REVISED FINAL FOUNDATION REPORT

Camino Capistrano Undercrossing (Widen)
Bridge No. 55-0227L
Orange County, California
12-ORA-5, PM 7.4
Caltrans Project No. 1200020279 (EA 12-0F96E4)
EMI Project No. 11-137
Date: January 23, 2013

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

January 23, 2013

EMI Project No. 11-137

TRC Solutions, Inc.
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Irvine, California 92618

Attention: Dr. Ayman Salama, P.E.

Subject: Revised Final Foundation Report for Camino Capistrano Undercrossing (Widen)
Bridge No. 55-0227L
Orange County, California
12-ORA-5, PM 7.4
Caltrans Project No. 1200020279 (EA 12-0F96E4)

Dear Dr. Salama:

Attached please find the Revised Final Foundation Report for the subject bridge widening. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the bridge foundations.

The previous version of the report dated January 19, 2013 was approved by Caltrans Office of Geotechnical Design South 1 (OGDS-1) and the approval memorandum dated January 22, 2013 is presented in Appendix D.

Earlier versions of this report dated April 23 and October 5, 2012 were submitted to Caltrans for review. OGDS-1 review comments were provided in memorandums dated August 31, 2012 and January 4, 2013. EMI responses to OGDS-1 comments were reviewed by the Caltrans Oversight Geo-Professional Dr. Sharid Amiri at the over-the-shoulder review meeting conducted at the EMI office on September 20, 2012 and January 9, 2013. The EMI oversight engineers, Mr. Lino Cheang and Mr. Raja Pirathiviraj on September 20, 2012, and Mr. Andrew Korkos, Mr. Mike Kapuskar and Mr. Raja Pirathiviraj on January 9, 2013, were the attendees of the meeting. Responses to Caltrans comments have been incorporated into this Foundation Report. Caltrans review comments, EMI responses, and email correspondences are provided in Appendix D.

We appreciate the opportunity to provide geotechnical design services for this project.

Sincerely,
EARTH MECHANICS, INC.

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REVISED FINAL FOUNDATION REPORT

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BRIDGE NO. 55-0227L
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Prepared for:

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EMI Project No. 11-137

January 23, 2013

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF STUDY

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed widening of Camino Capistrano Undercrossing (UC) (Bridge No. 55-0227L) in Orange County, California. A site location map is presented in Figure 1-1.

EMI is a subconsultant to TRC Solutions, Inc. (TRC). The geotechnical services provided for this project included the following tasks:

- Collection and review of existing geotechnical information;
- Site-specific field exploration consisting of drilling and logging exploratory borings and cone penetration test (CPT) soundings;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

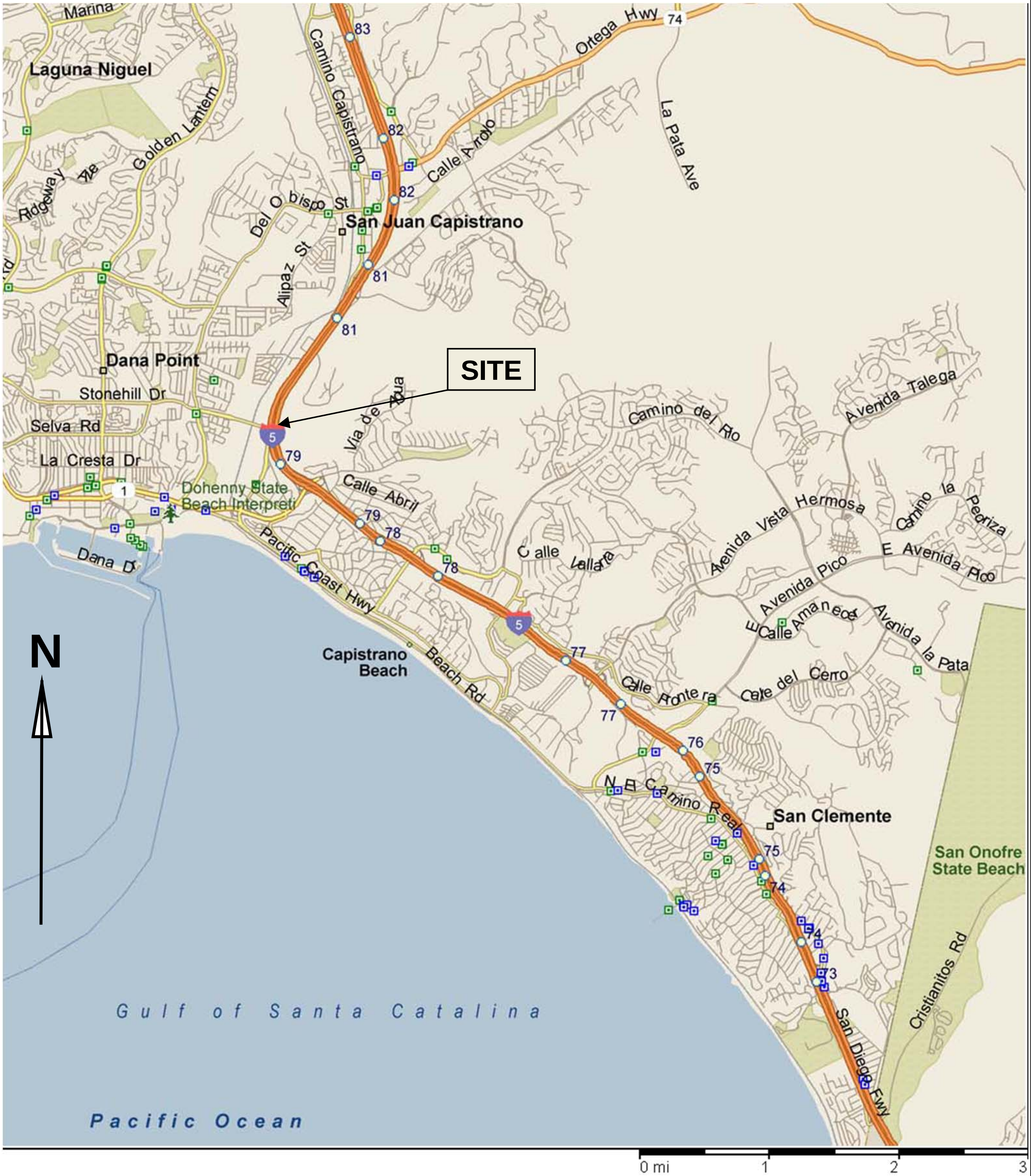
1.2 PROJECT DESCRIPTION

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Dana Point and San Juan Capistrano, proposes to improve the I-5 corridor. The project's southern terminus is approximately 0.6 mile south of the PCH/Camino Las Ramblas Interchange (I-5 Mainline Station 340+00) in the City of Dana Point. The northern terminus of the project is approximately 0.2 mile south of San Juan Creek Road (I-5 Mainline Station 465+00) in the City of San Juan Capistrano. The total project length along the I-5 corridor is approximately 2.5 miles. However, according to the Project Report prepared in October 2011, the proposed project improves the I-5 corridor from I-5 Mainline Stations 340+00 (southern project limit) to 407+50. From I-5 Mainline Stations 407+50 to 465+00 (northern project limit), the proposed project will consist primarily of restriping the existing pavements only. The proposed improvement project includes widening of three bridge structures; 5/N5-N1 Connector Separation (Bridge No. 55-0226), Route 5/1 Separation (Bridge No. 55-0510) and Camino Capistrano Undercrossing (Bridge No. 55-0227).

This foundation report addresses Camino Capistrano UC widening.

1.3 AS-BUILT FOUNDATION DATA

This bridge was originally entitled "Serra On-Ramp Undercrossing" in the 1960 and 1969 as-built plans, and then changed to "Camino Capistrano On-Ramp Undercrossing" in the 1996 as-built plans. Currently, the bridge is known as "Camino Capistrano Undercrossing".



Camino Capistrano UC (Widen)

Earth Mechanics, Inc.

Geotechnical and Earthquake Engineering

SITE LOCATION MAP

Figure 1-1

Project No. 11-137	Date: 03-29-12

The structure was originally constructed in 1960 as separate left and right bridges. The left and right bridges were widened in 1969. The median was closed in 1996. The existing structure is a four-span structure with a variable length of about 250 feet and a variable width of about 164 feet. The existing UC is supported on shallow and pile foundations. Pertinent foundation data as shown on the as-built plans is summarized in Table 1-1.

Table 1-1. As-Built Foundation Data

Structures	Support Location	Foundation Type	Foundation Load	Bottom of Footing Elevations (feet)	Average As-Built Pile Tip Elevations (feet)
1960 Original	Abutment 1R	Concrete Piles	45 tons	+101.0	+38.6 to +41.3
	Bent 2R			+85.5 to +88.0	+34.7 to +49.7
	Bent 3R	Spread Footing	3 tsf	+75.0 to +80.5	Not Applicable
	Bent 4R			+80.5 to +85.0	
	Abutment 5R			+95.0 to +96.5	
	Abutment 1L	Concrete Piles	45 tons	+96.5 to +100.5	+34.7
	Bent 2L			+79.5 to +88.0	+34.7
	Bent 3L			+75.0 to +76.5	+34.7
	Bent 4L			+77.0 to +78.5	+39.7
	Abutment 5L			+90.0 to +96.5	+39.6
1969 Widening	Abutment 1R	16-inch CIDH Piles	45 tons	Match Existing	+55.0
	Bent 2R			+86.0	+54.3
	Bent 3R			+80.0	+54.3
	Bent 4R			+80.0	+59.0
	Abutment 5R			+93.0	+64.0
	Abutment 1L	Driven Class I Concrete Piles	45 tons	+89.75 to +96.5	+34.5
	Bent 2L			+80.0	+35.0
	Bent 3L			+74.0	+10.0
	Bent 4L			+76.0	+35.0
	Abutment 5L			+98.0	+34.0
1996 Median Closure	Abutment 1R	Driven PCC, 15-inch Octagonal Piles	70 tons	Match Existing	+28.20
	Abutment 1L			Match Existing	+28.20
	Bent 2			+78.5	+30.00
	Bent 3			+73.0	+40.00
	Bent 4			+75.0	+40.00
	Abutment 5R			Match Existing	+53.75
	Abutment 5L			Match Existing	+55.92

The as-built pile types for the 1960 original bridge and the 1969 widening (left bridge only) are unknown. For the 1969 widening, the plan shows the left bridge is supported on Driven Class–I Concrete Piles but the actual as-built pile type is not shown.

The existing UC will be widened in the west side only by a maximum width of 10'-7"±.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 FIELD INVESTIGATION

As-built Log-of-Test-Borings (LOTB) sheets are included in Appendix A. The as-built LOTB sheet for the original bridge construction shows nine rotary borings and five penetration borings drilled between November 1955 and April 1956. The as-built LOTB sheet for the 1969 widening shows two penetration borings and two rotary borings drilled in October 1965. The as-built LOTB sheet for the 1996 median closure shows two rotary borings drilled in January 1992. The top-of-hole elevations vary from about +79 to +111 feet, and the deepest boring was advanced to about elevation -10 feet. Existing grade at the freeway surface is between elevations +108 and +114 feet.

To supplement the existing subsurface information, three soil borings and one CPT sounding were performed between October 2 and 11, 2011. The exploration locations were field surveyed using California Coordinate System (CCS) 83 (1991.35) Zone 6 and vertical datum NAVD 1988 to obtain coordinates and elevations and establish stations and offsets. Boring information, including surveyed locations and elevations, are summarized in Table 2-1. Locations of the borings and CPT are shown on the LOTB sheets provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring/ CPT	Easting	Northing	Station (A-Line) (feet)	Offset (feet)	Top of Boring El. (feet)	Bottom of Boring El. (feet)	Ground Water El. (feet)	Drilling Method
A-11-348	6,127,141	2,118,721	397+27	74 Lt	+116.9	+15.4	NE	HSA
A-11-349	6,127,118	2,118,868	398+69	102 Lt	+81.7	+0.2	+63.7	HSA
CPT-11-349	6,127,118	2,118,868	398+69	102 Lt	+81.7	-23.6	NM	CPT
A-11-350	6,127,160	2,119,046	400+46	75 Lt	+113.1	+12.5	+42.4	HSA

Notes:
(1) A-Line = I-5 Mainline; NE = Not Encountered; NM = Not Measured.
(2) CPT = Cone Penetration Test; HSA = Hollow-Stem Auger.
(3) Exploration locations were field surveyed using California Coordinate System (CCS) 83 (1991.35) Zone 6 and vertical datum NAVD 1988.

Boring A-11-349 and CPT-11-349 were performed at the same location in order to calibrate the CPT data.

The HSA borings were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval was generally 5 feet.

Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb automatic trip hammer free falling from a height of 30 inches. The numbers of blows to advance the sampler each 6 inches of penetration were recorded. The number of blows for the final 12 inches or shorter of driving was recorded on the LOTB sheets. Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the California Drive sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 which was used for this project. The SPT hammer energy measurements for this drill rig were performed by SPT CAL under subcontract with 2R Drilling on April 14, 2011. The SPT hammer energy report is provided in Appendix A.

The CPT sounding was performed using an electronic cone penetrometer in general accordance with current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in^2 (10 cm^2) and a cylindrical friction sleeve with a surface area of 23.25 in^2 (150 cm^2). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the testing equipment. The computer generated graphical logs include tip resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

Seismic Cone Penetration Test (SCPT) was performed in CPT-11-349 to measure shear wave velocities (V_S) at various depths. The SCPT was pushed into the ground at the standard rate. The penetration was stopped at desired depths and shear waves were generated at the surface by hitting a beam with a sledge hammer. The time for the shear waves to reach the seismometer was measured and the V_S was calculated. The time measurements and the calculated V_S values at each depth are presented in Appendix A.

2.2 LABORATORY TESTING

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. The laboratory tests conducted to supplement the observations recorded during the field investigation and to obtain design parameters are presented in Table 2-2. Laboratory test results are included in Appendix B.

Table 2-2. Explanation of Laboratory Tests Performed

Type of Test	Applicable Test Method	Purpose
Unit Weight	ASTM D 4767	Estimate in-situ unit soil weight
Moisture Content	ASTM D 2216	Estimate in-situ soil moisture content
Percent Passing No. 200 Sieve	ASTM D 1140	Determine the percentage of fine grained particles of soil
Consolidation	ASTM D 2435	Determine compressibility of fine-grained soil
Direct Shear	ASTM D 3080	Determine strength parameters of coarse-grained soil
Unconsolidated Undrained Triaxial	ASTM D 2850	Estimate strength parameters of fine-grained soil
Soil pH	CT 532/643	Determine corrosion potential of soil
Minimum Resistivity	CT 532/643	Determine corrosion potential of soil
Sulfate Content	CT 417	Determine corrosion potential of soil
Chloride Content	CT 422	Determine corrosion potential of soil

Notes:
1. ASTM = American Society for Testing and Materials.
2. CT = California Test Method.

3.0 GEOLOGY

3.1 PHYSIOGRAPHY

The project area is in the northwestern part of the Peninsular Ranges physiographic province. The Peninsular Ranges comprise a northwest-southeast trending group of fault-bounded ranges between the Salton Trough and the Pacific Ocean. The Santa Ana Mountains, Puente Hills, and San Joaquin Hills are ranges within the Peninsular Ranges.

The site is located on the low lying rolling hills westerly of the Santa Ana Mountains at the southerly end of the San Joaquin Hills in an area referred to as the Capistrano Embayment.

3.2 GEOLOGIC STRUCTURE

The geological structure at the site consists of slightly to moderately folded bedrock of the Capistrano formation overlain by horizontally bedded Quaternary terrace deposits and alluvium without any notable geological structures such as faults, folds, or unconformities. The northerly portion of the project is underlain by deposits of the McCracken Hill landslide which is described in Section 3.3.

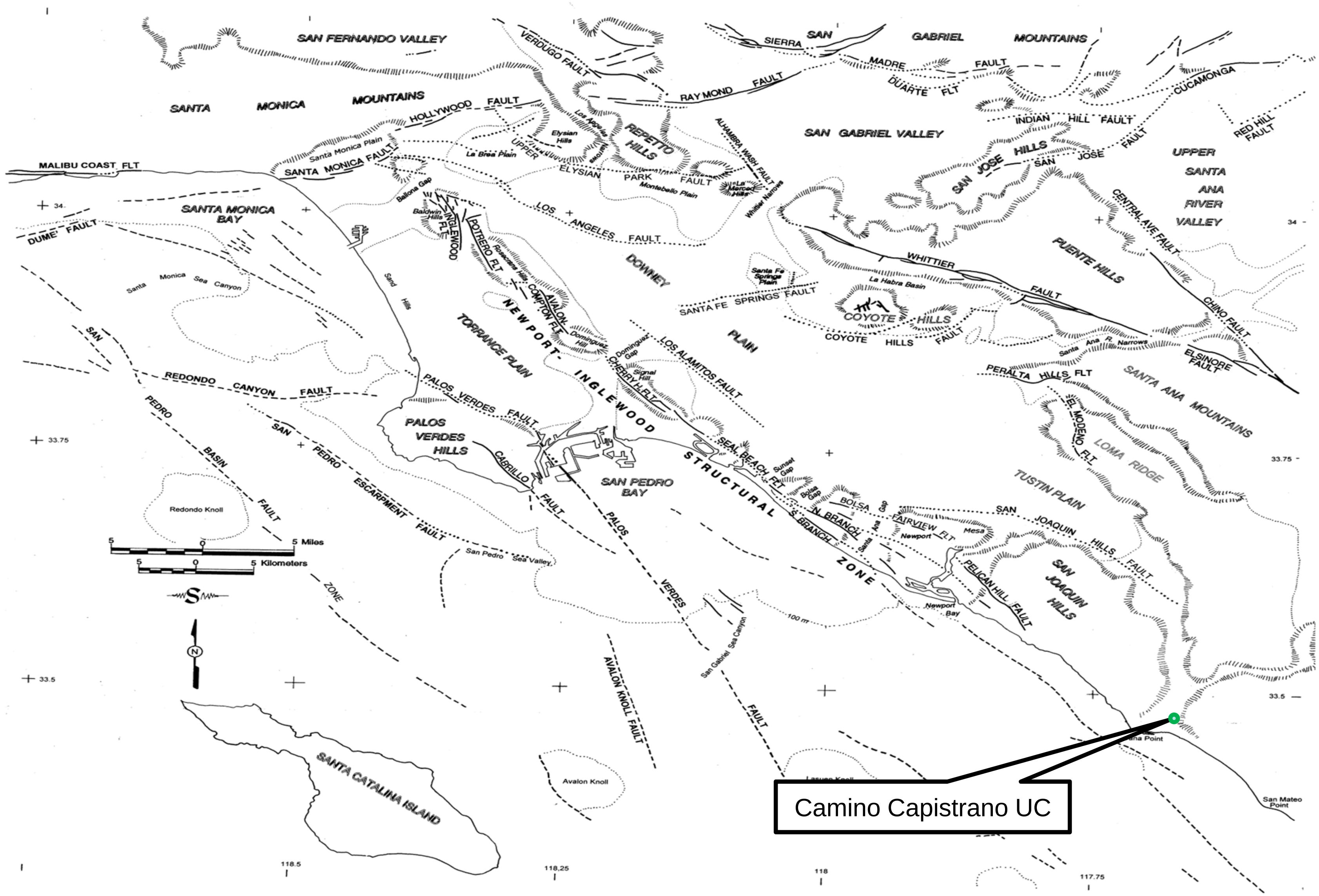
The Capistrano Formation is widespread throughout the southern part of Orange County, which is known geologically as the Capistrano Embayment. The Capistrano Embayment is the name given to the structural/stratigraphic block west of the Cristianitos Fault. Geologic faults in the region are shown on Figure 3-1. Geological structure in the Capistrano Embayment area consists primarily of a broad, gentle syncline of the Monterey and Capistrano Formations between the San Joaquin Hills and the Santa Ana Mountains. This structure originated as a deep submarine structural trough that has since been uplifted at least 3000 feet from the marine environment to its present position above sea level (Ehlig, 1989). Subsequent regional uplift during the late Pliocene and Pleistocene time resulted in folding of the bedrock units.

The bedrock of the Capistrano Formation underlying the site was found to be massive to poorly bedded. Where bedding was observed, the strikes were generally to the northeast with shallow dips less than about 10 degrees westerly. Throughout the project corridor, the dominant structural pattern is high-angle joints and fractures within the Capistrano bedrock.

Pleistocene Terrace Deposits unconformaly overlie the Capistrano Formation. The contact is generally undulatory, with a slight overall dip seaward averaging about 2 degrees. This erosional contact is marked by cobble and boulder rich beds of varying thicknesses.

3.3 GEOLOGIC HAZARD

The geological hazards present at the site include earthquake shaking and landsliding. The site lies outside identified tsunami inundation zones (CGS, 2009), and there are no large bodies of water within the site area that could generate a seiche. There are no volcanos in the region and there are no known active surface faults within the project area so ground rupture is not a factor. As shown in Figure 3-2, the California Geological Survey (CGS, 2001a) has indicated that the project alignment has a low susceptibility to liquefaction during a strong earthquake. The potential for liquefaction is discussed in detail in Section 5.4.



Camino Capistrano UC (Widen)

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REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 11-137

Date: 03-01-12

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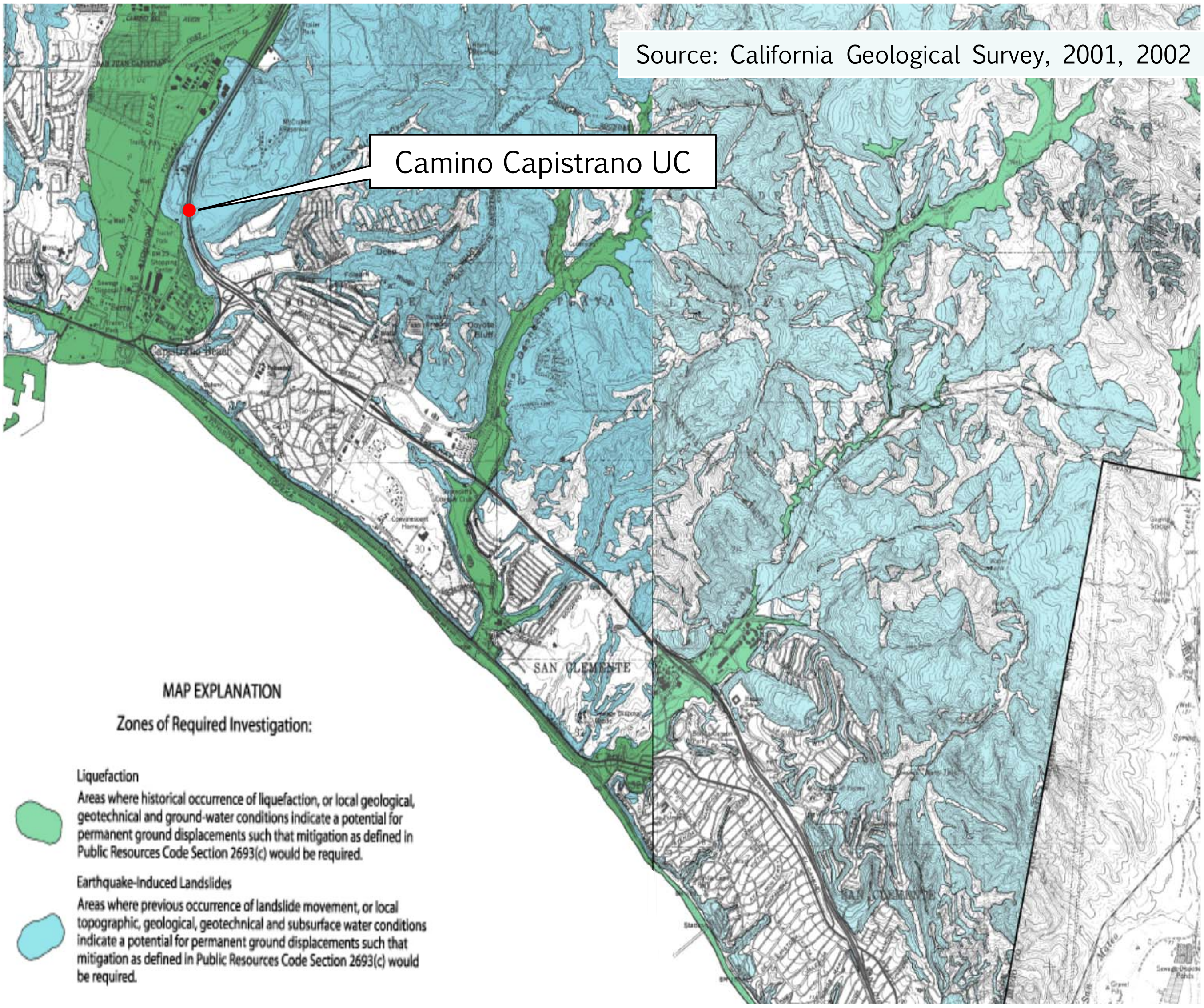
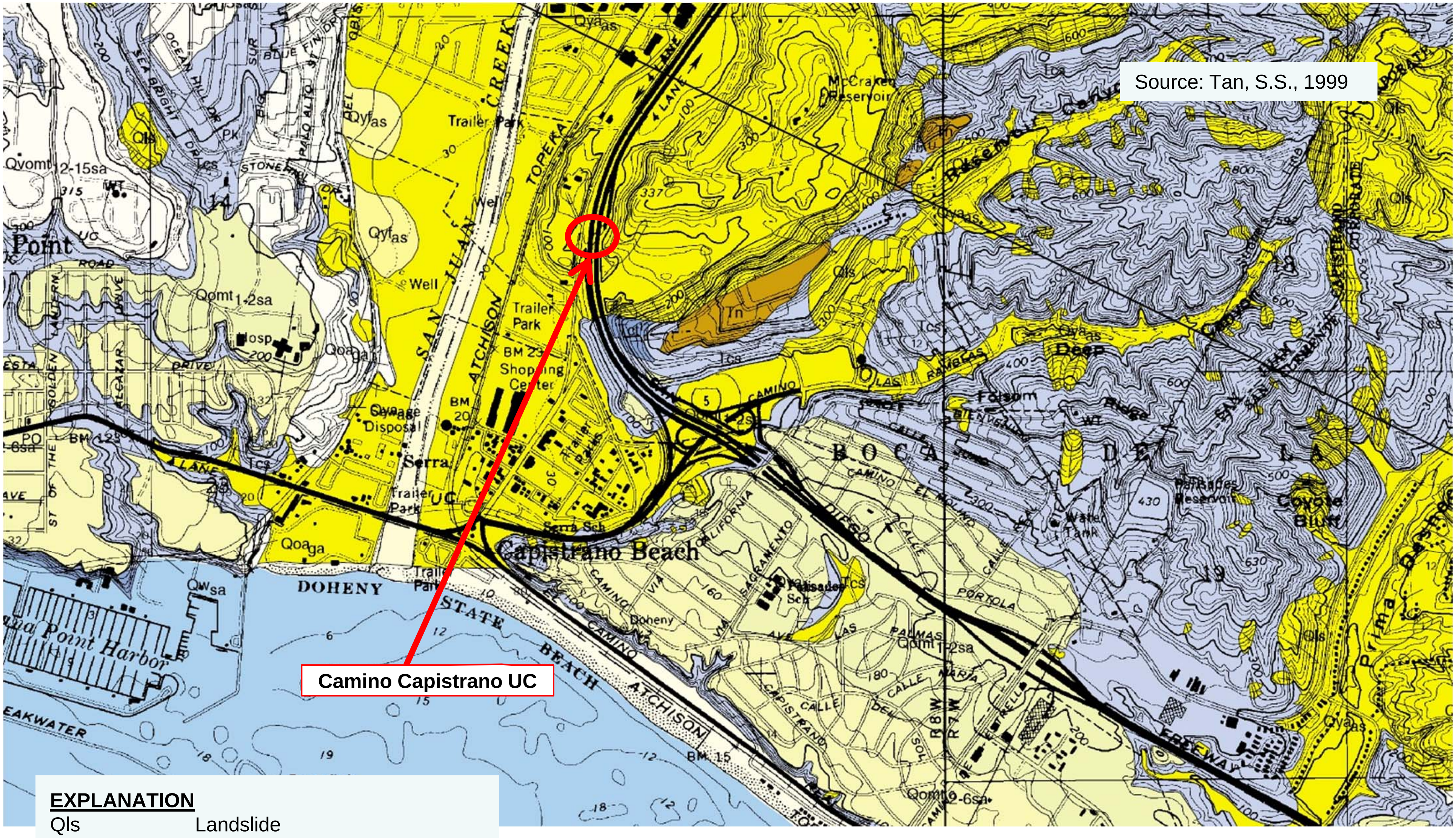


Camino Capistrano UC (Widen)	**MAP OF LIQUEFACTION POTENTIAL**	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 3-2	
	Project No. 11-137	Date: 03-01-12

The Capistrano Formation bedrock underlying the majority of the site is notoriously susceptible to landsliding. The landslides are shown in Figure 3-3. At the north of PCH/Camino Las Ramblas Interchange, the I-5 alignment traverses the McCracken Hill Landslide. The remnant headscarp of this ancient landslide is defined by a west to northwest facing slope that extends for about 7000 feet on the eastern side of the I-5 Freeway (AMEC, 2006a and 2006b). It is believed that the landslide occurred between 11,000 to 30,000 years ago when the sea level was lower than present day and San Juan Creek carved a deep channel on its course to the Pacific Ocean. During the Pleistocene, the climate was considerably wetter than present day and this combined with the loss of support at the toe of the slope due to erosion by San Juan Creek are believed to have been causative factors in the landslide failure. Since the landslide failure, a considerable thickness of alluvium has infilled the ancestral San Juan Creek channel with deposits more than 130 feet thick forming a natural buttress for the landslide mass. Extensive investigations of the landslide performed by Leighton and Associates (Leighton, 2004) and AMEC (AMEC, 2006a, 2006b, and 2000a through 2000e) in conjunction with proposed residential developments in the area indicate that the landslide is stable.

In addition, a smaller landslide is present along the PCH NB on-ramp to I-5 SB. The slope ascending from the PCH NB on-ramp to I-5 SB is underlain by Quaternary Terrace Deposits overlying bedrock of the Capistrano Formation. A landslide measuring approximately 150 feet wide by 300 feet long was observed on this slope during field mapping. Research of files at the City of Dana Point did not reveal any geologic reports relating to the landslide or details of when it occurred. Based on the geomorphology of the slide it appears to have been a shallow failure involving the Terrace Deposits and possibly the weathered upper portion of the underlying bedrock. It is estimated the landslide is likely less than about 30 feet deep. Proposed grading performed in conjunction with the project is not considered to have an impact on this landslide.

Bedrock exposures along Via Canon (southwesterly of the landslide, outside the limits of the geologic map) indicate that the bedding is variable but generally dips south to southeast at angles ranging from 5 to 22 degrees. This bedding orientation is generally considered favorable to the gross stability of the slope.



EXPLANATION

Qls	Landslide
Qya, Qoa	Alluvium
Qomt	Marine Terrace Deposits
Tcs, Tct	Capistrano Formation

Camino Capistrano UC (Widen)	**GEOLOGICAL MAP**
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 3-3
	Project No. 11-137 Date: 03-01-12

4.0 SUBSURFACE CONDITIONS

4.1 SOIL CONDITIONS

Near the proposed widening, the roadway elevation of the existing Camino Capistrano is about +81.5 feet and the roadway elevation of I-5 is about +113 feet. Based on the recent field investigation and as-built LOTB sheets, the site is underlain primarily by lean clay, lean clay with sand and silt with sand.

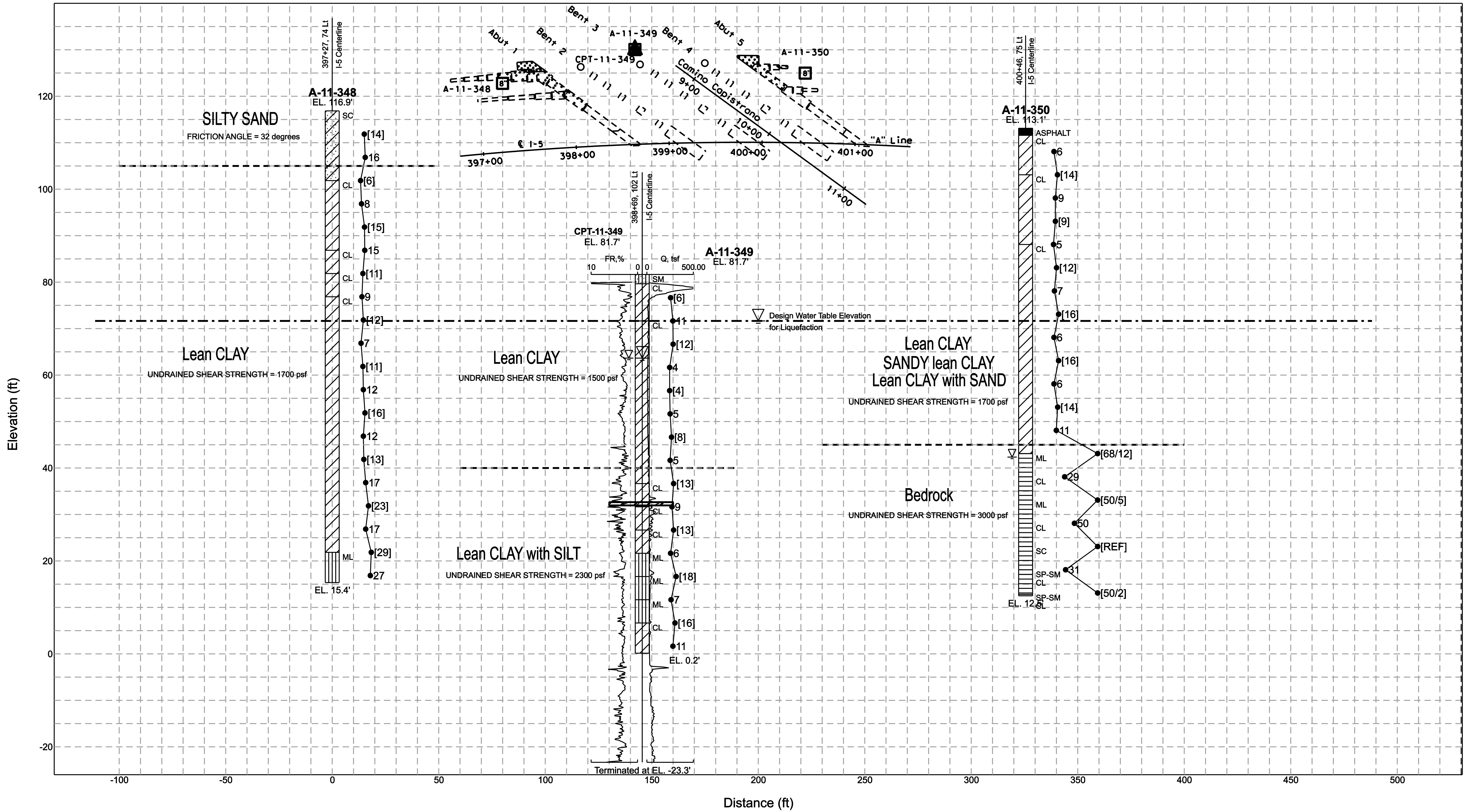
4.2 IDEALIZED SOIL PROFILE

The idealized soil profile and design strength parameters for foundation design are presented in Table 4-1 and shown in Figure 4-1. The strength parameters for the fine-grained soils in Table 4-1 were averages of shear strength parameters obtained from laboratory test results and CPT data (Robertson and Campanella, 1989). The strength parameters for the silty sand layer in Table 4-1 were based on correlations with SPT blowcounts (Lam and Martin, 1986).

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion / Undrained Shear Strength (psf)
Abutment 1 (Boring A-11-348)					
+117 to +105	Silty Sand	(14) and 16 Average = 15	120	32	100
+105 to +15	Lean Clay	(6) to (29) Average = 11	120	-	1700
Bents 2, 3 and 4 (Boring A-11-349 and CPT-11-349)					
+84 to +40	Lean Clay	4 to (12) Average = 7	120	-	1500
+40 to -23	Lean Clay and Silt	6 to (18) Average = 14	120	-	2300
Abutment 5 (Boring A-11-350)					
+110 to +45	Lean Clay, Sandy lean Clay and Lean Clay with Sand	5 to (16) Average = 10	115	-	1700
+45 to +12	Bedrock – Silt and Lean Clay	29 to >50 Average = 72	120	-	3000

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from Modified California Drive sampler blowcounts to SPT blowcounts is 0.5.



Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Camino Capistrano Undercrossing (Widen)
Bridge No. 55-0227

Date: 01-12-2013

Project No.: 11-137

Idealized Soil Profile

Figure 4-1

The as-built LOTB sheets for borings drilled in 1955, 1956, 1965 and 1992 appear to show that bedrock is shallower at west side of the I-5 median as compared to the east side of the I-5 median. At the same time, the subsurface data also shows that the bedrock contact is fairly uneven; for example, bedrock contact (1) varies from deeper than elevations zero to +90 feet between adjacent borings about 25 feet apart at one location, (2) remains relatively uniform at elevation +90 feet in the vicinity of the Camino Capistrano roadway centerline, and (3) dips downward from north to south. East of the I-5 median, none of the borings encountered bedrock with boring termination elevations varying from +30 to -10 feet except Penetrometer Boring B-3 met refusal at elevation +63 feet but there is no data supporting that bedrock was encountered at this elevation.

The recent borings and CPT were all located in the vicinity of the proposed widening. Thus, more emphasis is placed on using these recent borings and CPT data when estimating the elevation of the bedrock contact presented in Table 4-1. However, as supported by all the above data, there is uncertainty in the elevation of the bedrock contact.

Within the project limits, undrained shear strengths of the bedrock obtained from all the laboratory UU-tests range from 7,900 to 10,300 psf. Undrained shear strengths of the bedrock obtained from all the CPT correlations vary from 2,000 to over 10,000 psf. Based on this, it appears the laboratory measured shear strength is close to the average shear strength obtained from the CPT correlation. A closer examination of the CPT interpreted logs show a majority of the undrained shear strength values immediately below the bedrock contact varies from 2,000 to 6,000 psf. Conservatively, an undrained shear strength value of 3,000 psf was selected for the bedrock.

4.3 GROUNDWATER CONDITIONS

Groundwater was encountered only in two borings at elevations +42.4 feet and +63.7 feet during the recent field investigation. According to the attached as-built LOTB sheets, groundwater was encountered in two borings at elevations +24 and +57 feet in 1956, in one boring at elevation +59.7 feet in 1965, and at elevations +57.5 and +61 feet in 1992. Groundwater was not encountered in all the other borings.

The above data indicate that the groundwater encountered during EMI investigation in September and October of 2011 appears to be perched water. Nevertheless, groundwater during construction will likely be different from those reported above because groundwater level can fluctuate due to variations in seasonal precipitation, irrigation, groundwater injection or extraction, or numerous other man-made and natural influences.

Based on California Geological Survey, Division of Mines and Geology (CGS, 2001b), the highest historical groundwater at the project site is 5 to 10 feet below the ground surface. So, there is a major discrepancy between the CGS data and measured groundwater data described above. Based on our past experience, the CGS historical high groundwater data is often based on limited data and may or may not reflect actual site conditions. We believe the historical high groundwater data reported by CGS is likely to be either a perched water zone or the original ground surface is significantly lower than the current ground surface. In both cases, it does not appear to be representative of the site conditions. However, a conservative groundwater depth of 10 feet below the Camino Capistrano roadway is used for the liquefaction analyses.

5.0 SEISMICITY AND GEO-SEISMIC HAZARDS

5.1 SEISMIC STUDY

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, earthquake focal-mechanism solutions, and geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inch per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the region. Although historical earthquakes occur in proximity to known faults, they are difficult to directly associate with mapped faults. Part of this difficulty is due to the fact that the basin is underlain by several poorly known subsurface thrust faults, generally referred to as blind thrust faults. Ward (1994) estimated that about 40 percent of seismic moment cannot be associated with known faults. Earthquakes occur primarily as loose clusters along the Newport-Inglewood Structural Zone (NISZ), the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area. There is no clustering or alignment of earthquakes in proximity to the site. There are fewer earthquakes in the site region than anywhere else in the Los Angeles Basin area. This apparent lack of earthquake activity suggests that the site area is tectonically stable and suggests that there are no unrecognized active faults at the site.

The largest historical earthquake within the Los Angeles Basin was the 1933 Long Beach event which had a moment magnitude (M_W) of about 6.4 (M_L = 6.3). This earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). The association was based on abundant ground failures along the NISZ trend but no unequivocal surface rupture was identified. Reevaluation of the seismicity data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

Other major earthquakes in the region include the 1994 Northridge and the 1971 San Fernando earthquake both of which occurred in the San Fernando Valley region. The 1994 earthquake had a M_W of about 6.7 (M_S = 6.8, M_L = 6.4), and occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1.2 or 1.9 miles to 14 miles (Hauksson et al, 1995). The causative fault was never identified with certainty. The event may have occurred on an eastern extension of the Oakridge fault (Yeats and Huftile, 1995), a southerly dipping feature fault bounding the Ventura Basin and the Santa Susana Mountains.

The 1971 San Fernando earthquake was of similar size (M_W = 6.7, M_S = 6.4, M_L = 6.4) to the 1994 event but did involve surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains. Several mapped surface faults were involved such as the Sylmar fault, Tujunga fault, and Lakeview fault. These faults are commonly considered to be part of the Sierra Madre fault system which extends easterly from the San Fernando Valley, along the base of the San Gabriel Mountains on the north side of the San Gabriel Valley, and to the Cucamonga fault in the San Bernardino area.

