APPENDIX B

Geotechnical Study

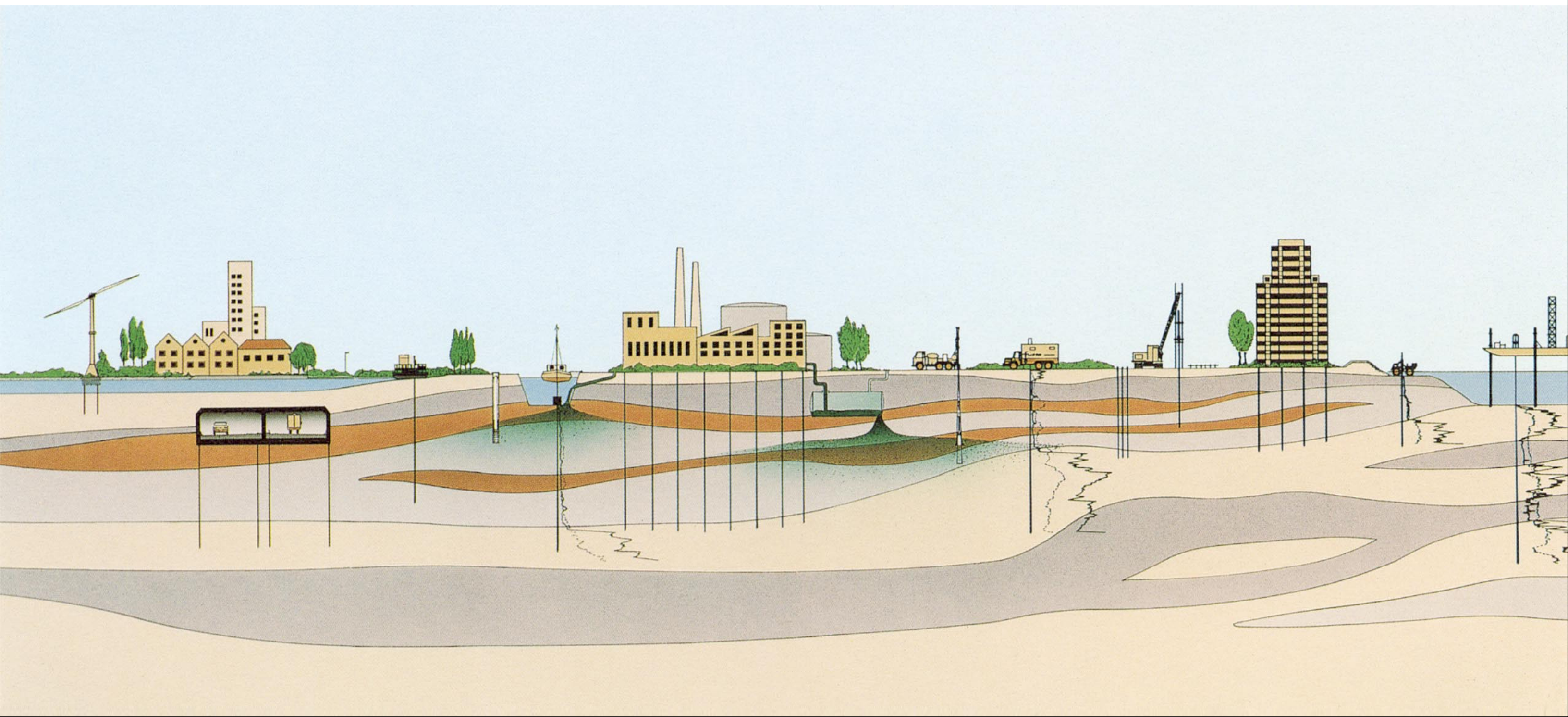
FUGRO WEST, INC.

GEOTECHNICAL STUDY

PROPOSED BLACK ROCK UNITS 1, 2 & 3
SINGLE FLASH GEOTHERMAL PLANT
CALIPATRIA, CALIFORNIA

Prepared for:
CalEnergy Operating Corporation

January 2009
Fugro Project No. 3652.001



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January 20, 2009
Project No. 3652.001

CalEnergy Operating Corporation
7030 Gentry Road
Calipatria, California 92233

Attention: Mr. George Furmanski, Senior Project Engineer

Subject: Geotechnical Study for the Proposed Black Rock Units 1, 2 & 3, Single Flash Geothermal Plant, Calipatria, California

Dear Mr. Furmanski:

Fugro herewith presents our geotechnical study and input relative to development of the Black Rock Units 1, 2 & 3 Single Flash Geothermal Plant in Calipatria, California. The purpose of this study was to provide the initial geotechnical engineering efforts for the development of the proposed geothermal power plant.

From a geotechnical perspective, we consider the development of the project to be feasible. The proposed site for the development of the geothermal power plant is currently undeveloped and used for agriculture. The primary geotechnical considerations for development of the site include the impact of potentially high seismically-induced settlements on the proposed structures, mitigating potentially liquefiable soils beneath the project area, and establishing seismic design criteria for structural design of the turbine/genrators, cooling towers and other critical structures.

We look forward to working with CalEnergy Operating Corporation in the development of this project. Please call if further information is required or if we can answer any questions.

Sincerely,

FUGRO WEST, INC.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACI	American Concrete Institute
ASTM	ASTM International
bpf	blows per foot
CalEnergy	CalEnergy Operating Corporation
CBC	California Building Code
CDSM	Cement Deep Soil Mixing
CGS	California Geologic Survey
CPT	cone penetration test
DLE	Design Level Earthquake
HSA	hollow-stem auger
IBC	International Building Code
mV	millivolt
MW	megawatt
NAD83	North American Datum 83
NAVD88	North American Vertical Datum 88
PGA	peak ground acceleration
ppm	parts per million
psf	pounds per cubic foot
psf	pounds per square foot
R-value	Resistance-value
RW	rotary wash
SAF	San Andreas Fault
sec	second
SPT	standard penetration test
USA	Underground Service Alert

CONTENTS

CONTENTS - CONTINUED

Page

TABLES

Page

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

CalEnergy Operating Corporation (CalEnergy) plans to construct a geothermal power plant comprising three separate units known as Black Rock 1, 2 and 3. The facility will be located on a 160-acre parcel located approximately 5 miles west of Calipatria in Imperial County, California. The approximate location of the site is depicted in Figure 1-1 (Vicinity Map).

Each unit of the proposed facility will consist of a generating area and a production area having identical structural and mechanical components. Each unit will have a gross output of 59 mega watts (MW) and a net output of 53 MW, resulting in a gross combined output of 177 MW and a net combined output of 159 MW for the entire facility. Based on preliminary equipment loading data furnished by CalEnergy, we understand that the largest structural loads will be at the Cooling Tower (7.6 million pounds [lbs]) and the Condenser/Turbine/Generator structure (1 million lbs). Various elements of the project will serve all three units. These common elements include a control building, fire water and purge water storage tanks, pipe support structures, a stormwater retention basin, and site access roads. The features of the proposed facility are depicted in Figure 1-2 (Site Layout). A list of the proposed major structures and loads, as provided by CalEnergy, is presented in Figure 1-3.

1.2 FUGRO SERVICES

To aid CalEnergy in the development and design of the proposed Black Rock Units 1, 2 and 3 Geothermal Power Plant, Fugro conducted a geotechnical study to provide data and recommendation relative to site grading and foundation design. The findings and recommendations for this study, described herein, are applicable for the project description and project components as known to Fugro as of September 2008. Fugro's recommendations are based, in part, on our general knowledge of the project area and recent and historical subsurface explorations that have been conducted in the proposed geothermal power plant area. Pertinent data and results from previous studies applicable to the project were reviewed for this study. This report supersedes any prior reports or memoranda prepared by Fugro for this proposed project.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of our study was to explore subsurface conditions at the project site to aid in the design of the proposed facility. The scope of work included the following:

1.3.1 Data Review, Site Reconnaissance, and Access Coordination

In preparation for the field exploration program, Fugro reviewed boring and CPT logs and report data from the previous geotechnical study performed by Geotechnics on the north half of the site, project plans for the current development provided by CalEnergy, and other documents, maps, and existing geologic literature relevant to the site. Fugro also visited the site to meet with CalEnergy to locate and stake the borings and CPTs in the field in advance of mobilizing the drilling crews.

1.3.2 Field Exploration

The field exploration program was completed by Fugro in October, 2008, and consisted of 30 borings and 21 cone penetration test (CPT) soundings. The explorations were concentrated at the planned locations of major plant components. Further details regarding the field exploration program are presented in Section 3.0 and in Appendix A.

1.3.3 Laboratory Testing

Laboratory testing was performed on selected soil samples obtained during the field exploration program. The types and numbers of tests were chosen to help classify and characterize the subsurface soil and evaluate its engineering properties with respect to the proposed construction. Further details regarding the laboratory testing program are presented in Section 4.0 and in Appendix B.

1.3.4 Geotechnical Analyses and Evaluation

Using the data obtained from the field exploration and laboratory testing programs together with preliminary design and loading information provided by CalEnergy, Fugro performed geotechnical analyses and evaluations regarding the following topics:

- Geohazards evaluation consisting of fault rupture, liquefaction potential, seismically-induced settlement, lateral movements, and expansive/collapsible soils ;
- Ground motions for use in seismic design of structures;
- Allowable bearing pressure and settlement analyses for various structural elements assuming shallow footing or mat foundations;
- Ground improvement procedures to mitigate excessive settlement;
- Axial and lateral capacities for driven pile foundations;
- Slope stability for berms or levees;
- Slab and pavement design parameters for various vehicle loading conditions; and
- Corrosion potential for buried concrete and metal.

1.3.5 Engineering Report

Fugro has compiled the results of the geotechnical analyses and evaluations into this report for use by the design team. The report includes recommendations for the following information:

- Summary of soil and groundwater conditions observed during subsurface exploration at the site;
- Geohazard evaluation;
- California Geologic Survey (CGS) ground motion parameters for seismic design from published references including ground acceleration, mapped geologic units, and nearby faults;
- Criteria for temporary excavations and support, and dewatering, where appropriate;
- Suitability of onsite materials for use as fill or backfill material;

- Site preparation including overexcavation recommendations, stabilization measures, and grading and compaction requirements for fill placement;
- Design of ground improvement procedures where appropriate;
- Design of shallow foundations, where appropriate, including foundation preparation recommendations, maximum allowable bearing pressures and potential settlement, resistance to lateral loads, passive soil pressures, and friction coefficients;
- Design of deep foundations, where appropriate, including pile tip elevations, allowable axial and uplift capacities, lateral load capacity, and pile construction recommendations;
- Static and dynamic lateral earth pressures for retaining walls;
- Requirements for imported soils and fill materials placed behind retaining walls;
- An assessment of slope stability during saturated conditions for the existing levee along the western border of the site;
- Expansion potential of onsite soils;
- Design of flexible pavement sections for facility driveways and access roads; and
- Corrosion potential (pH, resistivity, sulfate, chlorides) for buried concrete and metal.

Fugro understands that the proposed stormwater retention basin will be unlined, but is intended to rely primarily on evaporation for disposal of accumulated stormwater. Also, sewage will be contained in temporary holding tanks prior to collection for offsite disposal, rather than through an on-site septic and leach field system. Therefore, the percolation characteristics of site soils were not addressed in this report.

1.4 AUTHORIZATION

This geotechnical study was authorized by CalEnergy in their Consulting Agreement with Fugro dated October 2, 2008.

1.5 LIMITATIONS

The conclusions and professional opinions presented in this report were developed by Fugro solely for CalEnergy for use during the design of foundations and other improvements to be constructed at the project site. Although information contained in this report may be of some use for other purposes, it may not contain sufficient information for other parties or uses. If any changes are made to the project as described in this report, the conclusions and recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this report are modified or validated in writing by Fugro.

The scope of services did not include any environmental assessments for the presence or absence of hazardous/toxic materials in the soil, surface water, groundwater, or atmosphere. Any statements, or absence of statements, in this report or data presented herein regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous/toxic assessment.

In performing our professional services, we have used generally accepted geologic and geotechnical engineering principles and have applied that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers currently practicing in this or similar localities. No other warranty, express or implied, is made as to the professional advice included in this report. We recommend that Fugro be retained to review and comment on the geotechnical aspects of the project plans and specifications before they are finalized.

Users of this report should recognize that the construction process is an integral design component with respect to the geotechnical aspects of a project, and that geotechnical engineering is an inexact science due to the variability of natural and man-induced processes, which can produce unanticipated or changed conditions. Proper geotechnical observation and testing during construction are imperative in allowing the geotechnical engineer the opportunity to verify assumptions made during the design process. Therefore, we advise that Fugro be retained during site grading and foundation construction to observe compliance with the design concepts and geotechnical recommendations and to allow design changes in the event that subsurface conditions, or methods of construction, differ from those anticipated.

2.0 SITE DESCRIPTION

The project site is located on a 160-acre parcel approximately 5 miles west of Calipatria in Imperial County, California. As depicted on Figure 1-2, the site is bordered by McKendry Road to the north, Boyle Road to the east, Peterson Road to the south and Severe Road to the west. The site is divided into two 80-acre parcels separated a dirt road running in the east-west direction through the middle of the property. At the time of Fugro's field investigation in October 2008, the site was undeveloped and was being used for cultivation of alfalfa.

Generally, the site is relatively flat with a gentle downward gradient from southeast to northwest. The four roads that form the perimeter of the site, and the access road through the middle of the site, are all slightly higher in elevation than the adjacent cultivated fields, which vary in elevation from approximately -221 feet at the southeast corner to -229 feet at the northwest corner. The access road along the west side of the site separates the property from a drainage canal situated between the access road and Severe Road, and thereby functions as a levee or dike preventing the drainage canal water from flowing on to the site. The top of the access road/levee is about 4 to 8 feet above the adjacent fields.

3.0 FIELD EXPLORATION

3.1 PRIOR SUBSURFACE EXPLORATION PROGRAM

A geotechnical investigation was performed on the north half of the site for a project formerly known as the Salton Sea Unit No. 6 geothermal power plant. The report was prepared by Geotechnics, dated February 5, 2002 (Project No. 0673-002-00, Document No. 02-0022). This document, together with the Addendum to Geotechnical Investigation prepared by Geotechnics, dated March 27, 2002 (Project No. 0673-002-02, document No. 02-0296), was provided to Fugro by Tobey-Wade Consulting (Tobey-Wade) as authorized by CalEnergy. This project was postponed and eventually abandoned in favor of the currently proposed facility.

A brief review of the Geotechnics report indicates that the investigation included nine electric CPT soundings to depths ranging from 50 to 100 feet, and two hollow-stem-auger (HSA) borings ranging in depth from 58 to 77 feet. The locations of explorations performed as part of the Geotechnics study are shown on Figure 3-1. Geotechnics found that the site was underlain by loose sands and soft silts and clays susceptible to liquefaction and settlement and recommended that ground improvement methods (e.g., stone columns or vibroflotation) plus driven concrete pile foundations be used to support the facility structures.

As shown on Figure 3-1, the previous exploration program by Geotechnics (2002) for the former Salton Sea Unit No. 6 project provided only partial coverage of the currently proposed area of Black Rock Units 1, 2 and 3 power plant. Therefore, an additional exploration program was requested by CalEnergy and performed by Fugro.

3.2 FUGRO EXPLORATION PROGRAM

Overview. The field exploration program completed by Fugro for the Black Rock Units 1, 2 and 3 Project consisted of borings and CPTs. The locations of borings and CPTs performed for this study are shown on Figure 3-1. Information for each exploration including the California State Plane Zone 6 coordinates (in feet), ground surface elevations, and total exploration depth are tabulated in Table 3-1.

October 2008 Exploration. The field exploration program performed for the Black Rock Units 1, 2 and 3 project was initiated on October 7, 2008, and was completed on October 17, 2008. The subsurface exploration program consisted of 30 borings to obtain soil samples and 21 CPTs.

Of the 30 borings drilled on site, 23 were performed using a HSA and 7 were performed using rotary wash (RW) drilling equipment. RW borings were located under or near the planned locations of major features of the three generating areas. HSA borings were completed under the proposed locations of ponds, smaller equipment pads and along the access roads. The RW borings ranged in depth from approximately 50 to 85 feet below ground surface. The HSA borings ranged in depth from approximately 5 and 25 feet below ground surface. Soil samples were obtained at various depth intervals in both the RW and HSA borings. A Fugro geologist prepared a written log of the drilling and sampling conditions and the soil types observed for each boring. Further details regarding the field exploration program, including the boring logs, are presented in Appendix A.

Twenty-one CPTs were advanced at various locations across the site. The depths of the CPTs ranged from between 25 and 76 feet below ground surface. A total of about 1,330 linear feet of CPT soundings were performed for this study. A graphic log was generated in the field for each CPT performed. Further information regarding the CPT and the CPT logs are presented in Appendix A.

3.3 REFERENCE DATUM

A topographic survey map of the project site was provided by CalEnergy for Fugro's use in planning and executing the field investigation and engineering analyses. The map was based on the following data:

Horizontal Datum. California State Plane North American Datum 83 (NAD83), Zone 6 (Feet).

Vertical Datum. The vertical datum reference for this project is North American Vertical Datum 88 (NAVD88) (Feet).

3.4 SUBSURFACE OBSTRUCTIONS AND UTILITIES

Fugro notified Underground Service Alert (USA) and coordinated with CalEnergy for utility identification prior to commencement of the field exploration program. No utilities were identified at the site at any of Fugro's boring or CPT locations and no subsurface obstructions were encountered during the Fugro's field exploration program. However, it should be noted that other buried utilities and structures not located by USA or CalEnergy, or observed by Fugro, such as irrigation pipelines used for farming activities and pipes or other buried structures used by CalEnergy for their existing adjacent geothermal facilities, may be present on or adjacent to the Black Rock project site.

Table 3-1. Subsurface Explorations Summary

Boring / CPT	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (feet)	Start Date	Completion Date	Coordinates (feet) California State Zone 6, NAD 83	
					Northing	Easting
Rotary Wash Borings						
RW-01	-227.5	76.5	10/7/2008	10/8/2008	2004839	6752288
RW-02	-228.0	51.5	10/10/2008	10/10/2008	2004568	6751983
RW-03	-226.0	76.5	10/14/2008	10/14/2008	2004120	6751781
RW-04	-225.9	86.5	10/14/2008	10/14/2008	2004092	6751986
RW-05	-225.6	76.5	10/13/2008	10/13/2008	2004222	6752411
RW-06	-225.0	76.5	10/10/2008	10/10/2008	2004172	6752610
RW-07	-227.0	76.5	10/8/2008	10/8/2008	2004790	6752499
Hollow-Stem Auger Borings						
HSA-01	-228.5	6.5	10/15/2008	10/15/2008	2005752	6752870
HSA-02	-228.3	6.5	10/15/2008	10/15/2008	2005656	6752525
HSA-03	-228.9	26.5	10/15/2008	10/15/2008	2005555	6752124
HSA-04	-228.8	6.5	10/15/2008	10/15/2008	2005469	6751158
HSA-05	-224.0	6.5	10/17/2008	10/17/2008	2005837	6754161
HSA-06	-228.1	6.5	10/15/2008	10/15/2008	2005027	6752048

Boring / CPT	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (feet)	Start Date	Completion Date	Coordinates (feet) California State Zone 6, NAD 83	
					Northing	Easting
Hollow-Stem Auger Borings						
HSA-07	-228.0	6.5	10/15/2008	10/15/2008	2004934	6751075
HSA-08	-223.0	6.5	10/17/2008	10/17/2008	2005823	6755553
HSA-09	-227.5	26.5	10/15/2008	10/15/2008	2004753	6751236
HSA-10	-227.0	6.5	10/15/2008	10/15/2008	2004617	6751677
HSA-11	-227.0	11.5	10/15/2008	10/15/2008	2004291	6751165
HSA-12	-223.0	6.5	10/17/2008	10/17/2008	2004491	6752434
HSA-13	-219.0	6.5	10/17/2008	10/17/2008	2005204	6753571
HSA-14	-226.0	16.5	10/16/2008	10/16/2008	2004317	6751970
HSA-15	-226.2	11.5	10/15/2008	10/15/2008	2003996	6751182
HSA-16	-222.0	16.5	10/16/2008	10/16/2008	2004195	6750966
HSA-17	-226.0	6.5	10/16/2008	10/16/2008	2003936	6751586
HSA-18	-225.8	6.5	10/16/2008	10/16/2008	2003894	6752364
HSA-19	-221.0	16.5	10/18/2008	10/18/2008	2003583	6750967
HSA-20	-224.6	26.5	10/16/2008	10/16/2008	2003443	6752397
HSA-21	-225.8	6.5	10/16/2008	10/16/2008	2003288	6751504
HSA-22	-225.5	11.5	10/16/2008	10/16/2008	2003352	6751853
HSA-23	-225.8	6.5	10/16/2008	10/16/2008	2003270	6752135
Cone Penetration Tests (CPTs)						
C-101	-221.0	25.41	10/8/2008	10/8/2008	2005421	6750956
C-102	-228.9	50.19	10/8/2008	10/8/2008	2005697	6752117
C-103	-221.0	25.37	10/8/2008	10/8/2008	2004791	6750954
C-104	-227.9	75.24	10/7/2008	10/7/2008	2004966	6752229
C-105	-227.2	75.31	10/7/2008	10/7/2008	2004829	6752401
C-106	-227.3	50.15	10/7/2008	10/7/2008	2004673	6751827
C-107	-227.5	75.25	10/7/2008	10/7/2008	2004748	6752273
C-108	-226.6	75.36	10/7/2008	10/7/2008	2004655	6752567
C-109	-226.2	75.41	10/8/2008	10/8/2008	2004265	6751740
C-110	-225.6	75.37	10/9/2008	10/9/2008	2004312	6752361
C-111	-226.2	75.34	10/8/2008	10/8/2008	2004119	6751643
C-112	-225.7	75.37	10/8/2008	10/8/2008	2003996	6751779
C-113	-225.8	75.29	10/8/2008	10/8/2008	2004171	6751918
C-114	-225.7	75.28	10/8/2008	10/8/2008	2003947	6752088
C-115	-225.8	75.48	10/9/2008	10/9/2008	2004188	6752273
C-116	-225.2	75.43	10/8/2008	10/8/2008	2004134	6752408
C-117	-225.4	75.31	10/9/2008	10/9/2008	2004215	6752530
C-118	-224.9	75.8	10/9/2008	10/9/2008	2004045	6752706
C-119	-221.0	25.26	10/8/2008	10/8/2008	2003867	6750965
C-120	-224.9	50.33	10/8/2008	10/8/2008	2003460	6752247
C-121	-225.9	50.38	10/8/2008	10/8/2008	2004311	6752168

4.0 LABORATORY TESTING PROGRAM

The purpose of the laboratory testing program was to supplement field classification of soils and provided relevant physical indices and engineering properties of the subsurface materials. The primary objectives of the program were to:

- Classify and characterize sampled subsurface materials;
- Evaluate the existing in situ conditions; and
- Develop relevant strength and compressibility properties of selected subsurface materials.

To meet these objectives, various tests were performed on selected samples. Test types are generally grouped into six categories: classification and index tests, moisture content and density evaluations, strength tests and estimates, compressibility tests, soil chemical tests (for corrosion evaluations), and subgrade characterization tests. Classification and index, soil chemical, and subgrade characterization tests were performed on both disturbed and relatively undisturbed samples, including 3.0-inch diameter thin-wall push (i.e., Shelby) samples, 2.4-inch diameter drive (i.e., ring) samples, Standard Penetration Test (SPT), and bulk samples. Density evaluations, strength tests, and compressibility tests were typically performed only on relatively undisturbed Shelby and ring samples.

The numbers of the various tests conducted for the Black Rock units 1, 2 and 3 are listed in Table 4-1.

Table 4-1. Summary of Laboratory Tests Performed on Selected Samples

Laboratory Testing	Number of Tests	ASTM Test Designation[1]
Water Content	81	ASTM D2216
Density	79	ASTM D2937
Grain Size Distribution	3	ASTM D422
Percent Fines #200 Sieve	19	ASTM D1140
Atterberg Limits	22	ASTM D4318
Compaction	3	Cal. 216A[2]
Consolidation (Incremental Load Control)	6	ASTM D2435
Direct Shear	1	ASTM D3080
R-Value	3	ASTM D2435
Expansion Index	3	ASTM D4828
Corrosivity	5	ASTM D1498 ASTM D4972 ASTM G57 ASTM D4327

[1]ASTM International (2005)
[2]California Department of Transportation Test Designation

Laboratory test results are tabulated or presented graphically in Appendix B. A tabular summary of all laboratory tests performed for the Black Rock Units 1, 2 and 3 project is presented on Figures B-1 through B-6. Various laboratory test results also are tabulated versus depth on the individual boring logs (Figures A-2 through A-31). Test results that cannot be conveniently tabulated or plotted versus depth on logs also are provided in Appendix B. Test results in this category include: grain-size curves, plasticity charts, direct shear, consolidation, compaction test results and the corrosivity test results performed by a subconsultant laboratory.

5.0 GEOLOGIC AND SUBSURFACE CONDITIONS

5.1 REGIONAL SETTING

5.1.1 Geomorphic, Physiographic and Structural Setting

Southern California is divided into several physiographic regions, or provinces. The proposed project area is located in the Colorado Desert Geomorphic Province, which is a low-lying, barren basin dominated by the Salton Sea. The province is a depressed block that is bounded by the Mojave Desert Geomorphic Province to the east, and the Peninsular Ranges Geomorphic Province to the west (CGS, 2002).

The Salton Trough consists of the Coachella Valley to the north of the Salton Sea, the Salton Sea itself, and the Imperial Valley to the south (see Figure 5-1). The trough widens toward the southeast due to the nature of the relative plate motion as described in the following section. As shown on Figure 5-2, the Salton Trough is bounded by the San Andreas fault zone, Orocopia Mountains and Chocolate Mountains to the east; and the San Jacinto fault zone, Superstition Hills and Peninsular Ranges to the west. The east wall of the Trough at the San Andreas fault consists of Precambrian Rocks, Mesozoic plutons, and schists (Figures 5-3 and 5-4). The west wall consists of Cretaceous plutonic rocks of the Southern California (Peninsular Ranges) batholith and their metamorphic host rocks (Wallace, 1990, Jennings, 1994).

The structure of the Salton Trough itself can be generally described as a gap in the crystalline basement between the two walls of the Trough. This deep basin is underlain by a thick sequence of sediments and volcanic rocks. The volcanic rocks intrude into the sedimentary section as both silicic rocks that form volcanoes and as mafic rocks that are penetrated in geothermal wells. The volcanoes are found in areas where spreading is actively occurring in the Brawley Seismic Zone and Cerro Prieto geothermal area. Rhyolite and obsidian domes at the Salton Buttes are found in the Brawley Seismic Zone on the southeastern side of the Salton Sea near the project site, and Cerro Prieto Volcano is present in the Cerro Prieto geothermal area to the south (Wallace, 1990, Harden, 2004). Inclusions of mid-ocean ridge basalt have been found within the high-silica volcanic rocks indicating that mid-ocean ridge magma is interacting with the continental crust beneath the Salton Trough (Harden, 2004). Heat flow measurements also show that rifting is active in the trough, and the geothermal gradient is high enough to produce geothermal reservoirs. The proposed project will tap into one of these geothermal reservoirs.

The Salton Trough is being lengthened by continued right-lateral oblique transtension, and is being deepened by vertical motion on smaller faults associated with extension in the seismic zones where rifting is occurring. Thus, the trough is getting bigger and deeper as sediments accumulate in the large, subsiding basin. This process has been occurring continuously for the past 4 million years, allowing 5 to 6 kilometers (km) of Pliocene and Pleistocene sediments to accumulate (Wallace, 1990, Harden, 2004). This sediment thickness is obtained from numerous geophysical studies and wells drilled in the area (Wallace, 1990). Thus, "basement rock" or bedrock is at a depth of approximately 15,000 feet in the deepest portions of the trough. The subsidence in the trough has created a low-lying basin that is up to approximately 275 feet below sea level. Much of the Salton Trough, including the project site area, is below sea level.

5.1.2 Tectonic Setting

The tectonic setting of the Salton Trough is complex and is characterized by a transition along the Pacific-North American plate boundary from right-lateral strike-slip motion to ridge-transform divergent motion in the Gulf of California. Tectonic slip is funneled from the wide plate boundary zone in the northern part of the Salton Trough to the spreading centers in the Gulf of California to the south. This complex tectonic setting has created unique geomorphic and structural features in the region.

The Salton Trough marks a shift from a transform plate boundary consisting of the SAF and the other subparallel faults to the mid-ocean ridge-transform divergent plate boundary present in the Gulf of California to the south. This transition begins at the southern end of the Salton Sea (the northern end of the Imperial Valley) where nascent spreading is occurring between the southern end of the SAF and the northern end of the Imperial Fault (Figure 5-2). This spreading center (or pull-apart basin), known as the Brawley Seismic Zone, and the Cerro Prieto geothermal area in Mexico, represent the two northern-most in the series of small spreading centers offset by right-lateral transform faults which characterize the oblique spreading that is extending northward from the Gulf of California. The Brawley Seismic Zone is characterized by high levels of seismicity, as are the Elsinore, San Jacinto, and Imperial faults (Figure 5-1). The southern San Andreas fault has been seismically dormant in historical time, but has ruptured several times in the past 2,000 years (Bennett et al., 1996, Harden, 2004). The project site is located in the western portion of the Brawley Seismic Zone, which is characterized by geothermal and volcanic activity.

Relative motion between the Pacific and North American tectonic plates is accommodated primarily along the San Andreas fault (SAF) in California. However, the SAF is not the sole boundary between the two plates. Instead, relative plate motion is accommodated across a series of subparallel faults that form a broad boundary zone of deformation over 250 km wide. The relative motion between the Pacific and North American Plates in this boundary zone is approximately 50 millimeters per year (mm/yr) in a right-lateral sense (Bennett et al., 1996). The SAF, Elsinore, Imperial, Cerro Prieto, Laguna Salada, and San Jacinto faults are six of the subparallel faults that accommodate most of this motion (see Figure 5-2). While the displacement between the two tectonic plates occurs primarily along these plate-bounding faults, the tectonic regime also includes smaller faults and earthquakes associated with a change in the nature of the Pacific-North American plate boundary.

5.1.3 Stratigraphy

The considerable thickness of sediment that fills the Salton Trough has been deposited by the Colorado River at different locations that have varied through time. Today, the Colorado flows south into Mexico depositing sediments in a large delta at the northern tip of the Gulf of California. However, at least five times in the past 1,000 years, the Colorado River has flowed directly into the Salton trough, creating the freshwater Lake Cahuilla (Thomas and Rockwell, 1996). The lake would fill up to a level of about 13 meters above sea level before it would begin to flow out at the south end of the Salton Trough along the New River to the Gulf of California (Lippincott et al., 2008). The Colorado River would then migrate back to flowing south to the Gulf of California. During these periods, the lake dried up. This river avulsion sequence last occurred in about A.D. 1700, which was the last Lake Cahuilla highstand; the lake subsequently dried up by about 1750 (Lippincott et al., 2008). This change in flow and depositional patterns of the Colorado River is depicted in Figure 5-5. The approximate shoreline of Lake Cahuilla is shown on Figure 5-3: a large portion of the Imperial Valley, including the project site, was under water during lake highstands. This ancient shoreline is visible at several locations on the western side of Imperial Valley.

The Salton Trough was periodically inundated by smaller amounts of water until 1905, when severe flooding caused the Colorado River to overrun its banks and breach existing canal walls. The water flowed into and accumulated in the low-lying Salton Depression in the center of the Salton Trough. The river was not diverted back into its channel until 1907, and the Salton Sea was formed (Harden, 2004). The sea is maintained by water diverted from the Colorado River and by local inflow via the Alamo and other rivers. The Salton Sea highstand was in 1907; this is depicted on Figure 5-3. The Black Rock project site was under water at that time.

The presence of water in the Salton Trough is evident in the Holocene subsurface stratigraphy of the region. This stratigraphy is controlled by the presence or absence of the lake deposits. Therefore the alluvium in the region is a combination of fluvial, lacustrine, and deltaic sediments deposited during various stages of flow of the Colorado River. The fluvial and deltaic sediments are typically composed of sands and silts with a small amount of lean clay while the lacustrine sediments are composed primarily of clays (Thomas and Rockwell, 1996).

5.2 LOCAL GEOLOGIC SETTING

The project site is located adjacent to the southeastern side of the Salton Sea. As previously discussed, the Salton Sea once covered the project site, but has been slowly evaporating and becoming more saline. The surface of the Salton Sea has a current elevation of approximately -227 feet. The Salton Sea has no natural outlet, and its water level today is maintained primarily by the inflow of agricultural runoff from irrigation in the region via several sources including numerous small creeks, and the Alamo and New Rivers. Storm water runoff and effluent are a small component of inflow in addition to agricultural runoff. The Salton Sea shoreline is approximately a half-mile to the northwest of the site.

The Salton Buttes, an aforementioned volcanic feature of the Brawley Seismic Zone, are located to the west of the site along the Salton Sea. Obsidian Butte lies just west of the site and is the western-most of several small, rhyolite and obsidian domes that are arranged in a northeast trend. These domes are collectively called the Salton Buttes and are approximately 16,000 years old (Harden, 2004). Basalt erupted from mid-ocean ridges have been found in the domes, indicating that mid-ocean ridge magma is erupting and rifting is occurring beneath this portion of the Salton Trough (Harden, 2004).

The project site is underlain by late Holocene deposits associated with the presence or absence of ancient Lake Cahuilla. These deposits are typical of those found in the region as described above. The soils are composed of a combination of fluvial, lacustrine, and deltaic sediments. The fluvial and deltaic sediments consist of sands and silts, while the lacustrine deposits consist primarily of clays. Subsurface conditions are described in detail in the following section.

5.3 SUBSURFACE CONDITIONS

5.3.1 Earth Materials

The subsurface field investigation program consisted of rotary wash borings, HSA borings and CPT soundings, allowing the subsurface conditions of the site to be explored to a maximum depth of 85 feet below the ground surface (see Section 3.0 for details of the field investigation program). Subsurface conditions are described and illustrated in the boring and CPT logs (see Appendix A). Although the subsurface soils exhibit some variability both horizontally and vertically, for the purposes of this study they can be divided into layers that are generally identifiable across the site as depicted in the cross sections (Figures 5-6 through 5-11) and further described in the idealized soil profile discussed in Section 7 of this report and presented in Table 7.1. In summary, the project site is underlain by very soft to stiff clays with some interbedded silts and layers of very loose to dense silty sands.

5.3.2 Groundwater

Groundwater was observed in all of the HSA borings that were drilled to a depth of at least 10 feet. Free groundwater was initially encountered at a depth of approximately 8-9 feet across the majority of the site. The groundwater level was re-measured at four HSA boring locations approximately 36 hours after drilling was completed. The depth to groundwater was approximately 5 feet in HSA-14, HSA-3, and HSA-9, and was approximately 7 feet in HSA-20. Based on our observations at the time of the subsurface exploration program for this study, the depth to groundwater at the site generally appears to be approximately 5 feet below existing ground surface. However, variations in groundwater levels and soil moisture conditions can occur as a result of rainfall, runoff, and other factors. Fugro was informed that the alfalfa crop growing on site had not been irrigated for several weeks prior to the commencement of subsurface exploration, which likely had an effect on the observed water levels. Therefore, the soil moisture conditions and groundwater table elevations at this site should be assumed to fluctuate seasonally due to rainfall, on-site irrigation, local agricultural and industrial activities, changes in the water level of the Salton Sea and the adjacent drainage canal, and/or other factors not evident at the time of this study.

6.0 SEISMIC DESIGN CONSIDERATIONS

The proposed Black Rock Units 1, 2 and 3 project area is within a seismically active geologic setting in relatively close proximity to several faults and seismic zones as described in Section 5. Consequently, seismic shaking, fault rupture and liquefaction will need to be addressed as part of the project final design.

6.1 MINIMUM CODE REQUIREMENTS AND SEISMIC RISK

Fugro understands that the project will be designed in accordance with the 2007 California Building Code (CBC 2007), which went into effect on January 1, 2008, and is based on the 2006 International Building Code (IBC). The seismic design provisions of the 2006 IBC are based upon the ASCE 7-05 (ASCE, 2005) seismic design provisions. For seismic design of structures, CBC 2007 requires that the spectral lateral accelerations be based on mapped seismic parameters, site-specific procedures, or probabilistic methods.

The scope of this study was limited to providing recommendations based on mapped seismic parameters. Design spectral response acceleration parameters were assessed using the map-based acceleration parameters and site coefficients. The site coefficients were selected based on the site classification, which in turn were based on the soil properties in the top 100 feet at the site, including any special circumstances, such as the presence of liquefiable or soft soils.

Due to the presence of relatively loose sand layers underlying the project site, liquefaction is likely to occur during the design seismic event, as discussed below in Section 6.3. Therefore, based on the CBC 2007 requirements, the site is classified as Site Class F. However, the use of design spectral response acceleration parameters developed using the mapped parameters presented in CBC 2007 is limited to structures having a fundamental period of vibration (T) equal to or less than 0.5 seconds (ASCE 7-05). To develop design spectral response parameters for short-period structures (i.e., $T \leq 0.5$ seconds) the site coefficients can be assessed using site class as determined by CBC 2007 requirements without considering liquefaction, which for the project area is Site Class D. The mapped seismic parameters and the site coefficients for Site Class D for the current project area are summarized in Table 6-1.

For longer-period structures (i.e., $T \geq 0.5$ seconds), a site response analysis is required by CBC 2007 and ASCE 7-05 to assess the design spectral response acceleration parameters. However, a site response analysis is not part of the scope of this study.

It should be noted that the special requirements of CBC 2007 for Site Class F would not apply if liquefaction mitigation measures are implemented as part of the foundation design. For structures placed on improved soil mitigated to reduce liquefaction potential, the site classification will be Site Class D and the design spectral response acceleration parameters can be assessed using applicable seismic design parameters presented in Table 6-1.

Table 6-1. Summary of 2007 CBC Seismic Design Parameters

	Parameter	Value
Site Location	Latitude	33.1657
	Longitude	-115.6272
Occupancy Category (CBC Table 1604.5)		III
Mapped Acceleration Parameters[1]	S_S	1.5
	S_1	0.6
Site Classification[2]	Site Class	F / D [3]
Site Coefficients and Site Adjusted Acceleration Parameters for Site Class D	F_a	1.0
	F_v	1.5
	S_{MS}	1.5
	S_{M1}	0.9
Design Spectral Response Acceleration Parameters for Site Class D[4]	S_{DS}	1.0
	S_{D1}	0.6
Seismic Design Category		D

Notes:
[1] Coefficients estimated using the USGS calculator available at http://earthquake.usgs.gov/research/hazmaps/design/index.php for cited latitude and longitude.
[2] Site Classification based on the assessed shear wave velocity in top 100 feet.
[3] Site Class F if no liquefaction mitigation measures are implemented. Site Class D if liquefaction measures are implemented.
[4] Values applicable for Site Class F only for structures with fundamental period equal or below 0.5 seconds.

The ordinates for the recommended horizontal ground motion design spectra for 5 percent damping based on the CBC 2007 mapped acceleration parameters are included in Table 6-2 and presented graphically in Figure 6-1. The values for Site Class F are presented only for periods up to 0.5 seconds. A site response analysis using site-specific ground motion parameters is required by CBC 2007 and ASCE 7-05 to assess the spectral acceleration values for periods above 0.5 seconds for Site Class F.

Table 6-2. CBC2007 Recommended Horizontal Ground Motion Design Spectra

Period (sec)	Site Class F Spectral Acceleration (5% Damping)	Site Class D Spectral Acceleration (5% Damping)
PGA	0.400	0.400
0.05	0.675	0.675
0.10	0.900	0.900
0.12	1.000	1.000
0.15	1.000	1.000
0.20	1.000	1.000
0.30	1.000	1.000
0.50	1.000	1.000
0.60	A site response analysis using site specific ground motion parameters is required by CBC 2007 and ASCE-7-05 to assess the spectral acceleration values for periods above 0.5 seconds.	1.000
1.00		0.600
1.50		0.400
2.00		0.300
3.00		0.200
4.00		0.150
5.00		0.120

6.2 FAULT RUPTURE HAZARD

The proposed project site is located in the western portion of the Brawley Seismic Zone. This structural depression (or pull-apart basin) is a zone of transition between the northwest end of the Imperial fault, and the southwest end of the San Andreas fault (see Section 5). The zone's high seismicity is defined by microseismicity that appears to be due to magmatic intrusions caused by nascent spreading in the area, and aftershocks following earthquakes on nearby faults. The Brawley Seismic Zone is characterized by earthquake swarms, generally less than magnitude 3 or 4 (see Figure 5-2). Recent fault parameters characterize the Brawley Seismic Zone as a special case area of background seismicity, and not as a strike slip fault, so it is not modeled as a fault source by CGS (CGS, 2008). It is likely that the slip in this zone is being translated into regional subsidence and geothermal activity.

As discussed previously, the Brawley Seismic Zone is defined by epicenters of microseismicity or aftershocks following earthquakes on adjacent active faults rather than from geologic mapping of surface ruptures and geomorphic features. There are no known faults that reach the ground surface within the Brawley Seismic Zone. Thus, the site is not within an Alquist-Priolo Earthquake Fault Zone (Hart and Bryant, 1997). Although stress is being transferred to the Brawley Seismic Zone from nearby active faults, historic and microseismic records indicate the stress is released gradually through relatively constant earthquake swarm activity as described above. In addition, our aerial photographic review did not identify lineaments or other linear geomorphic features that trend toward the site, and the exploration we performed suggests relatively uniform stratigraphy that does not appear to have significant vertical offset. Therefore, based on the above information, we believe the potential for ground rupture at the site because of faulting in the Brawley Seismic Zone is considered to be low.

6.3 LIQUEFACTION HAZARD

Liquefaction is the loss of strength that can occur in loose, saturated sand during seismic shaking. The susceptibility of a granular soil to liquefaction is a function of the gradation, density, and fines content of the soil. Susceptibility to liquefaction decreases with respective increases in: a) distribution of grain size, b) soil density, c) fines content, d) clay-size fraction of the fines, and e) the age of the deposit. The soils under the area of the proposed facility are geologically recent, with extensive interbedded deposits of loose to medium dense, saturated sands that are susceptible to liquefaction.

There are a number of potential consequences when liquefaction occurs. When the shaking continues after the onset of liquefaction, liquefaction can produce a number of ground effects (e.g., sand boils, settlement, lurching, and lateral displacement). Liquefaction also can cause a loss of bearing capacity of shallow foundations, and lateral ground spreading. In general, the longer the duration of strong shaking after the initiation of liquefaction, the greater the consequences.

Evidence of liquefaction is known to have been observed in the general area of the site during past earthquakes. Potentially liquefiable soils are typically relatively loose sandy layers located within fine grained soils encountered underlying the site. There is no surficial evidence of historic occurrence of liquefaction at the site; however, due to the ongoing agricultural use of the site, such evidence would not be likely to remain visible for a significant length of time following any recent earthquakes.

Liquefaction analyses have been performed for this study using the CPT data for Design Level Earthquake (DLE). The DLE was characterized as having a peak ground acceleration (PGA) of 0.40g and moment magnitude of 6.5. Since the scope of this study did not include evaluation of ground motions at the site using site-specific deterministic or probabilistic hazard assessment, the selection of PGA was based on recommendations provided in ASCE 7-05. ASCE 7-05 recommends that a PGA equal to $S_{DS}/2.5$ be used for liquefaction triggering analyses in absence of site-specific ground motion study, where S_s is the mapped acceleration parameter evaluated from CBC 2007. The S_{DS} of 1.0 was evaluated for the project site as presented in Table 6-1. It should be noted that the CBC based PGA value of 0.40g is somewhat lower than the PGA value of 0.45g estimated using the CGS online interactive toolset (http://redirect.conservation.ca.gov/cgs/rghm/pshamap/pshamain.html) for the Black Rock project location and Site Class D for the 475-year return period presented. The DLE values based on CBC 2007 are similar to the 475-year return period events; however, small differences are to be expected since the CBC-based DLE is not directly based on the 475-year return period event.

The moment magnitude of 6.5 was selected based on the most recent evaluation of the expected maximum magnitude for Brawley Seismic Zone as presented by the CGS (2008). Although the Brawley Seismic Zone has been characterized as a zone of earthquake swarms or microseismicity based on observed recent seismic activity, it is considered capable of producing larger seismic events than just the earthquake swarms that have been observed in recent times. Furthermore, the site is also subject to ground accelerations generated by major seismic events on other faults in the area, for example the San Andreas fault. It is important to note that the source of the seismic activity that generates the ground acceleration experienced at a site need not be located at, or even in close proximity to, the site.

The liquefaction analyses were performed per the NCEER procedure (Youd , Iriss, 2001) over the entire depth of exploration assuming the groundwater table was at about 5 feet below the existing ground surface. Ground settlement due to liquefaction was calculated for the DLE using volumetric strain relationships by Ishihara and Yoshimine (1992). The results of these analyses for selected CPTs are presented graphically on Figures 6-2 through 6-6 (Subsurface Liquefaction Cross Sections) corresponding to the geologic cross-section locations shown on Figure 5-6. A key with definitions of symbols for the CPT liquefaction sections is presented on Figure 6-2. The results of the liquefaction triggering analysis for all CPTs are presented in Appendix C.

Figures 6-3 through 6-6 indicate that a significant portion of sandy materials in the upper 30 to 40 feet will likely liquefy during the design level event. These figures also indicate that some of the deeper sandy layers could also potentially liquefy during the DLE. Figures 6-2 through 6-5 also present the estimated liquefaction-induced settlements. According to Seed (1979), at most of the sites where some surface evidence of liquefaction has been observed in the field, the critical layer in which liquefaction is believed to have occurred has been located at depths of less than 45 feet and the depth of the groundwater table has been less than 15 feet. However, Seed (1979) states that this should not be construed to indicate that liquefaction cannot be induced at larger depths due to earthquake shaking.

In the context of this reasoning and published recommendations by the Southern California Earthquake Center (Martin and Lew, 1999), ground settlement due to liquefaction has been calculated using the CPT data for the design level earthquake event using volumetric strain relationships by Ishihara and Yoshimine (1992). Estimated total settlements for the design level event are presented in Table 6-3, with respect to CPT locations with at least 50 feet of penetration.

Table 6-3. Summary of Liquefaction Settlement Estimates

CPT	Estimated Total Settlement (inches)[1]	CPT Depth (feet)	Proposed Nearby Structures
C-102	5.5	50	Injection Area - Unit 3
C-104	5.0	75	Miscellaneous Equipment - Unit 3
C-105	6.0	75	Cooling Tower - Unit 3
C-106	5.0	50	Control Building
C-107	6.0	75	Turbine/Generator - Unit 3
C-108	6.5	75	Cooling Tower - Unit 3
C-109	6.5	75	Miscellaneous Equipment - Unit 2
C-110	6.5	75	Miscellaneous Equipment - Unit 1
C-111	8.5	75	Transformer - Unit 2
C-112	6	75	Turbine/Generator - Unit 2
C-113	7.5	75	Cooling Tower - Unit 2
C-114	7.5	75	Cooling Tower - Unit 2
C-115	6.5	75	Transformer - Unit 1
C-116	6.5	75	Turbine/Generator - Unit 1
C-117	6.5	75	Cooling Tower - Unit 1
C-118	6.5	75	Cooling Tower - Unit 1
C-120	5	50	Injection Area - Unit 1
C-121	6	50	Storm Water Retention Basin

Notes:
[1] Estimated settlements rounded up to the nearest half-inch.

Observations of liquefaction-induced settlements from past earthquakes throughout the world have shown that settlement from liquefaction is difficult to predict and can vary significantly over relatively short distances. Current SCEC guidelines recommend that differential settlement from liquefaction should be conservatively estimated as one-half to two-thirds the total settlement from liquefaction where sites have variable stratigraphy. Because the site is relatively flat and subsurface conditions are relatively consistent, we recommend that differential settlements for design of structures around the site be estimated as about one-half of the total settlement from liquefaction.

6.4 LATERAL SPREADING POTENTIAL

Estimating lateral movements resulting from seismic events is highly uncertain. Youd and Bartlett (2002) have developed empirical procedures for estimating lateral movements. Their empirically-derived procedures for estimating lateral movements depend on earthquake magnitude, distance between the site and seismic event, thickness of liquefied layer, ground slope or ratio of free-face height to distance between free-face and structure, fines content, the average particle size of the material forming the liquefied layer, and the SPT N-value. The proposed project site is relatively level and is not adjacent to any significant depressions (e.g. deep channels, river basins, etc.). Although subsurface conditions at the site consist of silty and sandy soils that are susceptible to liquefaction, we believe the risk of lateral movement at the site during a significant seismic event is very low.

6.5 SURFACE EFFECTS FROM LIQUEFACTION

Liquefaction is often accompanied by the development of sand boils and fissures, herein termed surface effects. Ishihara (1985) produced an empirical procedure to estimate the thickness of the overlying non-liquefiable layer to prevent level-ground liquefaction-related damage from surface effects. This procedure was later validated in a study by Youd and Garris (1995), where it was concluded that the procedure is not appropriate for assessing surface affects from liquefaction at level ground sites subject to lateral spreading. However, preliminary field data from the recent earthquakes (1999 Kocaeli [Turkey], 1999 Chi-Chi [Taiwan]) suggest that the Ishihara procedure may not always be capable of predicting the occurrence of surface effects.

Since the potential for lateral spreading at the project site is very low (see Section 6.4), the Ishihara procedure was used to estimate the potential for surface effects occurring at the site as a result of liquefaction. Review of subsurface conditions throughout the project area and application of the Ishihara procedure suggests that the site has a potential of experiencing surface effects if liquefaction at the site were to occur. Surface manifestations of liquefaction could include sand boils or ground fissures.

7.0 FOUNDATION RECOMMENDATIONS

7.1 INTRODUCTION

Each unit of the proposed facility will consist of a Generating Area and a Production Area. The structural and mechanical components of each respective area will be identical. Based on preliminary equipment loading data provided by CalEnergy, we understand that the largest structural loads will be in the Generating Areas at the cooling tower and the turbine/generator structures. Although plans showing the dimensions of all the structures and foundations had not been prepared at the time of this report, Fugro has assumed that the various mechanical equipment and structures will be grouped as required and supported on reinforced concrete footing and/or mat foundations. The three units will also share a number of facilities that include a control building, fire water and purge water storage tanks, and a storm water retention pond.

Fugro understands that it is planned to raise existing grades in the proposed structure and road areas a minimum of 1.5 feet above existing grade in order to achieve proper site drainage conditions. This will create a pad of engineered fill material beneath most structures and pavements and will help to mitigate some of foundation design and construction issues associated with the soft ground conditions at this site.

Recommendations are presented below for shallow and deep foundations together with estimated settlements under static and seismic (i.e., liquefaction) conditions. The structural designers should select the appropriate foundation type based on the sensitivity of the structures to the estimated settlements and the level of risk that CalEnergy is willing to accept in the performance of the facility.

7.1.1 Design Requirements and Considerations

In general, for satisfactory foundation performance, the selected foundation design must meet the following criteria:

1. Applied structural loads transmitted to the soils through shallow or deep foundations should not exceed the ultimate bearing capacity (which is a function of the shear strength) of the foundation soils. Moreover, the applied bearing pressures should not exceed an allowable bearing pressure determined by dividing the ultimate bearing capacity by an appropriate factor of safety.
2. The settlements due to compression and consolidation of the underlying soils must be within tolerable limits of the structure.

Our assessments of and recommendations for bearing capacity and settlement are presented in the following sections. Any major relocation of equipment or any significant increase in structural loads or foundation dimensions could result in a revision of these recommendations. Such changes should be reviewed by Fugro prior to finalizing design or implementing construction.

7.1.2 Foundation Loads

The expected foundation loads for major structures, such as cooling towers and turbine/generator structures, were estimated based on the preliminary information provided by CalEnergy. Based on the available data, the highest foundation loads are expected to be at the generator/turbine structures, which are expected to weigh about 1,000 kips each and exert an average pressure of about 600 pounds per square foot (psf) over a foundation area of 60 feet by 30 feet, and the cooling towers, which are expected to weigh about 7,600 kips each and exert an average pressure of about 500 psf over a foundation area of 282 feet by 54 feet.

For large-area foundations, the foundation stresses will be transferred relatively deep into underlying soils. To evaluate the subsurface stress distribution and estimated settlement under large-area foundations, the computer program UNISETTLE (Unisoft Ltd., 2002) was used. The Boussinesq elastic stress distribution option in UNISETTLE was selected for the stress analysis. The Boussinesq theory assumes the subsurface is an isotropic, homogeneous, linear elastic half-space.

7.1.3 Idealized Soil Profile

Foundation recommendations presented in this section were developed using the idealized subsurface conditions for major soil groups as listed in Table 7-1.

Table 7-1. Idealized Subsurface Profile for Foundation Recommendations Evaluation

Soil Unit	Depth to the Top of Layer (feet)	Total Unit Weight (pcf)	Apparent Cohesion / Undrained Shear Strength (psf)	Friction Angle (degrees)	Undrained Residual Strength of Liquefiable Soils (psf)
New Compacted Fill	0	120	100	35	-
Shallow Interbedded Clays, Silts and Sands	3	115	800	0	-
Loose to Medium Dense Silty Sands	10	120	0	30	250
Clays and Silts	15	120	1,500	0	-
Loose to Medium Dense Silty Sands	18	120	0	32	550
Clays and Silts	25	115	1,000	0	-
Medium Dense to Dense Silty Sands	35	125	0	35	-
Clays and Silts Interbedded with Sands	47	115	1,000 to 1,500	0	-

The shear strength parameters for the idealized subsurface profile were assessed using the data collected during the field exploration (CPT resistance values and SPT blowcounts), and results of the shear strength laboratory testing.

7.2 SHALLOW FOOTINGS

Proposed lightly-loaded ancillary buildings and selected equipment may be supported on shallow foundations. The use of shallow foundations is contingent on the assumption that the risks of the anticipated differential static and liquefaction-induced seismic settlements are acceptable and can be accommodated in the design of the structures. We recommend minimum footing widths of 24 inches for individual square footings and 18 inches for continuous strip footings. The footing thickness should be determined by a structural engineer, but should not be less than 12 inches.

As discussed in subsequent sections of this report, overexcavation and replacement of existing surficial soils will be performed in all foundation areas of the site and grades will be raised by at least 1.5 feet above existing elevations. Consequently, all footings should be founded on at least 12 inches of compacted structural fill at a minimum embedment of 24 inches, relative to the adjacent finished grade or slab elevation, whichever is lower. Where necessary, areas of overexcavation should be deepened to achieve the minimum recommended depth of embedment and thickness of structural fill beneath footings.

Existing surficial soils at the site exhibit a moderate expansion potential; however, the proposed overexcavation and replacement of existing surficial soils, together with proper site drainage, is expected to mitigate the potential for expansive soil damage to shallow foundations.

7.2.1 Allowable Bearing Pressures

Shallow footings should be proportioned for dead load plus probable maximum live load so that the maximum net bearing pressure does not exceed the maximum allowable net bearing pressure. The maximum allowable net bearing pressure of 1,500 psf should be used for foundation design, and provides a factor of safety greater than 2. A one-third increase can be applied to maximum bearing pressures for wind-loads. Because of the potential for liquefaction of the soil below the footings, the recommended maximum bearing pressures should not be increased for seismic loads.

7.2.2 Estimated Settlement

7.2.2.1 Static Settlement

Settlement estimates were based on the data provided by CPTs located in the project area and the idealized soil profile presented in Section 7.1.3 using standard settlement calculations. Estimated total settlements are presented in Table 7-2. Approximately two-thirds of the estimated static-load settlement is expected to occur during construction as loads are applied. The remaining estimated static-load settlement is expected to occur within 3 to 6 months of the application of the load. These estimates are based on the recommended minimum thickness of new structural fill below the bottom of the footings.

Table 7-2. Summary of Settlement Estimates for Shallow Footings

Foundation Type and Size	Contact Pressure (psf)	Estimated Total Static Settlement (inches)	Estimated Differential Static Settlement[1] (inches)	Estimated Total Liquefaction Induced Settlement (inches)	Estimated Differential Liquefaction Induced Settlement [1] (inches)
Strip footings (width 2 to 3 feet)	500	0.5 - 1	< 0.5	6 - 8	3 - 4
	1,000	0.8 - 1.2	< 0.8		
	1,500	1 - 1.5	0.5 - 1		
Individual footings (less than 5 feet square)	500	0.5 - 1	< 0.5	6 - 8	2 - 3
	1,000	1 - 1.5	0.5 - 1		
	1,500	1.5 - 2	0.5 - 1		
Individual footings (5 to 15 feet square)	500	1 - 1.5	0.5 - 1	6 - 8	3 - 4
	1,000	1.5 - 2	0.5 - 1		
	1500	2 - 2.5	1 - 1.5		

Notes: [1] Differential settlements are estimated over a distance of 30 feet

Differential settlements between footings may result from variations in subsurface conditions, differences in footing size, and variations in loading conditions. The differential settlements were estimated at about one-third to one-half the total settlement, depending on the size of the foundation.

Estimated total and differential settlements for shallow footings are based on the assumption that the foundations are not immediately adjacent to the cooling towers, turbine/generator structure or other heavy loads. If the subsurface soils beneath the footings are also subjected to stresses from adjacent heavy structures, then settlements beneath the buildings may be greater than the estimated settlements presented in the preceding paragraphs.

7.2.2.2 Liquefaction-Related Settlement

Although large settlements are not expected to occur due to static loads, additional settlements may occur if loose sand layers liquefy during a large earthquake. As summarized in Section 6.0, the submerged granular soils are susceptible to liquefaction and additional settlement may occur due to liquefaction during an earthquake. Seismically induced total settlements could be as much as 6 to 8 inches over the site, if earthquake-induced ground accelerations produce extensive liquefaction. Those settlements could be quite variable and create significant differential settlements over limited distances; therefore, the settlements due to liquefaction should be expected to vary laterally. The differential settlements can be estimated at about one-half of the total settlement. Estimated total and differential liquefaction induced settlements for the shallow footings are presented in Table 7-2.

7.2.3 Lateral Sliding and Passive Resistance

The sliding resistance generated through a soil/concrete interface can be computed by using an allowable coefficient of friction of 0.25 and the applicable structural load allowed by the

2007 CBC. A one-third increase may be applied to the allowable coefficient of friction for short-term loading.

For foundation elements bearing against compacted fill, the allowable passive earth resistance (neglecting the upper 1-foot) may be estimated using an equivalent fluid weight of 150 pcf. The allowable passive pressure may be used in combination with the frictional resistance. A one-third increase may be applied to the allowable passive pressure for short-term loading.

7.3 MAT FOUNDATIONS

Larger facilities such as the cooling towers and turbine/generator structures may be supported on mat foundations. The use of mat foundations is contingent on the assumption that the risks of the anticipated differential static and liquefaction-induced seismic settlements are acceptable and can be accommodated in the design of the structures. To limit the total and differential liquefaction induced seismic settlements, ground improvement measures can be implemented, as discussed in more detail in Section 7.5.

As discussed in subsequent sections of this report, overexcavation and replacement of existing surficial soils will be performed in all foundation areas of the site. Consequently, all mat foundations should rest on at least 12 inches of compacted structural fill at a minimum embedment of 24 inches, relative to the adjacent finished grade or slab elevation, whichever is lower. Where necessary, areas of overexcavation should be deepened to achieve the minimum recommended depth of embedment and thickness of structural fill beneath mat foundations.

7.3.1 Allowable Bearing Pressures

Mat foundations should be proportioned for dead load plus probable maximum live load so that the maximum net bearing pressure does not exceed the maximum allowable net bearing pressure. A maximum allowable net bearing pressure of 1,500 psf may be used for foundation design, and provides a factor of safety greater than 2. A one-third increase can be applied to maximum bearing pressures for wind-loads. Because of the potential for liquefaction of the soil below the footings, the recommended maximum bearing pressures should not be increased by one-third for seismic loads.

7.3.2 Estimated Settlement

7.3.2.1 Static Settlement

Estimated total settlements are presented in Table 7-3. Settlement estimates were based on soil profiles and data as interpreted from the CPTs located in the proposed cooling tower and turbine/generator locations and consolidation test results from samples obtained from the borings. Estimated contact pressures are based on structural loads and assumed foundations dimensions as interpreted from data provided by CalEnergy and described in Section 7.1.2 of this report. About one-third of the estimated static-load settlement is expected to occur during construction as loads are applied. The remaining estimated static-load settlement is expected to occur within six to nine months of the application of the load.

Table 7-3. Settlement Estimates for Selected Major Structures on Mat Foundations

Mat Foundation Location	Estimated Contact Pressures[1] (psf)	CPTs Used in Analysis	Estimated Total Static Settlement (inches)	Estimated Differential Static Settlement (inches)[2]	Estimated Total Liquefaction Induced Settlement (inches)	Estimated Differential Liquefaction Induced Settlement[3] (inches)
Cooling Tower - Unit 1	500	CPT-117 CPT-118	2.5 - 3	1.5 - 2	6.5 - 7	3 - 3.5
Cooling Tower - Unit 2	500	CPT-113 CPT-114	2.8 - 3.2	1.8 - 2.2	8 - 8.5	4 - 4.5
Cooling Tower - Unit 3	500	CPT-105 CPT-108	2.5 - 3	1.5 - 2	6 - 6.5	3 - 3.5
Turbine/Generator Unit 1	600	CPT-116	2 - 2.5	1 - 1.5	6.5	3.5
Turbine/Generator Unit 2	600	CPT-112	2 - 2.5	1 - 1.5	6	3
Turbine/Generator Unit 3	600	CPT-107	2 - 2.5	1 - 1.5	6	3

Notes:
[1] Estimated based on preliminary information provided by CalEnergy (Figure 1-3)
[2] Estimated differential settlement by considering the variation in soil conditions and stress distribution between the center and the edge of the mat foundation
[3] Differential settlement between the center and the edge of the mat foundations is estimated as one-half of the total liquefaction induced seismic settlement.

Differential settlements may result from variations in subsurface conditions and variations in loading conditions. The differential settlements were estimated by comparing the loading conditions underneath the center point and the corner point of the mat foundation.

7.3.2.2 Liquefaction-Related Settlement

Although large settlements are not expected to occur due to static loads, additional settlements may occur if looser sand layers liquefy during a large earthquake. As summarized in Section 6.0, the submerged granular fills are susceptible to liquefaction. Thus, additional settlement may occur due to liquefaction during an earthquake. Seismically induced total settlements could be as much as 6 to 8 inches over the site, if earthquake-induced ground accelerations produce extensive liquefaction. Those settlements could be quite variable and create significant differential settlements over limited distances; therefore, settlements due to liquefaction should be expected to vary laterally. The differential settlements can be estimated at about one-half of the total settlement. Estimated total and differential liquefaction induced settlements for the shallow footings are presented in Table 7-2.

7.3.3 Lateral Sliding and Passive Resistance

The sliding resistance generated through a soil/concrete interface can be computed by using an allowable coefficient of friction of 0.25 and the applicable structural load allowed by the

2007 CBC. A one-third increase may be applied to the allowable coefficient of friction for short-term loading.

For foundation elements bearing against compacted fill, the allowable passive earth resistance (neglecting the upper 1-foot) may be estimated using an equivalent fluid weight of 150 pcf. The allowable passive pressure may be used in combination with the frictional resistance. A one-third increase may be applied to the allowable passive pressure for short-term loading.

7.4 GROUND IMPROVEMENT

As discussed in preceding sections of this report, static settlements in the range of 2 to 3 inches were estimated for mats supporting structures such as the cooling tower and generator/turbine and 6 to 8 inches of total settlement due to liquefaction were estimated for the design seismic event, with possible differential settlements on the order of 3 to 4 inches. Therefore, seismic loading will probably control foundation design of the structures. For structures that are unable to tolerate settlements of this magnitude, various methods of deep ground improvement, such as stone columns or Cement Deep Soil Mixing (CDSM), could be used to mitigate liquefaction beneath the foundations. A treatment depth of approximately 50 feet below existing ground surface is considered appropriate for this site.

