6	2.0
		CbB	Chualar	10	3	30.0	0.2	5.5
		CbC	Chualar	1	0			1.7
		CcG	Cieneba	1	0			1.0
		GkB	Gorgonio	3	1	33.3	1.7	5.7
		HaE	Haire	1	0			0.4
		Jc	Junipero	2	0		0.6	1.4
		LeC	Lockwood	4	2	50.0	0.7	11.1
		OaD	Oceano	2	0		0.2	1.5
		SfE	Santa Lucia	1	0			1.1
		SfF	Santa Lucia	3	1	33.3	0.6	5.5
		Sg	Santa Lucia	1	0			0.2
		ShD	Santa Ynez	1	0			2.7
		ShE	Santa Ynez	2	1	50.0	0.6	6.2
		Xd	Xerothents, dissected	2	0		0.7	2.3
QTc	Continental deposits, undifferentiated (Pleistocene-Pliocene?)	Am	Arnold	1	0			1.9
		LhE	Lopez	1	0			1.1

		ScG	San Andreas	1	0			0.2
		SfF	Santa Lucia	1	0			0.6
		ShC	Santa Ynez	1	0			1.4
		ShE	Santa Ynez	12	1	8.3	0.2	5.6
		Xd	Xerothents, dissected	2			0.4	3.8
Qtmp	Fluvial terrace deposits (middle Pleistocene)	AeA	Antioch	28	3	10.7	0.2	6.3
		AeC	Antioch	2	0		0.3	1.2
		Cg	Clear Lake	1	0			3.2
		CnA	Cropley	3	0		0.2	0.6
		CnC	Cropley	4	1	25.0	0.3	7.0
		DbE	Dibble	1	0			1.9
		EeD	Elkhorn	2	0		0.8	2.3
		PnA	Placentia	1	0			0.2
		ShC	Santa Ynez	2	0		0.2	0.7
		ShD	Santa Ynez	4	0		0.2	3.3
		ShE	Santa Ynez	2	0		1.0	1.1
Tm	Monterey Formation, siliceous mudstone (Miocene)	CaD	Chamise	1	1	100.0		4.6
		EbC	Elder	1	0			2.6
		Fa	Fluvents, stony	1	0			1.2
		GfE	Gazos	1	0			1.8
		NcC	Narlon	1	0			0.6
		SfE	Santa Lucia	14	2	14.3	0.2	8.1
		SfF	Santa Lucia	7	2	28.6	0.2	25.1
		Sg	Santa Lucia	17	4	23.5	0.2	22.8
		Xc	Xerothents, loamy	2	0		1.0	1.0
		Xd	Xerothents, dissected	2	0		0.3	3.4
Tmdi	Monterey Formation, diatomite (Miocene)	AkF	Arnold	1	0			0.6
		SfE	Santa Lucia	1	1	100.0		8.7

		SfF	Santa Lucia	2	1	50.0	0.2	7.2
		Sg	Santa Lucia	1	1	100		22.1
Tml	Monterey Formation, siltstone (Miocene)	GfF	Gazos	1	0			1.9
		NcC	Narlon	3	0		0.2	3.3
		NcE	Narlon	5	0		0.2	3.7
		SfE	Santa Lucia	5	1	20.0	0.5	8.2
		SfF	Santa Lucia	1	0			0.2
Tms	Unnamed marine sandstone (late and middle Miocene)	PdD	Pfeiffer	1	0			1.3
		ScG	San Andreas	3	0		0.2	0.9
Tsm	Santa Margarita Sandstone (late Miocene)	ScG	San Andreas	1	0			1.6
Tts	Marine sandstone (middle Miocene	NcE	Narlon	2	0		0.2	0.6
		ScG	San Andreas	1	0			0.9
		SfF	Santa Lucia	1	0			1.2
		ShE	Santa Ynez	2	0		0.6	0.8
		SoE	Sheridan	2	0		0.9	1.0
Totals				***1,059***	***41***	***3.87***	***0.2***	***25.1***

APPENDIX F

Summary of NURE Airborne Radiometric Survey Equivalent Uranium Results for the Santa Cruz 1X2 Degree Quadrangle (*this quadrangle includes most of Monterey County and portions of adjoining counties.)*

1:250K Geologic Map Unit*	Mean eU (ppm)*	St. Dev. eU (ppm)*	Events (N)*	Population Distribution Type*	Related 1:100K Geologic Map Units**
E	3.93	2.00	1,781	Log-normal	Berry Conglomerate, Church Creek Fm, Reliz Canyon Fm—The Rocks Sandstone, Lucia Shale, Junipero Sandstone
EP	3.42	1.55	1,564	Log-normal	Reliz Canyon Formation inc. Junipero sandstone, Church Creek Fm, Carmelo Formation; includes some (quartzofeldspathic rocks Cretaceous or earlier)
GR	3.68	1.80	8,347	Log-normal	Many of the granitic rock units on the 100K map, marble, mica schist, and some Monterey Fm and other Tertiary units
KJF	3.01	1.98	6,158	Log-normal	Marine sandstone-late Cretaceous, marble, some Monterey Fm and other Tertiary units
KJFV	2.89	1.97	145	Log-normal	Franciscan mafic volcanic rocks, mélange, and undifferentiated Franciscan
KU	3.72	2.23	10,945	Log-normal	Marine sandstone-late Cretaceous, Italian Flat Formation, Gravelly Flat Formation, marble, Coastal terraces, Franciscan Complex, some granitic rocks
LS	3.93	2.03	302	Log-normal	Marble-Cretaceous or earlier, Coast Ridge belt-marble, Quartz monzonite (Fremont Peak), Quartz diorite-granodiorite (Johnson Canyon), Quartz monzonite (Bickmore

					Canyon)
M	2.92	1.45	6,114	Log-normal	Marble, gneiss-granofels-quartzite, diorite and hornblende-olivine gabbro, various granitic rock units, Marine sandstone-late Cretaceous
ML	4.19	2.26	2,056	Log-normal	Monterey Formation-siliceous mudstone, clay shale, semi-siliceous shale, Devil Water member, Temblor sandstone, Vaqueros sandstone, Marine sandstone-middle Miocene, Quartzofeldspathic rocks-Cretaceous or earlier, Berry conglomerate, Hornblend-biotite quartz diorite and some other granitic rock units
MM	5.44	2.50	4,782	Normal	Monterey Formation-siliceous mudstone, diatomite, clay shale, semi-siliceous shale, Devil Water member, Pancho Rico Formation-diatomaceous mudstone, sandstone lenses, diatomaceous siltstone, diatomite, Marine sandstone-middle Miocene, Vaqueros Formation, Santa Margarita sandstone, Temblor sandstone, Paso Robles Formation, Basaltic andesite flows, Porphyritic granodiorite and some other granitic rock units
MMC	3.02	1.64	566	Log-normal	Marine sandstone-middle Miocene, Monterey Formation-siliceous mudstone, Red beds-middle Miocene, Basaltic andesite flows, Porphyritic granodiorite and some other granitic

					rocks
MU	4.03	1.93	1,057	Log-normal	Monterey Formation-siliceous mudstone, diatomite, clay shale, semi-siliceous shale, Pancho Rico Formation-diatomaceous mudstone, sandstone lenses, diatomaceous siltstone, diatomite, Paso Robles Formation, Unnamed marine arkosic sandstone (late middle Miocene), Etchegoin Formation, Santa Margarita sandstone, Reef Ridge Shale
MV	5.01	3.55	1,170	Log-normal	Intrusive dacite felsite, Pinnacles Formation
MVB	1.74	0.37	10	Unknown	Basaltic andesite, Marine sandstone-middle Miocene
MVP	4.94	2.51	31	Unknown	Pinnacles Formation-dacitic breccia and tuff breccia
MVR	3.67	1.25	101	Log-normal	Intrusive Felsitic dacite, Dacite vent breccia, Pinnacles Formation
O	3.93	1.55	446	Log-normal	Church Creek Formation, Vaqueros Formation, Intrusive dioritic felsite, Reliz Canyon Formation—The Rocks Sandstone
OC	4.69	2.57	203	Log-normal	Berry conglomerate, Vaqueros Formation, Reliz Canyon Formation-The Rocks Sandstone, Red beds (middle Miocene)
PML	3.59	2.01	10,229	Log-normal	Paso Robles Formation-undifferentiated, Pancho Rico Formation-diatomaceous mudstone and sandstone lenses, Etchegoin Formation, Monterey Formation-siliceous mudstone, Franciscan Complex-undifferentiated, Quartz