The 1987 Whittier earthquake (M_L = 5.9, M_W = 5.9) occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

A magnitude 5.4 earthquake occurred at a depth of about 9 miles on 29 July 2008. The epicenter was in the Chino Hills area between the Chino fault and the Whittier fault. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62 degrees northeast. They suggested a preference for the Whittier fault being the causative fault but were uncertain, primarily because the Whittier fault is supposed to dip at about 80 degrees. The aftershock pattern formed a subhorizontal alignment indicating the possibility that the event could have been associated with a subsurface thrust fault such as one of the blind faults of the Puente Hills Blind Thrust Fault System or with a blind fault under the Peralta Hills.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1987; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large (M_W > 7.0) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola′ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events (for example, 1992 Landers event).

5.2 GROUND RUPTURE

There are no active faults through the project area, therefore the potential for ground rupture is remote to nil.

5.3 CALTRANS ARS CURVE

5.3.1 Development of V_s^{30}

A small-strain shear wave velocity (V_s^{30}) of 804 feet per seconds (ft/sec) was calculated using the measurements obtained by a seismic cone deployed in CPT-11-349 for the upper 100 feet of subsurface materials. A V_s^{30} of 663 ft/sec was also calculated using correlations with SPT blowcounts (Caltrans, 2009e) for the upper 100 feet of subsurface materials obtained from the soil boring A-11-349. The calculated V_s^{30} obtained from Boring A-11-349 and the remaining borings were normalized using the ratio of (804/663). The calculated and normalized V_s^{30} values are presented in Table 5-1.

Table 5-1. Small Strain Shear-Wave Velocity V_S^{30}

Boring/CPT	Source of Shear-Wave Velocity	Small Strain Shear-Wave Velocity V_S^{30} (feet/sec)	
		Calculated	Normalized
A-11-348	SPT Correlations	722	873
A-11-349	SPT Correlations	663	804
CPT-11-349	Field Measurements	804	804
A-11-350	SPT Correlations	774	938

5.3.2 Development of Caltrans ARS Curve

To develop the ARS curves in accordance with the 2010 Seismic Design Criteria (SDC) (Caltrans, 2010) and Geotechnical Services Design Manual (Caltrans, 2009e) procedures, we considered the following response spectra. The resulting ARS curve is the envelop of all the following spectra:

- Deterministic Criteria based on late-Quaternary faults in the 2007 fault database (Shantz and Merriam, 2009 and Caltrans, 2009a and 2009c).
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion.
- Minimum Deterministic Spectrum based on a Mw = 6.5 strike-slip event occurring at a distance of 7.5 miles (12 km) from the site.

We used the Caltrans Deterministic Response Spectrum Spreadsheet as recommended by the Geotechnical Services Design Manual (Caltrans, 2009e) to develop the deterministic ARS curves. The spreadsheet uses the arithmetic average of two Next Generation Attenuation (NGA) relationships developed by Chiou-Youngs (2008) and Campbell-Bozorgnia (2008) with user-provided input parameters as listed in Table 5-2. Results obtained from the spreadsheet were then verified with the Caltrans online web tool (Caltrans, 2009b).

The probabilistic response spectrum is based on data from the 2008 United States Geological Survey (USGS, 2008a) National Seismic Hazard Map for the 5% in 50 years probability of exceedance (975-year return period) ground motion. To develop the probabilistic spectrum, the Caltrans Probabilistic Response Spectrum Spreadsheet and the USGS Interactive Deaggregation Tool (USGS, 2008b) were used. Results obtained from both the spreadsheet and deaggregation tool were then verified with the Caltrans online web tool (Caltrans, 2009b).

Table 5-2. Site Characteristics and Deterministic Controlling Fault Parameters

Site Characteristics	
Site Coordinates	Latitude = 33.4736 degrees Longitude = -117.6749 degrees
Depth to V_s=1.0 km/s, $Z_{1.0}$	Site is not in deep sedimentary basin, therefore basin amplification factors = 1
Depth to V_s=2.5 km/s, $Z_{2.5}$	
Deterministic Controlling Fault Parameters	
Fault Name	Newport-Inglewood-Rose Canyon Fault (Offshore or Dana Point)
Fault ID	222
Fault Type	Right Lateral Strike Slip (RLSS)
Fault Dip	90 degrees
Dip Direction	Vertical
Top of Rupture Plane	0 miles (0 km)
Bottom of Rupture Plane	8.12 miles (13 km)
R_{RUP}[1]	3.93 miles (6.28 km)
R_{JB}[2]	3.93 miles (6.28 km)
R_X[3]	3.93 miles (6.28 km)
F_{rv} (1 for reverse, 0 for others)	0
F_{nm} (1 for normal, 0 for others)	0
Hang Wall	No
Near-Field Factor Required	Yes, up to 1.2

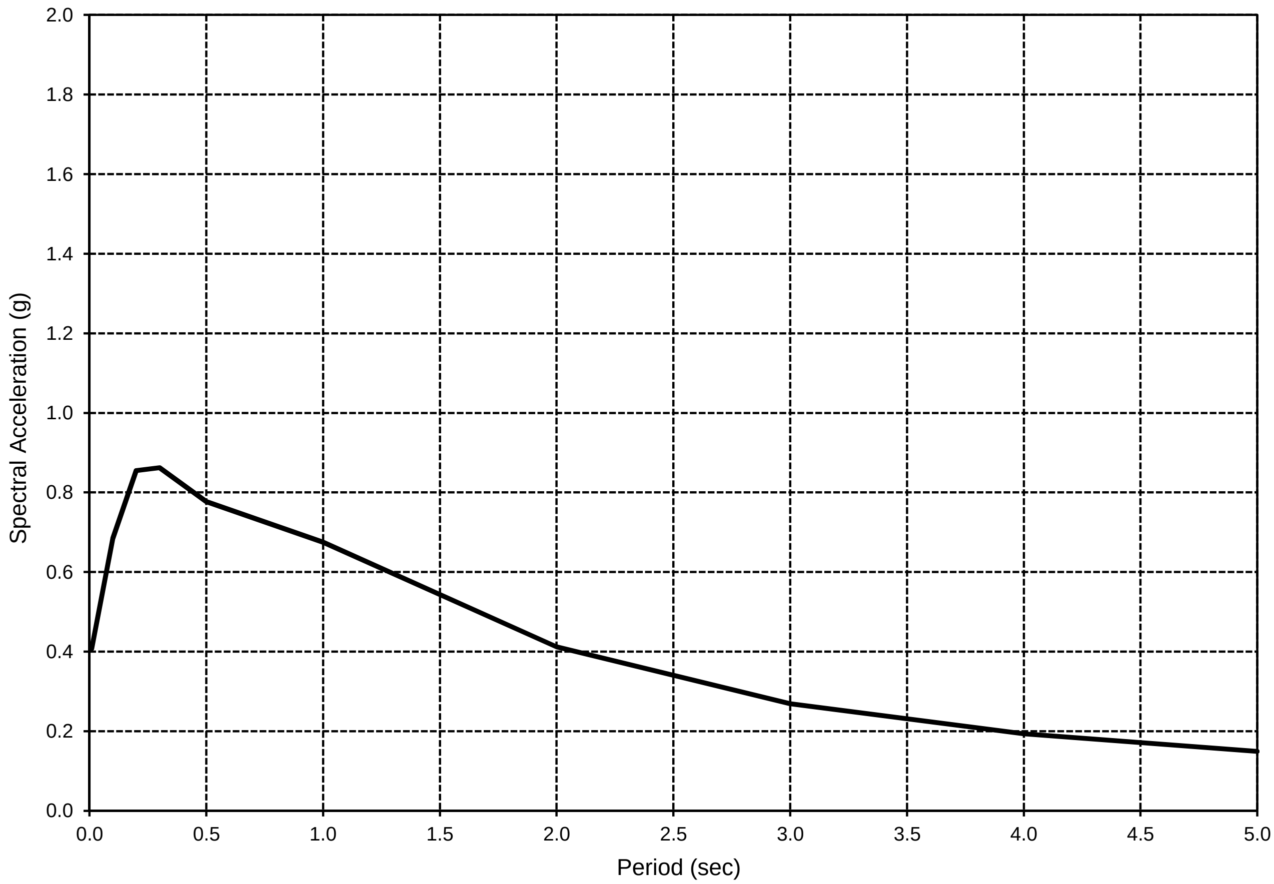
Note:
1. R_{RUP} = closest distance from the site to the fault rupture plane.
2. R_{JB} = Joyner-Boore distance; the shortest horizontal distance to the surface projection of the rupture area.
3. R_X = horizontal distance from the site to the fault trace or surface projection of the top of the rupture plane.

ARS curves were developed for each normalized V_s^{30} presented in Table 5-1. The design ARS curve is the mathematical mean of all the ARS curves, and this design ARS curve is presented in Figure 5-1 together with the digitized coordinates. As shown in Figure 5-1, a peak ground acceleration (PGA) of 0.408g is obtained from the design ARS curve.

5.4 LIQUEFACTION

Liquefaction analysis was performed using the available site-specific subsurface information from borings and CPT. As discussed in Section 4.3, there is a major discrepancy between CGS groundwater data and measured groundwater data. A conservative groundwater depth of 10 feet below the Camino Capistrano roadway is used for the liquefaction analyses.

The liquefaction potential of saturated, granular materials below the groundwater table was evaluated using the procedures outlined by Seed et al. (1983), Seed and Harder (1990), and updated by NCEER (1997). Results of the liquefaction analyses are included in Appendix C. Based on the analyses, granular materials susceptible to liquefaction were encountered only in the CPT using a very conservative groundwater depth. The liquefiable layer is less than 1.5 feet thick, and it is isolated and discontinuous. Therefore, the liquefaction potential is concluded to be low. Furthermore, as discussed in Section 3.3, the California Geological Survey (CGS, 2001a) has also indicated that the project alignment has a low susceptibility to liquefaction during a strong earthquake.



Latitude = 33.4736 °
Longitude = -117.6749 °
Damping Ratio = 5%

Spectral Coordinates	
	Acc. (g)
Period (sec)	Design
0.010	0.408
0.100	0.684
0.200	0.855
0.300	0.862
0.500	0.777
1.000	0.675
2.000	0.412
3.000	0.269
4.000	0.193
5.000	0.150

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Camino Capistrano UC		Design ARS Curve
	Project: 11-137	Date: 01/12/12	Figure 5-1

5.5 LATERAL SPREAD

Since the liquefaction potential at the project site is low, liquefaction induced lateral spreading is also considered low. Therefore, lateral spreading is not considered a design issue.

5.6 SEISMIC SETTLEMENT

The seismically-induced settlement calculation is also presented in Appendix C. In the liquefiable layer, seismically-induced settlement is expected to be no more than 0.1 inches. Since this liquefiable layer is relatively thin, isolated and discontinuous, the seismically-induced settlement is not expected to adversely impact the bridge widening.

6.0 SOIL CORROSIVITY

Three soil samples were tested for pH, minimum resistivity, soluble chloride content and soluble sulfate content. The test results are summarized in Table 6-1. Minimum resistivities were between 270 and 760 ohm-cm. The pH values were between 7.6 and 8.1. The soluble sulfate measurements were between 680 and 6,400 parts per million (ppm), and the soluble chloride measurements were between 341 and 649 ppm.

Table 6-1. Soil Corrosion Test Results

Boring	Location (A-Line Stations)		Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
	Station (feet)	Offset (feet)						
A-11-348	397+27	74 Lt	20.0	CL	270	7.6	6,400	649
A-11-349	398+69	102 Lt	5.0	CL	760	8.1	680	392
A-11-349	398+69	102 Lt	50.0	CL	510	8.0	1,800	341

Based on the Caltrans Corrosion Guidelines (2003c), soils are considered corrosive if the pH is 5.5 or less, or the sulfate concentration is 2,000 ppm or greater, or the chloride concentration is 500 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be corrosive to bare metals and concrete.

For the above measured chloride concentration, minimum concrete cover over reinforcement should be in accordance with Table 8.22.1 of the Caltrans BDS (Caltrans, 2003a) for "Corrosive soil above MLLW level with chloride concentration between 500 and 5,000 ppm". For the above measured sulfate concentration, cement type should be in accordance with Table 8.22.2 of the Caltrans BDS (Caltrans, 2003a) for "Sulfate Concentration from 2,000 to 15,000". Additional corrosion protection requirements for concrete structural members are presented in Section 8.22 of the Caltrans BDS (Caltrans, 2003b).

7.0 SCOUR

This site is located within an area that is presently improved; roadway surfaces are paved and drainage is controlled by engineered facilities. Therefore, scour is not considered a design issue.

8.0 FOUNDATION RECOMMENDATIONS

8.1 CAMINO CAPISTRANO UNDERCROSSING WIDENING

8.1.1 Foundation Type

According to the as-built plans, the original UC bridge is supported on shallow and pile foundations. Bents 3R and 4R, and Abutment 5R are supported on spread footings with a footing pressure of 3 tsf. Abutment 1R, Bent 2R, and the left bridge are supported on pile foundations. The bridge widening in 1969 and median closure in 1996 are supported on pile foundations. As-built foundation data from the as-built plans are summarized in Table 1-1.

According to the structural engineers, spread footings are not suitable because of large footing pressures and lateral demand at the abutments and bents. Additionally, settlement calculations were performed at the abutments and bents using the as-built bearing pressures. The settlement of the abutments and bents spread footing is estimated to be larger than 1-inch with 5-feet of overexcavation below the footing bottom. The settlement calculations at abutments and bent footings are presented in Appendix C.

Based on the settlement estimates and structural demand, deep foundation is recommended for the proposed widening. Both driven and Cast-in-Drilled-Hole (CIDH) piles are feasible. Due to the high lateral demand at the abutments, structural engineers proposed vertical and battered Caltrans Standard Class 200 (Alternative "X") 14-inch square concrete driven piles (Caltrans, 2010b) which matches the pile type of the 1969 left bridge widening and the 1996 median closure. At the bents, due to the higher lateral demand and lack of space to construct a pile cap, structural engineers proposed a 7-foot diameter CIDH pile.

8.1.2 Foundation Data Provided by Structural Designers

Per Caltrans policy, LRFD Service-I Limit State load combinations and Working Stress Design (WSD) method provided in the Caltrans Bridge Design Specifications (2003b) are used for design of the abutment footings. The LRFD Service-I Limit State, Strength Limit State, and Extreme Event Limit State load combinations are used for the design of the bent footing.

The foundation design data sheets are presented in Table 8-1. Foundation loads were provided by the structural designers following the latest Caltrans Memo To Designers (Caltrans, 2008) and presented in Table 8-2.

Table 8-1. Foundation Design Data Sheet

Support No.	Design Method	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inch)	Number of Pile per Support
					B	L		
Abut 1	WSD	Class 200 Alt. X	+94.00	+89.75	8.00	15.84	1	13
Bent 2	LRFD	7-foot CIDH	+84.05	+83.50	N/A	N/A	1	1
Bent 3	LRFD	7-foot CIDH	+80.25	+79.75	N/A	N/A	1	1
Bent 4	LRFD	7-foot CIDH	+83.44	+82.84	N/A	N/A	1	1
Abut 5	WSD	Class 200 Alt. X	+100.40	+95.25	8.00	15.84	1	13

Table 8-2. Foundation Design Loads

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	803	92	735	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	527	N/A	398	762	N/A	N/A	N/A	398	N/A	N/A	N/A
Bent 3	583	N/A	450	847	N/A	N/A	N/A	450	N/A	N/A	N/A
Bent 4	492	N/A	359	722	N/A	N/A	N/A	359	N/A	N/A	N/A
Abut 5	408	68	341	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

8.1.3 Axial Pile Capacity

Abutments and Bents foundation design recommendations are presented in Table 8-3 and Table 8-4, respectively. The Pile Data Table for the contract plans is presented in Table 8-5.

At the abutments, a pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacings. Based on the layouts provided by the structural designers, GEF of 0.86 is used for the abutments piles.

The pile capacity calculations are presented in Appendix C. The nominal resistances for the abutment and bent piles are controlled by the Service-I Limit State "Maximum Per Pile Load" and Strength Limit State "Maximum Per Pile Load, respectively.

The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 8-3. Abutments Foundation Design Recommendations

Support	Pile Type	Cut-Off Elev. (feet)	LRFD Service-I Limit State Load per Support (kips)		LRFD Service-I Limit State Total Load per Pile (kips)	Nominal Resistance (kips)	Design Tip Elev. (feet)	Specified Tip Elev. (feet)	Nominal Driving Resistance Required (kips)
			Total	Permanent					
Abut 1	Class 200 Alt. X	+89.75	803	735	92	190	+34 (a) +65 (c) +59 (d)	+34	190
Abut 5	Class 200 Alt. X	+95.25	408	341	68	140	+40 (a) +83 (c) +65 (d)	+40	140

Notes:

1. Design tip elevations are controlled by the following demands: (a) Compression, (c) Settlement and (d) Lateral Load.
2. There are no design tip elevations for Tension at abutments.
3. The specified tip elevations for abutments shall not be raised above the design tip elevations for settlement and Lateral Load.

Table 8-4. Bent Foundation Design Recommendations

Support Location	Pile Type	Cut-off Elevation (feet)	Service-I Limit State Loads per Support (kips)	Total Permissible Support Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (feet)	Specified tip Elevation (feet)
					Strength Limit		Extreme Event			
					Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
Bent 2	7-foot CIDH	+83.50	527	1	762	N/A	398	N/A	+18 (a-I) +48 (a-II) +56 (c) +28 (d)	+18
Bent 3	7-foot CIDH	+79.75	583	1	847	N/A	450	N/A	+10 (a-I) +42 (a-II) +52 (c) +24 (d)	+10
Bent 4	7-foot CIDH	+82.84	492	1	722	N/A	359	N/A	+17 (a-I) +47 (a-II) +55 (c) +27 (d)	+17

Notes:

1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), (c) Settlement and (d) Lateral Load.
2. There are no design tip elevations for Tension at bents.
3. The Specified tip elevations for bents shall not be raised above the design tip elevations for Settlement and Lateral Load.

Table 8-5. Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (feet)	Specified Tip Elevation (feet)	Nominal Driving Resistance (kips)
		Compression	Tension			
Abutment 1	Class 200 Alt. X	190	N/A	+34 (a) +65 (c) +59 (d)	+34	190
Bent 2	7-foot CIDH	1090	N/A	+18 (a) +56 (c) +28 (d)	+18	N/A
Bent 3	7-foot CIDH	1210	N/A	+10 (a) +52 (c) +24 (d)	+10	N/A
Bent 4	7-foot CIDH	1040	N/A	+17 (a) +55 (c) +27 (d)	+17	N/A
Abutment 5	Class 200 Alt. X	140	N/A	+40 (a) +83 (c) +65 (d)	+40	140

Notes:

1. Design tip elevations are controlled by: (a) Compression, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tension at abutments and bents.
3. The specified tip elevations shall not be raised above the design tip elevations for settlement and lateral load.

8.1.4 Lateral Pile Capacity

For abutment piles, results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented in Appendix C and summarized in Table 8-6. The maximum bending moment and the location of maximum moment are also presented. The solutions presented in Table 8-6 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Based on the pile layout provided by the structural designers, a group efficiency factor of 0.76 was used for the abutment piles. Lateral solutions are provided for pile-head deflections from 0.25 to 5 inches, and linear interpolation can be used for solutions between pile-head deflections of 0.25 and 5 inches.

Table 8-6. Lateral Pile Solutions for Abutments

Support Location	Pile Head Deflection (inch)	Pile Head Shear (kips)	Maximum Moment (kip-in)	Depth to Maximum Moment from Pile Top (feet)
Abutments 1 and 5 (Class 200 Alt X)	¼	15.2	466	5.0
	½	21.8	754	5.5
	1	31.3	1221	6.0
	2	44.8	1985	7.0
	5	65.9	3729	8.0

For the CIDH piles at the bents, structural engineers provided the pile-head shear and the pile-head moment. Results of lateral pile analysis in terms of pile-head lateral deflection, maximum shear and maximum moment for the given pile-head shear and moment are presented in Appendix C and summarized in Table 8-7. The solutions presented in Table 8-7 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details.

Table 8-7. Lateral Pile Solutions for Bents

Support Location	Pile Head Shear (kips)	Pile Head Moment (kip-in)	Pile Head Deflection (inch)	Maximum Shear (kips)	Maximum Moment (kip-in)	Depth from Pile Top (feet)	
						Max. Shear	Max. Moment
Bents 2, 3 and 4 (7-foot CIDH)	250	82,224	2.0	398	102,898	33.3	12.6

8.2 APPROACH EMBANKMENTS

About 17 feet of embankment fill near Abutment 1 and about 8 feet of embankment fill near Abutment 5 will need to be placed to construct the approaches to the bridge widening. Retaining walls will be constructed near the abutments to retain the new fill. Retaining Wall 387 with a maximum wall height of 24 feet, and Retaining Wall 399 with a maximum wall height of 10 feet will be constructed adjacent to Abutment 1 and Abutment 5, respectively. Settlement and stability analyses of Retaining Wall 387 and Retaining Wall 399 are presented in a separate foundation report (EMI, 2012a) and a geotechnical design report (EMI, 2012b), respectively.

8.2.1 Settlement and Settlement Period

Based on the onsite soil type, calculated ground subsidence due to new embankment fill at Abutments 1 and 5 is estimated to be less than 1 inch. We recommend a minimum settlement period of 5 days prior to pile driving at the abutments.

8.2.2 Slope Stability

Global stability analyses were conducted for both static and pseudo-static conditions for the bridge approach embankment slope. The analysis was performed using the computer program SLIDE 5.0 (Rocscience, 2006). The soil strength parameters in Table 4-1 were used in the static and pseudo-static analysis and the results are presented in Appendix C.

The calculated factor of safety for a deep-seated failure is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.136 (which is the smaller of either one-third the horizontal peak ground acceleration or 0.2) in accordance with guidelines provided in Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009d). Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

For embankment slopes with a gradient of 2H:1V or flatter, surficial stability should not be a design concern. If slope paving is proposed for embankment slopes with a gradient of 1.5H:1V, then surficial stability is also not a design concern. If slope paving is not used for the 1.5H:1V slopes, it is recommended that the upper 4 feet of any new 1.5H:1V slope face be covered with materials with a minimum internal friction angle of 27 degrees and a minimum cohesion of 200 psf. This select material should be properly keyed and benched into the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (Caltrans, 2010c) are also recommended.

8.3 BRIDGE ABUTMENT WALL DESIGN

8.3.1 Abutment Earth Pressures

If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining, level and compacted backfill should follow Section 5.5.5.11 of the Caltrans BDS (Caltrans, 2004). For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.46 and a soil unit weight of 120 lb/ft^3. If applicable, a uniform lateral pressure of at least 72 psf due to vehicle loads, equivalent to a vertical pressure produced by at least 2 feet of earth, should be added to the above lateral earth pressure.

8.3.2 Passive Resistance of Abutment Backfill

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with a height equal to or greater than 5.5 feet. For abutment walls with heights less than 5.5 feet, the passive pressure may be calculated proportionally (e.g., for a 4-foot high wall, the passive pressure is [4/5.5] x 5 ksf = 3.64 ksf. The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2010a).

9.0 CONSTRUCTION RECOMMENDATIONS

9.1 EARTHWORK

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010c). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

During the recent field investigation conducted on October 2 and 11, 2011, groundwater was encountered at elevations +42.4 feet and +63.7 feet. According to the attached as-built LOTB sheets, groundwater was encountered in two borings at elevations +24 and +57 feet in 1956, in one boring at elevation +59.7 feet in 1965, and at elevations +57.5 and +61 feet in 1992. Groundwater was not encountered in all the other borings. Using the above groundwater measurements, a wet construction will be required for the CIDH piles. Groundwater is not anticipated to be encountered during pile footing construction for abutments. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program and other man-made conditions. If groundwater is encountered during pile footing construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010c).

9.2 PILE CONSTRUCTION

9.2.1 Driven Piles

Piles should be driven at least to the specified tip elevation and the bearing value should be checked with the pile-driving formula given in Section 49-2.01A(4)(b) of the Caltrans Standard Specifications (2010c). However, if the specified tip elevation is reached without achieving the design load, pile driving should continue until bearing is attained. In this case, it may be prudent to allow the pile to "set up" before continuing the driving.

The selected pile-driving hammer such as diesel-type hammers should be able to deliver sufficient energy to drive the piles at a penetration rate of not less than 1/8 inch per blow at the required bearing value. Oversized predrilling through the embankment fill should conform to Section 49-2.01C(4) of the Caltrans Standard Specifications (2010c). Vibratory hammers are not allowed for pile installation.

Difficult pile driving is anticipated due to the presence of localized dense and hard soil layers, above and below the bedrock contact, caving soils and ground water. Based on the available soil boring data, hard driving is anticipated near and below El. +45 feet. Contractor should be prepared for hard driving conditions. Also, as discussed in Section 4.2, there is uncertainty in the bedrock contact. As a result, we recommend extending the main reinforcement of the Alternative "X" pile by an additional 10 feet below the pile top. This way if the pile meets early refusal, it can be cut-off without compromising the lateral pile capacity.

9.2.2 CIDH Piles

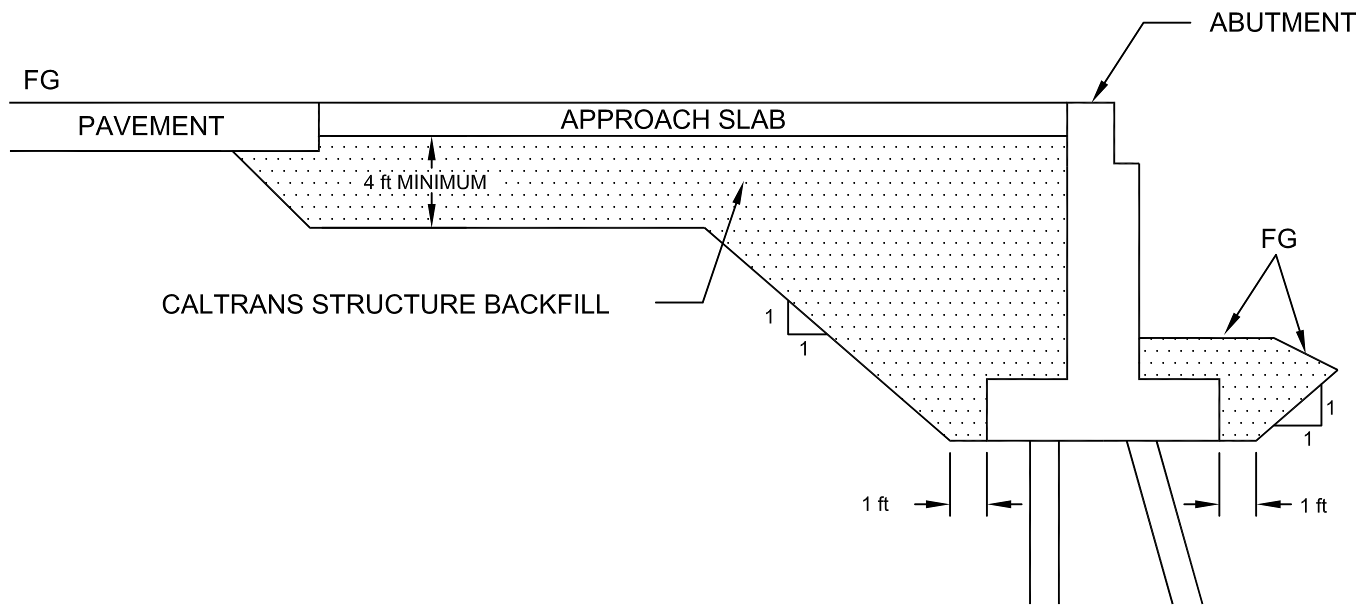
Difficult pile installation is anticipated due to the presence of localized dense and hard soil layers, above and below the bedrock contact, caving soils and high groundwater. Construction of CIDH piles should follow Section 49-3 of the Caltrans Standard Specifications (2010c). Loose soils should be cleaned from the bottom of the borings. Pile borings should be inspected and approved by the geotechnical engineer prior to the installation of reinforcement. Extreme care in drilling, placement of steel, and the pouring of concrete is essential to avoid excessive disturbance of pile boring walls. Concrete placement by pumping or tremie tube to the bottom of the pile borings is recommended. Specifications should require that sufficient space be provided in the pile reinforcing cage during fabrication to allow the insertion of a tremie tube for concrete placement. The pile reinforcing cage should be installed and the concrete pumped immediately after drilling is completed. Per Caltrans Amendments to AASHTO LRFD Bridge Design Specification Section 10.8.1.3 (Caltrans, 2011), 5-inch of concrete cover over reinforcement should be provided to improve construction of the CIDH piles.

Based on recent groundwater measurements, a wet construction is anticipated for the CIDH piles construction. Contractor should be fully prepared to implement the Caltrans Standard Specifications and Special Provisions for a wet construction. Localized dewatering is not recommended because the operation could induce soil settlement which could damage buried utilities and nearby structures including the existing bridge.

On-site earth materials are generally fine-grained and contain a few thin layers of granular soil. Granular soils are susceptible to caving. The use of temporary casing is left to the contractor's discretion. If temporary casing is used, vibratory and oversized predrilling techniques for casing installation are not allowed. Temporary casing should be placed tight in the borehole. The casing should be pulled as the concrete is being poured while always maintaining at least a 5-foot head of concrete inside the casing. If any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

9.3 BACKDRAIN AND BACKFILL REQUIREMENTS FOR ABUTMENT WALLS

Caltrans Structure Backfill should be used as backfill material behind the bridge abutment walls as shown in Figure 9-1. Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2010c). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.



NO SCALE

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Camino Capistrano UC (Widen) Bridge No. 55-0227		BRIDGE ABUTMENT WALL BACKFILL
	Project No. 11-137	Date: 01-18-2013	FIGURE 9-1

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010b) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

9.4 REVIEW OF CONSTRUCTION PLANS

Recommendations contained in this report are based on draft plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

9.5 GEOTECHNICAL OBSERVATION AND TESTING

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- Backdrain installation and backfilling of bridge abutment walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered

10.0 LIMITATIONS

This report is intended for the use of OCTA, TRC and Caltrans for design and construction of the Camino Capistrano UC (Widen) (Bridge No. 55-0227L). This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached LOTB sheets. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

11.0 REFERENCES

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Appendix A

LOG OF TEST BORING SHEETS

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	5	6.2/8.7		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. GE 2963 EXP. 12-31-13 GEOTECHNICAL STATE OF CALIFORNIA

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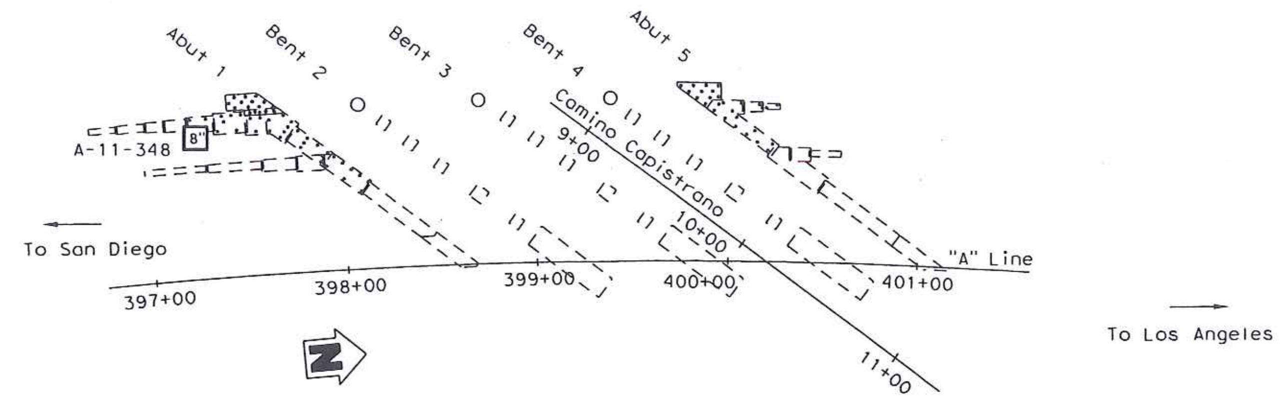
ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

Designation: F-785 Elev = 75.717 feet (NAVD 88); 73.413 feet (NGVD29) Described by OCS 2003 - Found 3¾" US Coast and Geodectic Survey Bronzed Disk Stomped "F 785 1946", Set in the Top of a Concrete Bridge Abutment. Monument is Located in the Southwesterly Corner of the Atchinso\Topeka and Santa Fe Railway Overcrossing of San Mateo Creek, 69 ft. Northerly Along the Railway from the Centerline of the Interstate 5 Freeway Southbound Onramp at Camino Copistrano Prolonged to the West and 150± Westerly from the Centerline of Camino Capistrano. Monument is Set 2.0 ft. below the Tracks.



PLAN
1" = 50'

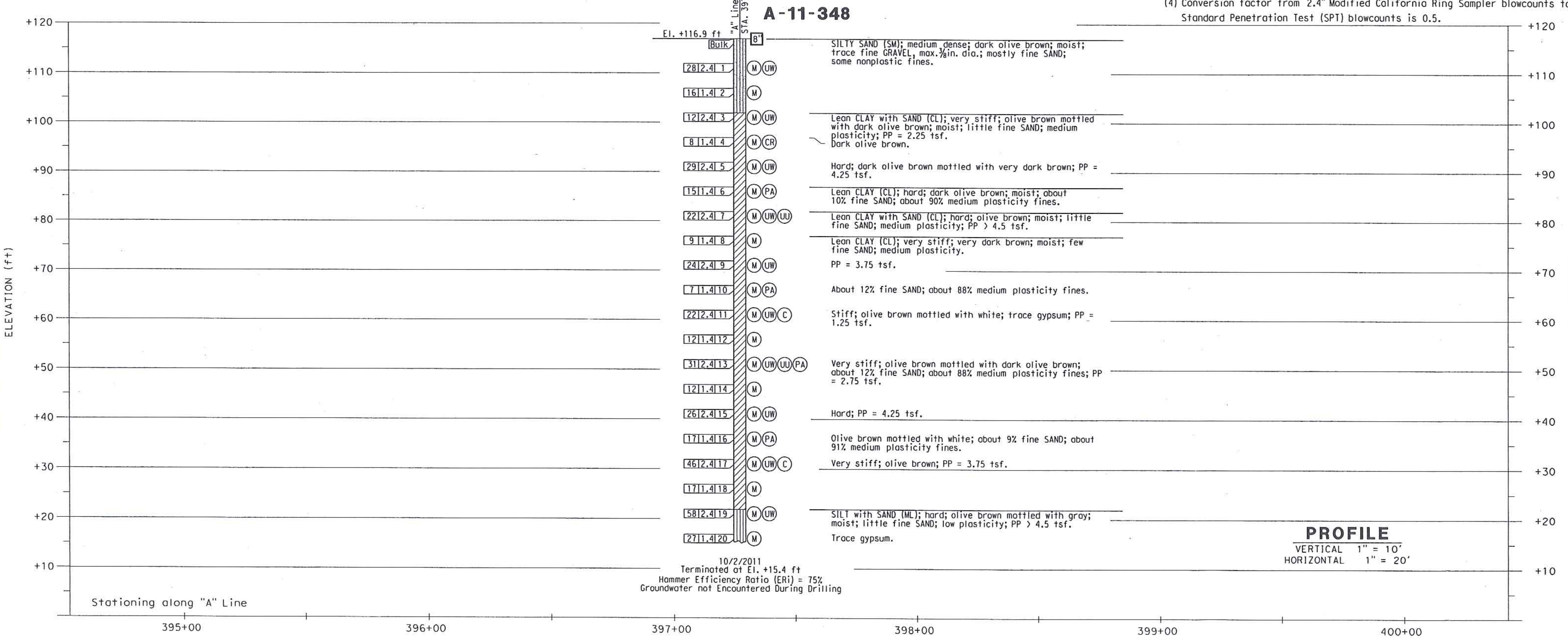
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie FIELD INVESTIGATION BY:	
SIGN OFF DATE	CHECKED BY	S. PIRATHIVIRAJ	DATE: 9/2011, 10/2011	

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. PIRATHIVIRAJ
PROJECT ENGINEER

BRIDGE NO. 55-0227L
POST MILES 7.40

CAMINO CAPISTRANO UC (WIDEN)
LOG OF TEST BORINGS 1 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2998
PROJECT NUMBER & PHASE: 12000202791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES SHEET OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	5	6.2/8.7		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

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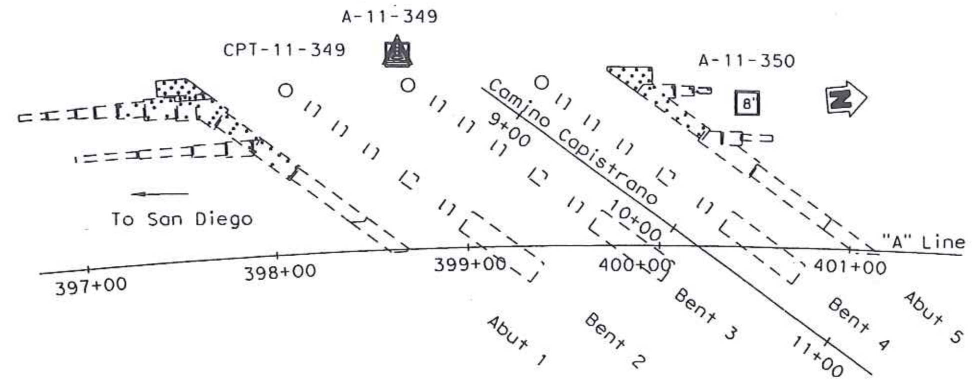
BENCH MARK

Designation: F-785 Elev = 75.717 feet (NAVD 88); 73.413 feet (NGVD29) Described by OCS 2003 - Found 3¾" US Coast and Geodectic Survey Bronzed Disk Stamped "F 785 1946", Set in the Top of a Concrete Bridge Abutment. Monument is Located in the Southwesterly Corner of the Atchinso\Topeka and Santa Fe Railway Overcrossing of San Mateo Creek, 69 ft. Northerly Along the Railway from the Centerline of the Interstate 5 Freeway Southbound Onramp at Camino Capistrano Prolonged to the West and 150± Westerly from the Centerline of Camino Capistrano. Monument is Set 2.0 ft. below the Tracks.



NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
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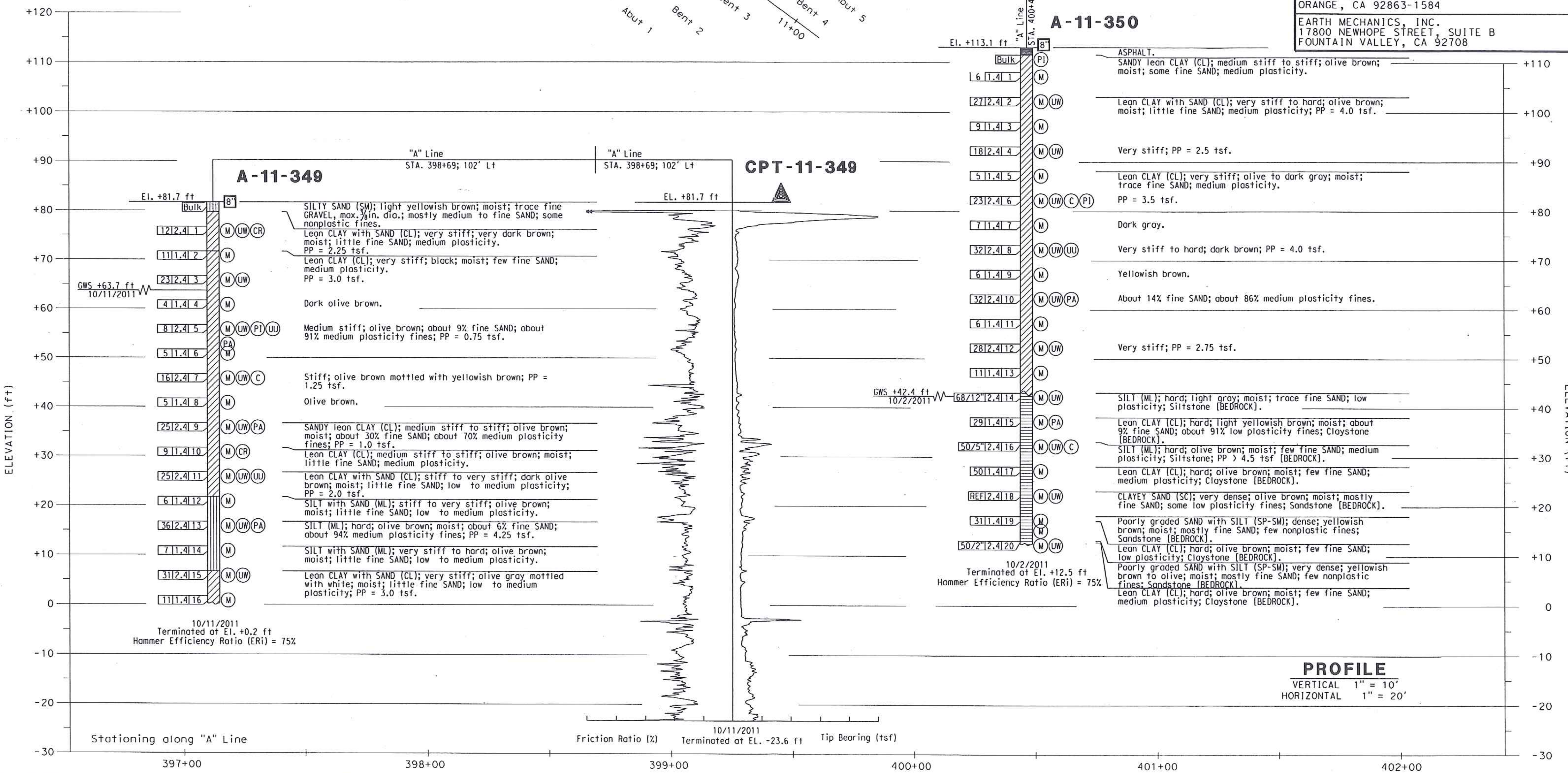

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	S. PIRATHIVIRAJ	DATE: 9/2011, 10/2011

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. PIRATHIVIRAJ
PROJECT ENGINEER

UNIT: 2998
PROJECT NUMBER & PHASE: 12000202791

BRIDGE NO. 55-0227L
POST MILES 7.40

DISREGARD PRINTS BEARING EARLIER REVISION DATES

CAMINO CAPISTRANO UC (WIDEN)

LOG OF TEST BORINGS 1 OF 5

REVISION DATES | SHEET | OF

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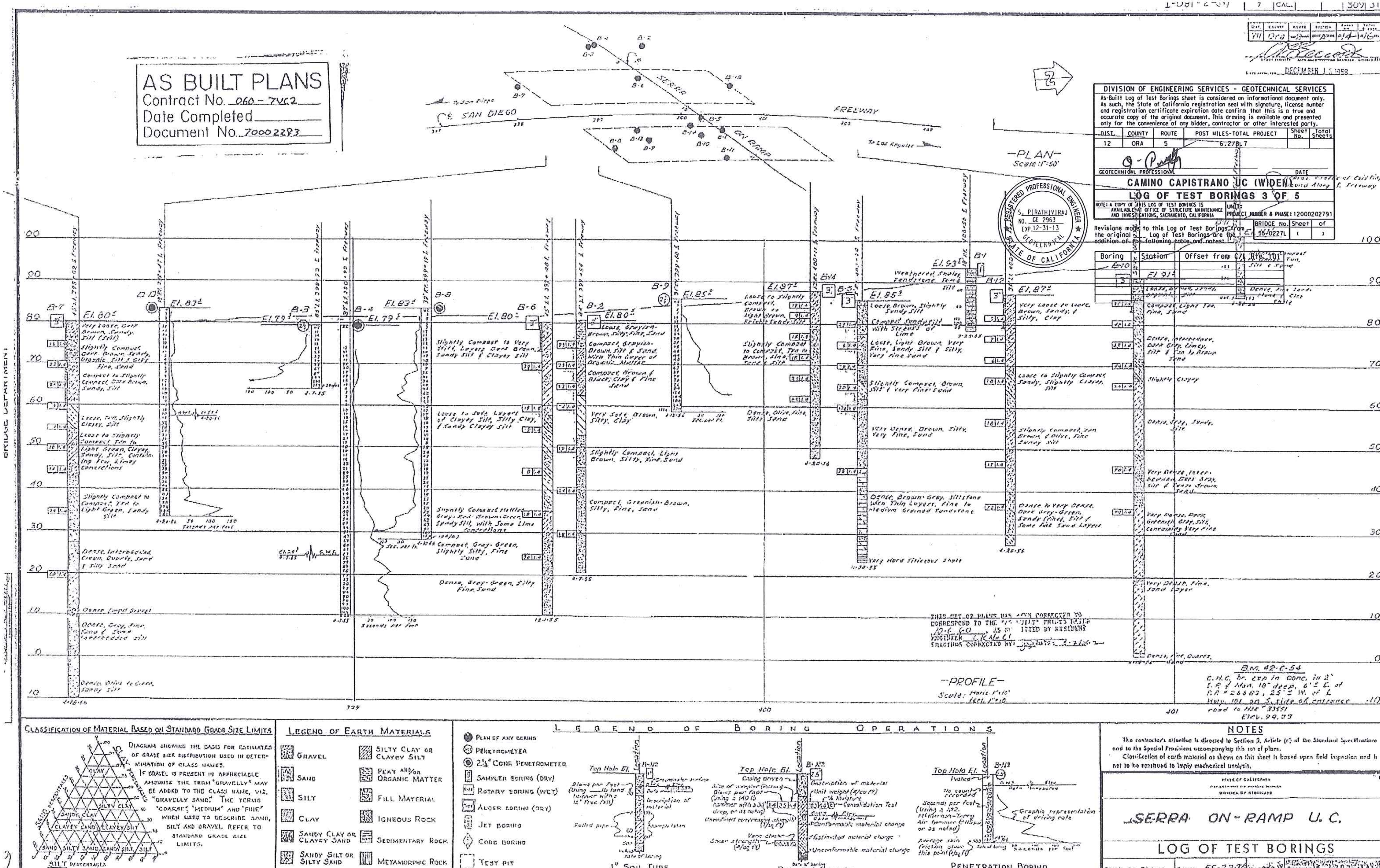
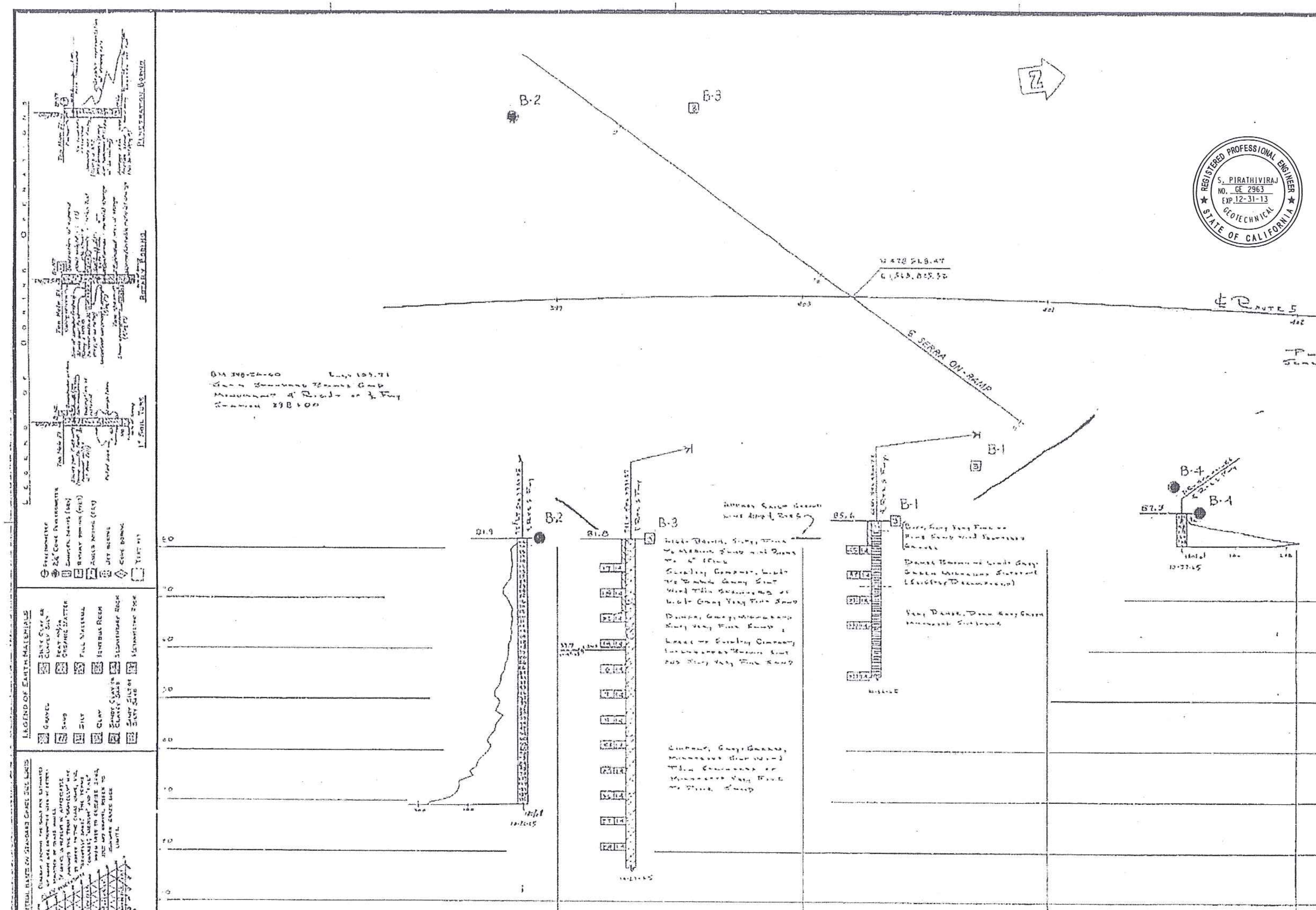

AS BUILT PLANS
Contract No. 060 - 7VC2
Date Completed
Document No. 70002293
DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES
As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.
DIST. 12 | COUNTY ORA | ROUTE 5 | POST MILES-TOTAL PROJECT 6.27R.7
GEOTECHNICAL PROFESSIONAL
CAMINO CAPISTRANO UC (WIDEN)
LOG OF TEST BORINGS 3 OF 5
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA
PROJECT NUMBER & PHASE: 12000202791
BRIDGE No. 55-0227L
REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. GE 2963
EXP. 12-31-13
GEOTECHNICAL
STATE OF CALIFORNIA
DECEMBER 1 5 1959
SAN DIEGO
FREEWAY
SERRA ON RAMP
To Los Angeles
-PLAN-
Scale: 1"=50'
-PROFILE-
BRIDGE DEPARTMENT
B.M. 42-C-54
Elev. 94.73
LEGEND OF EARTH MATERIALS
LEGEND OF BORING OPERATIONS
CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS
NOTES
The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.
Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.
SERRA ON-RAMP U. C.
LOG OF TEST BORINGS
SCALE As Shown
BRIDGE 55-227



DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
07	ORA	5		810	994

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	5	6.2/8.7		

GEOTECHNICAL PROFESSIONAL ______ DATE ______

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. GE 2963 — EXP. 12-31-13 — GEOTECHNICAL — STATE OF CALIFORNIA

CAMINO CAPISTRANO UC (WIDEN)

LOG OF TEST BORINGS 4 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT:
PROJECT NUMBER & PHASE: 12000202791

BRIDGE No.	Sheet	of
55-0227L	x	x

Revisions made to this Log of Test Borings from the original ____ Log of Test Borings are the addition of the following table and notes:

Boring	Station	Offset from C/L Rte. 101

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

AS BUILT PLANS

Contract No. 07-105224
Date Completed ______
Document No. 70000730

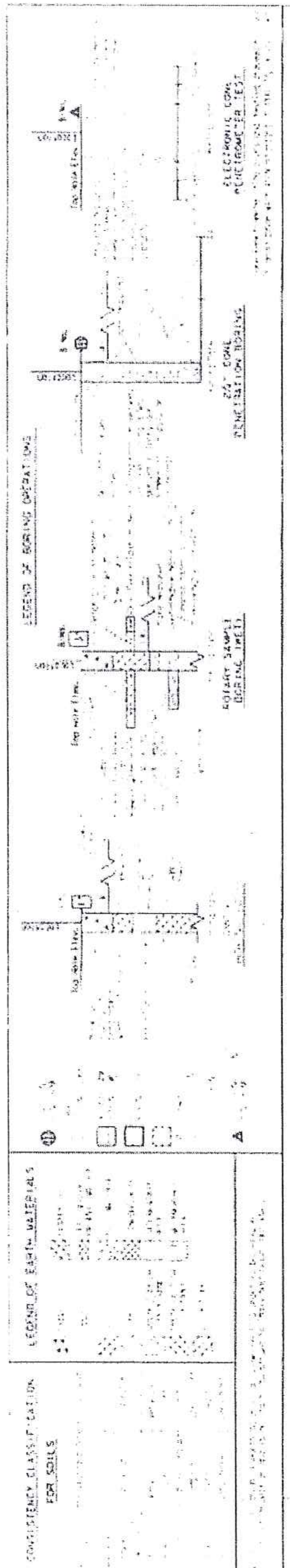
SHEET 15 OF 15

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

SERRA ON-RAMP
UNDERCROSSING (WIDENING)

LOG OF TEST BORINGS

SCALE As Noted | BRIDGE 55-227 R/L | FILE | DRAWING 55227-LO



NOTES:

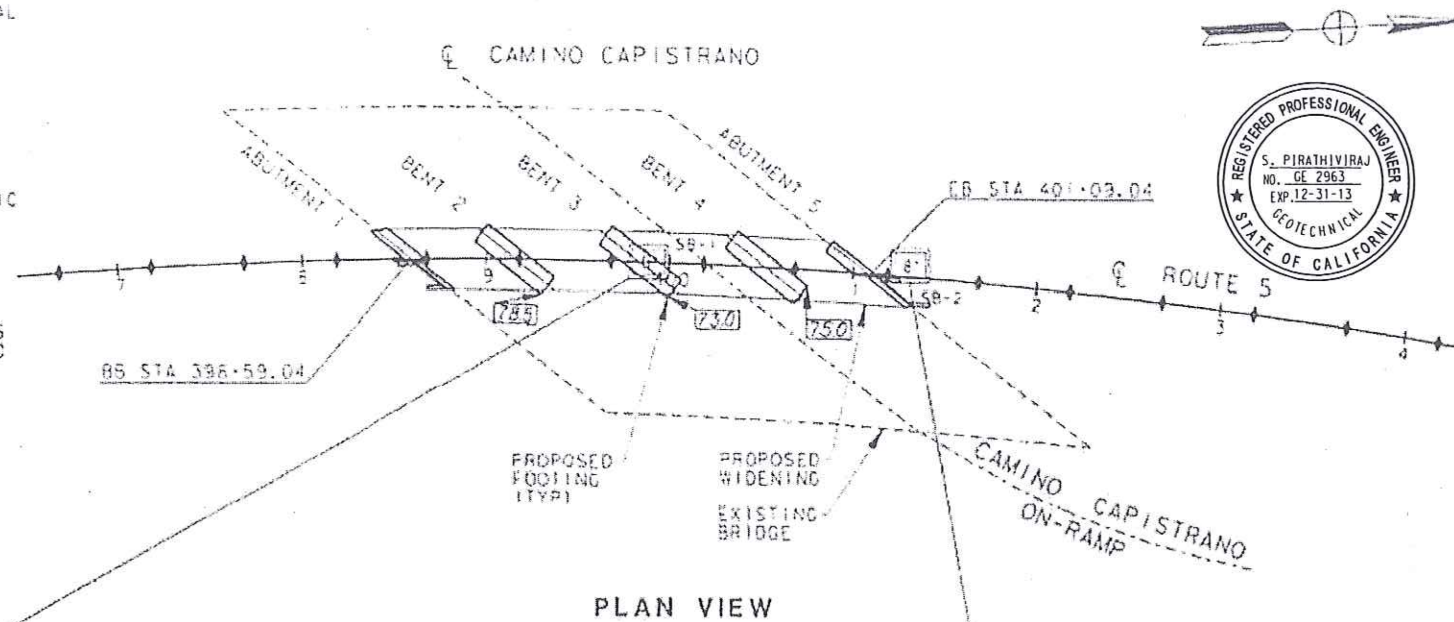
1. THE BORING LOGS AND RELATED INFORMATION REPRESENT THE OPINION OF THE GEOTECHNICAL ENGINEER AS TO THE CHARACTER OF THE MATERIALS AT THE LOCATIONS SHOWN. SOIL AND GROUNDWATER CONDITIONS BETWEEN ADJACENT TEST HOLES AND AT OTHER LOCATIONS MAY DIFFER FROM THOSE SHOWN. GROUNDWATER CONDITIONS MAY CHANGE WITH PASSAGE OF TIME.
2. TEST BORING ELEVATIONS ARE APPROXIMATE AND ARE INTERPOLATED BASED ON TOPOGRAPHIC BASE SHEET MAPPING PREPARED FOR THIS PROJECT. SEE FOUNDATION PLAN FOR BENCHMARK INFORMATION.
3. TEST BORING LOCATIONS WERE DETERMINED IN THE FIELD BASED ON TAPING AND PACING FROM MAPPED SITE FEATURES. THE LOCATIONS OF THE EXPLORATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE MEASURING METHODS USED.

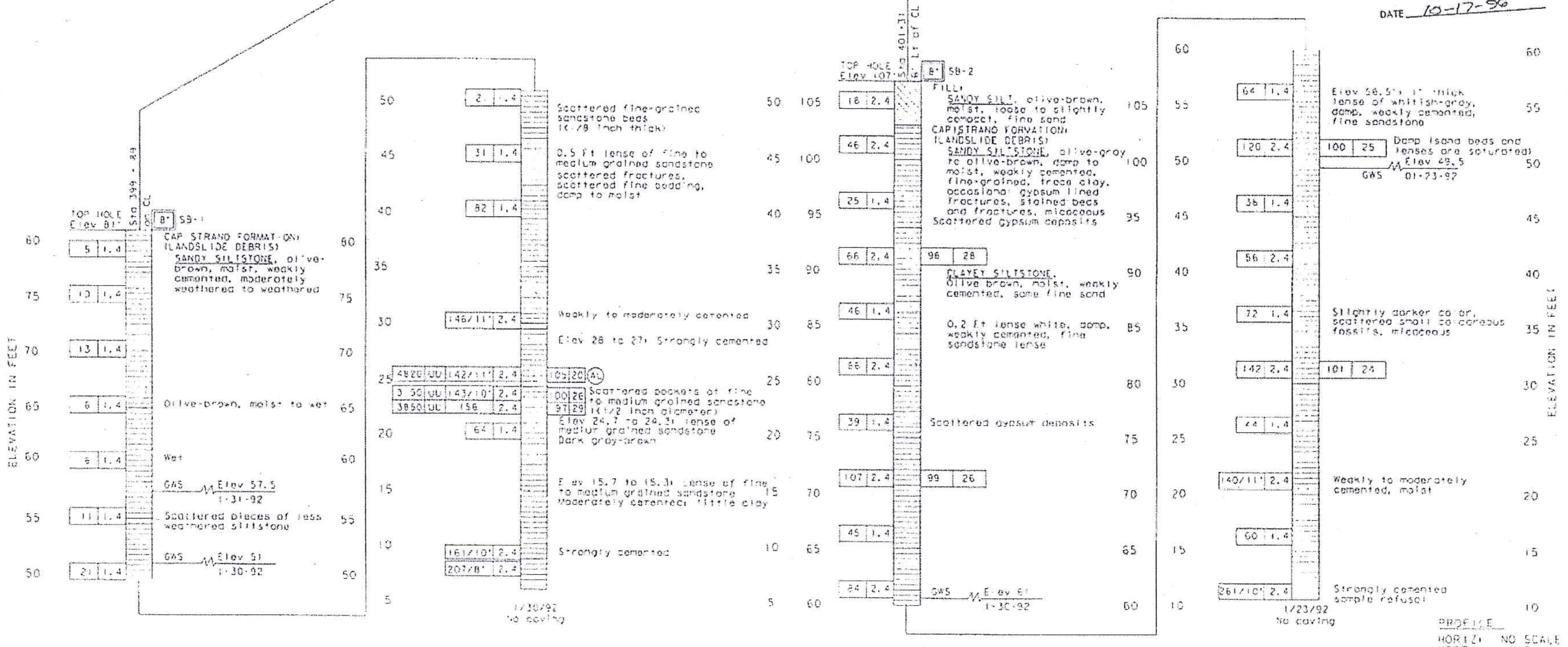
SOIL TEST DESIGNATIONS:

(UU) UNCONSOLIDATED UNDRAINED TRIAXIAL AT 5% STRAIN

(AL) ATTERBERG LIMITS

(GS) SIEVE ANALYSIS





DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	Ora	5	6.7/9.5	187	235

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	5	6.2/8.7		

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. GE 2963 — EXP. 12-31-13 — GEOTECHNICAL — STATE OF CALIFORNIA

1-17-94

GEOTECHNICAL PROFESSIONAL DATE

CAMINO CAPISTRANO UC (WIDEN)

LOG OF TEST BORINGS 5 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT:

PROJECT NUMBER & PHASE: 12000202791

BRIDGE No. 55-0227E | Sheet | of | 1

Revisions made to this Log of Test Borings from the original ___ Log of Test Borings are the addition of the following table and notes:

Boring	Station	Offset from C/L Rte. 101

NO AS-BUILT CHANGES

AS BUILT

CORRECTIONS BY SEC TRIPLAT

CONTRACT NO. 12-107224

DATE 10-17-96

BE O. NGUYEN

M.A. REICHERT

C.P. POLITO

M. VAN DE VRUGT

1/30/92

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C.E. JOSEPH

046680

55-227R/L

2.3

CAMINO CAPISTRANO ON-RAMP UC (WIDENING)

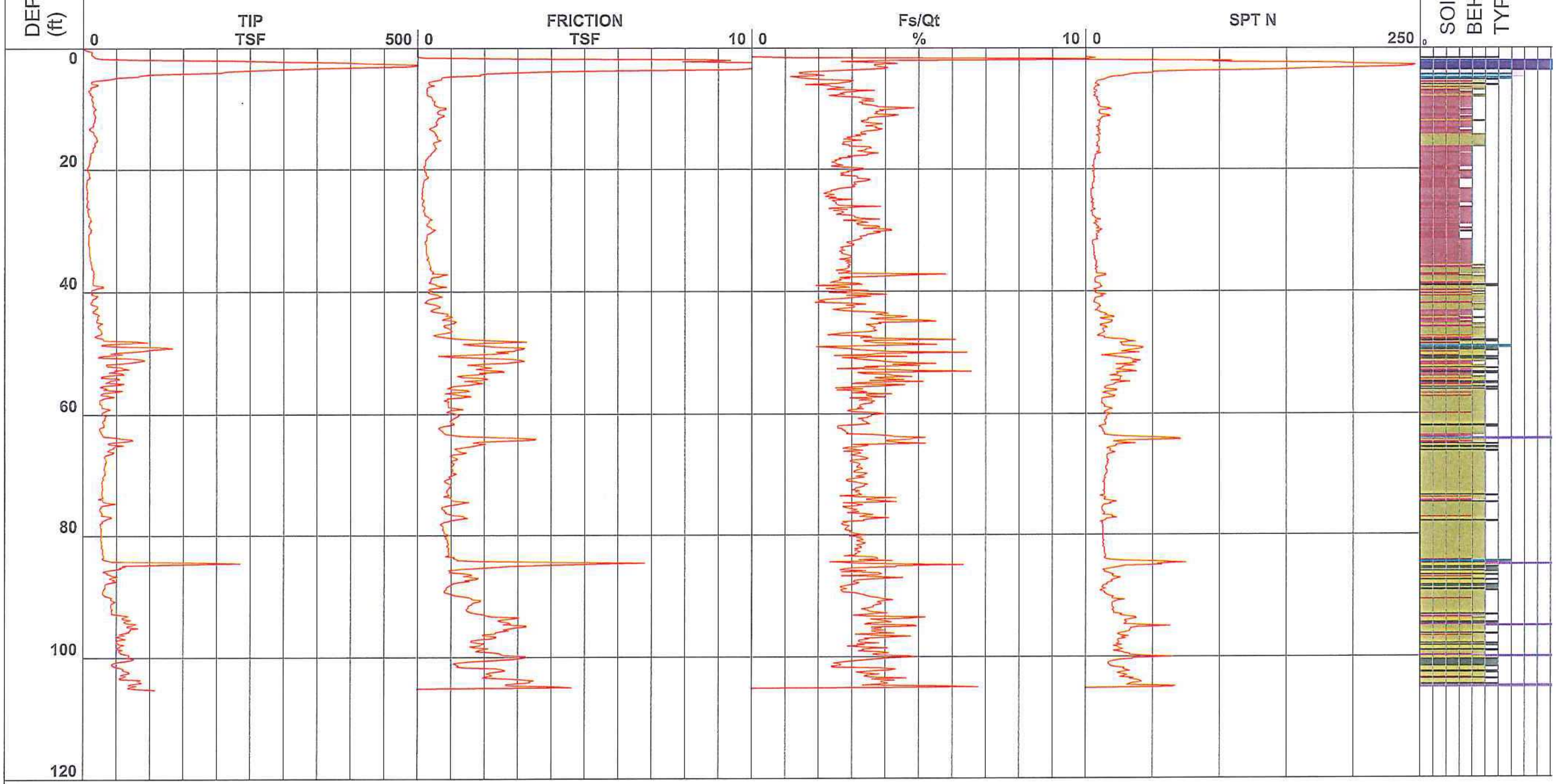
LOG OF TEST BORINGS

12104

Earth Mechanics

Location	I-5 HOV Widening Segment 3	Operator	BH-JC	Filename	SDF(575).cpt
Job Number	11-137	Cone Number	DSG1023	GPS	
Hole Number	CPT-11-349	Date and Time	10/11/2011 1:20:42 AM	Maximum Depth	105.31 ft
Water Table Depth	18.00 ft				

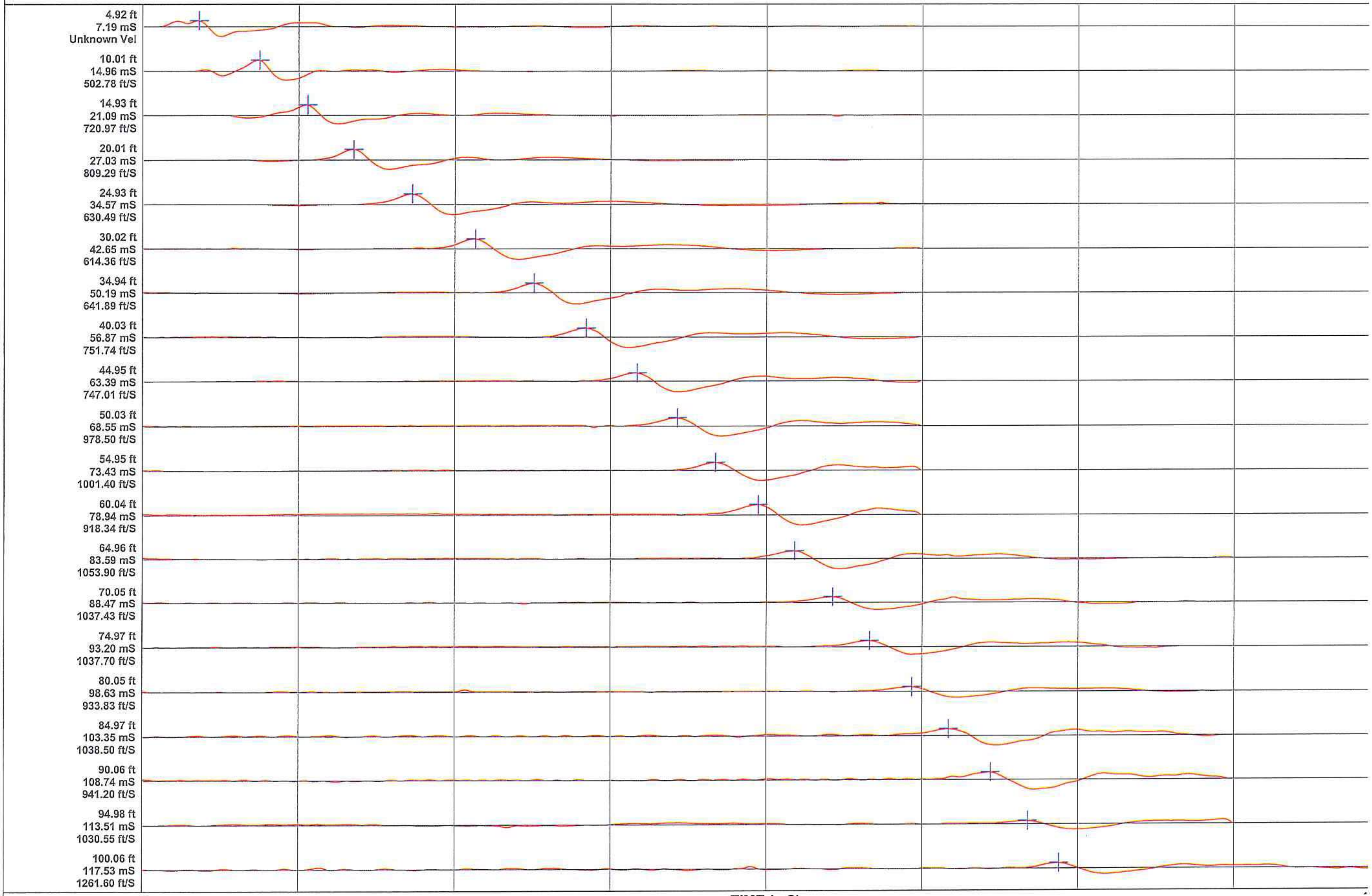
CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Earth Mechanics

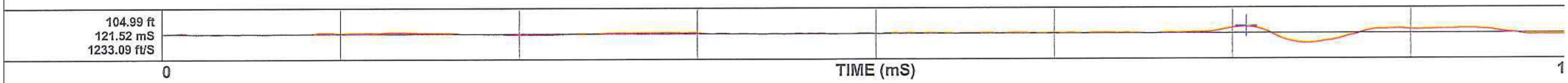
Location	I-5 HOV Widening Segment 3	Operator	BH-JC	GPS	
Job Number	11-137	Cone Number	DSG1023		
Hole Number	CPT-11-349	Date and Time	10/11/2011 1:20:42 AM		



Earth Mechanics

Location	I-5 HOV Widening Segment 3	Operator	BH-JC
Job Number	11-137	Cone Number	DSG1023
Hole Number	CPT-11-349	Date and Time	10/11/2011 1:20:42 AM

GPS



Project ID: Earth Mechanics
Data File: SDF(575)-18.cpt
CPT Date: 10/11/2011 1:20:42 AM
GW During Test: 18 ft

Sounding ID: CPT-11-349
Project No: 11-137
Cone/Rig: DSG1023

Depth ft	qc PS tsf	* qcln PS -	qlncs PS -	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	SPT R-N 60%	* SPT R-N1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* Nk -	* Vol Strn %	* Dry Stlmt 0.01	* Liq Stlmt 0.04	* Cycl SStn %
0.33	3.7	5.9	-	0.0	0.0	0.1	1	sensitive fine SOIL	115	2.0	2	3	-	-	0.3	9.9	41	15	N/A	0.01	N/A	N/A
0.49	7.8	12.4	28.3	0.0	0.0	0.1	5	silty SAND to sandy SILT	120	4.0	2	3	5	45	-	-	26	16	N/A	0.01	N/A	N/A
0.66	13.7	22.0	33.9	0.0	0.0	0.1	5	silty SAND to sandy SILT	120	4.0	3	6	17	47	-	-	17	16	N/A	0.01	N/A	N/A
0.82	13.6	21.8	33.8	0.0	0.0	0.1	5	silty SAND to sandy SILT	120	4.0	3	5	17	46	-	-	17	16	N/A	0.01	N/A	N/A
0.98	12.8	20.6	33.1	0.0	0.0	0.1	5	silty SAND to sandy SILT	120	4.0	3	5	15	44	-	-	18	16	N/A	0.01	N/A	N/A
1.15	12.6	20.2	32.9	0.0	0.0	0.1	5	silty SAND to sandy SILT	120	4.0	3	5	14	44	-	-	18	16	N/A	0.00	N/A	N/A
1.31	15.5	24.8	35.8	0.0	0.0	0.1	5	silty SAND to sandy SILT	120	4.0	4	6	21	44	-	-	16	16	N/A	0.00	N/A	N/A
1.48	16.9	27.1	37.4	0.0	0.1	0.1	5	silty SAND to sandy SILT	120	4.0	4	7	24	44	-	-	15	16	N/A	0.00	N/A	N/A
1.64	18.4	29.5	67.1	0.2	0.1	1.2	5	silty SAND to sandy SILT	120	4.0	5	7	27	44	-	-	26	16	N/A	0.00	N/A	N/A
1.80	29.4	47.2	-	3.1	0.1	9.9	3	silty CLAY to CLAY	115	1.5	20	31	-	-	2.1	9.9	49	15	N/A	0.00	N/A	N/A
1.97	82.3	131.9	434.6	8.7	0.2	9.9	9	very stiff fine SOIL	120	2.0	41	66	76	48	-	-	35	30	N/A	0.00	N/A	N/A
2.13	227.9	365.5	499.0	9.4	0.3	4.1	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	15.1	9.9	14	16	N/A	0.00	N/A	N/A
2.30	296.3	475.3	536.2	7.9	0.4	2.7	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	19.6	9.9	9	16	N/A	0.00	N/A	N/A
2.46	391.5	627.9	759.3	14.9	0.5	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	25.9	9.9	11	16	N/A	0.00	N/A	N/A
2.62	424.2	680.2	854.6	18.4	1.2	4.3	9	very stiff fine SOIL	120	2.0	100	100	95	48	-	-	12	30	N/A	0.00	N/A	N/A
2.79	513.2	823.1	955.4	18.8	1.1	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	34.0	9.9	10	16	N/A	0.00	N/A	N/A
2.95	508.9	816.2	947.5	18.6	1.4	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	33.7	9.9	10	16	N/A	0.00	N/A	N/A
3.12	482.9	774.5	914.7	18.4	1.6	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	32.0	9.9	10	16	N/A	0.00	N/A	N/A
3.28	400.8	642.7	792.7	16.2	1.9	4.1	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	26.5	9.9	11	16	0.00	-	0.04	0.0
3.45	338.1	542.3	681.1	13.5	1.9	4.0	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	22.4	9.9	12	16	0.00	-	0.04	0.0
3.61	287.6	461.3	557.6	9.6	1.8	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	19.0	9.9	11	16	0.00	-	0.04	0.0
3.77	245.0	393.0	449.0	6.2	1.6	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	-	-	16.2	9.9	9	16	0.00	-	0.04	0.0
3.94	214.0	343.2	368.8	3.9	1.5	1.8	6	clean SAND to silty SAND	125	5.0	43	69	95	48	-	-	7	16	0.00	-	0.04	0.0
4.10	207.0	332.0	337.4	2.9	1.6	1.4	6	clean SAND to silty SAND	125	5.0	41	66	95	48	-	-	6	16	0.00	-	0.04	0.0
4.27	145.8	233.9	252.5	2.1	-0.4	1.4	6	clean SAND to silty SAND	125	5.0	29	47	95	48	-	-	7	16	0.00	-	0.04	0.0
4.43	99.6	159.8	201.0	1.9	-0.5	1.9	6	clean SAND to silty SAND	125	5.0	20	32	82	48	-	-	12	16	0.00	-	0.04	0.0
4.59	86.7	139.0	189.6	1.9	-0.8	2.2	5	silty SAND to sandy SILT	120	4.0	22	35	78	47	-	-	14	16	0.00	-	0.04	0.0
4.76	81.9	131.3	152.2	1.0	-1.0	1.2	6	clean SAND to silty SAND	125	5.0	16	26	76	47	-	-	10	16	0.22	-	0.04	1.7
4.92	53.3	85.4	117.9	0.7	-1.0	1.4	5	silty SAND to sandy SILT	120	4.0	13	21	62	45	-	-	15	16	1.84	-	0.04	13.3
5.25	35.1	56.4	111.2	0.7	-1.8	2.1	5	silty SAND to sandy SILT	120	4.0	9	14	48	42	-	-	23	16	2.13	-	0.03	37.4
5.41	18.7	30.0	-	0.6	-1.8	3.1	4	clayy SILT to silty CLAY	115	2.0	9	15	-	-	1.3	9.9	37	15	-	-	0.03	-
5.58	13.0	20.8	-	0.4	-1.8	3.1	4	clayy SILT to silty CLAY	115	2.0	6	10	-	-	0.9	9.9	43	15	-	-	0.03	-
5.74	12.0	19.3	-	0.3	-1.8	2.8	4	clayy SILT to silty CLAY	115	2.0	6	10	-	-	0.8	9.9	44	15	-	-	0.03	-
5.91	13.7	22.0	-	0.3	-1.9	2.6	4	clayy SILT to silty CLAY	115	2.0	7	11	-	-	1.0	9.9	40	15	-	-	0.03	-
6.07	22.5	36.1	83.0	0.4	-3.0	1.6	5	silty SAND to sandy SILT	120	4.0	6	9	33	40	-	-	26	16	2.72	-	0.03	51.2
6.23	21.3	34.1	96.8	0.5	-3.7	2.4	4	clayy SILT to silty CLAY	115	2.0	11	17	-	-	1.5	9.9	31	15	2.40	-	0.02	51.2
6.40	15.1	24.2	-	0.4	-3.4	2.4	4	clayy SILT to silty CLAY	115	2.0	8	12	-	-	1.0	9.9	37	15	-	-	0.02	-
6.56	11.1	17.9	-	0.3	-3.4	2.9	4	clayy SILT to silty CLAY	115	2.0	6	9	-	-	0.8	9.9	46	15	-	-	0.02	-
6.73	12.0	19.2	-	0.3	-3.4	2.5	4	clayy SILT to silty CLAY	115	2.0	6	10	-	-	0.8	9.9	42	15	-	-	0.02	-
6.89	11.7	18.7	-	0.3	-3.4	2.3	4	clayy SILT to silty CLAY	115	2.0	6	9	-	-	0.8	9.9	42	15	-	-	0.02	-
7.05	8.5	13.6	-	0.3	-3.4	3.8	3	silty CLAY to CLAY	115	1.5	6	9	-	-	0.6	9.1	57	15	-	-	0.02	-
7.22	8.8	14.1	-	0.3	-3.4	3.3	3	silty CLAY to CLAY	115	1.5	6	9	-	-	0.6	9.3	53	15	-	-	0.02	-
7.38	10.1	16.2	-	0.3	-3.3	2.9	4	clayy SILT to silty CLAY	115	2.0	5	8	-	-	0.7	9.9	48	15	-	-	0.02	-
7.55	11.3	18.1	-	0.3	-3.3	2.7	4	clayy SILT to silty CLAY	115	2.0	6	9	-	-	0.8	9.9	45	15	-	-	0.02	-
7.71	10.8	17.3	-	0.3	-3.3	2.9	4	clayy SILT to silty CLAY	115	2.0	5	9	-	-	0.7	9.9	47	15	-	-	0.02	-
7.87	12.7	20.3	-	0.3	-3.3	2.4	4	clayy SILT to silty CLAY	115	2.0	6	10	-	-	0.9	9.9	41	15	-	-	0.02	-
8.04	15.2	24.4	-	0.4	-3.3	2.7	4	clayy SILT to silty CLAY	115	2.0	8	12	-	-	1.1	9.9	39	15	-	-	0.02	-
8.20	13.4	21.5	-	0.4	-3.3	3.3	4	clayy SILT to silty CLAY	115	2.0	7	11	-	-	0.9	9.9	44	15	-	-	0.02	-
8.37	13.1	21.0	-	0.4	-3.2	3.5	4	clayy SILT to silty CLAY	115	2.0	7	11	-	-	0.9	9.9	45	15	-	-	0.02	-
8.53	12.4	19.8	-	0.4	-3.2	3.8	3	silty CLAY to CLAY	115	1.5	8	13	-	-	0.9	9.9	48	15	-	-	0.02	-
8.69	13.8	22.1	-	0.5	-3.1	3.4	4	clayy SILT to silty CLAY	115	2.0	7	11	-	-	1.0	9.9	44	15	-	-	0.02	-
8.86	14.4	23.1	-	0.5	-3.1	3.8	4	clayy SILT to silty CLAY	115	2.0	7	12	-	-	1.0	9.9	45	15	-	-	0.02	-
9.02	15.9	25.4	-	0.5	-3.1	3.3	4	clayy SILT to silty CLAY	115	2.0	8	13	-	-	1.1	9.9	41	15	-	-	0.02	-
9.19	15.2	24.4	-	0.5	-3.1	3.4	4	clayy SILT to silty CLAY	115	2.0	8	12	-	-	1.1	9.9	42	15	-	-	0.02	-
9.35	15.2	24.4	-	0.5	-3.1	3.4	4	clayy SILT to silty CLAY	115	2.0	8	12	-	-	1.1	9.9	42	15	-	-	0.02	-
9.51	14.6	23.4	-	0.5	-3.1	3.7	4	clayy SILT to silty CLAY	115	2.0	7	12	-	-	1.0	9.9	44	15	-	-	0.02	-
9.68	15.3	24.6	-	0.6	-3.1	3.9	4	clayy SILT to silty CLAY	115	2.0	8	12	-	-	1.1	9.9	44	15	-	-	0.02	-
9.84	16.5	26.5	-	0.6	-3.0	4.0	4	clayy SILT to silty CLAY	115	2.0	8	13	-	-	1.1	9.9	43	15	-	-	0.02	-
10.01	17.6	28.2	-	0.9	-3.0	5.0	3	silty CLAY to CLAY	115	1.5	12	19	-	-	1.2	9.9	46	15	-	-	0.02	-
10.17	19.8	31.7	-	0.8	-2.9	4.4	3	silty CLAY to CLAY	115	1.5	13	21	-	-	1.4	9.9	42	15	-	-	0.02	-
10.34	17.9	28.6	-	0.7	-2.9	4.0	4	clayy SILT to silty CLAY	115	2.0	9	14	-	-	1.2	9.9	42	15	-	-	0.02	-
10.50	16.1	25.8	-	0.6	-2.9	4.1	3	silty CLAY to CLAY	115	1.5	11	17	-	-	1.1	9.9	44	15	-	-	0.02	-
10.66	16.3	26.2	-	0.6	-2.9	3.8	4	clayy SILT to silty CLAY	115	2.0	8	13	-	-	1.1	9.9	43	15	-	-	0.02	-
10.83	16.0	25.3	-	0.6	-2.9	3.9	4	clayy SILT to silty CLAY	115	2.0	8	13	-	-	1.1	9.9	44	15	-	-	0.02	-
10.99	16.9	26.4	-	0.6	-2.8	3.8	4	clayy SILT to silty CLAY	115	2.0	8	13	-	-	1.2	9.9	43	15	-	-	0.02	-
11.16	17.9	27.4	-	0.8	-2.8	4.6	3	silty CLAY to CLAY	115	1.5	12	18	-	-	1.2	9.9	45	15	-	-	0.02	-
11.32	18.9	28.6	-	0.8	-2.8	4.4	3	silty CLAY to CLAY	115	1.5	13	19	-	-	1.3	9.9	43	15	-	-	0.02	-
11.48	19.2	28.7	-	0.7	-2.7	3.9	4	clayy SILT to silty CLAY	115	2.0	10	14	-	-	1.3	9.9	41	15	-	-	0.02	-
11.65	18.4	27.0	-	0.6	-2.7	3.6	4	clayy SILT to silty CLAY	115	2.0	9	14	-	-	1.3	9.9	41	15	-	-	0.02	-
11.81	17.7	25.6	-	0.6	-2.7	3.6	4	clayy SILT to silty CLAY	115	2.0	9	13	-	-	1.2	9.9	42	15	-	-	0.02	-
11.98	17.3	24.7	-	0.6	-2.7	3.6	4	clayy SILT to silty CLAY	115	2.0	9	12	-	-	1.2	9.9	43	15	-	-	0.02	-
12.14	17.9	25.2	-	0.6	-2.7	3.4	4	clayy SILT to silty CLAY	115	2.0	9	13	-	-	1.2	9.9	42	15	-	-	0.02	-
12.30	16.9	23.6	-	0.6	-2.7	3.4	4	clayy SILT to silty CLAY	115	2.0	8	12	-	-	1.2	9.9	43	15	-	-	0.02	-
12.47	15.6	21.5	-	0.6	-2.7	3.8	3	silty CLAY to CLAY	115	1.5	10	14	-	-	1.1	9.9	46	15	-	-	0.02	-
12.63	15.4	20.9	-	0.6	-2.7	4.1	3	silty CLAY to CLAY	115	1.5	10	14	-	-	1.1	9.9	48	15	-	-	0.02	-
12.80	15.7	21.0	-	0.6	-2.7	3.9	3	silty CLAY to CLAY	115	1.5	10	14	-	-	1.1	9.9	47	15	-	-	0.02	-
12.96	15.5	20.5	-	0.5	-2.6	3.6	3	silty CLAY to CLAY	115	1.5	10	14	-	-	1.1	9.9	47	15	-	-	0.02	-
13.12	12.9	16.8	-	0.5	-2.6	4.0	3	silty CLAY to CLAY	115	1.5	9	11	-	-	0.9	8.8	53	15	-	-	0.02	-
13.29	10.4	13.4	-	0.4	-2.6	4.0	3	silty CLAY to CLAY	115	1.5	7	9	-	-	0.7	6.9	58	15	-	-	0.02	-
13.45	9.4	12.0	-	0.4	-2.6	4.3	3	silty CLAY to CLAY	115	1.5	6	8	-	-	0.6	6.1	62	15	-	-	0.02	-
13.62	11.4	14.4	-	0.4	-2.6	4.1	3	silty CLAY to CLAY	115	1.5	8	10	-	-	0.8	7.5	57	15	-	-	0.02	-
13.78	14.4	17.9	-	0.5	-2.6	3.6	3	silty CLAY to CLAY	115	1.5	10	12	-	-	1.0	9.5	50	15	-	-	0.02	-
13.94	15.9	19.6	-	0.5	-2.6	3.5	3	silty CLAY to CLAY	115	1.5	11	13	-	-	1.1	9.9	47	15	-	-	0.02	-
14.11	16.2	19.8	-	0.5	-2.6	3.4	3	silty CLAY to CLAY	115	1.5	11	13	-	-	1.1	9.9	47	15	-	-	0.02	-
14.27	16.6	20.0	-	0.6	-2.6	3.6	3	silty CLAY to CLAY	115	1.5	11	13	-	-	1.1	9.9	47	15	-	-	0.02	-
14.44	17.7	21.1	-	0.6	-2.6	3.3	4	clayy SILT to silty CLAY	115	2.0	9	11	-	-	1.2	9.9	45	15	-	-	0.02	-
14.60	18.6	21.9	-	0.6	-2.6	3.4	4	clayy SILT to silty CLAY	115	2.0	9	11	-	-	1.3	9.9	44	15	-	-	0.02	-
14.76	20.8	24.2	-	0.6	-2.6	3.0	4	clayy SILT to silty CLAY	115	2.0	10	12	-	-	1.4	9.9	40	15	-	-	0.02	-
14.93	19.9	22.9	-	0.6	-2.6	3.1	4	clayy SILT to silty CLAY	115	2.0	10	11	-	-	1.4	9.9	42	15	-	-	0.02	-
15.09	21.4	24.4	-	0.6	-2.5	2.9	4	clayy SILT to silty CLAY	115	2.0	11	12	-	-	1.5	9.9	40	15	-	-	0.02	-
15.26	21.2	23.9	-	0.7	-2.5	3.4	4	clayy SILT to silty CLAY	115	2.0	11	12	-	-	1.5	9.9	43	15	-	-	0.02	-
15.42	20.9	23.3	-	0.6	-2.5	3.1	4	clayy SILT to silty CLAY	115	2.0	10	12	-	-	1.4	9.9	42	15	-	-	0.02	-
15.58	18.9	20.8	-	0.5	-2.5	2.9	4	clayy SILT to silty CLAY	115	2.0	9	10	-	-	1.3	9.9	43	15	-	-	0.02	-

* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

Project ID: Earth Mechanics
Data File: SDF(575)-18.cpt
CPT Date: 10/11/2011 1:20:42 AM
GW During Test: 18 ft

Sounding ID: CPT-11-349
Project No: 11-137
Cone/Rig: DSG1023

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	Slv Stss tsf	pore prss (psi)	Frct Ratio %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	SPT R-N 60%	* SPT R-N1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* Nk -	* Vol Strn %	* Dry Stlmt 0.01	* Liq Stlmt 0.04	* Cycl SStn %
15.75	17.1	18.7	-	0.5	-2.5	2.9	4	clayy SILT to silty CLAY	115	2.0	9	9	-	-	1.2	9.9	45	15	-	-	0.02	-
15.91	17.9	19.3	-	0.5	-2.5	2.9	4	clayy SILT to silty CLAY	115	2.0	9	10	-	-	1.2	9.9	44	15	-	-	0.02	-
16.08	18.3	19.6	-	0.5	-2.5	3.1	4	clayy SILT to silty CLAY	115	2.0	9	10	-	-	1.3	9.9	45	15	-	-	0.02	-
16.24	17.5	18.5	-	0.5	-2.5	3.1	4	clayy SILT to silty CLAY	115	2.0	9	9	-	-	1.2	9.9	46	15	-	-	0.02	-
16.40	15.3	16.1	-	0.5	-2.4	3.8	3	silty CLAY to CLAY	115	1.5	10	11	-	-	1.0	8.8	53	15	-	-	0.02	-
16.57	15.7	16.3	-	0.6	-2.4	3.8	3	silty CLAY to CLAY	115	1.5	10	11	-	-	1.1	9.0	53	15	-	-	0.02	-
16.73	15.1	15.5	-	0.5	-2.4	3.6	3	silty CLAY to CLAY	115	1.5	10	10	-	-	1.0	8.5	53	15	-	-	0.02	-
16.90	15.4	15.7	-	0.5	-2.4	3.7	3	silty CLAY to CLAY	115	1.5	10	10	-	-	1.1	8.6	53	15	-	-	0.02	-
17.06	15.5	15.6	-	0.5	-2.4	3.4	3	silty CLAY to CLAY	115	1.5	10	10	-	-	1.1	8.6	52	15	-	-	0.02	-
17.23	13.2	13.2	-	0.5	-2.4	3.7	3	silty CLAY to CLAY	115	1.5	9	9	-	-	0.9	7.2	57	15	-	-	0.02	-
17.39	11.3	11.1	-	0.4	-2.4	4.2	3	silty CLAY to CLAY	115	1.5	8	7	-	-	0.8	6.0	64	15	-	-	0.02	-
17.55	11.8	11.6	-	0.4	-2.4	3.8	3	silty CLAY to CLAY	115	1.5	8	8	-	-	0.8	6.2	61	15	-	-	0.02	-
17.72	11.2	10.9	-	0.4	-2.4	3.8	3	silty CLAY to CLAY	115	1.5	7	7	-	-	0.8	5.9	63	15	-	-	0.02	-
17.88	11.5	11.0	-	0.3	-2.4	3.2	3	silty CLAY to CLAY	115	1.5	8	7	-	-	0.8	5.9	59	15	-	-	0.02	-
18.05	10.7	10.3	-	0.3	-2.4	3.3	3	silty CLAY to CLAY	115	1.5	7	7	-	-	0.7	5.5	62	15	-	-	0.02	-
18.21	11.4	10.9	-	0.3	-2.4	2.9	3	silty CLAY to CLAY	115	1.5	8	7	-	-	0.8	5.8	58	15	-	-	0.02	-
18.37	10.3	9.8	-	0.3	-2.4	3.0	3	silty CLAY to CLAY	115	1.5	7	7	-	-	0.7	5.1	61	15	-	-	0.02	-
18.54	10.0	9.5	-	0.2	-2.4	2.8	3	silty CLAY to CLAY	115	1.5	7	6	-	-	0.7	5.0	61	15	-	-	0.02	-
18.70	9.9	9.4	-	0.3	-2.4	2.9	3	silty CLAY to CLAY	115	1.5	7	6	-	-	0.7	4.9	62	15	-	-	0.02	-
18.87	10.0	9.4	-	0.2	-2.4	2.7	3	silty CLAY to CLAY	115	1.5	7	6	-	-	0.7	4.9	61	15	-	-	0.02	-
19.03	10.1	9.4	-	0.3	-2.4	2.8	3	silty CLAY to CLAY	115	1.5	7	6	-	-	0.7	4.9	62	15	-	-	0.02	-
19.19	9.4	8.8	-	0.2	-2.4	2.9	3	silty CLAY to CLAY	115	1.5	6	6	-	-	0.6	4.5	64	15	-	-	0.02	-
19.36	8.8	8.2	-	0.2	-2.4	3.1	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	4.1	68	15	-	-	0.02	-
19.52	8.5	7.9	-	0.2	-2.4	2.8	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	3.9	67	15	-	-	0.02	-
19.69	6.8	6.3	-	0.2	-2.4	3.3	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.4	3.0	77	15	-	-	0.02	-
19.85	6.7	6.2	-	0.2	-2.4	4.0	3	silty CLAY to CLAY	115	1.5	4	4	-	-	0.4	2.9	82	15	-	-	0.02	-
20.01	6.9	6.3	-	0.2	-2.4	4.0	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.4	3.0	81	15	-	-	0.02	-
20.18	6.8	6.2	-	0.2	-2.3	3.8	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.4	2.9	81	15	-	-	0.02	-
20.34	7.9	7.1	-	0.2	-2.3	3.4	3	silty CLAY to CLAY	115	1.5	5	5	-	-	0.5	3.4	73	15	-	-	0.02	-
20.51	9.0	8.1	-	0.3	-2.3	3.4	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	4.0	69	15	-	-	0.02	-
20.67	9.6	8.6	-	0.3	-2.3	3.0	3	silty CLAY to CLAY	115	1.5	6	6	-	-	0.6	4.3	66	15	-	-	0.02	-
20.83	9.5	8.5	-	0.3	-2.3	3.1	3	silty CLAY to CLAY	115	1.5	6	6	-	-	0.6	4.2	67	15	-	-	0.02	-
21.00	9.6	8.6	-	0.3	-2.3	3.1	3	silty CLAY to CLAY	115	1.5	6	6	-	-	0.6	4.2	66	15	-	-	0.02	-
21.16	9.9	8.8	-	0.3	-2.3	3.6	3	silty CLAY to CLAY	115	1.5	7	6	-	-	0.7	4.3	68	15	-	-	0.02	-
21.33	10.6	9.4	-	0.3	-2.3	3.6	3	silty CLAY to CLAY	115	1.5	7	6	-	-	0.7	4.6	66	15	-	-	0.02	-
21.49	9.1	8.0	-	0.3	-2.2	3.7	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	3.8	71	15	-	-	0.02	-
21.65	6.6	5.8	-	0.2	-2.2	4.4	3	silty CLAY to CLAY	115	1.5	4	4	-	-	0.4	2.6	86	15	-	-	0.02	-
21.82	5.8	5.1	-	0.2	-2.2	4.5	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.2	92	15	-	-	0.02	-
21.98	5.9	5.1	-	0.2	-2.2	4.3	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.2	91	15	-	-	0.02	-
22.15	6.1	5.3	-	0.2	-2.2	3.9	3	silty CLAY to CLAY	115	1.5	4	4	-	-	0.4	2.3	88	15	-	-	0.02	-
22.31	5.7	5.0	-	0.2	-2.2	3.9	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.1	90	15	-	-	0.02	-
22.47	5.4	4.7	-	0.2	-2.2	4.1	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.3	1.9	94	15	-	-	0.02	-
22.64	5.5	4.7	-	0.2	-2.2	3.9	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.3	2.0	92	15	-	-	0.02	-
22.80	5.5	4.7	-	0.2	-2.2	4.1	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.3	2.0	93	15	-	-	0.02	-
22.97	5.6	4.8	-	0.2	-2.2	3.9	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.3	2.0	92	15	-	-	0.02	-
23.13	6.0	5.1	-	0.2	-2.2	3.4	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.1	87	15	-	-	0.02	-
23.30	6.2	5.3	-	0.2	-2.2	3.2	3	silty CLAY to CLAY	115	1.5	4	4	-	-	0.4	2.2	84	15	-	-	0.02	-
23.46	6.9	5.8	-	0.2	-2.2	3.0	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.4	2.5	79	15	-	-	0.02	-
23.62	6.8	5.8	-	0.2	-2.2	3.0	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.4	2.5	79	15	-	-	0.02	-
23.79	6.5	5.4	-	0.1	-2.2	2.9	3	silty CLAY to CLAY	115	1.5	4	4	-	-	0.4	2.3	81	15	-	-	0.02	-
23.95	6.3	5.2	-	0.1	-2.2	2.8	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.2	82	15	-	-	0.02	-
24.12	6.3	5.2	-	0.2	-2.2	3.2	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.2	84	15	-	-	0.02	-
24.28	6.9	5.7	-	0.2	-2.2	2.9	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.4	2.4	79	15	-	-	0.02	-
24.44	6.4	5.3	-	0.1	-2.2	2.9	3	silty CLAY to CLAY	115	1.5	4	4	-	-	0.4	2.2	82	15	-	-	0.02	-
24.61	5.6	4.6	-	0.1	-2.2	3.4	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.3	1.8	92	15	-	-	0.02	-
24.77	5.8	4.8	-	0.1	-2.2	3.1	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	1.9	88	15	-	-	0.02	-
24.94	6.4	5.2	-	0.2	-2.2	3.9	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.1	89	15	-	-	0.02	-
25.10	8.2	6.7	-	0.2	-2.2	2.9	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.9	74	15	-	-	0.02	-
25.26	7.2	5.8	-	0.2	-2.1	3.1	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.5	80	15	-	-	0.02	-
25.43	6.4	5.2	-	0.2	-2.2	3.3	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	2.1	86	15	-	-	0.02	-
25.59	5.9	4.7	-	0.1	-2.2	3.4	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	1.9	90	15	-	-	0.02	-
25.76	5.8	4.6	-	0.1	-2.1	3.5	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	1.8	92	15	-	-	0.02	-
25.92	5.8	4.6	-	0.2	-2.1	3.5	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.4	1.8	92	15	-	-	0.02	-
26.08	5.5	4.4	-	0.2	-2.1	5.3	3	silty CLAY to CLAY	115	1.5	4	3	-	-	0.3	1.6	95	15	-	-	0.02	-
26.25	8.0	6.3	-	0.2	-2.1	3.4	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.7	79	15	-	-	0.02	-
26.41	9.4	7.4	-	0.2	-2.1	2.8	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	3.2	69	15	-	-	0.02	-
26.58	7.2	5.7	-	0.2	-2.1	3.6	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.3	84	15	-	-	0.02	-
26.74	7.2	5.7	-	0.2	-2.1	3.1	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.3	81	15	-	-	0.02	-
26.90	7.1	5.5	-	0.2	-2.1	3.4	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.4	2.2	84	15	-	-	0.02	-
27.07	7.7	6.0	-	0.2	-2.1	3.5	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.5	81	15	-	-	0.02	-
27.23	8.5	6.7	-	0.2	-2.1	3.3	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.8	76	15	-	-	0.02	-
27.40	8.4	6.5	-	0.2	-2.1	3.1	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.7	76	15	-	-	0.02	-
27.56	8.3	6.4	-	0.2	-2.1	3.7	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.7	80	15	-	-	0.02	-
27.72	9.9	7.7	-	0.3	-2.1	3.7	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	3.3	73	15	-	-	0.02	-
27.89	11.0	8.4	-	0.3	-2.1	3.6	3	silty CLAY to CLAY	115	1.5	7	6	-	-	0.7	3.7	70	15	-	-	0.02	-
28.05	11.5	8.8	-	0.4	-2.1	3.8	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.8	3.9	69	15	-	-	0.02	-
28.22	11.4	8.7	-	0.4	-2.1	4.4	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.7	3.8	73	15	-	-	0.02	-
28.38	12.6	9.6	-	0.3	-2.1	3.2	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.8	4.2	64	15	-	-	0.02	-
28.54	10.7	8.1	-	0.3	-2.1	3.8	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.7	3.5	72	15	-	-	0.02	-
28.71	9.9	7.5	-	0.3	-2.1	4.2	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	3.1	77	15	-	-	0.02	-
28.87	9.6	7.2	-	0.3	-2.1	3.8	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	3.0	76	15	-	-	0.02	-
29.04	8.6	6.5	-	0.3	-2.1	3.9	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.6	81	15	-	-	0.02	-
29.20	8.6	6.4	-	0.3	-2.1	4.3	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.6	83	15	-	-	0.02	-
29.36	9.2	6.9	-	0.4	-2.1	4.7	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	2.8	82	15	-	-	0.02	-
29.53	10.8	8.0	-	0.4	-2.1	4.6	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.7	3.4	76	15	-	-	0.02	-
29.69	12.3	9.1	-	0.4	-2.1	3.9	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.8	3.9	69	15	-	-	0.02	-
29.86	12.8	9.5	-	0.5	-2.1	4.8	3	silty CLAY to CLAY	115	1.5	9	6	-	-	0.8	4.1	72	15	-	-	0.02	-
30.02	11.7	8.6	-	0.5	-2.0	4.9	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.8	3.7	75	15	-	-	0.02	-
30.19	12.4	9.1	-	0.5	-2.0	4.3	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.8	3.9	71	15	-	-	0.02	-
30.35	10.5	7.7	-	0.4	-2.1	4.6	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.7	3.2	78	15	-	-	0.02	-
30.51	9.6	7.0	-	0.3	-2.1	4.5	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	2.8	81	15	-	-	0.02	-
30.68	8.5	6.2	-	0.3	-2.0	4.4	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.4	85	15	-	-	0.02	-
30.84	8.5	6.2	-	0.3	-2.0	4.3	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.4	85	15	-	-	0.02	-
31.01	9.1	6.6	-	0.3	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.6	81	15	-	-	0.02	-

* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Project ID: Earth Mechanics
Data File: SDF(575)-18.cpt
CPT Date: 10/11/2011 1:20:42 AM
GW During Test: 18 ft

Sounding ID: CPT-11-349
Project No: 11-137
Cone/Rig: DSG1023

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	SPT R-N 60%	* SPT R-N1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* Nk -	* Vol Strn %	* Dry Stlmt 0.01	* Liq Stlmt 0.04	* Cycl SStn %
31.17	8.8	6.3	-	0.3	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.5	83	15	-	-	0.02	-
31.33	8.8	6.3	-	0.3	-2.0	4.2	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.5	83	15	-	-	0.02	-
31.50	9.0	6.5	-	0.3	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.5	82	15	-	-	0.02	-
31.66	8.8	6.3	-	0.3	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.4	82	15	-	-	0.02	-
31.83	8.1	5.8	-	0.2	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.2	86	15	-	-	0.02	-
31.99	8.2	5.8	-	0.2	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.2	84	15	-	-	0.02	-
32.15	8.1	5.7	-	0.2	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	5	4	-	-	0.5	2.2	85	15	-	-	0.02	-
32.32	8.6	6.1	-	0.3	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.5	2.3	84	15	-	-	0.02	-
32.48	9.0	6.3	-	0.3	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.4	82	15	-	-	0.02	-
32.65	9.6	6.7	-	0.3	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.6	78	15	-	-	0.02	-
32.81	9.7	6.8	-	0.3	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	6	5	-	-	0.6	2.7	76	15	-	-	0.02	-
32.97	9.7	6.7	-	0.3	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	6	4	-	-	0.6	2.6	77	15	-	-	0.02	-
33.14	9.9	6.9	-	0.3	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	2.7	76	15	-	-	0.02	-
33.30	9.9	6.8	-	0.3	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	2.7	77	15	-	-	0.02	-
33.47	10.0	6.9	-	0.3	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	2.7	75	15	-	-	0.02	-
33.63	10.1	7.0	-	0.3	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	2.7	76	15	-	-	0.02	-
33.79	10.2	7.0	-	0.3	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.7	2.7	75	15	-	-	0.02	-
33.96	10.0	6.8	-	0.3	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	2.6	77	15	-	-	0.02	-
34.12	10.2	6.9	-	0.3	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.6	2.7	77	15	-	-	0.02	-
34.29	10.7	7.3	-	0.3	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.7	2.9	76	15	-	-	0.02	-
34.45	11.6	7.9	-	0.3	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.7	3.1	73	15	-	-	0.02	-
34.61	10.8	7.3	-	0.3	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.7	2.9	75	15	-	-	0.02	-
34.78	10.8	7.3	-	0.3	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	7	5	-	-	0.7	2.9	73	15	-	-	0.02	-
34.94	11.3	7.6	-	0.3	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.7	3.0	74	15	-	-	0.02	-
35.11	12.3	8.3	-	0.3	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.8	3.3	70	15	-	-	0.02	-
35.27	11.8	7.9	-	0.4	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	3.1	72	15	-	-	0.02	-
35.43	12.3	8.2	-	0.3	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	3.3	70	15	-	-	0.02	-
35.60	12.6	8.4	-	0.4	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	8	6	-	-	0.8	3.3	70	15	-	-	0.02	-
35.76	13.0	8.6	-	0.4	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	9	6	-	-	0.8	3.4	69	15	-	-	0.02	-
35.93	13.7	9.1	-	0.4	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	9	6	-	-	0.9	3.7	67	15	-	-	0.02	-
36.09	14.0	9.2	-	0.4	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	9	6	-	-	0.9	3.7	67	15	-	-	0.02	-
36.26	13.0	8.6	-	0.4	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	9	6	-	-	0.8	3.4	69	15	-	-	0.02	-
36.42	14.6	9.6	-	0.4	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.9	65	15	-	-	0.02	-
36.58	16.3	10.6	-	0.4	-2.0	2.9	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.1	4.4	60	15	-	-	0.02	-
36.75	15.8	10.3	-	0.5	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.0	4.2	63	15	-	-	0.02	-
36.91	16.8	10.9	-	0.5	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.1	4.5	61	15	-	-	0.02	-
37.08	16.8	10.9	-	0.4	-2.0	3.0	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.1	4.5	59	15	-	-	0.02	-
37.24	15.4	10.0	-	0.9	-2.0	6.7	3	silty CLAY to CLAY	115	1.5	10	7	-	-	1.0	4.0	78	15	-	-	0.02	-
37.40	16.0	10.3	-	0.7	-2.0	5.3	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.1	4.2	72	15	-	-	0.02	-
37.57	16.9	10.8	-	0.7	-2.0	4.5	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.1	4.4	67	15	-	-	0.02	-
37.73	16.1	10.3	-	0.4	-2.0	3.1	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.1	4.2	61	15	-	-	0.02	-
37.90	14.8	9.5	-	0.4	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.8	66	15	-	-	0.02	-
38.06	15.2	9.7	-	0.4	-2.0	3.1	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.9	63	15	-	-	0.02	-
38.22	15.4	9.8	-	0.4	-2.0	3.1	3	silty CLAY to CLAY	115	1.5	10	7	-	-	1.0	3.9	63	15	-	-	0.02	-
38.39	15.5	9.8	-	0.4	-2.0	2.9	3	silty CLAY to CLAY	115	1.5	10	7	-	-	1.0	3.9	62	15	-	-	0.02	-
38.55	14.9	9.4	-	0.4	-2.0	2.8	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.7	62	15	-	-	0.02	-
38.72	15.1	9.5	-	0.5	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.8	68	15	-	-	0.02	-
38.88	17.1	10.7	-	0.6	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	11	7	-	-	1.1	4.3	64	15	-	-	0.02	-
39.04	29.6	18.6	-	0.6	-2.0	2.1	4	clayy SILT to silty CLAY	115	2.0	15	9	-	-	2.0	8.0	41	15	-	-	0.02	-
39.21	30.9	19.3	-	0.9	-2.0	3.0	4	clayy SILT to silty CLAY	115	2.0	15	10	-	-	2.1	8.3	46	15	-	-	0.02	-
39.37	23.1	14.4	-	0.7	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	15	10	-	-	1.6	6.0	54	15	-	-	0.02	-
39.54	18.0	11.2	-	0.4	-2.0	2.6	3	silty CLAY to CLAY	115	1.5	12	7	-	-	1.2	4.5	56	15	-	-	0.02	-
39.70	13.3	8.2	-	0.3	-2.0	3.0	3	silty CLAY to CLAY	115	1.5	9	5	-	-	0.9	3.2	68	15	-	-	0.02	-
39.86	12.7	7.8	-	0.4	-2.0	4.3	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	3.0	76	15	-	-	0.02	-
40.03	12.3	7.6	-	0.4	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	2.8	75	15	-	-	0.02	-
40.19	14.7	9.0	-	0.3	-2.0	2.8	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.5	64	15	-	-	0.02	-
40.36	12.6	7.7	-	0.4	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	2.9	76	15	-	-	0.02	-
40.52	15.2	9.3	-	0.6	-2.0	4.8	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.6	73	15	-	-	0.02	-
40.68	22.3	13.6	-	0.6	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.6	55	15	-	-	0.02	-
40.85	20.6	12.5	-	0.7	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	14	8	-	-	1.4	5.1	61	15	-	-	0.02	-
41.01	18.9	11.5	-	0.6	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	13	8	-	-	1.3	4.6	61	15	-	-	0.02	-
41.18	15.0	9.1	-	0.4	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.5	67	15	-	-	0.02	-
41.34	14.4	8.7	-	0.3	-2.0	2.7	3	silty CLAY to CLAY	115	1.5	10	6	-	-	0.9	3.3	65	15	-	-	0.02	-
41.50	14.1	8.5	-	0.3	-2.0	2.4	3	silty CLAY to CLAY	115	1.5	9	6	-	-	0.9	3.2	63	15	-	-	0.02	-
41.67	12.6	7.6	-	0.3	-2.0	2.7	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	2.8	69	15	-	-	0.02	-
41.83	11.9	7.2	-	0.2	-2.0	2.4	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	2.6	69	15	-	-	0.02	-
42.00	12.3	7.4	-	0.4	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	8	5	-	-	0.8	2.7	76	15	-	-	0.02	-
42.16	15.6	9.3	-	0.5	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.6	70	15	-	-	0.02	-
42.32	21.5	12.8	-	0.6	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	14	9	-	-	1.4	5.1	56	15	-	-	0.02	-
42.49	22.1	13.1	-	0.7	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.3	57	15	-	-	0.02	-
42.65	21.9	12.9	-	0.7	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.2	57	15	-	-	0.02	-
42.82	19.0	11.2	-	0.5	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	13	7	-	-	1.3	4.4	60	15	-	-	0.02	-
42.98	18.7	11.0	-	0.5	-2.0	2.8	3	silty CLAY to CLAY	115	1.5	12	7	-	-	1.2	4.3	58	15	-	-	0.02	-
43.15	15.2	8.9	-	0.4	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.4	67	15	-	-	0.02	-
43.31	15.3	9.0	-	0.5	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	10	6	-	-	1.0	3.4	69	15	-	-	0.02	-
43.47	17.7	10.4	-	0.7	-2.0	4.6	3	silty CLAY to CLAY	115	1.5	12	7	-	-	1.2	4.0	69	15	-	-	0.02	-
43.64	22.2	13.0	-	0.9	-2.0	4.6	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.2	62	15	-	-	0.02	-
43.80	24.5	14.3	-	0.9	-2.0	4.2	3	silty CLAY to CLAY	115	1.5	16	10	-	-	1.6	5.8	58	15	-	-	0.02	-
43.97	21.7	12.6	-	0.9	-1.9	4.5	3	silty CLAY to CLAY	115	1.5	14	8	-	-	1.4	5.0	63	15	-	-	0.02	-
44.13	22.5	13.0	-	1.0	-1.9	5.2	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.2	65	15	-	-	0.02	-
44.29	22.2	12.8	-	1.0	-1.9	5.1	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.1	65	15	-	-	0.02	-
44.46	22.9	13.2	-	0.8	-1.9	4.0	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.3	60	15	-	-	0.02	-
44.62	20.4	11.7	-	0.8	-1.9	4.3	3	silty CLAY to CLAY	115	1.5	14	8	-	-	1.3	4.6	64	15	-	-	0.02	-
44.79	20.5	11.7	-	1.1	-1.9	6.1	3	silty CLAY to CLAY	115	1.5	14	8	-	-	1.4	4.6	71	15	-	-	0.02	-
44.95	20.9	12.0	-	1.2	-1.9	6.3	3	silty CLAY to CLAY	115	1.5	14	8	-	-	1.4	4.7	71	15	-	-	0.02	-
45.11	29.3	16.7	-	1.1	-2.0	4.2	3	silty CLAY to CLAY	115	1.5	20	11	-	-	2.0	6.8	54	15	-	-	0.02	-
45.28	25.9	14.7	-	1.0	-2.0	4.3	3	silty CLAY to CLAY	115	1.5	17	10	-	-	1.7	5.9	58	15	-	-	0.02	-
45.44	24.0	13.6	-	0.8	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	16	9	-	-	1.6	5.4	58	15	-	-	0.02	-
45.61	22.4	12.7	-	0.8	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	15	8	-	-	1.5	5.0	61	15	-	-	0.02	-
45.77	22.8	12.9	-	0.8	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	15	9	-	-	1.5	5.1	61	15	-	-	0.02	-
45.93	24.6	13.8	-	0.9	-2.0	4.2	3	silty CLAY to CLAY	115	1.5	16	9	-	-	1.6	5.5	59	15	-	-	0.02	-
46.10	26.6	15.0	-	1.0	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	18	10	-	-	1.8	6.0	56	15	-	-	0.02	-
46.26	27.1	15.2	-	1.0	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	18	10	-	-	1.8	6.1	56	15	-	-	0.02	-
46.43	27.8	15.5	-	1.0	-1.9	4.1	3	silty CLAY to CLAY	115	1.5	19	10	-	-	1.9	6.2	56	15	-	-	0.02	-

* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

Project ID: Earth Mechanics
Data File: SDF(575)-18.cpt
CPT Date: 10/11/2011 1:20:42 AM
GW During Test: 18 ft

Sounding ID: CPT-11-349
Project No: 11-137
Cone/Rig: DSG1023

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	SPT R-N 60%	* SPT R-N1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* Nk -	* Vol Strn %	* Dry Stlmt 0.01	* Liq Stlmt 0.04	* Cycl SStn %
46.59	28.4	15.9	-	1.0	-1.9	3.9	3	silty CLAY to CLAY	115	1.5	19	11	-	-	1.9	6.4	54	15	-	-	0.02	-
46.75	28.6	15.9	-	0.8	-1.9	3.3	3	silty CLAY to CLAY	115	1.5	19	11	-	-	1.9	6.4	51	15	-	-	0.02	-
46.92	26.1	14.5	-	0.7	-1.9	2.9	3	silty CLAY to CLAY	115	1.5	17	10	-	-	1.8	5.8	52	15	-	-	0.02	-
47.08	21.4	11.9	-	0.5	-1.9	2.6	3	silty CLAY to CLAY	115	1.5	14	8	-	-	1.4	4.6	55	15	-	-	0.02	-
47.25	18.1	10.0	-	0.6	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	12	7	-	-	1.2	3.8	66	15	-	-	0.02	-
47.41	21.5	11.8	-	0.8	-1.9	4.1	3	silty CLAY to CLAY	115	1.5	14	8	-	-	1.4	4.6	63	15	-	-	0.02	-
47.57	30.1	16.6	-	1.0	-1.9	3.6	3	silty CLAY to CLAY	115	1.5	20	11	-	-	2.0	6.7	52	15	-	-	0.02	-
47.74	30.7	16.8	-	1.3	-1.9	4.8	3	silty CLAY to CLAY	115	1.5	20	11	-	-	2.1	6.8	57	15	-	-	0.02	-
47.90	31.7	17.3	-	1.9	-1.9	6.7	3	silty CLAY to CLAY	115	1.5	21	12	-	-	2.1	7.0	62	15	-	-	0.02	-
48.07	80.2	57.6	149.6	2.7	-1.9	3.5	4	clayy SILT to silty CLAY	115	2.0	40	29	-	-	5.6	9.9	29	15	1.05	-	0.02	18.3
48.23	96.5	69.2	162.4	3.3	-1.9	3.5	4	clayy SILT to silty CLAY	115	2.0	48	35	-	-	6.7	9.9	27	15	0.00	-	0.02	0.0
48.39	54.4	29.5	-	2.0	-1.9	3.9	4	clayy SILT to silty CLAY	115	2.0	27	15	-	-	3.7	9.9	41	15	-	-	0.02	-
48.56	28.6	15.5	-	1.4	-1.9	5.4	3	silty CLAY to CLAY	115	1.5	19	10	-	-	1.9	6.2	61	15	-	-	0.02	-
48.72	28.3	15.3	-	1.6	-1.9	6.1	3	silty CLAY to CLAY	115	1.5	19	10	-	-	1.9	6.1	64	15	-	-	0.02	-
48.89	58.9	31.8	-	2.1	-1.9	3.7	4	clayy SILT to silty CLAY	115	2.0	29	16	-	-	4.1	9.9	39	15	-	-	0.02	-
49.05	123.4	87.9	138.4	2.4	-1.9	2.0	5	silty SAND to sandy SILT	120	4.0	31	22	63	40	-	-	18	16	1.62	-	0.02	17.9
49.22	133.7	95.2	158.7	3.2	-1.9	2.4	5	silty SAND to sandy SILT	120	4.0	33	24	65	40	-	-	19	16	0.74	-	0.01	4.5
49.38	108.5	77.1	158.0	3.2	-1.9	3.0	5	silty SAND to sandy SILT	120	4.0	27	19	58	39	-	-	24	16	0.73	-	0.01	5.2
49.54	95.9	68.0	153.2	3.0	-1.8	3.2	4	clayy SILT to silty CLAY	115	2.0	48	34	-	-	6.7	9.9	26	15	0.90	-	0.01	8.4
49.71	83.6	59.3	155.4	2.9	-1.8	3.6	4	clayy SILT to silty CLAY	115	2.0	42	30	-	-	5.8	9.9	29	15	0.78	-	0.01	8.5
49.87	56.8	30.2	-	2.4	-1.8	4.4	3	silty CLAY to CLAY	115	1.5	38	20	-	-	3.9	9.9	43	15	-	-	0.01	-
50.04	42.1	22.4	-	2.7	-1.8	6.9	3	silty CLAY to CLAY	115	1.5	28	15	-	-	2.9	9.1	57	15	-	-	0.01	-
50.20	59.3	31.4	-	2.3	-1.8	4.0	4	clayy SILT to silty CLAY	115	2.0	30	16	-	-	4.1	9.9	41	15	-	-	0.01	-
50.36	39.9	21.0	-	1.4	-1.8	3.8	3	silty CLAY to CLAY	115	1.5	27	14	-	-	2.7	8.5	48	15	-	-	0.01	-
50.53	25.7	13.6	-	0.6	-1.8	2.8	3	silty CLAY to CLAY	115	1.5	17	9	-	-	1.7	5.2	53	15	-	-	0.01	-
50.69	22.9	12.1	-	1.1	-1.8	5.3	3	silty CLAY to CLAY	115	1.5	15	8	-	-	1.5	4.6	67	15	-	-	0.01	-
50.86	71.6	50.3	126.6	1.9	-1.9	2.8	4	clayy SILT to silty CLAY	115	2.0	36	25	-	-	5.0	9.9	28	15	1.93	-	0.01	43.8
51.02	87.8	61.7	148.0	2.7	-1.9	3.2	4	clayy SILT to silty CLAY	115	2.0	44	31	-	-	6.1	9.9	27	15	1.09	-	0.01	14.3
51.18	92.4	64.9	157.8	3.1	-1.9	3.5	4	clayy SILT to silty CLAY	115	2.0	46	32	-	-	6.4	9.9	28	15	0.68	-	0.00	5.4
51.35	84.8	59.5	162.3	3.2	-1.9	3.9	4	clayy SILT to silty CLAY	115	2.0	42	30	-	-	5.9	9.9	30	15	0.00	-	0.00	0.0
51.51	74.0	38.5	-	3.0	-1.9	4.2	4	clayy SILT to silty CLAY	115	2.0	37	19	-	-	5.1	9.9	38	15	-	-	0.00	-
51.68	59.7	30.9	-	2.7	-1.9	4.7	3	silty CLAY to CLAY	115	1.5	40	21	-	-	4.1	9.9	43	15	-	-	0.00	-
51.84	35.6	18.4	-	2.0	-1.9	6.0	3	silty CLAY to CLAY	115	1.5	24	12	-	-	2.4	7.3	59	15	-	-	0.00	-
52.00	35.8	18.5	-	1.5	-1.9	4.6	3	silty CLAY to CLAY	115	1.5	24	12	-	-	2.4	7.3	54	15	-	-	0.00	-
52.17	37.8	19.5	-	1.9	-1.9	5.5	3	silty CLAY to CLAY	115	1.5	25	13	-	-	2.6	7.7	56	15	-	-	0.00	-
52.33	58.6	30.1	-	2.0	-1.9	3.6	4	clayy SILT to silty CLAY	115	2.0	29	15	-	-	4.0	9.9	40	15	-	-	0.00	-
52.50	58.8	30.1	-	2.2	-1.9	4.0	4	clayy SILT to silty CLAY	115	2.0	29	15	-	-	4.0	9.9	41	15	-	-	0.00	-
52.66	69.0	47.9	120.6	1.8	-1.9	2.7	4	clayy SILT to silty CLAY	115	2.0	34	24	-	-	4.8	9.9	28	15	2.00	-	0.00	46.5
52.82	47.4	24.2	-	1.9	-1.8	4.4	3	silty CLAY to CLAY	115	1.5	32	16	-	-	3.2	9.8	47	15	-	-	0.00	-
52.99	52.3	26.6	-	2.5	-1.9	5.1	3	silty CLAY to CLAY	115	1.5	35	18	-	-	3.6	9.9	48	15	-	-	0.00	-
53.15	39.5	20.1	-	2.6	-1.8	7.1	3	silty CLAY to CLAY	115	1.5	26	13	-	-	2.7	8.0	60	15	-	-	0.00	-
53.32	58.8	29.8	-	1.9	-1.8	3.4	4	clayy SILT to silty CLAY	115	2.0	29	15	-	-	4.0	9.9	39	15	-	-	0.00	-
53.48	61.5	31.1	-	2.0	-1.9	3.5	4	clayy SILT to silty CLAY	115	2.0	31	16	-	-	4.2	9.9	39	15	-	-	0.00	-
53.64	36.9	18.6	-	1.5	-1.8	4.5	3	silty CLAY to CLAY	115	1.5	25	12	-	-	2.5	7.3	53	15	-	-	0.00	-
53.81	28.5	14.4	-	1.2	-1.8	4.7	3	silty CLAY to CLAY	115	1.5	19	10	-	-	1.9	5.5	60	15	-	-	0.00	-
53.97	28.0	14.1	-	1.3	-1.8	5.4	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.9	5.4	63	15	-	-	0.00	-
54.14	54.0	27.1	-	2.0	-1.9	3.9	4	clayy SILT to silty CLAY	115	2.0	27	14	-	-	3.7	9.9	43	15	-	-	0.00	-
54.30	54.7	27.4	-	2.1	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	36	18	-	-	3.8	9.9	43	15	-	-	0.00	-
54.46	41.4	20.7	-	1.9	-1.9	4.9	3	silty CLAY to CLAY	115	1.5	28	14	-	-	2.8	8.2	52	15	-	-	0.00	-
54.63	40.0	19.9	-	1.4	-1.9	3.8	3	silty CLAY to CLAY	115	1.5	27	13	-	-	2.7	7.9	49	15	-	-	0.00	-
54.79	34.3	17.0	-	1.8	-1.9	5.6	3	silty CLAY to CLAY	115	1.5	23	11	-	-	2.3	6.6	59	15	-	-	0.00	-
54.96	61.2	30.4	-	1.9	-2.0	3.4	4	clayy SILT to silty CLAY	115	2.0	31	15	-	-	4.2	9.9	38	15	-	-	0.00	-
55.12	56.3	27.9	-	1.7	-2.0	3.2	4	clayy SILT to silty CLAY	115	2.0	28	14	-	-	3.9	9.9	39	15	-	-	0.00	-
55.28	32.5	16.0	-	1.5	-2.0	5.1	3	silty CLAY to CLAY	115	1.5	22	11	-	-	2.2	6.2	59	15	-	-	0.00	-
55.45	26.5	13.1	-	1.1	-2.0	4.6	3	silty CLAY to CLAY	115	1.5	18	9	-	-	1.8	4.9	63	15	-	-	0.00	-
55.61	31.2	15.4	-	1.0	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	21	10	-	-	2.1	5.9	54	15	-	-	0.00	-
55.78	36.1	17.7	-	0.9	-2.0	2.8	4	clayy SILT to silty CLAY	115	2.0	18	9	-	-	2.4	6.9	46	15	-	-	0.00	-
55.94	31.4	15.4	-	1.0	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	21	10	-	-	2.1	5.9	54	15	-	-	0.00	-
56.11	59.0	28.9	-	1.5	-2.0	2.7	4	clayy SILT to silty CLAY	115	2.0	30	14	-	-	4.1	9.9	36	15	-	-	0.00	-
56.27	47.3	23.1	-	1.5	-2.0	3.5	4	clayy SILT to silty CLAY	115	2.0	24	12	-	-	3.2	9.2	44	15	-	-	0.00	-
56.43	31.9	15.5	-	1.1	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	21	10	-	-	2.1	5.9	55	15	-	-	0.00	-
56.60	27.9	13.6	-	0.8	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.9	5.1	56	15	-	-	0.00	-
56.76	27.1	13.1	-	1.1	-2.0	4.8	3	silty CLAY to CLAY	115	1.5	18	9	-	-	1.8	4.9	63	15	-	-	0.00	-
56.93	38.4	18.6	-	1.3	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	26	12	-	-	2.6	7.2	50	15	-	-	0.00	-
57.09	46.5	22.4	-	1.6	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	31	15	-	-	3.2	8.8	46	15	-	-	0.00	-
57.25	33.1	15.9	-	1.3	-2.0	4.4	3	silty CLAY to CLAY	115	1.5	22	11	-	-	2.2	6.1	57	15	-	-	0.00	-
57.42	30.3	14.6	-	0.9	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	20	10	-	-	2.0	5.5	54	15	-	-	0.00	-
57.58	25.8	12.4	-	0.9	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	17	8	-	-	1.7	4.6	62	15	-	-	0.00	-
57.75	25.2	12.0	-	0.8	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	17	8	-	-	1.7	4.4	61	15	-	-	0.00	-
57.91	25.9	12.4	-	0.9	-2.0	4.2	3	silty CLAY to CLAY	115	1.5	17	8	-	-	1.7	4.6	62	15	-	-	0.00	-
58.07	25.3	12.1	-	0.9	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	17	8	-	-	1.7	4.4	63	15	-	-	0.00	-
58.24	25.9	12.3	-	0.9	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	17	8	-	-	1.7	4.5	62	15	-	-	0.00	-
58.40	27.8	13.2	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.8	4.9	59	15	-	-	0.00	-
58.57	28.8	13.6	-	0.9	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.9	5.1	57	15	-	-	0.00	-
58.73	28.5	13.5	-	0.9	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.9	5.0	58	15	-	-	0.00	-
58.89	28.7	13.6	-	0.9	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.9	5.0	58	15	-	-	0.00	-
59.06	37.7	17.8	-	1.2	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	25	12	-	-	2.5	6.8	50	15	-	-	0.00	-
59.22	40.8	19.2	-	1.4	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	27	13	-	-	2.8	7.4	49	15	-	-	0.00	-
59.39	35.9	16.8	-	1.1	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	24	11	-	-	2.4	6.4	50	15	-	-	0.00	-
59.55	32.5	15.2	-	0.9	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	22	10	-	-	2.2	5.7	52	15	-	-	0.00	-
59.71	28.8	13.5	-	0.9	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.9	5.0	57	15	-	-	0.00	-
59.88	28.9	13.5	-	1.1	-2.0	4.2	3	silty CLAY to CLAY	115	1.5	19	9	-	-	1.9	5.0	60	15	-	-	0.00	-
60.04	30.1	14.0	-	1.2	-2.0	4.5	3	silty CLAY to CLAY	115	1.5	20	9	-	-	2.0	5.2	60	15	-	-	0.00	-
60.21	34.9	16.2	-	1.3	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	23	11	-	-	2.3	6.1	54	15	-	-	0.00	-
60.37	34.0	15.7	-	1.2	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	23	10	-	-	2.3	5.9	55	15	-	-	0.00	-
60.53	33.6	15.5	-	1.2	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	22	10	-	-	2.3	5.8	55	15	-	-	0.00	-
60.70	32.3	14.9	-	1.1	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	22	10	-	-	2.2	5.6	56	15	-	-	0.00	-
60.86	33.1	15.3	-	1.1	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	22	10	-	-	2.2	5.7	54	15	-	-	0.00	-
61.03	30.7	14.1	-	1.0	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	20	9	-	-	2.0	5.2	57	15	-	-	0.00	-
61.19	29.6	13.6	-	1.0	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	20	9	-	-	2.0	5.0	58	15	-	-	0.00	-
61.35	30.0	13.7	-	1.0	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	20	9	-	-	2.0	5.1	58	15	-	-	0.00	-
61.52	31.1	14.2	-	1.1	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	21	9	-	-	2.1	5.3	57	15	-	-	0.00	-
61.68	31.2	14.2	-	1.1	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	21	9	-	-	2.1	5.3	58	15	-	-	0.00	-
61.85	32.0	14.6	-	1.0	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	21	10	-	-	2.1	5.4	55	15	-	-	0.00	-