Stone columns are a ground improvement technology involving the replacement of weak soils with columns of compacted gravel. The columns are typically about 3 feet in diameter and constructed in a grid pattern at a spacing of about 7 to 8 feet on-center, although the spacing can be increased or decreased to suit site conditions and project requirements. The treatment area would extend horizontally outside the perimeter of the foundation a distance of approximately one-third to one-half of the vertical depth of treatment. The primary use of stone columns is to densify loose granular soils and increase their strength. Therefore, they are best suited for use at sites where foundation soils are predominantly loose to medium dense sands or silty sands with relatively low fines content (i.e., silt and clay content) and no significant silt or clay strata. As observed during the subsurface exploration for this study and described previously in this report, the stratigraphy of the Black Rock site is predominantly clay with interbeds of loose to medium dense sands. Although stone columns will help mitigate the liquefaction potential under proposed structures at this site, they could experience vertical deformation (i.e., compression) during an earthquake due to lateral compression of soft fine-grained soils, which would result in surface settlement for structures resting on the columns. However, CalEnergy has used stone columns on previous geothermal plant projects in the area and is therefore familiar with the cost and performance to date of this technology in ground conditions similar to those at the Black Rock site.

CDSM is a ground improvement technology that consists of drilling a series of overlapping borings in which cement slurry is blended in situ with the subsurface soils to create columns of soil-cement having higher strength and lower compressibility than the untreated native soils. Rebar can be placed in the soil-cement columns to transfer lateral loads from structure foundations. In general, a network of interconnected soil-cement columns resulting from the CDSM process is structurally superior to a network of stone columns in that it is stiffer, less compressible, and offers superior lateral load transfer for foundations. This technology has been used successfully for over 30 years in ground conditions similar to those at the Black Rock site.

For CDSM, the treatment area would extend horizontally outside the perimeter of the foundation a distance equal to about one-third of the vertical depth of treatment. The effective treatment volume beneath a structure is a function of the treatment area and the depth of treatment. Multiplying the treatment area by the treatment depth gives the total volume, from which the effective treatment volume is obtained by taking approximately 25 to 30 percent of the total volume. The distribution of ground improvement points (i.e., the treatment pattern) within the treatment area is performed according to one of a variety of possible geometric patterns based on site conditions, structural support requirements, and other design criteria. The actual treatment pattern should be determined by consultation between the project structural and geotechnical engineers during the design phase.

7.5 DEEP FOUNDATIONS

If any of the anticipated settlements, either static, liquefaction-induced seismic, and/or differential, are not acceptable for sensitive equipment, a deep foundation system, such as driven piles, may be used for support of such structures. Alternatively, ground improvement methods may be employed to mitigate the liquefaction potential as described in Section 7.4. Pile capacities and special considerations associated with use of pile foundations at the site are presented in the following section.

7.5.1 Axial Capacity

Axial capacities were based on methods presented in the American Petroleum Institute (API, 2000) as coded into the program APile Plus, Version 4.0 (Ensoft, 2005). The idealized subsurface profile presented in Section 7.1.3 was used in developing axial pile capacity recommendations.

Axial Capacity under Static Loads. Figure 7-1 presents the ultimate axial capacity curves developed for 12-, 14- and 16-inch square driven concrete piles. The axial capacities presented in the figure are derived primarily from the frictional resistance of the subsurface materials. End bearing will also contribute to the axial load capacity if the pile tips are founded in a sand layer. Typically, factors of safety of 2.0 are applied to design dead loads to assess the required ultimate axial pile capacity. A minimum depth of embedment can then be assessed using the curves presented in Figure 7-1. Selection of minimum embedment in this manner should limit the vertical movement of pile head under design load to less than one-half inch.

Uplift Capacity. Driven piles can be used to resist intermittent uplift loads using skin friction. The allowable uplift resistance of the piles was estimated based on 50 percent of the frictional capacity of the pile. The allowable uplift resistance curves for 12-, 14- and 16-inch square driven concrete piles are presented in Figure 7-2.

Seismic Considerations and Down-drag Loads. The presence of liquefiable soils within the zone of pile embedment will have two effects: 1) reduction of axial pile capacity during seismic loading due to the loss of strength in liquefiable soils; and 2) downdrag loads applied on the pile as a result of liquefaction-induced soil settlements developing following the seismic loading.

To avoid significant loss of axial capacity during seismic loading, the pile tips should not be placed in liquefiable soils, i.e., the pile tip elevation should be below about elevation -265 feet. The medium dense to dense silty sands extending from about elevation -260 to -275 feet are generally not expected to fully liquefy; however, some development of excess pore pressure may occur. The liquefaction triggering analyses indicate that limited sand zones below elevation -265 feet might be susceptible to liquefaction and there is a potential for limited liquefaction-induced additional settlements on the order of 1 to 2 inches to occur even for structures on pile foundations.

As the excess pore pressures generated during seismic loading in liquefiable soils start to dissipate, settlement will occur and the soil overlying the liquefiable soil zone will move downward relative to the piles. This downward movement will result in down-drag forces (i.e., negative axial capacity) on the piles due to the skin friction between the piles and the soil, which in turn will cause a reduction in the load-carrying capacity of the piles. Therefore, to account for both the down-drag forces and the loss of positive axial capacity along the same portion of the pile, the ultimate axial pile capacities should be reduced by approximately 110, 130, and 150 kips for 12-, 14- and 16-inch square piles, respectively.

Because liquefaction-related settlement and the resulting down-drag forces occur in a matter of minutes to hours after the design seismic event, it is appropriate to consider these forces as static loads, i.e., there is no need to combine down-drag forces with the inertial forces caused by ground shaking.

7.5.2 Lateral Capacity

Lateral load pile evaluations were performed using the computer program LPile Plus Version 5.0 (Ensoft, 2008) which is based on a soil resistance-pile deflection model (p-y analysis). LPile Plus was used to estimate the lateral load capacity versus head deflection and maximum moment. To account for potential strength loss in soils during the design level earthquake, a reduction factor for lateral soil resistance was applied in the form of p-multipliers. The evaluated reductions include the loss of soil resistance due to development of excess pore pressures, soil liquefaction, and loss of soil strength due to cyclic degradation.

The relationships between lateral load capacity and maximum moment versus pile head displacement are presented in Figures 7-3 and 7-4 for fixed-head and free-head piles, respectively. The fixed-head pile case will apply when pile head is connected to a mat foundation of sufficient size and stiffness to limit the pile head rotation. The free-head pile case will apply for conditions where no such restraint will be provided by the pile head connection. The minimum pile embedment depth recommended to achieve the presented lateral pile capacities is about 35 to 40 feet.

No factor of safety has been applied to the estimated loads or deflections. Due to the interbedded distribution of sand within the predominantly clayey stratigraphy in the upper 60 feet, the presence of thin liquefiable layers was neglected for design purposes. Depth of fixity calculations are presented in Appendix E.

If additional lateral support is required, the piles may be augmented with stone columns or CDSM to depths of approximately 20 feet around the foundation perimeter. If such ground improvement measures are implemented, lateral load capacities for driven piles may be evaluated from the data presented in Figures 7-5 and 7-6 for fixed-head and free-head piles, respectively.

7.5.3 Pile Spacing and Pile Group Effects.

For closely spaced piles, the interaction between individual piles may result in a reduction of both axial and lateral pile capacity. Therefore, it is recommended that the piles are not spaced closer than 5 pile diameters on-center. If piles are to be spaced closer than 5 times the pile section diameters, Fugro should review the recommended pile capacity curves and lateral pile displacements curves and provide additional recommendations, as needed.

7.6 MISCELLANEOUS

7.6.1 Drilled Shaft Foundations

Drilled shafts (i.e., piers) may be used for foundation support of above-ground piping. Because no information as to the size of the piers and required capacities were available at the time of the preparation of this report, we are providing generalized recommendations for evaluation of stability of drilled piers under axial and lateral loads.

The allowable axial capacity was evaluated by taking into account skin friction around the pile perimeter and can be estimated from the following expression:

Allowable Axial Capacity (kips) = $0.1\ z^{2}D$

where: z = depth of embedment below final grade in feet
D = pier diameter in feet

This expression incorporates a safety factor of 2 and is based on the assumption that the drilled piers will be embedded no greater than 15 feet below final grade.

The minimum embedment depth required to maintain the lateral stability should be estimated using requirements set forth in CBC (2007) Section 1805.7.2.1 and 1805.7.2.2, and an allowable lateral bearing pressure of 200 psf/foot below grade. If equipment supported by the drilled piers is sensitive to lateral displacement allowable lateral bearing pressure should be reduced by one half. An increase of allowable lateral bearing pressure of one-third is permitted for short term loads.

The drilled piers are not expected to experience significant settlement if static loads do not exceed the recommended allowable axial capacity. The total settlement of drilled piers as a result of liquefaction occurring during the design level earthquake is expected to be on the order of 6 to 8 inches, if no ground improvement is used. The differential liquefaction-induced settlements can be estimated at about 2 to 4 inches over 30 feet.

7.6.2 Concrete Slabs On-grade

Minimum Slab Thickness and Reinforcement. We recommend that all concrete slabs be reinforced. Slab thickness and reinforcement should be designed by the project structural engineer to resist structural loading and to satisfy pertinent code, temperature, and shrinkage requirements. As a minimum, we suggest that all slabs be at least 6 inches thick and be reinforced with No. 4 reinforcing bars (Grade 40) spaced at 14 inches on-center each way.

Reinforcement should be placed at mid-thickness of the slab with means to ensure that the reinforcement remains in place during construction and concrete placement.

Existing surficial soils at the site exhibit a moderate expansion potential; however, the proposed overexcavation and replacement of existing surficial soils, together with proper site drainage, will create a layer of non-expansive material that is expected to mitigate the potential for expansive soil damage to concrete slabs on-grade.

Vapor Barrier. When moisture sensitive flooring is expected, interior floor slabs should be protected against moisture vapor penetration with a continuous impermeable membrane. The impermeable membrane should be at least a 6-mil-thick polyethylene sheet or similar commercial vapor barrier that is placed midway within 4 inches of sand placed directly beneath the slab. In descending sequence, slabs with moisture-sensitive flooring should be underlain by:

- Two inches of sand;
- The vapor barrier membrane;
- Two inches of sand; and
- Four inches of crushed stone.

The crushed stone beneath the 4 inches of sand is to act as a capillary break. This layer should consist of poorly graded pea gravel or crushed rock. A material conforming to ASTM C33, Grade 67 is suggested with sizes ranging mostly between one-quarter and one-half inch. The lower sand layer is to act as a protective layer against penetration of protrusions through the vapor layer. The top sand layer, which is to protect the vapor barrier from construction activities, should be moistened slightly prior to placing concrete. Those layers should consist of clean sand with less than 5 percent passing the No. 200 sieve.

Both the sand and crushed stone layer should be lightly vibrated with four to five passes of a base plate on a walk-behind, self propelled vibrator.

7.6.3 Berm Stability Evaluation

An existing berm borders the entire length of the west side of the project site and separates the site from a drainage canal immediately to the west. An unpaved access road runs along the crest of the berm, which has an elevation of about -221 feet (NAVD88). The height of the east side of the berm (i.e., facing the project site) varies between about 4 feet at the south end to about 7 feet at the north end. Based on information provided by CalEnergy, the existing berm crest will be raised to elevation -220 feet (NAVD88) and the east face of the berm will be regraded to a constant slope of about 2:1 (horizontal to vertical) or flatter. We have assumed that the berm crest will be about 12 feet wide to accommodate vehicle traffic.

The stability of a 2:1 berm was evaluated assuming subsurface soil properties similar to idealized soil profiles used for developing foundation recommendations as presented in Section 7. The soil properties of berm material were estimated by review of the data collected by CPTs and HSA borings advanced along the berm crest.

Berm stability was evaluated for static and dynamic loading conditions. Static loading conditions included water on the west side of the berm up to Elevation -223 feet (i.e., three feet of freeboard) and vehicle loading on top of the berm equal to a distributed load of 250 psf over the berm crest. Dynamic loading conditions were evaluated using pseudo-static analyses taking into account the potentially liquefiable soils underlying the berm.

The static stability analysis resulted in a factor of safety of 1.9 as presented in Figure 7-7, for the conditions described above, indicating that the berm is expected to remain stable under the assumed static loading conditions. The stability of the berm under seismic conditions was evaluated using a pseudo-static analysis by estimating the displacement expected to occur during a design level earthquake. Based on the results of the pseudo-static analysis, also presented in Figure 7-7, a yield coefficient of about 0.13g was assessed for a berm underlain by liquefiable sand materials. Based on the calculated yield coefficient, coupled with our understanding of seismic demand at the site and the seismic displacement assessment recommendations as presented by Bray and Travasarou (2007), a seismic horizontal displacement of less than 6 inches was estimated for the design level earthquake. The results indicate that, while some displacement is likely to occur (estimated up to 6 inches), the berm is not expected to suffer global failure, i.e., the berm will still remain functional. However, some regrading and slope repair might be required following the design level earthquake to return the berm surface elevations to pre-earthquake levels

New materials used for the improvement of the berm should be compacted to a minimum of 95 percent relative compaction per ASTM D1557. Unless otherwise specified, all fill shall be placed in accordance with the recommendations provided in Section 8 of this report.

7.7 FOUNDATION DESIGN SUMMARY AND CONCLUSIONS

Based on the subsurface exploration, laboratory testing, and engineering analysis phases of the geotechnical study, Fugro finds that the project site is suitable for development of the proposed Black Rock Units 1, 2, and 3 geothermal power plant. Due to the preliminary stage of development of the facility, detailed plans showing the dimensions of all the structures and foundations were not available at the time this report was prepared; however, recommendations for various foundation options were presented above, assuming that the various mechanical equipment and structures will be grouped as required and supported on reinforced concrete mat foundations or shallow footings where appropriate. Recommendations for ground improvement and deep foundations were also presented for consideration. The optimum foundation system must be selected by CalEnergy and its design team based on a number of criteria over which Fugro has limited control. In general, these criteria include performance, cost, and risk. The foundation system should provide the required level of performance at the lowest cost and at a level of risk acceptable to the owner.

7.7.1 Shallow Footing and Mat Foundations

For structures capable of withstanding the estimated settlements presented in this report, and that have a fundamental period of vibration of 0.5 seconds or less, it is the opinion of Fugro that shallow footing and mat foundations, designed and constructed in accordance with the recommendations of this report, are suitable for use at this site and will provide the lowest cost foundation system; however, CalEnergy must be prepared to accept any risk of damage to, or loss of use of, the facility resulting from static settlement or seismically induced settlements or ground shaking. For example, if the facility is required to either act as an emergency backup facility or be operational immediately after an earthquake, the time required to make repairs may be unacceptable. Moreover, the cost of the repairs alone may be unacceptable, regardless of any facility downtime considerations.

Structures that have a fundamental period of vibration greater than 0.5 seconds may also be supported on shallow footings or mat foundations but will require a site response analysis as required by CBC 2007 and ASCE 7-05 to assess the design spectral response acceleration parameters. This analysis would not be required if liquefaction mitigation measures, such as the ground improvement methods discussed previously, are implemented as part of the foundation design.

7.7.2 Ground Improvement

For structures supported on shallow footings or mats and that are not capable of withstanding the estimated settlements, or where the repair costs or facility downtime factors create an unacceptable level of risk, ground improvement may be performed to mitigate the liquefaction potential and reduce both static and seismically-induced settlements. A treatment depth of approximately 50 feet below existing ground surface is considered appropriate for this site. The treatment area will depend on structural loading requirements and the selected ground improvement technology. Ground improvement technologies suitable for use at this site include stone columns and Cement Deep Soil Mixing. Fugro understands that CalEnergy has used stone columns on previous geothermal plant projects in the area and is therefore familiar with the cost and performance of this technology in ground conditions similar to those at the Black Rock site; however, Fugro considers that CDSM would provide a structurally superior, and potentially less expensive, alternative to stone columns. Fugro recommends that CalEnergy and their design team evaluate both these ground improvement technologies with respect to cost, performance, and time of construction and select the optimum alternative.

7.7.3 Deep Foundations

If any of the anticipated settlements, either static, liquefaction-induced seismic, and/or differential, are not acceptable for sensitive equipment or structures, and ground improvement alone is not considered feasible for reasons of cost or performance, a deep foundation system consisting of driven piles may be used for support of such structures. Recommendations for design and installation of various sizes of driven precast concrete piles were presented in this report. As discussed previously in this report, a pile foundation system would have to be supplemented with stone columns or CDSM to depths of approximately 20 feet around the foundation perimeter in order to provide additional lateral support during the design seismic event. Fugro recommends that CalEnergy consult with their design team and equipment manufacturers to determine if a deep foundation system is a requirement for any component of the proposed facility.

8.0 SITE DEVELOPMENT AND GRADING

8.1 SITE PREPARATION

Soil containing debris, organics, pavement, abandoned utilities, or other unsuitable materials, should be stripped from all proposed foundation, structure, and pavement areas and discarded offsite. With the exception of the perimeter access roads, the majority of the project site consists of cultivated farm land that was planted with alfalfa at the time of Fugro's October 2008 field investigation. The surface of the cultivated area consists of rows of slightly raised planted beds separated by lower furrows for irrigation. In order to remove the root zone and other organic material, a minimum of 18 inches of existing soil, as measured from the top of the existing planted areas, should be stripped from the site in areas where roads, equipment, and structures will be constructed. This material is not considered suitable for re-use as structural fill at the site. Additional removal may be required depending on the conditions observed at the time the grading is performed.

Fugro understands that it is planned to raise existing grades in the proposed structure and road areas a minimum of 1.5 feet above existing grade in order to achieve proper site drainage conditions. Placement of compacted fill will require a stable grade on which to operate compaction equipment; however, the high-moisture content, fine-grained soils present across the site will likely prevent obtaining the specified compaction requirements and create difficult working conditions for the earth moving equipment anticipated for the project. If compaction cannot be achieved because of wet conditions and pumping soil, stabilization of the excavation bottom will be necessary. Recommendations for stabilization of the excavation bottom are presented in the following sections.

The exposed surface of all excavation areas should be observed by Fugro prior to processing or placing fill. Excavation bottoms should be deepened, as needed, to remove loose or soft materials, artificial fill, or other deleterious material where encountered.

8.2 SPECIAL SUBGRADE STABILIZATION MEASURES

Special stabilization measures will likely be required if moist, soft or pumping subgrade is encountered during construction. These measures will be required to provide a firm and unyielding subgrade surface on which to place fill and perform construction activities. Special subgrade stabilization measures that have been used successfully for other projects, and that are considered suitable for this site consist of:

- Deepening the excavation bottom by about 1 to 2 feet, followed by placing a layer of geotextile, such as Geolon HP570, or the equivalent, on the excavation bottom, followed by the placement of about 2 feet of 4-inch minus crushed rock over the fabric. A filter fabric such as Mirafi 180N, or equivalent, should be placed on top of the rock layer prior to placing fill in order to reduce the potential for migration of fines into the rock; or
- Lime or Portland cement treatment of the fine-grained subgrade, followed by placement of compacted structural fill. Depending on the type of fill soil available, additional lime or cement treatment of the structural fill may be warranted.

The measure required will depend on the condition of the subgrade at the time of construction, the type of structural fill material that will be placed, the nature of the construction activities (e.g., vibratory compaction equipment, number of equipment passes), and the availability/cost of materials.

Fugro understands that imported fill soils will likely be similar to the on-site fine-grained materials. These soils are generally very sensitive to moisture content and can be difficult to compact. Therefore, consideration should be given to use of lime or Portland cement throughout the fill layer beneath all structures and roads. This procedure will allow for greater ease of compaction and also create a much stronger structural layer that will be more resistant to changes in moisture content over time.

8.3 DRAINAGE

Positive drainage should be developed and maintained away from all structures, foundations, and any exterior improvements. Hardscape areas should be maximized where possible adjacent to foundations to reduce the potential for water infiltration. Roof and surface runoff should be collected and conveyed away from structures and on-grade improvement areas. Water should not be allowed to accumulate or pond near structure foundations or on-grade improvements.

8.4 FILL PLACEMENT AND COMPACTION

Fill placement and grading operations should be performed according to the grading recommendations of this report. Fugro recommends that, unless otherwise noted, all fill materials be compacted to at least 95 percent relative compaction based on the maximum dry density determined from ASTM D1557.

Imported soils used as compacted fill should be placed and compacted at a moisture content of between -1 and +3 percent of the optimum moisture content. Each layer should be spread evenly and should be thoroughly blade-mixed during the spreading to provide relative uniformity of material within each layer. Soft or yielding materials should be removed and be replaced with properly compacted fill material prior to placing the next layer.

Rock, gravel, and other oversized material (greater than 4 inches in diameter) should be removed from the fill material prior to being placed. Rock less than 4 inches in diameter should not be nested, and voids caused by inclusion of rock in the fill should be filled with sand or other approved material.

When the moisture content of the fill material is below that sufficient to achieve the recommended compaction, water should be added to the fill. While water is being added, the soil should be bladed and mixed to provide relatively uniform moisture content throughout the material. When the moisture content of the fill material is excessive, the fill material should be aerated by blading or other methods. Fill should be spread in loose lifts no thicker than about 8-inches prior to being compacted. Fill and backfill materials may need to be placed in thinner lifts to achieve the recommended compaction depending on the equipment being used.

8.5 MATERIALS

8.5.1 Imported Fill

Imported fill should be free of organics (i.e., roots, vegetative matter, etc.), oversize material (i.e., rocks greater than 4 inches in diameter), trash and debris, and other deleterious material. Organics should be removed from the soils to be used as fill so that fill soils have an organic content of less than 3 percent by weight. All imported fill materials should have an

Expansion Index (EI) of less than 20, which should be verified during grading. Imported fill meeting these requirements may be used as backfill in foundation and road overexcavation areas, except as noted otherwise in this report.

All fill of any origin proposed for use at the site should be observed and tested by Fugro prior to import to, or use at, the site.

8.6 GEOTECHNICAL OVERSIGHT

Proper geotechnical observation and testing during construction are imperative in allowing the geotechnical engineer the opportunity to verify assumptions made during the design process. Therefore, all overexcavation and fill placement activities should be performed under the observation and testing of the geotechnical engineer of record for the project.

The Conditions of Certification will require that the project owner assign California-registered civil and geotechnical engineers, and a California-certified engineering geologist to the project to provide the necessary oversight and inspection. Therefore, we recommend that Fugro be retained during site grading and foundation construction to observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those anticipated.

9.0 FLEXIBLE PAVEMENT DESIGN

9.1 DESIGN SECTION AND MATERIALS

Pavement thickness design depends on the strength of the subgrade soils, the type of construction materials, and on the traffic loading to which the pavement will be subjected. Subgrade strength was evaluated by Resistance-value (R-value) tests performed on three samples of subgrade soils obtained from proposed paving areas. Based on the results of the R-value tests and the general soil conditions at the site, an R-value of 4 is considered appropriate for design of pavement both on-site and on adjacent McKendry and Boyle Roads where pavement improvements will also be made. It is assumed that on-site subgrade will most likely be treated with lime or Portland cement and off-site subgrade (i.e., along McKendry and Boyle Roads) may not be treated.

Design traffic loading conditions were not available at the time of this study; therefore, Traffic Indices of 5, 6, 7, and 8 were assumed to be representative of the range of traffic loading conditions that will occur in road and parking areas and were used to develop pavement sections for the project. The project civil engineer should select the appropriate Traffic Index (T.I.) for each pavement area based on the design traffic loading conditions. If design T.I. values are different from the assumed values, Fugro should be notified for reevaluation of pavement section thickness.

Pavement sections were developed using the Caltrans design method for flexible pavement based on a 20-year design life and are presented in Tables 9-1 and 9-2. The sections are based on the parameters discussed above for both treated and untreated subgrade conditions.

Table 9-1. Recommended Pavement Sections for Pavement Supported on at least 12 inches of Soil-Cement or Lime Treated Subgrade

Traffic Index (TI)	5	6	7	8
Asphalt Concrete (ft)	0.25	0.25	0.35	0.40
Class II Aggregate Base (ft)	0.35	0.35	0.35	0.35

Table 9-2. Recommended Pavement Sections for Pavement with no Soil-Cement or Lime Treated Subgrade

Traffic Index (TI)	5	6	7	8
Asphalt Concrete (in.)	0.25	0.25	0.35	0.40
Class II Aggregate Base (in.)	0.80	1.15	1.25	1.50

9.2 CONSTRUCTION CONSIDERATIONS

Subgrade. Roadway areas should be prepared as described in Section 8 of this report. The areas to receive pavement should be stripped and excavated to the proposed subgrade elevation or entirely through any existing asphaltic-concrete or base. The upper 12 inches of all pavement subgrade, treated or untreated, should be moisture conditioned to within 2 percent of optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by the latest revision of ASTM D1557. All subgrade preparation activities should be performed under the observation and testing of a representative of the project geotechnical engineer.

R-value tests should be performed on subgrade materials near the completion of rough grading and on potential import soils in order to confirm pavement design sections. The samples for the confirmatory R-value tests should be obtained from the upper 3 feet of pavement subgrade soils.

Aggregate Base. Aggregate base should have a minimum R-value of 78 and conform to the requirements of California Class II Aggregate Base. Aggregate base material should be compacted in lifts not exceeding 6 to 8 inches in thickness, to at least 95 percent of the maximum dry density determined from ASTM D1557, latest revision. As-compacted moisture contents for the aggregate base materials should be within 2 percent of the optimum moisture content, as determined from ASTM D1557.

Drainage. Proper drainage of the paved and surrounding unpaved areas is essential. Grades should be established to expedite runoff away from the pavements and reduce moisture infiltration in the base and subgrade.

10.0 CORROSION AND CHEMICAL DATA

Soil corrosion potential for buried metal and concrete was estimated by performing water-soluble sulfate, chloride, pH, and electrical resistivity tests. Results of these tests for near-surface soils are provided in Appendix B and are summarized in Table 10-1.

Table 10-1. Summary of Chemical Test Results

Location	Depth (feet)	Material	Sulfates (ppm)	Chlorides (ppm)	Resistivity at 100% Saturation, ohms-cm	pH	Redox (mV)
HSA-3	0 - 3	Clay	2,800	1,500	270	8.2	470
HSA-10	0 - 3	Clay	1,300	800	280	7.9	460
HSA-11	0 - 3	Clay	1,200	630	310	7.9	470
HSA-14	0 - 3	Clay	1,200	970	400	7.9	460
HSA-20	0 - 3	Clay	1,600	970	260	8.4	460

ppm - parts per million; mV - millivolt

Electrical resistivity is a measure of soil resistance to the flow of electrical current. The electrical resistivity of a soil decreases primarily as its chemical and moisture contents increase. The corrosion potential for ferrous metals is generally higher in soils with low electrical resistivity. A commonly accepted correlation between electrical resistivity and corrosivity for buried ferrous metals is presented below in Table 10-2.

Table 10-2. Soil Corrosion Potential Correlation

Electrical Resistivity (Ohms-cm)	Corrosion Potential
Less than 1,000	Severe
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderate
Greater than 10,000	Mild

Results of electrical resistivity tests indicate values ranging between 260 and 400 ohms-cm for the near-surface soils. Based on this limited data, near-surface soils at the Black Rock site appear to have a severe corrosion potential for buried ferrous metals. This potential should be considered in design of underground metal pipes.

Based on the results of the sulfate tests presented above, the surficial soils appear to have a moderate to severe degree of corrosivity to concrete. Concrete in contact with site soils should be designed and constructed in accordance with the requirements of the American Concrete Institute (ACI) 318, Section 4.3 as specified in Section 1904A.3 of the 2007 CBC. The results of the tests presented above indicate this will require the use of Type V Portland cement and a maximum water-cement ratio of 0.45 for concrete in contact with soils. Appropriate testing should be performed at the completion of rough grading to confirm the corrosion resistance design requirements for concrete to be placed in contact with site soils.

Based on the results of the chloride tests presented above, the surficial soils appear to have a moderate to severe degree of corrosivity to ferrous metals. Reinforcement in concrete should be protected from corrosion and exposure to chlorides in accordance the requirements of the American Concrete Institute (ACI) 318, Section 4.4 as specified in Section 1904A.4 of the 2007 CBC. Appropriate testing should be performed at the completion of rough grading to confirm the corrosion resistance design requirements for concrete to be placed in contact with site soils.

In general, corrosive site soils should be assumed in estimating the design life of underground utility lines and buried structures at the Black Rock site. Fugro recommends that a corrosion engineer be consulted to determine the most appropriate corrosion protection measures for all buried utilities and structures at the site, including pile foundations.

11.0 REFERENCES

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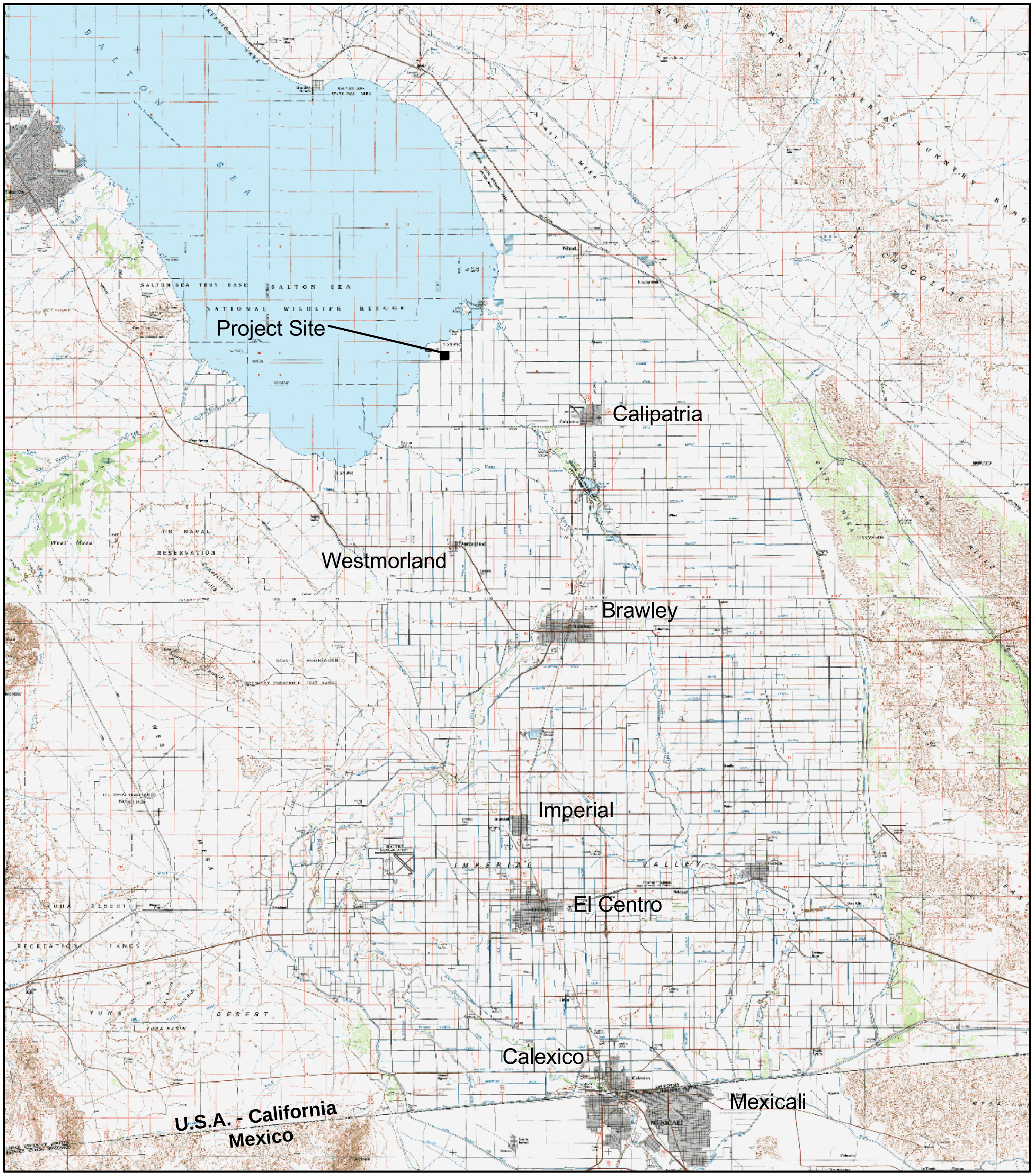
FIGURES



VICINITY MAP
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 1-1

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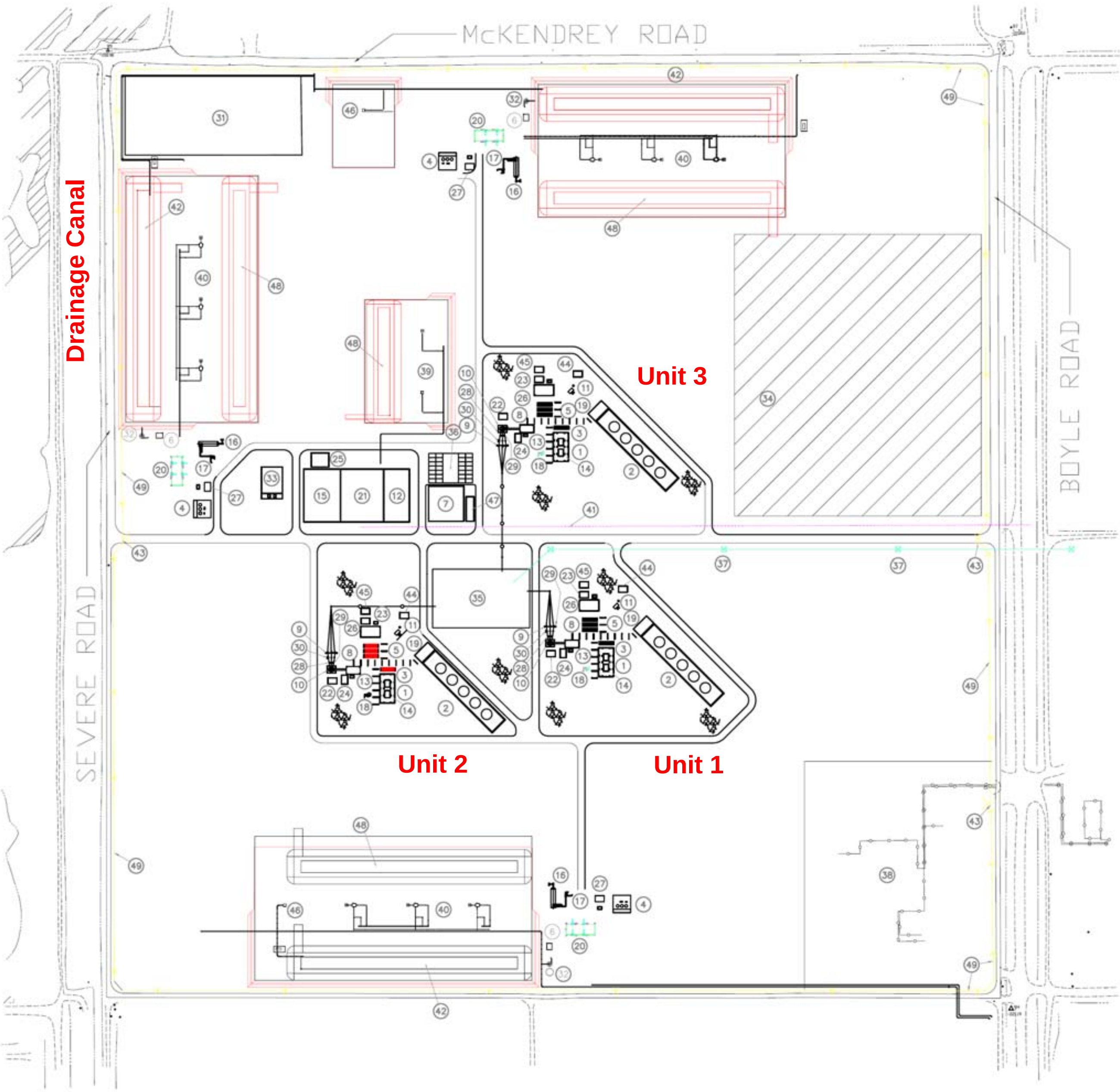

SITE LAYOUT
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 1-2

CEOC IV
ENGINEERING

EP-07-11
rev: 12/19/2008
by: J. Reverente

BLACK ROCK 1, 2 and 3

Major Equipment Dimension & Weights

EQUIPMENT DESCRIPTION	WEIGHTS	DIMENSION or SIZE	REMARKS
Equipment	*Pounds*		
HP Separator	350,000	12' ID x 54' T/T	Horizontal
HP Steam Scrubber	62,000	5' ID x 28' T/T	Vertical
HP Steam Demister	75,000	8' ID x 18' T/T	Vertical
Turbine	273,500	49' long x 16' wide x 10' high	Turbine/Generator combined
Generator	208,006		dimensions for TG set
Main Condenser	505,019		Under the turbine/generator set
First Stage Steam Ejector, 1st Train		26" x 26" Ejector with	
First Stage Ejector Nozzle, 1st Train		Multi-Nozzles	
First Stage Inter-Condenser, 1st Train	15,000	36" Shell Diameter	
First Stage Steam Ejector, 2nd Train		26" x 26" Ejector with	
First Stage Ejector Nozzle, 2nd Train		Multi-Nozzles	
First Stage Inter-Condenser, 2nd Train	15,000	36" Shell Diameter	
First Stage Steam Ejector, 3rd Train		26" x 26" Ejector with	
First Stage Ejector Nozzle, 3rd Train		Multi-Nozzles	
First Stage Inter-Condenser, 3rd Train	15,000	36" Shell Diameter	
Cooling Tower (fiber glass)	7,572,000	48.5' width x 276.5' length	Includes concrete basin + water
Cooling Tower Basin (Reinforced concrete)	2,800,000	54' width x 282' length	Water = 3,800,000 Lbs.
Rock Muffler (Reinforced concrete)		16' wide x 20' long x 24' high	
Production Test Unit	60,000	15' ID x 38' top to cone bottom	307,000 lbs with full of water
NCG Knock-Out Pot		36" Shell Diameter, 15' T/T	
NCG Oxidizer/Heat Exchanger	24,000	2,500 ACFM	
NCG Quench Tank & Scrubber + vent stack	6,500		
36% Acid Tank A	11,000 gallons		
36% Acid Tank B	11,000 gallons		
2.5% Acid Tank	38,000 gallons		
Brine Holding Pond (Earthen pond with liners)	1,100,000 gallons	600' long x 50' wide x 7' deep	with 2 feet freeboard
Common Holding Pond (Reinforced Concrete)	2,585,088 gallons	360' long x 120' wide x 10' high	rectangular structure with 12" wall
Power Distribution Control 1		42' x 27' x 10'	Metal Building
Power Distribution Control 2		40' x 28' x 10'	Metal Building
Power Distribution Control 3		42' x 27' x 10'	Metal Building
Control Building		100' x 100'	For Black Rock 1, 2 and 3
Emergency Diesel Generator, 1.5 MW	31,131	232.09"L x 99.9"W x 108.25"H	
Emergency Diesel Generator, 1.0 MW	17,738	183.74"L x 80.49"W x 86.7"H	
Step-up Transformer	212,374	223"H x 267"Width x 213"Depth	

Based on information provided by CalEnergy in September 2008.

PRELIMINARY EQUIPMENT SIZE AND WEIGHT LIST
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 1-3a

CEOC IV
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by: J. Reverente

BLACK ROCK 1, 2 and 3

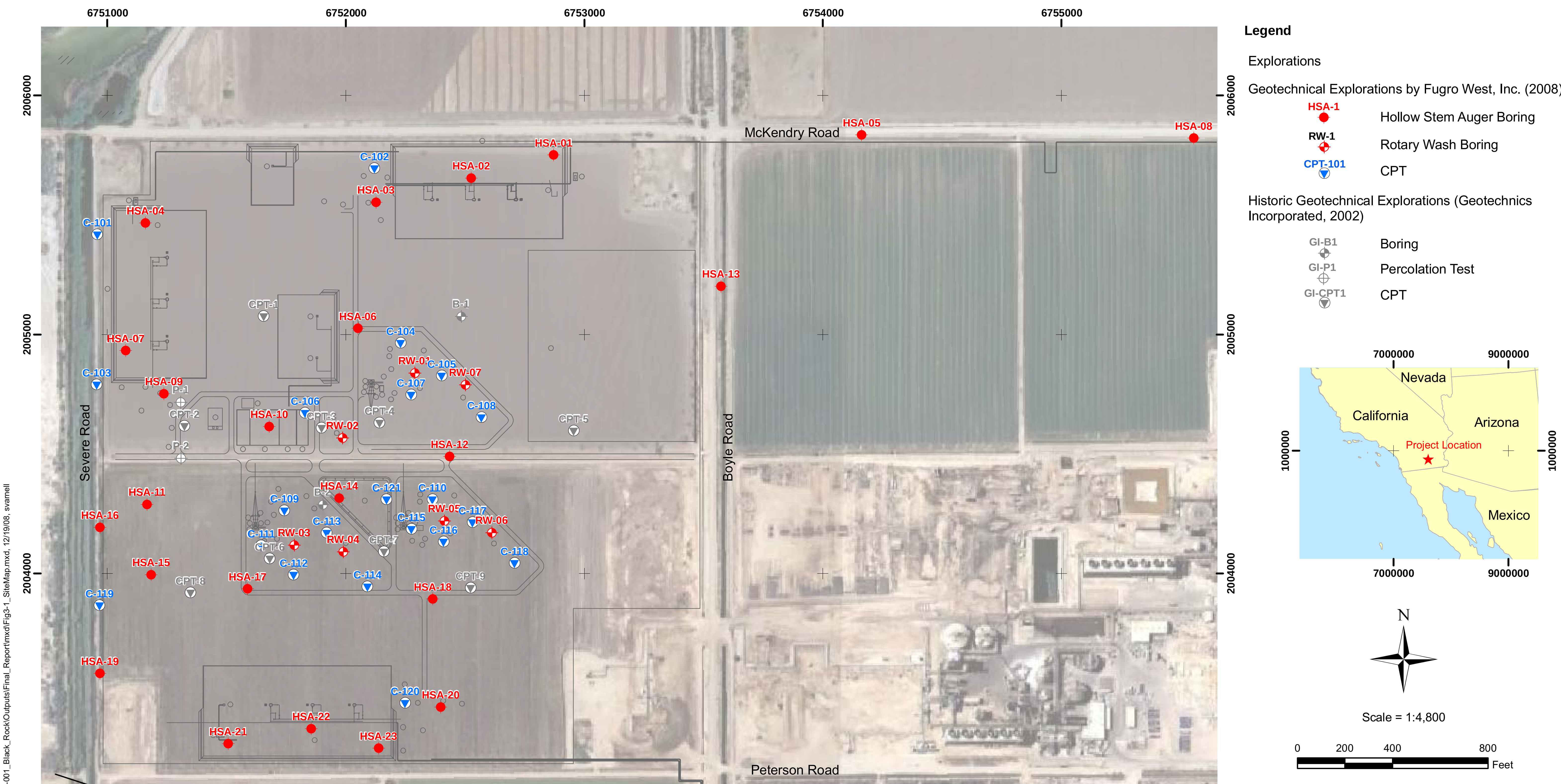
Major Equipment Dimension & Weights			
EQUIPMENT DESCRIPTION	**WEIGHTS**	**DIMENSION or SIZE**	**REMARKS**
Equipment	*Pounds*		
Pumps and Motors			
Brine Booster Injection Pump - A	4,030	14" x 16" x 26"	11,000 gpm flow capacity
Brine Booster Injection Pump - B	4,030	14" x 16" x 26"	11,000 gpm flow capacity
Brine Booster Injection Pump Motor - A	8,600	1,000 HP	
Brine Booster Injection Pump Motor - B	8,600	1,000 HP	
Brine Main Injection Pump - A	4,650	12" x 16" x 26"	11,000 gpm flow capacity
Brine Main Injection Pump - B	4,650	12" x 16" x 26"	11,000 gpm flow capacity
Brine Main Injection Pump Motor - A	10,000	2,000 HP	
Brine Main Injection Pump Motor - B	10,000	2,000 HP	
Aerated Brine Injection Vertical Pump - Toyo	900	8" x 6" x 84"	Cantilever Pump
Aerated Brine Injection Vertical Pump Motor - Toyo		75 HP	
Aerated Brine Main Injection Pump + motor	4,289	5" x 4", 400 HP	600 gpm Flow Capacity
Condensate Injection Pump - A + motor 400 HP	4,500		
Condensate Injection Pump - B + motor 400 HP	4,500		
Hot Well Condensate Pump - A	4,572	14DXC, 10" Discharge	2,100 gpm Flow Capacity
Hot Well Condensate Pump - B	4,572	14DXC, 10" Discharge	2,100 gpm Flow Capacity
Hot Well Condensate Pump Motor - A	1,836	125 HP	
Hot Well Condensate Pump Motor - B	1,836	125 HP	
Vacuum Pump - A, 1st Train + motor 350 HP			
Vacuum Pump - B, 2nd Train + motor 350 HP			
Vacuum Pump - C, 3rd Train + motor 350 HP			
Air Compressor - A + motor, 200 hp + dryer	7,572	826 cfm @ 150 psi	102" x 79" x 70"
Air Compressor - B + motor, 200 hp + dryer	7,572	826 cfm @ 150 psi	102" x 79" x 70"
Air Receiver	4,138 gallons	6' OD x 18' T/T	
Circulating Water Pump - A	20,683	44GHXC, 36" Discharge	
Circulating Water Pump - B	20,683	44GHXC, 36" Discharge	
Circulating Water Pump - C	20,683	44GHXC, 36" Discharge	
Circulating Water Pump Motor - A	15,000	1,000 HP	
Circulating Water Pump Motor - B	15,000	1,000 HP	
Circulating Water Pump Motor - C	15,000	1,000 HP	

Based on information provided by CalEnergy in September 2008.

PRELIMINARY EQUIPMENT SIZE AND WEIGHT LIST
Black Rock Units 1, 2 & 3
Calipatria, California

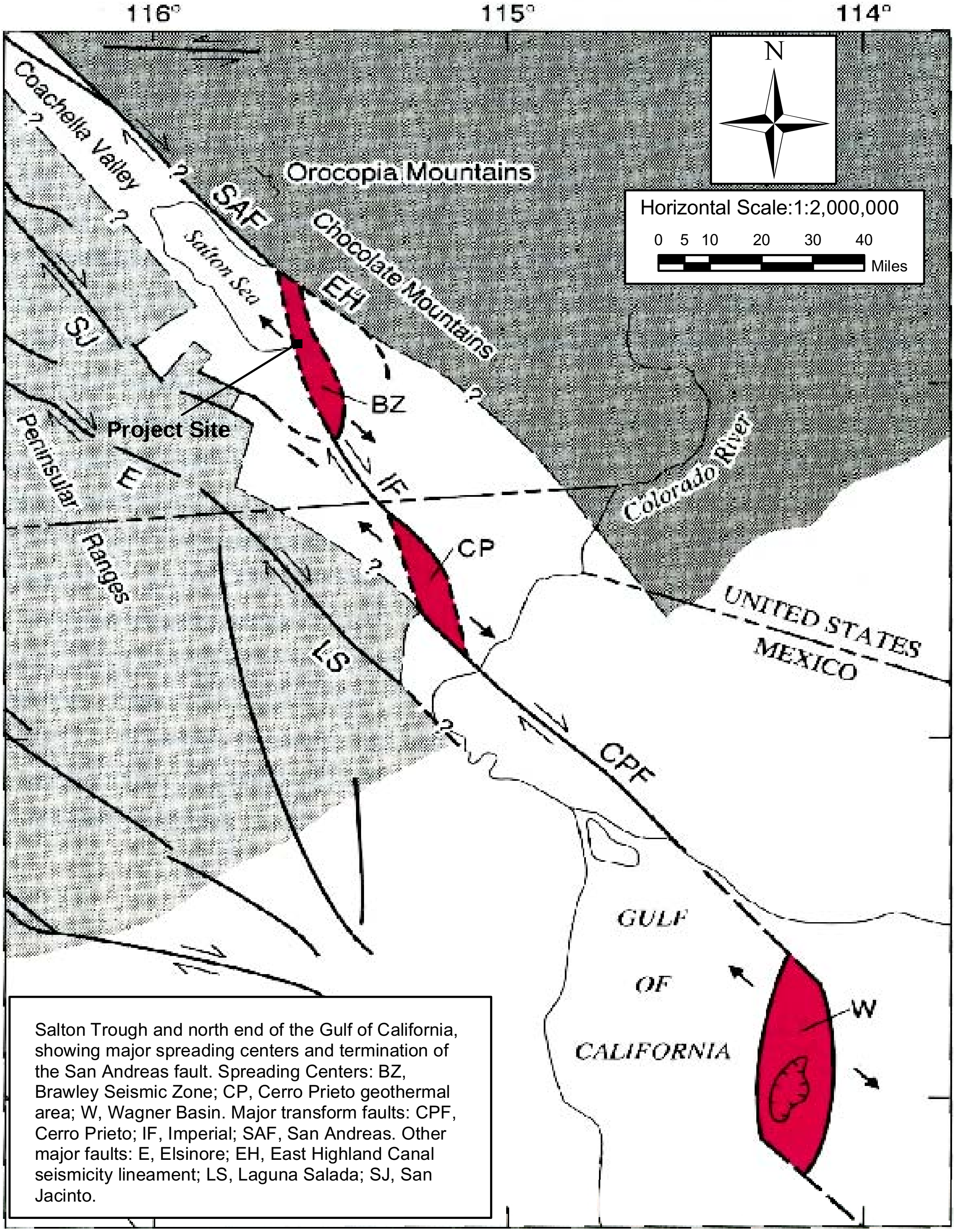
FIGURE 1-3b

CalEnergy Operating Corporation
Project No. 3652.001



SITE MAP
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 3-1



Salton Trough and north end of the Gulf of California, showing major spreading centers and termination of the San Andreas fault. Spreading Centers: BZ, Brawley Seismic Zone; CP, Cerro Prieto geothermal area; W, Wagner Basin. Major transform faults: CPF, Cerro Prieto; IF, Imperial; SAF, San Andreas. Other major faults: E, Elsinore; EH, East Highland Canal seismicity lineament; LS, Laguna Salada; SJ, San Jacinto.

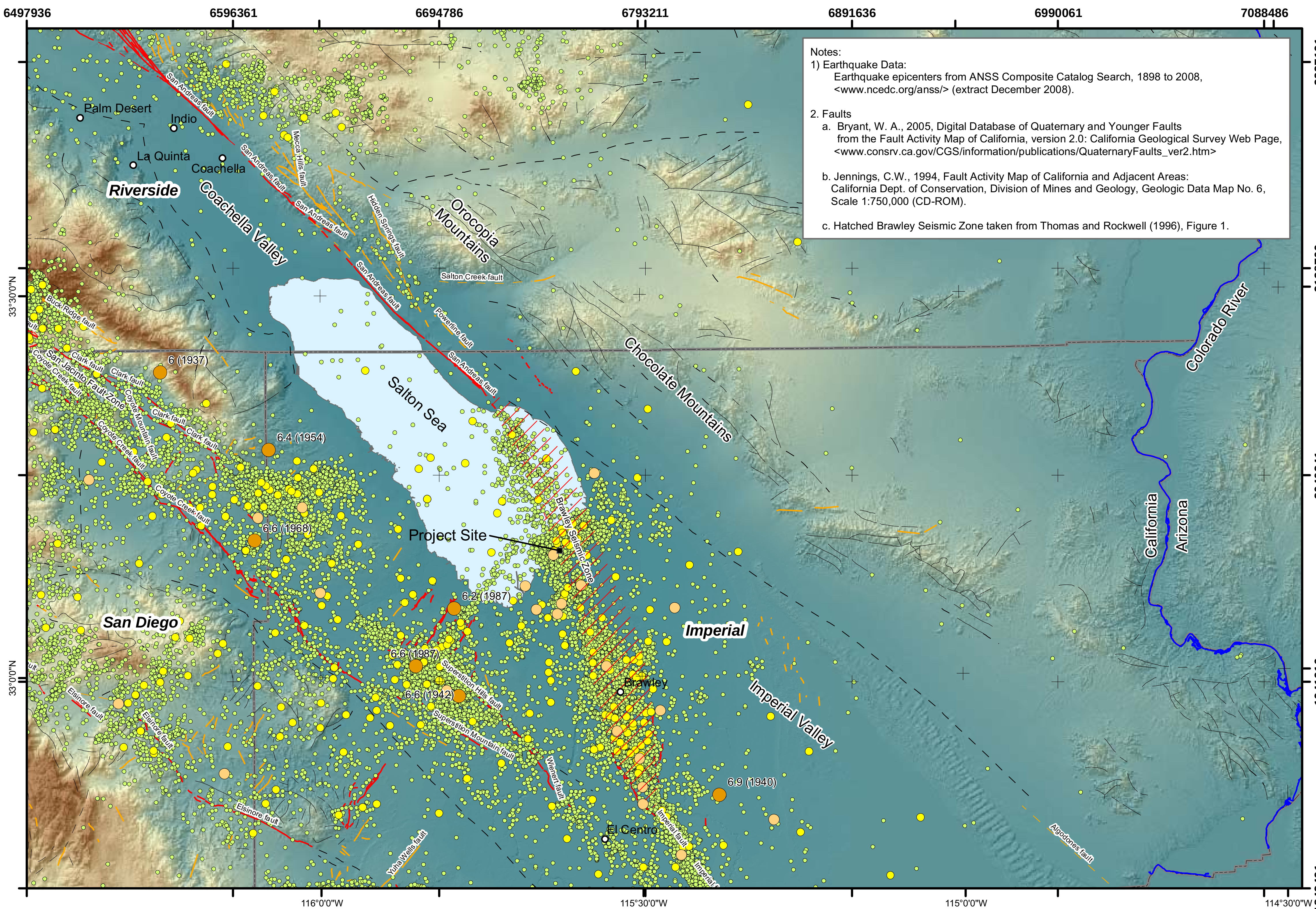
SOURCE: Wallace, 1990

TECTONIC SETTING

Black Rock Units 1, 2 & 3

Calipatria, California

FIGURE 5-1



Legend

○ Cities
County Boundaries

Faults

- Active Fault
- Active Fault, Inferred
- Active Fault, Concealed
- Potentially Active Fault
- Potenitally Active Fault, Inferred
- Potentially Active Fault, Concealed
- Inactive Fault
- Inactive Fault, Inferred
- Inactive Fault, Concealed

Historical Earthquake Magnitude (1932 to December 2008)
Magnitudes equal to and greater than 6 are labeled.

- 2.0 - 3.9
- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- 7+

Coordinate System: California State Plane, Zone 6, Feet

N

1:633,600
1" = 10 miles

0 5 10 20
Miles

FAULTING AND SEISMICITY
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 5-2

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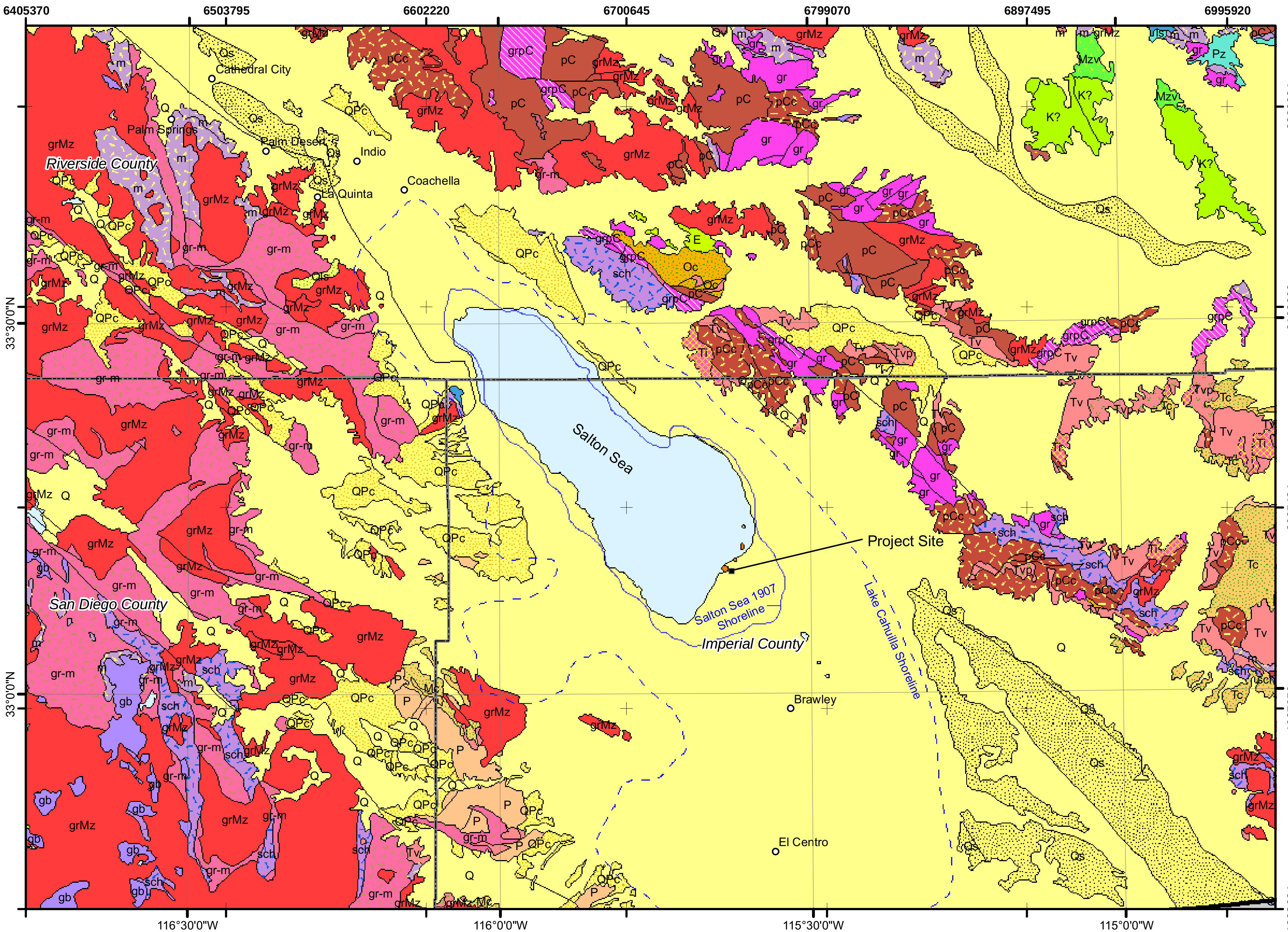

Legend

- ○ Cities
- ▭ County Boundaries
- ── Approximate Shoreline of the Salton Sea During March 1907 Highstand
- - - - Approximate Shoreline of Lake Cahuilla

Please See Figure 5-4 For Geologic Unit Descriptions

Notes:
1. Onshore Geology Source: George J. Saucedo, David R. Bedford, Gary L. Raines, Robert J. Miller, and Carl M. Wentworth, "GIS Data for the Geologic Map of California", Version 2.0, CD-ROM 2000-007, Department of Conservation, Division of Mines and Geology, Sacramento, California, 2000. The digital database contains the geologic units and faults as shown on the Geologic Map of California by Charles W. Jennings published in 1977.

2. Approximate shoreline during the Salton Sea March 1907 highstand digitized from Thomas and Rockwell (1996), Figure 3.

3. Approximate shoreline of Lake Cahuilla digitized from Thomas and Rockwell (1996), Figure 3.

Coordinate System: California State Plane, Zone 6, Feet

N

1:633,600
1" = 10 miles

0 5 10 20
Miles

REGIONAL GEOLOGY
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 5-3

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Offshore Geologic Units

- Q, Unconsolidated deposits of Quaternary age, includes ponded sediments.
- Qf, Quaternary fan deposits.
- Qt, Unconsolidated marine terrace deposits of probable Pliocene age.
- Qp, Unconsolidated marine shelf and slope deposits of late Pleistocene age.
- Qsp, Sediments that may correlate with the San Pedro formation.
- QTs, Undifferentiated sediments and sedimentary rocks of Quaternary and Tertiary (Pliocene and Miocene) age.
- QTt, Undifferentiated terrace deposits of Quaternary and late Tertiary (?) age
- Tp, Undifferentiated sedimentary rocks of Pliocene age.
- Tpr, Undifferentiated sedimentary rocks of early Pliocene age an late Miocene age.
- Tm, Undifferentiated sedimentary rocks of Miocene age.
- Tmv, Volcanic rocks of Miocene age.
- Tmu, Undifferentiated volcanic and sedimentary rocks of Miocene age.
- Tmp, Plutonic and hypabyssal rocks of Miocene age.
- To, Sedimentary rocks of Oligocene age.
- Te, Sedimentary rocks of Eocene age.
- Tep, Sedimentary rocks of Eocene and Paleocene age.
- Tv, Volcanic rocks of Tertiary age.
- Ku, Undifferentiated sedimentary rocksof Late Cretaceous age.
- TMz, Undifferentiated igneous rocks of Miocene age and metamorphic rocks of pre-Late Cretaceous age.
- Mz, Metamorphic rocks of pre-Late Cretaceous age.
- m, Metamorphic rocks of unknown age.
- gr, Grantic rocks, chiefly dioritic, of Mesozoic age.
- Channel Fill
- Channel Fill (inferred)
- Slump
- Creep
- Block Glide
- Levee
- Sediment Flow

Onshore Geologic Units

- C, Carboniferous marine
- Ca, Cambrian marine
- D, Devonian marine
- E, Eocene marine
- Ec, Eocene nonmarine
- Ep, Paleocene marine
- J, Jurassic marine
- K, Cretaceous marine undivided(in part nonmarine)
- KJf, Franciscan Complex
- KJfm, Franciscan melange
- KJfs, Franciscan schist
- Kl, Lower Cretaceous marine
- Ku, Upper Cretaceous marine
- M, Miocene marine
- Mc, Miocene nonmarine
- Mzv, Mesozoic volcanic and metavolcanic rocks; Franciscan volcanic rocks
- O, Oligocene marine
- Oc, Oligocene nonmarine
- P, Pliocene marine
- Pm, Permian marine
- Pz, Paleozoic marine, undivided
- Pzv, Paleozoic metavolcanic rocks
- Q, Alluvium (mostly Holocene some Pleistocene);Quaternary nonmarine; Quaternary marine
- QPc, Plio-Pleistocene nonmarine; Pliocene nonmarine
- Qg, Glacial deposits
- Qls, Selected large landslide deposits
- Qrv, Recent (Holocene) volcanic flow rocks(or predominantly flow rocks)
- Qrvp, Recent (Holocene) pyroclastic rocks and volcanic mudflow deposits
- Qs, Extensive sand dune deposits
- Qv, Quaternary volcanic flow rocks(or predominantly flow rocks)
- Qvp, Quaternary pyroclastic rocks and volcanic mudflow deposits
- SO, Silurian and/or Ordovician marine
- TK, Tertiary-Cretaceous Coastal Belt rocks
- Tc, Tertiary nonmarine, undivided
- Ti, Tertiary intrusive rocks
- Tr, Triassic marine
- Tv, Tertiary volcanic flow rocks(or predominantly flow rocks)
- Tvp, Tertiary pyroclastic rocks and volcanic mudflow deposits
- gb, Mesozoic gabbroic rocks
- gr, Undated granitic rocks
- gr-m, Granitic and metamorphic rocks, undivided, of pre-Cenozoic age+B84
- grCz, Cenozoic (Tertiary) granitic rocks
- grMz, Mesozoic granitic rocks
- grPz, Paleozoic and Permo- Triassic granitic rocks
- grpC, Precambrian granitic rocks
- ls, Limestone of probable Paleozoic or
- m, Undivided pre-Cenozoic metasedimentary and metavolcanic rocks
- mv, Undivided pre-Cenozoic metavolcanic rocks
- pC, Precambrian rocks, undivided
- pCc, Precambrian igneous and metamorphic rock complex
- sch, Schist of various types and ages (either metasedimentary or metavolcanic)
- um, Ultramafic rocks, chiefly Mesozoic
- water

REGIONAL GEOLOGY - LEGEND
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 5-4

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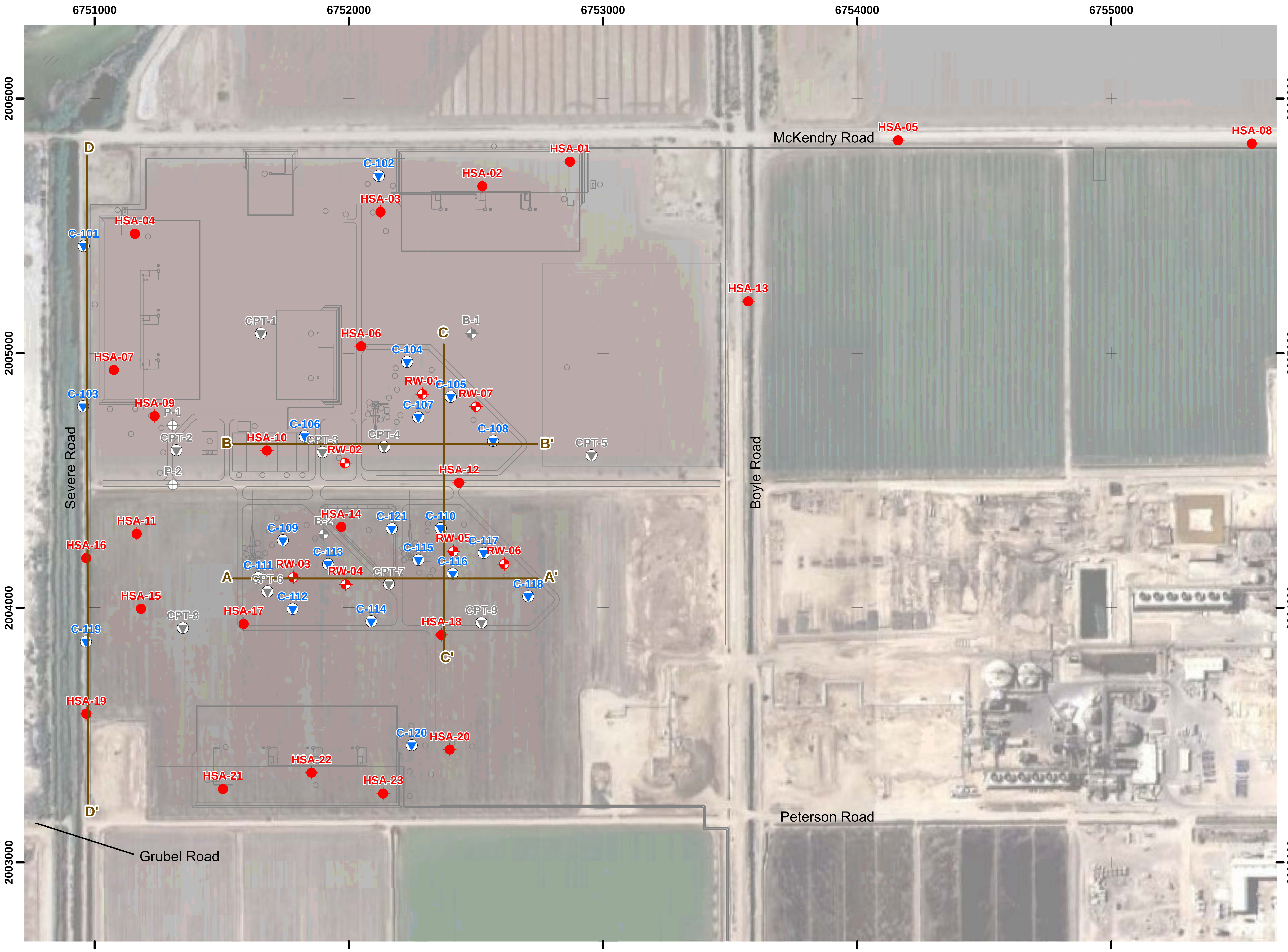
The maximum extent of Lake Cahuilla. The Colorado River normally flows south to the Gulf of California, however the river sometimes breaches delta walls and flows along the Alamo River into the Salton Depression. The Salton Depression is filled until water begins to flow out along the New River to the Gulf of California.