					diorite-granodiorite (Johnson Canyon) Reef Ridge shale
PU	3.07	1.71	987	Log-normal	Merced Fm., San Joaquin Fm.
QAL	3.76	1.55	8,742	Log-normal	various alluvial deposits
QC	3.80	2.36	4,105	Log-normal	Colluvium, Aromas sand, Continental deposits-equivalent to Paso Robles Formation?, Fluvial terrace deposits, some granitic rock units
QM	3.43	1.18	499	Log-normal	Coastal terraces, marine clastic sediment (late Cretaceous)
QP	3.48	2.17	6,364	Log-normal	Paso Robles Formation, Pancho Rico Fm, Santa Margarita sandstone
QS	3.34	1.46	134	Normal	Eolian deposits, Coastal terraces, Dune deposits, Flood plain deposits, Beach sand
QT	3.60	1.60	5,551	Log-normal	Alluvial Fans (Pleistocene), Coastal Terraces (Pleistocene), Paso Robles Formation, Flood Plain deposits, Eolian deposits, Fluvial terrace deposits (Pleistocene), Aromas Sand, Colluvium, Basin deposits
TI	8.53	4.41	119	Log-normal	Intrusive dacite felsite, Quartz diorite-granodiorite of Johnson Canyon
UB	2.54	1.29	1,194	Log-normal	Serpentinite (Jurassic), Franciscan Complex-undifferentiated, mélange, greywacke sandstone, mafic volcanics, some Monterey Formation and other Tertiary units

*Data from High Life Helicopters, Inc., 1981b.

**100,000-scale map Quaternary surficial deposits are not listed. Note that 1:250,000-scale map unit units are heterogeneous in regard to 100,000-scale map rock units—the 1:250,000-scale map units often including a number of 100,000 rock units-sometimes with diverse characteristics and origins. This situation results from increased detail of the 1:100,000 scale map, changes in mapping in the decades since 1:250,000–scale map completion, and problems related to registration of the two different scale maps.

APPENDIX G

NURE Airborne Radiometric Survey Equivalent Uranium Anomalies for the Santa Cruz 1X2 Degree Quadrangle (Anomaly information from High Life Helicopters, Inc., 1981; only anomalies within Monterey County are listed)

Anomaly # and 7.5 minute Quad Name	1:250K Map Geologic Unit	1:100K Map Geologic Unit	Geologic Units-Comments
# 5 San Juan Bautista	LS, GR	pKms, pKm	Anomaly over contact between marble and mica schist in the Gabilan Range
# 7 Mount Johnson	GR	Kqdj	Anomaly over quartz diorite-granodiorite of Johnson Canyon in Gabilan Range
# 14 Topo Valley	MVP	QTp, Tucs, Tpo	Anomaly over Paso Robles Formation (*Pleistocene-Pliocene nonmarine sediments*), Unnamed marine sandstone (Pliocene?), Pancho Rico Formation (late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments)
# 23 Pinalto Canyon	QT	Kqdj, QTp, Qal, Tpo	Anomaly over quartz diorite-granodiorite of Johnson Canyon in Gabilan Range, Paso Robles Formation (Pleistocene-Pliocene nonmarine sediments), unconsolidated alluvial deposits, Pancho Rico Formation (*late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments*)
# 24 Paraiso Springs	QT	QTp, Qfpl, Qls, Qhf	Anomaly over Paso Robles Formation, late Pleistocene alluvial fans, landslide deposits, and Holocene alluvial fans (*Note: alluvial fan and landslide deposits here likely contain Monterey Formation debris--RKC*)
# 25 Pinalto Canyon	GR	Kqdj, Tpo, QTp	Anomaly over quartz diorite-granodiorite of Johnson Canyon in Gabilan Range, Pancho Rico Formation (*late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments*), Paso Robles Formation (*Pleistocene-Pliocene nonmarine sediments*)
# 26 Pinalto Canyon	GR	Kqdj, Tpo, Qt,	Anomaly over quartz diorite-granodiorite of Johnson Canyon in Gabilan Range, Pancho Rico Formation (*late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments*), Fluvial terrace deposits

# 27 Pinalto Canyon	GR	Kgdg, Tpo	Anomaly over Granodiorite of Gloria Road, Pancho Rico Formation (*late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments*)
# 28 San Lucas	PML	Tpo, QTp	Anomaly over Pancho Rico Formation (*late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments*), Paso Robles Formation (*Pleistocene-Pliocene nonmarine sediments*)
# 31 Thompson Canyon	MM	Tm,Tps, QTp, Qfp,	Anomaly over Monterey Formation (*Miocene marine siliceous mudstone*), Pancho Rico Formation—marine sandstone lenses, Paso Robles Formation (*Pleistocene-Pliocene nonmarine sediments*), Flood-plain deposits (*Holocene*) in the Santa Lucia Range
# 35 Cosio Knob	MM	Tm	Anomaly over Monterey Formation (*Miocene marine siliceous mudstone*) in the Santa Lucia Range
# 36 Bear Canyon	M	pKqf, Kqmp	Anomaly over Quartzofeldspathic rocks (*gneiss, granofels, quartzite, minor schist*), Quartz monzonite of Pinyon Peak
# 37 Cosio Knob	QP,MU	Tm, Tps, QTp	Anomaly over Monterey Formation (*Miocene marine siliceous mudstone*), Pancho Rico Formation—marine sandstone lenses, Paso Robles Formation (*Pleistocene-Pliocene nonmarine sediments*)
# 38 Cosio Knob	MM	Tm, Tps, QTp	Anomaly over Monterey Formation (*Miocene marine siliceous mudstone*), Pancho Rico Formation—marine sandstone lenses, Paso Robles Formation (*Pleistocene-Pliocene nonmarine sediments*) in the Santa Lucia Range
# 41 San Ardo	QAL,PML	Tpo, Tucs, QTp, Qt, Qfp,	Anomaly over Pancho Rico Formation (*late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments*), Unnamed marine sandstone (Pliocene?), Paso Robles Formation (*Pleistocene-Pliocene nonmarine sediments*), Fluvial terrace deposits, Flood-plain deposits (*Holocene*)
# 42 San Ardo	PML	Tpo, Qfp	Anomaly over Pancho Rico Formation (*late Miocene to early Pliocene diatomaceous mudstone and siliceous sediments*), Flood-plain deposits (*Holocene*)

APPENDIX H

Monterey County NURE Airborne Radiometric Equivalent Uranium Data Equal or Greater than 7.5 ppm within the San Luis Obispo 1X2 degree quad NURE Airborne Radiometric Survey, by 1:100,000-Scale Geologic Map Unit

1:100,000-scale Geologic Map Unit Symbol and Name		Number of Flight-line data points at 7.5 ppm eU or greater	Percent of all Flight-line data points at 7.5 ppm eU or greater	7.5-minute quadrangles containing 7.5 ppm eU or greater locations
KJfm	Franciscan Complex, melange	3	3.8	Cape San Martin
KTs	Marine clastic sedimentary rocks (sandstone, minor shale, conglomerate)	2	2.5	Alder Peak
pKqf	Quartzofeldspathic rocks (gneiss, granofels, quartzite, and minor schist)	1	1.3	Alder Peak
Qal	Alluvial deposits (Holocene)	2	2.5	Valleton
Qfp	Flood-plain deposits (Holocene)	1	1.3	Wunpost
Qls (KJfm)	Landslide deposits (*KJfm debris?-RKC*)	3	3.8	Cape San Martin
Qt	Fluvial terrace deposits (Pleistocene and Holocene)	1	1.3	Alder Peak
QTp	Paso Robles Formation, terrestrial sediments	5	6.3	Bryson, Tierra Redonda Mountain
Tm	Monterey Formation, marine siliceous mudstone	50	63.6	Bryson, Hames Valley, Jolon, Stockdale Mountain, Tierra Redonda Mountain, Valleton, Williams Hill
Tml	Monterey Formation, semi-siliceous marine mudstone	6	7.6	Bryson
Tpd	Pancho Rico Formation, diatomite	1	1.3	Bryson
Tpo	Pancho Rico Formation, diatomaceous mudstone, siltstone-sandy siliceous sediments	2	2.5	Valleton
Tucs	Unnamed marine sandstone (Pliocene?)	1	1.3	Valleton
Tvq	Vaqueros Formation, marine arkosic sandstone	1	1.3	Jolon
total		79	100.1	