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Project No: 11-137
Cone/Rig: DSG1023

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	Slv Stss tsf	pore prss (psi)	Frct Ratio %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	SPT R-N 60%	* SPT R-N1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* Nk -	* Vol Strn %	* Dry Stlmt 0.01	* Liq Stlmt 0.04	* Cycl SStn %
62.01	31.5	14.3	-	0.8	-2.0	2.9	3	silty CLAY to CLAY	115	1.5	21	10	-	-	2.1	5.3	52	15	-	-	0.00	-
62.17	27.3	12.4	-	0.7	-1.9	3.0	3	silty CLAY to CLAY	115	1.5	18	8	-	-	1.8	4.5	56	15	-	-	0.00	-
62.34	24.8	11.2	-	0.6	-1.9	3.0	3	silty CLAY to CLAY	115	1.5	17	7	-	-	1.6	4.0	59	15	-	-	0.00	-
62.50	24.9	11.2	-	0.7	-1.9	3.2	3	silty CLAY to CLAY	115	1.5	17	7	-	-	1.6	4.0	60	15	-	-	0.00	-
62.67	26.2	11.8	-	0.7	-1.9	3.2	3	silty CLAY to CLAY	115	1.5	17	8	-	-	1.7	4.2	59	15	-	-	0.00	-
62.83	27.0	12.1	-	0.8	-1.9	3.2	3	silty CLAY to CLAY	115	1.5	18	8	-	-	1.8	4.4	58	15	-	-	0.00	-
63.00	27.5	12.4	-	0.8	-1.9	3.2	3	silty CLAY to CLAY	115	1.5	18	8	-	-	1.8	4.5	58	15	-	-	0.00	-
63.16	28.3	12.7	-	0.8	-1.9	3.3	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.6	57	15	-	-	0.00	-
63.32	29.5	13.2	-	0.8	-1.9	3.2	3	silty CLAY to CLAY	115	1.5	20	9	-	-	2.0	4.8	56	15	-	-	0.00	-
63.49	29.6	13.2	-	1.1	-1.9	4.2	3	silty CLAY to CLAY	115	1.5	20	9	-	-	2.0	4.8	61	15	-	-	0.00	-
63.65	31.7	14.1	-	1.3	-1.9	4.7	3	silty CLAY to CLAY	115	1.5	21	9	-	-	2.1	5.2	61	15	-	-	0.00	-
63.82	47.9	21.3	-	2.1	-1.9	4.6	3	silty CLAY to CLAY	115	1.5	32	14	-	-	3.3	8.2	51	15	-	-	0.00	-
63.98	57.4	25.5	-	3.0	-1.9	5.5	3	silty CLAY to CLAY	115	1.5	38	17	-	-	3.9	9.9	50	15	-	-	0.00	-
64.14	73.5	32.6	-	3.5	-1.9	5.1	3	silty CLAY to CLAY	115	1.5	49	22	-	-	5.1	9.9	44	15	-	-	0.00	-
64.31	74.5	32.9	-	3.5	-1.9	5.0	3	silty CLAY to CLAY	115	1.5	50	22	-	-	5.1	9.9	43	15	-	-	0.00	-
64.47	65.8	29.1	-	2.6	-2.0	4.2	3	silty CLAY to CLAY	115	1.5	44	19	-	-	4.5	9.9	43	15	-	-	0.00	-
64.64	44.8	19.7	-	1.8	-1.9	4.5	3	silty CLAY to CLAY	115	1.5	30	13	-	-	3.0	7.5	52	15	-	-	0.00	-
64.80	38.1	16.7	-	1.7	-1.9	4.9	3	silty CLAY to CLAY	115	1.5	25	11	-	-	2.6	6.2	57	15	-	-	0.00	-
64.96	39.2	17.2	-	2.0	-1.9	5.8	3	silty CLAY to CLAY	115	1.5	26	11	-	-	2.6	6.4	60	15	-	-	0.00	-
65.13	60.5	26.5	-	1.8	-2.0	3.2	4	clayy SILT to silty CLAY	115	2.0	30	13	-	-	4.1	9.9	41	15	-	-	0.00	-
65.29	48.7	21.3	-	1.7	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	32	14	-	-	3.3	8.1	47	15	-	-	0.00	-
65.46	46.0	20.1	-	1.5	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	31	13	-	-	3.1	7.6	48	15	-	-	0.00	-
65.62	46.0	20.1	-	1.3	-2.0	3.1	4	clayy SILT to silty CLAY	115	2.0	23	10	-	-	3.1	7.6	46	15	-	-	0.00	-
65.78	41.0	17.8	-	1.1	-1.9	3.0	3	silty CLAY to CLAY	115	1.5	27	12	-	-	2.8	6.7	48	15	-	-	0.00	-
65.95	38.9	16.9	-	1.2	-1.9	3.4	3	silty CLAY to CLAY	115	1.5	26	11	-	-	2.6	6.3	51	15	-	-	0.00	-
66.11	37.0	16.0	-	1.2	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	25	11	-	-	2.5	5.9	53	15	-	-	0.00	-
66.28	45.9	19.9	-	1.3	-1.9	3.0	4	clayy SILT to silty CLAY	115	2.0	23	10	-	-	3.1	7.5	45	15	-	-	0.00	-
66.44	45.3	19.6	-	1.5	-1.9	3.5	3	silty CLAY to CLAY	115	1.5	30	13	-	-	3.1	7.4	48	15	-	-	0.00	-
66.60	40.8	17.6	-	1.3	-1.9	3.6	3	silty CLAY to CLAY	115	1.5	27	12	-	-	2.8	6.6	51	15	-	-	0.00	-
66.77	34.6	14.9	-	1.1	-1.9	3.5	3	silty CLAY to CLAY	115	1.5	23	10	-	-	2.3	5.4	54	15	-	-	0.00	-
66.93	33.1	14.2	-	1.0	-1.9	3.4	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.2	55	15	-	-	0.00	-
67.10	32.6	14.0	-	1.1	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.1	57	15	-	-	0.00	-
67.26	33.0	14.1	-	1.1	-1.9	3.8	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.1	57	15	-	-	0.00	-
67.42	34.4	14.7	-	1.2	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	23	10	-	-	2.3	5.4	57	15	-	-	0.00	-
67.59	34.3	14.6	-	1.2	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	23	10	-	-	2.3	5.3	56	15	-	-	0.00	-
67.75	34.9	14.8	-	1.0	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	23	10	-	-	2.3	5.4	54	15	-	-	0.00	-
67.92	35.2	15.0	-	1.0	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	23	10	-	-	2.4	5.5	53	15	-	-	0.00	-
68.08	33.3	14.1	-	1.0	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.1	56	15	-	-	0.00	-
68.24	34.6	14.6	-	1.1	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	23	10	-	-	2.3	5.3	55	15	-	-	0.00	-
68.41	33.4	14.1	-	1.1	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.1	57	15	-	-	0.00	-
68.57	32.6	13.7	-	1.1	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	4.9	57	15	-	-	0.00	-
68.74	32.6	13.7	-	1.0	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	4.9	57	15	-	-	0.00	-
68.90	32.2	13.5	-	1.0	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	21	9	-	-	2.1	4.8	57	15	-	-	0.00	-
69.07	31.3	13.1	-	1.0	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	21	9	-	-	2.1	4.7	59	15	-	-	0.00	-
69.23	32.3	13.5	-	1.1	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.1	4.8	58	15	-	-	0.00	-
69.39	33.7	14.1	-	1.1	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.1	56	15	-	-	0.00	-
69.56	33.3	13.9	-	1.0	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.0	56	15	-	-	0.00	-
69.72	33.4	13.9	-	1.0	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.0	56	15	-	-	0.00	-
69.89	33.7	14.0	-	1.2	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	22	9	-	-	2.2	5.0	58	15	-	-	0.00	-
70.05	32.1	13.3	-	1.1	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	21	9	-	-	2.1	4.7	59	15	-	-	0.00	-
70.21	31.2	12.9	-	1.0	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	21	9	-	-	2.1	4.6	60	15	-	-	0.00	-
70.38	30.0	12.4	-	0.9	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.4	60	15	-	-	0.00	-
70.54	29.6	12.2	-	1.0	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.3	61	15	-	-	0.00	-
70.71	30.9	12.7	-	1.0	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	21	8	-	-	2.0	4.5	59	15	-	-	0.00	-
70.87	30.0	12.3	-	0.9	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.3	59	15	-	-	0.00	-
71.03	28.7	11.8	-	0.8	-2.0	3.3	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.1	60	15	-	-	0.00	-
71.20	28.6	11.7	-	0.8	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.1	60	15	-	-	0.00	-
71.36	28.0	11.4	-	0.9	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.8	4.0	62	15	-	-	0.00	-
71.53	28.8	11.8	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.1	62	15	-	-	0.00	-
71.69	29.1	11.9	-	1.0	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.1	63	15	-	-	0.00	-
71.85	29.2	11.9	-	1.0	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.1	63	15	-	-	0.00	-
72.02	29.0	11.8	-	1.0	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.1	63	15	-	-	0.00	-
72.18	29.6	12.0	-	1.0	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	4.2	62	15	-	-	0.00	-
72.35	30.0	12.1	-	0.9	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.2	60	15	-	-	0.00	-
72.51	29.6	12.0	-	0.9	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	4.2	61	15	-	-	0.00	-
72.67	28.7	11.6	-	0.9	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.0	61	15	-	-	0.00	-
72.84	28.1	11.3	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.8	3.9	63	15	-	-	0.00	-
73.00	28.3	11.4	-	0.9	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	3.9	62	15	-	-	0.00	-
73.17	28.5	11.4	-	0.9	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	3.9	63	15	-	-	0.00	-
73.33	28.4	11.4	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	3.9	63	15	-	-	0.00	-
73.49	29.0	11.6	-	1.0	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	4.0	63	15	-	-	0.00	-
73.66	29.8	11.9	-	0.8	-2.0	3.1	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.1	58	15	-	-	0.00	-
73.82	30.2	12.0	-	1.0	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.2	62	15	-	-	0.00	-
73.99	23.2	9.2	-	1.0	-2.0	5.3	3	silty CLAY to CLAY	115	1.5	15	6	-	-	1.5	3.0	76	15	-	-	0.00	-
74.15	29.6	11.7	-	1.0	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	4.1	63	15	-	-	0.00	-
74.31	29.6	11.7	-	1.0	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	4.1	63	15	-	-	0.00	-
74.48	30.2	12.0	-	1.2	-2.0	4.5	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.1	65	15	-	-	0.00	-
74.64	35.4	14.0	-	1.5	-2.0	4.9	3	silty CLAY to CLAY	115	1.5	24	9	-	-	2.4	5.0	62	15	-	-	0.00	-
74.81	48.2	19.0	-	1.3	-2.0	3.0	4	clayy SILT to silty CLAY	115	2.0	24	10	-	-	3.3	7.0	46	15	-	-	0.00	-
74.97	39.2	15.4	-	1.2	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	26	10	-	-	2.6	5.5	53	15	-	-	0.00	-
75.13	29.7	11.7	-	1.0	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	4.0	63	15	-	-	0.00	-
75.30	26.9	10.6	-	0.8	-2.0	3.7	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.6	65	15	-	-	0.00	-
75.46	27.4	10.7	-	0.7	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.6	62	15	-	-	0.00	-
75.63	25.7	10.0	-	0.7	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	17	7	-	-	1.7	3.3	65	15	-	-	0.00	-
75.79	25.2	9.8	-	0.8	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	17	7	-	-	1.6	3.3	67	15	-	-	0.00	-
75.96	25.9	10.1	-	0.8	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	17	7	-	-	1.7	3.4	67	15	-	-	0.00	-
76.12	26.8	10.4	-	0.8	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.5	65	15	-	-	0.00	-
76.28	27.0	10.5	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.5	66	15	-	-	0.00	-
76.45	29.1	11.3	-	0.8	-2.0	3.4	3	silty CLAY to CLAY	115	1.5	19	8	-	-	1.9	3.8	61	15	-	-	0.00	-
76.61	28.4	11.0	-	1.0	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.9	3.7	65	15	-	-	0.00	-
76.78	27.9	10.8	-	1.0	-2.0	4.3	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.6	67	15	-	-	0.00	-
76.94	41.0	15.8	-	1.4	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	27	11	-	-	2.7	5.7	54	15	-	-	0.00	-
77.10	42.8	16.5	-	1.4	-2.0	3.6	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	5.9	52	15	-	-	0.00	-
77.27	36.5	14.0	-	1.5	-2.0	4.7	3	silty CLAY to CLAY	115	1.5	24	9	-	-	2.4	4.9	61	15	-	-	0.00	-

* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

Project ID: Earth Mechanics
Data File: SDF(575)-18.cpt
CPT Date: 10/11/2011 1:20:42 AM
GW During Test: 18 ft

Sounding ID: CPT-11-349
Project No: 11-137
Cone/Rig: DSG1023

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	SPT R-N 60%	* SPT R-N1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* Nk -	* Vol Strn %	* Dry Stlmt 0.01	* Liq Stlmt 0.04	* Cycl SStn %
77.43	34.3	13.2	-	1.2	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	23	9	-	-	2.3	4.6	61	15	-	-	0.00	-
77.60	30.8	11.8	-	1.0	-1.9	3.9	3	silty CLAY to CLAY	115	1.5	21	8	-	-	2.0	4.0	63	15	-	-	0.00	-
77.76	28.3	10.8	-	0.9	-1.9	4.0	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.7	66	15	-	-	0.00	-
77.92	29.7	11.3	-	0.8	-2.0	3.2	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	3.9	60	15	-	-	0.00	-
78.09	26.4	10.0	-	0.8	-1.9	3.4	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.3	65	15	-	-	0.00	-
78.25	25.8	9.8	-	0.7	-1.9	3.3	3	silty CLAY to CLAY	115	1.5	17	7	-	-	1.7	3.2	65	15	-	-	0.00	-
78.42	26.5	10.1	-	0.7	-1.9	3.3	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.3	64	15	-	-	0.00	-
78.58	26.5	10.0	-	0.8	-1.9	3.5	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.3	66	15	-	-	0.00	-
78.74	27.0	10.2	-	0.8	-1.9	3.5	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.4	65	15	-	-	0.00	-
78.91	27.5	10.4	-	0.8	-1.9	3.4	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.5	64	15	-	-	0.00	-
79.07	26.9	10.1	-	0.8	-1.9	3.4	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.4	65	15	-	-	0.00	-
79.24	27.6	10.4	-	0.8	-1.9	3.4	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.5	64	15	-	-	0.00	-
79.40	26.9	10.1	-	0.8	-1.9	3.6	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.4	66	15	-	-	0.00	-
79.56	27.2	10.3	-	0.8	-1.9	3.5	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.4	65	15	-	-	0.00	-
79.73	27.0	10.2	-	0.8	-1.9	3.6	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.4	66	15	-	-	0.00	-
79.89	28.1	10.6	-	0.9	-1.9	3.8	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.5	66	15	-	-	0.00	-
80.06	27.4	10.4	-	0.9	-1.9	4.1	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.4	67	15	-	-	0.00	-
80.22	27.9	10.5	-	0.8	-2.0	3.5	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.5	64	15	-	-	0.00	-
80.38	26.8	10.1	-	0.9	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.3	68	15	-	-	0.00	-
80.55	26.8	10.1	-	0.8	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.3	67	15	-	-	0.00	-
80.71	26.7	10.1	-	0.9	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.7	3.3	68	15	-	-	0.00	-
80.88	27.4	10.3	-	0.9	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.3	67	15	-	-	0.00	-
81.04	28.3	10.7	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.5	65	15	-	-	0.00	-
81.20	27.4	10.3	-	0.9	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.3	67	15	-	-	0.00	-
81.37	27.3	10.3	-	0.9	-2.0	4.1	3	silty CLAY to CLAY	115	1.5	18	7	-	-	1.8	3.3	68	15	-	-	0.00	-
81.53	28.0	10.6	-	0.9	-2.0	4.0	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.4	67	15	-	-	0.00	-
81.70	28.7	10.8	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.9	3.5	65	15	-	-	0.00	-
81.86	27.8	10.5	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.4	66	15	-	-	0.00	-
82.02	27.8	10.5	-	0.9	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.8	3.4	66	15	-	-	0.00	-
82.19	29.1	11.0	-	1.0	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.9	3.5	65	15	-	-	0.00	-
82.35	30.0	11.3	-	0.9	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	3.7	63	15	-	-	0.00	-
82.52	29.8	11.3	-	0.9	-2.0	3.8	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	3.6	64	15	-	-	0.00	-
82.68	29.8	11.3	-	0.9	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	3.6	63	15	-	-	0.00	-
82.85	29.2	11.0	-	0.9	-2.0	3.9	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.9	3.5	65	15	-	-	0.00	-
83.01	29.5	11.1	-	0.9	-1.9	3.8	3	silty CLAY to CLAY	115	1.5	20	7	-	-	1.9	3.6	64	15	-	-	0.00	-
83.17	30.2	11.4	-	0.9	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	3.6	63	15	-	-	0.00	-
83.34	30.5	11.5	-	1.0	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	3.7	63	15	-	-	0.00	-
83.50	30.6	11.5	-	0.9	-1.9	3.3	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	3.7	61	15	-	-	0.00	-
83.67	30.6	11.6	-	1.1	-1.9	4.3	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	3.7	65	15	-	-	0.00	-
83.83	28.7	10.8	-	1.1	-1.9	4.5	3	silty CLAY to CLAY	115	1.5	19	7	-	-	1.9	3.4	68	15	-	-	0.00	-
83.99	31.5	11.9	-	1.2	-1.9	4.5	3	silty CLAY to CLAY	115	1.5	21	8	-	-	2.1	3.8	65	15	-	-	0.00	-
84.16	37.0	14.0	-	1.2	-1.9	3.7	3	silty CLAY to CLAY	115	1.5	25	9	-	-	2.4	4.6	57	15	-	-	0.00	-
84.32	43.2	16.3	-	1.8	-2.0	4.8	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	5.4	58	15	-	-	0.00	-
84.49	178.9	104.0	166.2	4.2	-2.0	2.4	5	silty SAND to sandy SILT	120	4.0	45	26	68	39	-	-	18	16	0.00	-	0.00	0.0
84.65	235.1	136.5	214.7	6.8	-2.0	3.0	5	silty SAND to sandy SILT	120	4.0	59	34	77	41	-	-	18	16	0.00	-	0.00	0.0
84.81	140.3	81.4	185.9	5.2	-2.4	3.8	4	clayy SILT to silty CLAY	115	2.0	70	41	-	-	9.7	9.9	26	15	0.00	-	0.00	0.0
84.98	59.3	22.4	-	3.8	-5.1	6.9	3	silty CLAY to CLAY	115	1.5	40	15	-	-	4.0	7.7	57	15	-	-	0.00	-
85.14	63.6	24.0	-	2.8	-5.3	4.7	3	silty CLAY to CLAY	115	1.5	42	16	-	-	4.3	8.2	49	15	-	-	0.00	-
85.31	54.7	20.6	-	2.4	-5.3	4.7	3	silty CLAY to CLAY	115	1.5	36	14	-	-	3.7	7.0	52	15	-	-	0.00	-
85.47	56.8	21.4	-	1.8	-5.3	3.5	3	silty CLAY to CLAY	115	1.5	38	14	-	-	3.8	7.3	46	15	-	-	0.00	-
85.63	47.1	17.8	-	1.3	-5.3	3.1	3	silty CLAY to CLAY	115	1.5	31	12	-	-	3.2	5.9	48	15	-	-	0.00	-
85.80	35.3	13.3	-	0.9	-5.4	3.1	3	silty CLAY to CLAY	115	1.5	24	9	-	-	2.3	4.2	55	15	-	-	0.00	-
85.96	30.1	11.4	-	1.0	-5.4	4.1	3	silty CLAY to CLAY	115	1.5	20	8	-	-	2.0	3.5	65	15	-	-	0.00	-
86.13	35.7	13.5	-	1.0	-5.4	3.1	3	silty CLAY to CLAY	115	1.5	24	9	-	-	2.4	4.3	55	15	-	-	0.00	-
86.29	36.1	13.6	-	1.4	-5.4	4.4	3	silty CLAY to CLAY	115	1.5	24	9	-	-	2.4	4.3	61	15	-	-	0.00	-
86.45	40.8	15.4	-	1.6	-5.4	4.4	3	silty CLAY to CLAY	115	1.5	27	10	-	-	2.7	5.0	58	15	-	-	0.00	-
86.62	43.4	16.4	-	1.6	-5.4	4.3	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	5.3	56	15	-	-	0.00	-
86.78	51.5	19.4	-	1.4	-5.4	3.0	4	clayy SILT to silty CLAY	115	2.0	26	10	-	-	3.5	6.4	46	15	-	-	0.00	-
86.95	43.4	16.4	-	1.6	-5.4	4.2	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	5.3	55	15	-	-	0.00	-
87.11	40.3	15.2	-	1.8	-5.4	5.2	3	silty CLAY to CLAY	115	1.5	27	10	-	-	2.7	4.8	61	15	-	-	0.00	-
87.27	47.4	17.9	-	1.8	-5.4	4.1	3	silty CLAY to CLAY	115	1.5	32	12	-	-	3.2	5.8	53	15	-	-	0.00	-
87.44	43.4	16.4	-	1.4	-5.4	3.7	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	5.3	53	15	-	-	0.00	-
87.60	50.8	19.2	-	1.6	-5.5	3.4	3	silty CLAY to CLAY	115	1.5	34	13	-	-	3.4	6.3	48	15	-	-	0.00	-
87.77	41.1	15.5	-	1.2	-5.5	3.5	3	silty CLAY to CLAY	115	1.5	27	10	-	-	2.7	4.9	54	15	-	-	0.00	-
87.93	34.6	13.1	-	1.1	-5.5	3.8	3	silty CLAY to CLAY	115	1.5	23	9	-	-	2.3	4.0	60	15	-	-	0.00	-
88.09	33.2	12.5	-	1.0	-5.5	3.7	3	silty CLAY to CLAY	115	1.5	22	8	-	-	2.2	3.8	60	15	-	-	0.00	-
88.26	33.6	12.7	-	1.0	-5.5	3.5	3	silty CLAY to CLAY	115	1.5	22	8	-	-	2.2	3.9	59	15	-	-	0.00	-
88.42	33.5	12.6	-	0.9	-5.5	3.3	3	silty CLAY to CLAY	115	1.5	22	8	-	-	2.2	3.8	58	15	-	-	0.00	-
88.59	33.5	12.7	-	0.9	-5.5	3.1	3	silty CLAY to CLAY	115	1.5	22	8	-	-	2.2	3.8	57	15	-	-	0.00	-
88.75	31.8	12.0	-	0.9	-5.5	3.2	3	silty CLAY to CLAY	115	1.5	21	8	-	-	2.1	3.6	59	15	-	-	0.00	-
88.92	31.0	11.7	-	0.9	-5.5	3.4	3	silty CLAY to CLAY	115	1.5	21	8	-	-	2.0	3.5	61	15	-	-	0.00	-
89.08	30.9	11.7	-	0.8	-5.5	3.2	3	silty CLAY to CLAY	115	1.5	21	8	-	-	2.0	3.5	60	15	-	-	0.00	-
89.24	30.0	11.3	-	0.8	-5.5	3.3	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	3.3	61	15	-	-	0.00	-
89.41	29.5	11.1	-	0.8	-5.5	3.3	3	silty CLAY to CLAY	115	1.5	20	7	-	-	1.9	3.3	62	15	-	-	0.00	-
89.57	29.8	11.3	-	0.9	-5.5	3.7	3	silty CLAY to CLAY	115	1.5	20	8	-	-	1.9	3.3	64	15	-	-	0.00	-
89.74	31.5	11.9	-	1.0	-5.5	3.9	3	silty CLAY to CLAY	115	1.5	21	8	-	-	2.1	3.5	63	15	-	-	0.00	-
89.90	32.9	12.4	-	1.1	-5.5	4.0	3	silty CLAY to CLAY	115	1.5	22	8	-	-	2.1	3.7	62	15	-	-	0.00	-
90.06	38.5	14.5	-	1.3	-5.5	4.0	3	silty CLAY to CLAY	115	1.5	26	10	-	-	2.5	4.4	58	15	-	-	0.00	-
90.23	43.0	16.2	-	1.5	-5.5	4.1	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	5.0	55	15	-	-	0.00	-
90.39	42.3	15.9	-	1.6	-5.5	4.4	3	silty CLAY to CLAY	115	1.5	28	11	-	-	2.8	4.9	57	15	-	-	0.00	-
90.56	41.5	15.7	-	1.6	-5.5	4.5	3	silty CLAY to CLAY	115	1.5	28	10	-	-	2.8	4.8	58	15	-	-	0.00	-
90.72	44.9	16.9	-	1.9	-5.5	4.8	3	silty CLAY to CLAY	115	1.5	30	11	-	-	3.0	5.2	57	15	-	-	0.00	-
90.88	48.3	18.2	-	1.9	-5.5	4.4	3	silty CLAY to CLAY	115	1.5	32	12	-	-	3.2	5.7	54	15	-	-	0.00	-
91.05	45.5	17.2	-	1.7	-5.5	4.3	3	silty CLAY to CLAY	115	1.5	30	11	-	-	3.0	5.3	55	15	-	-	0.00	-
91.21	42.7	16.1	-	1.7	-5.4	4.4	3	silty CLAY to CLAY	115	1.5	28	11	-	-	2.8	4.9	57	15	-	-	0.00	-
91.38	42.0	15.8	-	1.6	-5.4	4.4	3	silty CLAY to CLAY	115	1.5	28	11	-	-	2.8	4.8	57	15	-	-	0.00	-
91.54	42.4	16.0	-	1.6	-5.4	4.2	3	silty CLAY to CLAY	115	1.5	28	11	-	-	2.8	4.9	56	15	-	-	0.00	-
91.70	41.7	15.7	-	1.5	-5.4	4.2	3	silty CLAY to CLAY	115	1.5	28	10	-	-	2.8	4.8	57	15	-	-	0.00	-
91.87	42.0	15.8	-	1.5	-5.4	4.2	3	silty CLAY to CLAY	115	1.5	28	11	-	-	2.8	4.8	56	15	-	-	0.00	-
92.03	43.1	16.3	-	1.5	-5.4	4.0	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	4.9	55	15	-	-	0.00	-
92.20	44.6	16.8	-	1.5	-5.4	3.7	3	silty CLAY to CLAY	115	1.5	30	11	-	-	3.0	5.1	53	15	-	-	0.00	-
92.36	42.4	16.0	-	1.5	-5.4	4.0	3	silty CLAY to CLAY	115	1.5	28	11	-	-	2.8	4.8	55	15	-	-	0.00	-
92.52	43.7	16.5	-	1.5	-5.4	4.0	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	5.0	55	15	-	-	0.00	-
92.69	43.4	16.4	-	1.6	-5.4	4.2	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	4.9	56	15	-	-	0.00	-

* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Project ID: Earth Mechanics
Data File: SDF(575)-18.cpt
CPT Date: 10/11/2011 1:20:42 AM
GW During Test: 18 ft

Sounding ID: CPT-11-349
Project No: 11-137
Cone/Rig: DSG1023

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	SPT R-N 60%	* SPT R-N1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* Nk -	* Vol Strn %	* Dry Stlmt 0.01	* Liq Stlmt 0.04	* Cycl SStn %
92.85	43.2	16.3	-	1.8	-5.4	4.6	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	4.9	58	15	-	-	0.00	-
93.02	55.7	21.0	-	2.0	-5.4	3.9	3	silty CLAY to CLAY	115	1.5	37	14	-	-	3.8	6.5	49	15	-	-	0.00	-
93.18	67.9	25.6	-	2.1	-5.4	3.3	4	clayy SILT to silty CLAY	115	2.0	34	13	-	-	4.6	8.1	42	15	-	-	0.00	-
93.34	63.2	23.8	-	2.2	-5.4	3.8	3	silty CLAY to CLAY	115	1.5	42	16	-	-	4.3	7.4	46	15	-	-	0.00	-
93.51	58.7	22.1	-	3.0	-5.4	5.7	3	silty CLAY to CLAY	115	1.5	39	15	-	-	4.0	6.8	54	15	-	-	0.00	-
93.67	60.4	22.8	-	2.9	-5.4	5.2	3	silty CLAY to CLAY	115	1.5	40	15	-	-	4.1	7.0	52	15	-	-	0.00	-
93.84	71.7	27.0	-	2.6	-5.4	3.9	4	clayy SILT to silty CLAY	115	2.0	36	14	-	-	4.9	8.5	43	15	-	-	0.00	-
94.00	63.3	23.9	-	2.4	-5.4	4.2	3	silty CLAY to CLAY	115	1.5	42	16	-	-	4.3	7.4	47	15	-	-	0.00	-
94.16	61.6	23.2	-	2.5	-5.4	4.5	3	silty CLAY to CLAY	115	1.5	41	15	-	-	4.2	7.2	49	15	-	-	0.00	-
94.33	65.3	24.6	-	2.7	-5.4	4.6	3	silty CLAY to CLAY	115	1.5	44	16	-	-	4.4	7.6	48	15	-	-	0.00	-
94.49	79.5	30.0	-	2.8	-5.4	3.8	4	clayy SILT to silty CLAY	115	2.0	40	15	-	-	5.4	9.4	41	15	-	-	0.00	-
94.66	76.1	28.7	-	2.6	-5.4	3.7	4	clayy SILT to silty CLAY	115	2.0	38	14	-	-	5.2	9.0	41	15	-	-	0.00	-
94.82	67.0	25.3	-	3.3	-5.4	5.3	3	silty CLAY to CLAY	115	1.5	45	17	-	-	4.6	7.8	50	15	-	-	0.00	-
94.98	66.3	25.0	-	3.3	-5.4	5.4	3	silty CLAY to CLAY	115	1.5	44	17	-	-	4.5	7.7	50	15	-	-	0.00	-
95.15	82.0	30.9	-	2.9	-5.5	3.8	4	clayy SILT to silty CLAY	115	2.0	41	15	-	-	5.6	9.7	41	15	-	-	0.00	-
95.31	70.7	26.7	-	2.8	-5.5	4.2	3	silty CLAY to CLAY	115	1.5	47	18	-	-	4.8	8.2	45	15	-	-	0.00	-
95.48	71.5	27.0	-	2.6	-5.5	3.9	4	clayy SILT to silty CLAY	115	2.0	36	13	-	-	4.9	8.3	43	15	-	-	0.00	-
95.64	68.9	26.0	-	2.7	-5.5	4.3	3	silty CLAY to CLAY	115	1.5	46	17	-	-	4.7	8.0	46	15	-	-	0.00	-
95.81	69.2	26.1	-	2.5	-5.5	3.9	4	clayy SILT to silty CLAY	115	2.0	35	13	-	-	4.7	8.0	44	15	-	-	0.00	-
95.97	62.4	23.5	-	2.3	-5.4	4.1	3	silty CLAY to CLAY	115	1.5	42	16	-	-	4.2	7.1	47	15	-	-	0.00	-
96.13	54.9	20.7	-	2.3	-5.4	4.8	3	silty CLAY to CLAY	115	1.5	37	14	-	-	3.7	6.2	52	15	-	-	0.00	-
96.30	62.6	23.6	-	2.0	-5.4	3.4	4	clayy SILT to silty CLAY	115	2.0	31	12	-	-	4.2	7.1	44	15	-	-	0.00	-
96.46	53.6	20.2	-	2.0	-5.4	4.1	3	silty CLAY to CLAY	115	1.5	36	13	-	-	3.6	6.0	50	15	-	-	0.00	-
96.63	49.6	18.7	-	2.4	-5.4	5.4	3	silty CLAY to CLAY	115	1.5	33	12	-	-	3.3	5.5	57	15	-	-	0.00	-
96.79	57.3	21.6	-	2.3	-5.4	4.5	3	silty CLAY to CLAY	115	1.5	38	14	-	-	3.9	6.4	51	15	-	-	0.00	-
96.95	63.6	24.0	-	2.2	-5.5	3.7	4	clayy SILT to silty CLAY	115	2.0	32	12	-	-	4.3	7.2	45	15	-	-	0.00	-
97.12	52.5	19.8	-	1.8	-5.5	3.9	3	silty CLAY to CLAY	115	1.5	35	13	-	-	3.5	5.8	50	15	-	-	0.00	-
97.28	50.5	19.1	-	1.6	-5.5	3.6	3	silty CLAY to CLAY	115	1.5	34	13	-	-	3.4	5.6	50	15	-	-	0.00	-
97.45	50.2	18.9	-	1.6	-5.5	3.6	3	silty CLAY to CLAY	115	1.5	33	13	-	-	3.4	5.5	50	15	-	-	0.00	-
97.61	52.4	19.8	-	1.7	-5.5	3.7	3	silty CLAY to CLAY	115	1.5	35	13	-	-	3.5	5.8	49	15	-	-	0.00	-
97.77	52.7	19.9	-	2.0	-5.5	4.3	3	silty CLAY to CLAY	115	1.5	35	13	-	-	3.5	5.8	51	15	-	-	0.00	-
97.94	61.2	23.1	-	1.9	-5.5	3.5	4	clayy SILT to silty CLAY	115	2.0	31	12	-	-	4.1	6.8	45	15	-	-	0.00	-
98.10	55.9	21.1	-	1.9	-5.5	3.8	3	silty CLAY to CLAY	115	1.5	37	14	-	-	3.8	6.2	48	15	-	-	0.00	-
98.27	54.8	20.7	-	1.6	-5.5	3.2	4	clayy SILT to silty CLAY	115	2.0	27	10	-	-	3.7	6.0	46	15	-	-	0.00	-
98.43	50.9	19.2	-	1.7	-5.5	3.8	3	silty CLAY to CLAY	115	1.5	34	13	-	-	3.4	5.5	50	15	-	-	0.00	-
98.59	52.1	19.7	-	2.1	-5.5	4.6	3	silty CLAY to CLAY	115	1.5	35	13	-	-	3.5	5.7	53	15	-	-	0.00	-
98.76	59.5	22.5	-	2.0	-5.5	3.7	3	silty CLAY to CLAY	115	1.5	40	15	-	-	4.0	6.6	46	15	-	-	0.00	-
98.92	53.7	20.3	-	1.8	-5.5	3.8	3	silty CLAY to CLAY	115	1.5	36	14	-	-	3.6	5.8	49	15	-	-	0.00	-
99.09	54.8	20.7	-	1.8	-5.4	3.6	3	silty CLAY to CLAY	115	1.5	37	14	-	-	3.7	6.0	48	15	-	-	0.00	-
99.25	56.5	21.3	-	2.2	-5.5	4.4	3	silty CLAY to CLAY	115	1.5	38	14	-	-	3.8	6.2	50	15	-	-	0.00	-
99.41	60.0	22.6	-	2.5	-5.5	4.5	3	silty CLAY to CLAY	115	1.5	40	15	-	-	4.0	6.6	50	15	-	-	0.00	-
99.58	68.7	25.9	-	2.5	-5.5	4.0	3	silty CLAY to CLAY	115	1.5	46	17	-	-	4.7	7.6	44	15	-	-	0.00	-
99.74	69.6	26.3	-	2.6	-5.5	4.1	3	silty CLAY to CLAY	115	1.5	46	18	-	-	4.7	7.7	45	15	-	-	0.00	-
99.91	68.7	25.9	-	3.2	-5.5	5.1	3	silty CLAY to CLAY	115	1.5	46	17	-	-	4.7	7.6	49	15	-	-	0.00	-
100.07	66.5	25.1	-	3.2	-5.4	5.3	3	silty CLAY to CLAY	115	1.5	44	17	-	-	4.5	7.3	50	15	-	-	0.00	-
100.23	75.8	28.6	-	3.0	-5.5	4.3	3	silty CLAY to CLAY	115	1.5	51	19	-	-	5.2	8.4	44	15	-	-	0.00	-
100.40	73.8	27.8	-	2.8	-5.5	4.1	3	silty CLAY to CLAY	115	1.5	49	19	-	-	5.0	8.2	43	15	-	-	0.00	-
100.56	65.7	24.8	-	2.2	-5.5	3.7	4	clayy SILT to silty CLAY	115	2.0	33	12	-	-	4.4	7.2	44	15	-	-	0.00	-
100.73	54.0	20.4	-	1.6	-5.4	3.4	3	silty CLAY to CLAY	115	1.5	36	14	-	-	3.6	5.8	47	15	-	-	0.00	-
100.89	46.5	17.5	-	1.3	-5.4	3.1	3	silty CLAY to CLAY	115	1.5	31	12	-	-	3.1	4.9	49	15	-	-	0.00	-
101.05	44.0	16.6	-	1.1	-5.4	2.8	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	4.5	49	15	-	-	0.00	-
101.22	43.4	16.4	-	1.2	-5.4	3.1	3	silty CLAY to CLAY	115	1.5	29	11	-	-	2.9	4.5	51	15	-	-	0.00	-
101.38	46.1	17.4	-	1.2	-5.4	3.1	3	silty CLAY to CLAY	115	1.5	31	12	-	-	3.1	4.8	49	15	-	-	0.00	-
101.55	49.8	18.8	-	1.2	-5.5	2.7	4	clayy SILT to silty CLAY	115	2.0	25	9	-	-	3.3	5.2	46	15	-	-	0.00	-
101.71	57.1	21.6	-	1.4	-5.5	2.7	4	clayy SILT to silty CLAY	115	2.0	29	11	-	-	3.8	6.1	42	15	-	-	0.00	-
101.88	60.6	22.9	-	2.3	-5.5	4.3	3	silty CLAY to CLAY	115	1.5	40	15	-	-	4.1	6.5	48	15	-	-	0.00	-
102.04	59.1	22.3	-	2.5	-5.5	4.8	3	silty CLAY to CLAY	115	1.5	39	15	-	-	4.0	6.3	51	15	-	-	0.00	-
102.20	63.5	24.0	-	2.6	-5.5	4.6	3	silty CLAY to CLAY	115	1.5	42	16	-	-	4.3	6.8	48	15	-	-	0.00	-
102.37	68.7	25.9	-	2.5	-5.4	3.9	4	clayy SILT to silty CLAY	115	2.0	34	13	-	-	4.7	7.4	44	15	-	-	0.00	-
102.53	69.8	26.3	-	2.2	-5.4	3.4	4	clayy SILT to silty CLAY	115	2.0	35	13	-	-	4.7	7.5	42	15	-	-	0.00	-
102.70	62.0	23.4	-	2.1	-5.4	3.7	3	silty CLAY to CLAY	115	1.5	41	16	-	-	4.2	6.6	45	15	-	-	0.00	-
102.86	57.2	21.6	-	2.2	-5.4	4.3	3	silty CLAY to CLAY	115	1.5	38	14	-	-	3.8	6.0	50	15	-	-	0.00	-
103.02	64.4	24.3	-	2.2	-5.4	3.8	3	silty CLAY to CLAY	115	1.5	43	16	-	-	4.4	6.8	45	15	-	-	0.00	-
103.19	61.3	23.1	-	2.1	-5.4	3.7	3	silty CLAY to CLAY	115	1.5	41	15	-	-	4.1	6.5	46	15	-	-	0.00	-
103.35	54.8	20.7	-	2.0	-5.4	4.0	3	silty CLAY to CLAY	115	1.5	37	14	-	-	3.7	5.7	50	15	-	-	0.00	-
103.52	56.4	21.3	-	2.6	-5.4	5.2	3	silty CLAY to CLAY	115	1.5	38	14	-	-	3.8	5.9	53	15	-	-	0.00	-
103.68	86.4	32.6	-	3.1	-5.4	3.9	4	clayy SILT to silty CLAY	115	2.0	43	16	-	-	5.9	9.4	40	15	-	-	0.00	-
103.84	81.2	30.6	-	3.5	-5.4	4.6	3	silty CLAY to CLAY	115	1.5	54	20	-	-	5.5	8.7	44	15	-	-	0.00	-
104.01	85.8	32.4	-	3.3	-5.4	4.2	4	clayy SILT to silty CLAY	115	2.0	43	16	-	-	5.9	9.3	41	15	-	-	0.00	-
104.17	87.5	33.0	-	3.4	-5.4	4.2	4	clayy SILT to silty CLAY	115	2.0	44	17	-	-	6.0	9.4	41	15	-	-	0.00	-
104.34	72.5	27.4	-	3.0	-5.4	4.4	3	silty CLAY to CLAY	115	1.5	48	18	-	-	4.9	7.7	45	15	-	-	0.00	-
104.50	68.6	25.9	-	2.6	-5.3	4.2	3	silty CLAY to CLAY	115	1.5	46	17	-	-	4.6	7.2	46	15	-	-	0.00	-
104.66	80.3	30.3	-	2.7	-5.4	3.6	4	clayy SILT to silty CLAY	115	2.0	40	15	-	-	5.5	8.6	40	15	-	-	0.00	-
104.83	70.1	26.5	-	4.0	-5.4	6.3	3	silty CLAY to CLAY	115	1.5	47	18	-	-	4.8	7.4	52	15	-	-	0.00	-
104.99	68.0	25.7	-	4.6	-5.4	7.4	3	silty CLAY to CLAY	115	1.5	45	17	-	-	4.6	7.1	56	15	-	-	0.00	-

* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

Appendix B

LABORATORY TEST RESULTS

TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

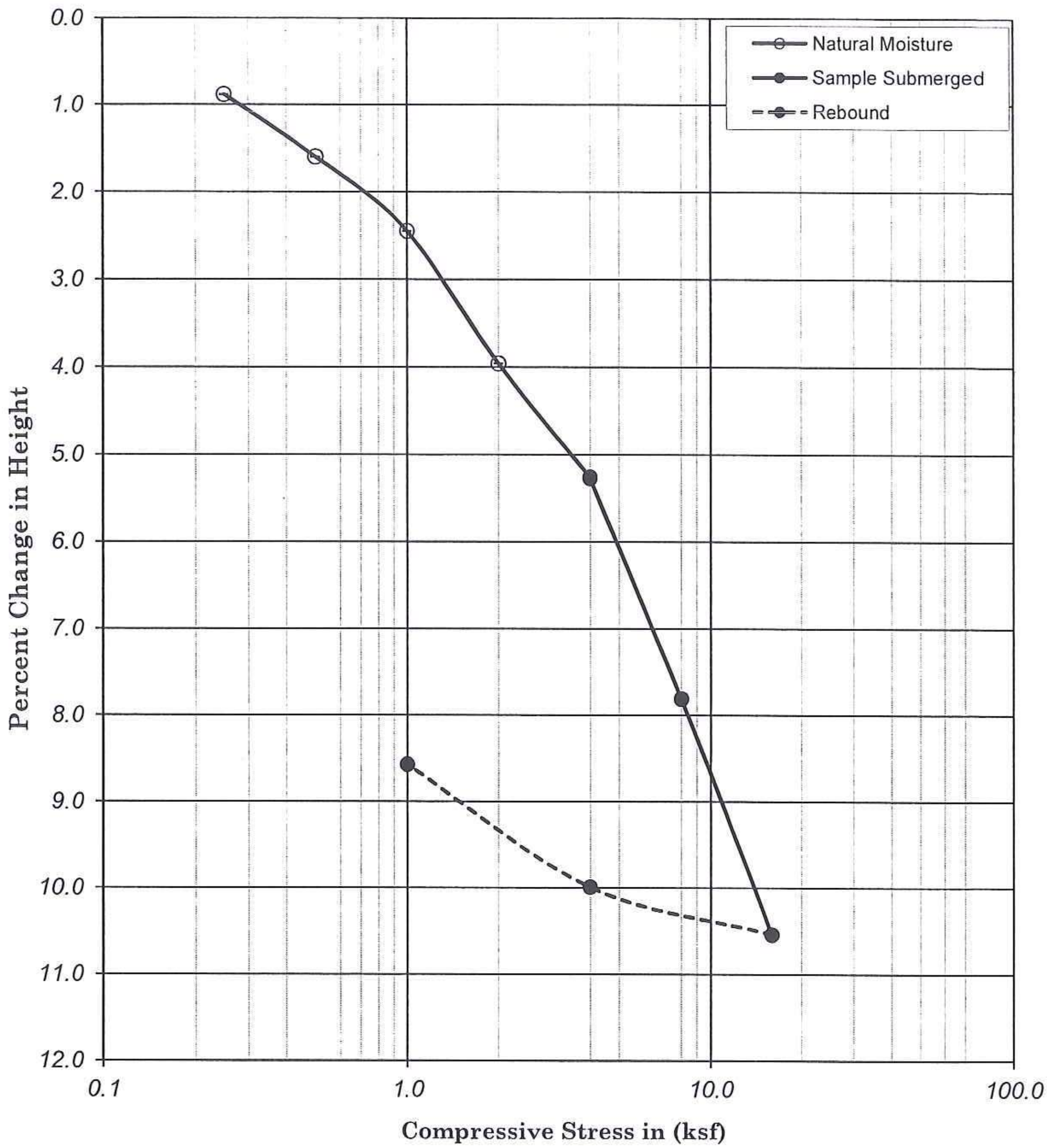
Project No. : 11-137 Project Name : Route 5/1 Separation (55-0510)

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil-pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-11-348	D-1	5	SM	4.1	127.2									
A-11-348	S-2	10	SM	5.3										
A-11-348	D-3	15	CL	25.5	116.2	2.25								
A-11-348	S-4	20	CL	25.3							270	7.6	6400	649
A-11-348	D-5	25	CL	22.2	121.3	4.25								
A-11-348	S-6	30	CL	21.1				0:10:90						
A-11-348	D-7	35	CL	18.2	121.4	>4.5								
A-11-348	S-8	40	CL	20.7										
A-11-348	D-9	45	CL	20.9	124.7	3.75								
A-11-348	S-10	50	CL	25.5				0:12:88						
A-11-348	D-11	55	CL	25.4	122.1	1.25								
A-11-348	S-12	60	CL	24.9										
A-11-348	D-13	65	CL	24.3	123.7	2.75		0:12:88						
A-11-348	S-14	70	CL	24.5										
A-11-348	D-15	75	CL	22.4	125.2	4.25								
A-11-348	S-16	80	CL	24.1				0:9:91						
A-11-348	D-17	85	CL	25.1	123.9	3.75								
A-11-348	S-18	90	CL	22.8										
A-11-348	D-19	95	ML	22.0	125.1	>4.5								
A-11-348	S-20	100	CL	23.7										
A-11-349	D-1	5	CL	26.1	116.3	2.25					760	8.1	680	392
A-11-349	S-2	10	CL	20.5										
A-11-349	D-3	15	CL	21.4	125.8	3.0								
A-11-349	S-4	20	CL	28.5										
A-11-349	D-5	25	CL	23.1	122.7	0.75		0:9:91		35/19/16				
A-11-349	S-6	30	CL	27.1										
A-11-349	D-7	35	CL	26.6	122.8	1.25								
A-11-349	S-8	40	CL	25.4										
A-11-349	D-9	45	CL	23.0	125.4	1.0		0:30:70						
A-11-349	S-10	50	CL	25.2							510	8.0	1800	341
A-11-349	D-11	55	CL	23.1	125.5	2.0								
A-11-349	S-12	60	ML	26.5										
A-11-349	D-13	65	ML	26.0	121.9	4.25		0:6:94						
A-11-349	S-14	70	ML	27.7										

TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

Project No. : 11-137 **Project Name :** Route 5/1 Separation (55-0510)

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil-pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-11-349	D-15	75	CL	23.8	124.2	3.0								
A-11-349	S-16	80	CL	27.9										
A-11-350	S-1	5	CL	20.7										
A-11-350	D-2	10	CL	21.7	123.6	4.0								
A-11-350	S-3	15	CL	22.0										
A-11-350	D-4	20	CL	24.8	117.1	2.5								
A-11-350	S-5	25	CL	19.9										
A-11-350	D-6	30	CL	20.2	123.3	3.5				38/19/19				
A-11-350	S-7	35	CL	23.2										
A-11-350	D-8	40	CL	19.4	126.4	4.0								
A-11-350	S-9	45	CL	26.4										
A-11-350	D-10	50	CL	28.5	120.6			0:14:86						
A-11-350	S-11	55	CL	29.1										
A-11-350	D-12	60	CL	29.4	120.0	2.75								
A-11-350	S-13	65	CL	27.4										
A-11-350	D-14	70	ML	27.4	119.4									
A-11-350	S-15	75	CL	30.5				0:9:91						
A-11-350	D-16	80	ML	28.5	121.5	>4.5								
A-11-350	S-17	85	CL	25.1										
A-11-350	D-18	90	SC	28.1	121.5									
A-11-350	S-19T	95	SP-SM	20.2										
A-11-350	S-19B	96	CL	27.5										
A-11-350	D-20	100	SP to CL	20.0	122.6									



Boring No.		: A-11-348		Liquid Limit :	-		Moisture Content (%)	Dry Density		Percent Saturation	Void Ratio
Sample No.		: D-11		Plastic Limit :	-			(pcf)	(kN/m³)		
Depth	(ft)	: 55.0	56.5	Plastic Index :	-	Initial	26.38	96.76	15.23	95.99	0.74
	(m)	: 16.78	17.23	Specific Gravity :	2.70	Final	22.77	105.84	16.66	103.74	0.59

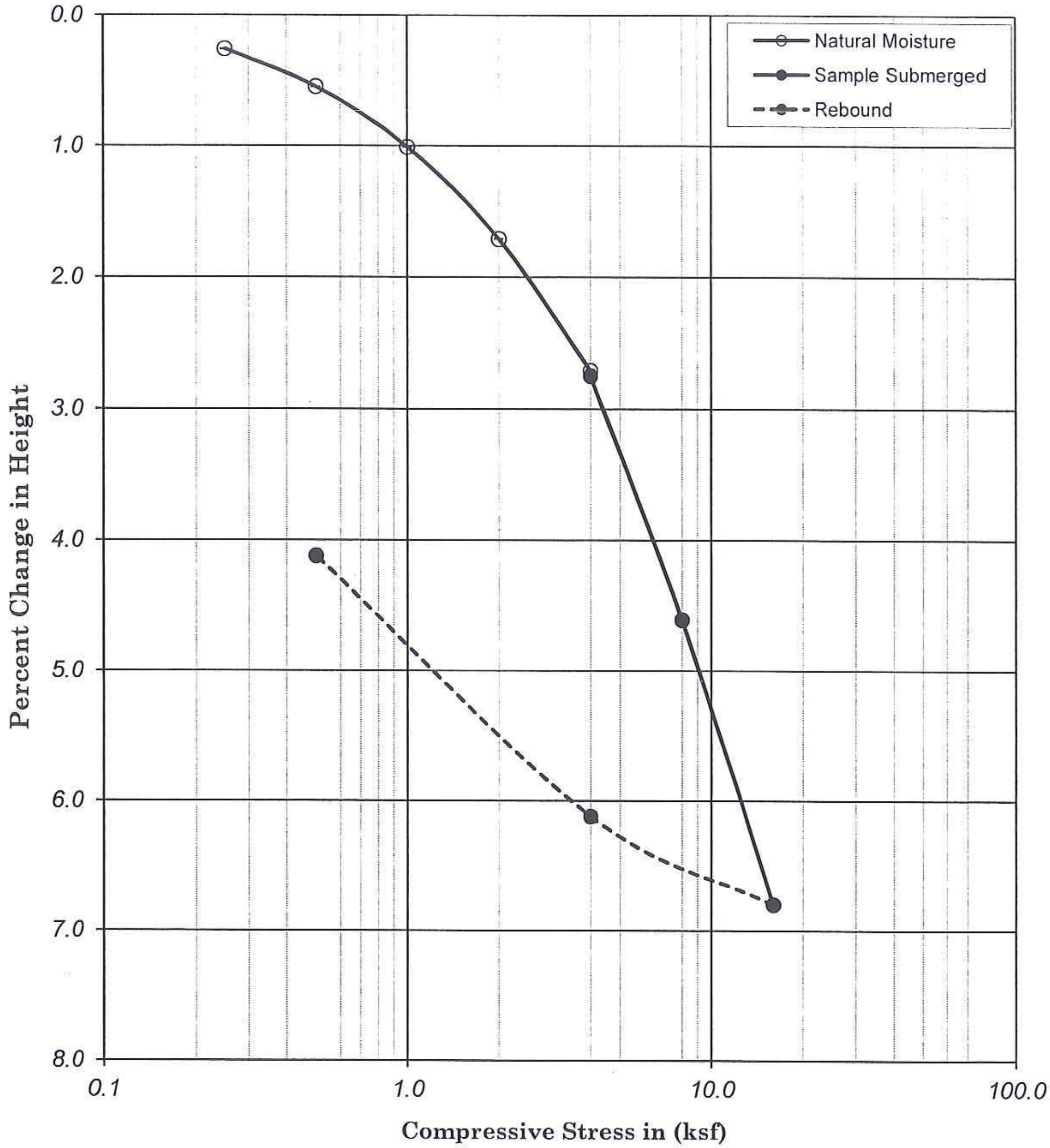
Description : *Very dark gray, Elastic SILT (MH)*

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

I-5 HOV Improvement Project
PCH to San Juan Creek Road

Project No. : 11-137 12/04/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No.	: A-11-348		Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No.	: D-17		Plastic Limit :	-						
Depth (ft)	: 85.0	86.5	Plastic Index :	-	Initial	26.59	98.69	15.53	101.43	0.71
Depth (m)	: 25.93	26.38	Specific Gravity :	2.70	Final	26.20	102.94	16.20	110.98	0.64

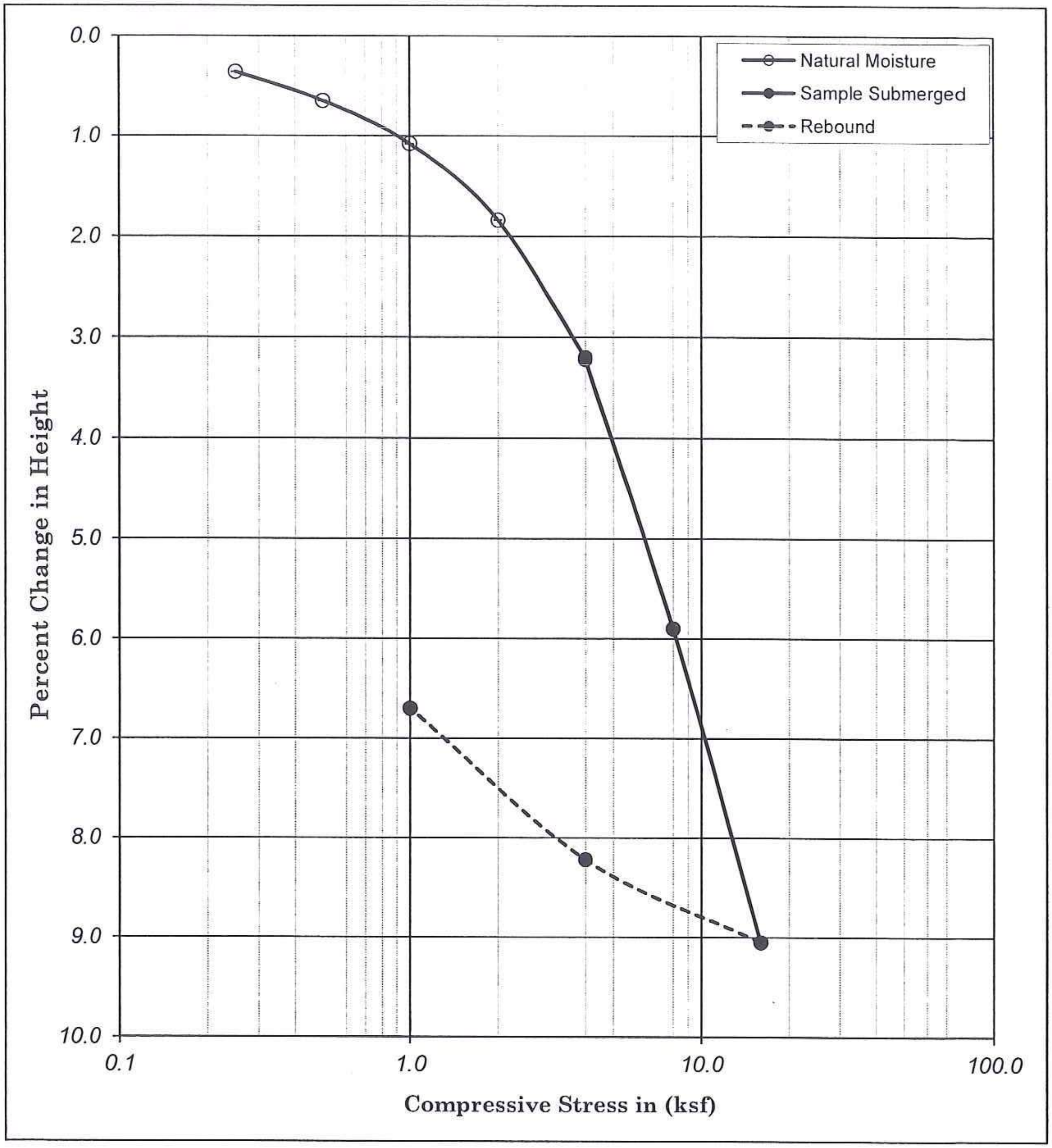
Description : *Olive-brown, Lean CLAY (CL)*

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

I-5 HOV Improvement Project
PCH to San Juan Creek Road

Project No. : *11-137* *12/04/11*

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No.		: A-11-349		Liquid Limit :	-		Moisture Content (%)	Dry Density		Percent Saturation	Void Ratio
Sample No.		: D-7		Plastic Limit :	-			(pcf)	(kN/m³)		
Depth	(ft)	: 35.0	36.5	Plastic Index :	-	Initial	27.93	97.23	15.30	102.79	0.73
	(m)	: 10.68	11.13	Specific Gravity :	2.70	Final	26.02	104.22	16.40	113.81	0.62

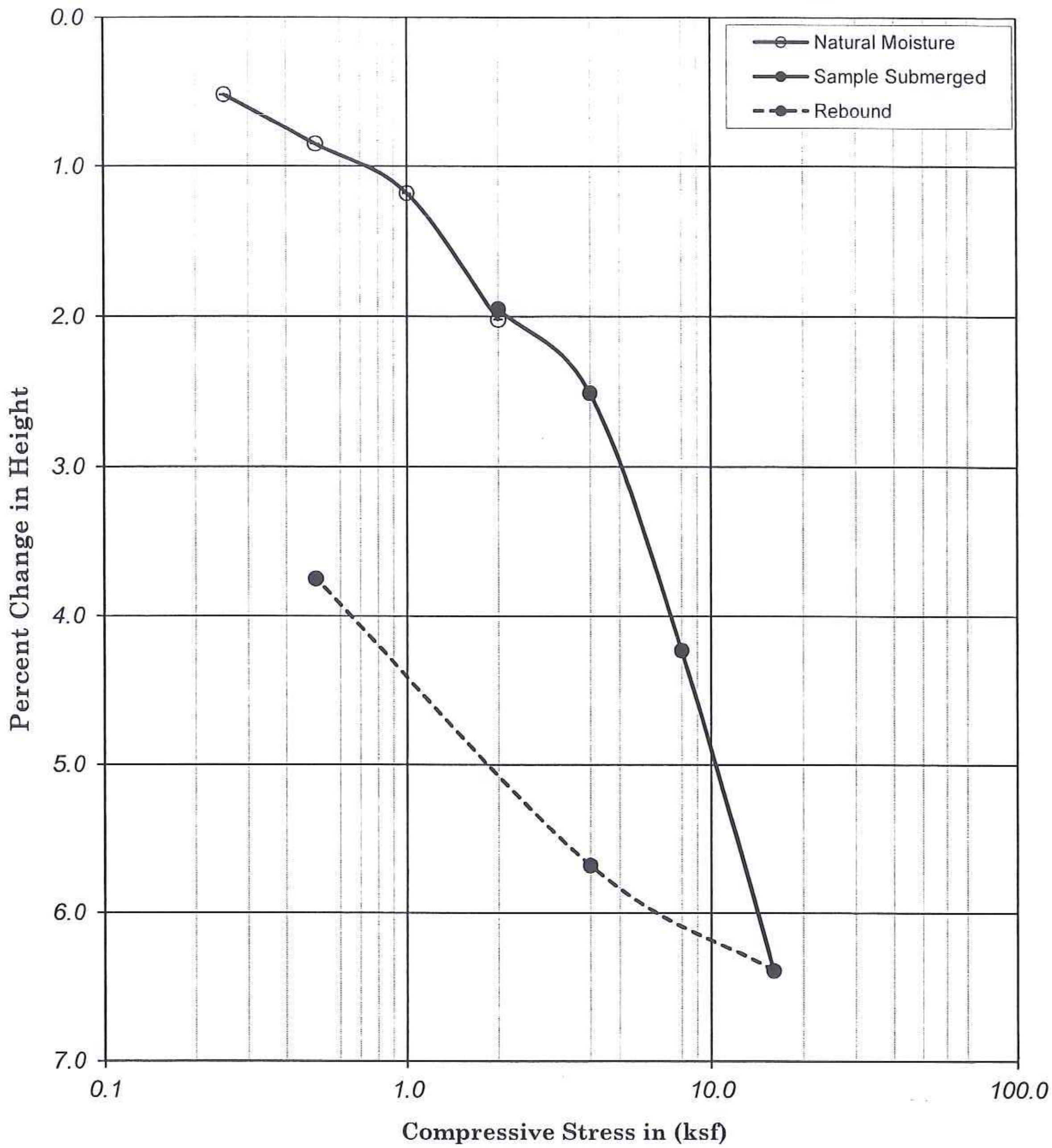
Description : Olive-brown with yellowish brown, Lean CLAY (CL)

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

I-5 HOV Improvement Project
PCH to San Juan Creek Road

Project No. : 11-137 12/04/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



								Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Boring No.		: A-11-350		Liquid Limit :	-							
Sample No.		: D-6		Plastic Limit :	-							
Depth	(ft)	: 30.0	31.5	Plastic Index :	-	Initial		34.14	85.74	13.50	95.42	0.97
	(m)	: 9.15	9.61	Specific Gravity :	2.70	Final		36.96	89.09	14.02	111.86	0.89

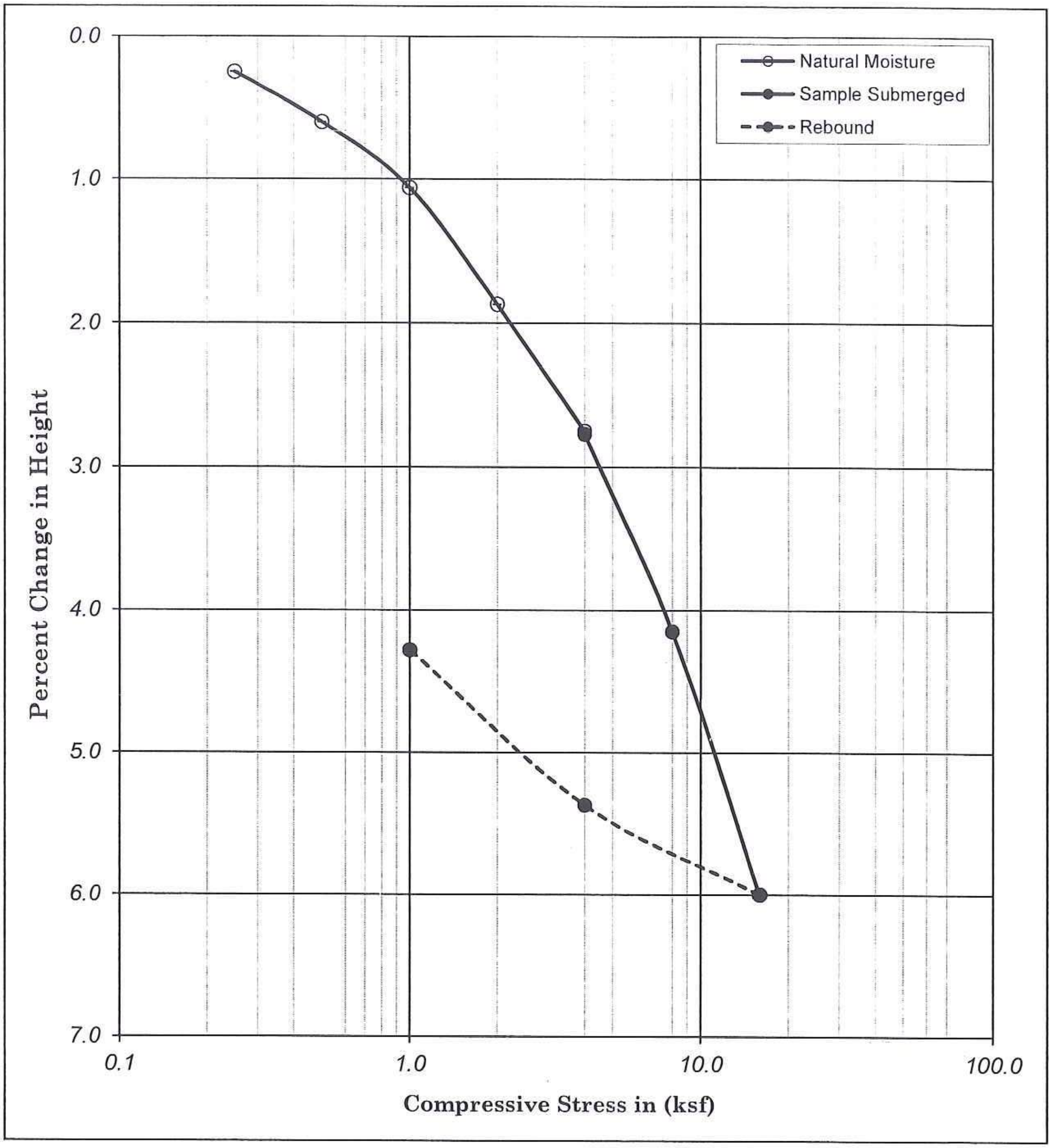
Description : Olive-brown with yellowish brown, Lean CLAY (CL)

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

I-5 HOV Improvement Project
PCH to San Juan Creek Road

Project No. : 11-137 12/04/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No.	: A-11-350		Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No.	: D-16		Plastic Limit :	-						
Depth (ft)	: 80.0	81.5	Plastic Index :	-	Initial	31.66	93.70	14.75	107.00	0.80
Depth (m)	: 24.40	24.86	Specific Gravity :	2.70	Final	29.97	97.90	15.41	112.12	0.72

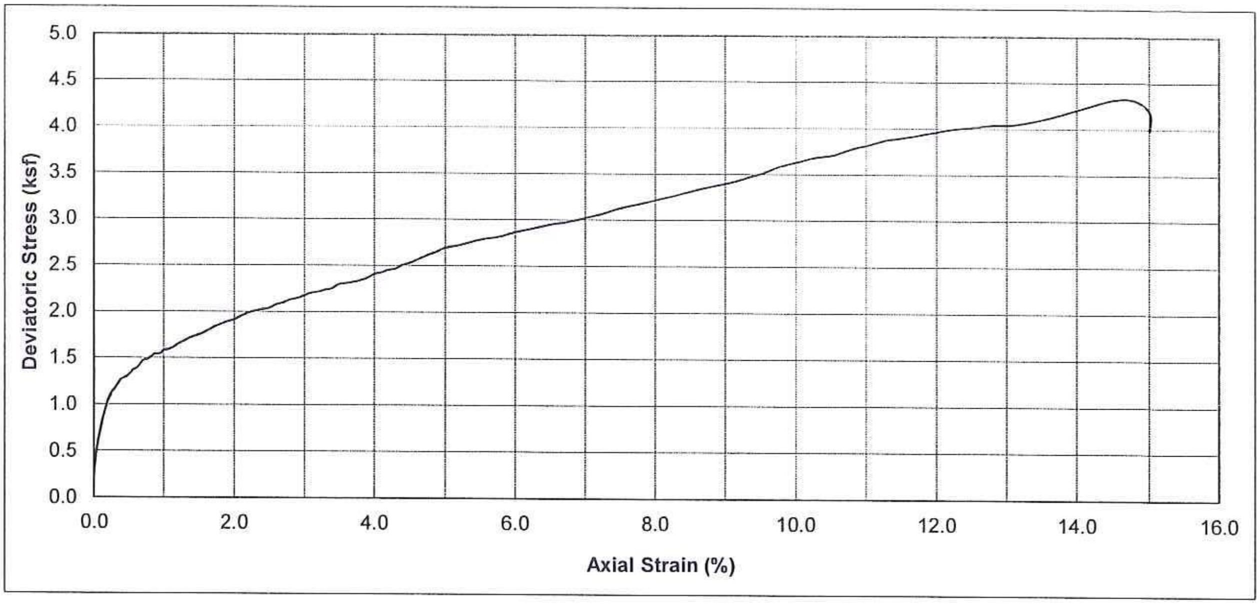
Description : *Very dark grayish brown, Elastic SILT (MH)*

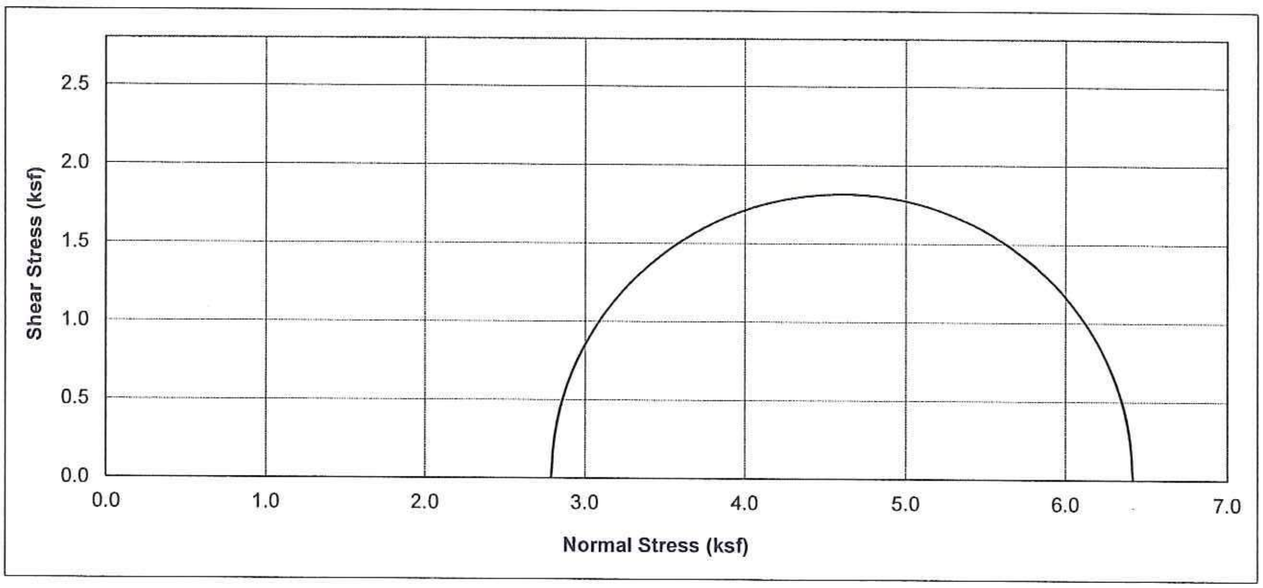
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Project No. : *11-137* *12/04/11*

I-5 HOV Improvement Project
PCH to San Juan Creek Road

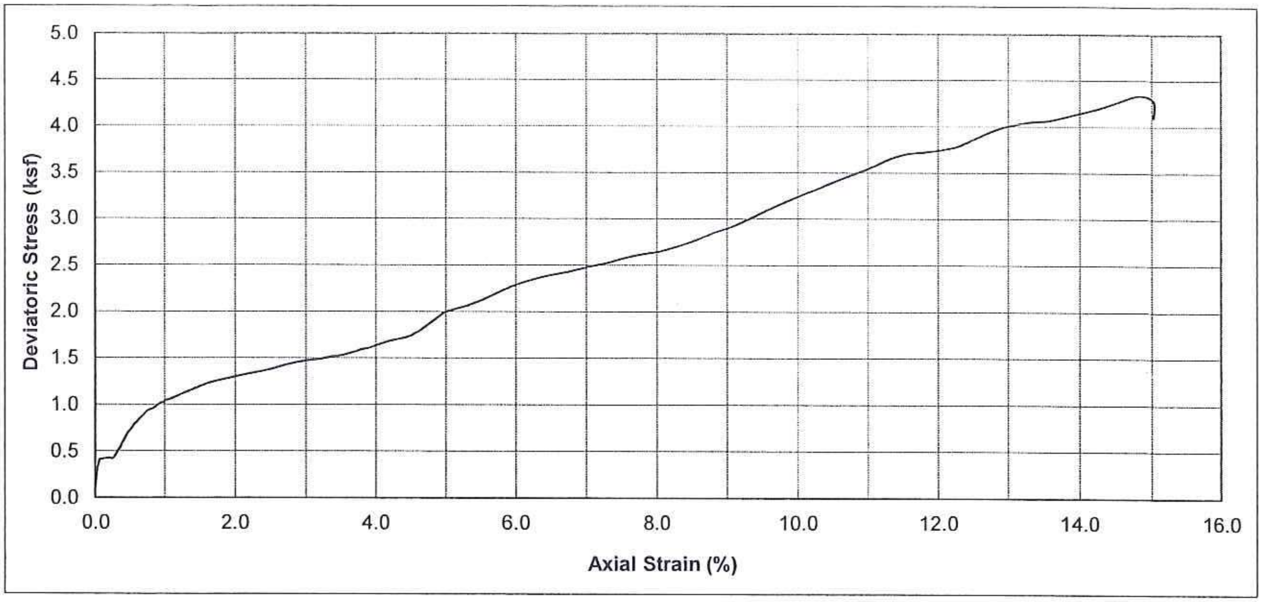
CONSOLIDATION TEST
(ASTM D-2435 / CT-219)

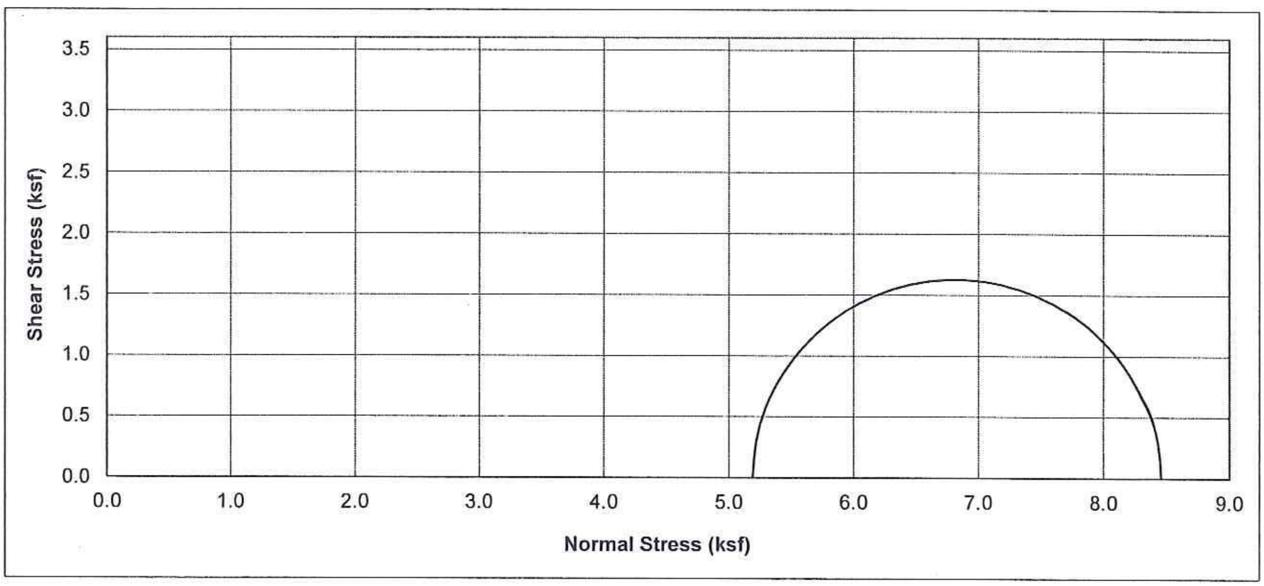




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-11-348	D-7	35	Olive brown , Lean CLAY with SAND (CL)	103.7	18.22	2.79	3.63	78.8

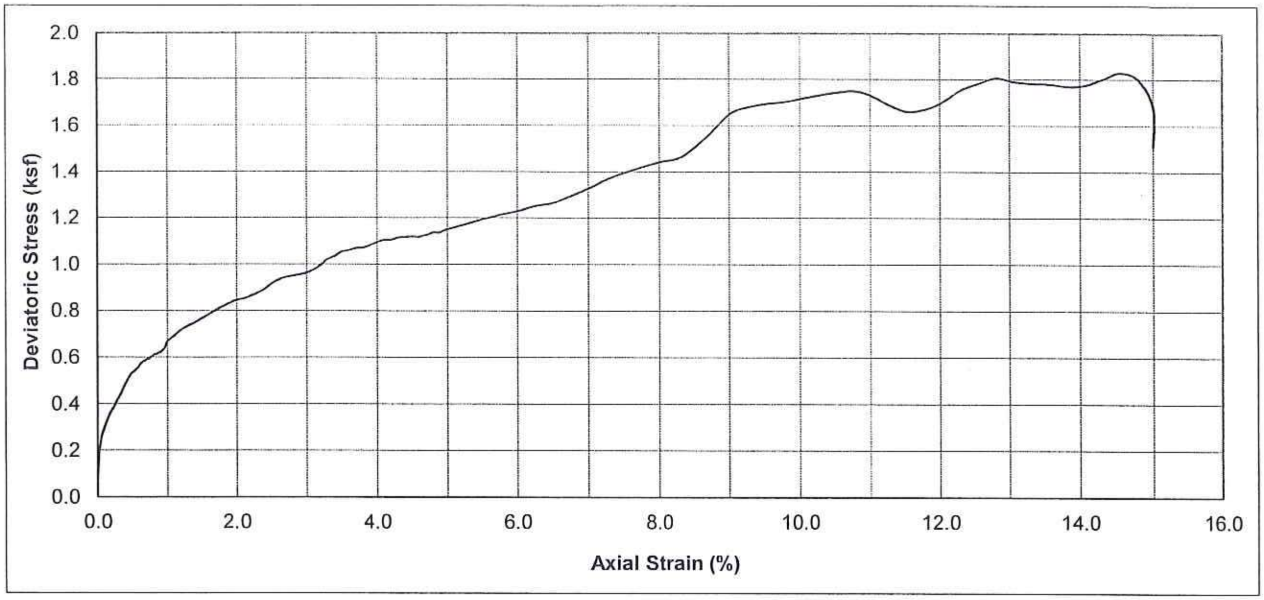
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	I-5 HOV Improvement Project PCH to San Juan Creek Road
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 11-137 | Date : 11/02/11	(ASTM D2850) Figure No. :