SOURCE: Lippincott et al., 2008

FORMATION OF LAKE CAHUILLA AND FLOW PATTERN CHANGES OF THE COLORADO RIVER

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 5-5



Legend

A ___ A' Cross Section

Explorations

Geotechnical Explorations by Fugro West, Inc. (2008)

- HSA-1 Hollow Stem Auger Boring
- RW-1 Rotary Wash Boring
- CPT-101 CPT

Historic Geotechnical Explorations (Geotechnics Incorporated, 2002)

- GI-B1 Boring
- GI-P1 Percolation Test
- GI-CPT1 CPT

N

Scale = 1:4,800

0 200 400 800 Feet

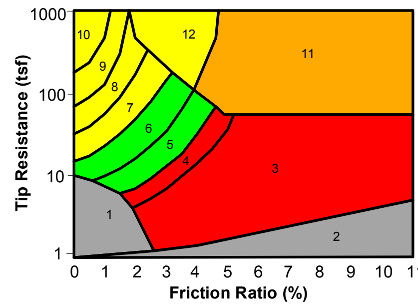
CROSS SECTION LOCATION MAP
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 5-6

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig5-6_XSectLocationMap.mxd, 01/20/09, CDean

SOIL TYPES

- Well graded GRAVEL (GW)
- Poorly graded GRAVEL (GP)
- GRAVEL with sand (GP or GW)
- GRAVEL with clay (GP or GW)
- Clayey GRAVEL (GC)
- GRAVEL with silt (GP or GW)
- Silty GRAVEL (GM)
- Well graded SAND (SW)
- Poorly graded SAND (SP)
- SAND with gravel (SP or SW)
- SAND with clay (SP-SC)
- Clayey SAND (SC)
- Silty SAND (SM)
- SAND with silt (SP-SM)
- Fat CLAY (CH)
- Sandy fat CLAY (CH)
- Lean CLAY (CL)
- Sandy lean CLAY (CL)
- Silty CLAY (CL-ML)
- Elastic SILT (MH)
- SILT (ML)
- Sandy SILT (ML)
- Clayey SILT (ML/CL)
- Highly plastic ORGANICS (OH)
- Low plasticity ORGANICS (OL)
- SANDSTONE (Rx)
- SILTSTONE (Rx)
- CLAYSTONE (Rx)
- Conglomerate (Rx)
- Interbedded Rock Strata (Rx)
- Pavement

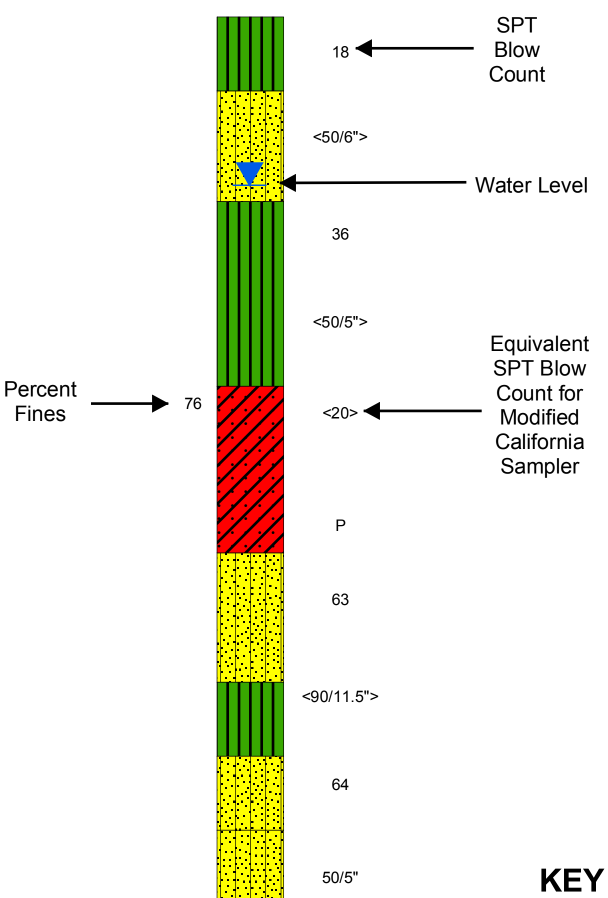


Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

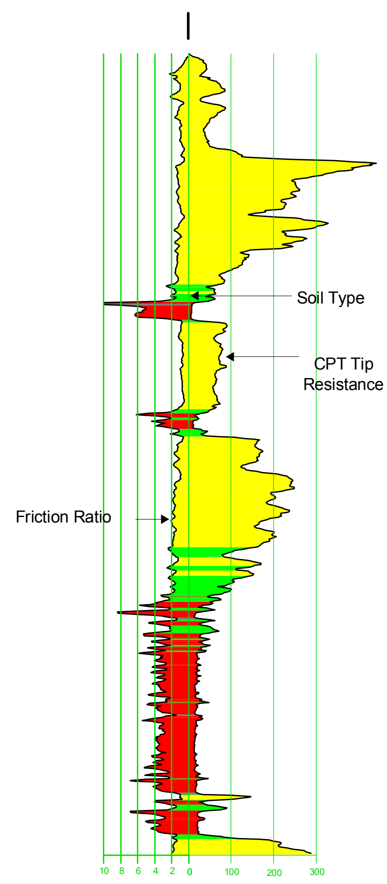
*overconsolidated or cemented

CPT CORRELATION CHART

(Robertson and Campanella, 1988)



SOIL BORING LITHOLOGY



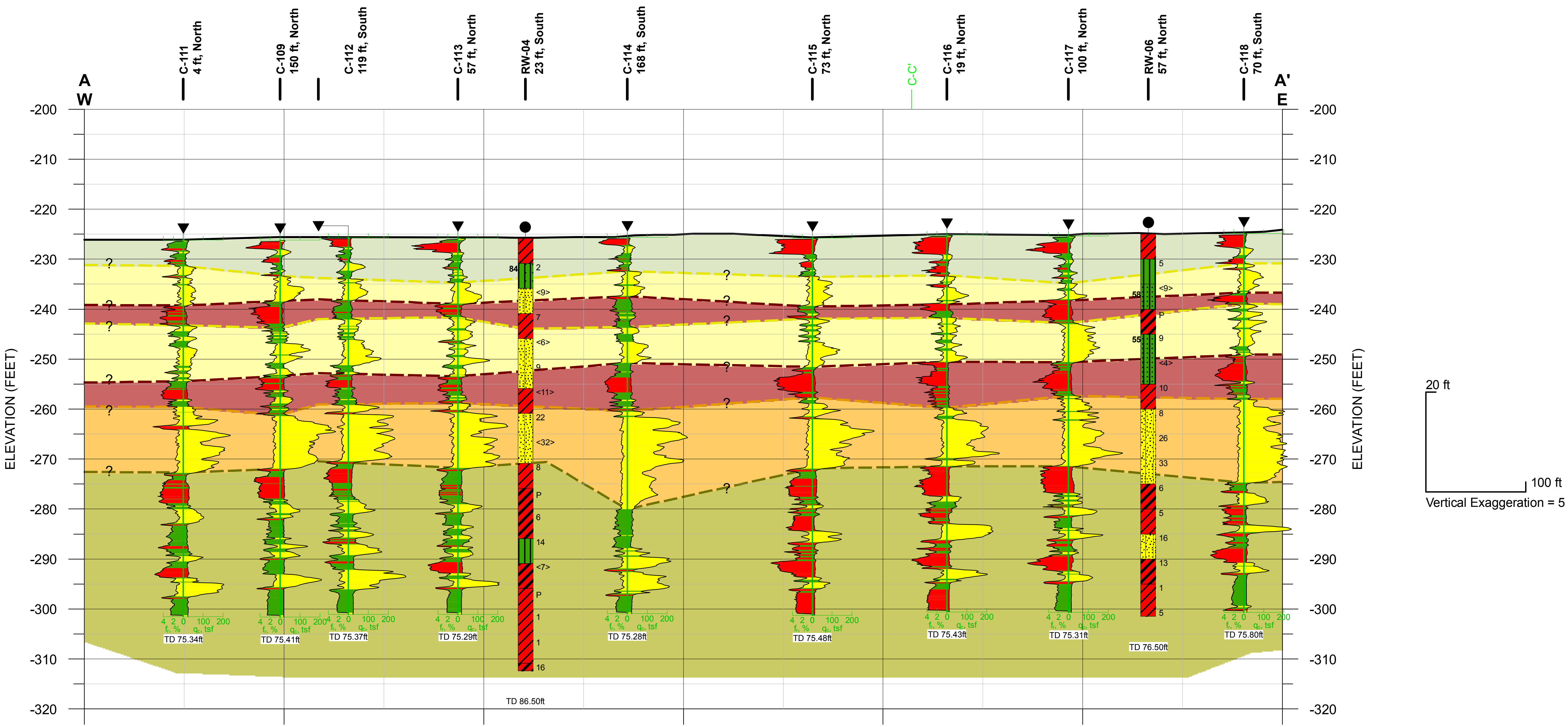
CPT SOUNDING WITH INTERPRETED LITHOLOGY

KEY TO CROSS SECTIONS
Black Rock Units 1, 2 & 3
Calipatria, California

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig5-7_Xsectkey.mxd, 12/18/08, dpase

FIGURE 5-7

FUGRO



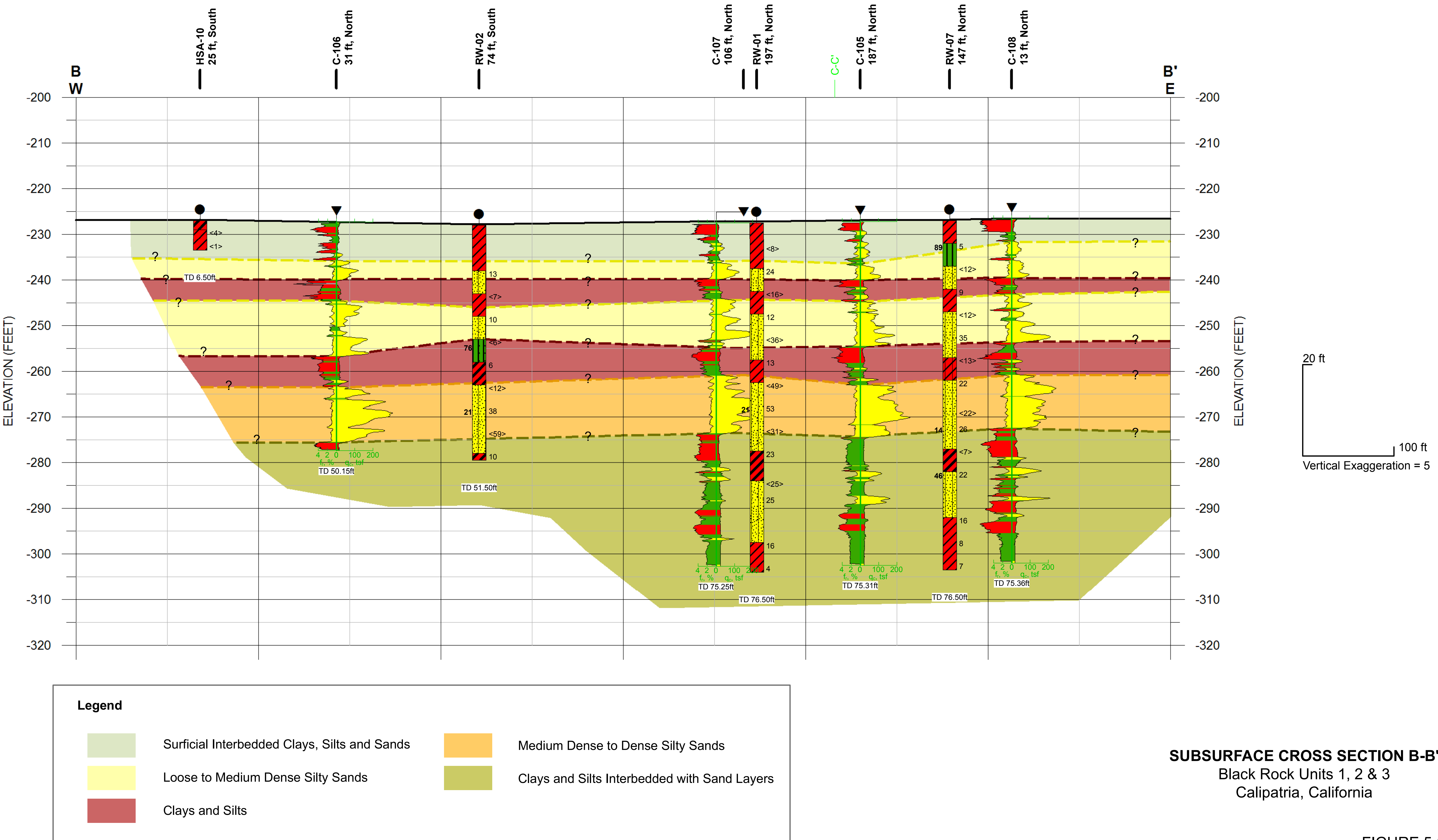
Legend

Surficial Interbedded Clays, Silts and Sands	Medium Dense to Dense Silty Sands
Loose to Medium Dense Silty Sands	Clays and Silts Interbedded with Sand Layers
Clays and Silts	

SUBSURFACE CROSS SECTION A-A'
Black Rock Units 1, 2 & 3
Calipatria, California

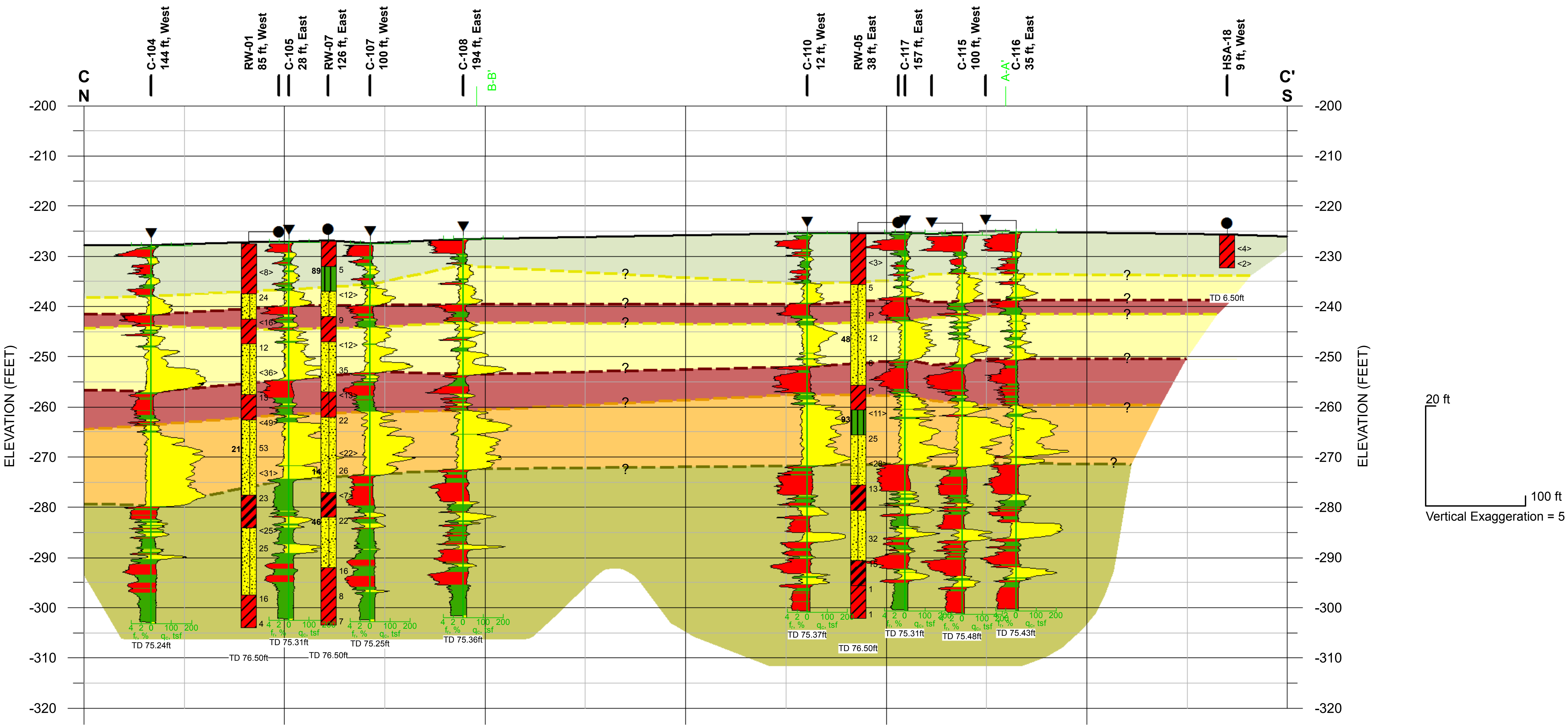
FIGURE 5-8

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig5-8_ProfileA.mxd, 01/20/09, CDean



SUBSURFACE CROSS SECTION B-B'
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 5-9



Legend

Surficial Interbedded Clays, Silts and Sands	Medium Dense to Dense Silty Sands
Loose to Medium Dense Silty Sands	Clays and Silts Interbedded with Sand Layers
Clays and Silts	

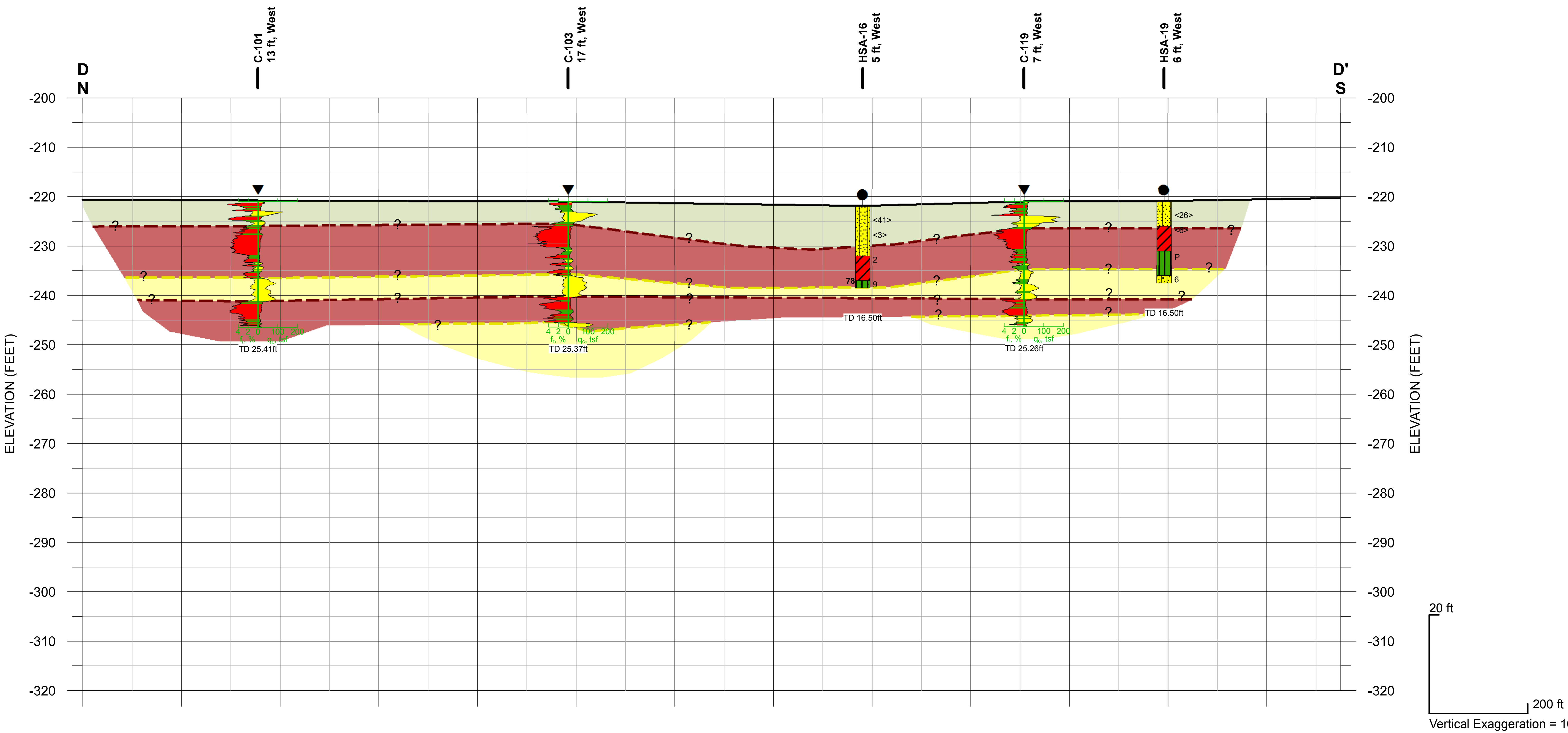
SUBSURFACE CROSS SECTION C-C'

Black Rock Units 1, 2 & 3

Calipatria, California

FIGURE 5-10

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig5-10_ProfileC.mxd, 01/20/09, CDean



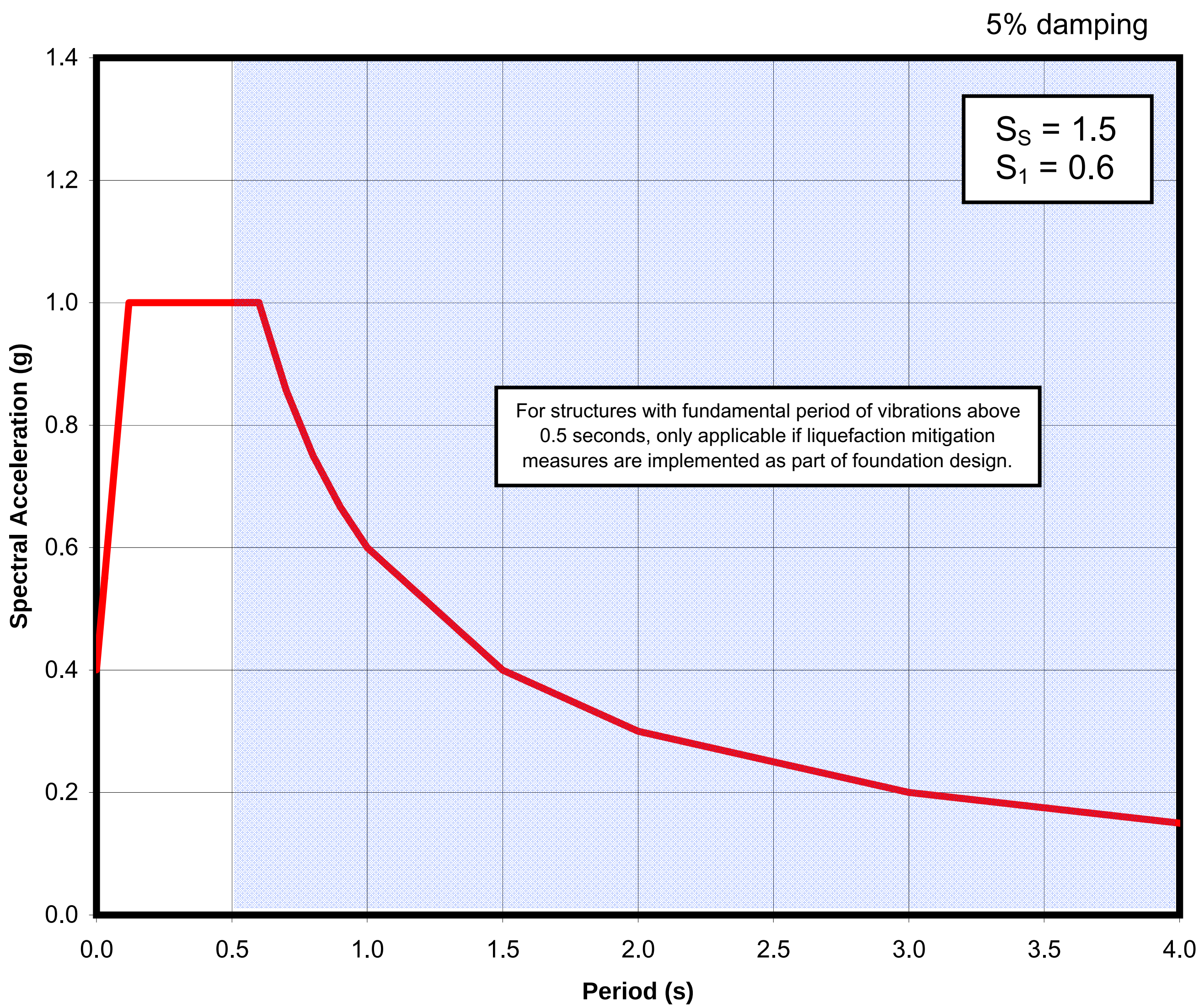
Legend

Surficial Interbedded Clays, Silts and Sands	Medium Dense to Dense Silty Sands
Loose to Medium Dense Silty Sands	Clays and Silts Interbedded with Sand Layers
Clays and Silts	

SUBSURFACE CROSS SECTION D-D'
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 5-11

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig5-11_ProfileD.mxd, 01/20/09, CDean

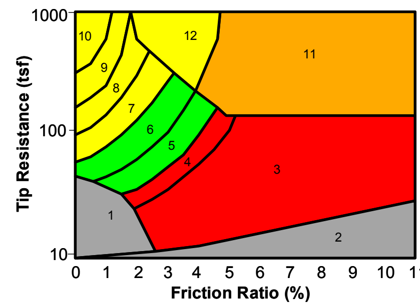


HORIZONTAL DESIGN SPECTRUM BASED ON CBC 2007
Black Rock Units 1, 2 a 3
Calipatria, California

FIGURE 6-1

SOIL TYPES

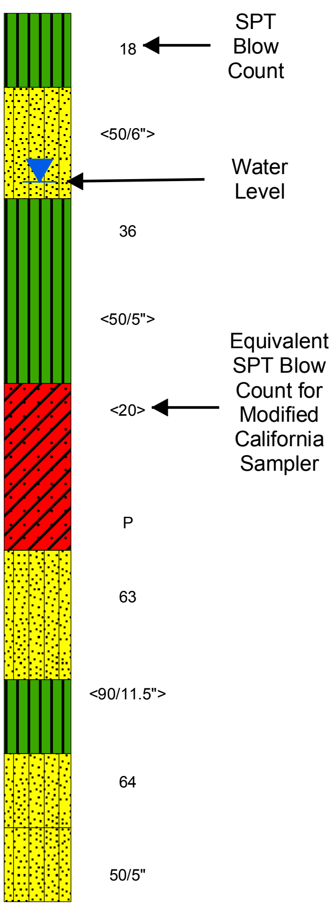
- Well graded GRAVEL (GW)
- Poorly graded GRAVEL (GP)
- GRAVEL with sand (GP or GW)
- GRAVEL with clay (GP or GW)
- Clayey GRAVEL (GC)
- GRAVEL with silt (GP or GW)
- Silty GRAVEL (GM)
- Well graded SAND (SW)
- Poorly graded SAND (SP)
- SAND with gravel (SP or SW)
- SAND with clay (SP-SC)
- Clayey SAND (SC)
- Silty SAND (SM)
- SAND with silt (SP-SM)
- Fat CLAY (CH)
- Sandy fat CLAY (CH)
- Lean CLAY (CL)
- Sandy lean CLAY (CL)
- Silty CLAY (CL-ML)
- Elastic SILT (MH)
- SILT (ML)
- Sandy SILT (ML)
- Clayey SILT (ML/CL)
- Highly plastic ORGANICS (OH)
- Low plasticity ORGANICS (OL)
- SANDSTONE (Rx)
- SILTSTONE (Rx)
- CLAYSTONE (Rx)
- Conglomerate (Rx)
- Interbedded Rock Strata (Rx)
- Pavement



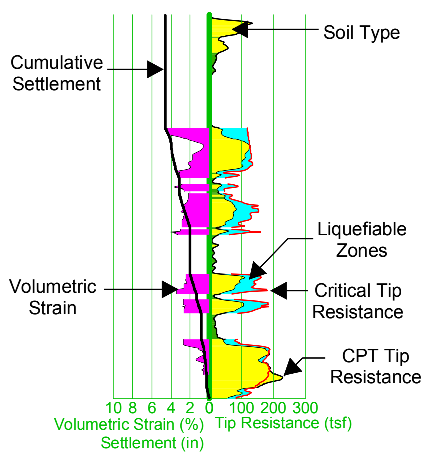
Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

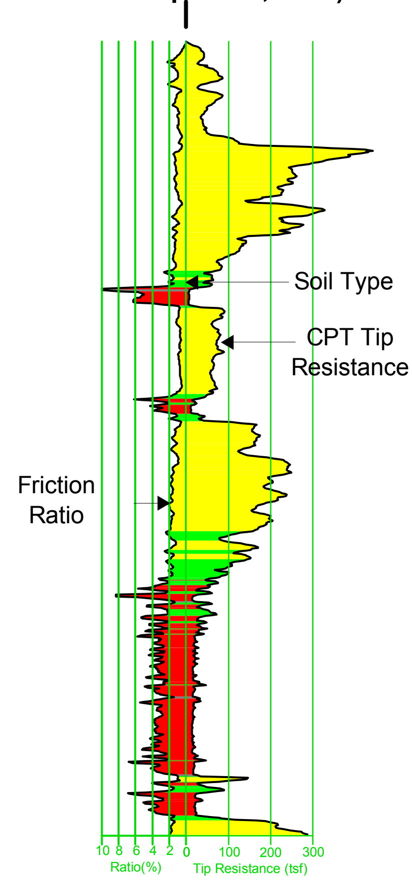
CPT CORRELATION CHART
(Robertson and Campanella, 1984)



SOIL BORING LITHOLOGY



CPT SOUNDING WITH LIQUEFACTION EVALUATION



CPT SOUNDING WITH INTERPRETED LITHOLOGY

KEY TO LIQUEFACTION CROSS SECTIONS

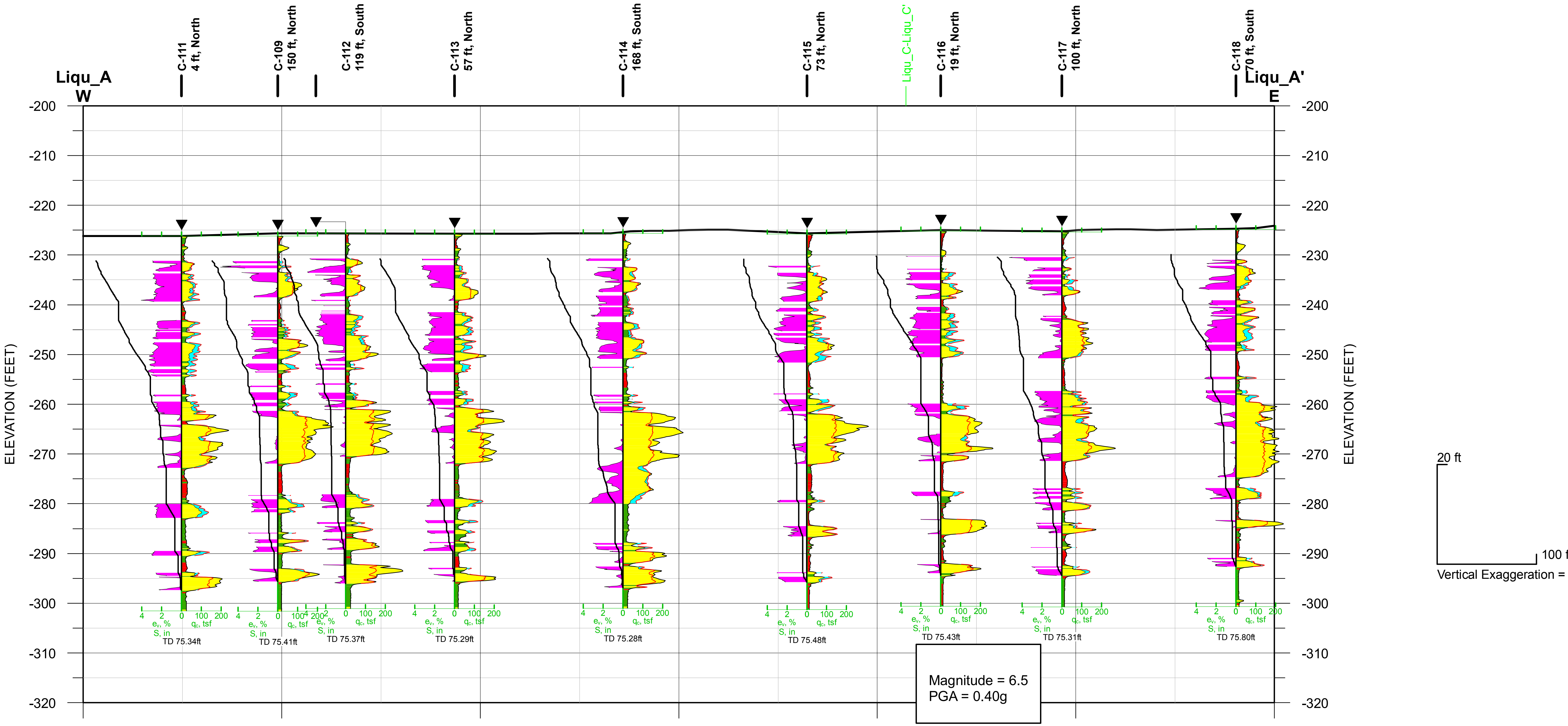
P.G.A. = 0.40g and M_w = 6.5

Black Rock Units 1, 2 & 3

Calipatria, California

FIGURE 6-2

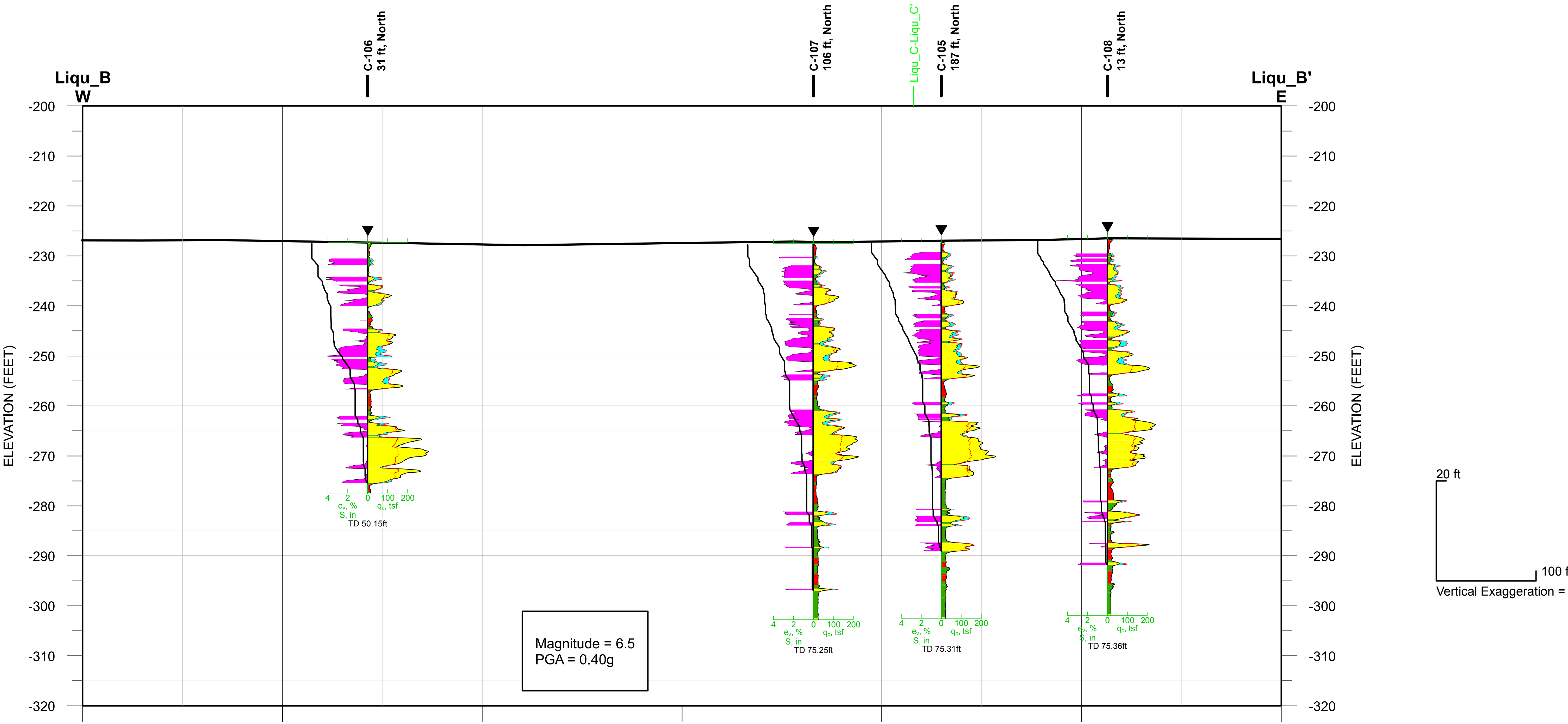
N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig6-2_liqxsectkey.mxd, 12/18/08, dpase



N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig6-3_Profile_Liqu_A.mxd, 01/20/09, CDean

SUBSURFACE LIQUEFACTION CROSS SECTION A-A'
Black Rock Units 1, 2 & 3
Calipatria, California

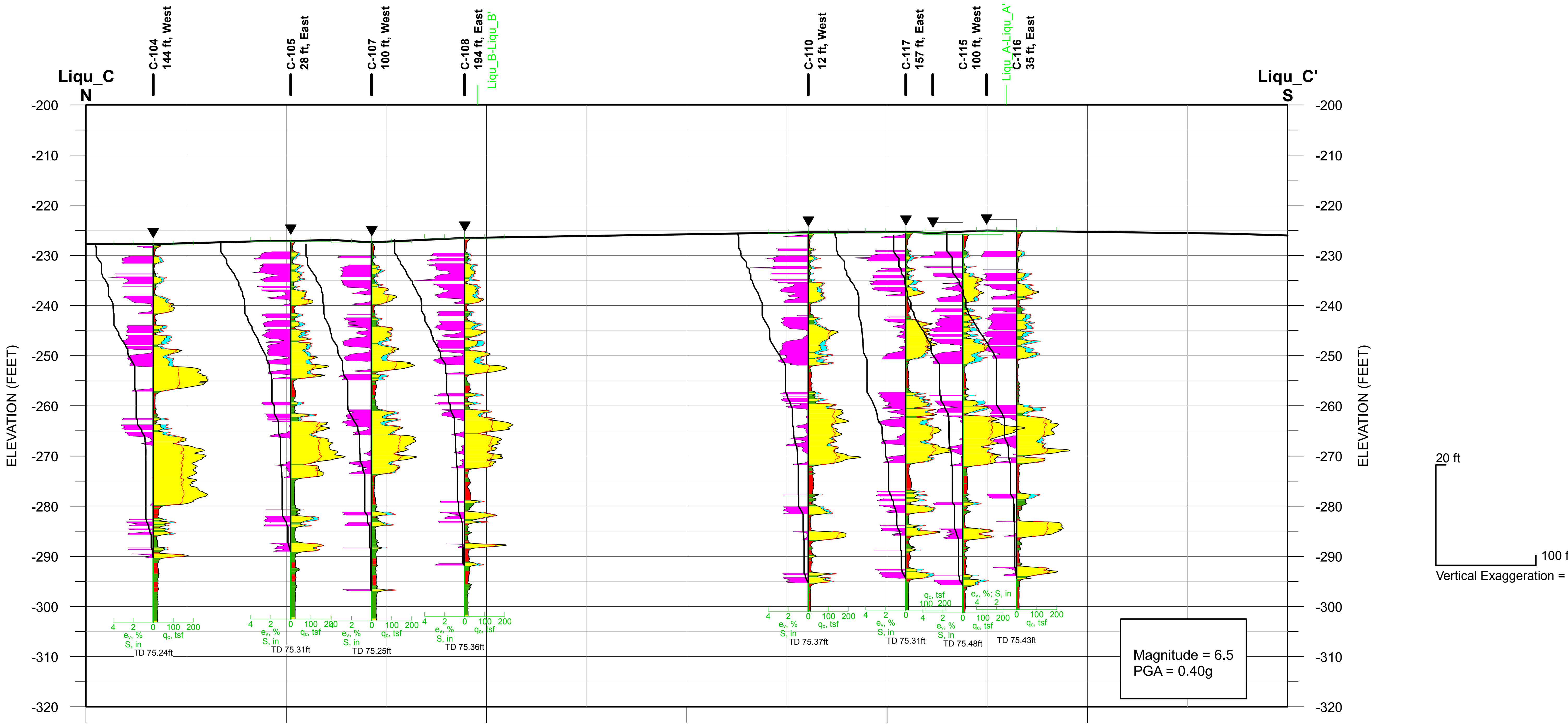
FIGURE 6-3



SUBSURFACE LIQUEFACTION CROSS SECTION B-B'

Black Rock Units 1, 2 & 3
Calipatria, California

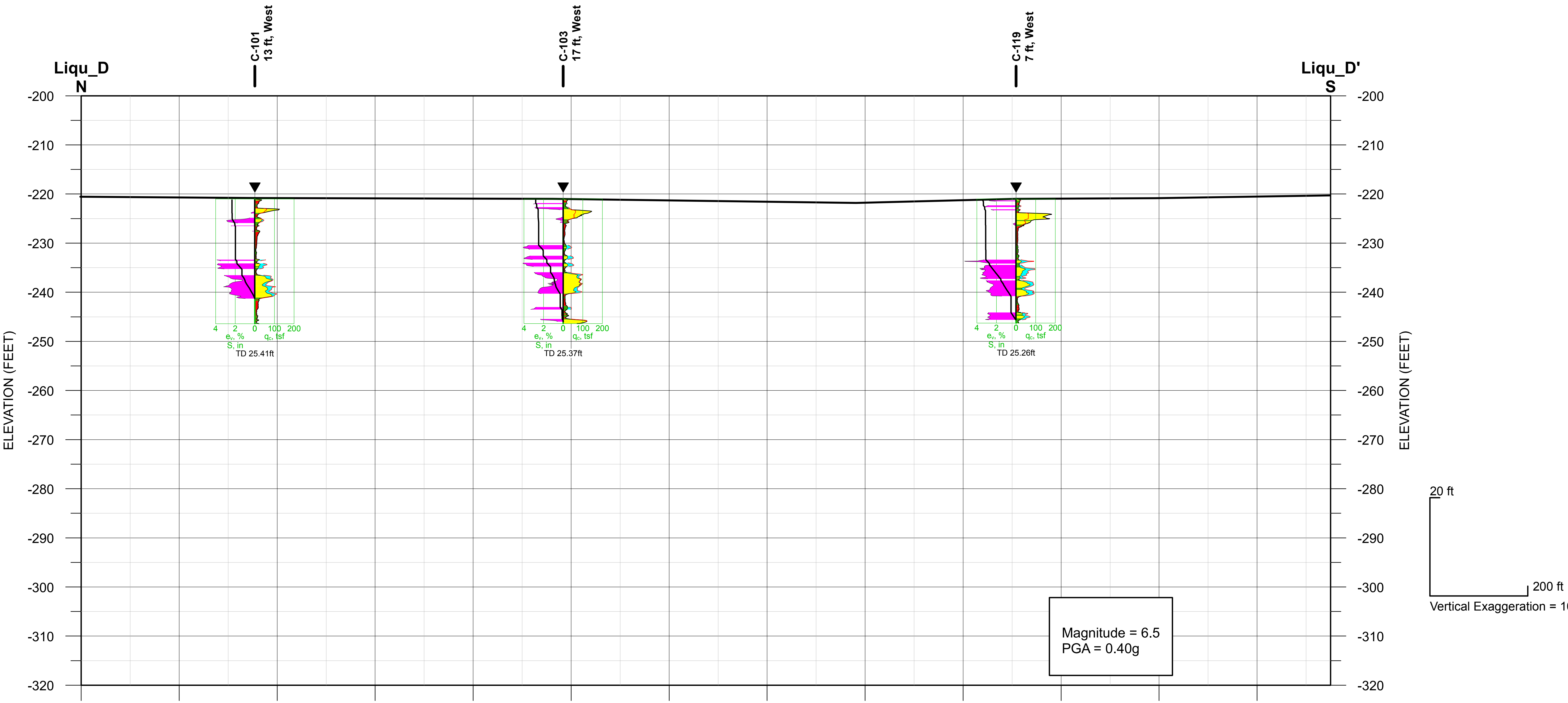
FIGURE 6-4



SUBSURFACE LIQUEFACTION
CROSS SECTION C-C'
Black Rock Units 1, 2 & 3
Calipatria, California

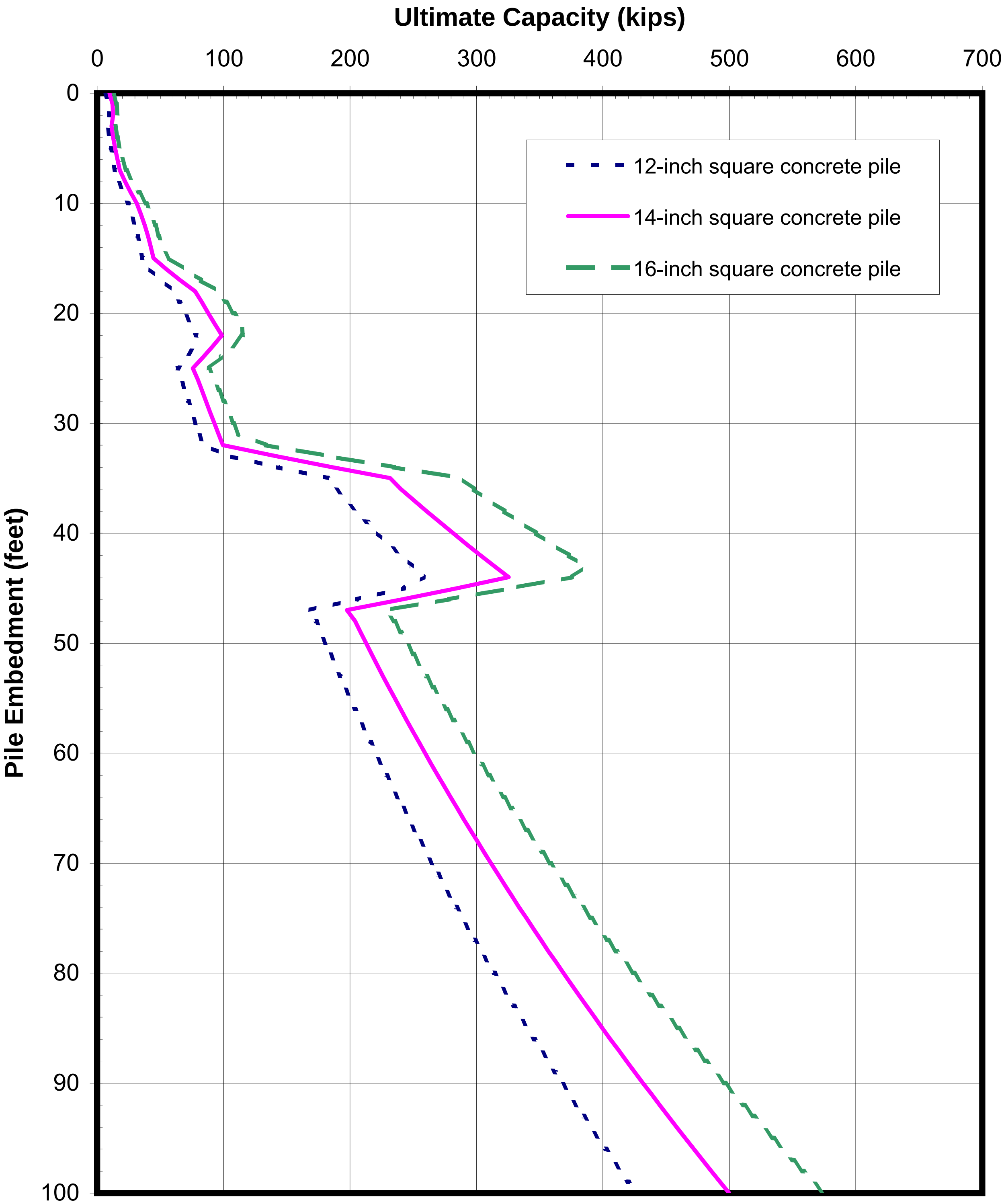
FIGURE 6-5

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Outputs\Final_Report\mxd\Fig6-5_Profile_Liqu_C.mxd, 01/20/09, CDean



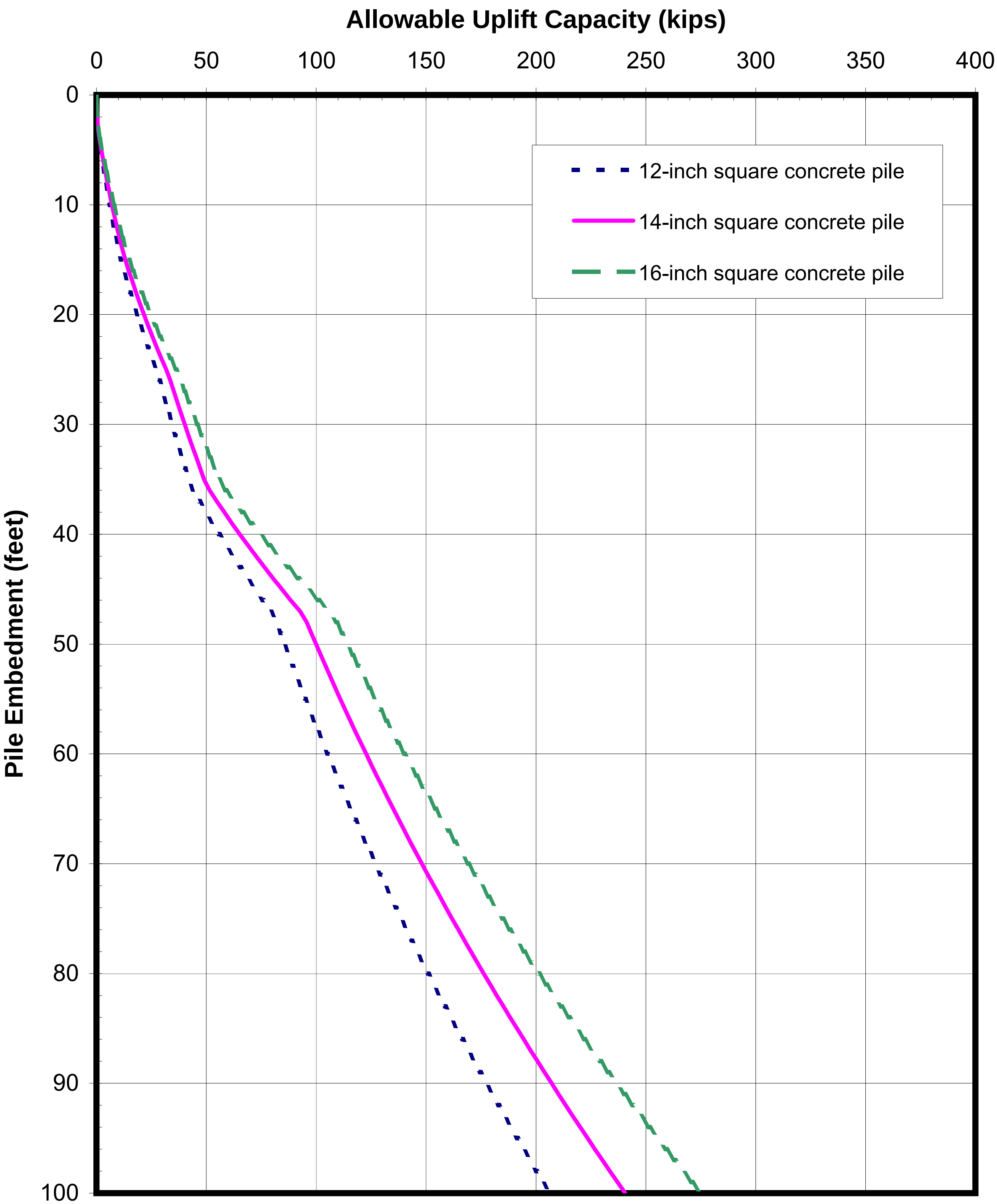
SUBSURFACE LIQUEFACTION
CROSS SECTION D-D'
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 6-6



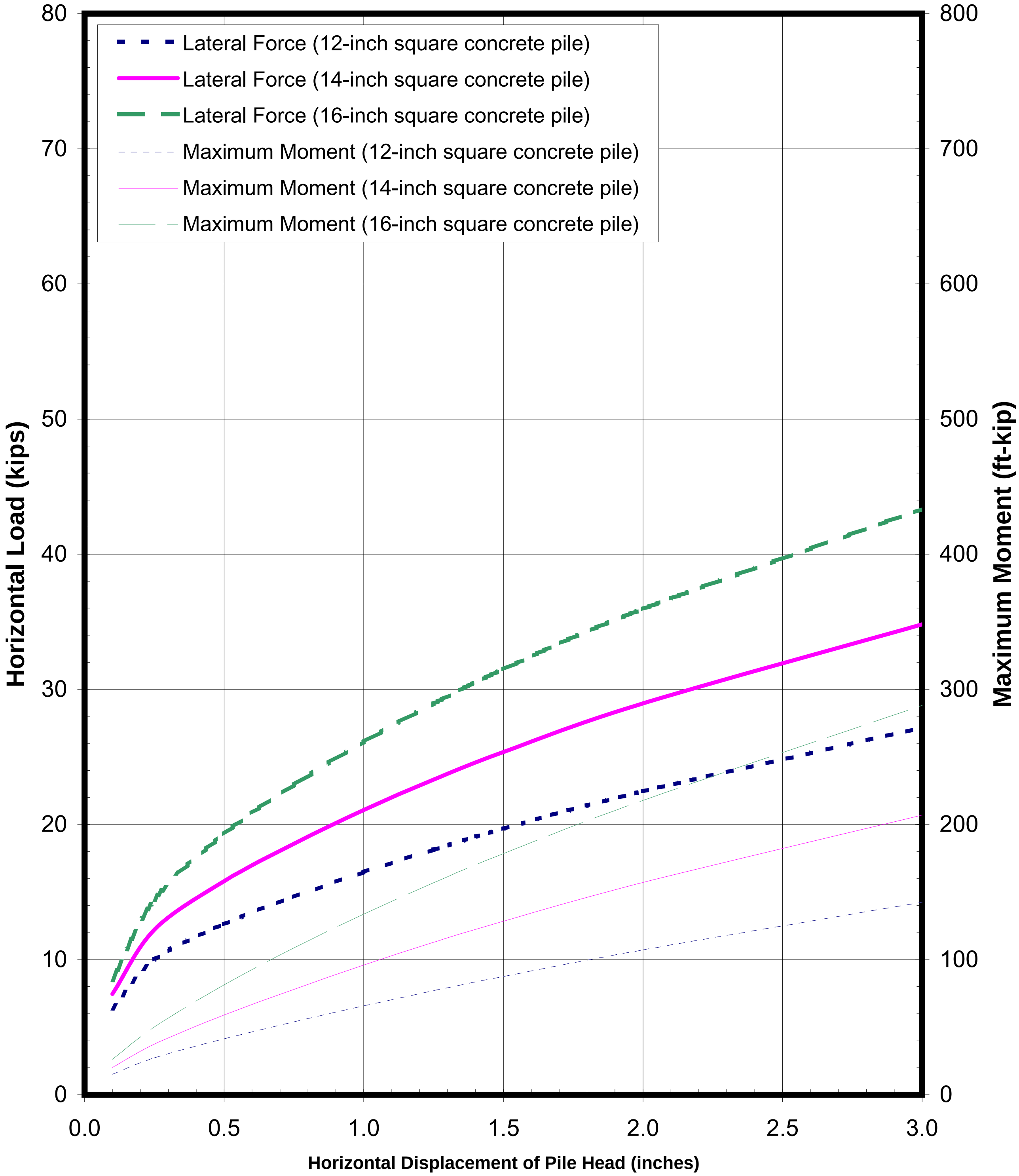
ULTIMATE AXIAL PILE CAPACITY
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 7-1



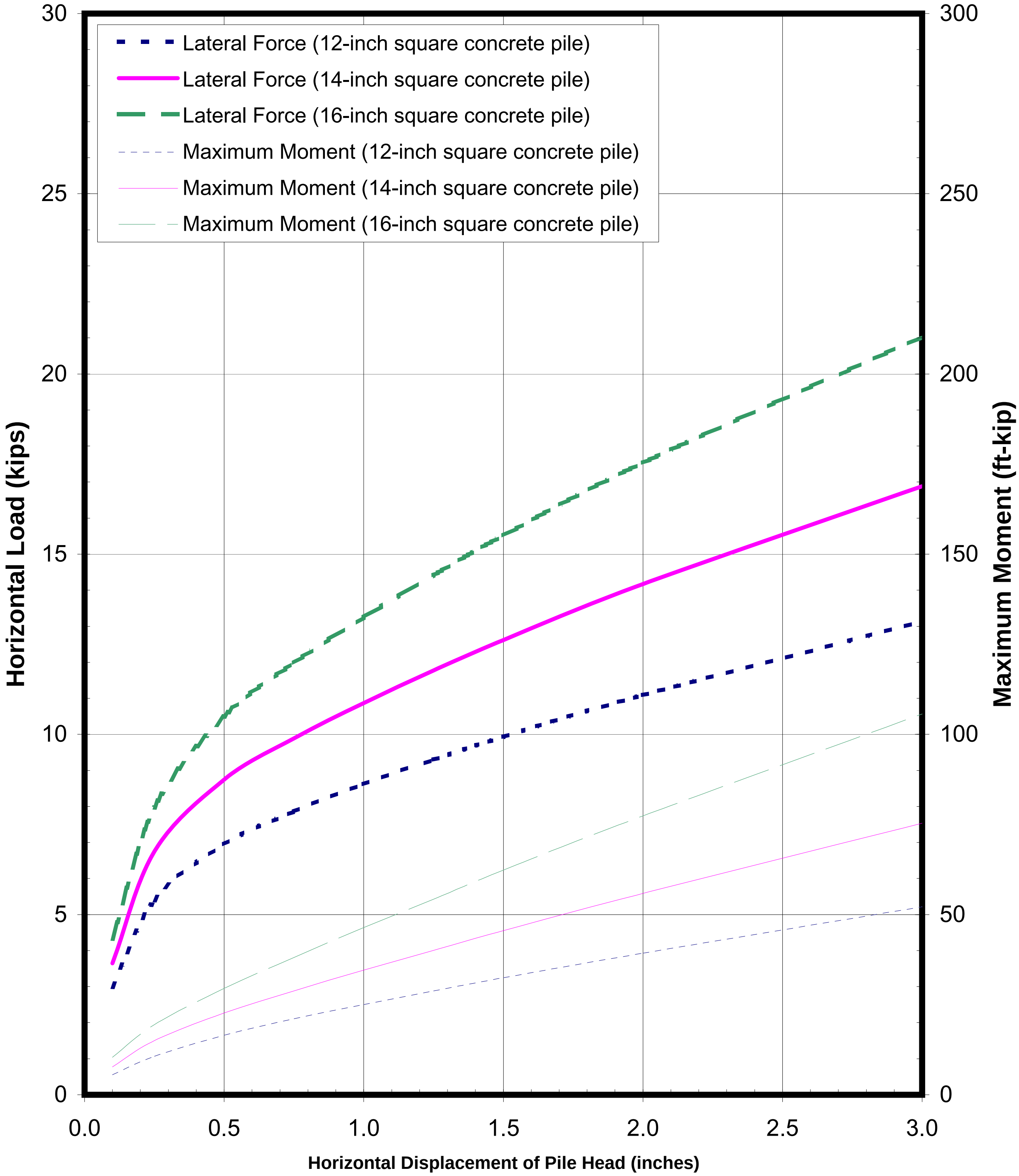
ALLOWABLE UPLIFT PILE CAPACITY
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 7-2