APPENDIX I

NURE Sediment(SS), Soil(SL) and Talus Uranium Data by Geologic unit—Monterey County

GEN Unit/NURE Data Type	Unit Description	N	NURE U Data (ppm)	Mean	Median	Low	High
Jsp-SS	Serpentinite (Jurassic)	1	0.8				0.8
Kct-SS	Charnockitic tonalite of Compton (1960) and related(?) rocks (Cretaceous)	3	1.1 5.8 8.9	5.3	5.8	1.1	8.9
Kep-SS	El Piojo Formation (Late Cretaceous)—Marine; thick-bedded sandstone, mudstone, and conglomerate	2	1.1 3.12	2.1	2.1	1.1	3.12
Kgdg-SS	Granodiorite of Gloria Road (Ross, 1972) (Cretaceous)	1	8				8
Kgdg-SL	—	1	4.2				4.2
Kgdm-SS	Porphyritic granodiorite of Monterey (Ross, 1976) (Cretaceous)	2	5.8 2.2	4.0	4.0	2.2	5.8
Kgdm-SL	—	1	3.3				
Kgdn-SS	Quartz monzonite of Fremont Peak (Ross, 1972) (Cretaceous	2	13.5 7.6	10.6	10.6	7.6	13.5
Kgds-SS	Porphyritic granodiorite of Sand Creek (Cretaceous)	2	5.1 4.2	4.7	4.7	4.2	5.1
Kgf-SS	Gravelly Flat Formation (Early Cretaceous)—Marine shale, sandstone at base, structurally overlies Franciscan assemblage	1	1.30				1.30
Kgh-SS	Heterogeneous granitic complex of Eiebe (1966) (Cretaceous)	1	2				2
Kgh-SL	—	2	5.4 1.8	3.6	3.6	1.8	5.4

KJf-SS	Franciscan Complex, undifferentiated (Cretaceous and Jurassic)	5	1.9 1.1 1 4.61 1.73		2.1	1.7	1	4.61
KJfm-SS	Franciscan Complex, melange (Cretaceous and Jurassic)	9	2.9 2.8 2.2 2.2 1.92	1.55 1.04 1.02 0.42	1.73	1.92	0.42	2.9
KJfm-SL	—	4	1.66 1.12 0.98 0.95		1.2	1.1	0.95	1.66
KJfv-SS	Franciscan Complex, mafic volcanic rocks (Cretaceous and Jurassic)	1	1.85					1.85
KJfv-Talus	—	1	2.9					2.9
Kms-SS	Schist of the Sierra de Salinas (Cretaceous)	1	2.7					2.7
Kms-SL	—	1	3.5					3.5
Kqdg-SS	Gneissic quartz diorite of Stonewall Canyon (Ross, 1972) (Cretaceous)	1	2.9					2.9
Kqdj-SS	Quartz diorite-granodiorite of Johnson Canyon (Ross, 1972) (Cretaceous)	7	6.2 5.8 4.9 2.8	2.8 2.6 2.2	3.9	2.8	2.2	6.2
Kqdj-Talus	—	1	10.9					10.9
Kqdp-SS	Hornblende-biotite quartz diorite of the Paraiso-Paloma area (Ross, 1976) (Cretaceous)	1	4.6					4.6
Kqds-SS	Hornblende-biotite quartz diorite of Soberanes Point (Ross, 1976) Cretaceous)	14	18.2 10.2 9.4 6.3 6.2 6.2 5.4	4.2 3 2.9 2.7 2.6 1.8 1.2	5.7	4.8	1.2	18.2

Kqds-SL	—	2	3 2.7		2.9	2.9	2.7	3
Kqds-Talus		1	3					3
Kqdv-SS	Quartz diorite of Vergeles (Ross, 1972) (Cretaceous)	1	2.2					2.2
Kqmf-SS	Quartz monzonite of Bickmore Canyon (Ross, 1972) (Cretaceous)	3	51.2 39.8 23		38	39.8	23	51.2
Kqmp-SS	Granodiorite of Natividad Ross, 1972) (Cretaceous)	2	11.8 4.7		8.3	8.3	4.7	11.8
Kqmv-SS	Variable quartz monzonite-granodiorite of Big Pines and Island Mountain (Wiebe, 1966)_ and similar(?) mass of Willow Creek (Cretaceous)	1	4.8					4.8
Ks-SS	Marine clastic sedimentary rocks, western facies (Late Cretaceous)—Mostly sandstone	1	4.8					4.8
KTg-SS	Marine clastic sedimentary rocks (Paleocene and Late Cretaceous)—Light brown, conglomerate, minor sandstone	1	4.03					4.03
KTs-SS	Marine clastic sedimentary rocks (Paleocene and Late Cretaceous)—Light brown, hard sandstone, minor shale, and conglomerate	2	4.1 3.3		3.7	3.7	3.3	4.1
Ku-SS	Marine clastic sedimentary rocks, eastern facies (Late Cretaceous)—Mostly sandstone	4	6.2 4.3 3.8 3		4.3	4.1	3	6.2
Ku-SL	—	3	4.4 4.1 3.5		4.0	4.1	3.5	4.4
Ku-Talus	—	1	4					4
pKc-SS	Coast Ridge belt (Cretaceous or earlier)—Mostly marble	8	6.9 6.9 5 4.3	3.6 3.2 2.1 2.1	4.3	4.0	2.1	6.9

pKc-SL	—	5	10.7 6.6 3.7 3.3 0.61		5.0	3.7	0.61	10.7
pKg-SS	Graphitic and pyritic belt (Cretaceous or earlier)—Los Padres unit of Wiebe (1970)	1	10.2					10.2
pKm-SL	Marble (Cretaceous or earlier)—Mainly metamorphosed limestone, some dolomite in the Gabilan Range, Includes slide blocks near Parkfield	1	33.9					33.9
pKm-Talus	—	1	1.8					1.8
pKqf-SS	Quartzofeldspathic rocks (Cretaceous or earlier)—Gneiss, granofels, quartzite, and minor schist	15	11.3 9.2 8.9 8.3 8.3 7.2 6.1 6.1	6 5.2 3.9 3.8 3.8 2.3 0.55	6.1	6.1	0.55	11.3
pKqf-SL	—	4	12.3 6.3 5.6 4		7.1	6.0	4	12.3
pKqf-Talus	—	3	8.2 5.1 3.6		5.6	5.1	3.6	8.2
Qa-SS	Aromas Sand, undifferentiated (Pleistocene)—Heterogeneous sequence of mainly eolian and fluvial sand, silt, clay, and gravel	2	9.9 2.1		6.0	6.0	2.1	9.9
Qa-SL	—	2	2.8 2.6		2.7	2.7	2.6	2.8

Qal-SS	Alluvial deposits, undifferentiated (Holocene)—Unconsolidated, heterogeneous, moderately sorted silt and sand with discontinuous lenses of clay and silty clay	80	21.9 19 18.4 12.2 10.9 9.4 8.4 8 7.9 7 6.5 6.5 6.44 6.3 5.7 5.7 5.5 5 4.77 4.7 4.7 4.5 4.5 4.5 4.42 4.4 4.4	4.32 4.3 4 3.93 3.9 3.9 3.81 3.7 3.7 3.66 3.6 3.6 3.6 3.6 3.5 3.4 3.3 3.3 3.3 3.3 3.3 3.2 3.2 3.2 3.2 3.1 3.1	3 3 2.99 2.8 2.8 2.75 2.7 2.7 2.7 2.67 2.5 2.44 2.44 2.4 2.4 2.23 2.05 1.99 1.93 1.9 1.9 1.8 1.70 1.58 1.4 1.27	4.6	3.6	1.27	21.9
Qal-SL	—	4	6.7 4.3 2.57 1.8			3.8	3.4	1.8	6.7
Qal-Talus	—	2	4.5 2.6			3.6	3.6	2.6	4.5