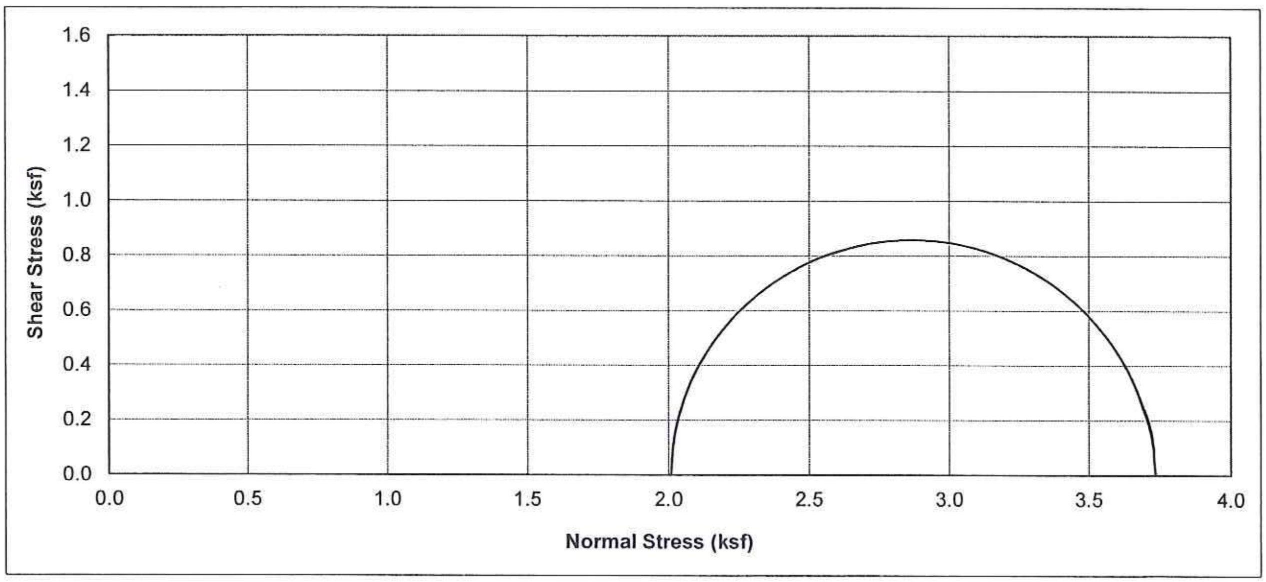




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-11-348	D-13	65	Olive brown , Lean CLAY with gypsum(CL)	99.6	24.33	5.19	3.25	95.0

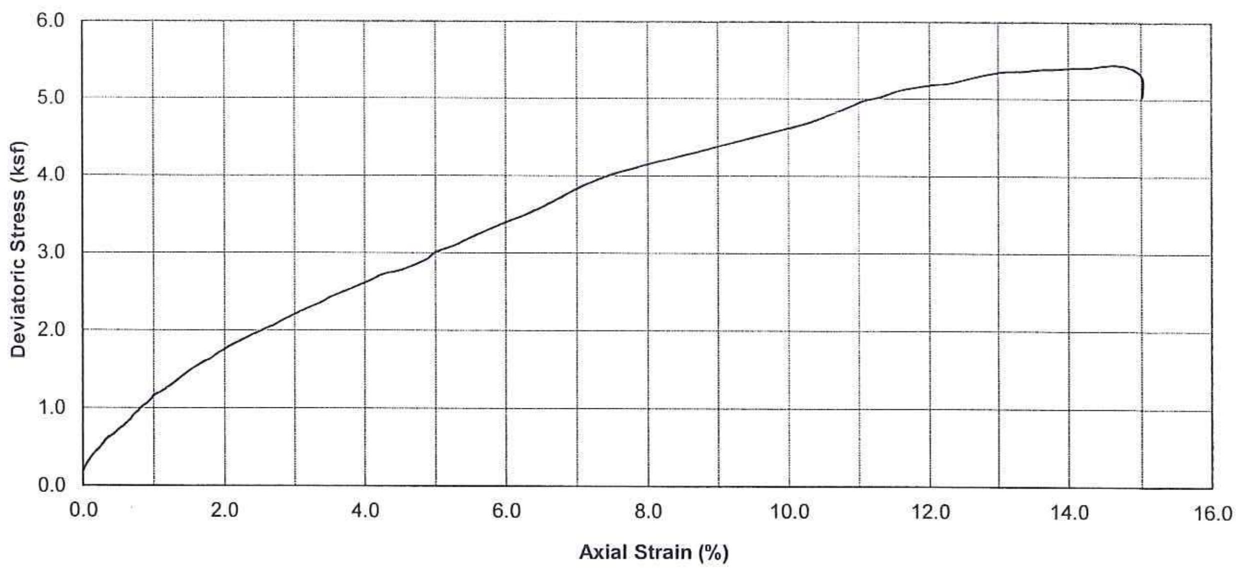
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**I-5 HOV Improvement Project** **PCH to San Juan Creek Road**
Project No. : 11-137 **Date :** 11/02/11	**UNCONSOLIDATED UNDRAINED TEST** **(ASTM D2850)** Figure No. :

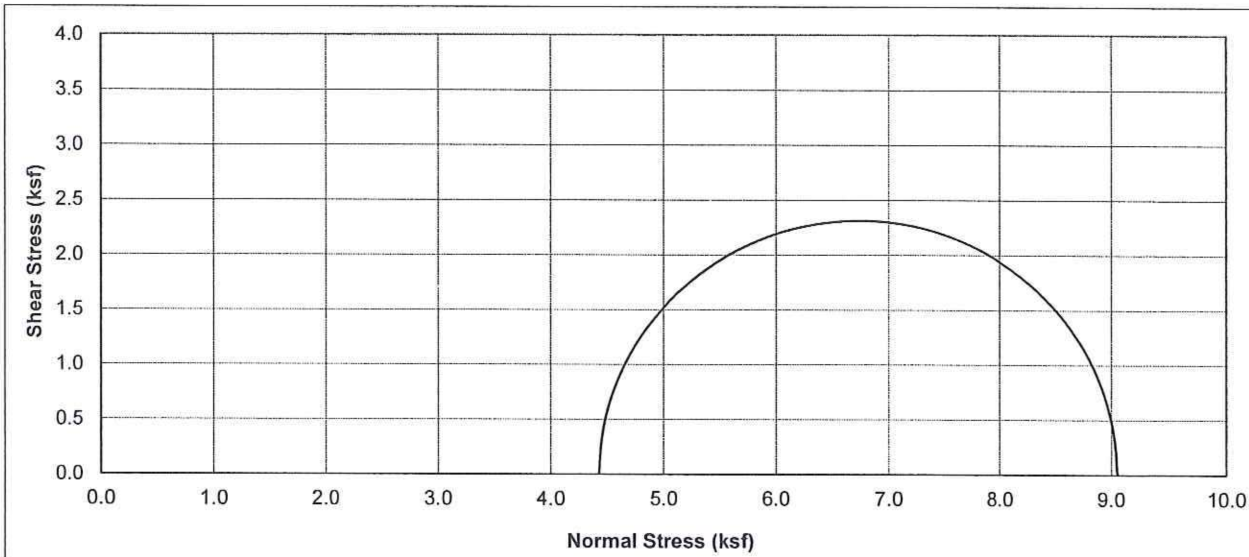




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-11-349	D-5	25	Olive brown , Lean CLAY (CL)	98.0	26.47	2.01	1.72	99.3

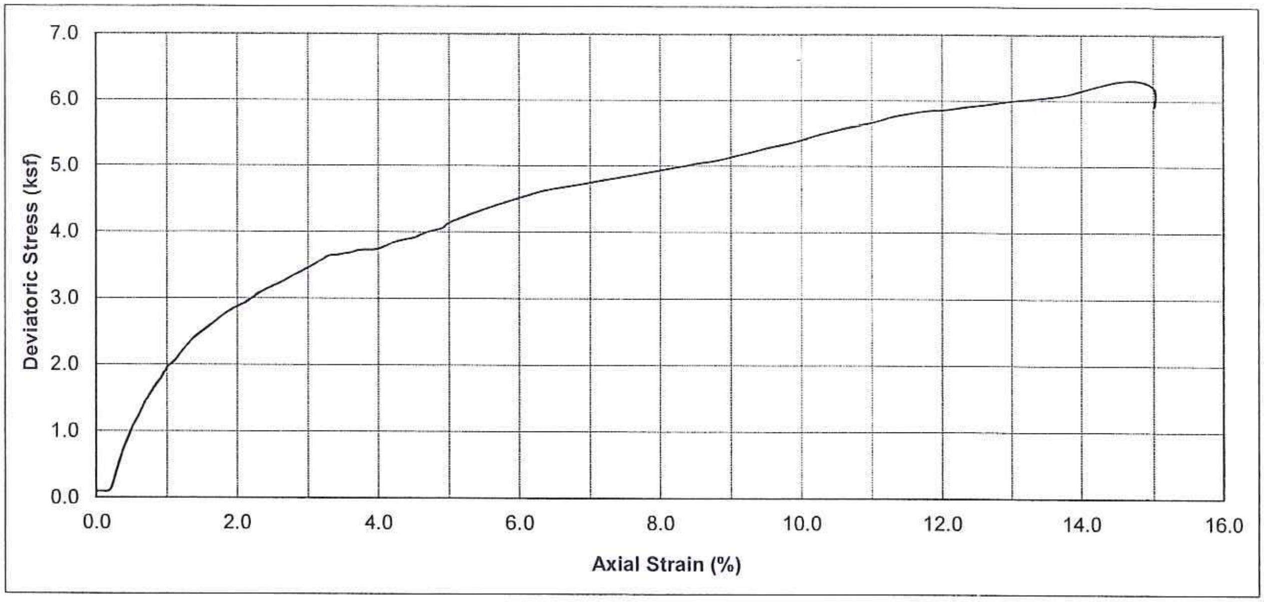
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**I-5 HOV Improvement Project PCH to San Juan Creek Road**
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 11-137 **Date :** 11/02/11	**(ASTM D2850)** Figure No. :

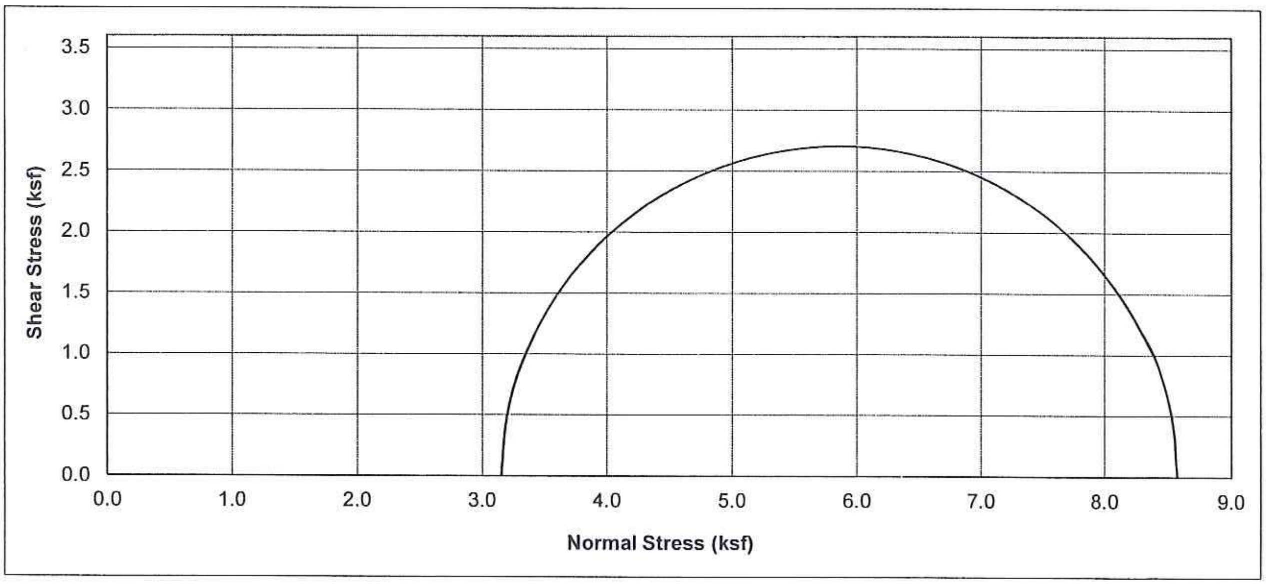




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-11-349	D-11	55	Olive brown , Lean CLAY with SAND (CL)	102.5	23.12	4.43	4.63	96.9

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**I-5 HOV Improvement Project PCH to San Juan Creek Road**
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 11-137 **Date :** 11/02/11	**(ASTM D2850)** Figure No. :



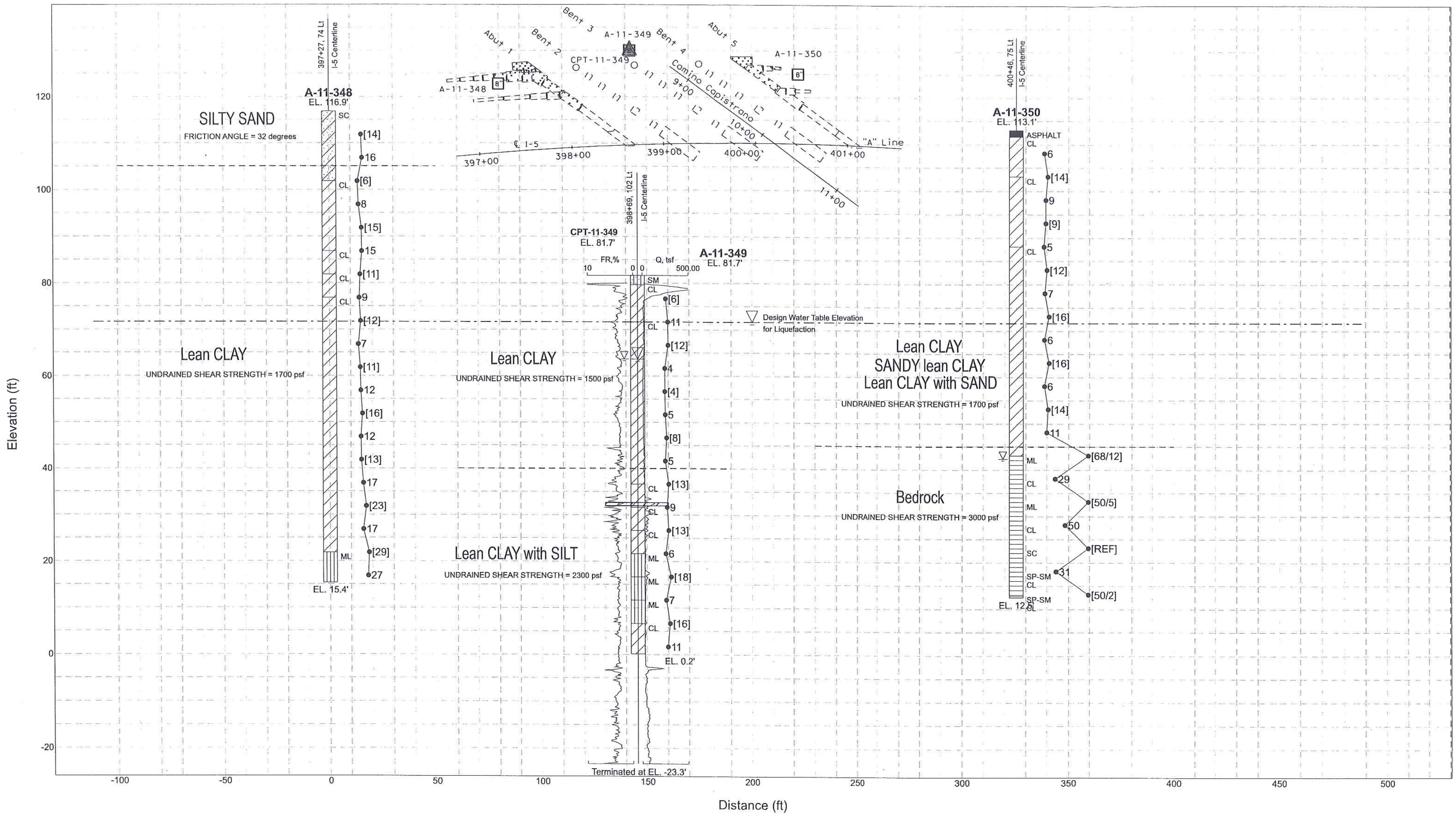


Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-11-350	D-8	40	Dark brown , Lean CLAY (CL)	107.1	19.44	3.16	5.41	91.6

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		I-5 HOV Improvement Project PCH to San Juan Creek Road
		UNCONSOLIDATED UNDRAINED TEST
Project No. : 11-137	Date : 11/02/11	(ASTM D2850) Figure No. :

Appendix C

DESIGN CALCULATIONS



Cross Section Identification				
DIST.	COUNTY Orange	ROUTE	POSTMILE	EA 11-137
PROJECT OR BRIDGE NAME Camino Capistrano UC (Widen)				
BRIDGE NUMBER 55-0227	PREPARED BY		DATE 6-25-12	SHEET 1 of 0

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project Camino Capistrano UC (widen) 55-0227L Project No. 11-137

By SP Date 9/17/12 Checked By LLC Date 10/5/12 Sheet ____ of ____

Abutments 1&5 settlement considering spread footing

consider as-built bearing pressure = 6 ksf
using footing size = 8' x 16' - proposed footing size

8'

+89'

c' = 40 clay

▽ +64'

Cc = 0.025 clay

σ_{vo}	$\Delta\sigma$	settlement
① 5 x 120 = 0.6	6 x 0.8 = 4.8	$10 \times \frac{1}{40} \log\left(\frac{0.6+4.8}{0.6}\right) = 2.9$
② 17 x 120 = 2.04	6 x 0.35 = 2.1	$14 \times \frac{1}{40} \log\left(\frac{2.04+2.1}{2.04}\right) = 1.3$
		4.2"

with 5-feet of over excavation

σ_{vo}	$\Delta\sigma$	settlement
① 7.5 x 120 = 0.9	6 x 0.5 = 3.0	$5 \times \frac{1}{40} \log\left(\frac{0.9+3}{0.9}\right) = 0.96$
② 17 x 120 = 2.04	6 x 0.35 = 2.1	$14 \times \frac{1}{40} \log\left(\frac{2.04+2.1}{2.04}\right) = 1.3$
		2.3"

to get 1" of settlement bearing pressure = 2 ksf
with 5 feet of over excavation

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project Camino Capistrano UC 49-0227L Project No. 11-187

By SP Date 9/17/12 Checked By KCL Date 10/5/12 Sheet ____ of ____

Bents 2, 3, 4 settlement considering spread footing

consider as-built bearing pressure = 6 ksf
consider footing size = 14' x 14'

← 14' →

+83'

c' = 40 clay

▽ 64'

Cc = 0.025 clay

σvo	Δσ	settlement
① 5 x 120 = 0.6	6 x 0.85 = 5.1	10 x 1/40 log((0.6 + 5.1)/0.6) = 2.9
② 14.5 x 120 = 1.74	6 x 0.5 = 3	9 x 1/40 log((1.74 + 3)/1.74) = 1.18
③ 19 x 120 + 10 x 57.6 = 2.86	6 x 0.25 = 1.5	20 x 0.025 log((2.86 + 1.5)/2.86) = 1.1
		5.2"

with 5 feet of overexcavation

σvo	Δσ	settlement
① 7.5 x 120 = 0.9	6 x 0.8 = 4.8	5 x 1/40 log((0.9 + 4.8)/0.9) = 1.2
② 14.5 x 120 = 1.74	6 x 0.5 = 3	9 x 1/40 log((1.74 + 3)/1.74) = 1.18
③ 19 x 120 + 10 x 57.6 = 2.86	6 x 0.25 = 1.5	20 x 0.025 log((2.86 + 1.5)/2.86) = 1.1
		3.5"

to get 1-inch settlement
bearing pressure has to be 1.1 ksf with
5 feet of overexcavation

the depth and horizontal distance at which a subsurface stress acts are expressed in terms of the dimensions of the loaded foundation area. Subsurface stress conditions indicated by Boussinesq and Westergaard equations for commonly occurring foundation loadings are presented in Figures 9-7 and 9-8. The following illustration problems serve to demonstrate the use of these figures.

The stress curves in Figures 9-7 and 9-8 show that the stresses beneath the center of a loaded foundation area will be greater than stresses beneath the edge of the foundation until a depth of about twice the foundation width is reached. Below this level, the stresses beneath the center and edge become practically equal. Consequently, in making determinations of the stresses resulting from a foundation loading, it is suitable to assume a concentrated point loading, if convenient, where the subsurface depth is greater than twice the foundation width.

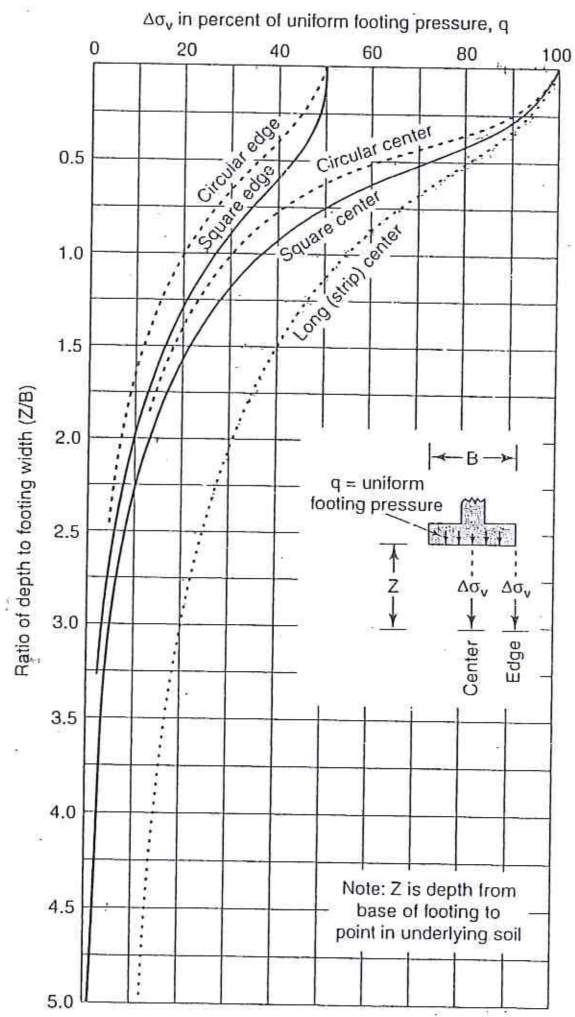


Figure 9-7 Variation of vertical stress beneath a foundation: Boussinesq analysis.

Camino Capistrano UC (55-0227) SP 11-137
LIQUEFACTION ANALYSIS; ACC. = 0.4 g 01-Mar-12

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))
Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-11-348

Emean (%) 75 Sur.= psf 116.9 =top of ground el. Borehole Diamete 8 71.7 =water table El. acc. max = 0.41 g Earthq. M= 7.5
C_E 1.25 C_B 1.15 Cm= 1.00

ELEVATION TOP OF LAYER (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-				-	-		-	-	-	-	-		-	-		-	-
111.9	5	0.29	0.29	5.00	1.91	0.75	1.20	1.00	115	1	1	16	0.99	0.26	40	30.0	51	1.00	high N	high N	LARGE	AboveWT
106.9	5	0.58	0.58	10.00	1.35	0.75	1.00	0.50	115	2	2	79	0.98	0.26	58	30.0	72	1.00	high N	high N	LARGE	AboveWT
101.9	5	0.86	0.86	15.00	1.10	0.85	1.20	1.00	115	1	1	13	0.97	0.26	21	51.0	31	1.00	high N	high N	LARGE	AboveWT
96.9	5	1.15	1.15	20.00	0.95	0.85	1.00	0.50	115	2	2	36	0.95	0.25	21	51.0	31	0.98	high N	high N	LARGE	AboveWT
91.9	5	1.44	1.44	25.00	0.85	0.95	1.20	1.00	115	1	1	11	0.94	0.25	16	51.0	25	0.94	0.29	0.27	1.09	AboveWT
86.9	5	1.73	1.73	30.00	0.78	0.95	1.00	0.50	115	2	2	40	0.93	0.25	22	51.0	32	0.90	high N	high N	LARGE	AboveWT
81.9	5	2.01	2.01	35.00	0.72	1.00	1.20	1.00	115	1	1	13	0.89	0.24	17	51.0	26	0.88	0.31	0.28	1.16	AboveWT
76.9	5	2.30	2.30	40.00	0.67	1.00	1.00	0.50	115	2	2	21	0.85	0.23	11	51.0	19	0.86	0.20	0.17	0.77	AboveWT
71.9	5	2.59	2.59	45.00	0.64	1.00	1.20	1.00	115	1	1	13	0.81	0.22	15	51.0	23	0.83	0.26	0.21	0.99	AboveWT
66.9	5	2.88	2.72	50.00	0.62	1.00	1.00	0.50	115	2	2	40	0.77	0.22	18	51.0	27	0.82	0.34	0.28	1.29	fines
61.9	5	3.16	2.85	55.00	0.61	1.00	1.20	1.00	115	1	1	18	0.73	0.21	19	51.0	28	0.81	0.37	0.30	1.40	fines
56.9	5	3.45	2.98	60.00	0.59	1.00	1.00	0.50	115	2	2	25	0.69	0.21	11	51.0	19	0.80	0.20	0.16	0.77	fines
51.9	5	3.74	3.11	65.00	0.58	1.00	1.20	1.00	115	1	1	13	0.64	0.21	13	51.0	21	0.77	0.23	0.18	0.86	fines
46.9	5	4.03	3.25	70.00	0.57	1.00	1.00	0.50	115	2	2	29	0.60	0.20	12	51.0	20	0.77	0.22	0.17	0.83	fines
41.9	5	4.31	3.38	75.00	0.56	1.00	1.20	1.00	115	1	1	10	0.56	0.19	10	51.0	17	0.76	0.18	0.14	0.72	fines
36.9	5	4.60	3.51	80.00	0.55	1.00	1.00	0.50	115	2	2	14	0.55	0.19	6	51.0	13	0.75	0.14	0.11	0.55	fines
31.9	5	4.89	3.64	85.00	0.54	1.00	1.20	1.00	115	1	1	31	0.54	0.19	29	51.0	40	0.74	high N	high N	LARGE	high N/fines

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
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CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))
Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-11-349

Emean (%) 75 Sur.= psf 81.7 =top of ground el. Borehole Diamete 8 71.7 =water table El. acc. max = 0.41 g Earthq. M= 7.5
C_E 1.25 C_B 1.15 Cm= 1.00

ELEVATION TOP OF LAYER (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-				-	-	-	-	-	-	-	-		-	-		-	-
76.7	5	0.29	0.29	5.00	1.91	0.75	1.00	0.50	115	2	2	12	0.99	0.26	13	51.0	21	1.00	0.23	0.23	0.87	AboveWT
71.7	5	0.58	0.58	10.00	1.35	0.75	1.20	1.00	115	1	1	11	0.98	0.26	20	51.0	29	1.00	0.41	0.41	1.58	fines
66.7	5	0.86	0.71	15.00	1.22	0.85	1.00	0.50	115	2	2	23	0.97	0.31	18	51.0	27	1.00	0.34	0.34	1.08	fines
61.7	5	1.15	0.84	20.00	1.12	0.85	1.20	1.00	115	1	1	4	0.95	0.35	7	51.0	14	1.00	0.15	0.15	0.43	fines
56.7	5	1.44	0.97	25.00	1.04	0.95	1.00	0.50	115	2	2	8	0.94	0.37	6	51.0	13	1.00	0.14	0.14	0.38	fines
51.7	5	1.73	1.10	30.00	0.97	0.95	1.20	1.00	115	1	1	5	0.93	0.39	8	51.0	15	0.99	0.16	0.16	0.41	fines
46.7	5	2.01	1.23	35.00	0.92	1.00	1.00	0.50	115	2	2	16	0.89	0.39	11	51.0	19	0.97	0.20	0.20	0.51	fines
41.7	5	2.30	1.36	40.00	0.87	1.00	1.20	1.00	115	1	1	5	0.85	0.38	8	51.0	15	0.95	0.16	0.15	0.40	fines
36.7	5	2.59	1.50	45.00	0.84	1.00	1.00	0.50	115	2	2	25	0.81	0.37	16	51.0	25	0.93	0.29	0.27	0.73	fines
31.7	5	2.88	1.63	50.00	0.80	1.00	1.20	1.00	115	1	1	9	0.77	0.36	13	51.0	21	0.91	0.23	0.21	0.58	fines
26.7	5	3.16	1.76	55.00	0.77	1.00	1.00	0.50	115	2	2	25	0.73	0.35	14	51.0	22	0.89	0.24	0.22	0.62	fines
21.7	5	3.45	1.89	60.00	0.74	1.00	1.20	1.00	115	1	1	6	0.69	0.33	8	51.0	15	0.88	0.16	0.14	0.42	fines
16.7	5	3.74	2.02	65.00	0.72	1.00	1.00	0.50	115	2	2	36	0.64	0.32	19	51.0	28	0.88	0.37	0.32	1.02	fines
11.7	5	4.03	2.15	70.00	0.70	1.00	1.20	1.00	115	1	1	7	0.60	0.30	9	51.0	16	0.87	0.17	0.15	0.49	fines
6.7	5	4.31	2.28	75.00	0.68	1.00	1.00	0.50	115	2	2	31	0.56	0.28	16	51.0	25	0.86	0.29	0.25	0.88	fines
1.7	5	4.60	2.42	80.00	0.66	1.00	1.20	1.00	115	1	1	11	0.55	0.28	13	51.0	21	0.85	0.23	0.19	0.69	fines

Liquefaction Analysis with Cone Penetration Test (CPT) Data

Earth Mechanics, Inc.
17800 Newhope Street
Suite B
Fountain Valley, CA 92708

CPT Number: CPT-11-349
Project Name: I-5 HOV Improvement Project, PCH to San Juan Creek Road
Project Number: 11-137
Location: Orange County
California

Computed by: SP
Checked by: [signature]

Date: 03/01/12
Date: 4/12/12

Figure No.: ______

Reference:

1) Seed, R.B., et al, *Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework,* Keynote Presentation, 26th Annual ASCE Los Angeles Geotechnical Spring Seminar, April 30, 2003.
2) Youd, T.L. & Idriss, I.M., et al, *Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils.* ASCE Journal of Geotechnical and Geoenvironmental Engineering, Pp. 817-833, October 2001.
3) Pradel D., *Procedure to Evaluate Earthquake-induced Settlements in Dry Sandy Soils,* ASCE Journal of Geotechnical and Geoenvironmental Engineering, Pp. 364-368, April 1998.
4) Tokimatsu, K. & Seed, H.B., *Evaluation of Settlements in Sands due to Earthquake Shaking,* ASCE Journal of Geotechnical Engineering, Pp. 861-878, August 1987.
5) Jefferies, M.G. & Davies, M.P., *Use of CPT to Estimate Equivalent SPT N_{60},* ASTM Geotechnical Testing Journal, Vol.17, No. 4, Pp. 458-567, 1993.
6) Robertson, P.K. et al, *Use of Piezometer Cone Data*, Proceedings of the ASCE Specialty Conference In Situ 86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, Pp. 1263-1280, 1986.

Surface Elevation = 81.7 ft MSL
Design Magnitude, M_w = 7.50
PGA, a_{max} = 0.4 g
Earthquake Scaling Factor, MSF = 1.000 for M_w = 7.5
Design Water Level = 71.7 ft MSL
Water Level at Investigation = 63.7 ft MSL
Req'd Factor of Safety = 1

Summary of Seismically Induced Settlement:

Dry Settlement (in)	0.024
Post-liquefaction Settlement (in)	0.077
Total Settlement (in)	**0.101**

Depth (ft)	Elev. (ft, MSL)	Unit Weight (pcf) γ'_{MOIST}	Unit Weight (pcf) γ'_{SAT}	q_c (tsf)	f_s (tsf)	Frict. Ratio (%)	% Fines	Equiv. N_{60}	Equiv. $(N_1)_{60}$	α	β	Equiv. $(N_1)_{60CS}$	Stresses at Exploration Water Level σ_v (tsf)	Stresses at Exploration Water Level σ_v' (tsf)	Stresses at Design Water Level σ_v (tsf)	Stresses at Design Water Level σ_v' (tsf)	I_c	Soil Type Character (SAND, SILT or non-LIQ CLAY)	Normalization of Tip Resistance n	C_Q	q_{c1N}	Fines Correction Kc	$(q_{c1N})_{cs}$	$CRR_{7.5}$	r_d	CSR_M	$CSR_{7.5}$	FS	a	b	Max Shear Modulus G_{max} (tsf)	Cyclic Shear Strain γ (%)	Norm. Vol. Strain ε_{Nc} (%)	Dry Settle. ΔS (in)	Post-Liq. $(N_1)_{60CS}$	Post-Liq. Vol. Strain ε (%)	Layer Post-Liq. Settle. ΔS (in)
0.33	81.4	115.0	115.0	3.7	0.0	0.0	37	1	7	5.00	1.20	14	0.019	0.019	0.019	0.019	2.63	non-LIQ CLAY	1	1.70	NA	3.50	non-LIQ	non-LIQ	0.999	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
0.49	81.2	115.0	115.0	7.8	0.0	0.0	50	2	14	5.00	1.20	22	0.028	0.028	0.028	0.028	2.86	non-LIQ CLAY	1	1.70	NA	5.34	non-LIQ	non-LIQ	0.999	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
0.66	81.0	115.0	115.0	13.7	0.0	0.0	62	5	24	5.00	1.20	34	0.038	0.038	0.038	0.038	3.06	non-LIQ CLAY	1	1.70	NA	7.38	non-LIQ	non-LIQ	0.998	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
0.82	80.9	115.0	115.0	13.6	0.0	0.0	64	5	22	5.00	1.20	31	0.047	0.047	0.047	0.047	3.08	non-LIQ CLAY	1	1.70	NA	7.71	non-LIQ	non-LIQ	0.998	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
0.98	80.7	115.0	115.0	12.8	0.0	0.0	65	4	19	5.00	1.20	28	0.056	0.056	0.056	0.056	3.09	non-LIQ CLAY	1	1.70	NA	7.84	non-LIQ	non-LIQ	0.998	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
1.15	80.6	115.0	115.0	12.6	0.0	0.0	67	4	17	5.00	1.20	26	0.066	0.066	0.066	0.066	3.12	non-LIQ CLAY	1	1.70	NA	8.12	non-LIQ	non-LIQ	0.997	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
1.31	80.4	115.0	115.0	15.5	0.0	0.0	72	6	21	5.00	1.20	30	0.075	0.075	0.075	0.075	3.19	non-LIQ CLAY	1	1.70	NA	9.06	non-LIQ	non-LIQ	0.997	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
1.48	80.2	115.0	115.0	16.9	0.0	0.0	75	6	22	5.00	1.20	32	0.085	0.085	0.085	0.085	3.23	non-LIQ CLAY	1	1.70	NA	9.63	non-LIQ	non-LIQ	0.997	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
1.64	80.1	115.0	115.0	18.4	0.2	1.1	16	4	13	2.88	1.06	16	0.094	0.094	0.094	0.094	2.12	SAND	0.5	1.70	29.6	1.49	44.2	0.09	0.996	0.26	0.260	Above Water	0.13	33560	262.2	0.03	0.06	0.002	NA	NA	0.000
1.80	79.9	115.0	115.0	29.4	3.1	10.5	36	8	24	5.00	1.20	34	0.104	0.104	0.104	0.104	2.60	SILT	0.7	1.70	47.2	3.35	158.4	0.45	0.996	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
1.97	79.7	115.0	115.0	82.3	8.7	10.6	31	20	61	4.74	1.16	76	0.113	0.113	0.113	0.113	2.50	SAND	0.5	1.70	132.2	2.76	364.3	non-LIQ	0.995	0.26	0.260	Above Water	0.13	30065	485.2	0.01	0.00	0.000	NA	NA	0.000
2.13	79.6	115.0	115.0	227.9	9.4	4.1	12	44	129	1.46	1.03	135	0.122	0.122	0.122	0.122	1.95	SAND	0.5	1.70	366.2	1.24	455.5	non-LIQ	0.995	0.26	0.260	Above Water	0.13	28688	647.8	0.01	0.00	0.000	NA	NA	0.000
2.30	79.4	115.0	115.0	296.3	7.9	2.7	7	53	150	0.11	1.01	151	0.132	0.132	0.132	0.132	1.74	SAND	0.5	1.70	476.1	1.07	507.7	non-LIQ	0.995	0.26	0.260	Above Water	0.13	27397	707.0	0.01	0.00	0.000	NA	NA	0.000
2.46	79.2	115.0	115.0	391.5	14.9	3.8	9	73	200	0.69	1.02	204	0.141	0.141	0.141	0.141	1.86	SAND	0.5	1.70	629.0	1.15	725.3	non-LIQ	0.994	0.26	0.260	Above Water	0.13	26313	804.5	0.01	0.00	0.000	NA	NA	0.000
2.62	79.1	115.0	115.0	424.2	18.4	4.3	11	81	214	1.08	1.02	220	0.151	0.151	0.151	0.151	1.91	SAND	0.5	1.70	681.5	1.20	816.6	non-LIQ	0.994	0.26	0.260	Above Water	0.13	25337	849.1	0.01	0.00	0.000	NA	NA	0.000
2.79	78.9	115.0	115.0	513.2	18.8	3.7	9	95	243	0.45	1.02	247	0.160	0.160	0.160	0.160	1.62	SAND	0.5	1.70	824.5	1.12	926.6	non-LIQ	0.993	0.26	0.260	Above Water	0.13	24399	914.2	0.01	0.00	0.000	NA	NA	0.000
2.95	78.8	115.0	115.0	508.9	18.6	3.7	9	94	234	0.46	1.02	238	0.170	0.170	0.170	0.170	1.83	SAND	0.5	1.70	817.6	1.13	920.3	non-LIQ	0.993	0.26	0.260	Above Water	0.13	23596	929.0	0.01	0.00	0.000	NA	NA	0.000
3.12	78.6	115.0	115.0	482.9	18.4	3.8	9	90	218	0.63	1.02	223	0.179	0.179	0.179	0.179	1.85	SAND	0.5	1.70	775.9	1.15	888.9	non-LIQ	0.993	0.26	0.260	Above Water	0.13	22816	932.9	0.01	0.00	0.000	NA	NA	0.000
3.28	78.4	115.0	115.0	400.8	16.2	4.0	10	76	180	0.99	1.02	185	0.189	0.189	0.189	0.189	1.90	SAND	0.5	1.70	643.9	1.19	764.7	non-LIQ	0.992	0.26	0.260	Above Water	0.13	22142	896.7	0.01	0.00	0.000	NA	NA	0.000
3.45	78.3	115.0	115.0	338.1	13.5	4.0	11	64	149	1.16	1.03	154	0.198	0.198	0.198	0.198	1.92	SAND	0.5	1.70	543.2	1.21	655.5	non-LIQ	0.992	0.26	0.260	Above Water	0.13	21480	863.8	0.01	0.00	0.000	NA	NA	0.000
3.61	78.1	115.0	115.0	287.6	9.6	3.3	10	54	122	0.78	1.02	125	0.208	0.208	0.208	0.208	1.87	SAND	0.5	1.70	462.1	1.16	537.9	non-LIQ	0.992	0.26	0.260	Above Water	0.13	20904	826.2	0.01	0.00	0.000	NA	NA	0.000
3.77	77.9	115.0	115.0	245.0	6.2	2.5	8	45	99	0.29	1.01	100	0.217	0.217	0.217	0.217	1.79	SAND	0.5	1.70	393.6	1.10	433.7	non-LIQ	0.991	0.26	0.260	Above Water	0.13	20367	787.1	0.01	0.00	0.000	NA	NA	0.000
3.94	77.8	115.0	115.0	214.0	3.9	1.8	6	38	82	0.03	1.00	82	0.227	0.227	0.227	0.227	1.70	SAND	0.5	1.70	343.8	1.04	356.3	non-LIQ	0.991	0.26	0.260	Above Water	0.13	19835	755.1	0.01	0.00	0.000	NA	NA	0.000
4.10	77.6	115.0	115.0	207.0	2.9	1.4	5	35	75	0.00	1.00	75	0.236	0.236	0.236	0.236	1.61	SAND	0.5	1.70	332.6	1.00	332.6	non-LIQ	0.990	0.26	0.260	Above Water	0.13	19367	749.3	0.01	0.00	0.000	NA	NA	0.000
4.27	77.4	115.0	115.0	145.8	2.1	1.4	6	26	54	0.05	1.01	54	0.246	0.246	0.246	0.246	1.71	SAND	0.5	1.70	234.3	1.05	245.0	non-LIQ	0.990	0.26	0.260	Above Water	0.13	18901	683.6	0.01	0.00	0.000	NA	NA	0.000
4.43	77.3	115.0	115.0	99.6	1.9	1.9	11	19	39	1.12	1.03	41	0.255	0.255	0.255	0.255	1.91	SAND	0.5	1.70	160.0	1.20	192.5	non-LIQ	0.990	0.26	0.260	Above Water	0.13	18488	624.4	0.02	0.01	0.000	NA	NA	0.000
4.59	77.1	115.0	115.0	86.7	1.9	2.2	13	17	34	1.91	1.04	37	0.264	0.264	0.264	0.264	2.00	SAND	0.5	1.70	139.3	1.31	181.9	non-LIQ	0.989	0.26	0.260	Above Water	0.13	18099	610.2	0.02	0.01	0.000	NA	NA	0.000
4.76	76.9	115.0	115.0	81.9	1.0	1.2	9	15	30	0.53	1.02	31	0.274	0.274	0.274	0.274	1.84	SAND	0.5	1.70	131.6	1.13	149.3	0.39	0.989	0.26	0.260	Above Water	0.13	17708	593.5	0.02	0.01	0.001	NA	NA	0.000
4.92	76.8	115.0	115.0	53.3	0.7	1.3	13	10	20	1.87	1.04	23	0.283	0.283	0.283	0.283	2.00	SAND	0.5	1.70	85.6	1.30	111.3	0.21	0.989	0.26	0.260	Above Water	0.13	17360	530.7	0.03	0.03	0.001	NA	NA	0.000
5.25	76.5	115.0	115.0	35.1	0.7	2.0	21	8	14	3.83	1.09	20	0.302	0.302	0.302	0.302	2.27	SAND	0.5	1.70	56.4	1.85	104.4	0.19	0.988	0.26	0.260	Above Water	0.13	16697	489.2	0.04	0.06	0.005	NA	NA	0.000
5.41	76.3	115.0	115.0	18.7	0.6	3.2	33	5	9	4.86	1.18	15	0.311	0.311	0.311	0.311	2.54	SILT	0.7	1.70	30.0	2.98	89.7	0.15	0.987	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
5.58	76.1	115.0	115.0	13.0	0.4	3.1	38	3	6	5.00	1.20	12	0.321	0.321	0.321	0.321	2.66	SILT	0.7	1.70	20.9	3.71	77.4	0.12	0.987	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
5.74	76.0	115.0	115.0	12.0	0.3	2.5	37	3	6	5.00	1.20	12	0.330	0.330	0.330	0.330	2.64	SILT	0.7	1.70	19.3	3.56	68.7	0.11	0.987	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
5.91	75.8	115.0	115.0	13.7	0.3	2.2	34	3	6	4.91	1.18	12	0.340	0.340	0.340	0.340	2.56	SILT	0.7	1.70	22.0	3.10	68.3	0.11	0.986	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
6.07	75.6	115.0	115.0	22.5	0.4	1.8	27	5	9	4.47	1.13	15	0.349	0.349	0.349	0.349	2.41	SAND	0.5	1.70	36.1	2.37	85.5	0.14	0.986	0.26	0.260	Above Water	0.13	15305	452.3	0.07	0.18	0.007	NA	NA	0.000
6.23	75.5	115.0	115.0	21.3	0.5	2.3	31	5	9	4.78	1.16	15	0.358	0.358	0.358	0.358	2.51	SAND	0.5	1.70	34.2	2.83	96.9	0.16	0.985	0.26	0.260	Above Water	0.13	15068	455.0	0.07	0.19	0.007	NA	NA	0.000
6.40	75.3	115.0	115.0	15.1	0.4	2.6	35	4	7	5.00	1.20	13	0.368	0.368	0.368	0.368	2.60	SILT	0.7	1.70	24.3	3.32	80.6	0.13	0.985	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
6.56	75.1	115.0	115.0	11.1	0.3	2.7	36	3	5	5.00	1.20	11	0.377	0.377	0.377	0.377	2.62	non-LIQ CLAY	1	1.70	NA	3.43	non-LIQ	non-LIQ	0.985	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
6.73	75.0	115.0	115.0	12.0	0.3	2.5	39	3	5	5.00	1.20	11	0.387	0.387	0.387	0.387	2.68	SILT	0.7	1.70	19.3	3.84	74.1	0.12	0.984	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
6.89	74.8	115.0	115.0	11.7	0.3	2.6	35	3	5	5.00	1.20	11	0.396	0.396	0.396	0.396	2.60	non-LIQ CLAY	1	1.70	NA	3.33	non-LIQ	non-LIQ	0.984	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
7.05	74.7	115.0	115.0	8.5	0.3	3.5	47	2	4	5.00	1.20	10	0.405	0.405	0.405	0.405	2.81	non-LIQ CLAY	1	1.70	NA	4.89	non-LIQ	non-LIQ	0.984	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
7.22	74.5	115.0	115.0	8.8	0.3	3.4	46	2	4	5.00	1.20	10	0.415	0.415	0.415	0.415	2.80	non-LIQ CLAY	1	1.70	NA	4.77	non-LIQ	non-LIQ	0.983	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
7.38	74.3	115.0	115.0	10.1	0.3	3.0	41	3	4	5.00	1.20	10	0.424	0.424	0.424	0.424	2.72	non-LIQ CLAY	1	1.70	NA	4.13	non-LIQ	non-LIQ	0.983	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
7.55	74.2	115.0	115.0	11.3	0.3	2.7	38	3	5	5.00	1.20	11	0.434	0.434	0.434	0.434	2.66	non-LIQ CLAY	1	1.70	NA	3.68	non-LIQ	non-LIQ	0.982	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
7.71	74.0	115.0	115.0	10.8	0.3	2.8	40	3	4	5.00	1.20	10	0.443	0.443	0.443	0.443	2.69	non-LIQ CLAY	1	1.70	NA	3.94	non-LIQ	non-LIQ	0.982	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
7.87	73.8	115.0	115.0	12.7	0.3	2.4	40	3	5	5.00	1.20	11	0.453	0.453	0.453	0.453	2.68	SILT	0.7	1.70	20.4	3.88	79.2	0.13	0.982	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
8.04	73.7	115.0	115.0	15.2	0.4	2.6	38	4	6	5.00	1.20	12	0.462	0.462	0.462	0.462	2.65	SILT	0.7	1.70	24.4	3.67	89.5	0.15	0.981	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
8.20	73.5	115.0	115.0	13.4	0.4	3.0	38	4	5	5.00	1.20	11	0.472	0.472	0.472	0.472	2.66	non-LIQ CLAY	1	1.70	NA	3.69	non-LIQ	non-LIQ	0.981	0.26	0.260	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
8.37	73.3	115.0	115.0	13.1	0.4	3.1	39	3	5	5.00	1.20	11	0.481	0.481	0.481	0.481	2.68	non-LIQ CLAY	1	1.70	NA	3.84	non-LIQ	non-LIQ	0.980	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
8.53	73.2	115.0	115.0	12.4	0.4	3.2	41	3	5	5.00	1.20	11	0.490	0.490	0.490	0.490	2.72	non-LIQ CLAY	1	1.70	NA	4.14	non-LIQ	non-LIQ	0.980	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
8.69	73.0	115.0	115.0	13.8	0.5	3.6	42	4	5	5.00	1.20	12	0.500	0.500	0.500	0.500	2.72	non-LIQ CLAY	1	1.70	NA	4.15	non-LIQ	non-LIQ	0.980	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000