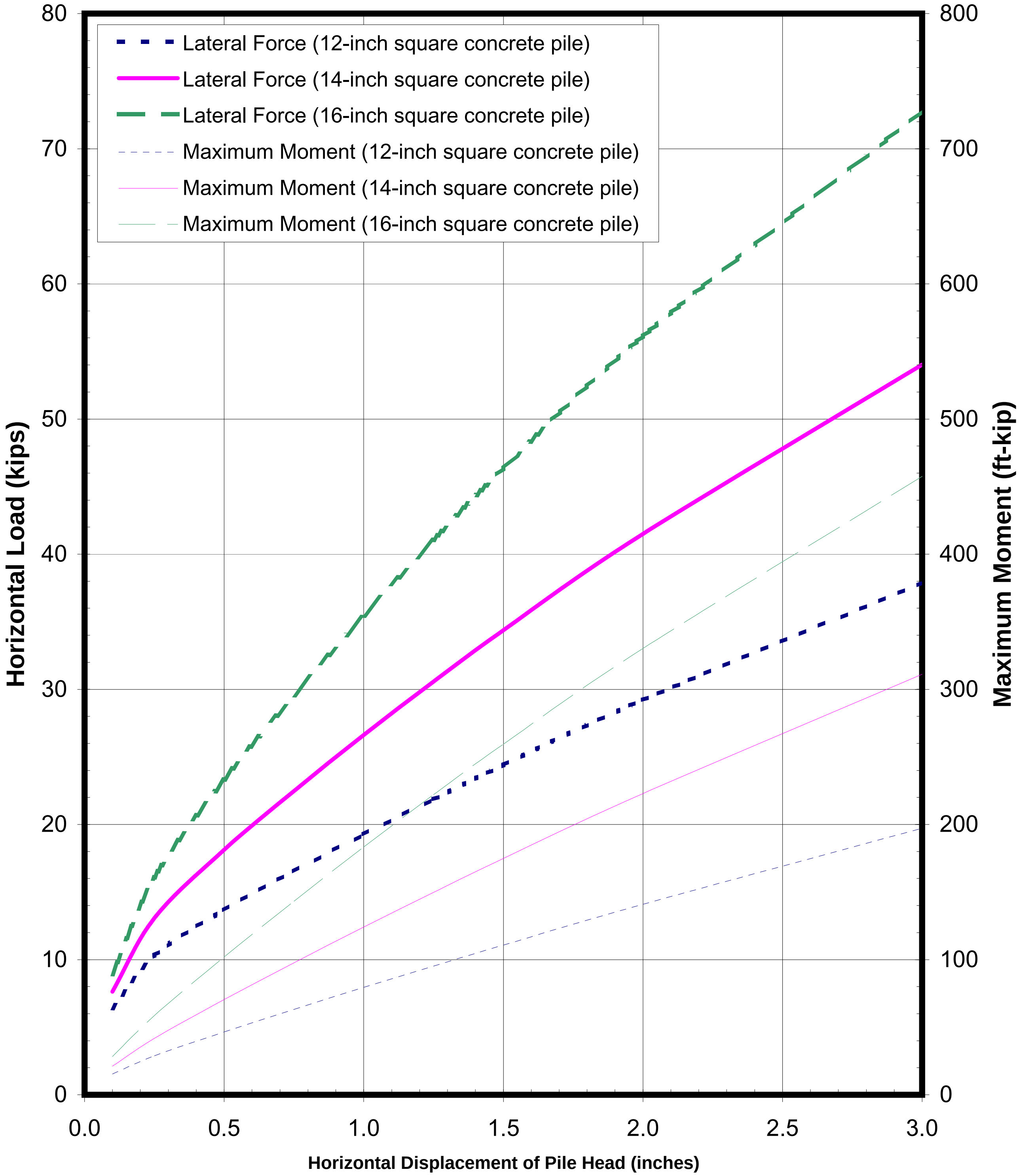
LATERAL PILE LOAD - DISPLACEMENT CURVE
Fixed Pile Head / Without Ground Improvement
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 7-3



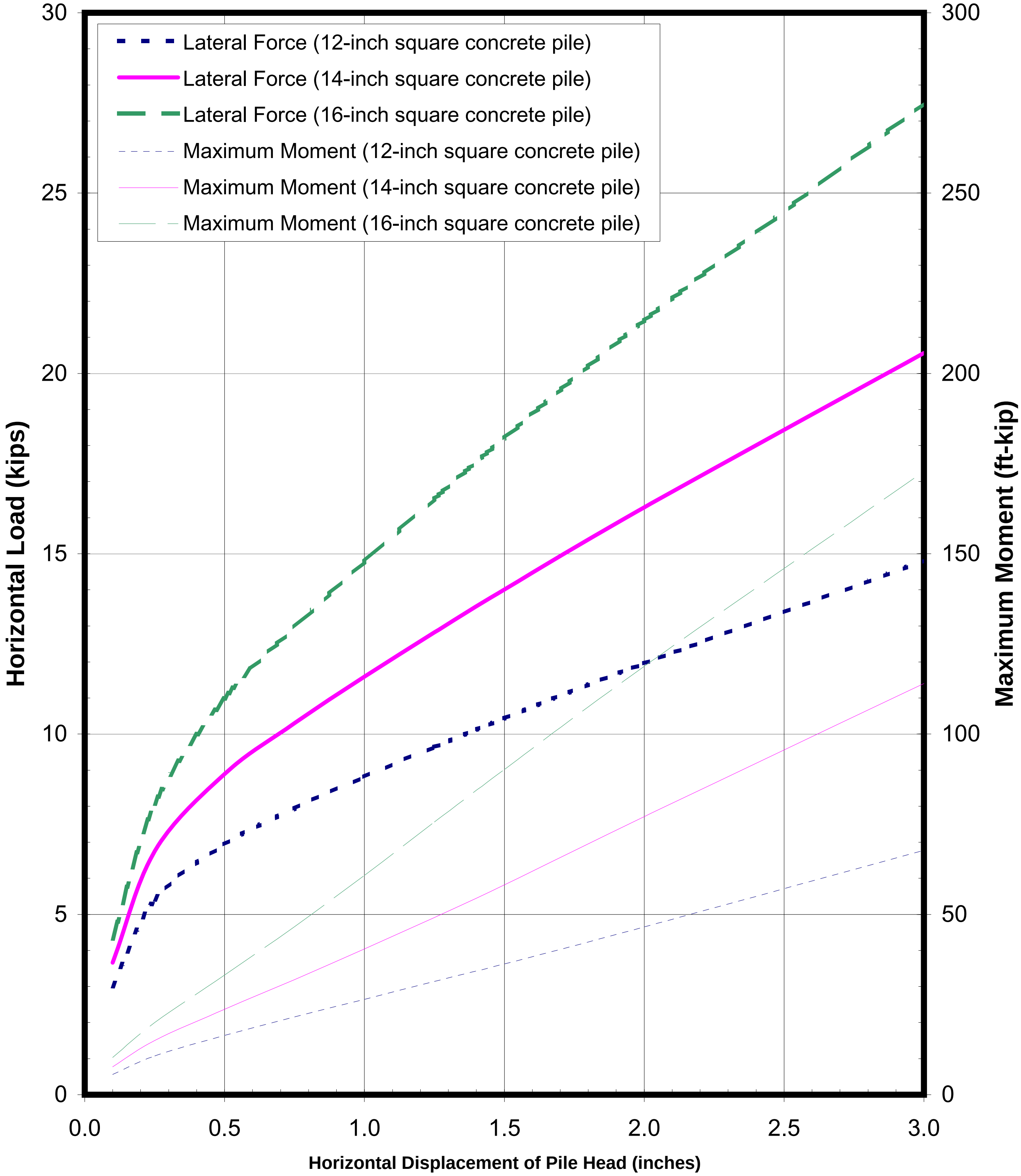
LATERAL PILE LOAD - DISPLACEMENT CURVE
Free Pile Head / Without Ground Improvement
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 7-4



LATERAL PILE LOAD - DISPLACEMENT CURVE
Fixed Pile Head / With Ground Improvement
Black Rock Units 1, 2 & 3
Calipatria, California

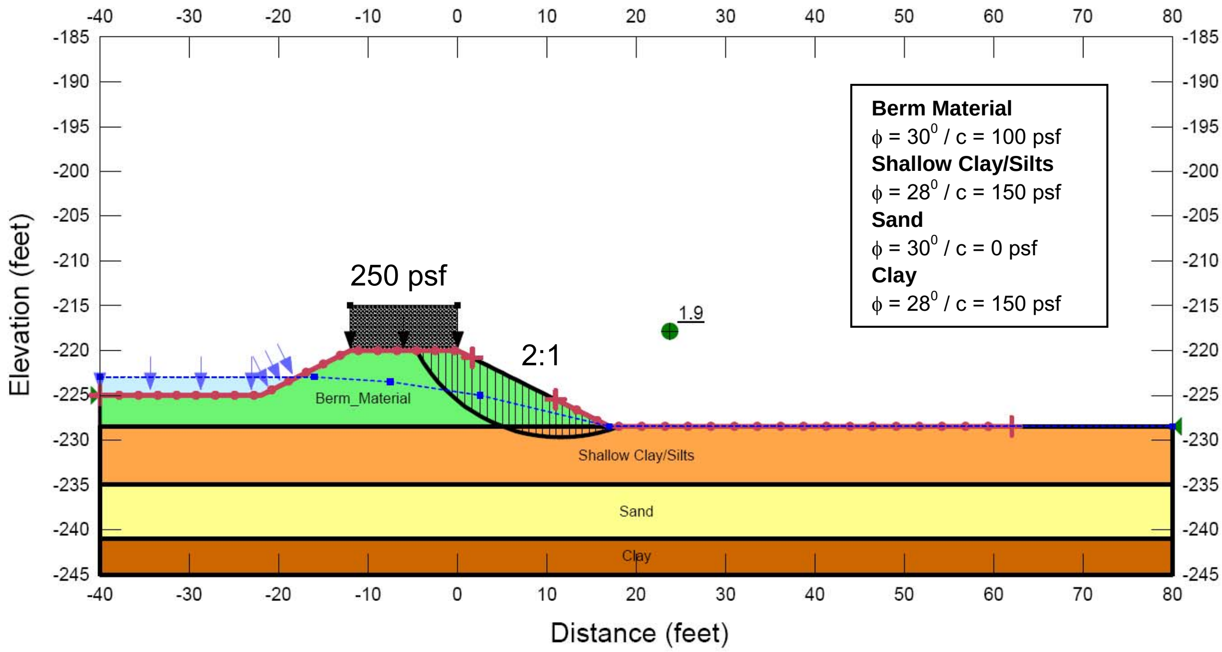
FIGURE 7-5



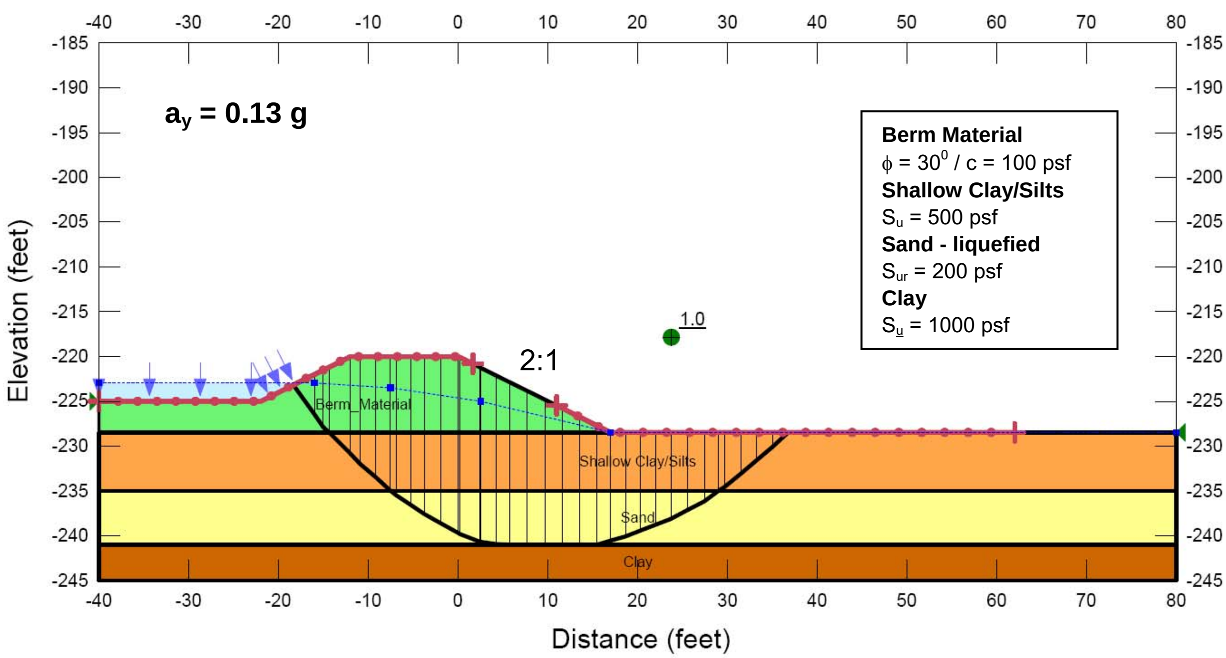
LATERAL PILE LOAD - DISPLACEMENT CURVE
Free Pile Head / With Ground Improvement
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 7-6

a) Static Stability Evaluation



b) Pseudo-static Stability Evaluation



BERM STABILITY EVALUATIONS
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE 7-7

APPENDIX A
SUBSURFACE EXPLORATIONS

APPENDIX A - SUBSURFACE EXPLORATIONS

Introduction

The subsurface exploration program for the Black Rock Units 1, 2 and 3 project consisted of drilling 30 borings and advancing 21 Cone Penetration Tests (CPTs). The field exploration program was completed between October 7, 2008 and October 17, 2008. This appendix provides general information on the drilling and CPT equipment and soil sampling methods. Boring and CPT logs are also included in this appendix.

Exploration Locations and Elevations

The boring locations were selected prior to commencement of the field exploration program and located in the field by Fugro using a handheld GPS system. The horizontal datum for this project is California State Plane North American Datum 83 (NAD83), Zone 6, Feet.

Ground elevations at boring locations were estimated using the site topographic map provided by CalEnergy. The vertical datum reference for this project is North American Vertical Datum 88 (NAVD88).

Summary of Subsurface Exploration Program

A tabulation of the borings and CPTs completed during the field exploration program is presented in Table A-1. Table A-1 presents the coordinates, completion date, approximate ground surface elevation, and completion depth of the borings and CPTs for this phase of the project.

Drilling Methods and Equipment

Drilling services for the borings were provided by Gregg Drilling. Gregg Drilling's drilling equipment consisted of a truck-mounted Mobile B-53 D-1 drill rig and a support truck with a trailer-mounted water tank. Drilling operations were conducted under the technical guidance and observation of a Fugro geologist who also logged the soils in accordance with ASTM D2488 and packaged the recovered samples.

Both hollow-stem auger and rotary wash drilling methods were used during the field exploration program. Twenty-three (23) borings were drilled using 8-inch diameter hollow-stem augers. Seven (7) rotary wash borings were drilled using wet/rotary procedures that utilized a 4-inch diameter drag bit attached to a drill string of Mayhew Junior drill pipes. The rotary wash borings were advanced using non-toxic, bentonite-based drilling fluid to suspend and remove drill cuttings and to provide lateral support to the sides of the boreholes.

Following the completion of the drilling and sampling, all borings were backfilled with a soil-cement grout consisting of soil cuttings mixed with Portland cement. Bentonite chips were used to complete the backfilling in the top 3 to 5 feet. Excess drilling fluids, soil cuttings and grout mix were placed in a dumpster that was put on site by CalEnergy for our use. At the completion of the exploration activities, CalEnergy removed the dumpster for disposal of the drilling wastes in accordance with their facility permit requirements.

Geotechnical Samples and Sampling Equipment.

Samples were generally taken at 5-foot intervals for the full boring depth. The nominal 5-foot spacing was occasionally adjusted to sample site-specific intervals. The sampling methods included driven sampling techniques using standard penetration test (SPT) and Modified California samplers (with rings). These samplers were driven using an out-of-hole, 140-pound automatic trip hammer falling 30 inches. When soft soil was encountered, selected samples were collected using the push method in place of the driven method.

Further details regarding the sampling and drilling procedures and the subsurface conditions are presented in Figure A1-1 – Key to Terms and Symbols used on logs and in Figures A1-2 through A1-31, Logs of Borings.

Descriptions of the procedures used for each sampling method are described in the following table:

Type of Sampling	Sampler Description	Description of Sampling Method
SPT Samples	2-inch-OD, 1-3/8-inch-ID	The SPT sampler was attached to an exploratory rod drill pipe that was lowered to the sample depth. The sampler was driven with a 140-pound automatic trip hammer attached to the top of the drill rod. The test was performed in general conformance with standard test method ASTM D1586. The number of blows required to drive the samplers the last 12 inches of the 18-inch penetration are shown on the boring logs.
Modified California Samples (California Liner Samples)	3-inch-OD, 2-3/8-inch-ID	The Modified California or California Liner test sampler was attached to an exploratory rod drill pipe that was lowered to the sample depth. The sampler was driven with a 140-pound automatic trip hammer attached to the top of the drill rod. The number of blows required to drive the samplers the last 12 inches of the 18-inch penetration are shown on the boring logs.
Push Samples	3-inch-OD, 2.83-inch-ID	Push samples were obtained by pushing a thin walled tube into the soil with the weight of the drill string. After the boring is drilled to the desired depth, the drill bit is raised from the borehole bottom and the sampler is lowered through the drill string until it rests on a catch ring above the drill bit. The sampler is then pushed about 24 to 30 inches into the formation by lowering the drill string. The sampler is retrieved by pulling it from the formation with the drill string and raising it with an overshot retrieving device attached to a wire line. The boring is then advanced to the next sampling interval.

Cone Penetrometer Testing Equipment.

CPT services were provided by Kehoe Testing & Engineering (Kehoe). Kehoe's CPT equipment is mounted on a 30-ton truck and consists of a steel rod with a 15-square-centimeter cone at the tip. The cone is equipped with electronic load cells that measure the point resistance on the tip and frictional resistance on a 225-square-centimeter sleeve (located behind the cone tip) and a transducer that measures pore pressures as the cone is hydraulically pushed through subsurface earth materials. The cone is pushed at a velocity of about 0.8 inches per second. Point resistance, frictional resistance, and pore pressure are recorded every second (i.e., about every 0.8 inches of penetration).

CPT soundings were terminated at depths of about 25, 50 or 75 feet, depending on location at the site. Abandonment of CPT soundings was performed by grouting each CPT sounding hole.

Figure A2-1 provides a key for the interpretation of soil classification based on the CPT tip resistance and friction ratio. Logs of the CPT soundings, which graphically present the CPT sleeve friction (f), CPT tip resistance (q_c), the ratio of sleeve friction to tip resistance (friction ratio or f/q_c), and pore pressure (u) at depth are provided on Figures A2-2 through A2-22 in this appendix.

During CPTs C-102, C-106, and C-118 shear wave measurements were obtained at approximately 5-foot intervals. The shear wave was generated using an air-actuated hammer, which is located inside the front jack of the CPT rig. The cone has a triaxial geophone, which recorded the shear wave signal generated by the air hammer. The cone was stopped to record the arrival of the shear waves from the excitation source at the surface. Interpreted shear wave velocity data are shown on Table A-2.

Table A-1. Subsurface Explorations Summary

Boring / CPT	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (ft)	Start Date	Completion Date	Coordinates (feet) California State Zone 6, NAD 83	
					Northing	Easting
Rotary Wash Borings						
RW-01	-227.5	76.5	10/7/2008	10/8/2008	2004839	6752288
RW-02	-228.0	51.5	10/10/2008	10/10/2008	2004568	6751983
RW-03	-226.0	76.5	10/14/2008	10/14/2008	2004120	6751781
RW-04	-225.9	86.5	10/14/2008	10/14/2008	2004092	6751986
RW-05	-225.6	76.5	10/13/2008	10/13/2008	2004222	6752411
RW-06	-225.0	76.5	10/10/2008	10/10/2008	2004172	6752610
RW-07	-227.0	76.5	10/8/2008	10/8/2008	2004790	6752499
Hollow Stem Auger Borings						
HSA-08	-223.0	6.5	10/17/2008	10/17/2008	2005823	6755553
HSA-09	-227.5	26.5	10/15/2008	10/15/2008	2004753	6751236
HSA-10	-227.0	6.5	10/15/2008	10/15/2008	2004617	6751677
HSA-11	-227.0	11.5	10/15/2008	10/15/2008	2004291	6751165
HSA-12	-223.0	6.5	10/17/2008	10/17/2008	2004491	6752434
HSA-13	-219.0	6.5	10/17/2008	10/17/2008	2005204	6753571
HSA-14	-226.0	16.5	10/16/2008	10/16/2008	2004317	6751970
HSA-15	-226.2	11.5	10/15/2008	10/15/2008	2003996	6751182
HSA-16	-222.0	16.5	10/16/2008	10/16/2008	2004195	6750966
HSA-17	-226.0	6.5	10/16/2008	10/16/2008	2003936	6751586
HSA-18	-225.8	6.5	10/16/2008	10/16/2008	2003894	6752364
HSA-19	-221.0	16.5	10/18/2008	10/18/2008	2003583	6750967
HSA-20	-224.6	26.5	10/16/2008	10/16/2008	2003443	6752397
HSA-21	-225.8	6.5	10/16/2008	10/16/2008	2003288	6751504
HSA-22	-225.5	11.5	10/16/2008	10/16/2008	2003352	6751853
HSA-23	-225.8	6.5	10/16/2008	10/16/2008	2003270	6752135
HSA-01	-228.5	6.5	10/15/2008	10/15/2008	2005752	6752870
HSA-02	-228.3	6.5	10/15/2008	10/15/2008	2005656	6752525
HSA-03	-228.9	26.5	10/15/2008	10/15/2008	2005555	6752124
HSA-04	-228.8	6.5	10/15/2008	10/15/2008	2005469	6751158
HSA-05	-224.0	6.5	10/17/2008	10/17/2008	2005837	6754161
HSA-06	-228.1	6.5	10/15/2008	10/15/2008	2005027	6752048
HSA-07	-228.0	6.5	10/15/2008	10/15/2008	2004934	6751075

Table A-1. Subsurface Explorations Summary - cont.

Boring / CPT	Estimate Ground Surface Elevation (feet, NAVD88)	Completion Depth (ft)	Start Date	Completion Date	Coordinates (feet) California State Zone 6, NAD 83	
					Northing	Easting
Cone Penetration Tests (CPTs)						
C-101	-221.0	25.41	10/8/2008	10/8/2008	2005421	6750956
C-102	-228.9	50.19	10/8/2008	10/8/2008	2005697	6752117
C-103	-221.0	25.37	10/8/2008	10/8/2008	2004791	6750954
C-104	-227.9	75.24	10/7/2008	10/7/2008	2004966	6752229
C-105	-227.2	75.31	10/7/2008	10/7/2008	2004829	6752401
C-106	-227.3	50.15	10/7/2008	10/7/2008	2004673	6751827
C-107	-227.5	75.25	10/7/2008	10/7/2008	2004748	6752273
C-108	-226.6	75.36	10/7/2008	10/7/2008	2004655	6752567
C-109	-226.2	75.41	10/8/2008	10/8/2008	2004265	6751740
C-110	-225.6	75.37	10/9/2008	10/9/2008	2004312	6752361
C-111	-226.2	75.34	10/8/2008	10/8/2008	2004119	6751643
C-112	-225.7	75.37	10/8/2008	10/8/2008	2003996	6751779
C-113	-225.8	75.29	10/8/2008	10/8/2008	2004171	6751918
C-114	-225.7	75.28	10/8/2008	10/8/2008	2003947	6752088
C-115	-225.8	75.48	10/9/2008	10/9/2008	2004188	6752273
C-116	-225.2	75.43	10/8/2008	10/8/2008	2004134	6752408
C-117	-225.4	75.31	10/9/2008	10/9/2008	2004215	6752530
C-118	-224.9	75.8	10/9/2008	10/9/2008	2004045	6752706
C-119	-221.0	25.26	10/8/2008	10/8/2008	2003867	6750965
C-120	-224.9	50.33	10/8/2008	10/8/2008	2003460	6752247
C-121	-225.9	50.38	10/8/2008	10/8/2008	2004311	6752168

Table A-2. Seismic CPT Shear Wave Measurements

CPT-102

Depth (ft)	Travel Distance (ft)	S-Wave Arrival (msec)	S-Wave Velocity from Surface (ft/sec)	Interval S-Wave Velocity (ft/sec)
10.12	11.29	29.38	384.20	
21.20	21.78	48.93	445.16	536.77
30.06	30.47	65.52	465.09	523.89
40.17	40.48	83.19	486.60	566.33
50.19	50.44	100.09	503.93	589.26

CPT-106

Depth (ft)	Travel Distance (ft)	S-Wave Arrival (msec)	S-Wave Velocity from Surface (ft/sec)	Interval S-Wave Velocity (ft/sec)
11.93	12.94	32.26	400.97	
20.25	20.86	47.82	436.18	509.17
30.14	30.55	63.30	482.65	626.21
40.16	40.47	80.87	500.43	564.49
50.19	50.44	94.98	531.04	706.48

CPT-118

Depth (ft)	Travel Distance (ft)	S-Wave Arrival (msec)	S-Wave Velocity from Surface (ft/sec)	Interval S-Wave Velocity (ft/sec)
10.15	11.31	30.01	377.03	
20.35	20.96	48.90	428.53	510.35
30.37	30.78	71.09	432.96	442.70
40.33	40.64	87.07	466.74	617.02
50.26	50.51	100.15	504.32	754.54
60.25	60.46	117.15	516.07	585.24
70.34	70.52	134.34	524.92	585.25

Shear Wave Source Offset = 5 ft

S-Wave Velocity from Surface = Travel Distance/S-Wave Arrival
Interval S-Wave Velocity = (Travel Dist2-Travel Dist1)/(Time2-Time1)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	BLOW COUNT / REC"/DRIVE"	MATERIAL DESCRIPTION	
		1	25	Well graded GRAVEL (GW)	COARSE GRAINED
-12	2			Poorly graded GRAVEL (GP)	COARSE GRAINED
-14	4	2	(25)	Well graded SAND (SW)	COARSE GRAINED
-16	6	3	(25)	Poorly graded SAND (SP)	COARSE GRAINED
-18	8	4	(25)	Silty SAND (SM)	COARSE GRAINED
-20	10	5	18"/ 30"	Clayey SAND (SC)	COARSE GRAINED
-22	12			Silty, Clayey SAND (SC-SM)	COARSE GRAINED
-24	14	6		Elastic SILT (MH)	FINE GRAINED
-26	16	7		SILT (ML)	FINE GRAINED
-28	18	8	20"/ 24"	Silty CLAY (CL-ML)	FINE GRAINED
-30	20	9	(25)	Fat CLAY (CH)	FINE GRAINED
-32	22			Lean CLAY (CL)	FINE GRAINED
-34	24	10	30"/ 30"	CONGLOMERATE	ROCK
-36	26	11	20"/ 24"	SANDSTONE	ROCK
-38	28	12		SILTSTONE	ROCK
-40	30	13		MUDSTONE	ROCK
-42	32			CLAYSTONE	ROCK
-44	34			BASALT	ROCK
-46	36			ANDESITE BRECCIA	ROCK
-48	38			Paving and/or Base Materials	

LOCATION: The drill hole location referencing local landmarks or coordinates

SURFACE EL: Using local, MSL, MLLW or other datum

General Notes

Soil Texture Symbol

Sloped line in symbol column indicates transitional boundary

Samplers and sampler dimensions
(unless otherwise noted in report text) are as follows:

Symbol for:

1. SPT Sampler, driven 1-3/8" ID, 2" OD
2. CA Liner Sampler, driven 2-3/8" ID, 3" OD
3. CA Liner Sampler, disturbed 2-3/8" ID, 3" OD
4. Thin-walled Tube, pushed 2-7/8" ID, 3" OD
5. Bulk Bag Sample (from cuttings)
6. CA Liner Sampler, Bagged
7. Hand Auger Sample
8. CME Core Sample
9. Pitcher Sample
10. Lexan Sample
11. Vibracore Sample
12. No Sample Recovered
13. Sonic Soil Core Sample

Sampler Driving Resistance

Number of blows with 140 lb. hammer, falling 30" to drive sampler 1 ft. after seating sampler 6"; for example,

Blows/ft	Description
25	25 blows drove sampler 12" after initial 6" of seating
86/11"	After driving sampler the initial 6" of seating, 36 blows drove sampler through the second 6" interval, and 50 blows drove the sampler 5" into the third interval
50/6"	50 blows drove sampler 6" after initial 6" of seating
Ref/3"	50 blows drove sampler 3" during initial 6" seating interval

Blow counts for California Liner Sampler shown in ( )

Length of sample symbol approximates recovery length

Classification of Soils per ASTM D2487 or D2488

Geologic Formation noted in bold font at the top of interpreted interval

Strength Legend

Q = Unconfined Compression
u = Unconsolidated Undrained Triaxial
t = Torvane
p = Pocket Penetrometer
m = Miniature Vane

Water Level Symbols

- Initial or perched water level
- Final ground water level
- Seepages encountered

Rock Quality Designation (RQD) is the sum of recovered core pieces greater than 4 inches divided by the length of the cored interval.

KEY TO TERMS & SYMBOLS USED ON LOGS

FIGURE A1-1

LOCATION: N 2,004,839 E 6,752,288 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -227.5 ft +/- (rel. NAVD88 datum)

ELEVATION, ft: -228, -230, -232, -234, -236, -238, -240, -242, -244, -246, -248, -250, -252, -254, -256, -258, -260, -262, -264, -266

DEPTH, ft: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38

SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
		Lean CLAY (CL): - moderate yellowish brown and dry at 0.0'							
1	(13)	- medium stiff, moderate brown, and wet, with a trace of sand and some rootlets at 5.0'	123	95	30				
2	24	Silty Fine SAND (SM): medium dense, moderate yellowish brown, wet, with a trace of clay							
3	(26)	Lean CLAY (CL): very stiff, moderate brown, wet, with a trace of sand	122	95	29				
4	12	Silty Fine SAND (SM): moderate yellowish brown, wet - medium dense, with a trace of clay at 20.0'							
5	(58)	- dense at 25.0'	125	103	22				
6	13	Lean CLAY (CL): stiff, dark yellowish brown, wet					32	13	
7	(78)	Silty Fine SAND (SM): dense, wet - dark yellowish brown at 35.0'	126	103	22				

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 8, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-01
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-2a

LOCATION: N 2,004,839 E 6,752,288 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -227.5 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft
-268	
	42
-270	
	44
-272	
	46
-274	
	48
-276	
	50
-278	
	52
-280	
	54
-282	
	56
-284	
	58
-286	
	60
-288	
	62
-290	
	64
-292	
	66
-294	
	68
-296	
	70
-298	
	72
-300	
	74
-302	
	76
-304	
	78
-306	

SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
8	53	- very dense and light reddish brown at 40.0'				21			
9	(49)	- with a trace of clay, 35.0' to 45.0' - dense and light reddish brown to dark yellowish brown at 45.0'	127	103	23				
10	23	Fat CLAY (CH): very stiff, light brown, wet					67	41	
NR	19								
11	(40)	Silty Fine SAND (SM): medium dense, light reddish brown, wet - with a trace of clay at 56.5'	127	103	23				
12	25	- interlayered with Lean CLAY (CL) below 60.0'							
NR	22								
13	16	Lean CLAY (CL): light reddish brown, wet, with a trace of sand - very stiff at 70.0'							
14	4	- soft at 75.0'							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 8, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-01
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-2b

LOCATION: N 2,004,568 E 6,751,983 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -228 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft
-230	2
-232	4
-234	6
-236	8
-238	10
-240	12
-242	14
-244	16
-246	18
-248	20
-250	22
-252	24
-254	26
-256	28
-258	30
-260	32
-262	34
-264	36
-266	38

SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
		Lean CLAY (CL): - moderate yellowish brown and dry at 0.0'							
1	(10)	- medium stiff, light reddish brown, and wet, with a trace of sand at 5.0'	123	97	27		27	8	
2	13	Silty Fine SAND (SM): medium dense, light reddish brown, wet							
3	(11)	Lean CLAY (CL): medium stiff, light reddish brown, wet	121	94	30		28	9	
4	10	Silty Fine SAND (SM): loose, dark yellowish brown to light reddish brown, wet							
5	(10)	SILT with sand (ML): firm, light reddish brown, wet, with some clay	122	94	29	76			
6	6	Fat CLAY (CH): medium stiff, dark yellowish brown, wet					61	38	
7	(20)	Silty Fine SAND (SM): wet - medium dense and light reddish brown at 35.0'	127	102	24				

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 51.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 10, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-02

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-3a

LOCATION: N 2,004,568 E 6,751,983 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -228 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
			8		38	- dense and dark yellowish brown to light reddish brown at 40.0'				21			
-270	42												
-272	44												
			9		(94)	- very dense and dark yellowish brown at 45.0'							
-274	46						125	102	23				
-276	48												
-278	50		10		10	Fat CLAY (CH): stiff, dark yellowish brown, wet							
-280	52												
-282	54												
-284	56												
-286	58												
-288	60												
-290	62												
-292	64												
-294	66												
-296	68												
-298	70												
-300	72												
-302	74												
-304	76												
-306	78												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 51.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 10, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-02
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-3b

LOCATION: N 2,004,120 E 6,751,781 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -226 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
				Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-228	2										
-230	4										
		1	(2)	- very soft, moderate yellowish brown, and wet at 5.0'							
-232	6				121	93	30				
-234	8										
-236	10	2	6	Silty Fine SAND (SM): loose, moderate to dark yellowish brown, wet, with a trace of clay				41			
-238	12										
-240	14										
		3	(13)	Lean CLAY (CL): medium stiff, dark yellowish brown, wet							
-242	16				119	90	33				
-244	18										
-246	20	4	2	SILT (ML): soft, moderate yellowish brown, with some sand							
-248	22										
-250	24										
		5	(15)	Silty Fine SAND (SM): loose, moderate yellowish brown, wet							
-252	26				126	103	23				
-254	28										
-256	30	6	8	Lean CLAY (CL): wet - medium stiff and moderate to dark yellowish brown at 30.0' - with some sand at 31.0'							
-258	32										
-260	34										
		7	(27)	- very stiff and dark yellowish brown at 35.0'							
-262	36			- with some sand at 36.0'	127	104	23		28	7	
-264	38										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 14, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-03

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-4a

LOCATION: N 2,004,120 E 6,751,781 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -226 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
		8	9	Silty Fine SAND (SM): wet - loose and moderate yellowish brown at 40.0'							
-268	42										
-270	44										
		9	(32)	- medium dense and moderate to dark yellowish brown at 45.0'							
-272	46			Lean CLAY (CL): wet - very stiff and dark brown at 46.3'	121	94	29				
-274	48										
-276	50	10		- moderate yellowish brown at 50.0'							
					121	92	32				
-278	52										
-280	54										
		11	(11)	- medium stiff and dark yellowish brown at 55.0'							
-282	56				108	73	48				
-284	58										
-286	60	12	9	SILT with sand (ML): stiff, dark yellowish brown, wet							
-288	62										
-290	64										
		13	8	Lean CLAY (CL): wet - medium stiff and moderate to dark yellowish brown to 75.0'							
-292	66										
-294	68										
-296	70	14	5								
-298	72										
-300	74										
		15	1	- very soft and dark yellowish brown to dark grayish brown at 75.0'							
-302	76										
-304	78										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 14, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-03
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-4b

LOCATION: N 2,004,092 E 6,751,986 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.9 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
				Lean CLAY (CL): pale yellowish brown, dry							
-228	2										
-230	4										
		1	2	SILT with sand (ML): soft, light reddish brown, wet, fine-grained sand				84			
-232	6										
-234	8										
-236	10	2	(15)	Silty Fine SAND (SM): loose, light reddish brown, wet	126	103	23				
-238	12										
-240	14										
		3	7	Lean CLAY (CL): medium stiff, dark yellowish brown, wet, with a trace of sand							
-242	16										
-244	18										
-246	20	4	(9)	Silty Fine SAND (SM): loose, light reddish brown, wet	121	96	26				
-248	22										
-250	24										
		5	9								
-252	26										
-254	28										
-256	30	6	(18)	Lean CLAY (CL): stiff, dark yellowish brown, wet	115	84	37				
-258	32										
-260	34										
		7	22	Silty Fine SAND (SM): dark yellowish brown, wet - medium dense at 35.0'							
-262	36										
-264	38										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 86.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 14, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-04

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-5a

LOCATION: N 2,004,092 E 6,751,986 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.9 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft
-268	42
-270	44
-272	46
-274	48
-276	50
-278	52
-280	54
-282	56
-284	58
-286	60
-288	62
-290	64
-292	66
-294	68
-296	70
-298	72
-300	74
-302	76
-304	78

SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
8	(51)	- dense at 40.0'	122	104	17				
9	8	Lean CLAY (CL): medium stiff, dark yellowish brown, wet, with a trace of sand							
10		Fat CLAY (CH): dark yellowish brown, wet	115	78	48		73	50	
11	6	- medium stiff at 55.0'							
12	14	SILT (ML): stiff, light reddish brown, wet, with a trace of sand - with a 2" silty clay seam at 61.5'							
13	(12)	Fat CLAY (CH): stiff, moderate to dark yellowish brown, wet							
14		Lean CLAY (CL): wet - moderate yellowish brown at 70.0'	128	103	24				
15	1	- very soft and dark yellowish brown below 75.0'					31	16	

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 86.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 14, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-04
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-5b

LOCATION: N 2,004,092 E 6,751,986 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.9 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
			16		1								
-308	82												
-310	84												
			17		16	Fat CLAY (CH): very stiff, dark yellowish brown, wet					71	45	
-312	86												
-314	88												
-316	90												
-318	92												
-320	94												
-322	96												
-324	98												
-326	100												
-328	102												
-330	104												
-332	106												
-334	108												
-336	110												
-338	112												
-340	114												
-342	116												
-344	118												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 86.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 14, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-04
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-5c

LOCATION: N 2,004,222 E 6,752,411 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.6 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-226	0			Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-231	5	1	(5)	- soft, dark yellowish brown, and wet at 5.0'	111	87	28				
-236	10	2	5	Silty Fine SAND (SM): moderate yellowish brown, wet - very loose at 10.0'							
-241	15	3		- with a trace of clay at 15.0'	125	98	27				
-246	20	4	12	- medium dense at 20.0'				48			
-251	25	5	6	- loose, with a trace of clay at 25.0'							
-256	30	6		Lean CLAY (CL): moderate yellowish brown, wet	119	88	35				
-261	35	7	(18)	SILT (ML): stiff, moderate yellowish brown, wet	117	92	27	93			

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 13, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-05
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-6a

CalEnergy Operating Corporation
Project No. 3652.001

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-266		8	25	Silty Fine SAND (SM): medium dense, wet - moderate to dark yellowish brown with some iron-oxide staining at 40.0'							
-268	42										
-270	44										
		9	(45)	- dark yellowish brown at 45.0'							
-272	46				123	101	22				
-274	48										
-276	50	10	13	Fat CLAY (CH): stiff, dark yellowish brown, wet					64	39	
-278	52										
-280	54										
		11	(28)	Silty Fine SAND (SM): wet - medium dense and dark yellowish brown at 55.0'							
-282	56				117	93	25				
-284	58										
-286	60	12	32	- with a 2" clay seam at 60.0' - dense and moderate yellowish brown at 60.0'							
-288	62										
-290	64										
		13	15	Fat CLAY (CH): stiff, moderate to dark yellowish brown, wet							
-292	66										
-294	68										
-296	70	14	1	Lean CLAY (CL): very soft, wet - dark yellowish brown at 70.0'							
-298	72										
-300	74										
		15	1	- moderate to dark yellowish brown at 75.0'							
-302	76										
-304	78										

LOCATION: N 2,004,222 E 6,752,411 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.6 ft +/- (rel. NAVD88 datum)

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 13, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-05
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-6b

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	LOCATION: N 2,004,172 E 6,752,610 California State Plane, Zone 6, NAD83, Feet SURFACE EL: -225 ft +/- (rel. NAVD88 datum) MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-226, -228	2, 4					Lean CLAY (CL): moderate yellowish brown, dry							
-230, -232, -234	6, 8		1		5	SILT (ML): medium stiff, light reddish brown, wet, with a trace of sand							
-236, -238, -240	10, 12, 14		2		(14)	Sandy SILT (ML): stiff, light reddish brown, wet	118	94	25	58			
-242, -244	16, 18		3			Fat CLAY (CH): light reddish brown, wet	123	94	30		71	50	
-246, -248, -250	20, 22, 24		4		9	Sandy SILT (ML): wet - stiff and dark yellowish brown to light reddish brown, with some clay at 20.0'				55			
-252, -254	26, 28		NS		(7)	- light reddish brown at 25.0'							
-256, -258, -260	30, 32, 34		5		10	Lean CLAY (CL): stiff, dark yellowish brown, wet							
-262, -264	36, 38		6		8	Silty Fine SAND (SM): dark yellowish brown, wet - loose, with a trace of clay at 35.0'							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 10, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-06
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-7a

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	LOCATION: N 2,004,172 E 6,752,610 California State Plane, Zone 6, NAD83, Feet SURFACE EL: -225 ft +/- (rel. NAVD88 datum) MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-266	40		7		26	- medium dense at 40.0'							
-268	42												
-270	44												
	45		8		33	- dense at 45.0'							
-272	46												
-274	48												
-276	50		9		6	Fat CLAY (CH): medium stiff, moderate yellowish brown to dark yellowish brown, wet							
-278	52												
-280	54												
	55		10		5	Lean CLAY (CL): medium stiff, dark yellowish brown, wet, with some iron oxide staining and dark gray banding							
-282	56												
-284	58												
-286	60		11		16	Silty Fine SAND (SM): medium dense, dark yellowish brown, wet - with a 2" silty clay seam at 61.5'							
-288	62												
-290	64												
	65		12		13	Fat CLAY (CH): stiff, dark yellowish brown, wet					75	50	
-292	66												
-294	68												
-296	70		13		1	Lean CLAY (CL): dark yellowish brown, wet - very soft, with some iron oxide staining at 70.0'							
-298	72												
-300	74												
	75		14		5	- medium stiff, with a trace of sand and rock fragments at 75.0'							
-302	76												
-304	78												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 10, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-06

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-7b

LOCATION: N 2,004,790 E 6,752,499 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -227 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
	0			Lean CLAY (CL): moderate yellowish brown, dry							
	5	1	5	SILT (ML): medium stiff, dark yellowish brown, wet				89			
	10	2	(20)	Silty Fine SAND (SM): medium dense, dark yellowish brown, wet	121	98	24				
	15	3	9	Lean CLAY (CL): stiff, light reddish brown, wet					50	30	
	20	4	(19)	Silty Fine SAND (SM): medium dense, light reddish brown, wet	123	99	24				
	25	5	35								
	30	6	(21)	Lean CLAY (CL): stiff, dark yellowish brown to light reddish brown, wet, 1" clayey silt seam at 31.5'	118	88	34				
	35	7	22	Silty Fine SAND (SM): medium dense, light reddish brown, wet							

Elevation scale: -228, -230, -232, -234, -236, -238, -240, -242, -244, -246, -248, -250, -252, -254, -256, -258, -260, -262, -264, -266
Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 8, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-07
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-8a

LOCATION: N 2,004,790 E 6,752,499 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -227 ft +/- (rel. NAD88 datum)

ELEVATION, ft: -268, -270, -272, -274, -276, -278, -280, -282, -284, -286, -288, -290, -292, -294, -296, -298, -300, -302, -304, -306

DEPTH, ft: 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78

SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
NR	35								
8	(35)		133	110	21				
9	26					14			
10	(11)	Fat CLAY (CH): medium stiff, light reddish brown, wet, with a trace of silt	116	85	38		72	48	
11	22	Silty Fine SAND (SM): medium dense, light reddish brown, wet				46			
NR	83								
12	16	Lean CLAY (CL): wet - dark yellowish brown to 75.0' - very stiff at 65.0'							
13	8	- medium stiff below 70.0'							
14	7	- dark yellowish brown to light reddish brown at 75.0'							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 76.5 ft

BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 8, 2008

DRILLING METHOD: 4-inch-dia. Mud Rotary Wash
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. RW-07

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-8b

LOCATION: N 2,005,752 E 6,752,870 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -228.5 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
	0					Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-230	2		1		(4)	- soft, light brown, and slightly moist to moist at 2.0'	123	96	28				
-232	4												
-234	6		2		2	Silty Fine SAND (SM): very loose, moderate yellowish brown, very moist							
-236	8												
-238	10												
-240	12												
-242	14												
-244	16												
-246	18												
-248	20												
-250	22												
-252	24												
-254	26												
-256	28												
-258	30												
-260	32												
-262	34												
-264	36												
-266	38												
-268													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-01
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-9

LOCATION: N 2,005,656 E 6,752,525 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -228.3 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
	0					Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-230	2		1		(3)	- very soft, moderate yellowish brown, and very moist to wet at 2.0'	116	91	28				
-234	5		2		(2)	SILT (ML): very soft, moderate yellowish brown, very moist to wet, with a trace of sand	119	94	27				

Elevation scale: -230, -232, -234, -236, -238, -240, -242, -244, -246, -248, -250, -252, -254, -256, -258, -260, -262, -264, -266, -268
Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-02
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-10

LOCATION: N 2,005,555 E 6,752,124 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -228.9 ft +/- (rel. NAVD88 datum)

DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
0	B	BULK	Lean CLAY (CL): pale yellowish brown, dry				96	38	25	
2	1	(6)	SILT (ML): moderate to dark yellowish brown, very moist to wet - soft at 2.0'	117	92	28				
5	2	(3)	- very soft at 5.0'	122	98	24				
10	3	5	Silty Fine SAND (SM): loose, moderate yellowish brown, wet							
15	4	8	Lean CLAY (CL): medium stiff, dark yellowish brown, wet							
20	5	4	Silty Fine SAND (SM): very loose, dark yellowish brown, wet							
25	6	7	Silty Fine SAND (SM) to Sandy SILT (ML): loose, dark yellowish brown, wet							

Elevation scale: -230 to -268 ft; depth scale: 2 to 38 ft.

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 5.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-03
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-11

LOCATION: N 2,005,469 E 6,751,158 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -228.8 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
	0		B		BULK	Lean CLAY (CL): - pale yellowish brown and dry at 0.0'				98	33	17	
	2		1		(2)	- soft, moderate yellowish brown, and moist at 2.0'	117	89	31				
	5		2		(4)	Silty Fine SAND (SM) to Sandy SILT (ML): very loose, moderate yellowish brown, very moist to wet	126	101	25				

Elevation scale: -230 to -268 ft; depth scale: 2 to 38 ft.

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-04
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-12

LOCATION: N 2,005,837 E 6,754,161 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -224 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
		B	BULK	Lean CLAY with sand (CL): pale yellowish brown, dry - with a 6" silty sand layer at 0.0' (dirt road)				75			
-226	2	1	(8)	SILT (ML): medium stiff, moderate yellowish brown, very moist to wet	118	94	26				
-228	4										
		2	(5)	Silty Fine SAND (SM): very loose, moderate yellowish brown, very moist to wet	120	97	23				
-230	6										
-232	8										
-234	10										
-236	12										
-238	14										
-240	16										
-242	18										
-244	20										
-246	22										
-248	24										
-250	26										
-252	28										
-254	30										
-256	32										
-258	34										
-260	36										
-262	38										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 17, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-05
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-13

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	LOCATION: N 2,005,027 E 6,752,048 California State Plane, Zone 6, NAD83, Feet SURFACE EL: -228.1 ft +/- (rel. NAVD88 datum) MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
						Lean CLAY (CL): pale yellowish brown, dry							
-230	2		1		(8)	Silty Fine SAND (SM) to Sandy SILT (ML): loose, moderate yellowish brown, moist to very moist	115	92	26				
-232	4												
-234	6		2		(2)	Lean CLAY (CL): very soft, moderate yellowish brown, moist to very moist	115	88	31				
-236	8												
-238	10												
-240	12												
-242	14												
-244	16												
-246	18												
-248	20												
-250	22												
-252	24												
-254	26												
-256	28												
-258	30												
-260	32												
-262	34												
-264	36												
-266	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-06

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-14

LOCATION: N 2,004,934 E 6,751,075 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -228 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
						Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-230	2		1		(3)	- very soft, moderate yellowish brown, and moist at 2.0'	114	88	30				
-232	4												
-234	6		2		(10)	Silty Fine SAND (SM): loose, moderate yellowish brown, very moist to wet	121	98	23				
-236	8												
-238	10												
-240	12												
-242	14												
-244	16												
-246	18												
-248	20												
-250	22												
-252	24												
-254	26												
-256	28												
-258	30												
-260	32												
-262	34												
-264	36												
-266	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-07

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-15

LOCATION: N 2,005,823 E 6,755,553 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -223 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-223 to -225	0–2	B	BULK	Lean CLAY (CL): pale yellowish brown, dry - with a 6" silty sand layer at 0.0' (dirt road)				98			
-225 to -228	2–5	1	(2)	Sandy SILT (ML): very soft, moderate yellowish brown, moist	107	83	29				
-228 to -229.5	5–6.5	2	(7)	Silty Fine SAND (SM): loose, moderate yellowish brown, very moist to wet	115	92	25				

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 17, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-08

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-16

LOCATION: N 2,004,753 E 6,751,236 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -227.5 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-228	0	B	BULK	Lean CLAY (CL): pale yellowish brown, dry							
-230	2	1	(6)	Silty Fine SAND (SM): very loose, moderate yellowish brown, very moist to wet	108	83	30				
-232	4	2	(6)	SILT (ML): soft, moderate yellowish brown, very moist to wet	115	91	26				
-238	10	3	10	Silty Fine SAND (SM): loose, moderate yellowish brown, wet							
-243	15	4	1	Lean CLAY (CL): very soft, moderate yellowish brown, wet, with a trace of sand							
-248	20	5	1	Silty Fine SAND (SM): moderate yellowish brown, wet - very loose at 20.0'							
-253	25	6	11	- medium dense at 25.0'							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 5.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-09

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-17

LOCATION: N 2,004,617 E 6,751,677 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -227 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-228	0		B		BULK	Fat CLAY (CH): pale yellowish brown, dry					52	33	
-230	2		1		(7)	Lean CLAY (CL): moderate yellowish brown, very moist to wet - medium stiff at 2.0'	114	90	27				
-232	5		2		(2)	- very soft at 5.0'	115	89	29				

Depth scale: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38

Elevation scale: -228, -230, -232, -234, -236, -238, -240, -242, -244, -246, -248, -250, -252, -254, -256, -258, -260, -262, -264, -266

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-10

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-18

LOCATION: N 2,004,291 E 6,751,165 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -227 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-227	0	B	BULK	Lean CLAY (CL): - pale yellowish brown and dry at 0.0'					36	17	
-229	2	1	(2)	- very soft, moderate yellowish brown, and very moist at 2.0'	116	87	34				
-232	5	2	(7)	Silty Fine SAND (SM) to Sandy SILT (ML): loose, moderate yellowish brown, very moist to wet	121	98	24				
-237	10	3	5	Silty Fine SAND (SM): loose, moderate yellowish brown, wet							

Groundwater symbol at 8.5 ft. Depth scale 0–40 ft; elevation scale -228 to -266 ft.

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 11.5 ft
DEPTH TO WATER: 8.5 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-11
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-19

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	LOCATION: N 2,004,491 E 6,752,434 California State Plane, Zone 6, NAD83, Feet SURFACE EL: -223 ft +/- (rel. NAVD88 datum) MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-224			B		BULK	Lean CLAY (CL): - with a 6" silty sand layer at 0.0' (dirt road) - pale yellowish brown and dry at 0.5' - medium stiff, moderate yellowish brown, and moist at 2.0'				100			
-226	2		1		(12)		119	94	27				
-228	4		2		(3)	SILT (ML): very soft, moderate yellowish brown, very moist to wet	115	89	29				
-230	6												
-232	8												
-234	10												
-236	12												
-238	14												
-240	16												
-242	18												
-244	20												
-246	22												
-248	24												
-250	26												
-252	28												
-254	30												
-256	32												
-258	34												
-260	36												
-262	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 17, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-12
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-20

LOCATION: N 2,005,204 E 6,753,571 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -219 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-220	0		B		BULK	Lean CLAY (CL): - with a 6" silty sand layer at 0.0' (dirt road) - pale yellowish brown and dry at 0.5'				87			
-222	2		1		(8)	- medium stiff at 2.0' - moderate yellowish brown and moist below 2.0'	110	86	29				
-224	5		2		(4)	- soft at 5.0'	115	86	34				

Elevation scale: -220 to -258; depth scale: 2 to 38.

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 17, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-13

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-21

LOCATION: N 2,004,317 E 6,751,970 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -226 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
		B	BULK	Lean CLAY (CL): pale yellowish brown, dry, with some clay				91	27	8	
-228	2										
		1	(9)	Silty Fine SAND (SM) to Sandy SILT (ML): loose, moderate yellowish brown, very moist to wet	115	91	27				
-230	4										
		2	(8)		129	97	33				
-232	6										
-234	8										
-236	10	3	10	Silty Fine SAND (SM): loose, moderate yellowish brown, wet							
-238	12										
-240	14										
		4	3	Lean CLAY (CL): soft, moderate yellowish brown, wet							
-242	16										
-244	18										
-246	20										
-248	22										
-250	24										
-252	26										
-254	28										
-256	30										
-258	32										
-260	34										
-262	36										
-264	38										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 16.5 ft
DEPTH TO WATER: 5.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-14

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-22

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	LOCATION: N 2,003,996 E 6,751,182 California State Plane, Zone 6, NAD83, Feet SURFACE EL: -226.2 ft +/- (rel. NAVD88 datum) MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
						Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-228	2		1		(4)	- soft, moderate yellowish brown, and very moist to wet at 2.0'	118	89	33				
-230	4												
-232	6		2		(2)	Silty Fine SAND (SM) to Sandy SILT (ML): very loose, moderate yellowish brown, very moist to wet	116	89	30				
-234	8				▽								
-236	10		3		3	Silty Fine SAND (SM): very loose, moderate yellowish brown, wet							
-238	12												
-240	14												
-242	16												
-244	18												
-246	20												
-248	22												
-250	24												
-252	26												
-254	28												
-256	30												
-258	32												
-260	34												
-262	36												
-264	38												
-266													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 11.5 ft
DEPTH TO WATER: 8.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 15, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-15
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-23

LOCATION: N 2,004,195 E 6,750,966 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -222 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
	0	B	BULK	Silty SAND (SM): (0.0' to 0.5': dirt road) - pale yellowish brown and dry to 2.0'							
-224	2	1	(65)	- dense, moderate yellowish brown, wet, fine- to coarse-grained, with some gravel and gray sand below 2.0'			14				
-226	4										
		NS	(5)								
-228	6										
-230	8										
-232	10	2	2	Lean CLAY (CL): soft, moderate yellowish brown, very moist					31	11	
-234	12										
-236	14										
		3	9	SILT with sand (ML): stiff, moderate yellowish brown, wet, with a trace of clay				78			
-238	16										
-240	18										
-242	20										
-244	22										
-246	24										
-248	26										
-250	28										
-252	30										
-254	32										
-256	34										
-258	36										
-260	38										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 16.5 ft
DEPTH TO WATER: 11.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-16
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-24

LOCATION: N 2,003,936 E 6,751,586 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -226 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
						Lean CLAY (CL): pale yellowish brown, dry							
-228	2		1		(4)	Silty Fine SAND (SM) to Sandy SILT (ML): very loose, moderate yellowish brown, very moist to wet	118	91	29				
-230	4												
			2		(4)	SILT (ML): soft, moderate yellowish brown, very moist to wet, with a trace of sand	117	93	26				
-232	6												
-234	8												
-236	10												
-238	12												
-240	14												
-242	16												
-244	18												
-246	20												
-248	22												
-250	24												
-252	26												
-254	28												
-256	30												
-258	32												
-260	34												
-262	36												
-264	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-17
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-25

LOCATION: N 2,003,894 E 6,752,364 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.8 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-226						Lean CLAY (CL): - pale yellowish brown and damp at 0.0'							
-228	2		1		(6)	- moist at 2.0' - soft and moderate yellowish brown below 2.0'	117	91	29				
-230	4												
			2		(4)	- very moist to wet at 5.0'							
-232	6						119	95	26				
-234	8												
-236	10												
-238	12												
-240	14												
-242	16												
-244	18												
-246	20												
-248	22												
-250	24												
-252	26												
-254	28												
-256	30												
-258	32												
-260	34												
-262	36												
-264	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-18
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-26

LOCATION: N 2,003,583 E 6,750,967 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -221 ft +/- (rel. NAVD88 datum)

DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
0.0	B	BULK	Silty SAND (SM): (0.0' to 0.5': dirt road) - pale yellowish brown and dry to 2.0'							
2.0	1	(42)	- medium dense, moderate yellowish brown, moist, fine- to coarse-grained, with some gravel at 2.0'			13				
5.0	2	(9)	Lean CLAY (CL): medium stiff, dark yellowish brown, moist			29				
10.0	3		SILT (ML): moderate yellowish brown, moist	118	88	34		34	9	
15.0	4	6	Silty Fine SAND (SM) to Sandy SILT (ML): loose, moderate yellowish brown, wet, with some clay							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 16.5 ft
DEPTH TO WATER: 15.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 18, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-19

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-27

LOCATION: N 2,003,443 E 6,752,397 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -224.6 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-224.6	0	B	BULK	Lean CLAY (CL): - pale yellowish brown and dry at 0.0'				94			
-226.6	2	1	(5)	- very loose, moderate yellowish brown, and very moist to wet at 2.0'	115	90	28				
-229.6	5	2	(5)	Silty Fine SAND (SM) to Sandy SILT (ML): very loose, moderate yellowish brown, very moist to wet	116	92	26				
-234.6	10	3	21	Silty Fine SAND (SM): medium dense, moderate to dark yellowish brown, wet							
-239.6	15	4	5	Lean CLAY (CL): medium stiff, moderate yellowish brown, very moist to wet, with a trace of sand							
-244.6	20	5	5	Silty Fine SAND (SM): loose, moderate yellowish brown, wet							
-249.6	25	6	7								

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 7.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-20
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-28

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	LOCATION: N 2,003,288 E 6,751,504 California State Plane, Zone 6, NAD83, Feet SURFACE EL: -225.8 ft +/- (rel. NAVD88 datum) MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-226						Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-228	2		1		(7)	- medium stiff, moderate yellowish brown, and very moist to wet at 2.0'	111	85	30				
-230	4		2		(12)		118	95	24				
-232	6												
-234	8												
-236	10												
-238	12												
-240	14												
-242	16												
-244	18												
-246	20												
-248	22												
-250	24												
-252	26												
-254	28												
-256	30												
-258	32												
-260	34												
-262	36												
-264	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-21
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-29

LOCATION: N 2,003,352 E 6,751,853 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.5 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-226	0		B		BULK	Lean CLAY (CL): - pale yellowish brown and dry at 0.0'				99	45	30	
-228	2		1		(5)	- moist at 2.0' - soft and moderate yellowish brown below 2.0'	116	88	31				
-231	5		2		(4)	- very moist to wet at 5.0'	118	92	28				
-236	10		3		7	Silty Fine SAND (SM): loose, moderate yellowish brown, wet							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 11.5 ft
DEPTH TO WATER: 8.0 ft
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-22
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-30

LOCATION: N 2,003,270 E 6,752,135 California State Plane, Zone 6, NAD83, Feet

SURFACE EL: -225.8 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-226						Lean CLAY (CL): - pale yellowish brown and dry at 0.0'							
-228	2		1		(4)	- soft, moderate yellowish brown, and very moist to wet at 2.0'	114	88	29				
-230	4												
-232	6		2		(13)	Silty Fine SAND (SM) to Sandy SILT (ML): loose, moderate yellowish brown, very moist to wet	119	96	24				
-234	8												
-236	10												
-238	12												
-240	14												
-242	16												
-244	18												
-246	20												
-248	22												
-250	24												
-252	26												
-254	28												
-256	30												
-258	32												
-260	34												
-262	36												
-264	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

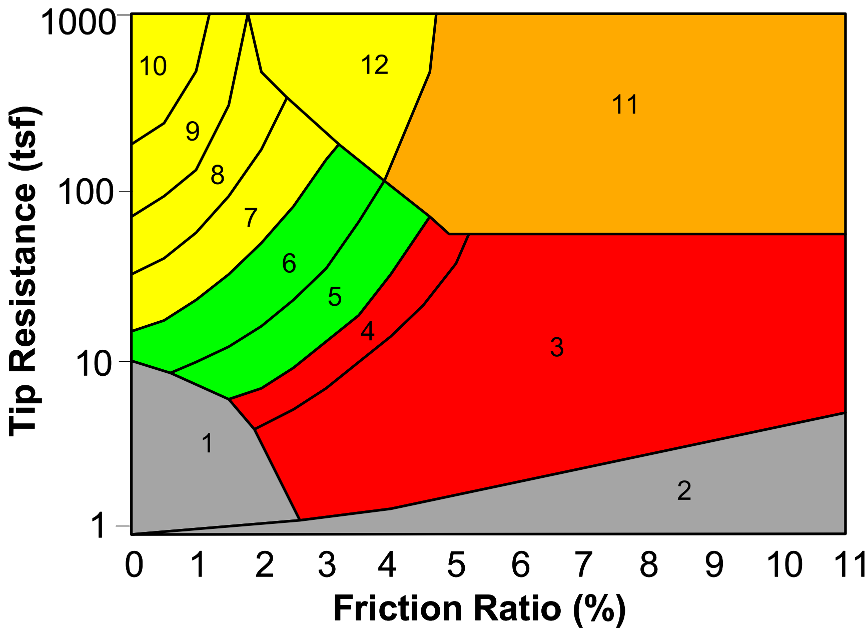
COMPLETION DEPTH: 6.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout with Bentonite Chips
DRILLING DATE: October 16, 2008

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: Gregg Drilling
LOGGED BY: S Varnell
CHECKED BY: J Everett

LOG OF BORING NO. HSA-23
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE A1-31