Qal-Tm*	—	15	9.4 7.9 6.5 6.44 6.3 5.7 5.7 4.77	4.7 4.5 3.81 3.5 2.44 1.93 1.27	5.0	4.8	1.27	9.4
Qb-SS	Basin deposits (Holocene)—Unconsolidated, plastic clay and silty clay containing much organic material; locally contains interbedded thin layers of silt and silty sand	3	6.7 3.8 2.45		4.2	3.8	2.45	6.7
Qb-SL	—	6	3.7 3.6 3.6	3.5 3.4 3	3.5	3.6	3	3.7
Qc-SS	Colluvium (Holocene)—Unconsolidated, heterogeneous deposits of moderately to poorly sorted silt, sand, and gravel deposited by slope wash and mass movement	5	20.7 3.18 2.8 2.44 2.38		6.3	2.8	2.38	20.7
Qc-SL	—	2	3.4 2.7		3.1	3.1	2.7	3.4

Qct-SS	Coastal terraces, undifferentiated (Pleistocene)—Simiconsolidated, moderately well-sorted marine sand containing thin, discontinuous gravel-rich layers. Locally includes some terrace surfaces and debris flow deposits resting on terrace surfaces	2	5.3 2		3.7	3.7	2	5.3
Qct-SL	—	2	3.9 2.1		3.0	3.0	2.1	3.9
Qe-SS	Eolian deposits, undifferentiated (Pleistocene)—weakly to moderately consolidated, moderately to well-sorted silt and fine-to medium-grained sand deposited in extensive coastal dune field	1	5.4					5.4
Qe-SL	—	12	6.8 4.5 3.9 3.8 3.7 3.7	3.2 3 3 2.9 2.8 1.9	3.6	3.5	1.9	6.8
Qfp-SS	Flood-plain deposits, undifferentiated (Holocene)—Unconsolidated, relatively fine-grained, heterogeneous deposits of sand and silt; commonly includes relatively thin, discontinuous layers of clay	29	6.3 5.7 4.5 3.9 3.9 3.4 3.2 3.1 3 2.9 2.9 2.9 2.8 2.8 2.76	2.7 2.45 2.43 2.40 2.3 2.3 2.3 2.23 2.2 2.1 2 1.91 1.85 1.8	2.9	2.8	1.8	6.3

Qfp-SL	—	28	7.2 5.6 5.5 5.06 4.5 4.2 4.1 4 4 4 3.9 3.8 3.8 3.7	3.5 3.4 3.3 3.3 3.2 3.2 3.1 3.1 3.1 2.9 2.9 2.8 2.4 2	3.8	3.6	2	7.2
Qfpl-SS	Alluvial fans (late Pleistocene)—Weakly consolidated, moderately to poorly sorted sand, silt, and gravel	10	8.6 5.8 5.6 3.6 3.57	3.54 3.3 3.28 2.8 2.1	4.2	3.6	2.1	8.6
Qfpl-SL	—	17	8.2 6.3 6.2 5.2 5.2 5 4.6 4.6 4.5	3.8 3.7 3.5 3.4 3.2 3.2 2.8 2.7	4.5	4.5	2.7	8.2
Qfpm-SS	Alluvial fans (middle Pleistocene)—Moderately consolidated, deeply weathered, moderately to poorly sorted sand, silt, and gravel, capped with moderately well drained, maximally developed soils	9	8.2 6.7 6.1 5.4 4.8	4.5 3.9 3.8 2.1	5.1	4.8	2.1	8.2
Qfpm-SL	—	1	3.9					3.9
Qfpm-Talus	—	1	2.8					2.8

Qfu-SS	Alluvial fans, undifferentiated (Pleistocene)—Weakly to moderately consolidated, moderately to poorly sorted sand, silt, and gravel deposits, but includes some fan surfaces near Lockwood. Locally divided into: Qfpl and Qfpm	6	4.48 2.39 2.38 2.09 1.67 1.36		2.4	2.2	1.36	4.48
Qfu-SL	—	1	7.17					7.17
Qhf-SS	Alluvial fan deposits, undifferentiated (Holocene)—Unconsolidated, moderately to poorly sorted sand, silt, and gravel, with layers of silty clay	13	20.1 9.8 5.6 4.1 4.1 3.8 3.7	3.1 3 2.9 2.9 2.7 2.6	5.3	3.7	2.6	20.1
Qhf-SL	—	11	17.8 13.5 10.7 10 6.3 5.8	5.6 4.8 4.1 3.3 2.8	7.7	5.8	2.8	17.8
Qls-SS	Landslide deposits (Quaternary)—Heterogeneous mixture of deposits ranging from large block slides of indurated bedrock to debris slows in semiconsolidated sand and clay	15	8 4.6 4 3.6 3.6 3.1 3 2.9	2.9 2.7 2 1.94 1.6 1.46 1.3	3.1	2.9	1.3	8
Qls-Talus	—	5	13.2 1.4 1.2	0.7 0.3	3.4	1.2	0.3	13.2
Qls-Tm-SL	—	1	3.9					3.9

Qsc-SS	Stream channel deposits, undifferentiated (Holocene)—Modern stream channels and channel deposits of the Salinas River and principal tributaries. Loose, moderately-to well-sorted gravel, coarse-to fine-grained sand and silt	1	4.2					4.2
Qsc-SL	—	1	3.2					3.2
Qscp-SS	Sandstone and conglomerate of Sims, 1990 (Pleistocene?)—Sand and gravel, olive gray, poorly sorted, poorly consolidated; contains clasts derived from Franciscan Complex	1	2.7					2.7
Qt-SS	Fluvial terrace deposits, undifferentiated (Pleistocene and Holocene)—Weakly consolidated to semiconsolidated, moderately to poorly sorted silt, silty clay, sand, and gravel deposited in a fluvial environment. Age is Pleistocene, except in near Parkfield, where map unit includes Holocene deposits. Locally divided into: Qtlp—Fluvial terrace deposits (late Pleistocene); and Qtmp—Fluvial terrace deposits (middle Pleistocene)	22	8.1 6.9 6.2 5.6 5.6 4.2 3.8 3.2 3.2 3 3	2.7 2.7 2.6 2.6 2.60 2.34 2.22 2.1 1.98 1.75 0.73	3.5	2.9	0.73	8.1
Qt-SL	—	3	3.7 2.4 2.12		2.7	2.4	2.12	3.7
QTc-SS	Continental deposits, undifferentiated (Pleistocene-Pliocene?)—Semiconsolidated, relatively fine-grained, oxidized sand and silt. Probably equivalent to Paso Robles Formation	1	6.3					6.3
QTc-SL	—	1	3.9					3.9
QTc-Talus	—	1	2.1					2.1
QTcl-SS	Paso Robles Formation, clay (Pleistocene-Pliocene?)—mainly clay	2	2.12 1.75		1.9	1.9	1.75	2.12
QTg-SS	Paso Robles Formation. Cobble gravel (Pleistocene-Pliocene?)—Cobble gravel	1	2.1					2.1

Qtmp-SL	Fluvial terrace deposits (Middle Pleistocene)—Semi-consolidated, moderately well to poorly sorted sand, silt, and clay with interbedded gravel	4	4.2 2.8 2.6 2.5		3.0	2.7	2.5	4.2
QTp-SS	Paso Robles Formation, undifferentiated (Pleistocene-Pliocene?)—Terrestrial sediments of Salinas Valley, weakly indurated pebble gravel with minor sand and clay. Locally divided into: QTcl (clay), QTm(marl), QTpc(clay and minor gravel) and QTg(cobble gravel)	27	4.32 4.19 3.3 3.3 3.02 3.00 2.84 2.81 2.66 2.42 2.25 2.24 2.18 2.18	2.06 2.04 2.02 1.95 1.95 1.95 1.86 1.82 1.8 1.73 1.58 1.51 1.46	2.4	2.2	1.46	4.32
QTp-SL	—	2	2.6 2.28		2.4	2.4	2.28	2.6
Tbe-SS	Berry Conglomerate (Oligocene)—Terrestrial red beds, sandstone, and conglomerate	1	2.3					2.3
Tcc-SS	Church Creek Formation (Eocene)—Marine; dark gray, micaceous siltstone-mudstone	3	3.7 3.1 3		3.3	3.1	3	3.7
Te-SS	Etchegoin Formation (late Miocene to Pliocene)—Marine sandstone and claystone, fossiliferous. Overlies Reef Ridge Shale or unconformable on older formations	6	2.3 2.1 2.1 1.9 1.8 1.38		1.9	2.0	1.38	2.3
Tj-SS	Junipero Sandstone (Early Eocene and Late Paleocene?)—Shallow marine; tan, arkosic; medium-grained sandstone, transgressive	2	11 7.8		9.4	9.4	7.8	11

Tm-SS	—	31	12.2 10 8.65 8.07 7.93 7.7 7.33 7.23 7 6.8 6.8 6.7 6.65 6.6 6.4 6.3	6.2 6.2 6.10 5.5 5.12 5.1 4.8 4.64 4.5 4.3 3.9 3.70 3 2.87 1.8	6.1	6.3	1.8	12.2
Tm-SL	—	7	9 7.2 4.6 4.3	3.8 3.4 0.98	5.2	4.6	0.98	9
Tm-Talus	—	3	15.4 8.2 5.26		9.6	8.2	5.26	15.4
Tml-SS	Monterey Formation, semi-siliceous mudstone (middle Miocene)—Semi-siliceous mudstone and siltstone (Sandholdt Shale Member of Durham 1968; 1974)	2	5.7 5.17		5.4	5.4	5.17	5.7
Tms-SS	Unnamed marine sandstone (late and middle Miocene)—Marine, buff to light gray, poorly to well-sorted arkosic sandstone	1	4.46					4.46
Tms-Talus	—	1	1.69					1.69
Tnt-SS	Unnamed nonmarine red beds of upper Tularcitos Canyon (age uncertain)—Terrestrial sandstone and siltstone, weakly indurated	2	6.1 2.4		4.3	4.2	2.4	6.1

Tpa-Talus	Pledras Altas Formation (Eocene or Paleocene)—Non-marine sandstone, red beds, and conglomerate	1	4.1					4.1
Tpi-SS	Pancho Rico Formation, siltstone (late Miocene to early Pliocene)—Diatomaceous siltstone to silty sandstone	1	3.5					3.5
Tpo-SS	Pancho Rico Formation, mudstone (late Miocene to early Pliocene)—Diatomaceous mudstone, siltstone to sandy siliceous sediments	13	6 4 3.3 3.3 3.1 2.8 2.8	2.7 2.7 2.6 2.3 2.2 2.11	3.1	2.8	1.65	6
Tpo-SL	—	2	3 2.39		2.7	2.7	2.39	3
Tps-SS	Pancho Rico Formation, sandstone lenses (late Miocene to early Pliocene)—Sandstone lenses	2	5.2 2.1		3.7	3.7	2.1	5.2
Tsm-SS	Santa Margarita Sandstone (late Miocene)—Marine and brackish-marine; white, friable; fine- to coarse-grained arkosic sandstone	1	2.5					2.5
Tss-SS	Unnamed marine sandstone (Paleocene)—Dark gray thin-bedded to very thick bedded sandstone and conglomerate	2	8.7 6.7		7.7	7.7	6.7	8.7
Tss-Talus	—	1	12.1					12.1
Tt-SS	Temblor Sandstone (middle Miocene)—Marine sandstone	2	1.65 0.85		1.25	1.25	0.85	1.65
Trb-SL	Red beds (middle Miocene)—Terrestrial; red to gray, poorly sorted arkosic sandstone, cobble conglomerate, and siltstone. Age of unit is probably middle Miocene	1	4.2					4.2
Ttr-SS	The Rocks Sandstone (Middle and Early Eocene)—Deep marine; tan bedded arkosic sandstone	1	5.6					5.6
Ttr-Talus	—	1	3.5					3.5

Tts-SS	Marine sandstone (middle Miocene)—Marine; buff to light gray, poorly to well-sorted arkosic sandstone, locally friable, locally conglomeratic	3	9.8 5.4 3.4		6.2	5.4	3.4	9.8
Tts-SL	—	1	3.6					3.6
Tucc-SS	Unnamed clastic sedimentary unit (probably Pliocene)—Terrestrial pebble-cobble conglomerate/gravel	1	2.52					
Tucg-SS	Unnamed clastic sedimentary unit (probably Pliocene)—Terrestrial cobble gravel	2	2.32 2.07		2.2	2.2	2.07	2.32
Tucs-SS	Unnamed clastic sedimentary unit (probably Pliocene)—Marine sandstone, locally fossiliferous	7	3.7 3.3 3.2 2.9	2.4 2.4 2.29	2.9	2.9	2.29	3.7
Tvq-SS	Vaqueros Formation (of Hamlin, 1904; Durham, 1974) (Oligocene)—Light brown marine arkosic sandstone	7	8.8 5.8 5.6 3.8	3.7 3.7 2.8	4.9	3.8	2.8	8.8
Tvq-Talus	—	1	1.81					1.81

APPENDIX J

NRCS Soil Units with One or More ≥ 4 pCi/l Sites

Soil Unit	Soil Unit Symbol(s)	N	N ≥ 4 pCi/l	R (%)*	Permeability*** by Soil Depth Interval	Shrink-Swell Character
Antioch	AeA	28	3	10.7	0-21" Moderate 21-40" Very slow 40-67" Slow 67-72" Moderately slow	0-21" Low 21-40" High 40-67" High 67-72" Low
Chamise	CaD	20	1	5.0	0-19" Moderate 19-40" Moderately slow 40-60" Moderately slow	0-19" Low 19-40" Moderate 40-60" Moderate
Chualar	CbA, CbB	71	4	5.6	0-21" Moderate 21-44" Moderately slow 44-59" Moderately slow 59-80" Moderately rapid	0-21" Low 21-44" Moderate 44-59" Low 59-80" Low
Cropley	CnA, CnC	31	2	6.5	0-69" Slow	0-69" High
Danville	DaA	2	1	**	0-18" Moderately slow 18-38" Slow 38-67" Moderately slow	0-18" Moderate 18-38" High 38-67" Moderate
Gorgonio	GkB	38	2	5.3	0-22" Rapid 22-63" Rapid	0-22" Low 22-63" Low
Lockwood	LeC	7	2	**	0-40" Moderate 40-82" Moderately slow	0-40" Moderate 40-82" High
Narlon	NcC, NcE	191	3	1.6	0-13" Moderately rapid 13-53" Very slow	0-13" Low 13-53" High
Rincon	RaA	6	2	**	0-14" Moderately slow 14-49" Slow 49-60" Moderately slow	0-14" Moderate 14-49" High 49-60" Moderate

Santa Lucia	SfE, SfF, Sg	99	16	16.2	0-24" Moderate	0-24" Low
Santa Ynez	ShE	23	2	8.7	0-18" Moderate 18-43" Very slow 43-61" Slow	0-18" Low 18-43" High 43-61" Moderate
Salinas	SbA	68	3	4.4	0-5" Moderate 5-75" Moderately Slow	Low Low
Totals		584	41			

* R=percent of measurements at 4 pCi/l or greater

**Too few data

***NRCS Soil Permeability Definitions: very slow = <0.06 in/hr; slow = 0.06-0.2 in/hr; moderately slow = 0.2-0.6 in/hr; moderate = 0.6-2.0 in/hr; moderately rapid = 2.0-6.0 in/hr; rapid = 6.0-20.0 in/hr; very rapid >20.0

APPENDIX K

Descriptive Statistics and Statistical Comparison of Indoor Measurement (non-transformed) for Monterey County Radon Zones

	All Indoor Radon Data	High Zone Radon Data	Moderate Zone Radon Data	Low Zone Radon Data
Size	1,059	84	166	809
Mean	1.126	3.473	1.292	0.848
Std Dev	1.873	5.163	1.418	0.887
Std Error	0.0575	0.563	0.110	0.0312
C.I. of Mean	0.113	1.120	0.217	0.0612
Range	24.9	24.9	6.8	8.5
Max	25.1	25.1	7.0	8.7
Min	0.2	0.2	0.2	0.2
Median	0.60	1.65	0.85	0.60
25%	0.20	0.60	0.30	0.20
75%	1.20	3.85	1.60	1.10
Skewness	7.233	2.793	2.108	3.098
Kurtosis	74.045	8.107	4.455	15.648
K-S Dist.	0.311	0.263	0.221	0.233
K-S-Prob.	<0.001	<0.001	<0.001	<0.001
Sum	1,192.1	291.7	214.50	685.90
Sum of Squares	5,051.69	3,225.33	608.87	1,217.49

APPENDIX L

Descriptive Statistics and Statistical Comparison of Indoor Measurement Data (Log10-transformed) for Monterey County Radon Zones