COLOR LEGEND FOR FRICTION RATIO TRACES



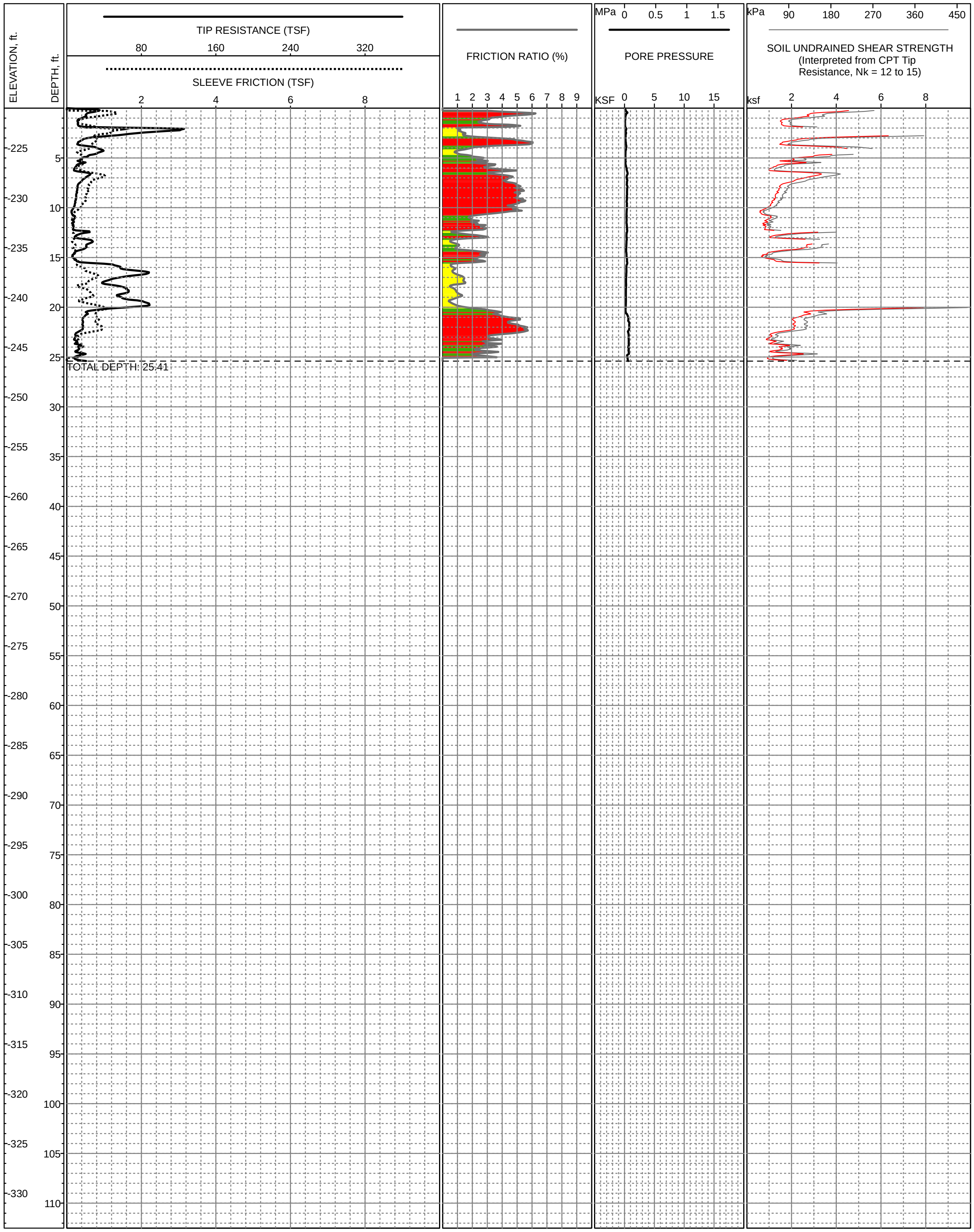
Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART
(Robertson and Campanella, 1984)

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\A2-22_KeytoCPT-RC88.mxd, 01/16/09, CDean

KEY TO CPT LOGS
Black Rock Units 1, 2 & 3
Calpatria, California



LOCATION: E6,750,956, N2,005,421, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -221.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.41ft
TESTDATE: 10/8/2008

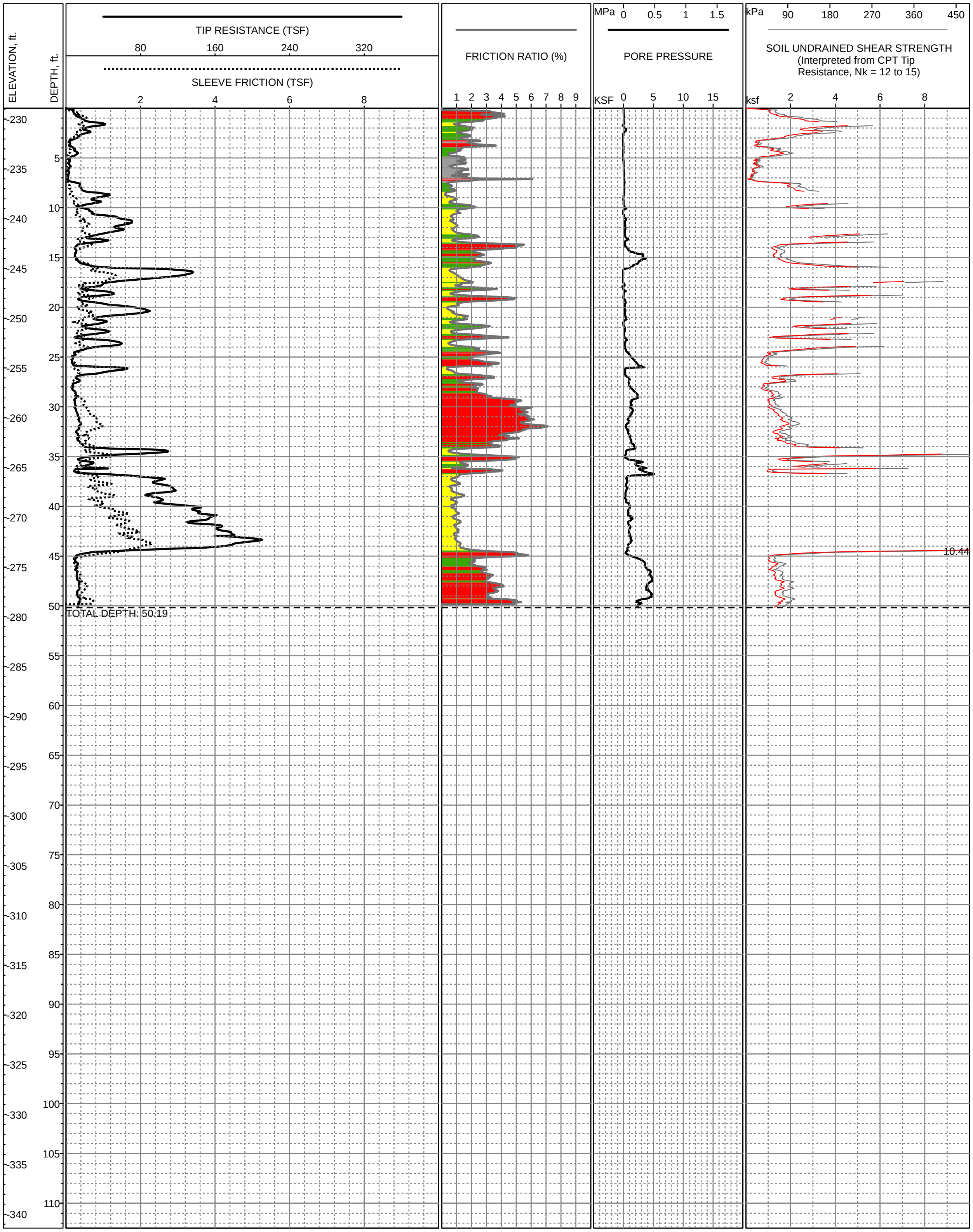
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-101
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-2

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,117, N2,005,697, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -228.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.19ft
TESTDATE: 10/8/2008

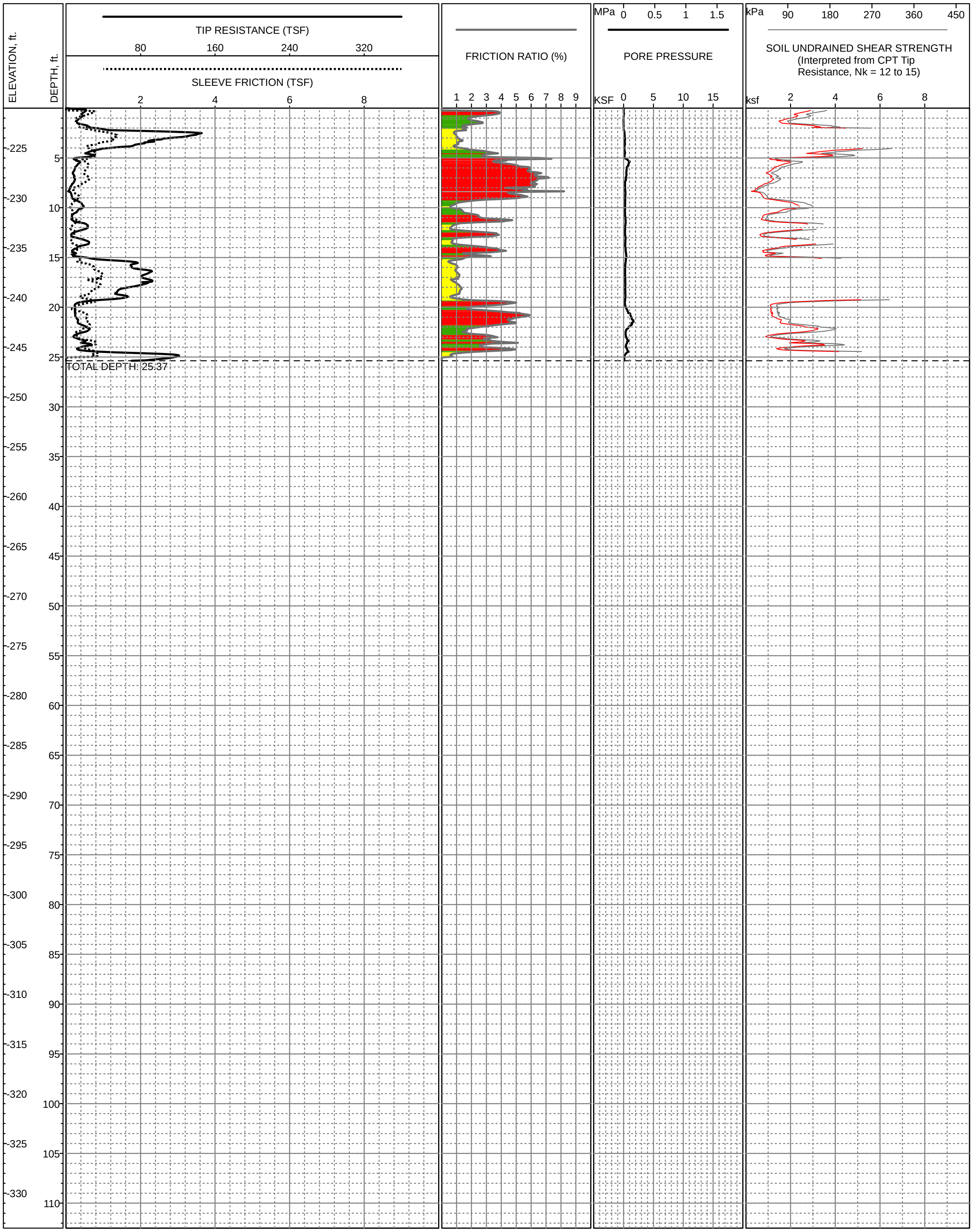
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-102
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-3

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,750,954, N2,004,791, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -221.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.37ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

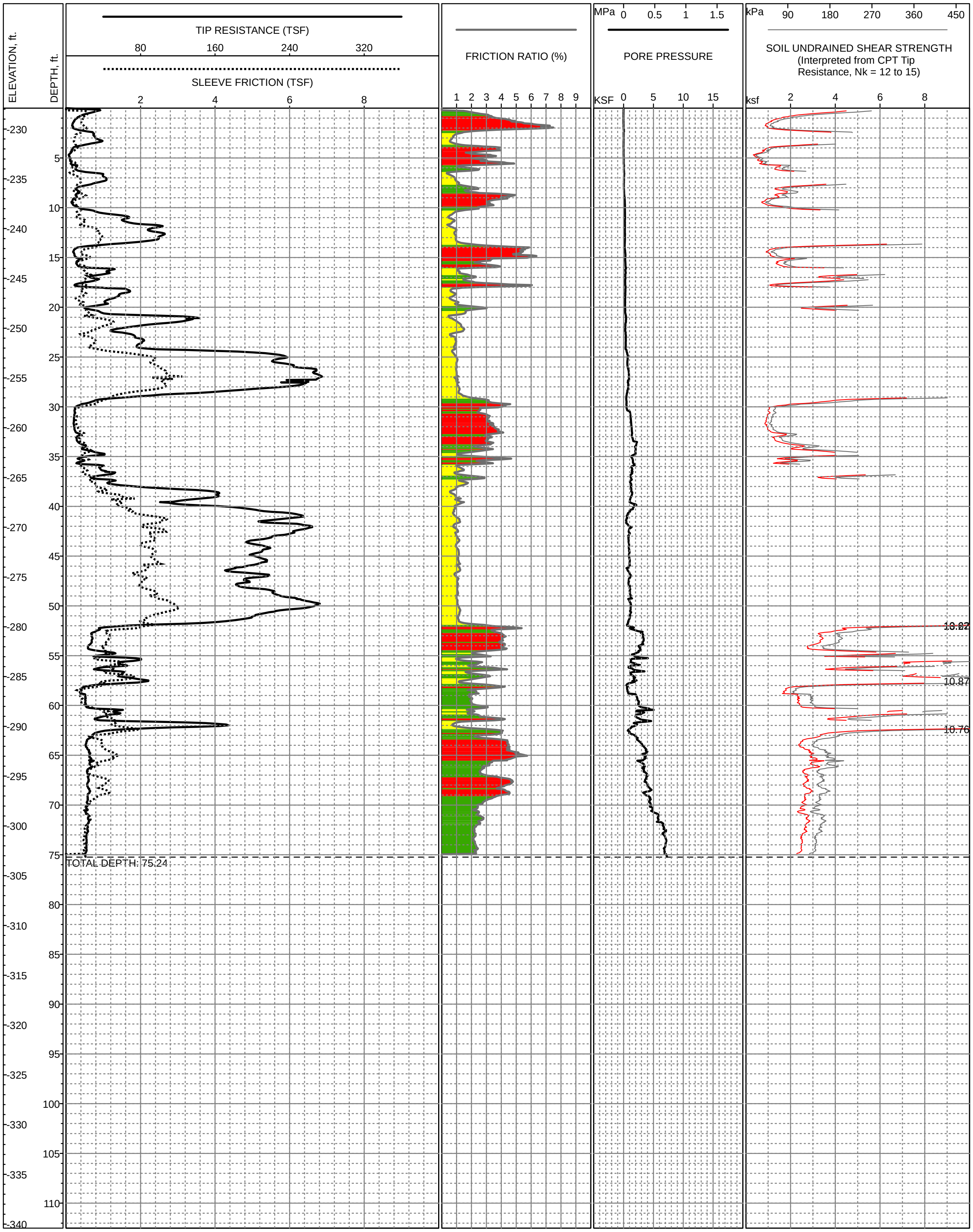
LOG OF C-103

Black Rock Units 1,2 & 3

Calipatria, California

FIGURE A2-4

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean



LOCATION: E6,752,229, N2,004,966, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.9ft +/- (NAVD88)
COMPLETION DEPTH: 75.24ft
TESTDATE: 10/7/2008

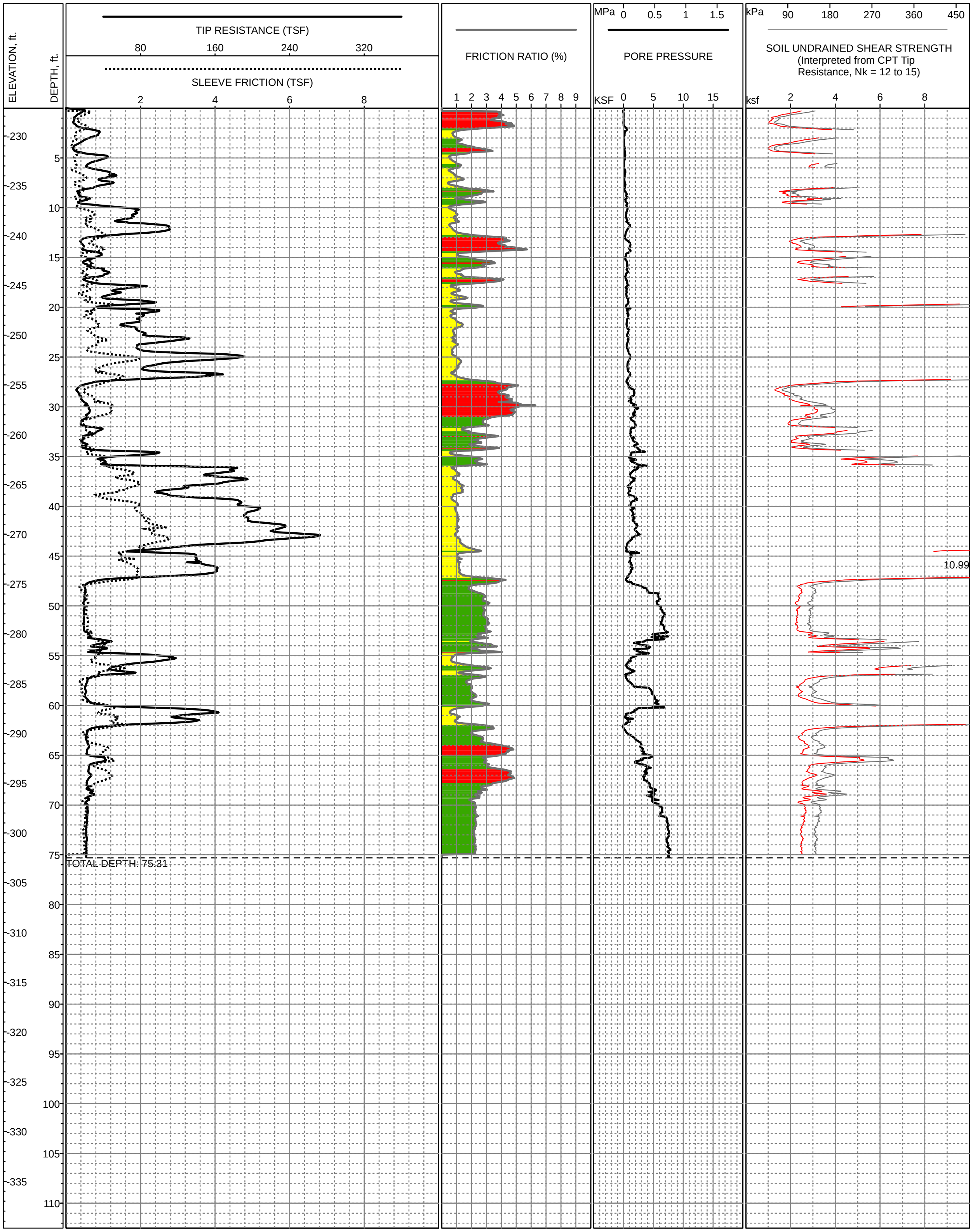
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-104

Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-5

N:\Projects\3652\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean



LOCATION: E6,752,401, N2,004,829, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.31ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

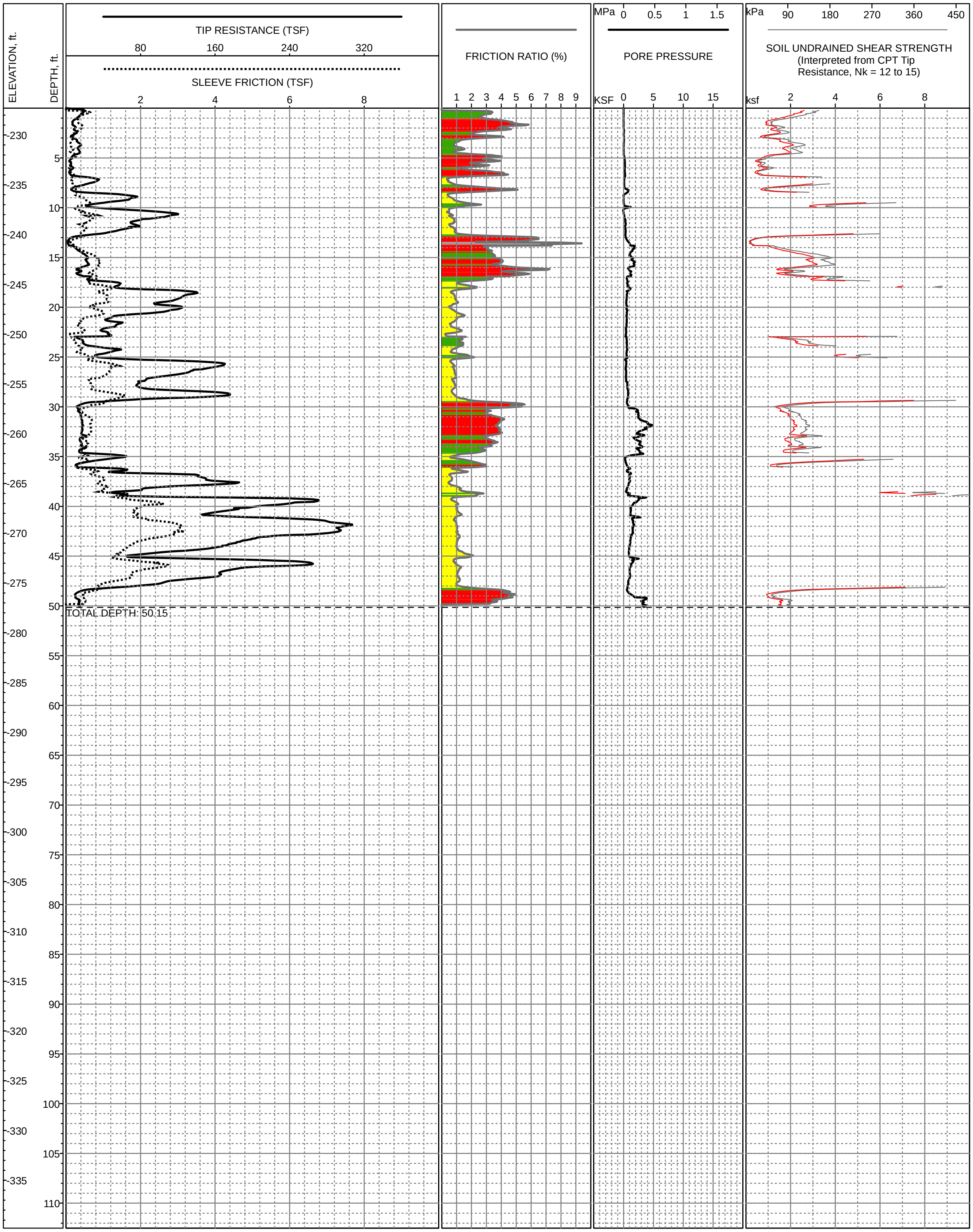
LOG OF C-105

Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-6

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



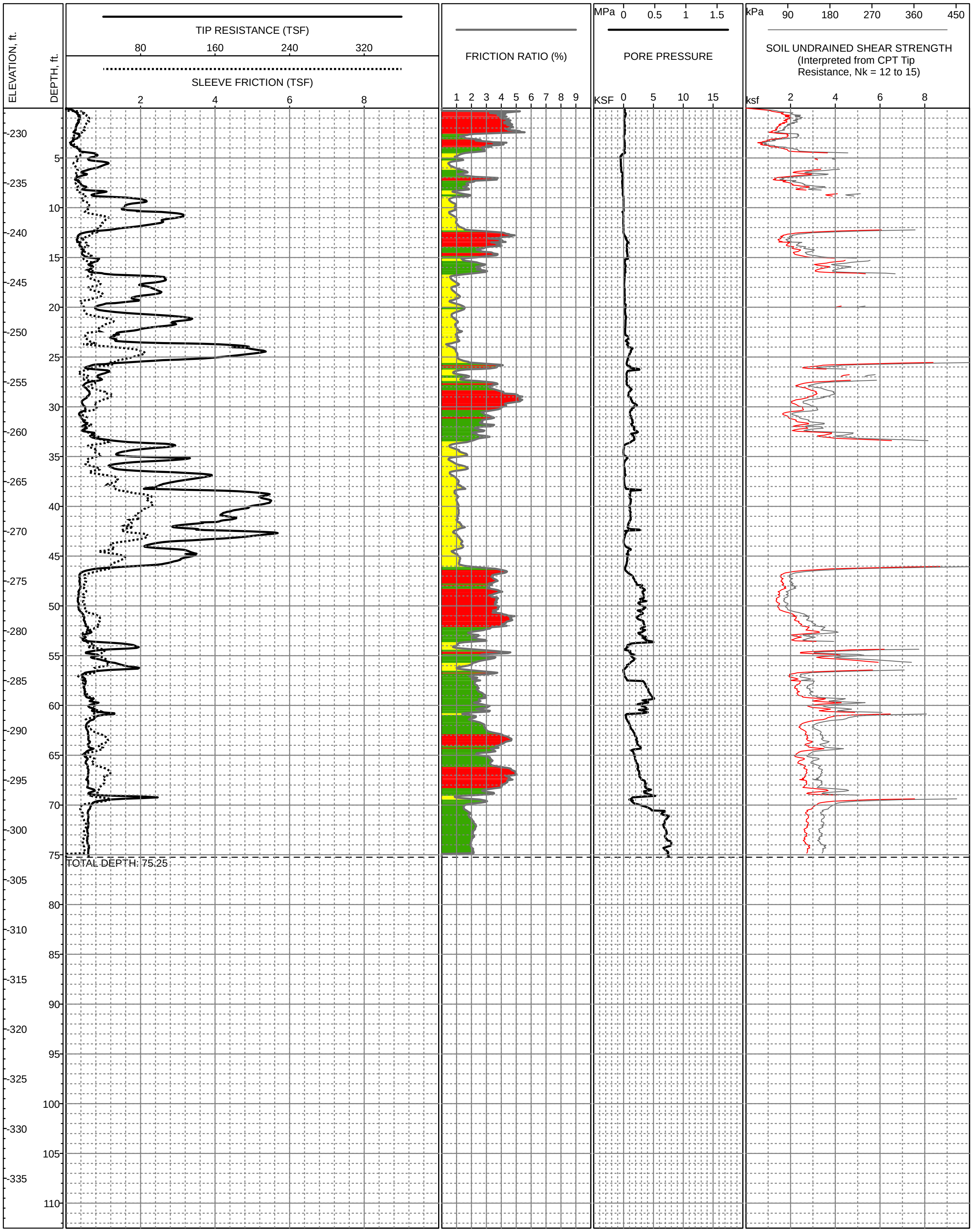
LOCATION: E6,751,827, N2,004,673, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.3ft +/- (NAVD88)
COMPLETION DEPTH: 50.15ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-106
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-7

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

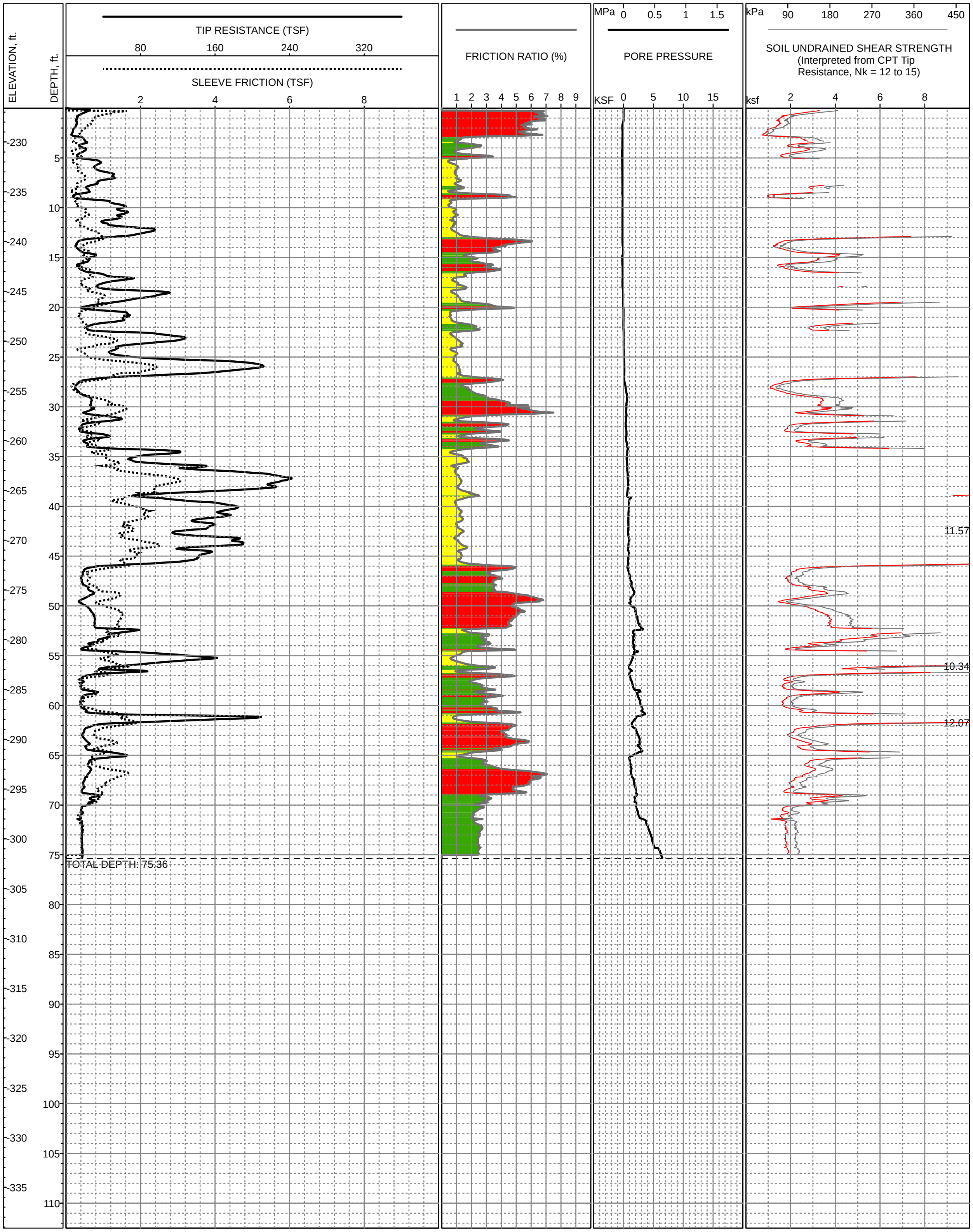


LOCATION: E6,752,273, N2,004,748, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.5ft +/- (NAVD88)
COMPLETION DEPTH: 75.25ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-107
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-8



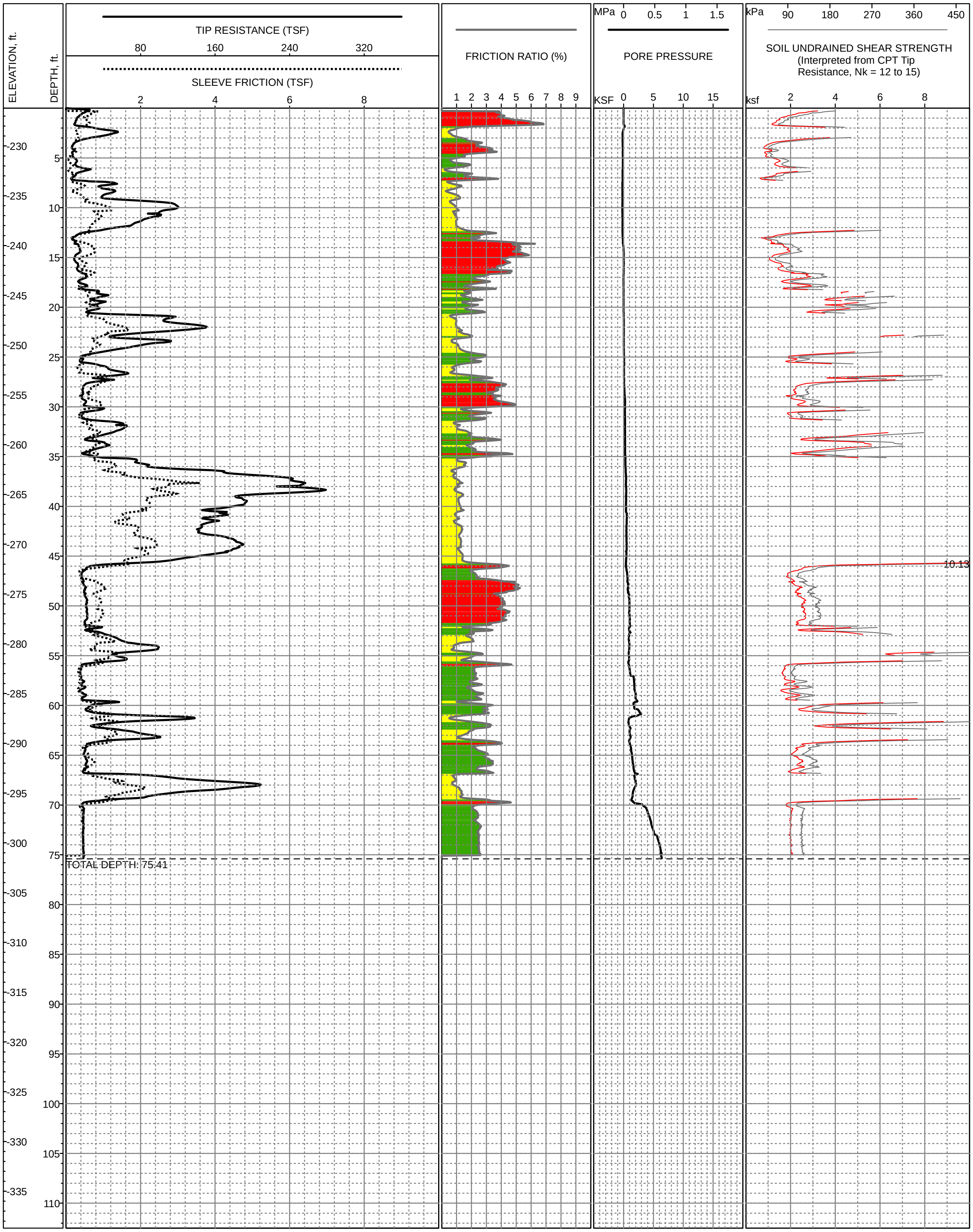
LOCATION: E6,752,567, N2,004,655, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -226.6ft +/- (NAVD88)
COMPLETION DEPTH: 75.36ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-108

Black Rock Units 1,2 & 3
Calipatria, California

N:\Projects\3652\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean



LOCATION: E6,751,740, N2,004,265, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -226.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.41ft
TESTDATE: 10/8/2008

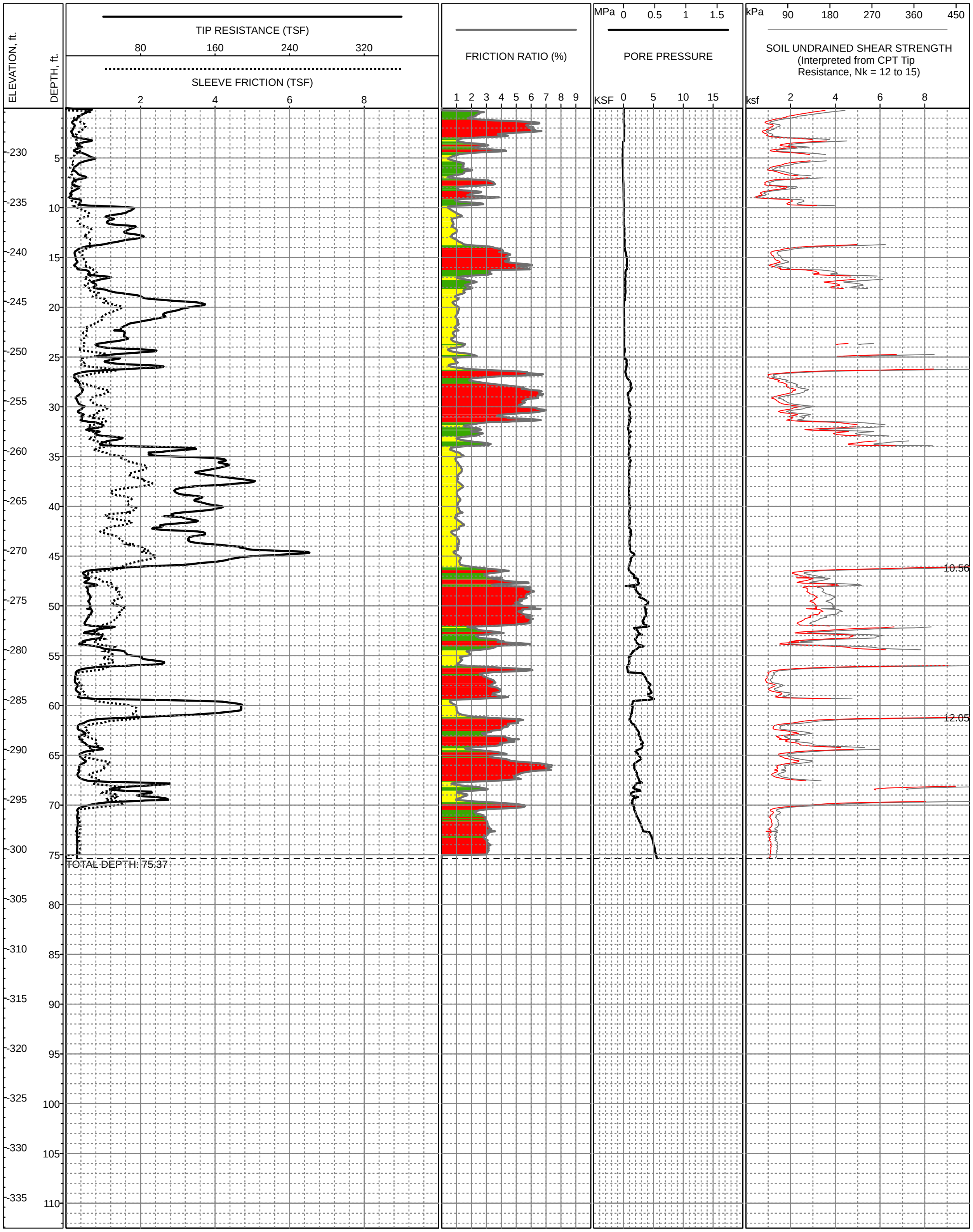
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-109
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-10

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,361, N2,004,312, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.6ft +/- (NAVD88)
COMPLETION DEPTH: 75.37ft
TESTDATE: 10/9/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

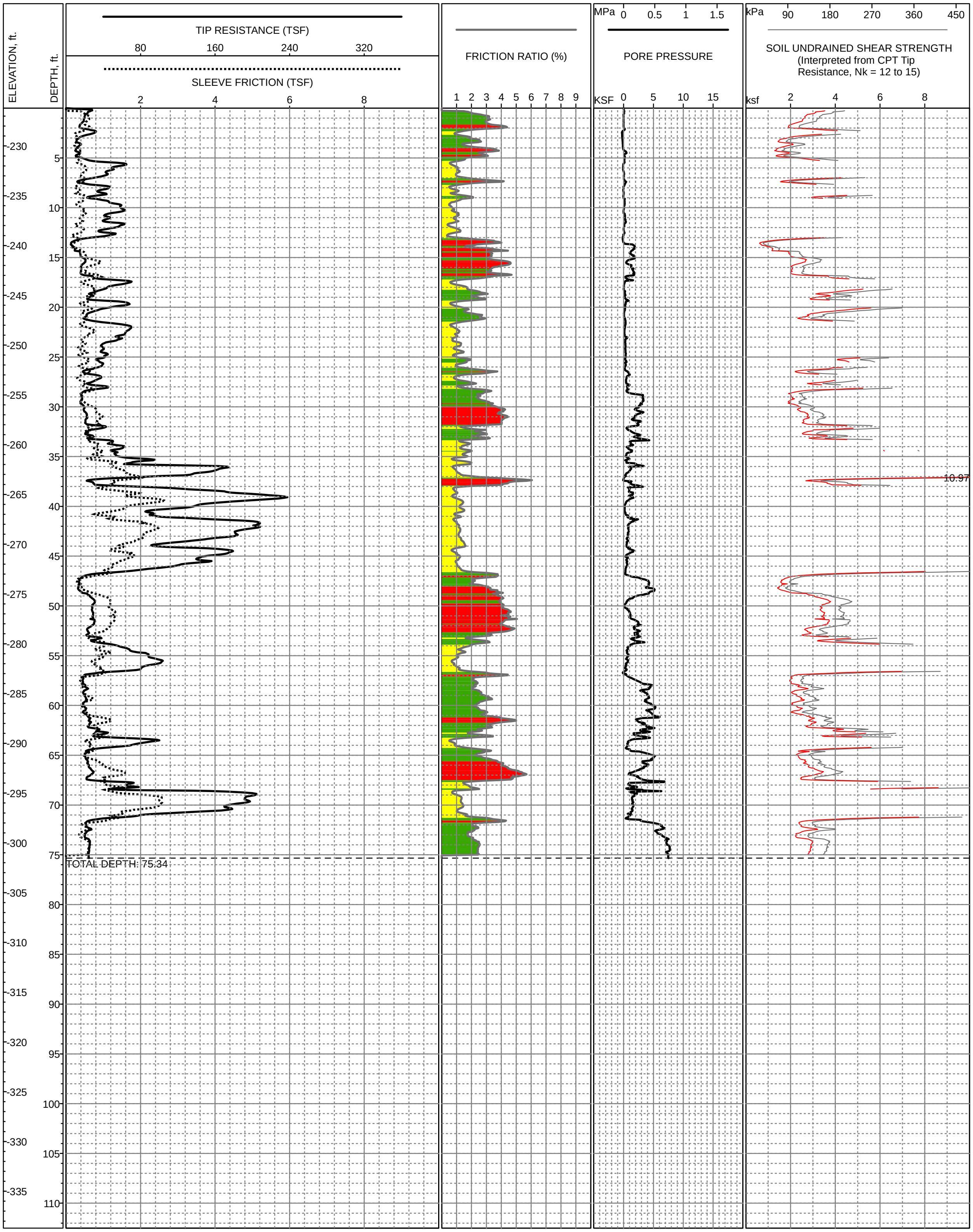
LOG OF C-110

Black Rock Units 1,2 & 3

Calipatria, California

FIGURE A2-11

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,751,643, N2,004,119, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -226.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.34ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

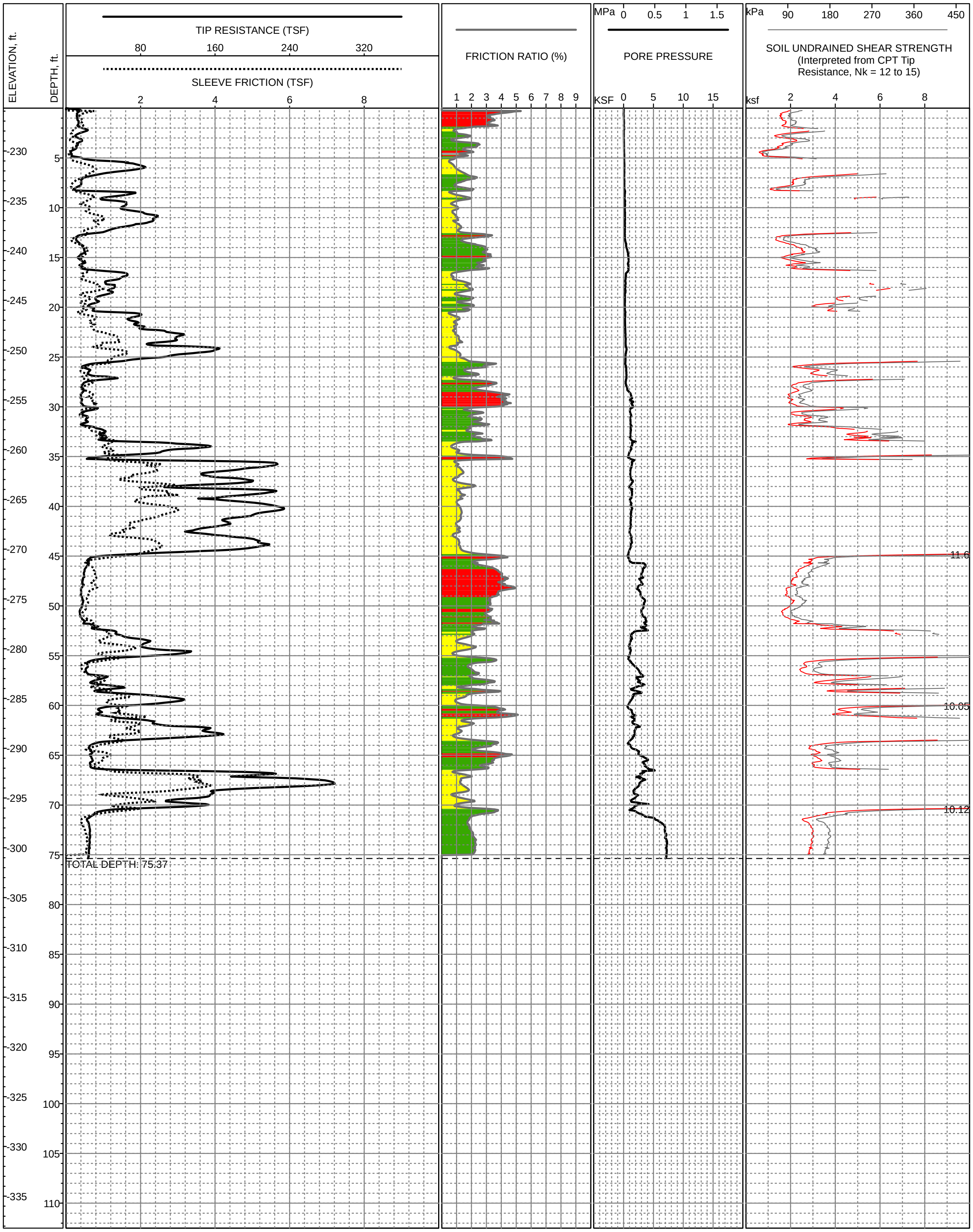
LOG OF C-111

Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-12

N:\Projects\3652\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,751,779, N2,003,996, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.7ft +/- (NAVD88)
COMPLETION DEPTH: 75.37ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-112

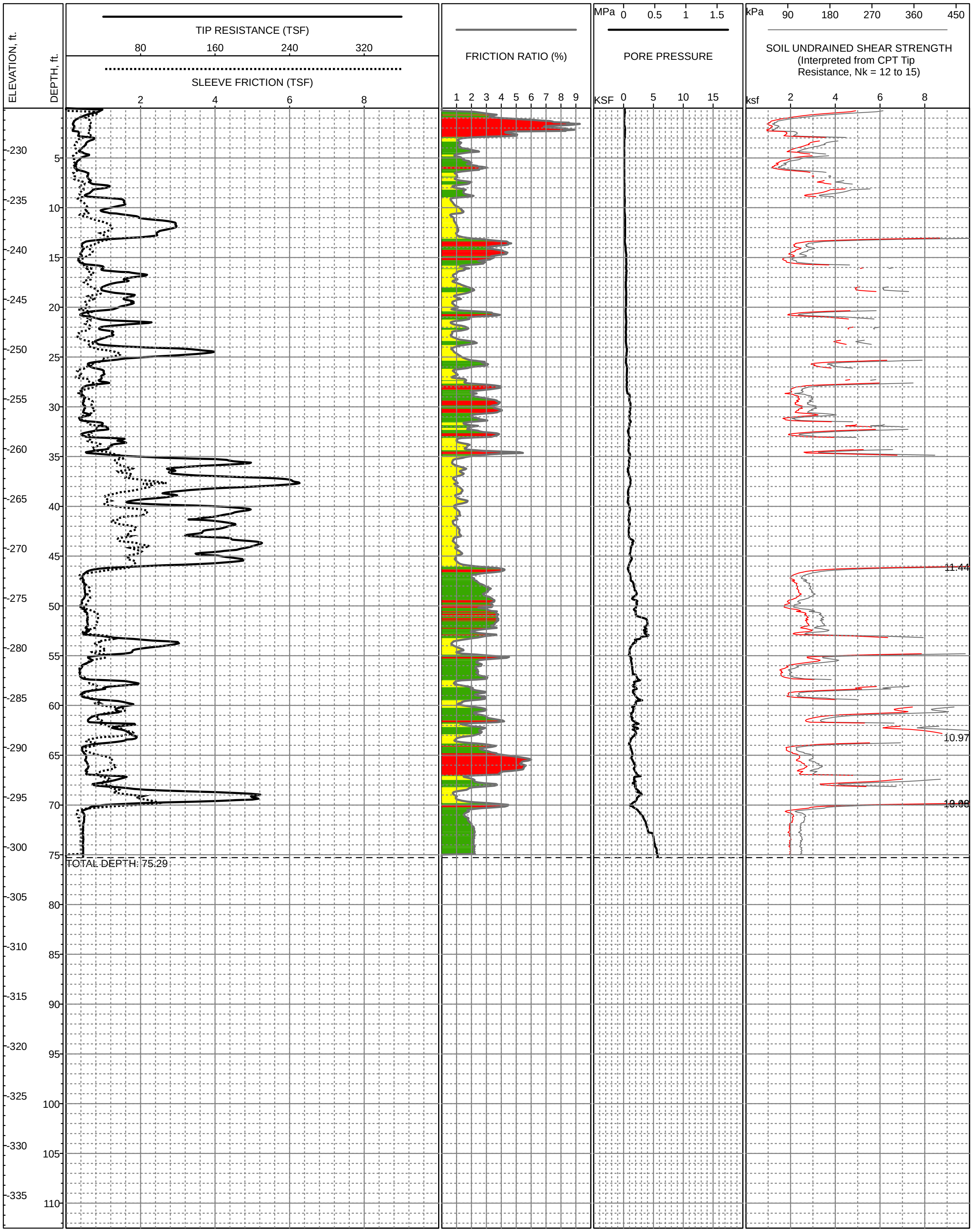
Black Rock Units 1,2 & 3

Calipatria, California

FIGURE A2-13

N:\Projects\3652\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



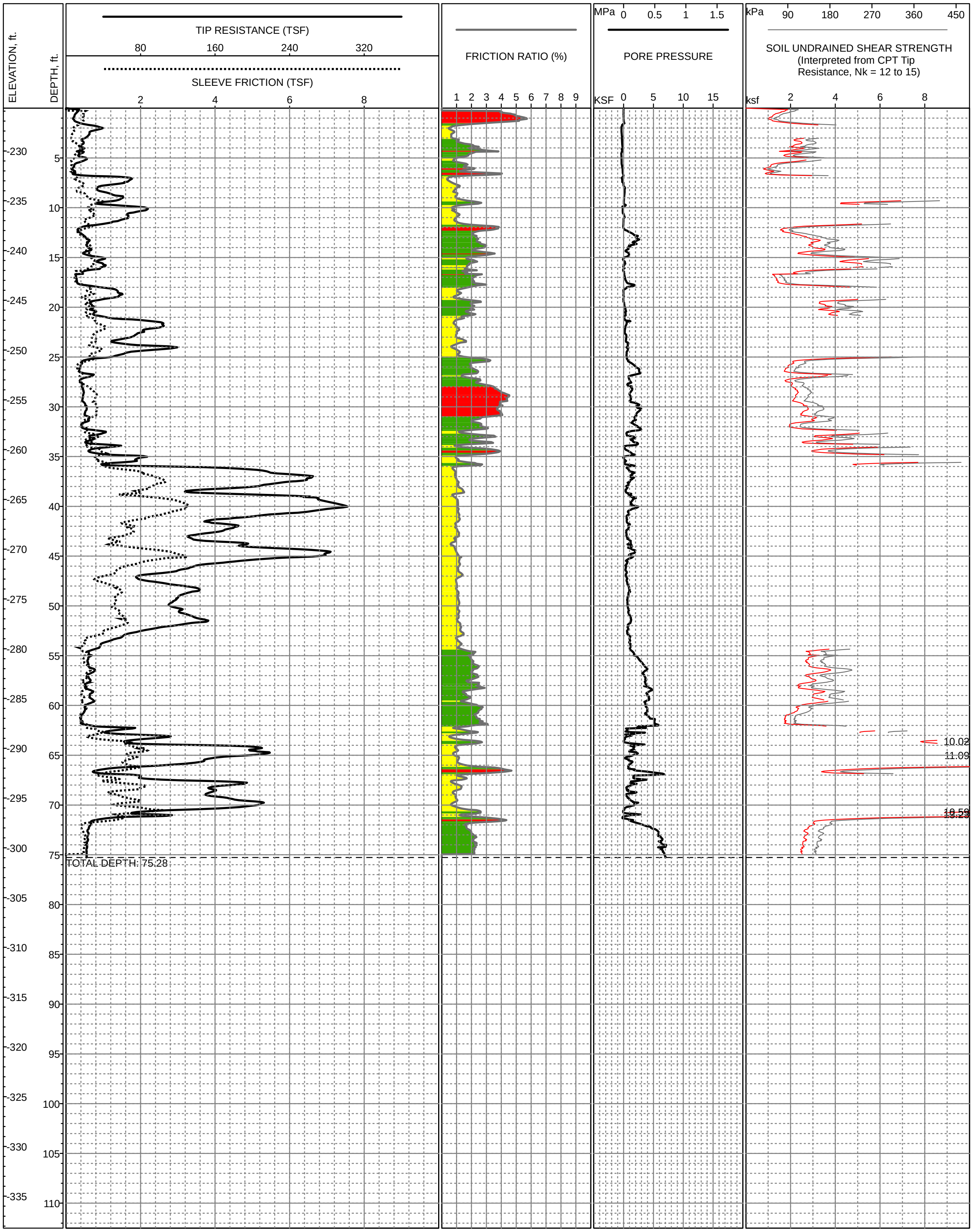
LOCATION: E6,751,918, N2,004,171, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.8ft +/- (NAVD88)
COMPLETION DEPTH: 75.29ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-113
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-14

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean



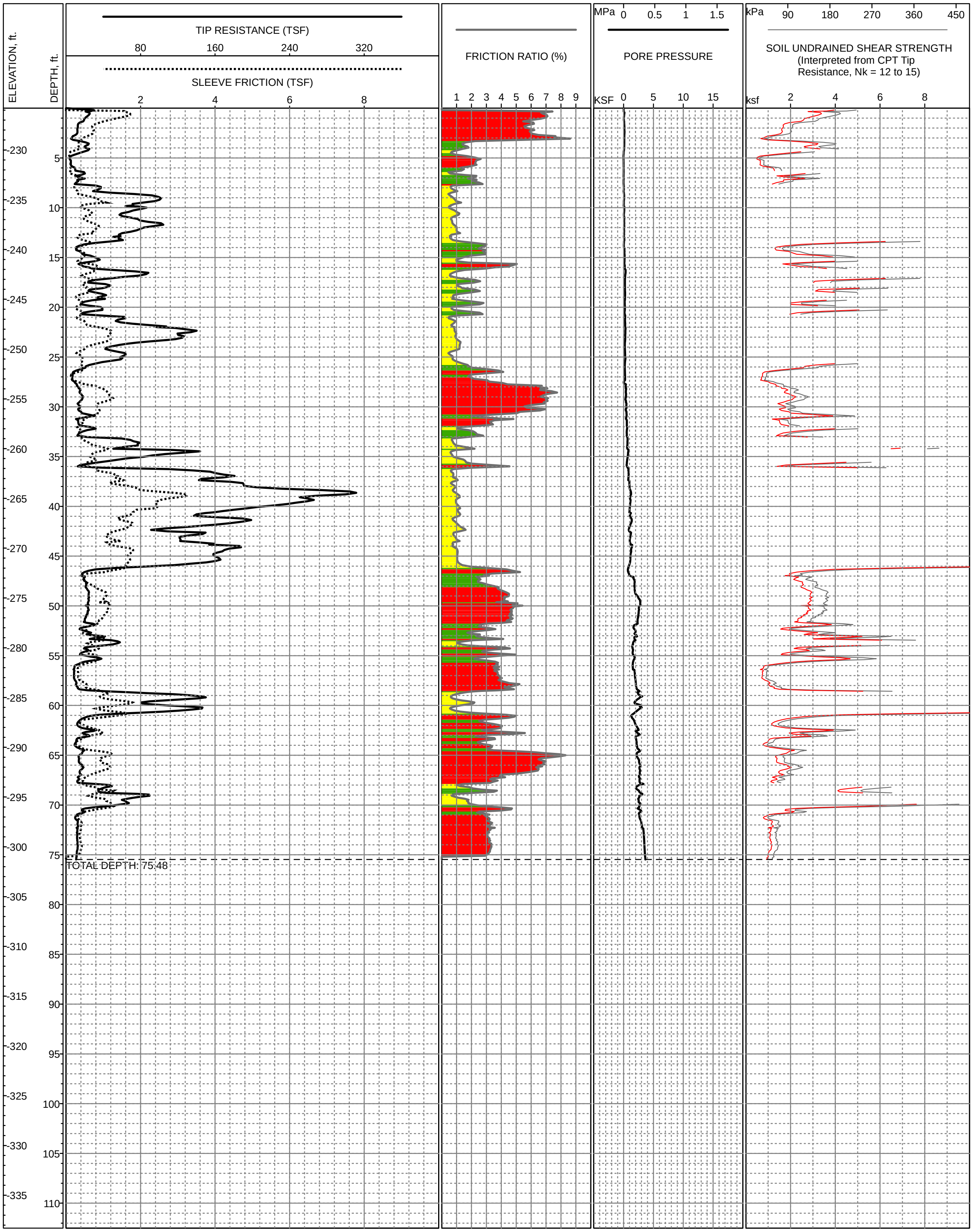
LOCATION: E6,752,088, N2,003,947, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.7ft +/- (NAVD88)
COMPLETION DEPTH: 75.28ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-114
Black Rock Units 1,2 & 3
Calipatria, California

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



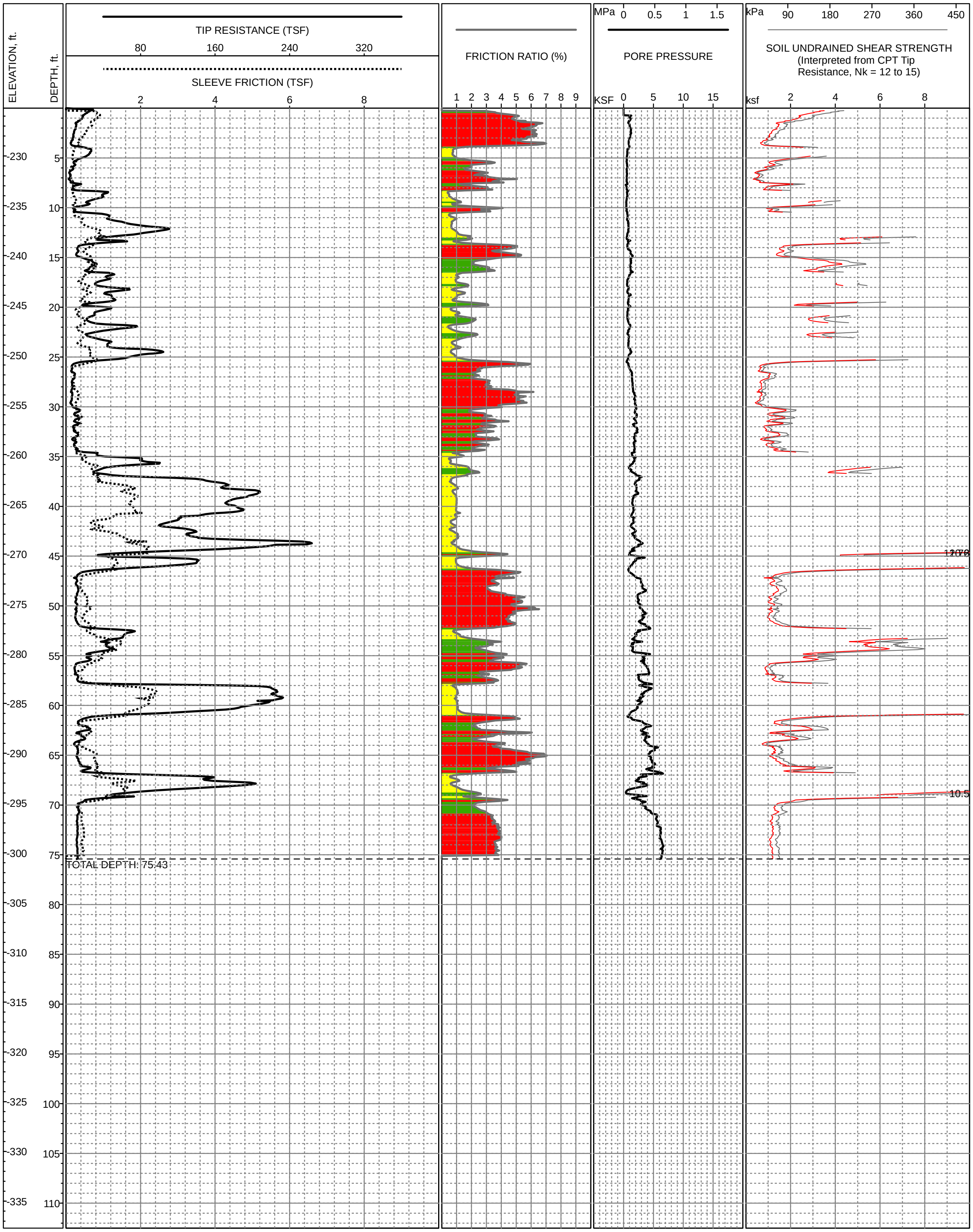
LOCATION: E6,752,273, N2,004,188, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.8ft +/- (NAVD88)
COMPLETION DEPTH: 75.48ft
TESTDATE: 10/9/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-115
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-16

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean



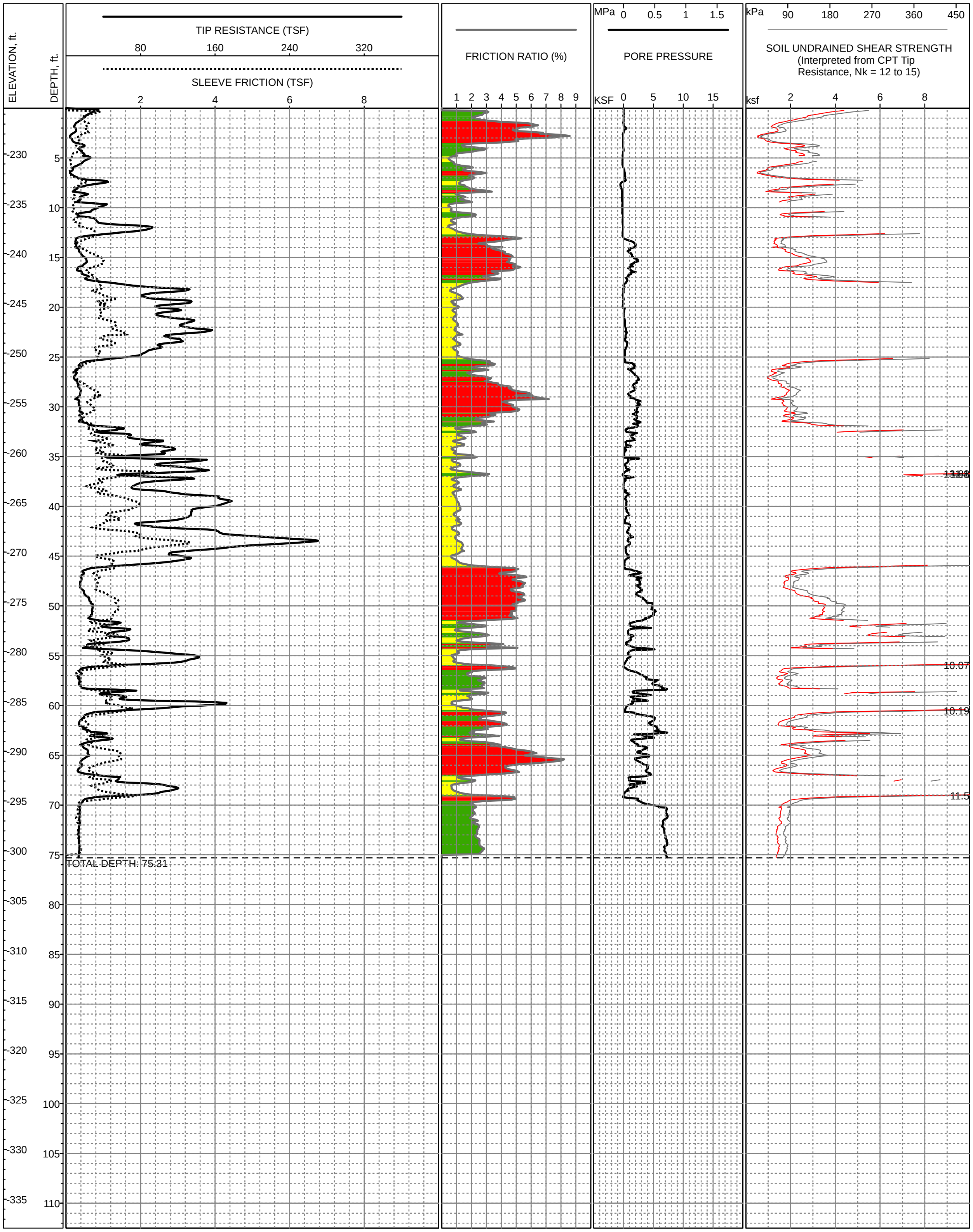
LOCATION: E6,752,408, N2,004,134, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.43ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-116
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-17

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean



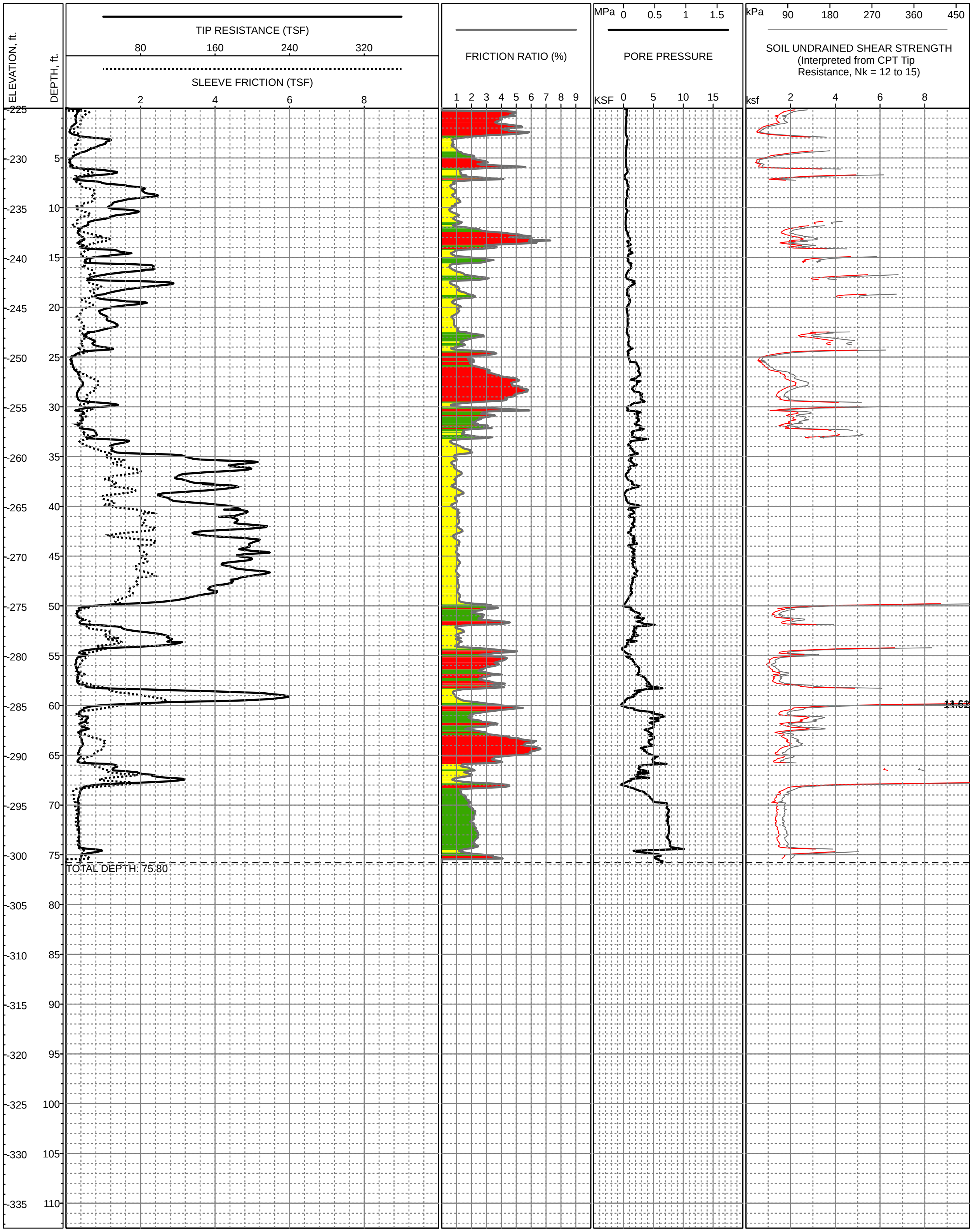
LOCATION: E6,752,530, N2,004,215, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.4ft +/- (NAVD88)
COMPLETION DEPTH: 75.31ft
TESTDATE: 10/9/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-117
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-18

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean



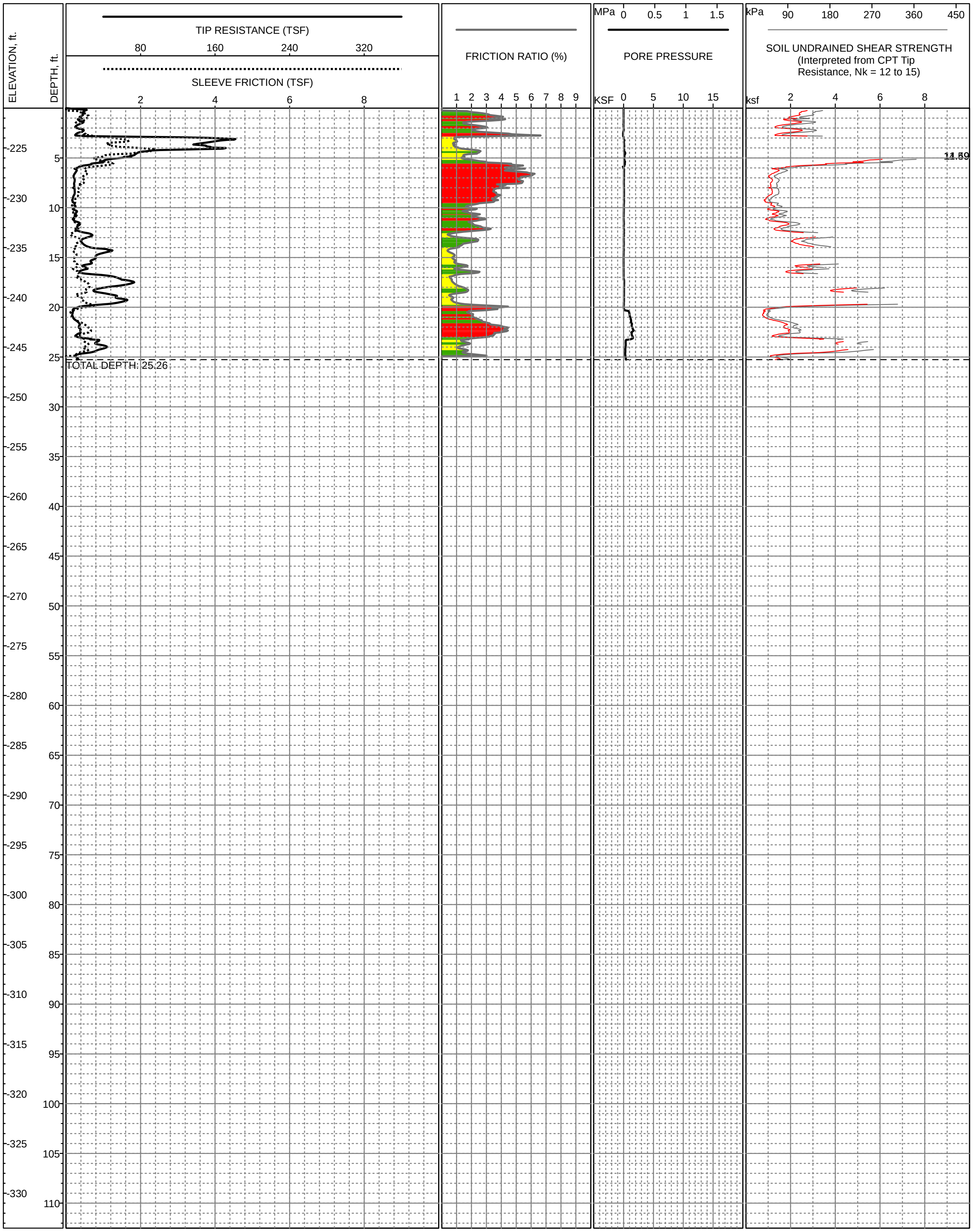
LOCATION: E6,752,706, N2,004,045, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -224.9ft +/- (NAVD88)
COMPLETION DEPTH: 75.80ft
TESTDATE: 10/9/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-118
Black Rock Units 1,2 & 3
Calipatria, California

N:\Projects\3652\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,750,965, N2,003,867, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -221.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.26ft
TESTDATE: 10/8/2008

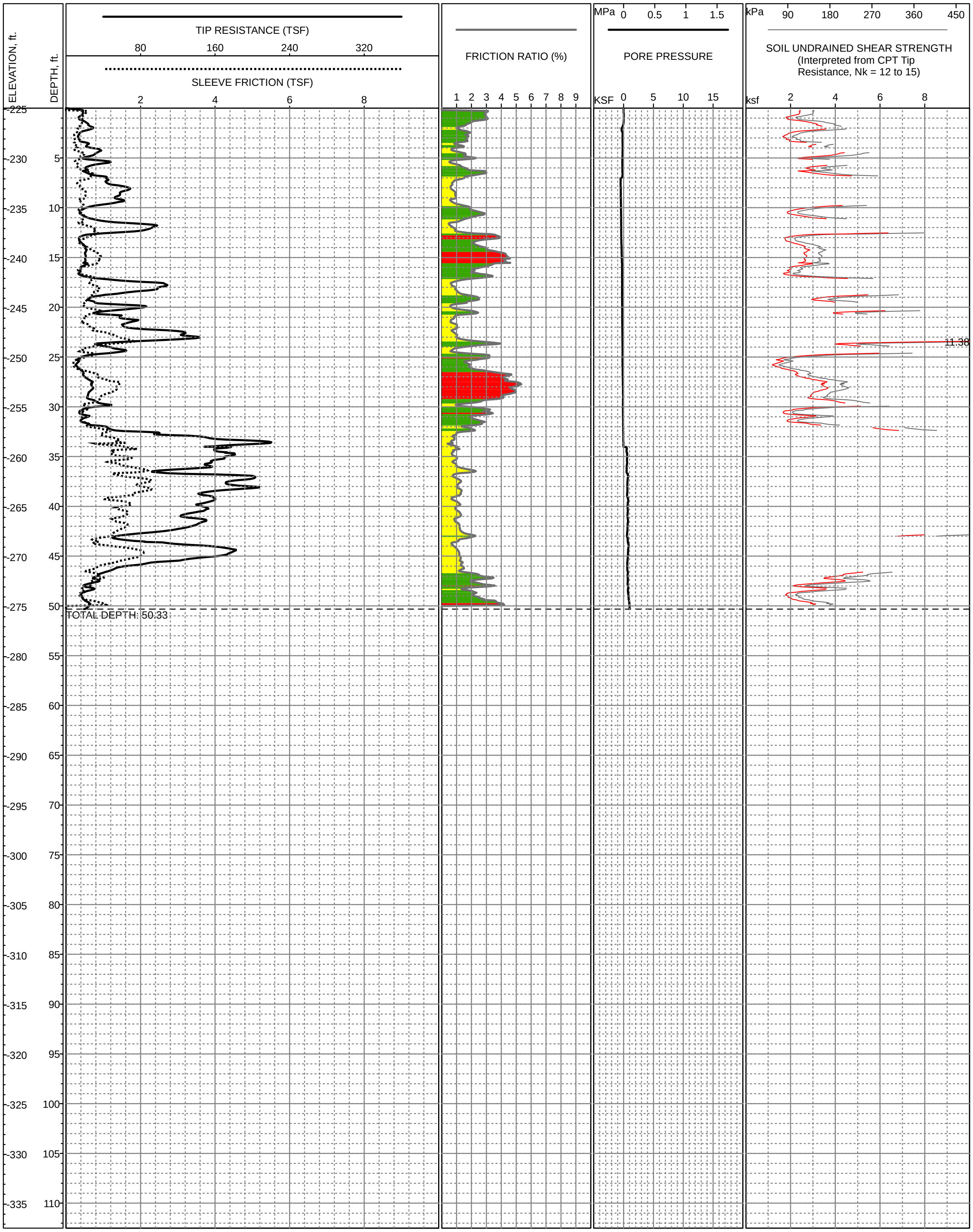
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-119
Black Rock Units 1,2 & 3
Calipatria, California

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

FIGURE A2-20

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,247, N2,003,460, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -224.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.33ft
TESTDATE: 10/8/2008

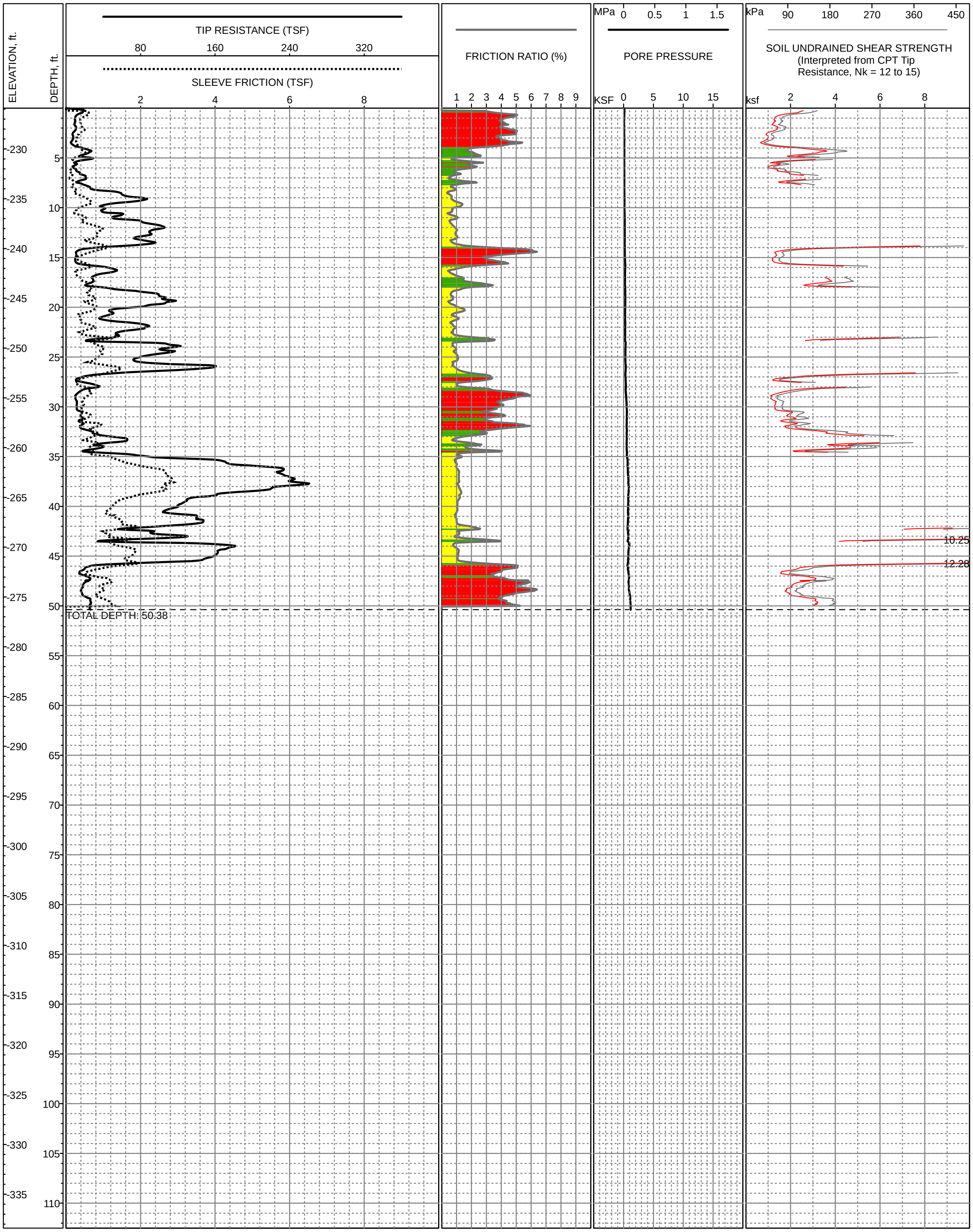
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-120
Black Rock Units 1,2 & 3
Calipatria, California

FIGURE A2-21

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,168, N2,004,311, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.38ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LOG OF C-121

Black Rock Units 1,2 & 3
Calipatria, California

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_Su_2008_10_28\MXD\CPTLogs_Su.mxd,01/16/2009,CDean

APPENDIX B
LABORATORY TEST RESULTS

APPENDIX B - GEOTECHNICAL LABORATORY TESTING

Introduction

Laboratory testing was performed on samples obtained from the field exploration program described in Appendix A to define pertinent classification and engineering properties of site soils. The majority of the testing was performed at Fugro's soil mechanics laboratories in Oakland, San Luis Obispo and Ventura, California. Corrosivity testing was performed by a subcontractor laboratory specializing in corrosion analyses. A summary of the soil testing program is shown in Table B-1.

Table B-1: Summary of Sample Testing Program

Laboratory Test	Quantity	Testing Standard
Water Content	82	ASTM D2216
Density	79	ASTM D2937
Grain Size Distribution	3	ASTM D422
Percent Fines #200 Sieve	19	ASTM D1140
Atterberg Limits	22	ASTM D4318
Compaction	3	Cal. 216A
Consolidation (Incremental Load Control)	6	ASTM D2435
Direct Shear	1	ASTM D3080
R-Value	3	ASTM D2435
Expansion Index	3	ASTM D4828
Corrosivity	5	ASTM D1498 ASTM D4972 ASTM G57 ASTM D4327

The results of the soil laboratory testing are presented at the conclusion of this appendix. A short description of individual test types is presented in the following paragraphs.

Moisture Content and Dry Density

The in situ moisture content for selected bulk and ring samples recovered from the borings was evaluated in accordance with ASTM Test Designation D2116. These results are recorded on the Logs of Borings in Appendix A and in Figure B-1 - Summary of Soil Laboratory Data.

Dry density determinations were performed on ring and push samples of the subsurface soils to aid in evaluating their physical properties. The results of these tests are presented on the Logs of Borings in Appendix and in Figure B-1 - Summary of Soil Laboratory Data.

Gradation Tests

Gradation tests were performed on samples of the subsurface soils in accordance with ASTM 422. These tests were performed to assist in the classification of the soils and to determine their grain size distribution. The results of these tests are presented in Figure B-2 - Grain Size Curves.

Percent Passing #200 Sieve

The percent passing the #200 sieve was determined for selected samples to aid in the classification of these soils. This is a key index property because it separates coarse-grained soils from fine-grained soils. These tests were performed in accordance with ASTM Designation D-1140. The results of these tests are presented on the Logs of Borings in Appendix A and in Figure B-1 - Summary of Soil Laboratory Data.

Atterberg Limits

Atterberg Limits tests were performed on samples of selected samples of fine-grained soils to evaluate the range of water content over which these materials exhibit plasticity. The Atterberg Limits were determined in accordance with ASTM D-4318. These values are also used to classify the soil in accordance with the Unified Soil Classification System and as indications of a soil's compressibility and expansion potential. The results of these tests are presented on the Logs of Borings in Appendix, in Figure B-1 - Summary of Soil Laboratory Data, and in Figure B-3 - Plasticity Chart.

Compaction

Compaction tests were performed on bulk soil samples collected from the upper three feet to assist in evaluating the compaction characteristics of onsite soils. The compaction tests were performed in accordance with ASTM D1557. The results of the tests are presented in Table B-1 - Summary of Soil Laboratory Data, and in Figure B-4 - Compaction Curves.

Consolidation Tests (Incremental Load Control)

Consolidation tests were performed on relatively undisturbed samples of the subsurface clays to assist in evaluating the compressibility characteristics of these materials under anticipated foundation loads. The consolidation tests were performed in accordance with ASTM D-4186. The results of these tests are presented in Figure B-5 - Consolidation Test Data.

Direct Shear Test

Direct shear testing was performed to evaluate the drained shear strength of a sample of soil from the existing road embankment/berm along the west side of the site. The testing was conducted according to the testing procedure described in ASTM D3080. The samples were sheared at three different vertical stresses, approximately 1, 2, and 4 kips per square foot. The results of the test are presented in Figure B-1 - Summary of Soil Laboratory Data and in Figure B-6 - Direct Shear Test Report.

R-Value

R-value tests were performed on bulk soil samples collected from the upper three feet in areas where it is expected that pavement will be constructed. The R-value test measures the response of a compacted sample of soil to a vertically applied pressure under specific conditions. This test is typically used by many public agencies, such as Caltrans, as the basis for pavement design. The results of these tests are presented in Figure B-1 - Summary of Soil Laboratory Data and in Figure B-7 - R-Value Test Results.

Expansion Index

Expansion Index tests were performed on bulk soil samples collected from the upper 3 feet to evaluate the expansion potential of the onsite soils when inundated with water. The Expansion Index tests were performed in general accordance with ASTM D4828. The results of these tests are presented in Figure B-1 - Summary of Soil Laboratory Data and in Figure B-8 - Expansion Index.

Corrosivity Test

Corrosivity tests were performed at the specialty laboratory of Cerco Analytical, Inc. in Concord, California. A suite of tests was performed on selected samples to evaluate soil resistivity, redox potential, pH value and the chloride and sulfate ion concentrations. These findings are useful in the evaluating the corrosion potential that site soils may pose to buried concrete and ferrous metals. The findings of the corrosivity tests are presented in Figure B-9 - Cerco Analytical Corrosivity Analysis.

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	COMPACTION TEST MAX DD pcf	COMPACTION TEST OPT MC %	DIRECT SHEAR C ksf	DIRECT SHEAR PHI deg	COMPRESSIVE STRENGTH TESTS Qu, ksf	COMPRESSIVE STRENGTH TESTS S_u (Cell Prs.) ksf	CORROSIVITY TESTS R	CORROSIVITY TESTS pH	CORROSIVITY TESTS Cl	CORROSIVITY TESTS So_4 (%)	R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
RW-01	6.0	1	Lean CLAY (CL)	123	95	30																	
RW-01	16.0	3	Lean CLAY (CL)	122	95	29																	
RW-01	26.0	5	Silty Fine SAND (SM)	125	103	22																	
RW-01	30.0	6	Lean CLAY (CL)					32	13														
RW-01	36.0	7	Silty Fine SAND (SM)	126	103	22																	
RW-01	40.0	8	Silty Fine SAND (SM)				21																
RW-01	46.0	9	Silty Fine SAND (SM)	127	103	23																	
RW-01	50.0	10	Fat CLAY (CH)					67	41														
RW-01	57.5	11	Silty Fine SAND (SM)	127	103	23																	
RW-02	6.0	1	Lean CLAY (CL)	123	97	27		27	8														
RW-02	16.0	3	Lean CLAY (CL)	121	94	30		28	9														
RW-02	26.0	5	SILT with sand (ML)	122	94	29	76																
RW-02	30.0	6	Fat CLAY (CH)					61	38														
RW-02	36.0	7	Silty Fine SAND (SM)	127	102	24																	
RW-02	40.0	8	Silty Fine SAND (SM)				21																
RW-02	46.0	9	Silty Fine SAND (SM)	125	102	23																	
RW-03	6.0	1	Lean CLAY (CL)	121	93	30																	
RW-03	10.0	2	Silty Fine SAND (SM)				41																
RW-03	16.0	3	Lean CLAY (CL)	119	90	33																	
RW-03	26.0	5	Silty Fine SAND (SM)	126	103	23																	
RW-03	36.0	7	Lean CLAY (CL)	127	104	23		28	7														
RW-03	46.0	9	Lean CLAY (CL)	121	94	29																	
RW-03	51.0	10	Lean CLAY (CL)	121	92	32																	
RW-03	56.0	11	Lean CLAY (CL)	108	73	48																	
RW-04	5.0	1	SILT with sand (ML)				84																
RW-04	11.0	2	Silty Fine SAND (SM)	126	103	23																	
RW-04	21.0	4	Silty Fine SAND (SM)	121	96	26																	
RW-04	31.0	6	Lean CLAY (CL)	115	84	37																	
RW-04	41.0	8	Silty Fine SAND (SM)	122	104	17																	
RW-04	50.5	10	Fat CLAY (CH)	115	78	48		73	50														

SUMMARY OF LABORATORY TEST RESULTS

Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-1a

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS		COMPACTION TEST		DIRECT SHEAR		COMPRESSIVE STRENGTH TESTS		CORROSIVITY TESTS				R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
								LL	PI	MAX DD pcf	OPT MC %	C ksf	PHI deg	Qu, ksf	S_u (Cell Prs.) ksf	R	pH	Cl	So_4 (%)				
RW-04	71.8	14	Lean CLAY (CL)	128	103	24																	
RW-04	75.0	15	Lean CLAY (CL)					31	16														
RW-04	85.0	17	Fat CLAY (CH)					71	45														
RW-05	6.0	1	Lean CLAY (CL)	111	87	28																	
RW-05	16.4	3	Silty Fine SAND (SM)	125	98	27																	
RW-05	20.0	4	Silty Fine SAND (SM)				48																
RW-05	31.5	6	Lean CLAY (CL)	119	88	35																	
RW-05	36.0	7	SILT (ML)	117	92	27	93																
RW-05	46.0	9	Silty Fine SAND (SM)	123	101	22																	
RW-05	50.0	10	Fat CLAY (CH)					64	39														
RW-05	56.0	11	Silty Fine SAND (SM)	117	93	25																	
RW-06	11.0	2	Sandy SILT (ML)	118	94	25	58																
RW-06	16.0	3	Fat CLAY (CH)	123	94	30		71	50														
RW-06	20.0	4	Sandy SILT (ML)				55																
RW-06	65.0	12	Fat CLAY (CH)					75	50														
RW-07	5.0	1	SILT (ML)				89																
RW-07	11.0	2	Silty Fine SAND (SM)	121	98	24																	
RW-07	15.0	3	Lean CLAY (CL)					50	30														
RW-07	21.0	4	Silty Fine SAND (SM)	123	99	24																	
RW-07	31.0	6	Lean CLAY (CL)	118	88	34																	
RW-07	42.0	7	Silty Fine SAND (SM)	133	110	21																	
RW-07	45.0	9	Silty Fine SAND (SM)				14																
RW-07	51.0	10	Fat CLAY (CH)	116	85	38		72	48														
RW-07	55.0	11	Silty Fine SAND (SM)				46																
HSA-01	3.0	1	Lean CLAY (CL)	123	96	28																	
HSA-02	3.0	1	Lean CLAY (CL)	116	91	28																	
HSA-02	6.0	2	SILT (ML)	119	94	27																	
HSA-03	0.0	B	Lean CLAY (CL)				96	38	25												62		
HSA-03	3.0	1	SILT (ML)	117	92	28																	
HSA-03	6.0	2	SILT (ML)	122	98	24																	

SUMMARY OF LABORATORY TEST RESULTS
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-1b

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS		COMPACTION TEST		DIRECT SHEAR		COMPRESSIVE STRENGTH TESTS		CORROSIVITY TESTS				R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
								LL	PI	MAX DD pcf	OPT MC %	C ksf	PHI deg	Qu, ksf	S_u (Cell Prs.) ksf	R	pH	Cl	So_4 (%)				
HSA-04	0.0	B	Lean CLAY (CL)				98	33	17	116.5	10.5												
HSA-04	3.0	1	Lean CLAY (CL)	117	89	31																	
HSA-04	6.0	2	Silty Fine SAND (SM) to Sandy SILT (ML)	126	101	25																	
HSA-05	0.0	B	Lean CLAY with sand (CL)				75																
HSA-05	3.0	1	SILT (ML)	118	94	26																	
HSA-05	6.0	2	Silty Fine SAND (SM)	120	97	23																	
HSA-06	3.0	1	Silty Fine SAND (SM) to Sandy SILT (ML)	115	92	26																	
HSA-06	6.0	2	Lean CLAY (CL)	115	88	31																	
HSA-07	3.0	1	Lean CLAY (CL)	114	88	30																	
HSA-07	6.0	2	Silty Fine SAND (SM)	121	98	23																	
HSA-08	0.0	B	Lean CLAY (CL)				98													4			
HSA-08	3.0	1	Sandy SILT (ML)	107	83	29																	
HSA-08	6.0	2	Silty Fine SAND (SM)	115	92	25																	
HSA-09	3.0	1	Silty Fine SAND (SM)	108	83	30																	
HSA-09	6.0	2	SILT (ML)	115	91	26																	
HSA-10	0.0	B	Fat CLAY (CH)					52	33												74		
HSA-10	3.0	1	Lean CLAY (CL)	114	90	27																	
HSA-10	6.0	2	Lean CLAY (CL)	115	89	29																	
HSA-11	0.0	B	Lean CLAY (CL)					36	17														
HSA-11	3.0	1	Lean CLAY (CL)	116	87	34																	
HSA-11	6.0	2	Silty Fine SAND (SM) to Sandy SILT (ML)	121	98	24																	
HSA-12	0.0	B	Lean CLAY (CL)				100													2			
HSA-12	3.0	1	Lean CLAY (CL)	119	94	27																	
HSA-12	6.0	2	Lean CLAY (CL)	115	89	29																	
HSA-13	0.0	B	Lean CLAY (CL)				87																
HSA-13	3.0	1	Lean CLAY (CL)	110	86	29																	
HSA-13	6.0	2	Lean CLAY (CL)	115	86	34																	
HSA-14	0.0	B	SILT (ML)				91	27	8	119.0	12.0												
HSA-14	3.0	1	Silty Fine SAND (SM) to Sandy SILT (ML)	115	91	27																	
HSA-14	6.0	2	Silty Fine SAND (SM) to Sandy SILT (ML)	129	97	33																	

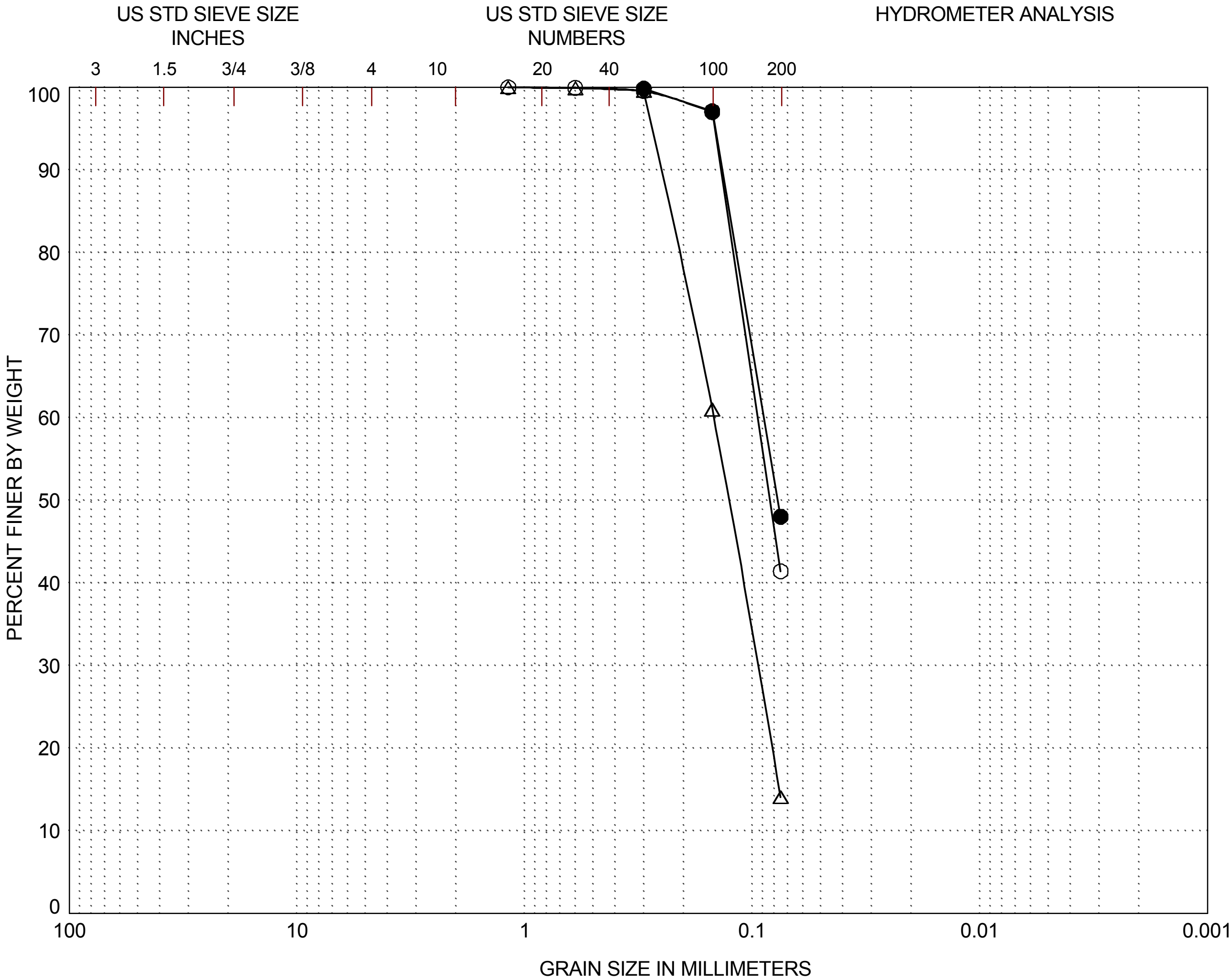
SUMMARY OF LABORATORY TEST RESULTS
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-1c

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS		COMPACTION TEST		DIRECT SHEAR		COMPRESSIVE STRENGTH TESTS		CORROSIVITY TESTS				R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
								LL	PI	MAX DD pcf	OPT MC %	C ksf	PHI deg	Qu, ksf	S_u (Cell Prs.) ksf	R	pH	Cl	So_4 (%)				
HSA-15	3.0	1	Lean CLAY (CL)	118	89	33																	
HSA-15	6.0	2	Silty Fine SAND (SM) to Sandy SILT (ML)	116	89	30																	
HSA-16	3.0	1	Silty SAND (SM)			14																	
HSA-16	10.0	2	Lean CLAY (CL)					31	11														
HSA-16	15.0	3	SILT with sand (ML)				78																
HSA-17	3.0	1	Silty Fine SAND (SM) to Sandy SILT (ML)	118	91	29																	
HSA-17	6.0	2	SILT (ML)	117	93	26																	
HSA-18	3.0	1	Lean CLAY (CL)	117	91	29																	
HSA-18	6.0	2	Lean CLAY (CL)	119	95	26																	
HSA-19	3.0	1	Silty SAND (SM)			13																	
HSA-19	6.0	2	Lean CLAY (CL)			29						0.3	28										
HSA-19	11.4	3	SILT (ML)	118	88	34		34	9														
HSA-20	0.0	B	Lean CLAY (CL)				94													28			
HSA-20	3.0	1	Lean CLAY (CL)	115	90	28																	
HSA-20	6.0	2	Silty Fine SAND (SM) to Sandy SILT (ML)	116	92	26																	
HSA-21	3.0	1	Lean CLAY (CL)	111	85	30																	
HSA-21	6.0	2	Lean CLAY (CL)	118	95	24																	
HSA-22	0.0	B	Lean CLAY (CL)				99	45	30	115.5	15.0										68		
HSA-22	3.0	1	Lean CLAY (CL)	116	88	31																	
HSA-22	6.0	2	Lean CLAY (CL)	118	92	28																	
HSA-23	3.0	1	Lean CLAY (CL)	114	88	29																	
HSA-23	6.0	2	Silty Fine SAND (SM) to Sandy SILT (ML)	119	96	24																	

SUMMARY OF LABORATORY TEST RESULTS
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-1d

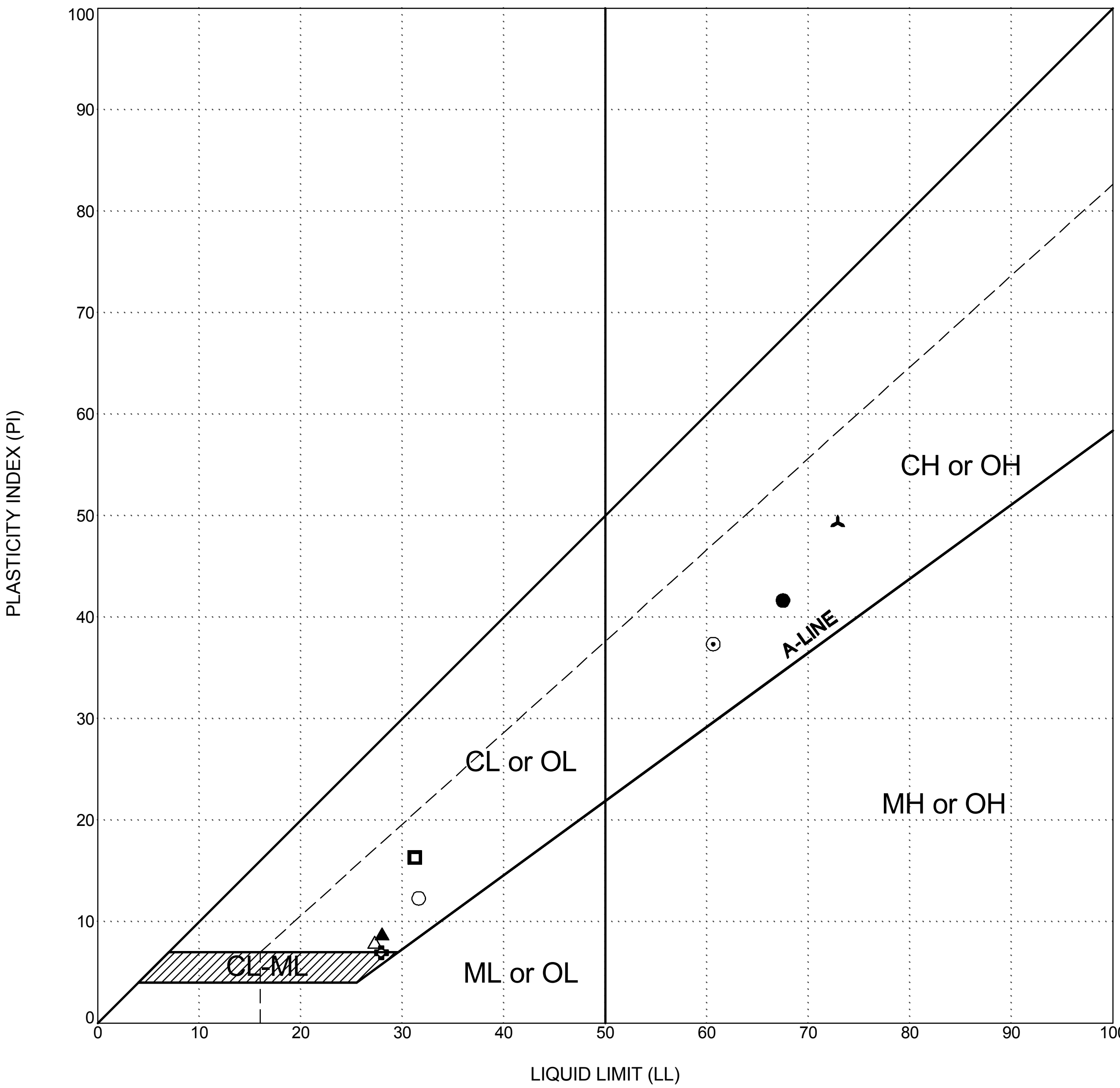


GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND (location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○ RW-03	10.0	Silty Fine SAND (SM)		
● RW-05	20.0	Silty Fine SAND (SM)		
△ RW-07	45.0	Silty Fine SAND (SM)		

GRAIN SIZE CURVES
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-2

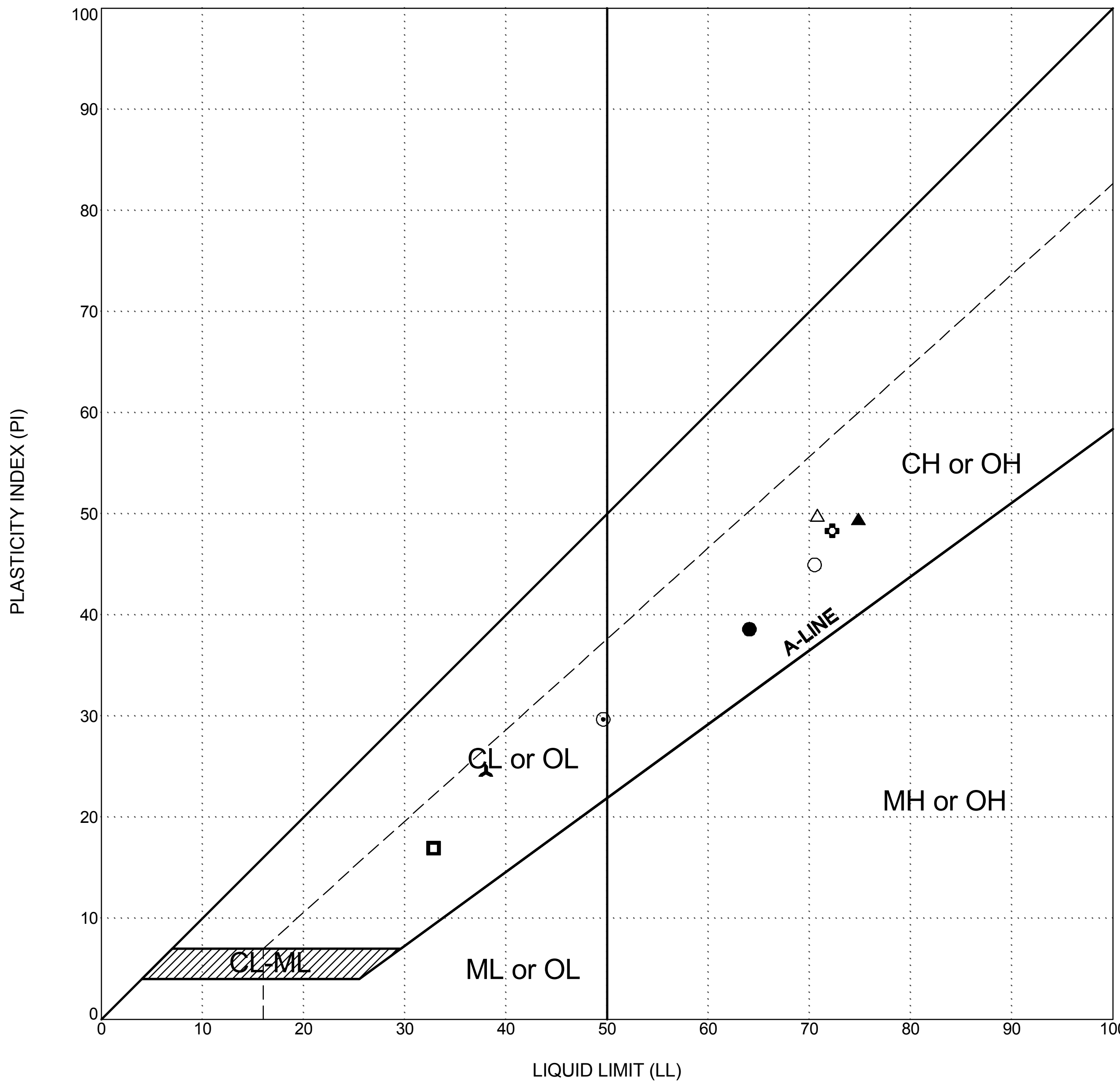


LEGEND	location	depth, ft	CLASSIFICATION	LIQUID LIMIT(LL)	PLASTIC LIMIT(PL)	PLASTICITY INDEX (PI)
○	RW-01	30.0	Lean CLAY (CL)	32	19	13
●	RW-01	50.0	Fat CLAY (CH)	67	26	41
△	RW-02	6.0	Lean CLAY (CL)	27	19	8
▲	RW-02	16.0	Lean CLAY (CL)	28	19	9
⊙	RW-02	30.0	Fat CLAY (CH)	61	23	38
✿	RW-03	36.0	Lean CLAY (CL)	28	21	7
⅄	RW-04	50.5	Fat CLAY (CH)	73	23	50
◘	RW-04	75.0	Lean CLAY (CL)	31	15	16

ATTERBERG LIMITS TEST RESULTS

PLASTICITY CHART
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-3a

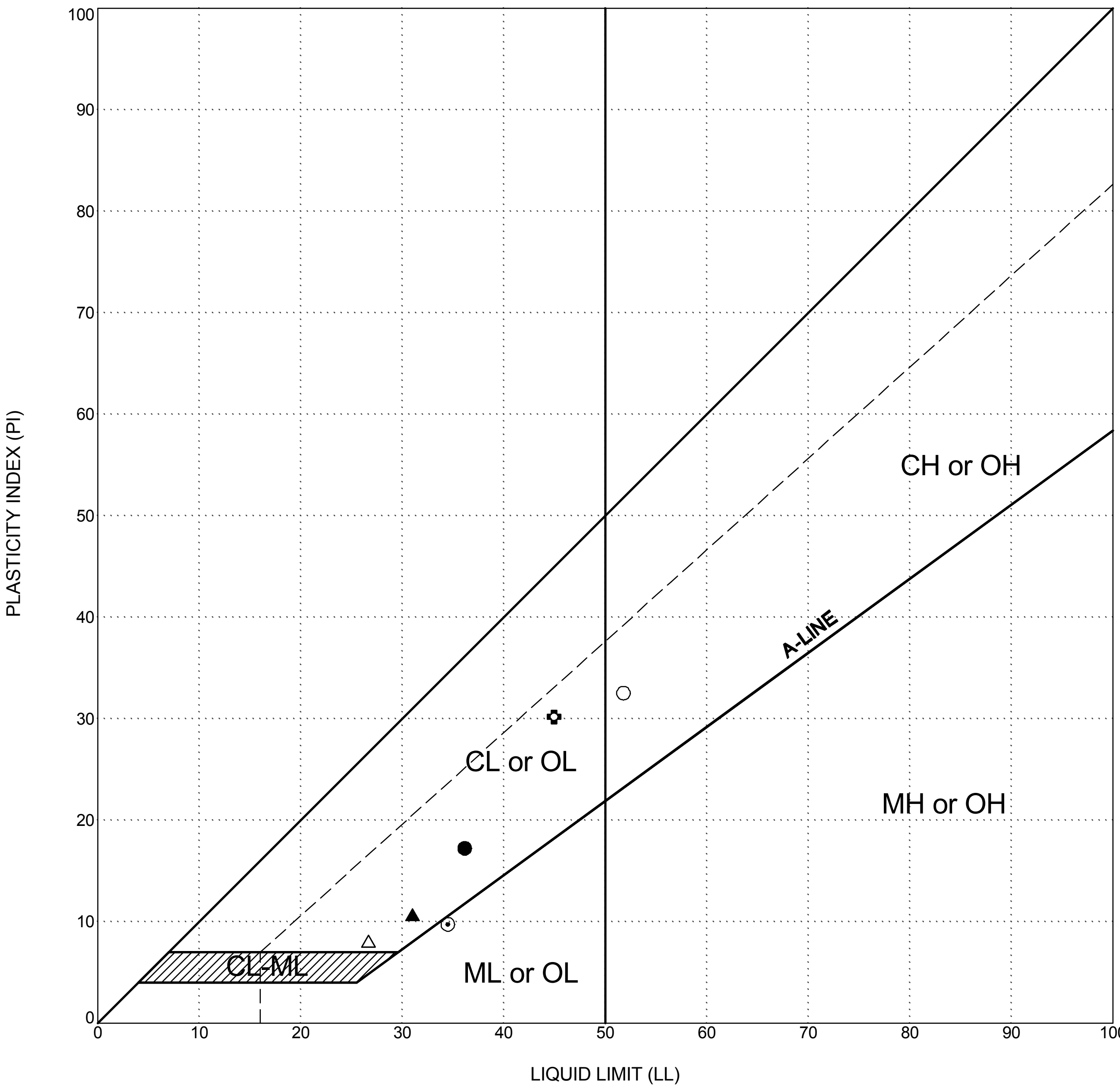


ATTERBERG LIMITS TEST RESULTS

LEGEND location	depth, ft	CLASSIFICATION	LIQUID LIMIT(LL)	PLASTIC LIMIT(PL)	PLASTICITY INDEX (PI)
○ RW-04	85.0	Fat CLAY (CH)	71	26	45
● RW-05	50.0	Fat CLAY (CH)	64	25	39
△ RW-06	16.0	Fat CLAY (CH)	71	21	50
▲ RW-06	65.0	Fat CLAY (CH)	75	25	50
⊙ RW-07	15.0	Lean CLAY (CL)	50	20	30
✿ RW-07	51.0	Fat CLAY (CH)	72	24	48
⅄ HSA-03	0.0	Lean CLAY (CL)	38	13	25
◘ HSA-04	0.0	Lean CLAY (CL)	33	16	17

PLASTICITY CHART
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-3b



LEGEND	location	depth, ft	CLASSIFICATION	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)
○	HSA-10	0.0	Fat CLAY (CH)	52	19	33
●	HSA-11	0.0	Lean CLAY (CL)	36	19	17
△	HSA-14	0.0	SILT (ML)	27	19	8
▲	HSA-16	10.0	Lean CLAY (CL)	31	20	11
⊙	HSA-19	11.4	SILT (ML)	34	25	9
✿	HSA-22	0.0	Lean CLAY (CL)	45	15	30

ATTERBERG LIMITS TEST RESULTS

PLASTICITY CHART
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE B-3c

COMPACTION

FUGRO

Job No. 3652.001	Job Name: Black Rock		Date: 11/20/08
Lab ID: 4124	Client:		Pg. 1 of

SAMPLE DATA

Boring No.:		Sample No.:	HSA-14	Depth (ft):		Reporting Depth (ft):	
Description of Soil / Material			Brown Fat Clay				

TEST DATA

TOTAL SAMPLE Wt. (g):	Wt RETAINED ON 3/4in. (19.0mm) SIEVE (g) :		% RETAINED ON 3/4in. (19.0mm) SIEVE (g) :			BLOWS PER LAYER :	25
12,985	Wt RETAINED ON 3/8in. (9.5mm) SIEVE (g) :		% RETAINED ON 3/8in. (9.5mm) SIEVE (g) :			No. OF LAYERS :	5
	Wt RETAINED ON No. 4 (4.75mm) SIEVE (g) :		% RETAINED ON No 4 (4.75mm) SIEVE (g) :			VOLUME OF MOLD :	0.03332
ASTM METHOD USED (SEE **NOTE 1**) :	A	INITIAL M/CONTENT :		PREPARATION METHOD USED		RAMMER :	Hand

Test No.	1	2	3	4	5
Wt. Of Wet Soil (lb)	8.490	8.810	8.810	8.840	8.830
Wt. Of Mold (lb)	4.380	4.380	4.380	4.380	4.380
Wet Unit Weight (lb/ft³)	123.3	133.0	133.0	133.9	133.6
Tare No.	LPT-52	YO-22	YO-22	YO-11	LPT-46
Wt. of Wet Soil + Tare (g)	605.50	606.30	606.30	603.70	601.40
Wt. of Dry Soil + Tare(g)	565.20	545.40	545.40	533.00	533.10
Wt. of Water (g)	40.30	60.90	60.90	70.70	68.30
Wt. of Tare (g)	38.60	38.30	38.30	38.30	38.40
Wt. of Dry Soil (g)	526.60	507.10	507.10	494.70	494.70
Moisture Content (%)	7.7	12.0	12.0	14.3	13.8
Dry Unit Weight (lb/ft³)	114.6	118.7	118.7	117.1	117.4

MAX. DRY DENSITY (lb/ft³)	**119.0**	**OPT. MOISTURE CONTENT (%)**	**12**
CORRECTED MDD	**119.0**	**CORRECTED MOISTURE CONTENT**	**12**

<u>NOTE 1</u> <u>ASTM METHODS AS FOLLOWS</u> :-

METHOD A - < 20 % RET. No.4 (4.75mm) SIEVE
4in MOLD.

METHOD B - > 20 % RET. No.4 (4.75mm) &
< 20 % RET. 3/8in (9.5mm) SIEVE
4in MOLD.

METHOD C - > 20 % RET. 3/8in (9.5mm) &
< 30 % RET. 3/4in (19mm) SIEVE
6in MOLD.

IF 30% OR MORE IS RET. ON THE 3/4in (19mm) SIEVE THEN <u>NONE</u> OF THE METHODS DETAILED ABOVE MAY BE USED. (INFORM THE LABORATORY SUPERVISOR)

VOLUME OF MOLD :-
6in mold - 0.0750
4in mold - 0.0333

REMARKS : Assumed density of 2.700 kg/m³ used for Air voids calculations

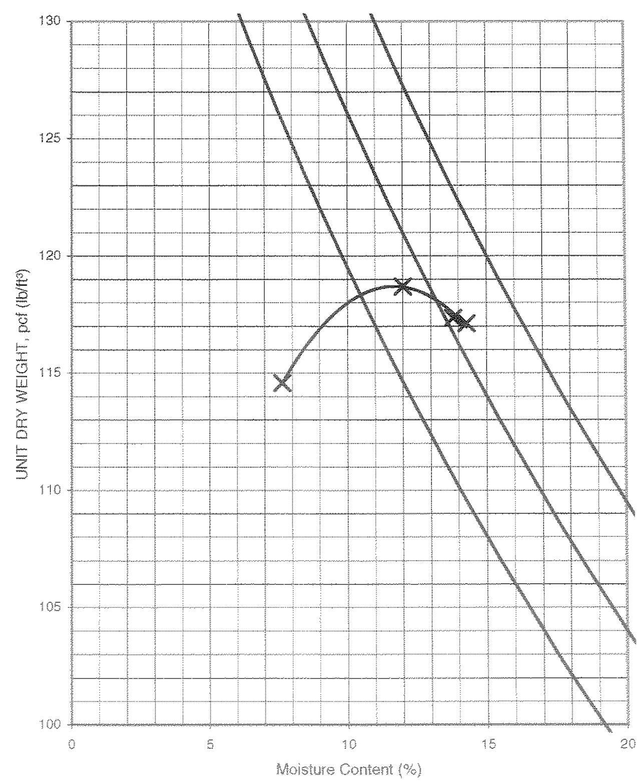


FIGURE B-4a

Tested by :		Date :		Calculated by :		Checked by :	

HSA-14

COMPACTION

Job No.	3652.001	Job Name:	Black Rock	Date:	11/20/08
Lab ID:	4124	Client:			Pg. 1 of

SAMPLE DATA

Boring No.:		Sample No.:	HSA-22	Depth (ft):		Reporting Depth (ft):	
Description of Soil / Material			Brown Fat Clay				

TEST DATA

TOTAL SAMPLE Wt. (g):	Wt RETAINED ON 3/4in. (19.0mm) SIEVE (g) :		% RETAINED ON 3/4in. (19.0mm) SIEVE (g) :		BLOWS PER LAYER :	25
8,798	Wt RETAINED ON 3/8in. (9.5mm) SIEVE (g) :		% RETAINED ON 3/8in. (9.5mm) SIEVE (g) :		No. OF LAYERS :	5
	Wt RETAINED ON No. 4 (4.75mm) SIEVE (g) :		% RETAINED ON No 4 (4.75mm) SIEVE (g) :		VOLUME OF MOLD :	0.03332
ASTM METHOD USED (SEE **NOTE 1**) :	A	INITIAL M/CONTENT :	PREPARATION METHOD USED		RAMMER :	Hand

Test No.	1	2	3	4	5
Wt. Of Wet Soil (lb)	8.700	8.700	8.790	8.700	8.700
Wt. Of Mold (lb)	4.380	4.380	4.380	4.380	4.380
Wet Unit Weight (lb/ft³)	129.7	129.7	132.4	129.7	129.7
Tare No.	LPT-68	LPT-68	LPT-31	YO-16	YO-16
Wt. of Wet Soil + Tare (g)	620.80	620.80	609.50	603.20	603.20
Wt. of Dry Soil + Tare(g)	552.00	552.00	533.50	517.90	517.90
Wt. of Water (g)	68.80	68.80	76.00	85.30	85.30
Wt. of Tare (g)	38.40	38.40	38.20	38.40	38.40
Wt. of Dry Soil (g)	513.60	513.60	495.30	479.50	479.50
Moisture Content (%)	13.4	13.4	15.3	17.8	17.8
Dry Unit Weight (lb/ft³)	114.3	114.3	114.7	110.1	110.1

MAX. DRY DENSITY (lb/ft³)	**115.5**	**OPT. MOISTURE CONTENT (%)**	**15**
CORRECTED MDD	**115.5**	**CORRECTED MOISTURE CONTENT**	**15**

NOTE 1 ASTM METHODS AS FOLLOWS :-

METHOD A - < 20 % RET. No.4 (4.75mm) SIEVE 4in MOLD.

METHOD B - > 20 % RET. No.4 (4.75mm) & < 20 % RET. 3/8in (9.5mm) SIEVE 4in MOLD.

METHOD C - > 20 % RET. 3/8in (9.5mm) & < 30 % RET. 3/4in (19mm) SIEVE 6in MOLD.

IF 30% OR MORE IS RET. ON THE 3/4in (19mm) SIEVE THEN **NONE** OF THE METHODS DETAILED ABOVE MAY BE USED. (INFORM THE LABORATORY SUPERVISOR)

VOLUME OF MOLD :-
6in mold - 0.0750
4in mold - 0.0333

REMARKS : Assumed density of 2.700 kg/m³ used for Air voids calculations

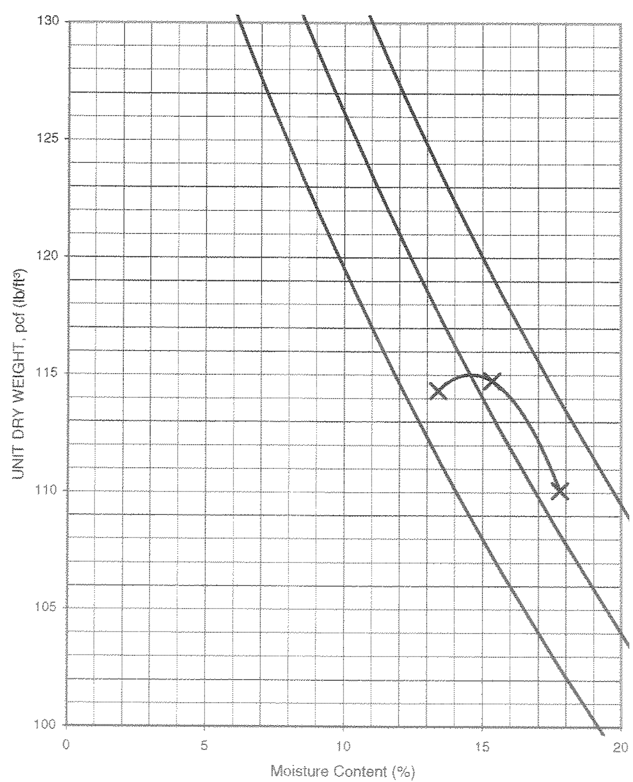


FIGURE B-4b

Tested by :		Date :		Calculated by :		Checked by :	

HSA-22

COMPACTION

Job No.	3652.001	Job Name:	Black Rock	Date:	11/24/08
Lab ID:	4124	Client:			Pg. 1 of

SAMPLE DATA

Boring No.:		Sample No.:	HSA-4	Depth (ft):		Reporting Depth (ft):	
Description of Soil / Material	Brown Fat Clay						

TEST DATA

TOTAL SAMPLE Wt. (g): 8,253	Wt RETAINED ON 3/4in. (19.0mm) SIEVE (g) :		% RETAINED ON 3/4in. (19.0mm) SIEVE (g) :		BLOWS PER LAYER :	25
	Wt RETAINED ON 3/8in. (9.5mm) SIEVE (g) :		% RETAINED ON 3/8in. (9.5mm) SIEVE (g) :		No. OF LAYERS :	5
	Wt RETAINED ON No. 4 (4.75mm) SIEVE (g) :		% RETAINED ON No 4 (4.75mm) SIEVE (g) :		VOLUME OF MOLD :	0.03320
ASTM METHOD USED (SEE **NOTE 1**) :	A	INITIAL M/CONTENT :	PREPARATION METHOD USED		RAMMER :	Hand

Test No.	1	2	3	4	5
Wt. Of Wet Soil (lb)	8.570	8.570	8.670	8.710	8.710
Wt. Of Mold (lb)	4.380	4.380	4.380	4.380	4.380
Wet Unit Weight (lb/ft³)	126.2	126.2	129.2	130.4	130.4
Tare No.	LPT-52	LPT-52	LPT-31	YO-16	YO-16
Wt. of Wet Soil + Tare (g)	611.70	611.70	607.60	608.30	608.30
Wt. of Dry Soil + Tare(g)	565.60	565.60	551.20	542.90	542.90
Wt. of Water (g)	46.10	46.10	56.40	65.40	65.40
Wt. of Tare (g)	38.60	38.60	38.20	38.40	38.40
Wt. of Dry Soil (g)	527.00	527.00	513.00	504.50	504.50
Moisture Content (%)	8.7	8.7	11.0	13.0	13.0
Dry Unit Weight (lb/ft³)	116.1	116.1	116.4	115.5	115.5

MAX. DRY DENSITY (lb/ft³)	**116.5**	**OPT. MOISTURE CONTENT (%)**	**10.5**
CORRECTED MDD	**116.5**	**CORRECTED MOISTURE CONTENT**	**10.5**

NOTE 1 ASTM METHODS AS FOLLOWS :-

METHOD A - < 20 % RET. No.4 (4.75mm) SIEVE 4in MOLD.

METHOD B - > 20 % RET. No.4 (4.75mm) & < 20 % RET. 3/8in (9.5mm) SIEVE 4in MOLD.

METHOD C - > 20 % RET. 3/8in (9.5mm) & < 30 % RET. 3/4in (19mm) SIEVE 6in MOLD.