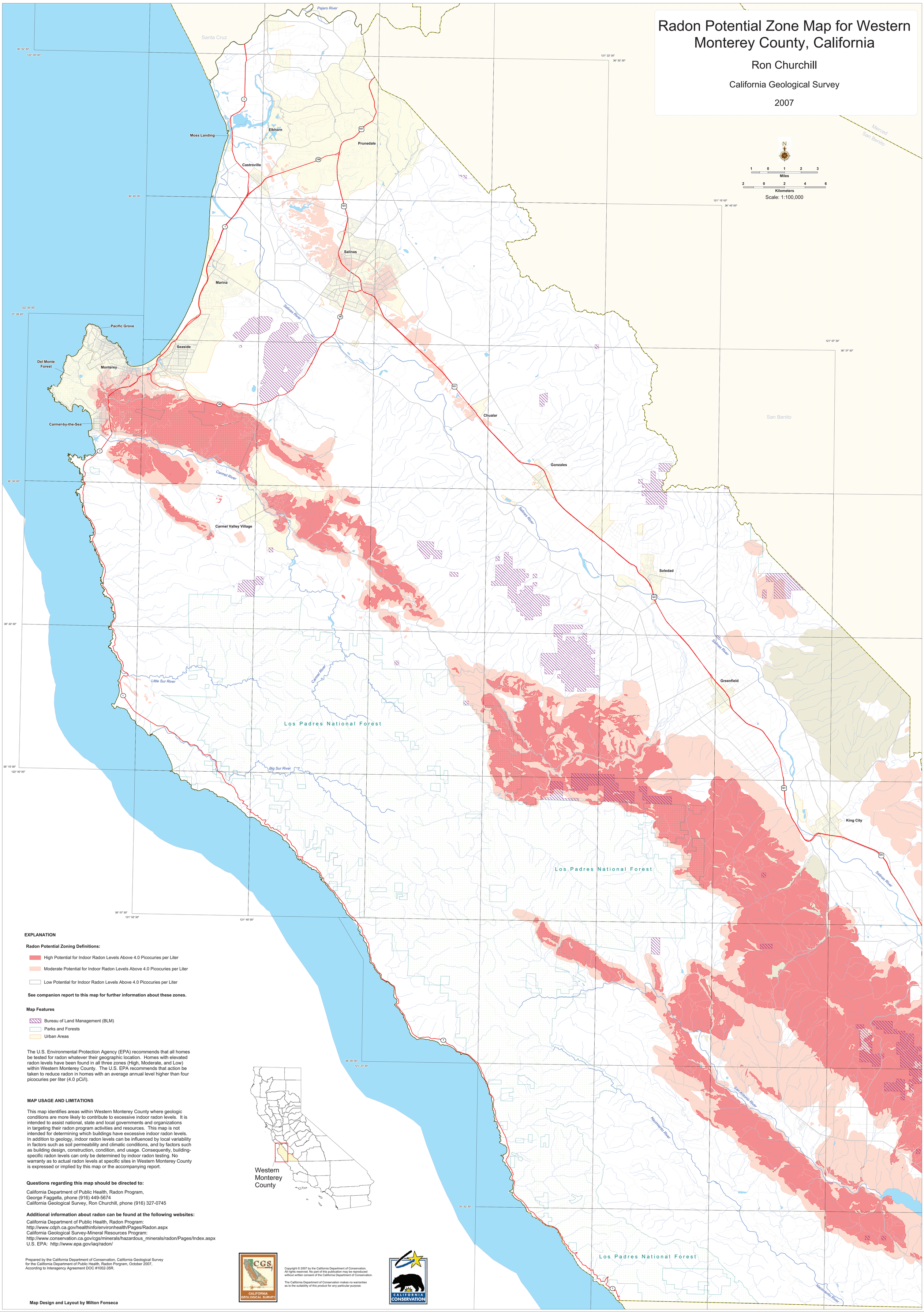
	All Indoor Radon Data	High Zone Radon Data	Moderate Zone Radon Data	Low Zone Radon Data
Size	1,059	84	166	809
Mean	-0.188	0.179	-0.102	-0.244
Std Dev	0.424	0.583	0.433	0.379
Std Error	0.0130	0.0636	0.0336	0.0133
C.I. of Mean	0.0256	0.127	0.0664	0.0262
Range	2.099	2.099	1.544	1.638
Max	1.400	1.400	0.845	0.940
Min	-0.699	-0.699	-0.699	-0.699
Median	-0.222	0.217	-0.0713	-0.222
25%	-0.699	-0.222	-0.523	-0.699
75%	0.0792	0.584	0.204	0.0414
Skewness	0.513	0.0535	0.189	0.3324
Kurtosis	-0.173	-0.739	-0.835	-0.830
K-S Dist.	0.151	0.113	0.121	0.172
K-S-Prob.	<0.001	0.010	<0.001	<0.001
Sum	-199.119	15.074	-16.930	-197.263
Sum of Squares	228.067	30.946	32.702	164.419

Radon Potential Zone Map for Western Monterey County, California

Ron Churchill

California Geological Survey

2007



EXPLANATION

Radon Potential Zoning Definitions:

- High Potential for Indoor Radon Levels Above 4.0 Picocuries per Liter
- Moderate Potential for Indoor Radon Levels Above 4.0 Picocuries per Liter
- Low Potential for Indoor Radon Levels Above 4.0 Picocuries per Liter

See companion report to this map for further information about these zones.

Map Features

- Bureau of Land Management (BLM)
- Parks and Forests
- Urban Areas

The U.S. Environmental Protection Agency (EPA) recommends that all homes be tested for radon whatever their geographic location. Homes with elevated radon levels have been found in all three zones (High, Moderate, and Low) within Western Monterey County. The U.S. EPA recommends that action be taken to reduce radon in homes with an average annual level higher than four picocuries per liter (4.0 pCi/l).

MAP USAGE AND LIMITATIONS

This map identifies areas within Western Monterey County where geologic conditions are more likely to contribute to excessive indoor radon levels. It is intended to assist national, state and local governments and organizations in targeting their radon program activities and resources. This map is not intended for determining which buildings have excessive indoor radon levels. In addition to geology, indoor radon levels can be influenced by local variability in factors such as soil permeability and climatic conditions, and by factors such as building design, construction, condition, and usage. Consequently, building-specific radon levels can only be determined by indoor radon testing. No warranty as to actual radon levels at specific sites in Western Monterey County is expressed or implied by this map or the accompanying report.

Questions regarding this map should be directed to:

California Department of Public Health, Radon Program,
George Faggella, phone (916) 449-5674
California Geological Survey, Ron Churchill, phone (916) 327-0745

Additional information about radon can be found at the following websites:

California Department of Public Health, Radon Program:
http://www.cdph.ca.gov/healthinfo/environhealth/Pages/Radon.aspx
California Geological Survey-Mineral Resources Program:
http://www.conservation.ca.gov/cgs/minerals/hazardous_minerals/radon/Pages/Index.aspx
U.S. EPA: http://www.epa.gov/iaq/radon/

Prepared by the California Department of Conservation, California Geological Survey
for the California Department of Public Health, Radon Porgram, October 2007,
According to Interagency Agreement DOC #1002-35R.

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The California Department of Conservation makes no warranties
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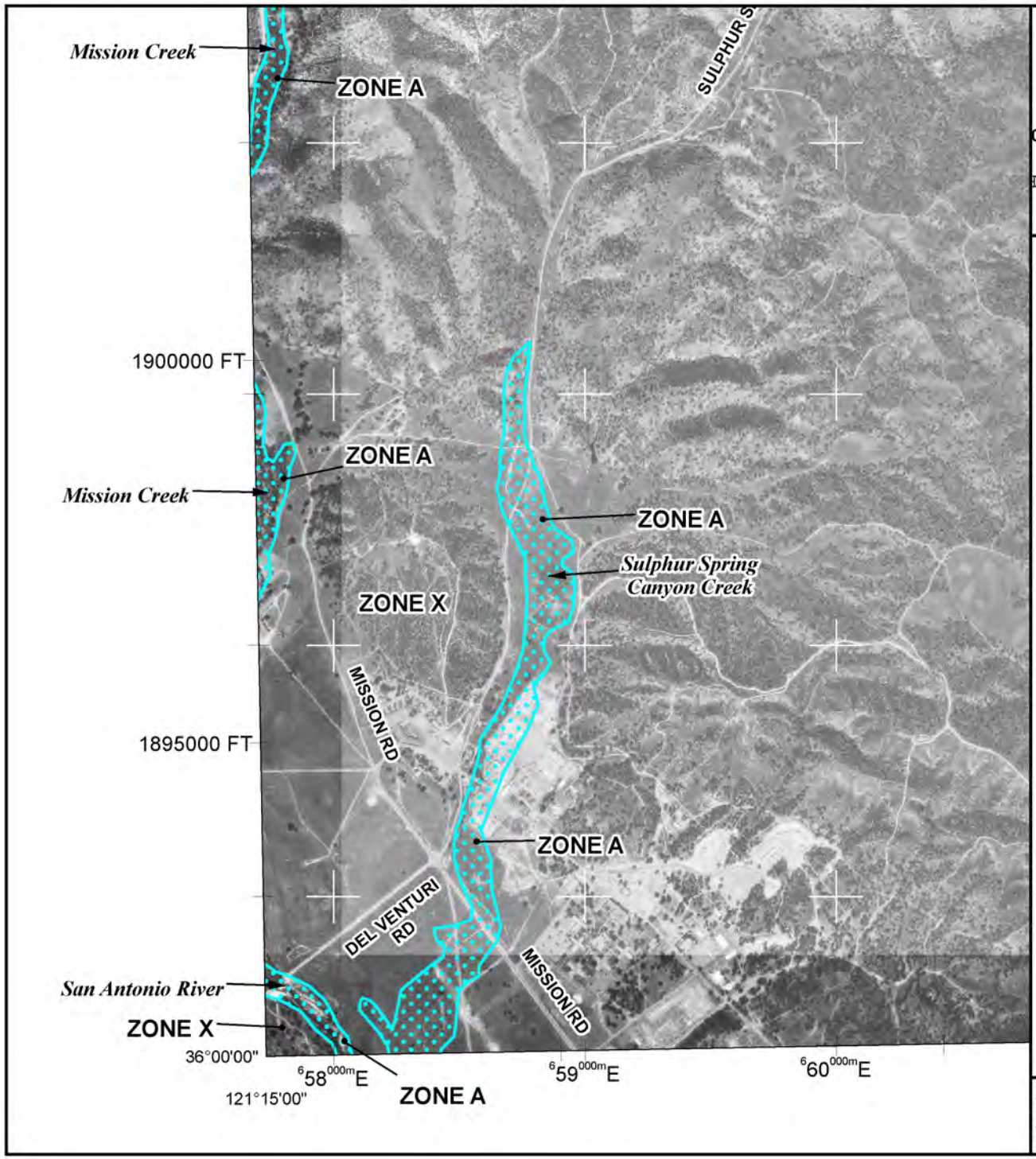
Map Design and Layout by Milton Fonseca



MAP SCALE 1" = 2000'

000 0 2000 4000 FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1325G

FIRM

FLOOD INSURANCE RATE MAP

MONTEREY COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 1325 OF 2050

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MONTEREY COUNTY	060195	1325	G

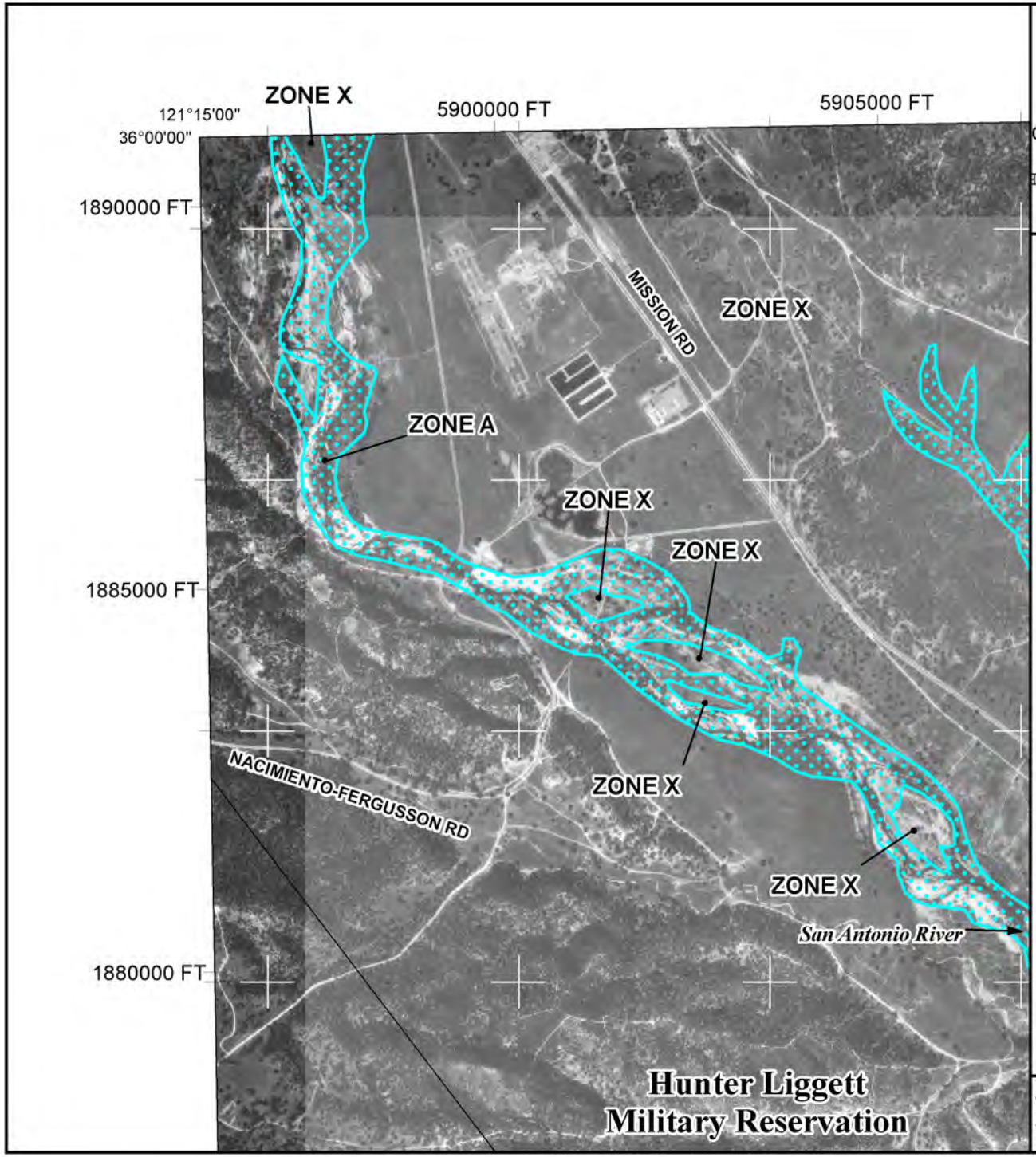
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06053C1325G

EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



MAP SCALE 1" = 2000'

000 0 2000 4000 FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1575G

FIRM

FLOOD INSURANCE RATE MAP

MONTEREY COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 1575 OF 2050

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MONTEREY COUNTY	060195	1575	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06053C1575G

EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix H

Qualifications of the Environmental Professional(s)

Andrea L Naccarato
Scientist Specialist

Education

B.S., Biology (Minors in Chemistry and Geography-Environmental Studies), Radford University, 1993

Professional Registrations

Registered Environmental Manager (REM), (2006, #12363)
Certified Environmental Scientist (CES), (2009, #84008)

Distinguishing Qualifications

- National Environmental Policy Act (NEPA) Specialist
- Project Management. Managed a team of 5 employees, total project load for the team was over ~150 projects

Relevant Experience

Ms. Naccarato is a project management specialist with over 17 years of experience as of 2012. Her primary focus area has been ensuring that a Federal agency (Army Reserve) complies with the NEPA and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
Ms. Naccarato has 12 years of experience working with the Army Reserve and has worked as a contractor for the HQ office (ACSIM-ARD) supporting the Military Construction Army Reserve (MCAR) program, Real Property Exchange program (RPX), Real Property Disposals, and Training exercises.

Representative Projects and Dates of Involvement

Project Manager, Army Reserve Disposal Environmental Condition of Property Reports: San Bernardino, CA (Update); Houston, TX; Greencastle, PA; Devens, MA; Suffolk, VA; Aguadilla, PR; 2012. Managed the preparation of the reports in accordance with the ASTM standards to support future disposal actions.