IF 30% OR MORE IS RET. ON THE 3/4in (19mm) SIEVE THEN **NONE** OF THE METHODS DETAILED ABOVE MAY BE USED. (INFORM THE LABORATORY SUPERVISOR)

VOLUME OF MOLD :-
6in mold - 0.0750
4in mold - 0.0333

REMARKS : Assumed density of 2.700 kg/m³ used for Air voids calculations

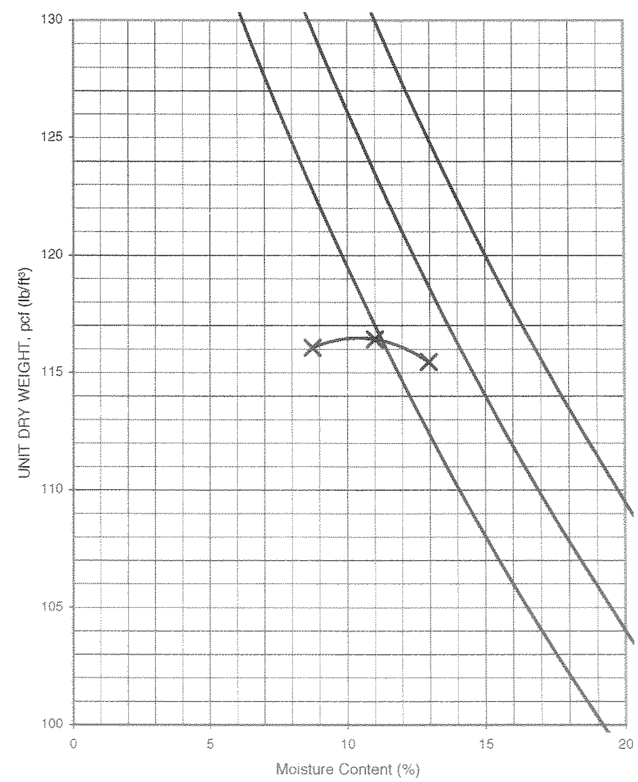
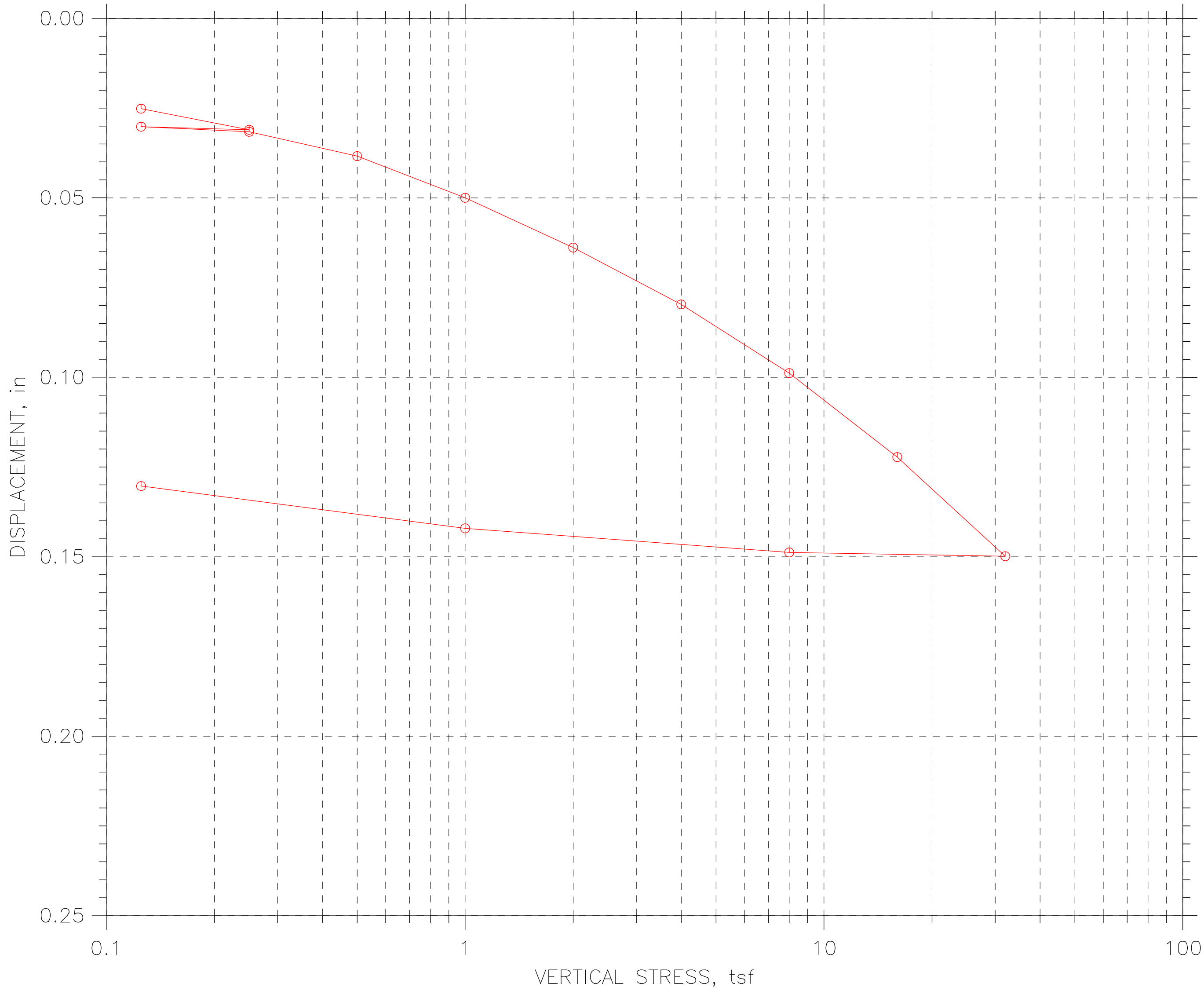


FIGURE B-4c

Tested by :	Date :	Calculated by :	Checked by :
HSA-4			

CONSOLIDATION TEST DATA

SUMMARY REPORT



					Before Test	After Test
Overburden Pressure: 0 tsf				Water Content, %	30.62	24.96
Preconsolidation Pressure: 0 tsf				Dry Unit Weight, pcf	93.88	108.
Compression Index: 3.81959e-313				Saturation, %	91.06	100.00
Diameter: 2.4 in		Height: 1 in		Void Ratio	1.02	0.76
LL: ---	PL: ---	PI: ---	GS: 3.04			

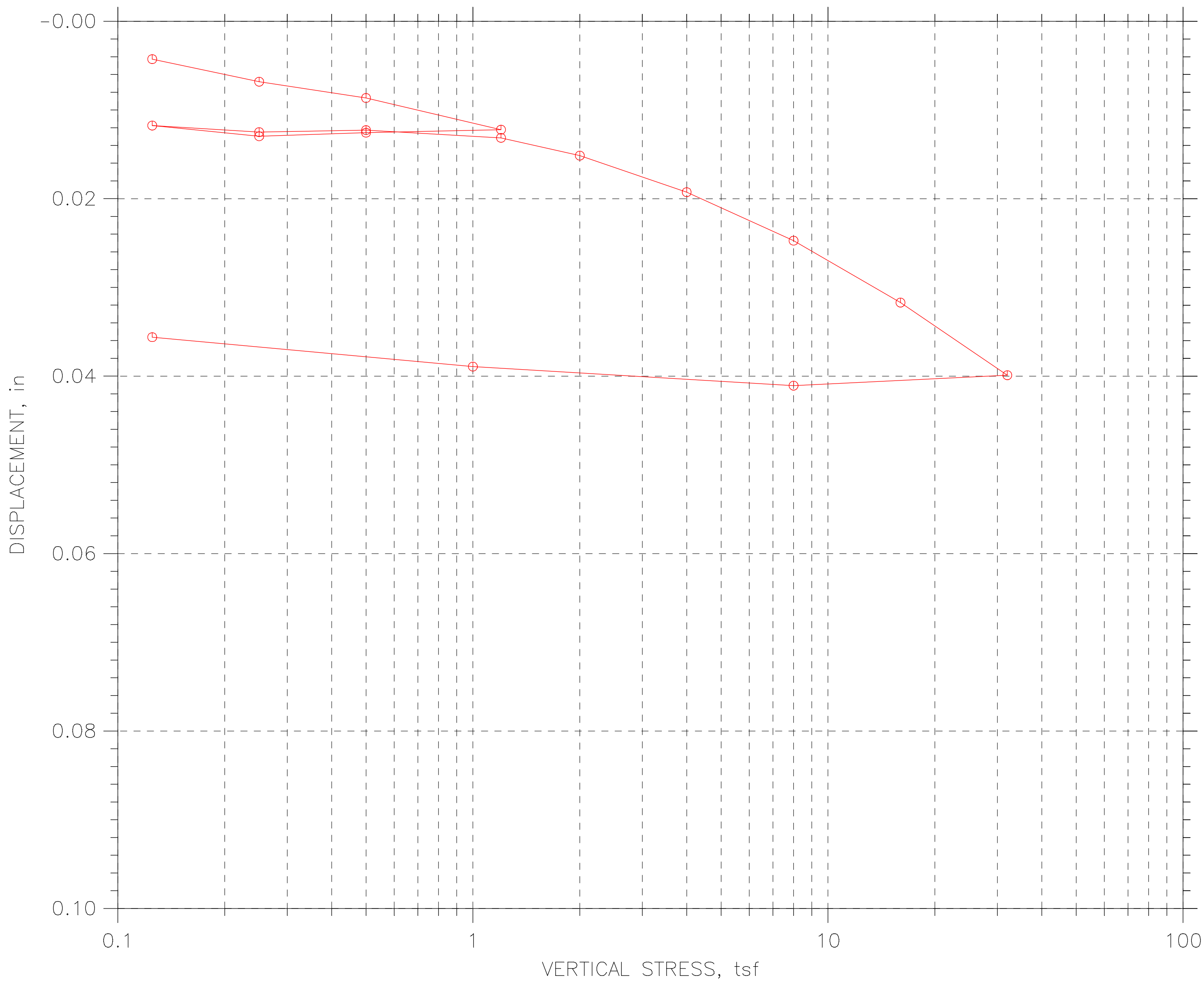
	Project: Black Rock Units 1,2,3	Location: Calipatria, CA	Project No.: 3652.001
	Boring No.: RW-01	Tested By: NJD	Checked By: NJD
	Sample No.: #1	Test Date: 11/7/08	Depth: 6.0ft
	Test No.: D	Sample Type: Ring	Elevation: N/A
	Description: Clayey SILT (ML): brown, wet		
	Remarks: 3652.001_RW-01_#1_6.0ft_Node65_Black Rock Units 1,2,3		

FIGURE B-5a

Thu, 04-DEC-2008 09:35:39

CONSOLIDATION TEST DATA

SUMMARY REPORT



					Before Test	After Test
Overburden Pressure: 0 tsf				Water Content, %	24.67	22.37
Preconsolidation Pressure: 0 tsf				Dry Unit Weight, pcf	101.6	105.4
Compression Index: 3.81959e-313				Saturation, %	101.17	100.79
Diameter: 2.42 in		Height: 1 in		Void Ratio	0.66	0.60
LL: ---	PL: ---	PI: ---	GS: 2.70			

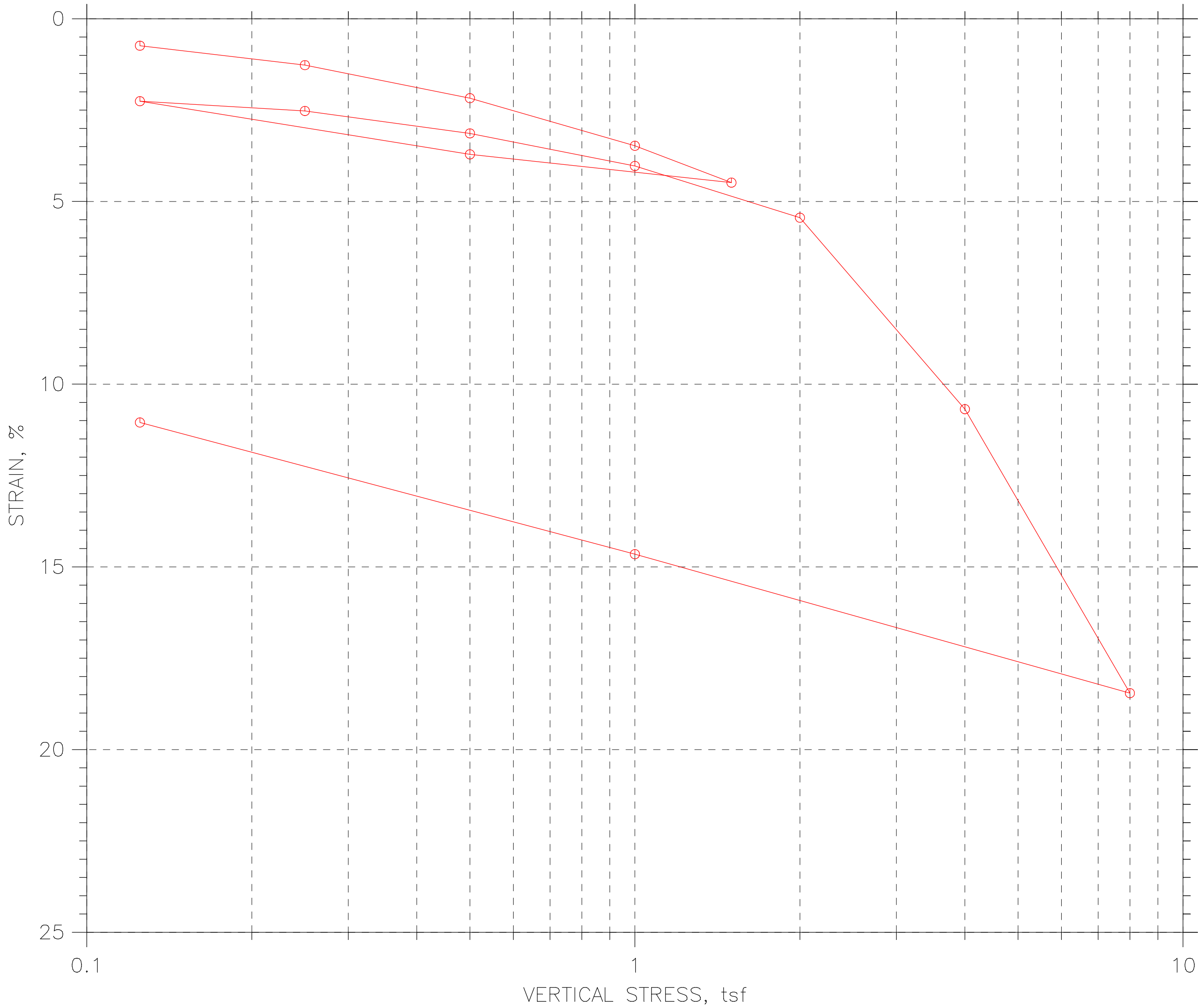
Project: Black Rock Units 1,2,3	Location: Calipatria, CA	Project No.: 3652.001
Boring No.: RW-03	Tested By: NJD	Checked By: NJD
Sample No.: #7	Test Date: 11/10/08	Depth: 36.0ft
Test No.: E	Sample Type: Ring	Elevation: N/A
Description: Silty SAND (SM): brown, moist, fine sand		
Remarks: 3652.001_RW-03_#7_36.0ft_Node65_Black Rock Units 1,2,3.dat		

FIGURE B-5b

Thu, 04-DEC-2008 09:37:06

CONSOLIDATION TEST DATA

SUMMARY REPORT



		Before Test	After Test
Overburden Pressure: 0 tsf	Water Content, %	48.36	40.47
Preconsolidation Pressure: 0 tsf	Dry Unit Weight, pcf	77.66	87.31
Compression Index: 3.81959e-313	Saturation, %	111.56	117.41
Diameter: 2.4 in / Height: 1 in	Void Ratio	1.17	0.93
LL: --- / PL: --- / PI: --- / GS: 2.70			

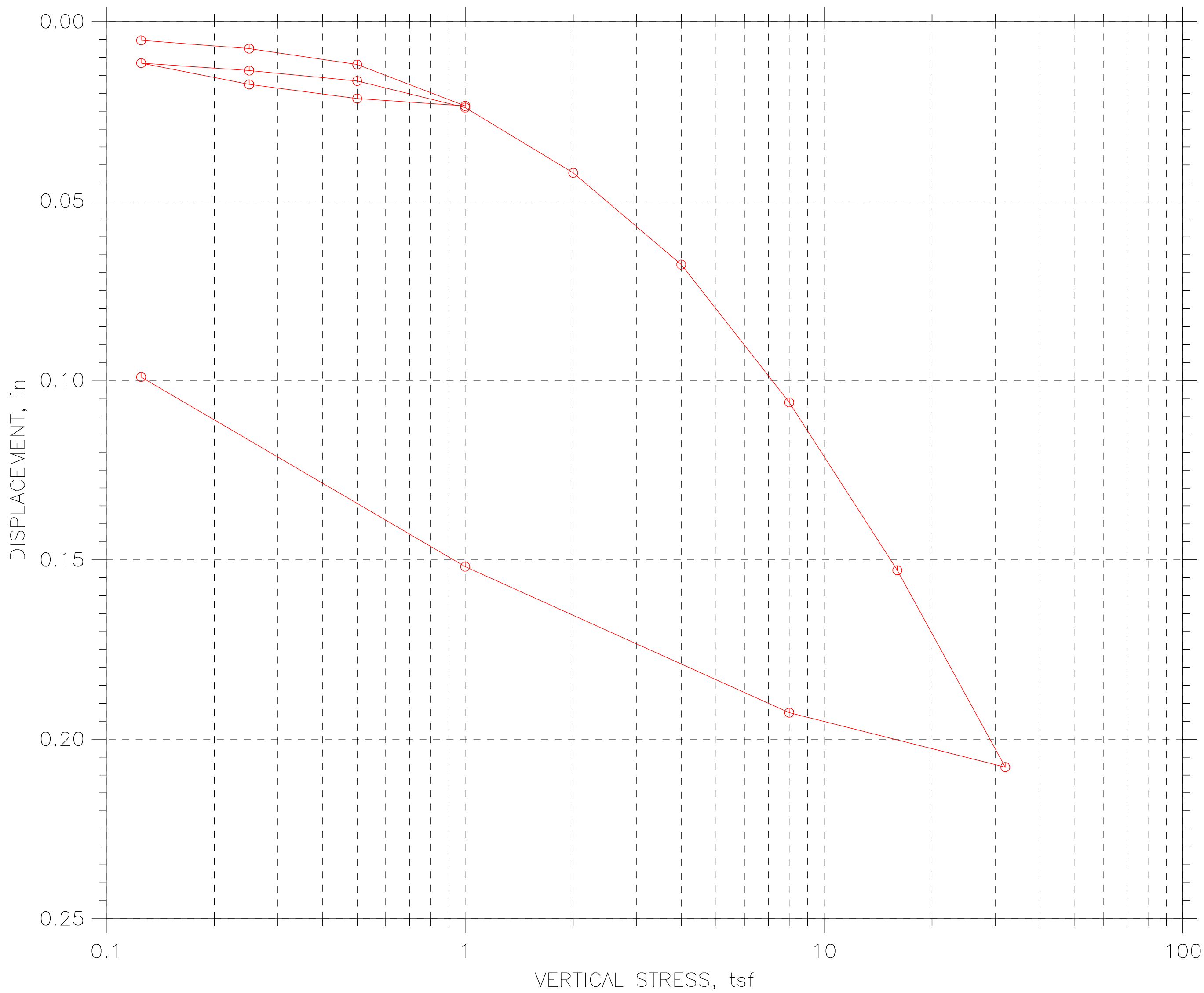
	Project: Black Rock Units 1,2,3	Location: Calipatria, CA	Project No.: 3652.001
	Boring No.: RW-4	Tested By: NJD	Checked By: NJD
	Sample No.: #10	Test Date: 11/3/08	Depth: 50.5ft
	Test No.: A	Sample Type: Shelby	Elevation: N/A
	Description: Fat CLAY (CH): brown, wet		
	Remarks: 3652.001_RW-04_#10_50.5ft_Node66_Black Rock Units 1,2,3.dat		

FIGURE B-5c

Thu, 04-DEC-2008 09:27:01

CONSOLIDATION TEST DATA

SUMMARY REPORT



					Before Test	After Test
Overburden Pressure: 0 tsf				Water Content, %	35.02	30.32
Preconsolidation Pressure: 0 tsf				Dry Unit Weight, pcf	87.89	97.56
Compression Index: 3.81959e-313				Saturation, %	93.75	100.00
Diameter: 2.42 in		Height: 1 in		Void Ratio	1.11	0.90
LL: ---	PL: ---	PI: ---	GS: 2.97			

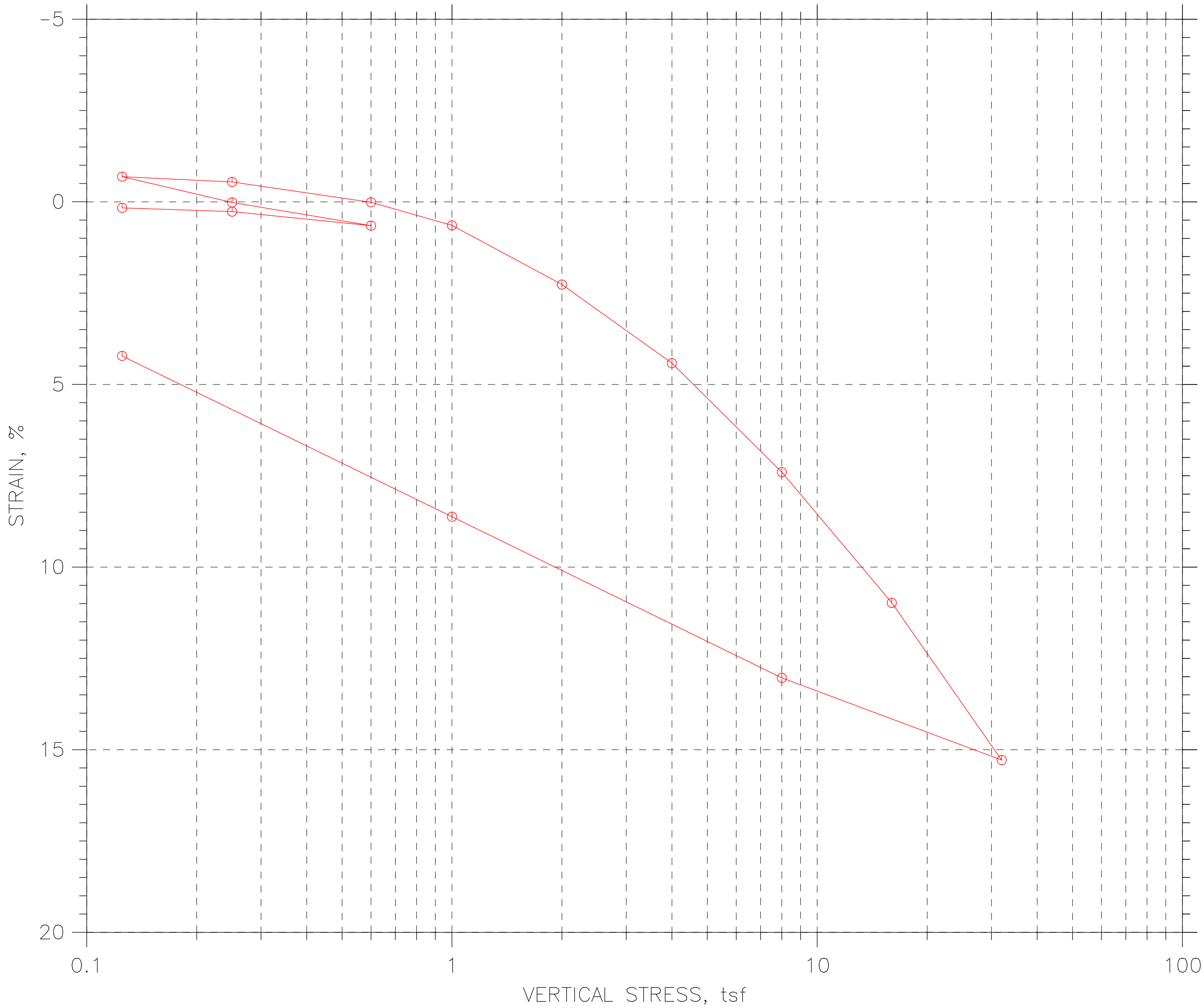
	Project: Black Rock Units 1,2,3	Location: Calipatria, CA	Project No.: 3652.001
	Boring No.: RW-05	Tested By: NJD	Checked By: NJD
	Sample No.: #6	Test Date: 11/11/08	Depth: 31.5ft
	Test No.: N/A	Sample Type: Shelby	Elevation: N/A
	Description: Fat CLAY (CH): brown, wet		
	Remarks: 3652.001_RW-05_#6_31.5ft_Node65_Black Rock Units 1,2,3.dat		

FIGURE B-5d

Thu, 04-DEC-2008 09:38:19

CONSOLIDATION TEST DATA

SUMMARY REPORT



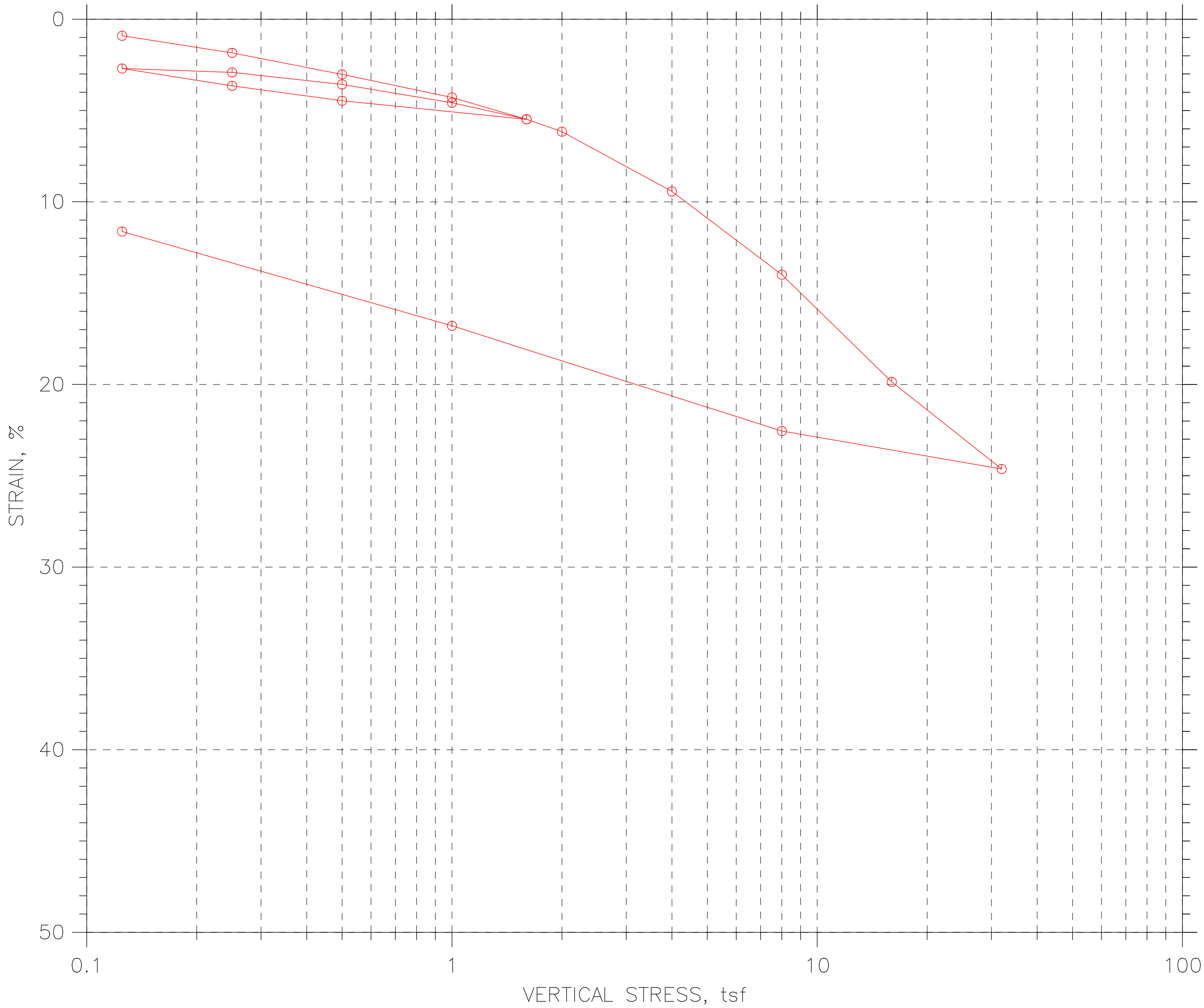
					Before Test	After Test
Overburden Pressure: 0 tsf				Water Content, %	29.94	28.39
Preconsolidation Pressure: 0 tsf				Dry Unit Weight, pcf	94.34	98.5
Compression Index: 3.81959e-313				Saturation, %	102.77	107.76
Diameter: 2.42 in		Height: 1 in		Void Ratio	0.79	0.71
LL: ---	PL: ---	PI: ---	GS: 2.70			

	Project: Black Rock Units 1,2,3	Location: Calipatria, CA	Project No.: 3652.001
	Boring No.: RW-6	Tested By: NJD	Checked By: NJD
	Sample No.: #3	Test Date: 11/7/08	Depth: 16.0ft
	Test No.: C	Sample Type: Shelby	Elevation: N/A
	Description: Fat CLAY (CH): brown, wet		
	Remarks: 3652.001_RW-06_#3_16.0ft_Node66_Black Rock Units 1,2,3.dat		

FIGURE B-5e

CONSOLIDATION TEST DATA

SUMMARY REPORT



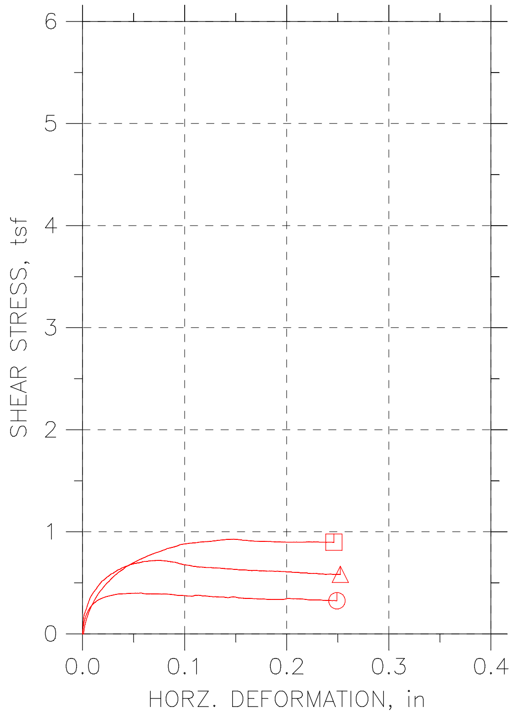
					Before Test	After Test
Overburden Pressure: 0 tsf				Water Content, %	38.33	33.13
Preconsolidation Pressure: 0 tsf				Dry Unit Weight, pcf	84.19	95.27
Compression Index: 3.81959e-313				Saturation, %	103.29	116.29
Diameter: 2.42 in		Height: 1 in		Void Ratio	1.00	0.77
LL: ---	PL: ---	PI: ---	GS: 2.70			

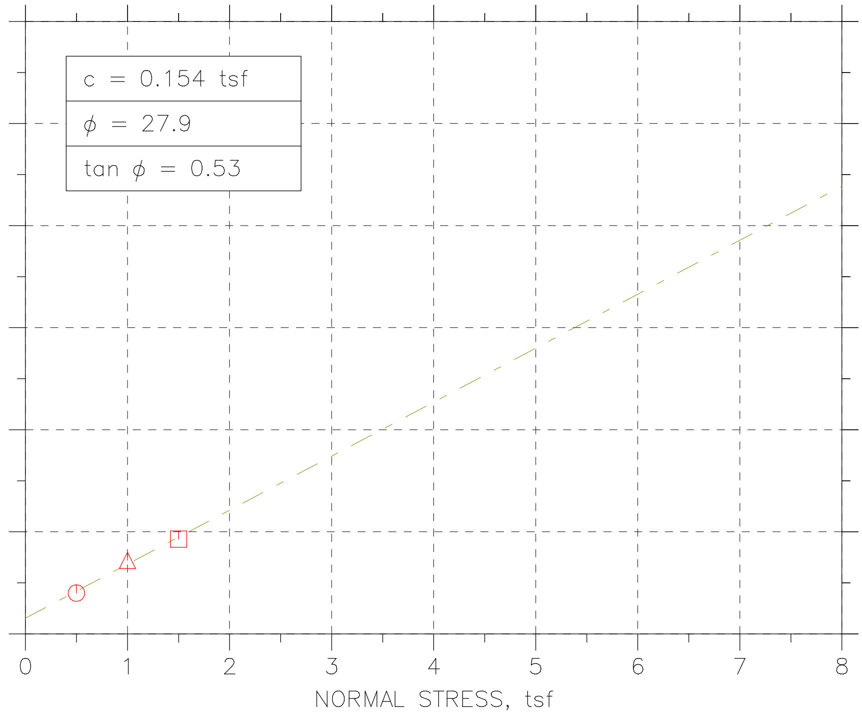
	Project: Black Rock Units 1,2,3	Location: Calipatria, CA	Project No.: 3652.001
	Boring No.: RW-7	Tested By: NJD	Checked By: NJD
	Sample No.: #10	Test Date: 11/11/08	Depth: 51.0ft
	Test No.: N/A	Sample Type: Ring	Elevation: N/A
	Description: Fat CLAY (CH): brown, wet		
	Remarks: 3652.001_RW-07_#10_51.0ft_Node66_Black Rock Units 1,2,3.dat		

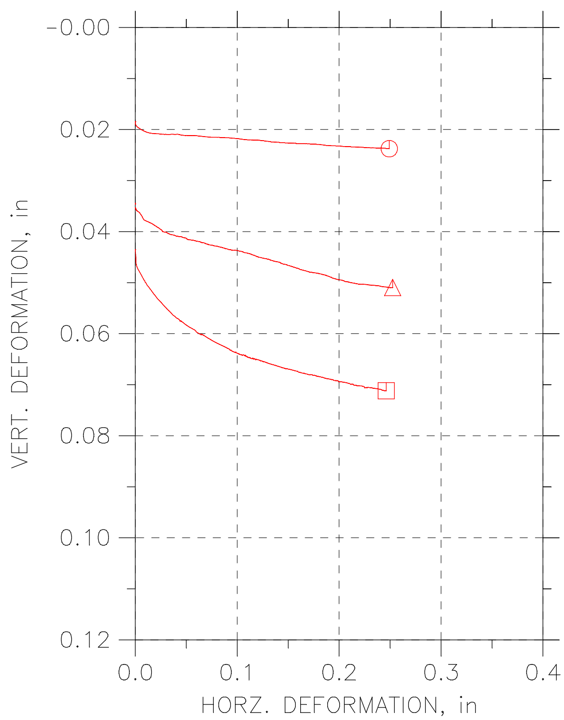
FIGURE B-5f

Thu, 04-DEC-2008 09:20:15

DIRECT SHEAR TEST REPORT







Symbol		○	△	□	
Test No.		A	B	C	
Sample No.		#2	#2	#2	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	2	2	2	
	Area, in^2	3.1416	3.1416	3.1416	
	Height, in	1	1	1	
	Water Content, %	28.74	28.74	28.73	
	Dry Density, pcf	95.104	96.817	94.489	
	Saturation, %	98.17	102.23	96.73	
	Void Ratio	0.80515	0.77321	0.8169	
Consol. Height, in		0.98258	0.96705	0.95798	
Consol. Void Ratio		0.7737	0.71479	0.74056	
Final	Water Content, %	31.23	27.10	31.42	
	Dry Density, pcf	97.419	102.02	101.73	
	Saturation, %	112.66	109.16	125.66	
	Void Ratio	0.76226	0.68283	0.68754	
Normal Stress, tsf		0.49995	0.99967	1.4999	
Max. Shear Stress, tsf		0.39963	0.72021	0.92855	
Ult. Shear Stress, tsf		0.3244	0.58309	0.89799	
Time to Failure, min		350	490	919	
Disp. Rate, in/min		0.00017	0.00017	0.00017	
Estimated Specific Gravity		2.75	2.75	2.75	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: Black Rock Units 1,2,3

Location: Calipatria, CA

Project No.: 3652.001

Boring No.: HSA-19

Sample Type: Ring

Description: Fat CLAY (CH): brown, moist

Remarks: 3652.001_HSA-19_#2_6.0ft_0.5tsf_STA_Black Rock Units 1,2,3

FIGURE B-6

Fri, 12-DEC-2008 11:27:47

-R- VALUE TEST RESULT

PROJECT NO: 3652.001

PROJECT NAME: BLACK ROCK UNITS 1 - 2 & 3

SAMPLE NO. HSA - 8 @ 0 - 3' SOURCE: Onsite

DESCRIPTION: Brown lean to fat CLAY with sand (CL-CH)

TESTED BY: JA DATE: 11-10-08

ATTENTION: Jon Everett

COPY TO: Jim Bruss

* * * * * * RESISTANCE VALUE DATA SUMMARY * * * * * *

INITIAL MOISTURE CONTENT: 20 %

DRY DENSITY (pcf)	WATER CONTENT (%)	EXUDATION PRESSURE (psi)	EXPANSION PRESSURE (psf)	* R * VALUE
99.3	23.8	231	0	2
99.8	23.2	326	35	4
100	22.6	446	39	6

AT EXUDATION PRESSURE OF 300 PSI:

99.6	23.4	300	31	4

FIGURE B-7a

-R- VALUE TEST RESULT

PROJECT NO: 3652.001

PROJECT NAME: BLACK ROCK UNITS 1 - 2 & 3

SAMPLE NO. HSA - 12 @ 0 - 3' SOURCE: Onsite

DESCRIPTION: Brown lean to fat CLAY with sand (CL-CH)

TESTED BY: JC DATE: 11/10/08

ATTENTION: Jon Everett

COPY TO: Jim Bruss

* * * * * * RESISTANCE VALUE DATA SUMMARY * * * * * *

INITIAL MOISTURE CONTENT: 23 %

DRY DENSITY (pcf)	WATER CONTENT (%)	EXUDATION PRESSURE (psi)	EXPANSION PRESSURE (psf)	* R * VALUE
96.1	26.1	215	0	1
98.6	24.9	310	9	2
100.8	23.8	390	83	5

AT EXUDATION PRESSURE OF 300 PSI:

98.4	25	300	8	2

FIGURE B-7b

-R- VALUE TEST RESULT

PROJECT NO: 3652.001

PROJECT NAME: BLACK ROCK UNITS 1 - 2 & 3

SAMPLE NO. HSA - 20 @ 0' - 3' SOURCE: Onsite

DESCRIPTION: Brown lean CLAY with sand (CL)

TESTED BY: GB DATE: 11-10-08

ATTENTION: Jon Everett

COPY TO: Jim Bruss

* * * * * * RESISTANCE VALUE DATA SUMMARY * * * * * *

INITIAL MOISTURE CONTENT: 16 %

DRY DENSITY (pcf)	WATER CONTENT (%)	EXUDATION PRESSURE (psi)	EXPANSION PRESSURE (psf)	* R * VALUE
106.7	17.4	199	0	16
108.5	16.9	310	0	29
108.1	16.3	358	0	31

AT EXUDATION PRESSURE OF 300 PSI:

107.9	16.8	300	0	28

FIGURE B-7c

EXPANSION INDEX

ASTM D4829-03 / UBC 29-1

Project Name: Black Rock Unit 1,2 3
Project Number: 3652.001
Sample Source HSA-3 @ 0-3'
Tested By: DC
Sample Description: Brown lean CLAY with sand (CL).
Date Tested: 11/7/2008

Test Data:

Expansion: Load-Expanded: [x] Expanded-Load: [ ] Other: [ ]

MOISTURE CONTENT	BEFORE TEST	AFTER TEST
Ring Number		
Weight of Wet Soil + Ring (gms)	385.0	472.4
Weight of Dry Soil + Ring (gms)	346.5	385.1
Weight of Ring (gms)	0.0	38.6
Weight of Dry Soil (gms)	346.5	346.5
Weight of Water (gms)	38.5	87.3
Volume of Soil (ft^3)	0.0073	0.0077
Water Content, %	11.1	25.2
Dry Density (pcf)	105.0	98.9

REMOLDING DATA			
Water content, %	11.1	Desired Density	105.0
Total Dry Soil, gms.			
Water Added, gms.			

SPECIMEN DATA:

Height 1.00 **inches** **Diameter:** 4.00 **inches**
Gs = 2.7 **estimatec** **V_0 =** 0.0073 **inch.^{3}**
δ_d = 105.0
δ_f = 98.9

EXPANSION INDEX	**62**

SPECIMEN HEIGHT (inches)	H_0-H_f	(w/c)(Gs)(δ_d) (x)	(Gs)(62.4)-δ_d (y)	S% x / y	
1.000		3151.26	63.44	50	**Initial**
1.062	0.0619	6729.06	69.56	97	**Final**

Date:	Time:	Reading:	Remarks:
11/10/08	3:30	0.3435	
11/10/08	3:56	0.3200	
11/10/08	4:18	0.3003	
11/11/08	8:10	0.2814	
11/11/08	11:50	0.2816	
11/11/08	1:10	0.2816	

EXPANSION INDEX
ASTM D4829-03 / UBC 29-1

Project Name: Black Rock Unit 1,2 3 **Project Number:** 3652.001
Sample Source HSA-10 @ 0-3' **Tested By:** DC
Sample Description: Brown fat CLAY with sand (CH). **Date Tested:** 11/7/2008

Test Data:

Expansion: Load-Expanded: [X] Expanded-Load: [ ] Other: [ ]

MOISTURE CONTENT	BEFORE TEST	AFTER TEST
Ring Number		
Weight of Wet Soil + Ring (gms)	365.0	461.1
Weight of Dry Soil + Ring (gms)	321.6	360.4
Weight of Ring (gms)	0.0	38.8
Weight of Dry Soil (gms)	321.6	321.6
Weight of Water (gms)	43.4	100.7
Volume of Soil (ft^3)	0.0073	0.0078
Water Content, %	13.5	31.3
Dry Density (pcf)	97.5	90.8

REMOLDING DATA			
Water content, %	13.5	Desired Density	97.5
Total Dry Soil, gms.			
Water Added, gms.			

SPECIMEN DATA:

Height 1.00 **inches** **Diameter:** 4.00 **inches**
Gs = 2.7 **estimatec** **V_0 =** 0.0073 **inch.^{3}**
δ_d = 97.5
δ_f = 90.8

EXPANSION INDEX	**74**

SPECIMEN HEIGHT (inches)	H_0-H_f	(w/c)(Gs)(δ_d) (x)	(Gs)(62.4)-δ_d (y)	S% x / y	
1.000		3552.33	70.99	50	**Initial**
1.074	0.0740	7674.48	77.70	99	**Final**

Date:	Time:	Reading:	Remarks:
11/10/08	3:56	0.3225	
11/10/08	4:02	0.3000	
11/10/08	4:13	0.2800	
11/11/08	8:10	0.2480	
11/11/08	11:50	0.2484	
11/11/08	1:10	0.2485	

FIGURE B-8b

EXPANSION INDEX

ASTM D4829-03 / UBC 29-1

Project Name: Black Rock Unit 1,2 3
Project Number: 3652.001
Sample Source HSA-22 @ 0-3'
Tested By: DC
Sample Description: Brown lean CLAY with sand (CL).
Date Tested: 11/7/2008

Test Data:

Expansion: Load-Expanded: [X] Expanded-Load: [ ] Other: [ ]

MOISTURE CONTENT	BEFORE TEST	AFTER TEST
Ring Number		
Weight of Wet Soil + Ring (gms)	372.0	512.3
Weight of Dry Soil + Ring (gms)	331.3	417.8
Weight of Ring (gms)	0.0	86.5
Weight of Dry Soil (gms)	331.3	331.3
Weight of Water (gms)	40.7	94.5
Volume of Soil (ft^3)	0.0073	0.0078
Water Content, %	12.3	28.5
Dry Density (pcf)	100.4	94.1

REMOLDING DATA			
Water content, %	12.3	Desired Density	100.4
Total Dry Soil, gms.			
Water Added, gms.			

SPECIMEN DATA:

Height 1.00 **inches** **Diameter:** 4.00 **inches**
Gs = 2.7 **estimatec** **V_0 =** 0.0073 **inch.^{3}**
δ_d = 100.4
δ_f = 94.1

EXPANSION INDEX	**68**

SPECIMEN HEIGHT (inches)	H_0-H_f	(w/c)(Gs)(δ_d) (x)	(Gs)(62.4)-δ_d (y)	S% x / y	
1.000		3331.33	68.05	49	Initial
1.067	0.0672	7247.86	74.37	97	Final

Date:	Time:	Reading:	Remarks:
11/11/08	2:03	0.3389	
11/11/08	3:15	0.3010	
11/11/08	4:35	0.2815	
11/12/08	7:55	0.2715	
11/12/08	10:25	0.2717	
11/12/08	1:50	0.2717	

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 **462 2771** Fax: 925 **462 2775**
www.cercoanalytical.com

25 November 2008

Job No.0811051
Cust. No.11608

Mr. Kim Yee
Fugro West, Inc.
1000 Broadway, Suite 440
Oakland, CA 94607

Subject: Project No.: 3652.001
Project Name: Black Rock Units 1, 2, 3
Corrosivity Analysis – ASTM Test Methods with Brief Evaluation

Dear Mr. Yee:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on November 07, 2008. Based on the analytical results, a brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurements, all samples are classified as "severely corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentrations range from 630 to 1,500 mg/kg. Because the chloride ion concentrations are greater than 300 mg/kg, they are determined to be sufficient to attack steel embedded in a concrete mortar coating.

The sulfate ion concentrations range from 1,200 to 2,800 mg/kg and are determined to be sufficient to damage reinforced concrete structures and cement mortar-coated steel at these locations. Therefore, concrete that comes into contact with this soil should use sulfate resistant cement such as Type II, in accordance with the Uniform building Code requirements.

The pH of the soils range from 7.9 to 8.4 which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

The redox potentials range from 460 to 470-mV, which are indicative of aerobic soil conditions.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc. at (925) 927-6630.*

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.

for Shean Moore

J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

FIGURE B-9a

California State Certified Laboratory No. 2153

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax: 925 462 2775
www.cercoanalytical.com

Client: Fugro West
Client's Project No.: 3652.001
Client's Project Name: Black Rock Units 1, 2, 3
Date Sampled: Not Indicated
Date Received: 7-Nov-08
Matrix: Soil
Authorization: Signed Chain of Custody

Date of Report: 25-Nov-2008

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)*	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
0811051-001	HSA-3 @ 0-3'	470	8.2	-	270	-	1,500	2,800 (1)
0811051-002	HSA-10 @ 0-3'	460	7.9	-	280	-	800	1,300
0811051-003	HSA-11 @ 0-3'	470	7.9	-	310	-	630	1,200
0811051-004	HSA-14 @ 0-3'	460	7.9	-	400	-	970	1,200
0811051-005	HSA-20 @ 0-3"	460	8.4	-	260	-	970	1,600

Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Detection Limit:	-	-	10	-	50	15	15
Date Analyzed:	21-Nov-2008	21-Nov-2008	-	25-Nov-2008	-	21-Nov-2008	21-Nov-2008 & 24-Nov-2008

Cheryl McMillen
Laboratory Director

* Results Reported on "As Received" Basis

N.D. - None Detected

(1) Detection limit is elevated to 75 mg/kg due to dilution

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

FIGURE B-9b

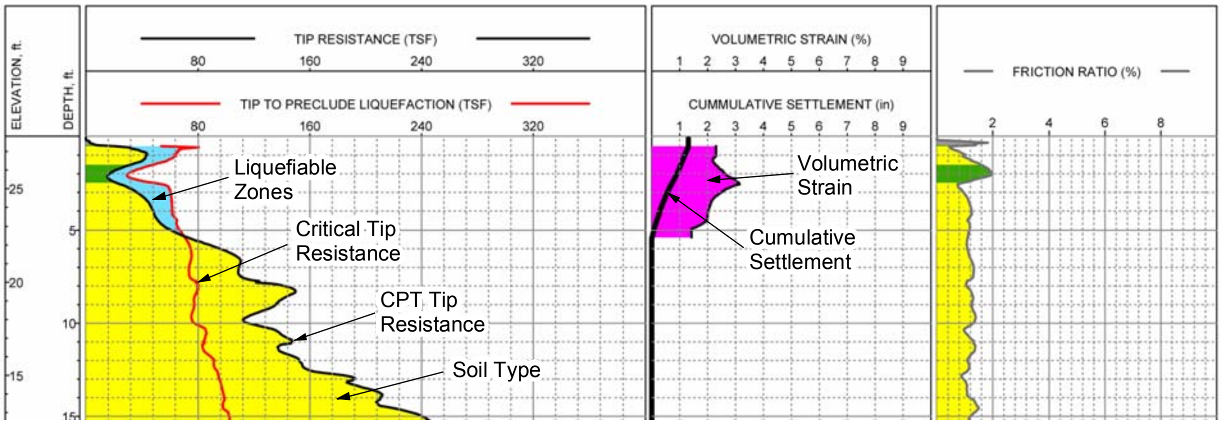
APPENDIX C
LIQUEFACTION ANALYSES

APPENDIX C
LIQUEFACTION ANALYSES

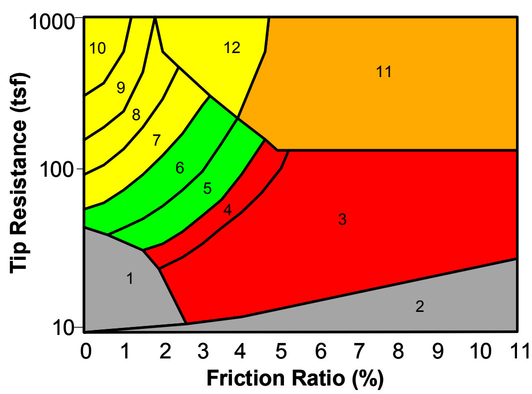
Appendix C presents the results of the CPT liquefaction assessments for the Design Level Earthquake (DLE) event in accordance with the criteria presented in Section 6 of this report. For the analyses, the DLE event is defined as having a moment magnitude (M) of 6.5 and a PGA of 0.40g.

The susceptibility of granular soils to liquefaction is a function of gradation, density, and type of fines content of the soil. The susceptibility in general decreases with respective increases in: 1) distribution of grain size, and 2) soil density. The detailed liquefaction susceptibility was based on the CPT-based empirical procedures recommended by Youd et. al., (2001) and used typical CPT tip resistance data that are representative of the soils at the project site. It should be noted that all zones susceptible to liquefaction are shown to the base of each exploration, and cumulative settlement commences with the deepest encountered liquefiable zones; however, past research has suggested that in most cases liquefaction does not occur at depths greater than about 50 feet below ground surface.

Figure C-1 provides a key for the interpretation of the liquefaction analyses based on the CPT data. Figures C-2 through C-22 present the CPT liquefaction assessments for the DLE event. The CPT plots show zones of materials susceptible to liquefaction in pink, and cumulative settlements along with volumetric strains.



COLOR LEGEND FOR FRICTION RATIO TRACES



Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART

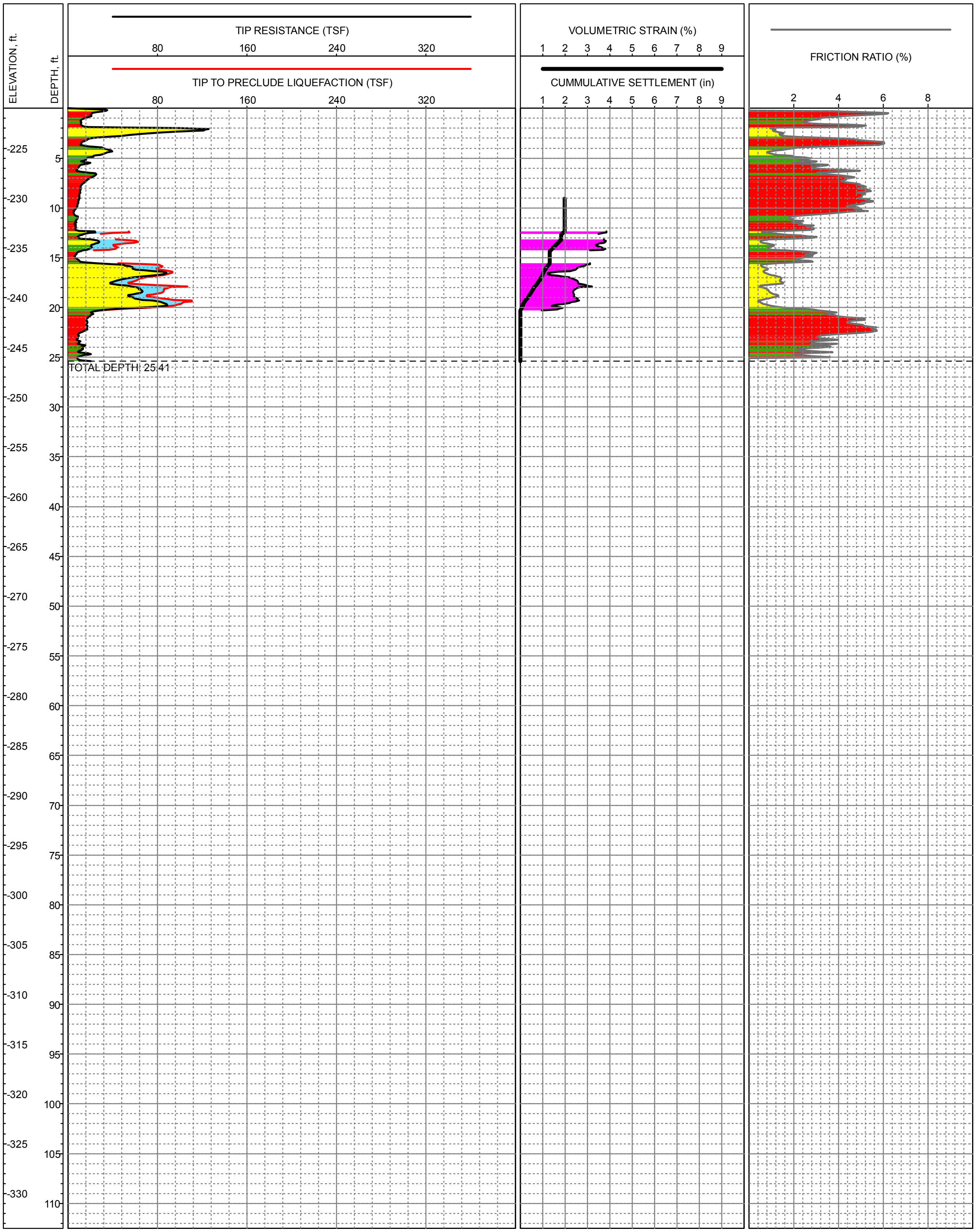
(Robertson and Campanella, 1984)

KEY TO LIQUEFACTION LOGS

Black Rock Units 1, 2, & 3
Calipatria, California

FIGURE C-1

CalEnergy Operating Corporation
Project No. 3652.001



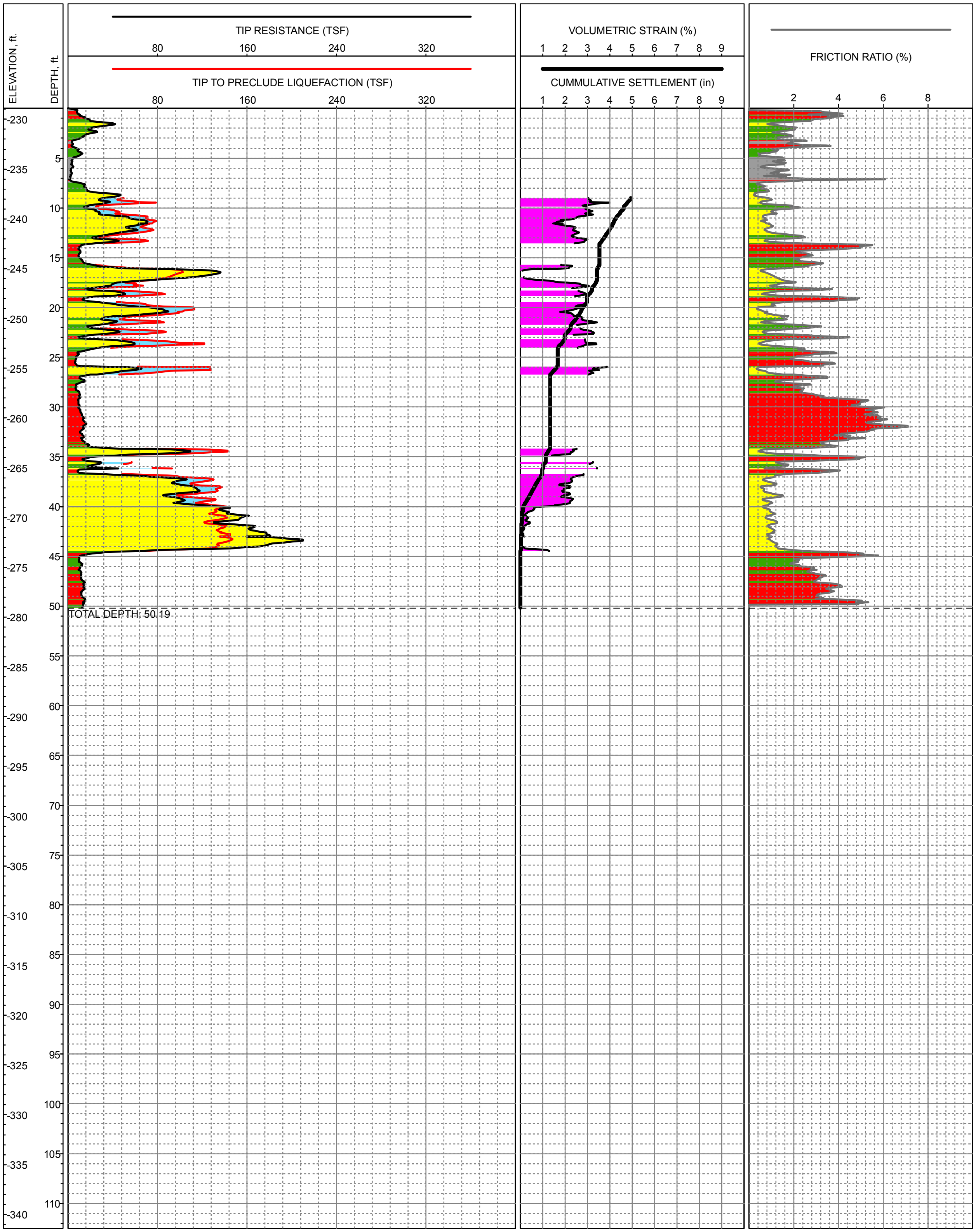
LOCATION: E6,750,956, N2,005,421, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -221.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.41ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-101

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-2



LOCATION: E6,752,117, N2,005,697, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -228.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.19ft
TESTDATE: 10/8/2008

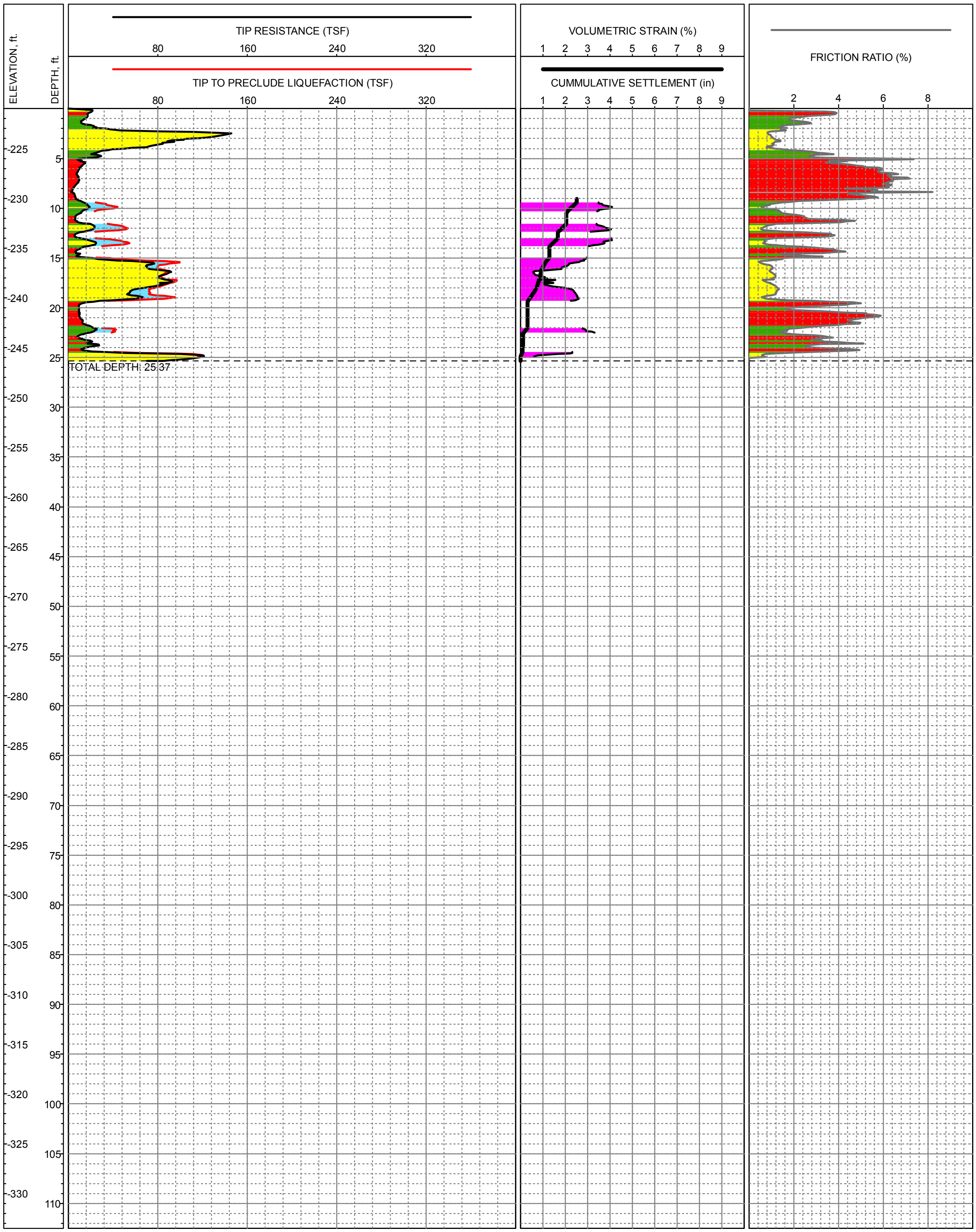
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-102

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-3

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,750,954, N2,004,791, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -221.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.37ft
TESTDATE: 10/8/2008

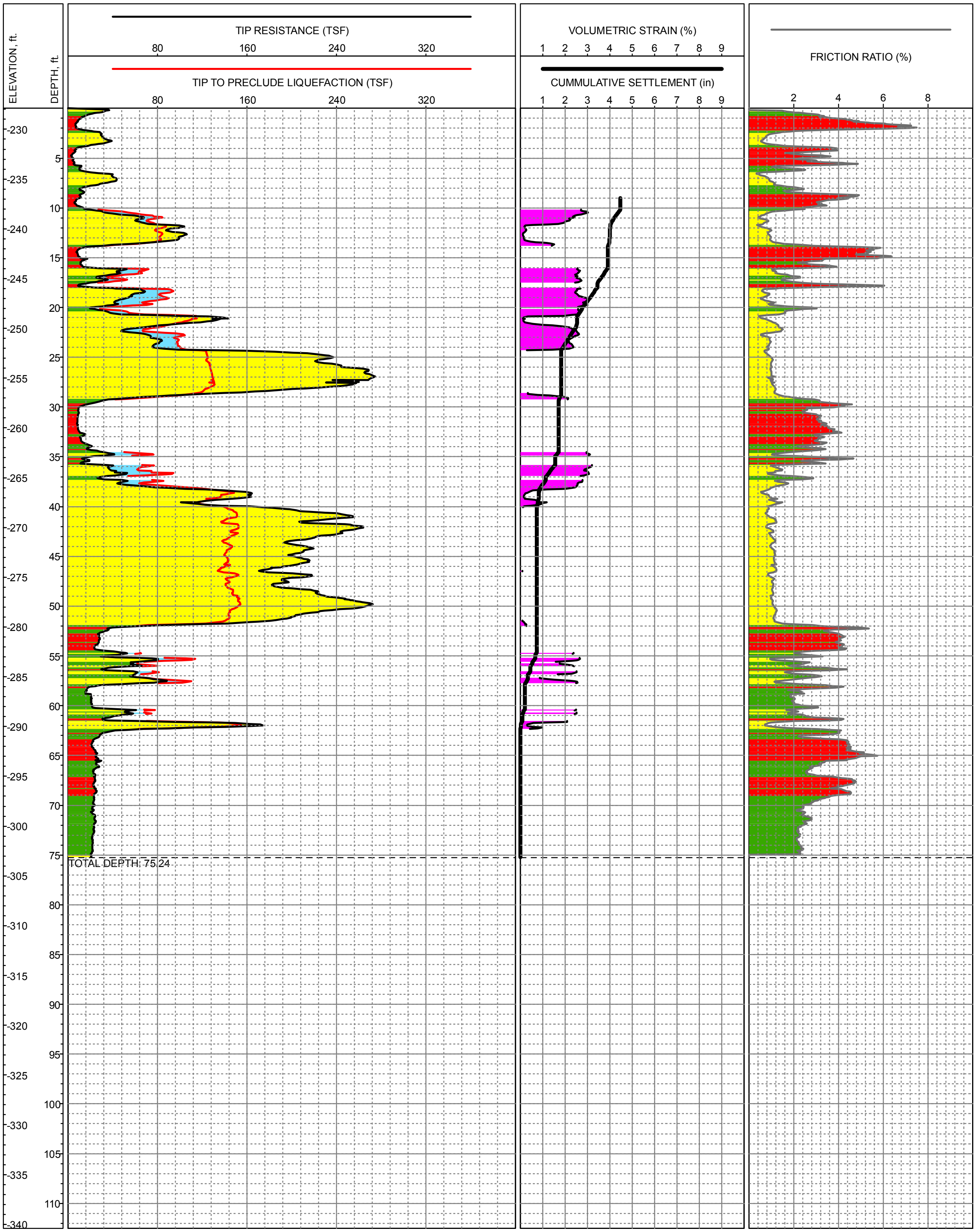
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-103

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-4

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean



LOCATION: E6,752,229, N2,004,966, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.9ft +/- (NAVD88)
COMPLETION DEPTH: 75.24ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

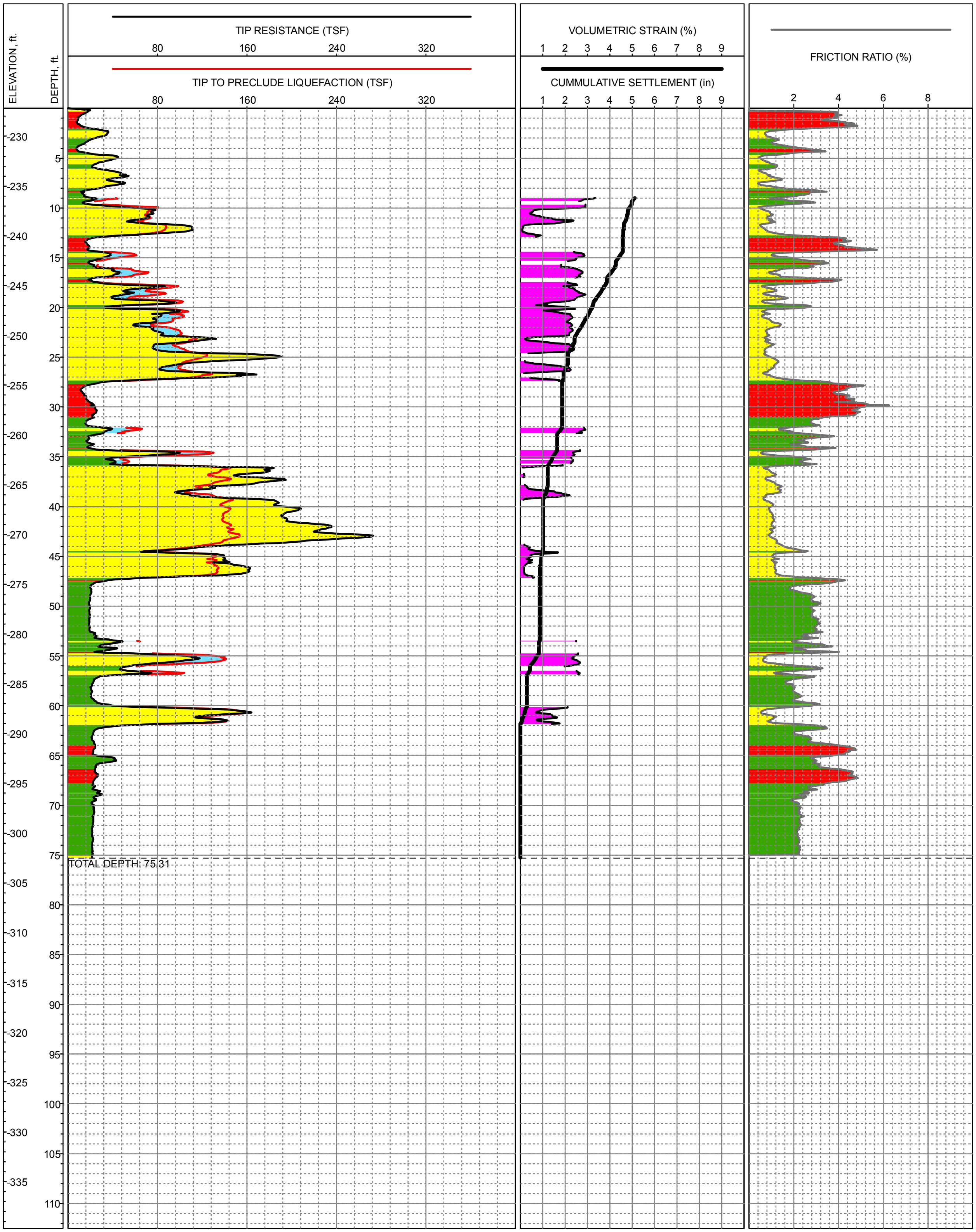
LIQUEFACTION LOG OF CPT NO: C-104

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-5

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

FUGRO



LOCATION: E6,752,401, N2,004,829, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.31ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-105

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-6

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

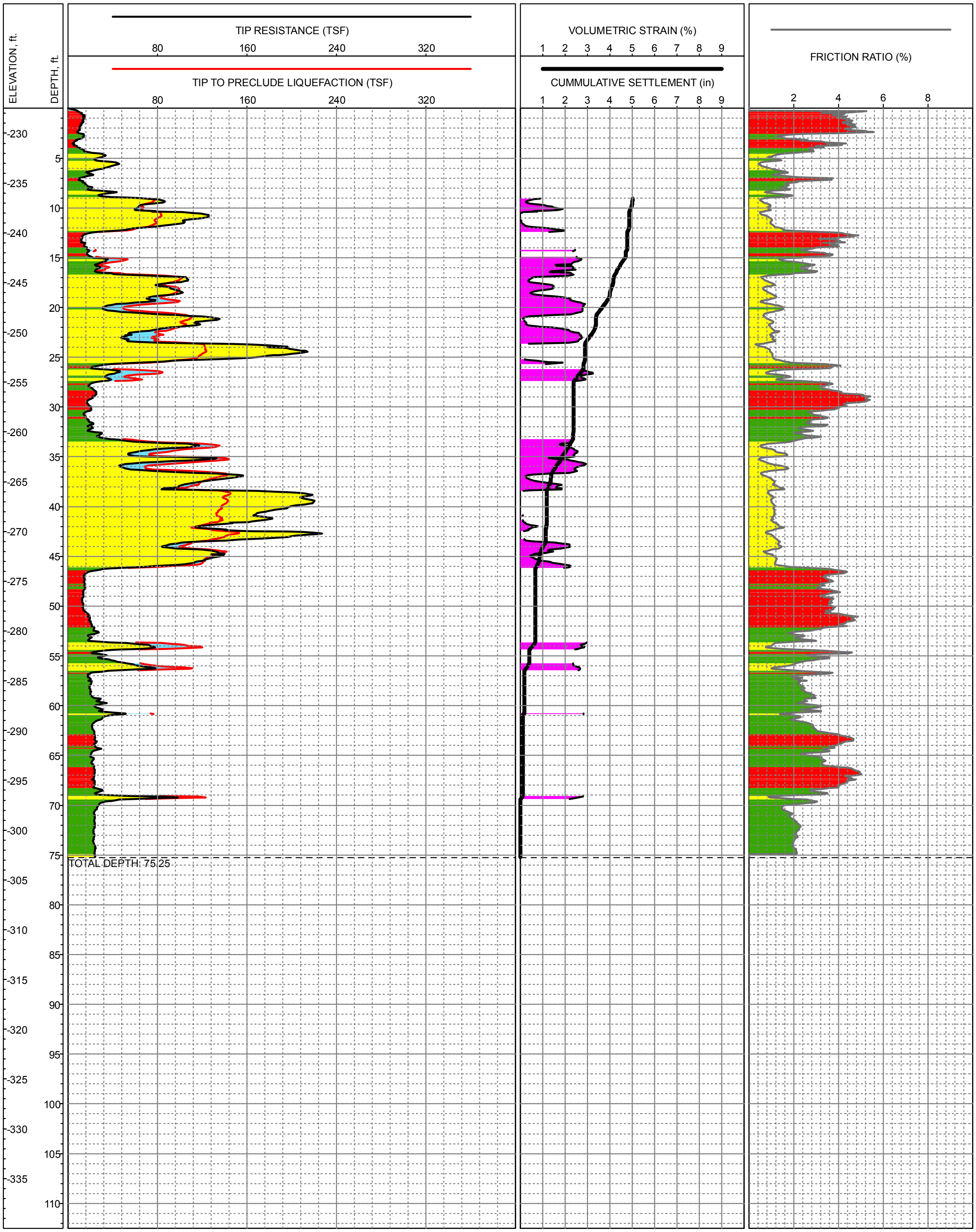
LOCATION: E6,751,827, N2,004,673, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.3ft +/- (NAVD88)
COMPLETION DEPTH: 50.15ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-106

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-7



LOCATION: E6,752,273, N2,004,748, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -227.5ft +/- (NAVD88)
COMPLETION DEPTH: 75.25ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

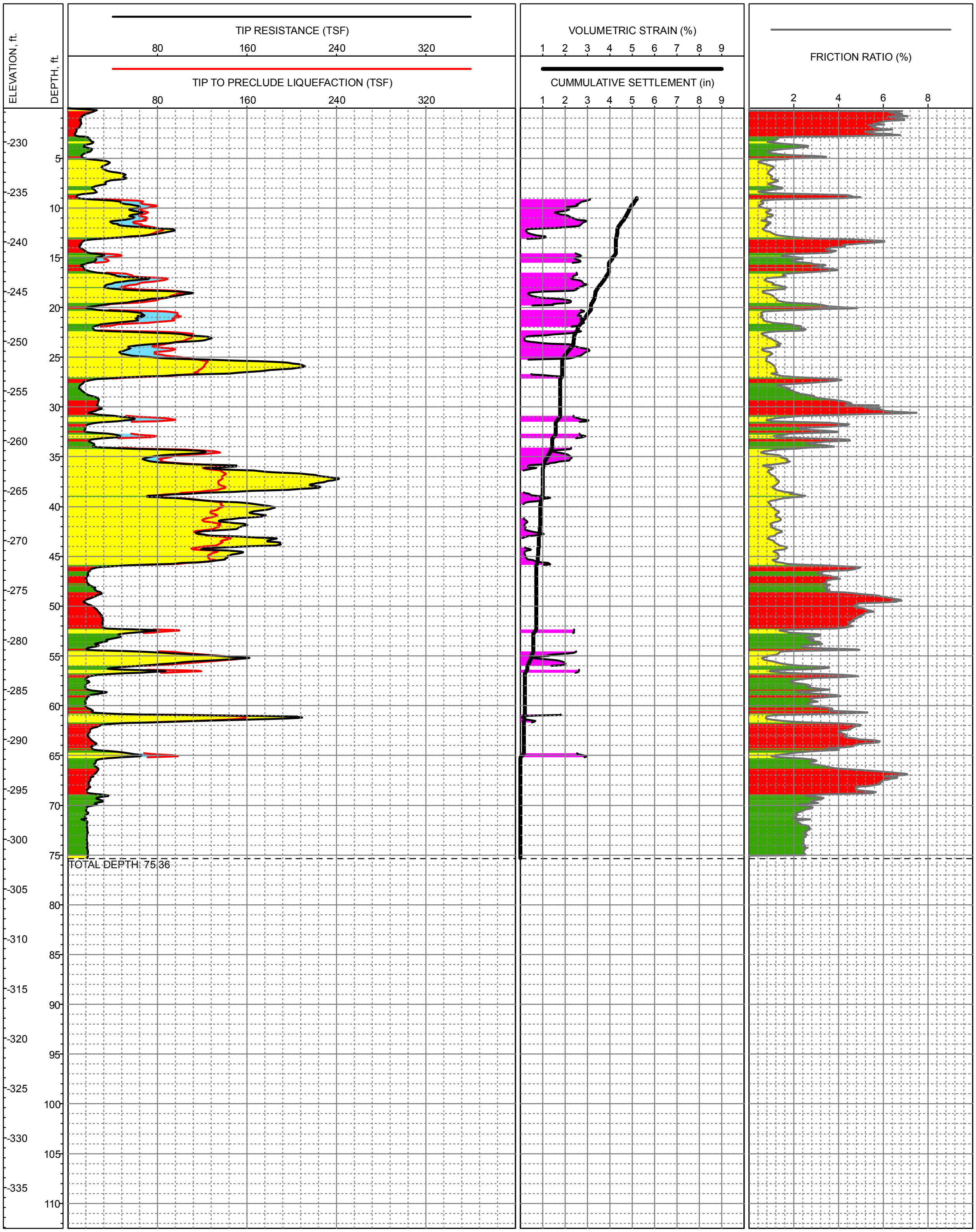
LIQUEFACTION LOG OF CPT NO: C-107

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-8

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,567, N2,004,655, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -226.6ft +/- (NAVD88)
COMPLETION DEPTH: 75.36ft
TESTDATE: 10/7/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

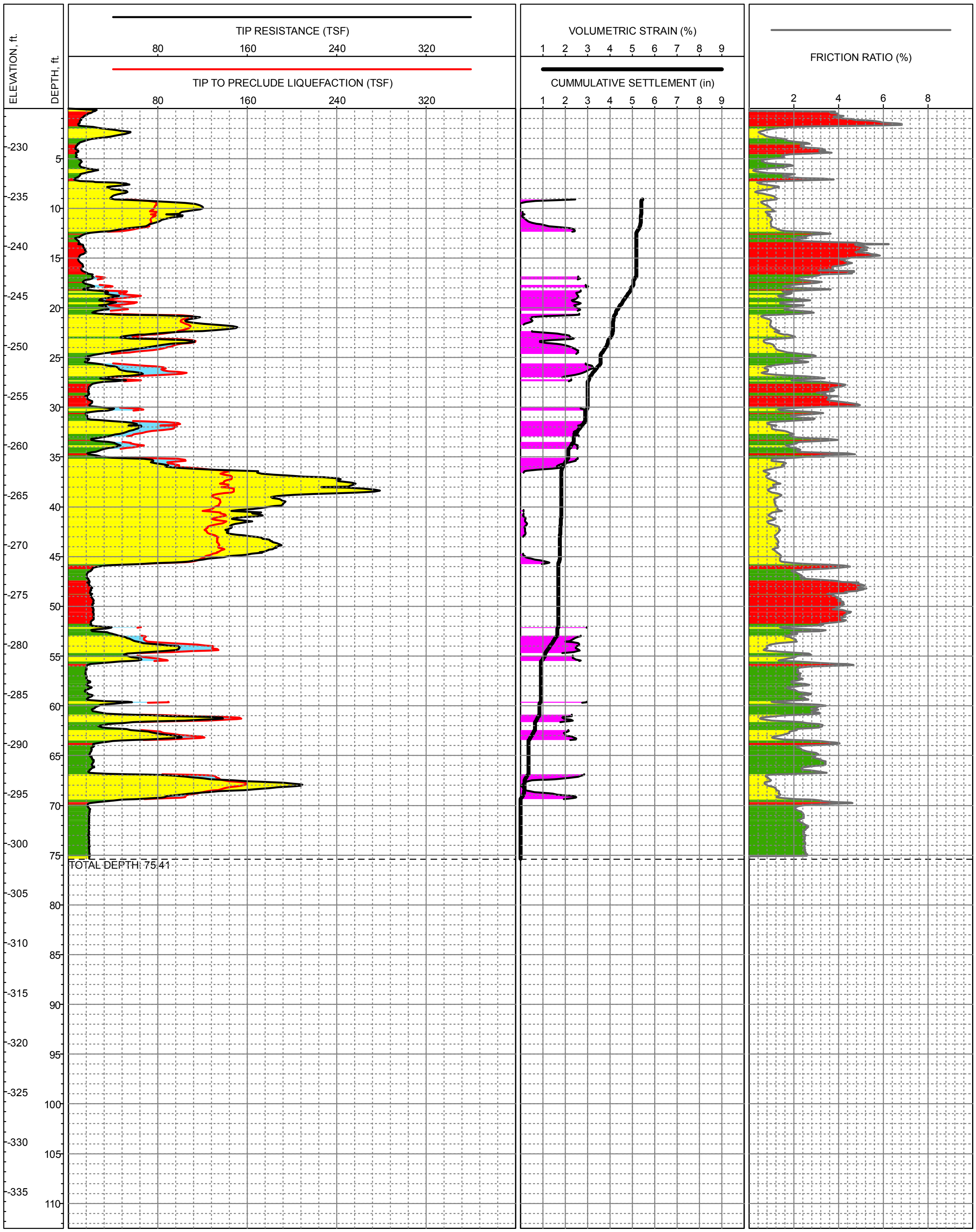
LIQUEFACTION LOG OF CPT NO: C-108

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-9

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



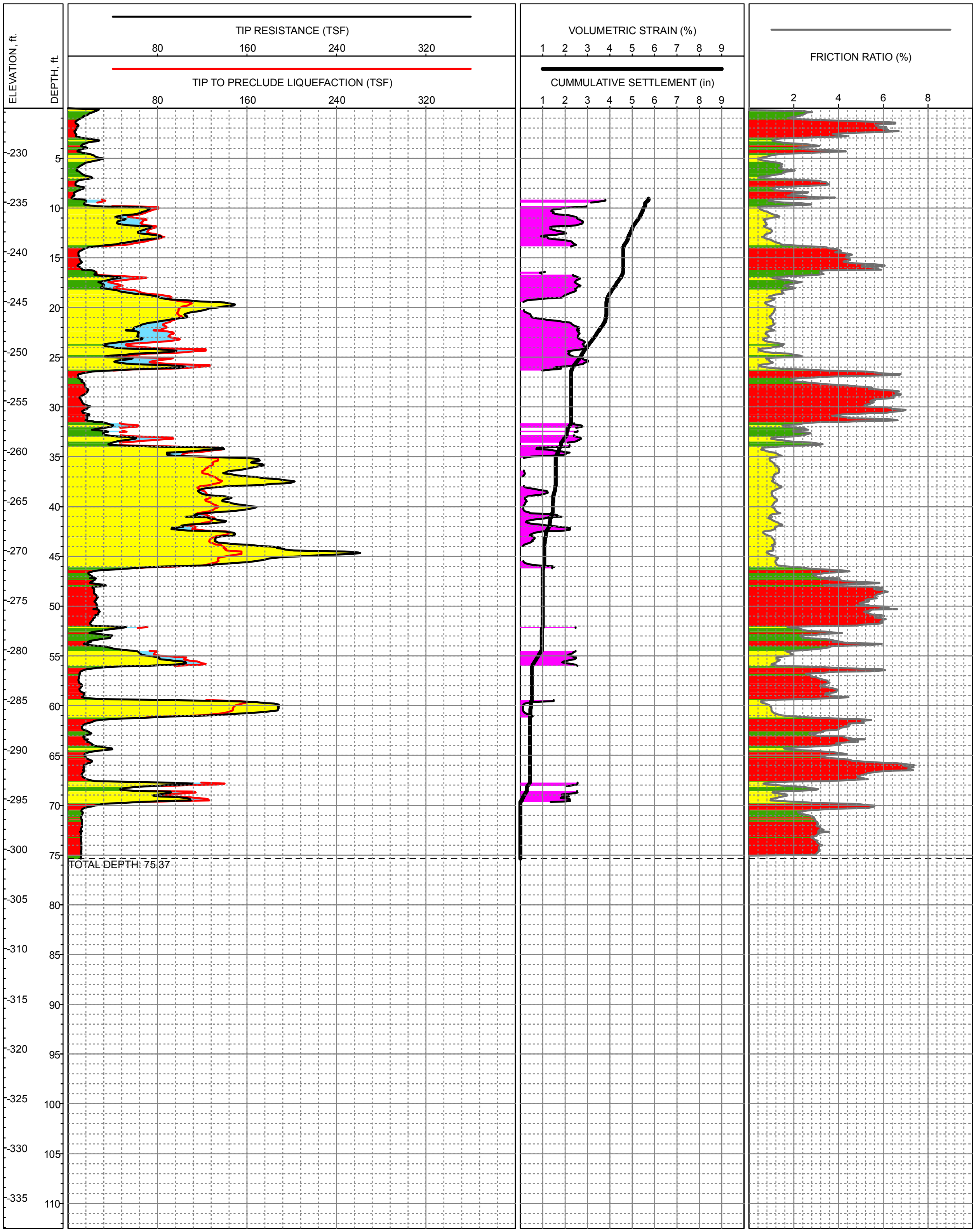
LOCATION: E6,751,740, N2,004,265, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -226.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.41ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-109

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-10



LOCATION: E6,752,361, N2,004,312, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.6ft +/- (NAVD88)
COMPLETION DEPTH: 75.37ft
TESTDATE: 10/9/2008

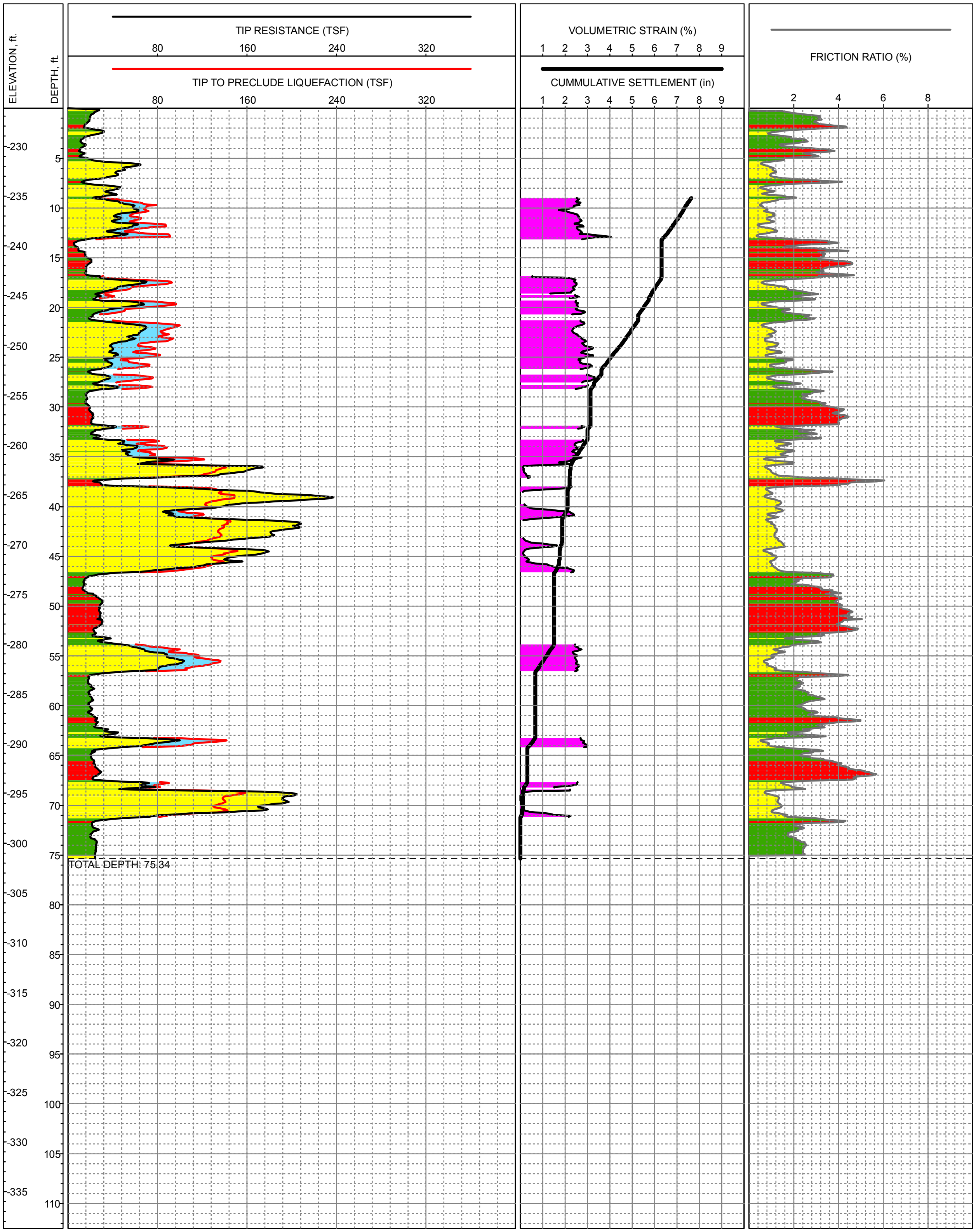
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-110

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-11

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,751,643, N2,004,119, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -226.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.34ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-111

P.G.A. = 0.40g and Mw = 6.5

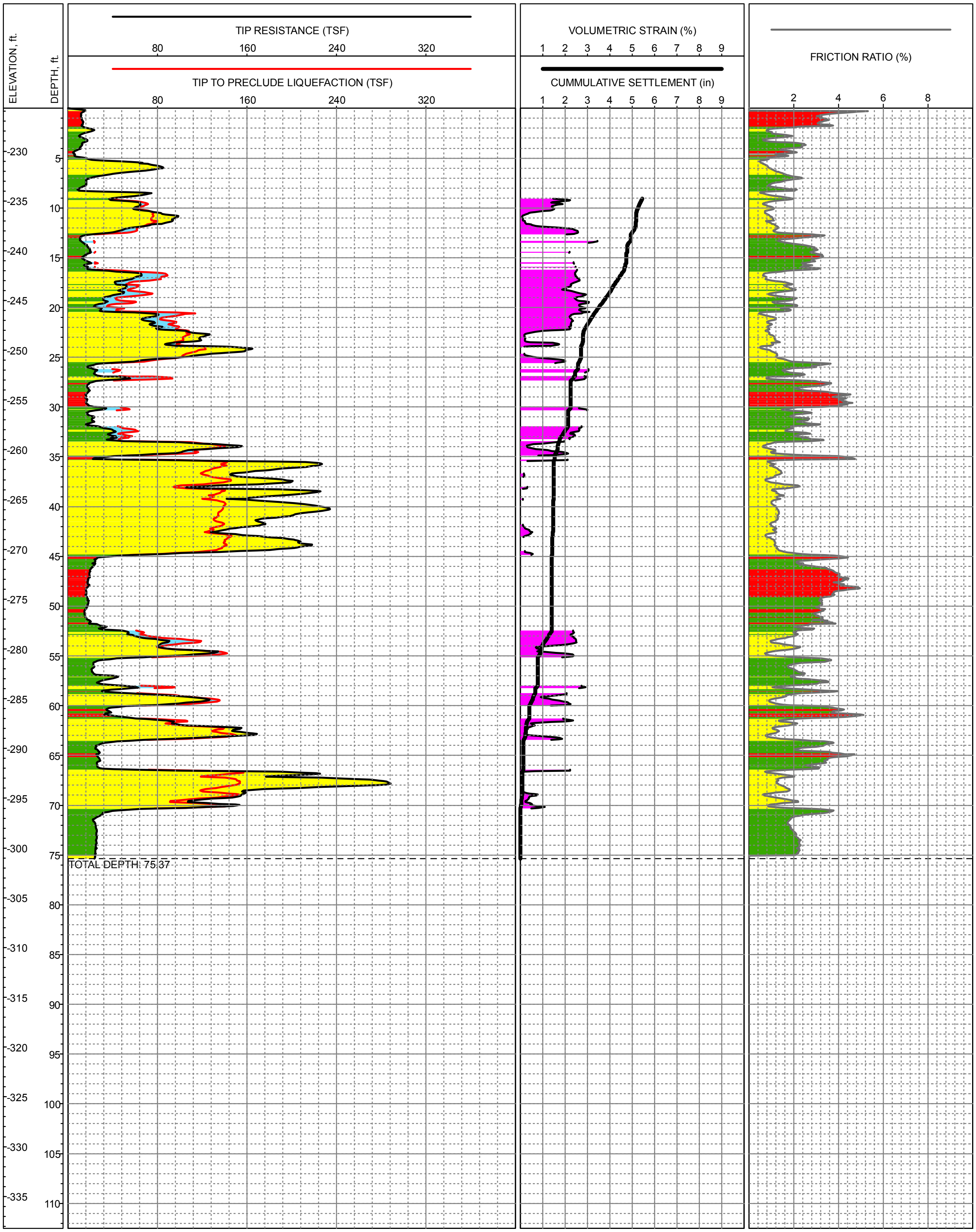
Black Rock Units 1, 2 & 3

Calipatria, California

FIGURE C-12

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,751,779, N2,003,996, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.7ft +/- (NAVD88)
COMPLETION DEPTH: 75.37ft
TESTDATE: 10/8/2008

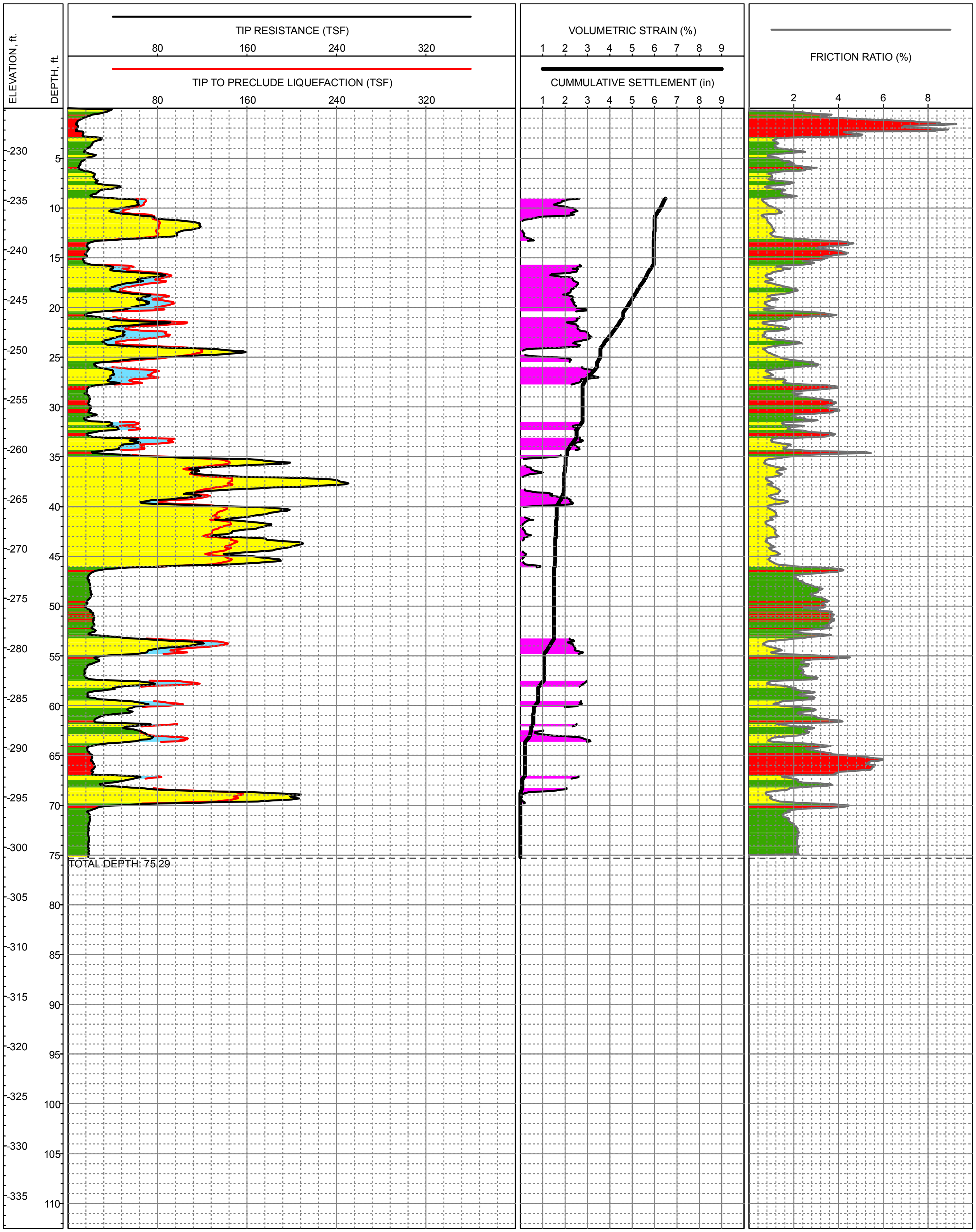
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-112

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-13

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean



LOCATION: E6,751,918, N2,004,171, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.8ft +/- (NAVD88)
COMPLETION DEPTH: 75.29ft
TESTDATE: 10/8/2008

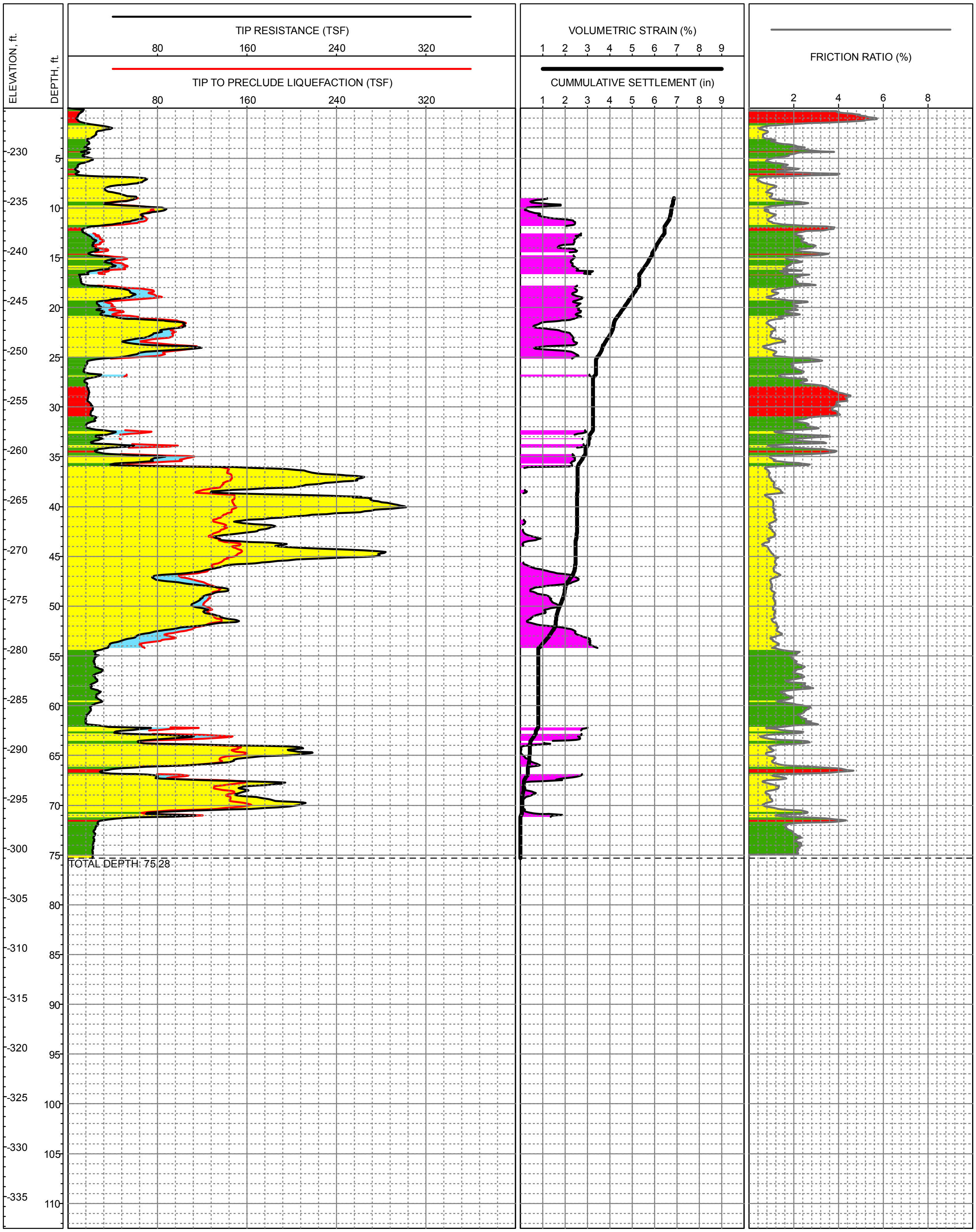
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-113

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-14

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean



LOCATION: E6,752,088, N2,003,947, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.7ft +/- (NAVD88)
COMPLETION DEPTH: 75.28ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

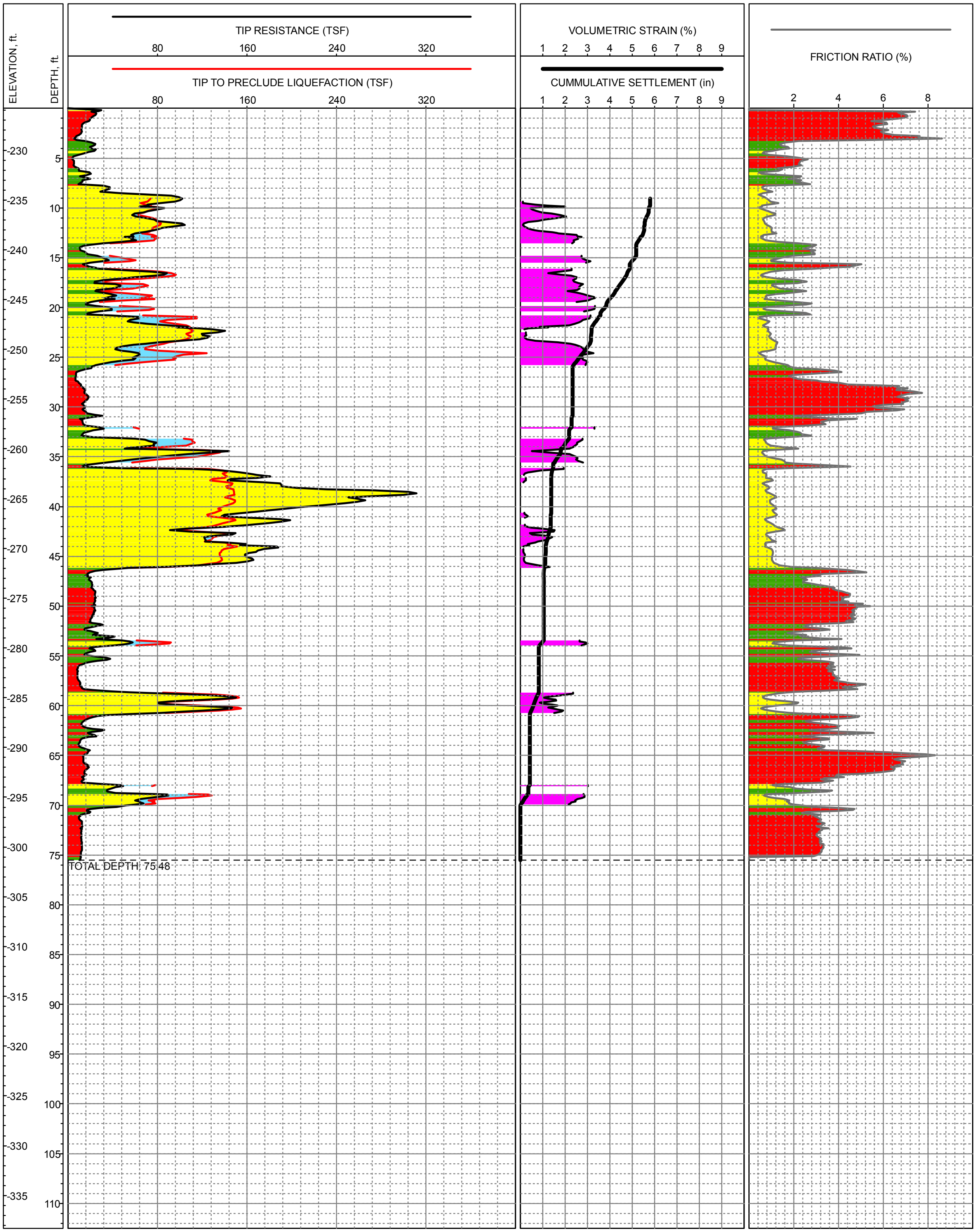
LIQUEFACTION LOG OF CPT NO: C-114

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-15

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,273, N2,004,188, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.8ft +/- (NAVD88)
COMPLETION DEPTH: 75.48ft
TESTDATE: 10/9/2008

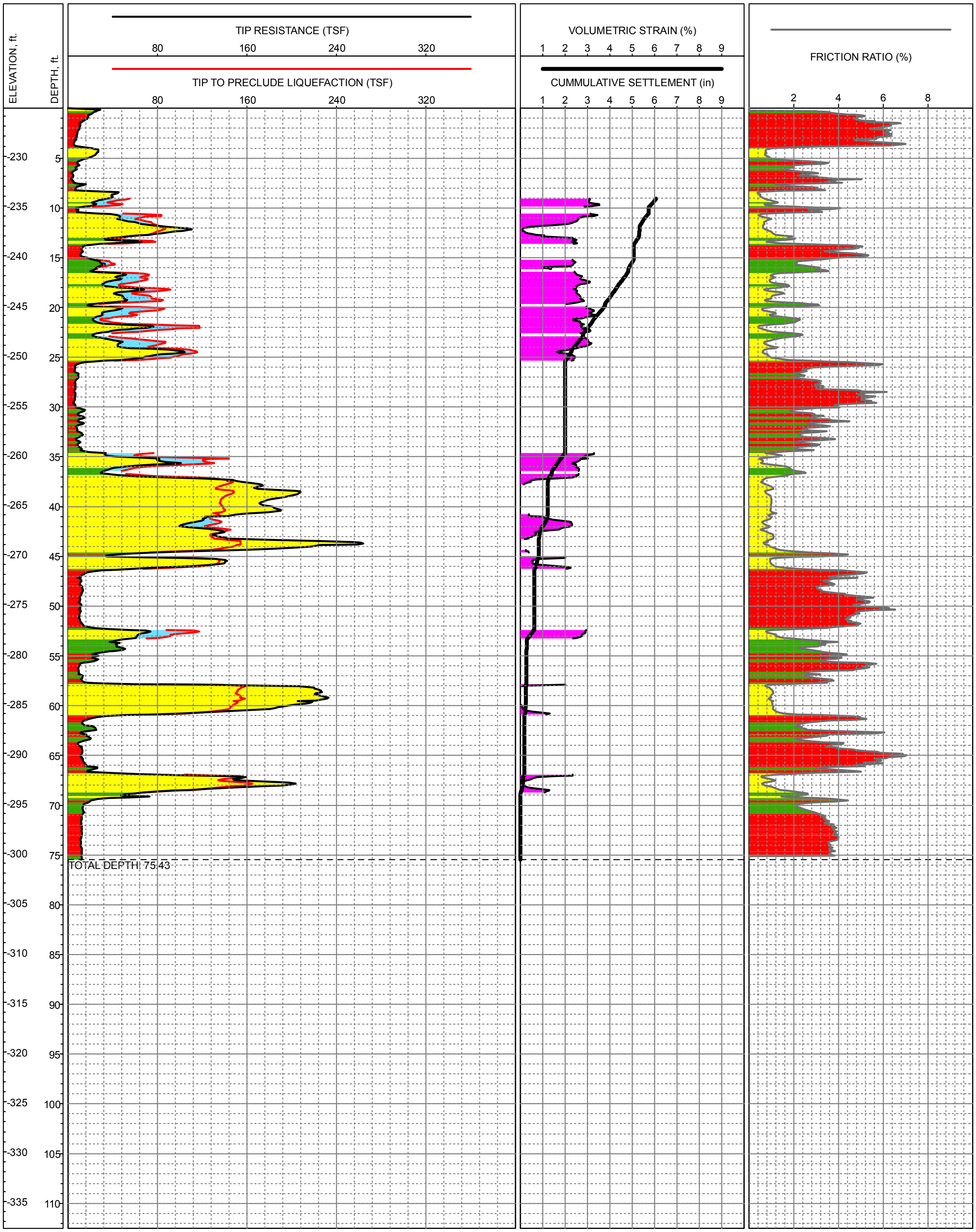
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-115
P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-16

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,408, N2,004,134, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.2ft +/- (NAVD88)
COMPLETION DEPTH: 75.43ft
TESTDATE: 10/8/2008

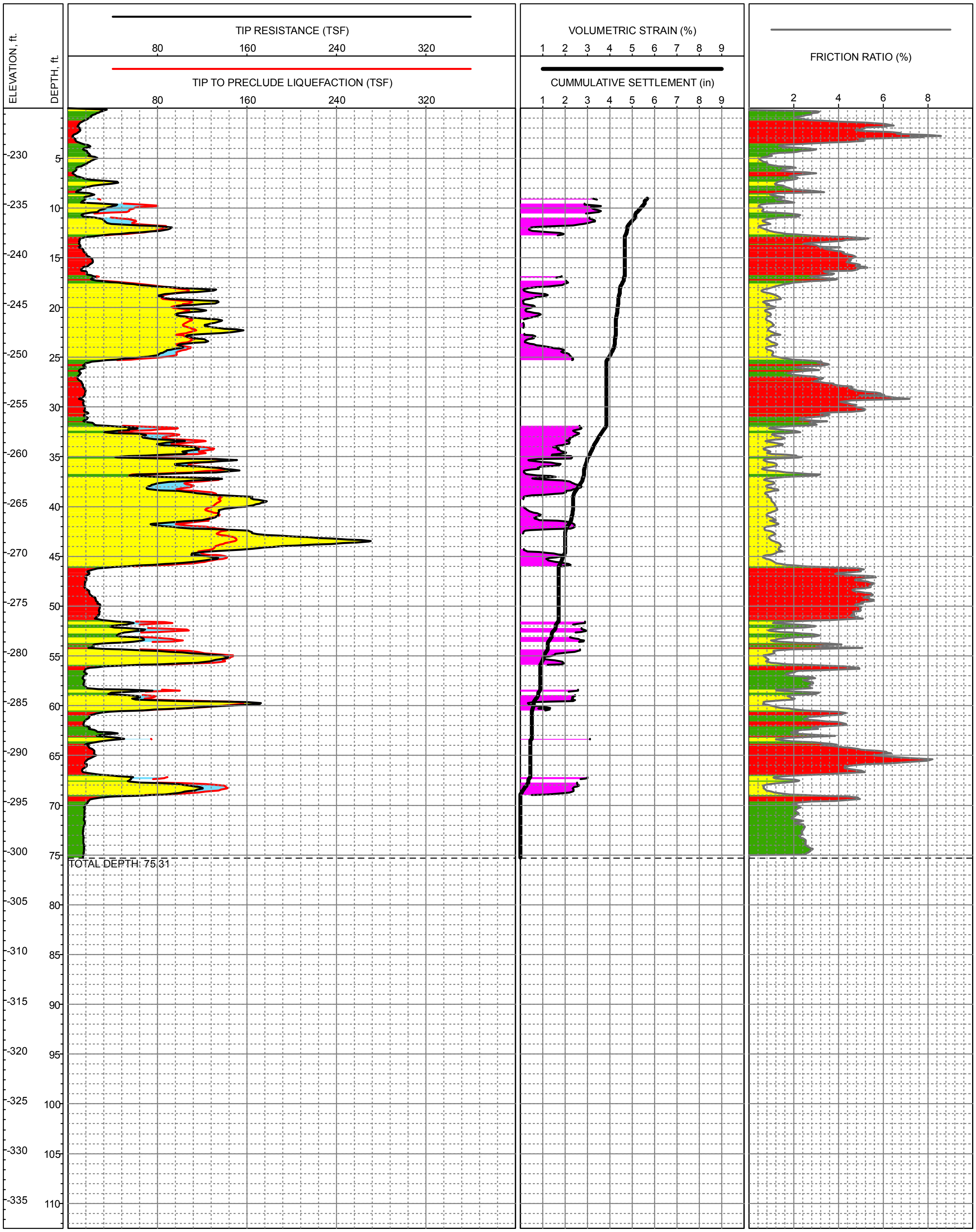
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-116

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-17

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean



LOCATION: E6,752,530, N2,004,215, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.4ft +/- (NAVD88)
COMPLETION DEPTH: 75.31ft
TESTDATE: 10/9/2008

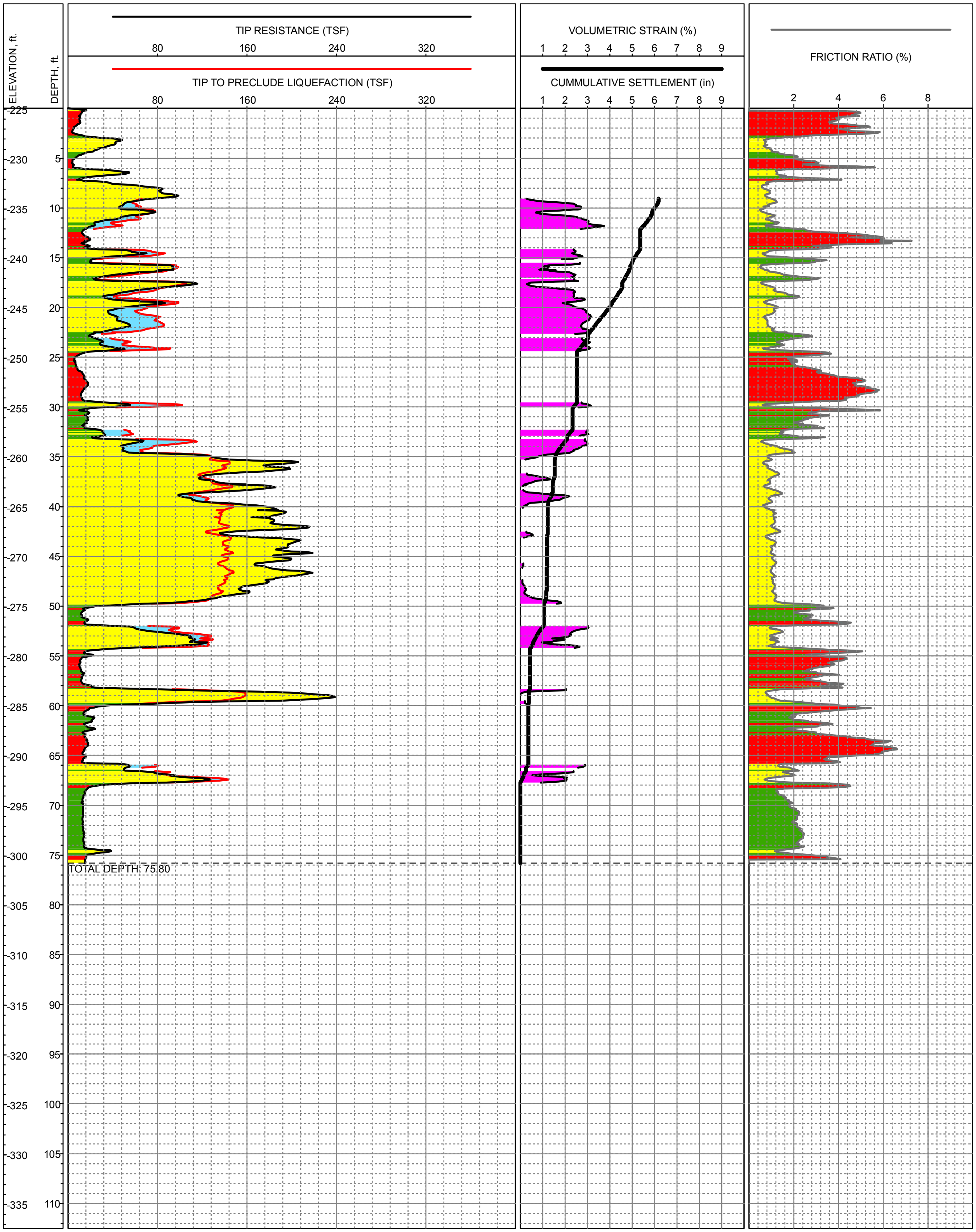
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-117

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-18

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,706, N2,004,045, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -224.9ft +/- (NAVD88)
COMPLETION DEPTH: 75.80ft
TESTDATE: 10/9/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

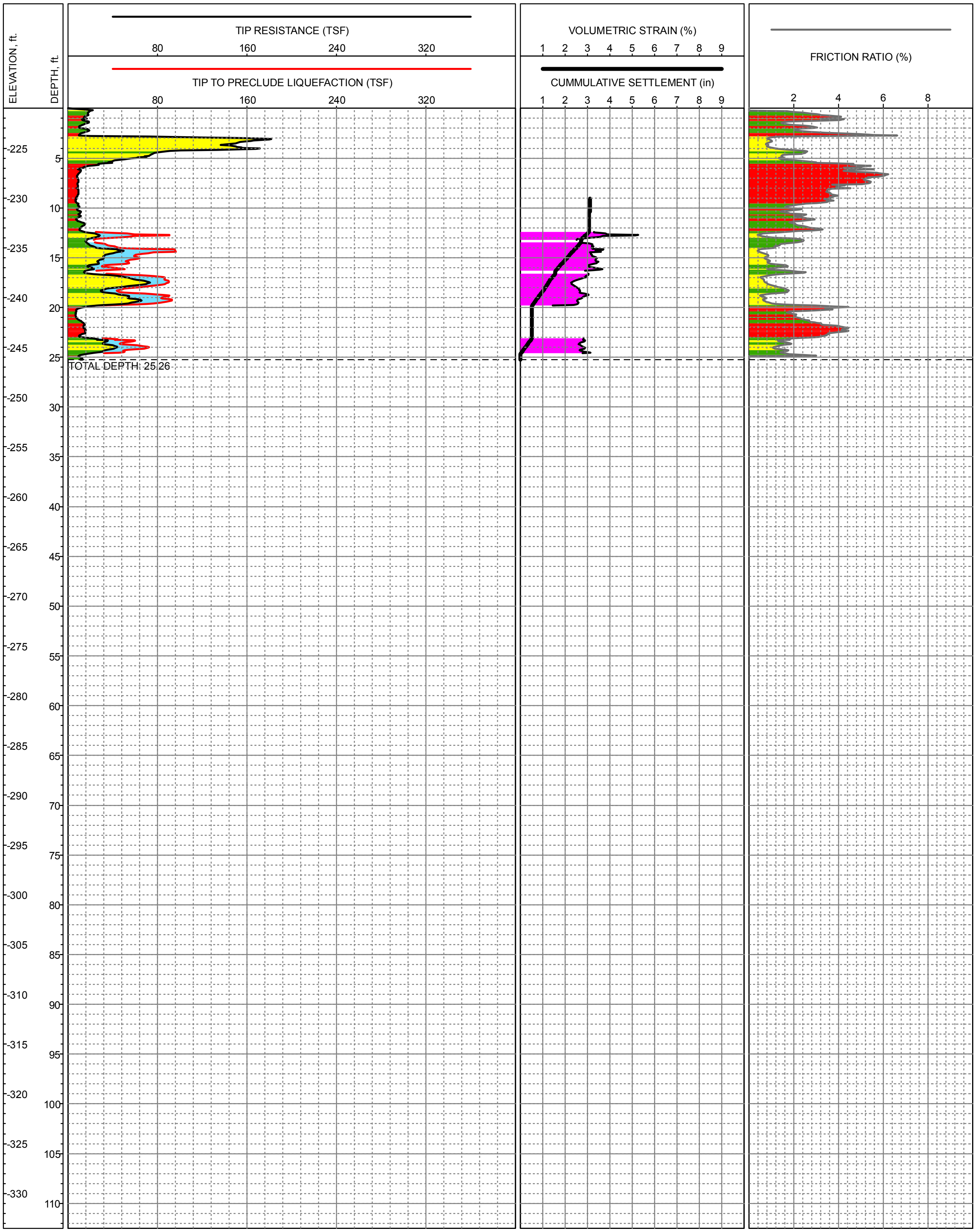
LIQUEFACTION LOG OF CPT NO: C-118

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-19

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,750,965, N2,003,867, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -221.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.26ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

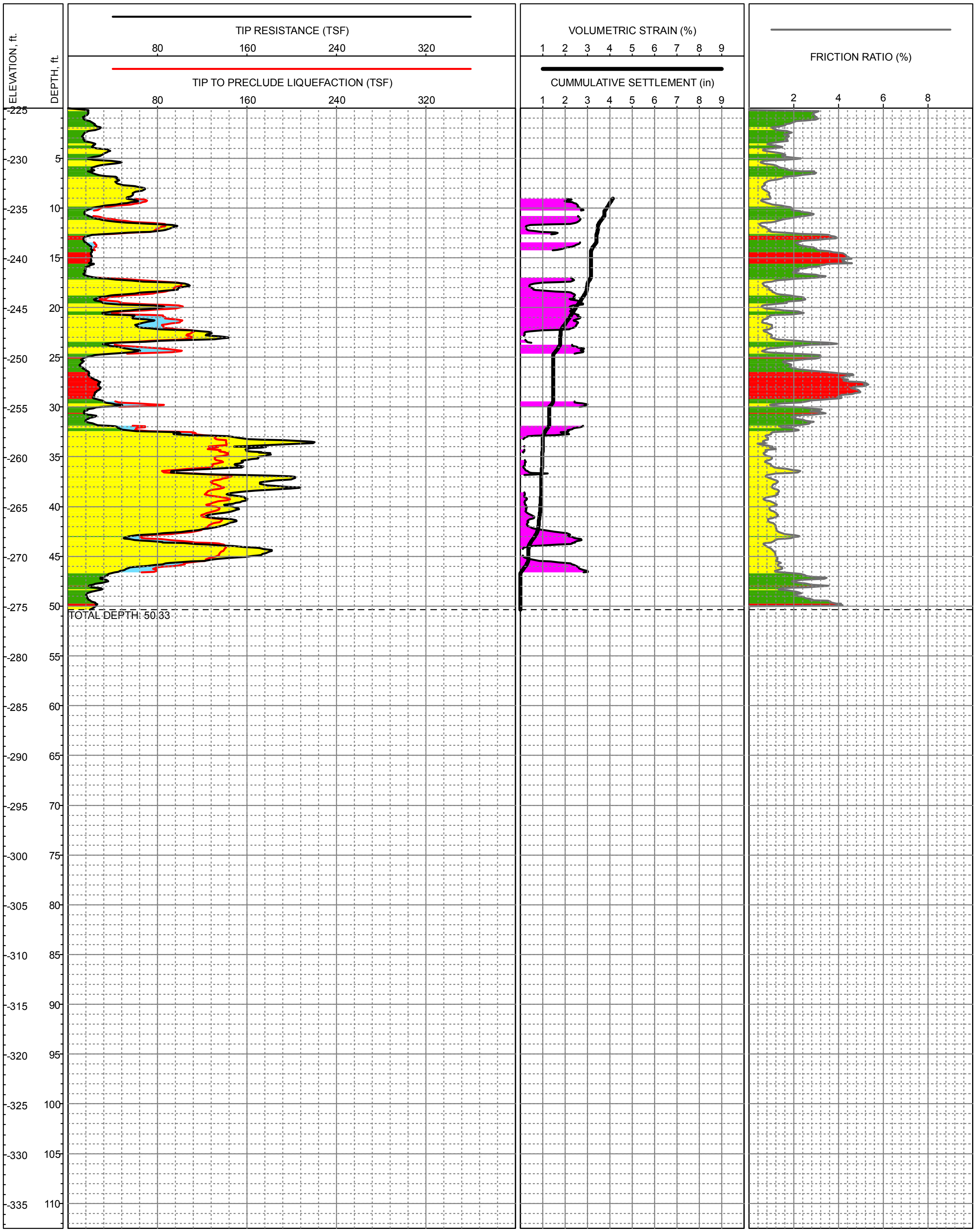
LIQUEFACTION LOG OF CPT NO: C-119

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-20

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean

CalEnergy Operating Corporation
Project No. 3652.001



LOCATION: E6,752,247, N2,003,460, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -224.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.33ft
TESTDATE: 10/8/2008

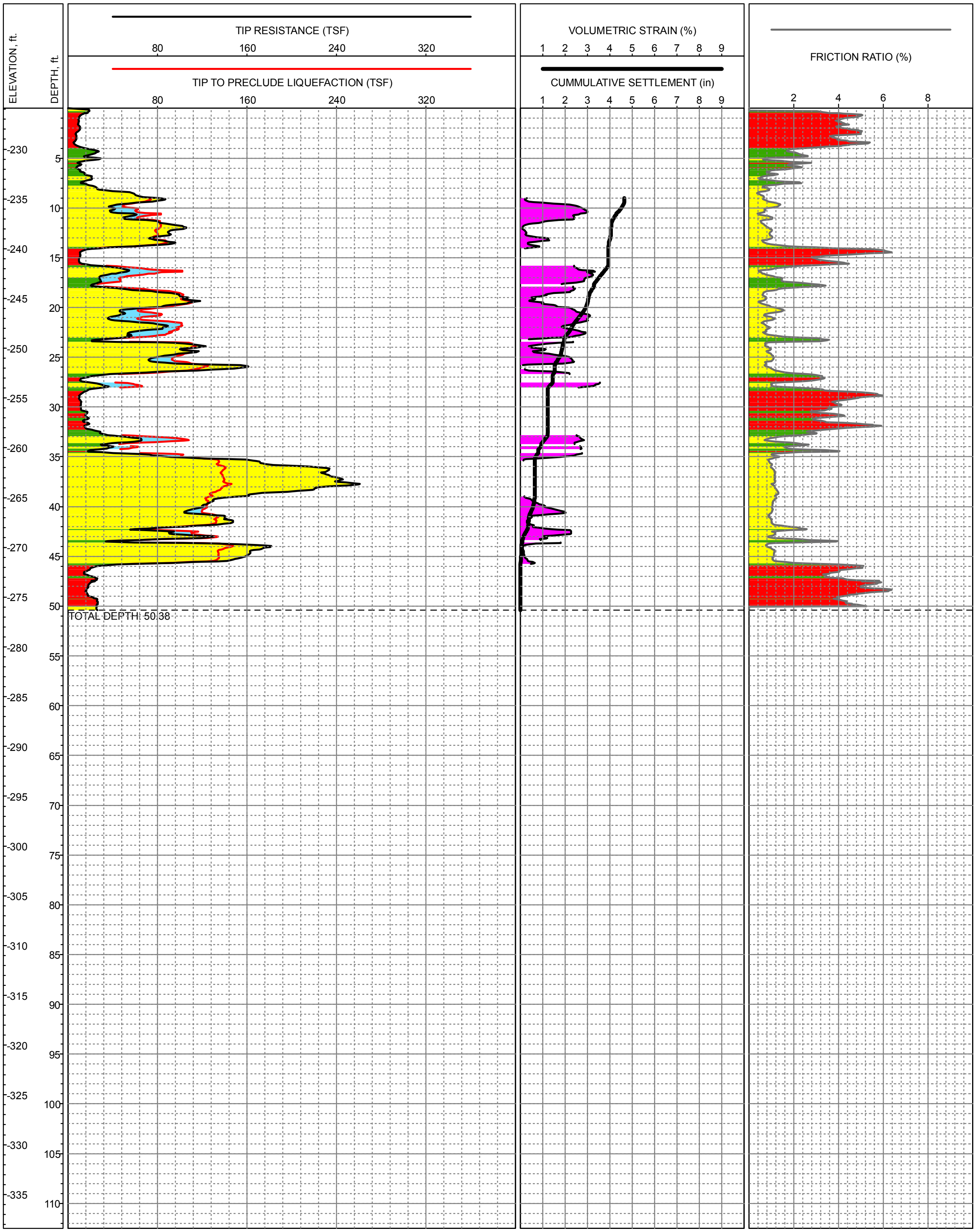
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-120

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-21

N:\Projects\3652_CalEnergy\3652-001_Black_Rock\Explorations\CPT\2008\Logs\Logs_BlackRock123_Liqu_2008_12_18\MXD\Logs_BlackRock123_Liqu_2008_12_18.mxd,01/16/2009,CDean



LOCATION: E6,752,168, N2,004,311, CA State Plane, Zone 6, NAD83, Feet
SURFACE EL: -225.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.38ft
TESTDATE: 10/8/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Kehoe Testing & Engineering
REVIEWED BY: Jon Everett

LIQUEFACTION LOG OF CPT NO: C-121

P.G.A. = 0.40g and Mw = 6.5
Black Rock Units 1, 2 & 3
Calipatria, California

FIGURE C-22