Project Manager, Military Construction Army Reserve Projects: West Palm Beach, FL; Bridgeport, CT; Uniontown, PA; Caguas, PR; Millington, TN; Newtown Square, PA; North Attleborough, MA; Fairchild AFB, WA; and Rockford, IL; 2011. Managed the NEPA and CERCLA documentation to support the MCAR project; ensured compliance while working within the design/construction schedule. Communicated issues quickly to allow the US Army Corps of Engineers (USACE)-Louisville District and ACSIM-ARD to take appropriate action.

Project Manager, Army Reserve Cultural Resource surveys: Fort Douglas, UT; Fort Missoula, MT; Joliet Training Area, Elwood, IL; Kinsgbury Local Training Area, Kingsbury, IN; 2011. Managed the Archaeological Resource Assessment and Management Plan for Fort Douglas, UT and the Post Cemetery at Fort Missoula, MT. Managed the Headstone Condition Assessment and Maintenance Plan for the historic Post Cemeteries on Fort Douglas, UT and Fort Missoula, MT. Managed the Phase I and II Archaeological Investigation at the Joliet Training Area in Elwood, IL. Managed the Phase I Archaeological Investigation at the Kingsbury Local Training Area in Kingsbury,

IN; received concurrence of “no historic properties affected” from the State Historic Preservation Office in September 2010.

Project Manager, Army Reserve Training and Disposal Projects: Milwaukee, WI and Bismarck, ND; 2010. Managed the NEPA documentation to support the proposed construction of a local training area on Army Reserve property in Milwaukee, WI. Managed the NEPA documentation to support the proposed conveyance of Army Reserve Property in Bismarck, ND.

Project Manager, Military Construction Army Reserve Projects: Bryan, TX; Kansas City, MO; Arden Hills, MN; Uniontown, PA; Ashley, PA; Des Moines, IA; Houston, TX; and Rochester, NY; 2010. Managed the NEPA and CERCLA documentation to support the MCAR project; will ensure compliance while working within the design/construction schedule. Communicated issues quickly to allow the US Army Corps of Engineers (USACE)-Louisville District and ACSIM-ARD to take appropriate action.

Project Manager, Military Construction Army Reserve Project; Winder, Georgia; 2009. Managed the NEPA and CERCLA documentation to support the land acquisition and MCAR project; will ensure compliance while working within the design/construction schedule. Quickly communicated issues to allow the USACE-Louisville District and ACSIM-ARD to take appropriate action.

Experience Prior to CH2M HILL

NEPA Compliance Specialist, Military Construction Army Reserve Project; Hayden Lake, Idaho; 2008. As a contractor working for ACSIM-ARD, ensured compliance with the NEPA and CERCLA while maintaining the design/construction schedule. Provided coordination between environmental team and design/construction team to ensure requirements were understood and addressed accordingly.

NEPA Compliance Specialist, Military Construction Army Reserve Project; Shoreham, New York; 2008. As a contractor working for ACSIM-ARD, ensured compliance with the NEPA and Section 106 of the National Historic Preservation Act. Communicated requirements to the design and construction team and ensured that Sec 106 coordination stayed on track and was completed prior to the award date of the project.

NEPA Compliance Specialist, Military Construction Army Reserve Project; Fort Dix, New Jersey (Tactical Training Base); 2008. As a contractor working for ACSIM-ARD, ensured compliance with the NEPA while maintaining the design/construction schedule that accomplished the mission for the USACE-Louisville District and Army Reserve. Communicated requirements to the design/construction team and the installation points of contact, coordinated the NEPA requirements with the Environmental Law Division to allow a REC to be completed for Phase 1A of the project while the Environmental Assessment was completed for the remainder of the project.

NEPA Compliance Specialist, Military Construction Army Reserve Project, Omaha (Offutt Air Force Base-Elkhorn Communication Facility), Nebraska; 2007. As a contractor working for the Installation Management Agency-Army Reserve Office (IMA-ARO), ensured compliance with the NEPA while maintaining the design/construction schedule. Worked with Air Force environmental personnel and the

USACE-Louisville District, who prepared the Environmental Assessment, to ensure that project details were communicated efficiently.

NEPA Compliance Specialist, Base Realignment and Closure-Armed Forces Reserve Center Construction Project; Kirtland Air Force Base, New Mexico; 2007. As a contractor working for the IMA-ARO, ensured compliance with the NEPA while maintaining the design/construction schedule. Worked with the USACE-Mobile District and Air Force personnel to ensure issues and details were communicated efficiently.

NEPA Compliance Specialist, Base Realignment and Closure-Armed Forces Reserve Center Construction Project; Fairchild Air Force Base, Spokane, Washington; 2006. As a contractor working for the IMA-ARO, ensured compliance with the NEPA while maintaining the design/construction schedule. Worked with Air Force environmental personnel, who prepared the Environmental Assessment, to ensure that project details were communicated efficiently.

Professional Development

OSHA 40-hour Hazardous Waste Operations Training, November 2009
OSHA 8-hour Hazardous Waste Refresher Training, May 2012

Supplemental Information

Years Experience Previous to CH2M HILL: 14 years
CH2M HILL Hire Date: April 20, 2009

Grant Koster
Task Manager

Education

B.S., Geology, Grand Valley State University, 2007
Central Colorado Field Camp, Oklahoma State University, 2006

Relevant Experience

Mr. Koster has experience with Phase I (ASTM E1527-05) and Phase II Environmental Site Assessments; Brownfield Redevelopments; Wetland Mitigation Permitting; and Michigan Department of Environmental Quality Part 201 Remediation projects. He is HAZWOPER 40-hour trained.

Other Related Skills

- Chemical titrations
- X-ray diffraction
- LASER particle counter
- Hollow-stemmed auger sampling
- Mineral identification
- Petrographical identification
- Stratigraphy correlation
- Dynamic Cone Penetrometer
- Air particulate monitoring
- Air sampling

Representative Projects

Environmental Geologist, Multiple Environmental Assessments (2009 - Present). Provides technical and field support for completion of NEPA EA and Environmental Condition of Property documents in association with Grow the Army and Base Realignment Closure programs.

Environmental Geologist, Alternative Closure Study, Confidential Client, Ludington, Michigan (2008 – 2009). Aided in preparing, developing and implementing work plan for investigation of alternative site closure methods.

Environmental Geologist, Pine River (2008). Provided field and technical support for Feasibility Study of the Pine River Superfund Site.

Environmental Geologist, USEPA, River Raisin (2009). Provided technical support for remediation design data collection on the River Raisin. Provided field support for the investigation of river bottom sediments, sediment core processing, and sample collection.

Environmental Geologist, Union Pacific Railroad (2008 – 2009). Provided field support for contaminate and elutriate testing. Results of the testing are being included within the remedial investigation and used for support of the remedial design of UPRR Escanaba, Michigan.

Experience Prior to CH2M HILL

Environmental Geologist; Investigation, Authoring and Oversight (2006 – 2008):

- Transaction Screen Process
- NEPA Reports
- Phase I ESA (AAI and MSHDA)
- Phase II ESA
- Baseline Environmental Assessments (Category N, D & S)
- Wetland Investigation
- Wetland Delineation
- Wetland Mitigation Plan
- NRCS Soil Characterization
- Soil Load Bearing Capacity Determination
- IRDC annual update reporting
- Brownfield Amendments
- MBT (SBT) Credit Application
- Brownfield Plan
- Oversight of Part 201 site redevelopment
- Environmental monitoring of Brownfield Redevelopment
- Installation of monitoring wells
- Installation of Standpipe Piezometers

Mineralogy Field Expedition, Bancroft, Ontario, Canada, Field identification of minerals (09/2005 – 09/2006)

- Mineral extraction
- Identification of minerals and processes of formations and structures

Oklahoma State University, Geology Field Camp, Canõn City, Colorado (2006)

Performed geological mapping of areas surrounding Canõn City, Colorado. The following data sources were collected / generated / utilized for the development of the geologic maps produced:

- Use of air-photographs and topographical maps
- Collection and analysis of geophysical data (gravity and magnetic)
- Field data collection using basic and technical methods
- Stratigraphic correlation and interpretation based on field observation
- Hand produced stratigraphic maps of local geology (USGS format)
- Hand produced surface geologic maps of local geology (USGS format)

Sedimentary, Stratigraphy and Petrology Field Expedition; Tennessee, North Carolina and Virginia (2006)

- Examined major rock beds and structures
- Inferred ancient environments
- Examined rock and mineral occurrences
- Studied mountain building mechanics