Liquefaction Analysis with Cone Penetration Test (CPT) Data

Depth (ft)	Elev. (ft, MSL)	Unit Weight (pcf) γ'_{MOIST}	Unit Weight (pcf) γ'_{SAT}	q_c (tsf)	f_s (tsf)	Frict. Ratio (%)	% Fines	Equiv. N_{60}	Equiv. $(N_1)_{60}$	α	β	Equiv. $(N_1)_{60CS}$	Stresses at Exploration Water Level σ_v (tsf)	Stresses at Exploration Water Level σ_v' (tsf)	Stresses at Design Water Level σ_v (tsf)	Stresses at Design Water Level σ_v' (tsf)	I_c	Soil Type Character (SAND, SILT or non-LIQ CLAY)	Normalization of Tip Resistance n	C_Q	q_{c1N}	Fines Correction Kc	$(q_{c1N})_{cs}$	$CRR_{7.5}$	r_d	CSR_M	$CSR_{7.5}$	FS	a	b	Max Shear Modulus G_{max} (tsf)	Cyclic Shear Strain γ (%)	Norm. Vol. Strain ε_{vol} (%)	Dry Settle. ΔS (in)	Post-Liq. $(N_1)_{60CS}$	Post-Liq. Vol. Strain ε (%)	Layer Post-Liq. Settle. ΔS (in)
8.86	72.8	115.0	115.0	14.4	0.5	3.5	40	4	6	5.00	1.20	12	0.509	0.509	0.509	0.509	2.70	non-LIQ CLAY	1	1.70	NA	4.00	non-LIQ	non-LIQ	0.979	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
9.02	72.7	115.0	115.0	15.9	0.5	3.1	38	4	6	5.00	1.20	12	0.519	0.519	0.519	0.519	2.64	non-LIQ CLAY	1	1.70	NA	3.61	non-LIQ	non-LIQ	0.979	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
9.19	72.5	115.0	115.0	15.2	0.5	3.3	39	4	6	5.00	1.20	12	0.528	0.528	0.528	0.528	2.68	non-LIQ CLAY	1	1.70	NA	3.85	non-LIQ	non-LIQ	0.979	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
9.35	72.4	115.0	115.0	15.2	0.5	3.3	40	4	6	5.00	1.20	12	0.538	0.538	0.538	0.536	2.69	non-LIQ CLAY	1	1.70	NA	3.89	non-LIQ	non-LIQ	0.978	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
9.51	72.2	115.0	115.0	14.6	0.5	3.4	41	4	6	5.00	1.20	12	0.547	0.547	0.547	0.547	2.72	non-LIQ CLAY	1	1.70	NA	4.12	non-LIQ	non-LIQ	0.978	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
9.68	72.0	115.0	115.0	15.3	0.6	3.9	43	4	6	5.00	1.20	12	0.557	0.557	0.557	0.557	2.75	non-LIQ CLAY	1	1.70	NA	4.34	non-LIQ	non-LIQ	0.977	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
9.84	71.9	115.0	115.0	16.5	0.6	3.6	41	4	6	5.00	1.20	12	0.566	0.566	0.566	0.566	2.70	non-LIQ CLAY	1	1.70	NA	4.02	non-LIQ	non-LIQ	0.977	0.25	0.250	Above Water	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
10.01	71.7	115.0	115.0	17.6	0.9	5.1	45	5	7	5.00	1.20	13	0.576	0.576	0.576	0.575	2.79	non-LIQ CLAY	1	1.70	NA	4.68	non-LIQ	non-LIQ	0.977	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
10.17	71.5	115.0	115.0	19.8	0.8	4.0	40	5	7	5.00	1.20	14	0.585	0.585	0.585	0.580	2.68	non-LIQ CLAY	1	1.70	NA	3.87	non-LIQ	non-LIQ	0.976	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
10.34	71.4	115.0	115.0	17.9	0.7	3.9	41	5	6	5.00	1.20	13	0.595	0.595	0.595	0.589	2.71	non-LIQ CLAY	1	1.70	NA	4.09	non-LIQ	non-LIQ	0.976	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
10.50	71.2	115.0	115.0	16.1	0.6	3.7	43	4	6	5.00	1.20	12	0.604	0.604	0.604	0.599	2.74	non-LIQ CLAY	1	1.70	NA	4.31	non-LIQ	non-LIQ	0.976	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
10.66	71.0	115.0	115.0	16.3	0.6	3.7	43	4	6	5.00	1.20	12	0.613	0.613	0.613	0.608	2.74	non-LIQ CLAY	1	1.70	NA	4.29	non-LIQ	non-LIQ	0.975	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
10.83	70.9	115.0	115.0	16.0	0.6	3.8	44	4	6	5.00	1.20	12	0.623	0.623	0.623	0.617	2.76	non-LIQ CLAY	1	1.70	NA	4.42	non-LIQ	non-LIQ	0.975	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
10.99	70.7	115.0	115.0	16.9	0.6	3.6	42	5	6	5.00	1.20	12	0.632	0.632	0.632	0.627	2.73	non-LIQ CLAY	1	1.67	NA	4.19	non-LIQ	non-LIQ	0.974	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
11.16	70.5	115.0	115.0	17.9	0.8	4.5	45	5	6	5.00	1.20	13	0.642	0.642	0.642	0.636	2.78	non-LIQ CLAY	1	1.65	NA	4.60	non-LIQ	non-LIQ	0.974	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
11.32	70.4	115.0	115.0	18.9	0.8	4.2	43	5	7	5.00	1.20	13	0.651	0.651	0.651	0.646	2.75	non-LIQ CLAY	1	1.63	NA	4.37	non-LIQ	non-LIQ	0.974	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
11.48	70.2	115.0	115.0	19.2	0.7	3.6	41	5	7	5.00	1.20	13	0.660	0.660	0.660	0.655	2.70	non-LIQ CLAY	1	1.60	NA	4.03	non-LIQ	non-LIQ	0.973	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
11.65	70.1	115.0	115.0	18.4	0.6	3.3	40	5	6	5.00	1.20	12	0.670	0.670	0.670	0.665	2.69	non-LIQ CLAY	1	1.58	NA	3.94	non-LIQ	non-LIQ	0.973	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
11.81	69.9	115.0	115.0	17.7	0.6	3.4	42	5	6	5.00	1.20	12	0.679	0.679	0.679	0.674	2.72	non-LIQ CLAY	1	1.56	NA	4.16	non-LIQ	non-LIQ	0.972	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
11.98	69.7	115.0	115.0	17.3	0.6	3.5	43	5	6	5.00	1.20	12	0.689	0.689	0.689	0.684	2.74	non-LIQ CLAY	1	1.54	NA	4.31	non-LIQ	non-LIQ	0.972	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
12.14	69.6	115.0	115.0	17.9	0.6	3.4	42	5	6	5.00	1.20	12	0.698	0.698	0.698	0.693	2.73	non-LIQ CLAY	1	1.52	NA	4.18	non-LIQ	non-LIQ	0.972	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
12.30	69.4	115.0	115.0	16.9	0.6	3.6	44	5	6	5.00	1.20	12	0.707	0.707	0.707	0.702	2.77	non-LIQ CLAY	1	1.50	NA	4.51	non-LIQ	non-LIQ	0.971	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
12.47	69.2	115.0	115.0	15.6	0.6	3.8	47	4	5	5.00	1.20	12	0.717	0.717	0.717	0.712	2.82	non-LIQ CLAY	1	1.48	NA	4.98	non-LIQ	non-LIQ	0.971	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
12.63	69.1	115.0	115.0	15.4	0.6	3.9	48	4	5	5.00	1.20	11	0.726	0.726	0.726	0.721	2.84	non-LIQ CLAY	1	1.46	NA	5.09	non-LIQ	non-LIQ	0.971	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
12.80	68.9	115.0	115.0	15.7	0.6	3.8	48	5	5	5.00	1.20	12	0.736	0.736	0.736	0.731	2.83	non-LIQ CLAY	1	1.44	NA	5.03	non-LIQ	non-LIQ	0.970	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
12.96	68.7	115.0	115.0	15.5	0.5	3.2	45	4	5	5.00	1.20	11	0.745	0.745	0.745	0.740	2.79	non-LIQ CLAY	1	1.42	NA	4.70	non-LIQ	non-LIQ	0.970	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
13.12	68.6	115.0	115.0	12.9	0.5	3.9	53	4	5	5.00	1.20	11	0.754	0.754	0.754	0.749	2.91	non-LIQ CLAY	1	1.40	NA	5.83	non-LIQ	non-LIQ	0.969	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
13.29	68.4	115.0	115.0	10.4	0.4	3.8	58	3	4	5.00	1.20	10	0.764	0.764	0.764	0.759	3.00	non-LIQ CLAY	1	1.38	NA	6.73	non-LIQ	non-LIQ	0.969	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
13.45	68.3	115.0	115.0	9.4	0.4	4.3	63	3	4	5.00	1.20	9	0.773	0.773	0.773	0.768	3.07	non-LIQ CLAY	1	1.37	NA	7.56	non-LIQ	non-LIQ	0.969	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
13.62	68.1	115.0	115.0	11.4	0.4	3.5	55	4	4	5.00	1.20	10	0.783	0.783	0.783	0.778	2.95	non-LIQ CLAY	1	1.35	NA	6.18	non-LIQ	non-LIQ	0.968	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
13.78	67.9	115.0	115.0	14.4	0.5	3.5	50	4	5	5.00	1.20	11	0.792	0.792	0.792	0.787	2.86	non-LIQ CLAY	1	1.34	NA	5.32	non-LIQ	non-LIQ	0.968	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
13.94	67.8	115.0	115.0	15.9	0.5	3.1	46	5	5	5.00	1.20	11	0.802	0.802	0.802	0.797	2.80	non-LIQ CLAY	1	1.32	NA	4.79	non-LIQ	non-LIQ	0.967	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
14.11	67.6	115.0	115.0	16.2	0.5	3.1	46	5	5	5.00	1.20	11	0.811	0.811	0.811	0.806	2.79	non-LIQ CLAY	1	1.30	NA	4.73	non-LIQ	non-LIQ	0.967	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
14.27	67.4	115.0	115.0	16.6	0.6	3.6	48	5	5	5.00	1.20	12	0.821	0.821	0.821	0.816	2.83	non-LIQ CLAY	1	1.29	NA	5.06	non-LIQ	non-LIQ	0.967	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
14.44	67.3	115.0	115.0	17.7	0.6	3.4	46	5	6	5.00	1.20	12	0.830	0.830	0.830	0.825	2.79	non-LIQ CLAY	1	1.27	NA	4.74	non-LIQ	non-LIQ	0.966	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
14.60	67.1	115.0	115.0	18.6	0.6	3.2	44	5	6	5.00	1.20	12	0.839	0.839	0.839	0.835	2.77	non-LIQ CLAY	1	1.26	NA	4.51	non-LIQ	non-LIQ	0.966	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
14.76	66.9	115.0	115.0	20.8	0.6	2.9	40	6	6	5.00	1.20	13	0.849	0.849	0.849	0.844	2.70	non-LIQ CLAY	1	1.25	NA	3.99	non-LIQ	non-LIQ	0.966	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
14.93	66.8	115.0	115.0	19.9	0.6	3.0	42	5	6	5.00	1.20	12	0.858	0.858	0.858	0.853	2.73	non-LIQ CLAY	1	1.23	NA	4.24	non-LIQ	non-LIQ	0.965	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
15.09	66.6	115.0	115.0	21.4	0.6	2.8	40	6	6	5.00	1.20	13	0.868	0.868	0.868	0.863	2.69	non-LIQ CLAY	1	1.22	NA	3.92	non-LIQ	non-LIQ	0.965	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
15.26	66.4	115.0	115.0	21.2	0.7	3.3	43	6	6	5.00	1.20	13	0.877	0.877	0.877	0.872	2.74	non-LIQ CLAY	1	1.21	NA	4.31	non-LIQ	non-LIQ	0.964	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
15.42	66.3	115.0	115.0	20.9	0.6	2.9	41	6	6	5.00	1.20	12	0.887	0.887	0.887	0.882	2.71	non-LIQ CLAY	1	1.19	NA	4.09	non-LIQ	non-LIQ	0.964	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
15.58	66.1	115.0	115.0	18.9	0.5	2.6	42	5	6	5.00	1.20	12	0.896	0.896	0.896	0.891	2.73	non-LIQ CLAY	1	1.18	NA	4.23	non-LIQ	non-LIQ	0.964	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
15.75	66.0	115.0	115.0	17.1	0.5	2.9	46	5	5	5.00	1.20	11	0.906	0.906	0.906	0.900	2.80	non-LIQ CLAY	1	1.17	NA	4.78	non-LIQ	non-LIQ	0.963	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
15.91	65.8	115.0	115.0	17.9	0.5	2.8	45	5	5	5.00	1.20	11	0.915	0.915	0.915	0.910	2.77	non-LIQ CLAY	1	1.16	NA	4.57	non-LIQ	non-LIQ	0.963	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
16.08	65.6	115.0	115.0	18.3	0.5	2.7	44	5	5	5.00	1.20	12	0.925	0.925	0.925	0.919	2.76	non-LIQ CLAY	1	1.14	NA	4.49	non-LIQ	non-LIQ	0.963	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
16.24	65.5	115.0	115.0	17.5	0.5	2.9	46	5	5	5.00	1.20	11	0.934	0.934	0.934	0.929	2.80	non-LIQ CLAY	1	1.13	NA	4.76	non-LIQ	non-LIQ	0.962	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
16.40	65.3	115.0	115.0	15.3	0.5	3.3	51	5	5	5.00	1.20	11	0.943	0.943	0.943	0.938	2.89	non-LIQ CLAY	1	1.12	NA	5.58	non-LIQ	non-LIQ	0.962	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
16.57	65.1	115.0	115.0	15.7	0.6	3.8	53	5	5	5.00	1.20	11	0.953	0.953	0.953	0.947	2.92	non-LIQ CLAY	1	1.11	NA	5.93	non-LIQ	non-LIQ	0.961	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
16.73	65.0	115.0	115.0	15.1	0.5	3.3	52	5	5	5.00	1.20	11	0.962	0.962	0.962	0.957	2.90	non-LIQ CLAY	1	1.10	NA	5.73	non-LIQ	non-LIQ	0.961	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
16.90	64.8	115.0	115.0	15.4	0.5	3.2	52	5	5	5.00	1.20	11	0.972	0.972	0.972	0.966	2.89	non-LIQ CLAY	1	1.09	NA	5.65	non-LIQ	non-LIQ	0.961	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
17.06	64.6	115.0	115.0	15.5	0.5	3.2	52	5	5	5.00	1.20	11	0.981	0.981	0.981	0.976	2.89	non-LIQ CLAY	1	1.08	NA	5.64	non-LIQ	non-LIQ	0.960	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
17.23	64.5	115.0	115.0	13.2	0.5	3.8	59	4	4	5.00	1.20	10	0.991	0.991	0.991	0.985	3.00	non-LIQ CLAY	1	1.07	NA	6.78	non-LIQ	non-LIQ	0.960	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
17.39	64.3	115.0	115.0	11.3	0.4	3.5	62	4	4	5.00	1.20	10	1.000	1.000	1.000	0.995	3.05	non-LIQ CLAY	1	1.06	NA	7.33	non-LIQ	non-LIQ	0.959	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
17.55	64.2	115.0	115.0	11.8	0.4	3.4	60	4	4	5.00	1.20	10	1.009	1.009	1.009	1.004	3.03	non-LIQ CLAY	1	1.05	NA	7.04	non-LIQ	non-LIQ	0.959	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
17.72	64.0	115.0	115.0	11.2	0.4	3.6	63	4	4	5.00	1.20	10	1.019	1.019	1.019	1.014	3.06	non-LIQ CLAY	1	1.04	NA	7.50	non-LIQ	non-LIQ	0.959	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
17.88	63.8	115.0	115.0	11.5	0.3	2.6	57	4	4	5.00	1.20	9	1.028	1.028	1.028	1.023	2.98	non-LIQ CLAY	1	1.03	NA	6.51	non-LIQ	non-LIQ	0.958	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
18.05	63.7	115.0	115.0	10.7	0.3	2.8	61	3	4	5.00	1.20	9	1.038	1.036	1.038	1.033	3.03	non-LIQ CLAY	1	1.02	NA	7.09	non-LIQ	non-LIQ	0.958	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
18.21	63.5	115.0	115.0	11.4	0.3	2.6	56	4	4	5.00	1.20	9	1.047	1.041	1.047	1.041	2.99	non-LIQ CLAY	1	1.02	NA	6.64	non-LIQ	non-LIQ	0.958	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
18.37	63.3	115.0	115.0	10.3	0.3	2.9	63	3	3	5.00	1.20	9	1.056	1.045	1.056	1.045	3.06	non-LIQ CLAY	1	1.01	NA	7.44	non-LIQ	non-LIQ	0.957	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
18.54	63.2	115.0	115.0	10.0	0.2	2.0	58	3	3	5.00	1.20	9	1.066	1.049	1.066	1.049	2.99	non-LIQ CLAY	1	1.01	NA	6.59	non-LIQ	non-LIQ	0.957	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
18.70	63.0	115.0	115.0	9.9	0.3	3.0	65	3	3	5.00	1.20	9	1.075	1.053	1.075	1.053	3.09	non-LIQ CLAY	1	1.00	NA	7.81	non-LIQ	non-LIQ	0.956	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
18.87	62.8	115.0	115.0	10.0	0.2	2.0	58	3	3	5.00	1.20	9	1.085	1.058	1.085	1.056	2.99	non-LIQ CLAY	1	1.00	NA	6.64	non-LIQ	non-LIQ	0.956	0.25	0.250	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
19.03	62.7	115.0	115.0	10.1	0.3	3.0	64	3	3	5.00	1.20	9	1.094	1.062	1.094	1.062	3.08	non-LIQ CLAY	1	1.00	NA	7.70	non-LIQ	non-LIQ	0.956	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
19.19	62.5	115.0	115.0	9.4	0.2	2.1	61	3	3	5.00	1.20	9	1.103	1.066	1.103	1.066	3.04	non-LIQ CLAY	1	0.99	NA	7.15	non-LIQ	non-LIQ	0.955	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
19.36	62.3	115.0	115.0	8.8	0.2	2.3	64	3	3	5.00	1.20	9	1.113	1.071	1.113	1.071	3.08	non-LIQ CLAY	1	0.99	NA	7.72	non-LIQ	non-LIQ	0.955	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
19.52	62.2	115.0	115.0	8.5	0.2	2.4	66	3	3	5.00	1.20	8	1.122	1.075	1.122	1.075	3.11	non-LIQ CLAY	1	0.98	NA	8.04	non-LIQ	non-LIQ	0.954	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
19.69	62.0	115.0	115.0	6.8	0.2	2.9	78	3	3	5.00	1.20	8	1.132	1.079	1.132	1.079	3.27	non-LIQ CLAY	1	0.98	NA	10.24	non-LIQ	non-LIQ	0.954	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
19.85	61.9	115.0	115.0	6.7	0.2	3.0	80	3	3	5.00	1.20	8	1.141	1.084	1.141	1.084	3.28	non-LIQ CLAY	1	0.98	NA	10.44	non-LIQ	non-LIQ	0.954	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
20.01	61.7	115.0	115.0	6.9	0.2	2.9	78	3	3	5.00	1.20	8	1.151	1.088	1.151	1.088	3.26	non-LIQ CLAY	1	0.97	NA	10.16	non-LIQ	non-LIQ	0.953	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
20.18	61.5	115.0	115.0	6.8	0.2	2.9	79	3	3	5.00	1.20	8	1.160	1.092	1.160	1.092	3.28	non-LIQ CLAY	1	0.97	NA	10.35	non-LIQ	non-LIQ	0.953	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
20.34	61.4	115.0	115.0	7.9	0.2	2.5	71	3	3	5.00	1.20	8	1.170	1.097	1.170	1.097	3.17	non-LIQ CLAY	1	0.96	NA	8.86	non-LIQ	non-LIQ	0.953	0.26	0.260	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
20.51	61.2	115.0	115.0	9.0	0.3	3.3	71	3	3	5.00	1.20	9	1.179	1.101	1.179	1.101	3.18	non-LIQ CLAY	1	0.96	NA	8.97	non-LIQ	non-LIQ	0.952	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
20.67	61.0	115.0	115.0	9.6	0.3	3.1	66	3	3	5.00	1.20	9	1.189	1.105	1.189	1.105	3.14	non-LIQ CLAY	1	0.96	NA	8.40	non-LIQ	non-LIQ	0.952	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
20.83	60.9	115.0	115.0	9.5	0.3	3.2	69	3	3	5.00	1.20	9	1.198	1.109	1.198	1.109	3.15	non-LIQ CLAY	1	0.95	NA	8.52	non-LIQ	non-LIQ	0.951	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
21.00	60.7	115.0	115.0	9.6	0.3	3.1	69	3	3	5.00	1.20	9	1.208	1.114	1.208	1.114	3.14	non-LIQ CLAY	1	0.95	NA	8.46	non-LIQ	non-LIQ	0.951	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
21.16	60.5	115.0	115.0	9.9	0.3	3.0	67	3	3	5.00	1.20	9	1.217	1.118	1.217	1.118	3.12	non-LIQ CLAY	1	0.95	NA	8.21	non-LIQ	non-LIQ	0.951	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
21.33	60.4	115.0	115.0	10.6	0.3	2.8	64	4	3	5.00	1.20	9	1.226	1.123	1.226	1.123	3.08	non-LIQ CLAY	1	0.94	NA	7.65	non-LIQ	non-LIQ	0.950	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
21.49	60.2	115.0	115.0	9.1	0.3	3.3	72	3	3	5.00	1.20	9	1.236	1.127	1.236	1.127	3.18	non-LIQ CLAY	1	0.94	NA	9.04	non-LIQ	non-LIQ	0.950	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
21.65	60.1	115.0	115.0	6.6	0.2	3.0	83	3	3	5.00	1.20	8	1.245	1.131	1.245	1.131	3.32	non-LIQ CLAY	1	0.94	NA	11.03	non-LIQ	non-LIQ	0.950	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
21.82	59.9	115.0	115.0	5.8	0.2	3.4	91	3	2	5.00	1.20	8	1.255	1.135	1.255	1.135	3.42	non-LIQ CLAY	1	0.93	NA	12.67	non-LIQ	non-LIQ	0.949	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
21.98	59.7	115.0	115.0	5.9	0.2	3.4	91	3	2	5.00	1.20	8	1.264	1.140	1.264	1.140	3.41	non-LIQ CLAY	1	0.93	NA	12.49	non-LIQ	non-LIQ	0.949	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
22.15	59.6	115.0	115.0	6.1	0.2	3.3	89	3	2	5.00	1.20	8	1.274	1.144	1.274	1.144	3.39	non-LIQ CLAY	1	0.92	NA	12.10	non-LIQ	non-LIQ	0.948	0.27	0.270	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
22.31	59.4	115.0	115.0	5.7	0.2	3.5	93	3	2	5.00	1.20	8	1.283	1.148	1.283	1.148	3.44	non-LIQ CLAY	1	0.92	NA	13.04	non-LIQ	non-LIQ	0.948	0.28	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
22.47	59.2	115.0	115.0	5.4	0.2	3.7	98	2	2	5.00	1.20	8	1.292	1.153	1.292	1.153	3.49	non-LIQ CLAY	1	0.92	NA	13.83	non-LIQ	non-LIQ	0.948	0.28	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
22.64	59.1	115.0	115.0	5.5	0.2	3.6	97	2	2	5.00	1.20	8	1.302	1.157	1.302	1.157	3.47	non-LIQ CLAY	1	0.91	NA	13.62	non-LIQ	non-LIQ	0.947	0.28	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
22.80	58.9	115.0	115.0	5.5	0.2	3.6	97	3	2	5.00	1.20	8	1.311	1.161	1.311	1.161	3.48	non-LIQ CLAY	1	0.91	NA	13.67	non-LIQ	non-LIQ	0.947	0.28	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000

Liquefaction Analysis with Cone Penetration Test (CPT) Data

Depth (ft)	Elev. (ft, MSL)	Unit Weight (pcf) γ'_{MOIST}	Unit Weight (pcf) γ'_{SAT}	q_c (tsf)	f_s (tsf)	Frict. Ratio (%)	% Fines	Equiv. N_{60}	Equiv. $(N_1)_{60}$	α	β	Equiv. $(N_1)_{60CS}$	Stresses at Exploration Water Level σ_v (tsf)	Stresses at Exploration Water Level σ_v' (tsf)	Stresses at Design Water Level σ_v (tsf)	Stresses at Design Water Level σ_v' (tsf)	I_c	Soil Type Character (SAND, SILT or non-LIQ CLAY)	Normalization of Tip Resistance n	Normalization of Tip Resistance C_Q	Normalization of Tip Resistance q_{c1N}	Fines Correction Kc	Fines Correction $(q_{c1N})_{cs}$	$CRR_{7.5}$	r_d	CSR_M	$CSR_{7.5}$	FS	a	b	Max Shear Modulus G_{max} (tsf)	Cyclic Shear Strain γ (%)	Norm. Vol. Strain ε_{Nc} (%)	Dry Settle. ΔS (in)	Post-Liq. $(N_1)_{60CS}$	Post-Liq. Vol. Strain ε (%)	Layer Post-Liq. Settle. ΔS (in)
22.97	58.7	115.0	115.0	5.6	0.2	3.6	96	3	2	5.00	1.20	8	1.321	1.166	1.321	1.166	3.47	non-LIQ CLAY	1	0.91	NA	13.47	non-LIQ	non-LIQ	0.946	0.26	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
23.13	58.6	115.0	115.0	6.0	0.2	3.3	91	3	2	5.00	1.20	8	1.330	1.170	1.330	1.170	3.41	non-LIQ CLAY	1	0.90	NA	12.58	non-LIQ	non-LIQ	0.946	0.26	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
23.30	58.4	115.0	115.0	6.2	0.2	3.2	89	3	2	5.00	1.20	8	1.340	1.174	1.340	1.174	3.39	non-LIQ CLAY	1	0.90	NA	12.19	non-LIQ	non-LIQ	0.946	0.26	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
23.46	58.2	115.0	115.0	6.9	0.2	2.9	82	3	3	5.00	1.20	8	1.349	1.179	1.349	1.179	3.31	non-LIQ CLAY	1	0.90	NA	10.93	non-LIQ	non-LIQ	0.945	0.26	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
23.62	58.1	115.0	115.0	6.8	0.2	2.9	83	3	3	5.00	1.20	8	1.358	1.183	1.358	1.183	3.33	non-LIQ CLAY	1	0.89	NA	11.13	non-LIQ	non-LIQ	0.945	0.26	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
23.79	57.9	115.0	115.0	6.5	0.1	1.5	74	2	2	5.00	1.20	8	1.368	1.187	1.368	1.187	3.21	non-LIQ CLAY	1	0.89	NA	9.41	non-LIQ	non-LIQ	0.945	0.28	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
23.95	57.8	115.0	115.0	6.3	0.1	1.6	76	2	2	5.00	1.20	8	1.377	1.191	1.377	1.191	3.24	non-LIQ CLAY	1	0.89	NA	9.78	non-LIQ	non-LIQ	0.944	0.28	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
24.12	57.6	115.0	115.0	6.3	0.2	3.2	89	3	3	5.00	1.20	8	1.387	1.196	1.387	1.196	3.39	non-LIQ CLAY	1	0.88	NA	12.20	non-LIQ	non-LIQ	0.944	0.28	0.280	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
24.28	57.4	115.0	115.0	6.9	0.2	2.9	83	3	3	5.00	1.20	8	1.396	1.200	1.396	1.200	3.33	non-LIQ CLAY	1	0.88	NA	11.11	non-LIQ	non-LIQ	0.943	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
24.44	57.3	115.0	115.0	6.4	0.1	1.6	76	2	2	5.00	1.20	8	1.405	1.204	1.405	1.204	3.23	non-LIQ CLAY	1	0.88	NA	9.71	non-LIQ	non-LIQ	0.943	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
24.61	57.1	115.0	115.0	5.6	0.1	1.8	84	2	2	5.00	1.20	8	1.415	1.209	1.415	1.209	3.34	non-LIQ CLAY	1	0.88	NA	11.31	non-LIQ	non-LIQ	0.943	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
24.77	56.9	115.0	115.0	5.8	0.1	1.7	82	2	2	5.00	1.20	8	1.424	1.213	1.424	1.213	3.31	non-LIQ CLAY	1	0.87	NA	10.92	non-LIQ	non-LIQ	0.942	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
24.94	56.8	115.0	115.0	6.4	0.2	3.1	89	3	3	5.00	1.20	8	1.434	1.218	1.434	1.218	3.39	non-LIQ CLAY	1	0.87	NA	12.20	non-LIQ	non-LIQ	0.942	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
25.10	56.6	115.0	115.0	8.2	0.2	2.4	74	3	3	5.00	1.20	8	1.443	1.222	1.443	1.222	3.21	non-LIQ CLAY	1	0.87	NA	9.38	non-LIQ	non-LIQ	0.941	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
25.26	56.4	115.0	115.0	7.2	0.2	2.8	62	3	3	5.00	1.20	8	1.452	1.226	1.452	1.226	3.31	non-LIQ CLAY	1	0.86	NA	10.83	non-LIQ	non-LIQ	0.941	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
25.43	56.3	115.0	115.0	6.4	0.2	3.1	90	3	3	5.00	1.20	8	1.462	1.230	1.462	1.230	3.40	non-LIQ CLAY	1	0.86	NA	12.32	non-LIQ	non-LIQ	0.941	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
25.59	56.1	115.0	115.0	5.9	0.1	1.7	82	2	2	5.00	1.20	8	1.471	1.235	1.471	1.235	3.31	non-LIQ CLAY	1	0.86	NA	10.92	non-LIQ	non-LIQ	0.940	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
25.76	55.9	115.0	115.0	5.8	0.1	1.7	84	2	2	5.00	1.20	8	1.481	1.239	1.481	1.239	3.33	non-LIQ CLAY	1	0.85	NA	11.17	non-LIQ	non-LIQ	0.940	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
25.92	55.8	115.0	115.0	5.8	0.2	3.4	97	3	2	5.00	1.20	8	1.490	1.243	1.490	1.243	3.46	non-LIQ CLAY	1	0.85	NA	13.61	non-LIQ	non-LIQ	0.940	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
26.08	55.6	115.0	115.0	5.5	0.2	3.6	102	3	2	5.00	1.20	8	1.500	1.248	1.500	1.248	3.53	non-LIQ CLAY	1	0.85	NA	14.66	non-LIQ	non-LIQ	0.939	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
26.25	55.5	115.0	115.0	8.0	0.2	2.5	76	3	3	5.00	1.20	8	1.509	1.252	1.509	1.252	3.24	non-LIQ CLAY	1	0.85	NA	9.85	non-LIQ	non-LIQ	0.939	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
26.41	55.3	115.0	115.0	9.4	0.2	2.1	67	3	3	5.00	1.20	9	1.519	1.256	1.519	1.256	3.13	non-LIQ CLAY	1	0.84	NA	8.27	non-LIQ	non-LIQ	0.938	0.29	0.290	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
26.58	55.1	115.0	115.0	7.2	0.2	2.8	83	3	3	5.00	1.20	8	1.528	1.261	1.528	1.261	3.33	non-LIQ CLAY	1	0.84	NA	11.11	non-LIQ	non-LIQ	0.938	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
26.74	55.0	115.0	115.0	7.2	0.2	2.8	83	3	3	5.00	1.20	8	1.538	1.265	1.538	1.265	3.33	non-LIQ CLAY	1	0.84	NA	11.15	non-LIQ	non-LIQ	0.938	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
26.90	54.8	115.0	115.0	7.1	0.2	2.8	84	3	3	5.00	1.20	8	1.547	1.269	1.547	1.269	3.34	non-LIQ CLAY	1	0.83	NA	11.35	non-LIQ	non-LIQ	0.937	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
27.07	54.6	115.0	115.0	7.7	0.2	2.6	80	3	3	5.00	1.20	8	1.557	1.274	1.557	1.274	3.28	non-LIQ CLAY	1	0.83	NA	10.43	non-LIQ	non-LIQ	0.937	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
27.23	54.5	115.0	115.0	8.5	0.2	2.4	74	3	3	5.00	1.20	8	1.566	1.278	1.566	1.278	3.21	non-LIQ CLAY	1	0.83	NA	9.39	non-LIQ	non-LIQ	0.937	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
27.40	54.3	115.0	115.0	8.4	0.2	2.4	75	3	3	5.00	1.20	8	1.576	1.282	1.576	1.282	3.22	non-LIQ CLAY	1	0.83	NA	9.55	non-LIQ	non-LIQ	0.936	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
27.56	54.1	115.0	115.0	8.3	0.2	2.4	76	3	3	5.00	1.20	8	1.585	1.286	1.585	1.286	3.23	non-LIQ CLAY	1	0.82	NA	9.70	non-LIQ	non-LIQ	0.936	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
27.72	54.0	115.0	115.0	9.9	0.3	3.0	73	4	3	5.00	1.20	9	1.594	1.291	1.594	1.291	3.20	non-LIQ CLAY	1	0.82	NA	9.26	non-LIQ	non-LIQ	0.935	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
27.89	53.8	115.0	115.0	11.0	0.3	2.7	67	4	3	5.00	1.20	9	1.604	1.295	1.604	1.295	3.13	non-LIQ CLAY	1	0.82	NA	8.28	non-LIQ	non-LIQ	0.935	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
28.05	53.7	115.0	115.0	11.5	0.4	3.5	71	4	4	5.00	1.20	9	1.613	1.299	1.613	1.299	3.17	non-LIQ CLAY	1	0.81	NA	8.82	non-LIQ	non-LIQ	0.935	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
28.22	53.5	115.0	115.0	11.4	0.4	3.5	71	4	4	5.00	1.20	9	1.623	1.304	1.623	1.304	3.18	non-LIQ CLAY	1	0.81	NA	8.92	non-LIQ	non-LIQ	0.934	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
28.38	53.3	115.0	115.0	12.6	0.3	2.4	61	4	4	5.00	1.20	9	1.632	1.308	1.632	1.308	3.04	non-LIQ CLAY	1	0.81	NA	7.18	non-LIQ	non-LIQ	0.934	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
28.54	53.2	115.0	115.0	10.7	0.3	2.8	69	4	3	5.00	1.20	9	1.641	1.312	1.641	1.312	3.15	non-LIQ CLAY	1	0.81	NA	8.63	non-LIQ	non-LIQ	0.933	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
28.71	53.0	115.0	115.0	9.9	0.3	3.0	74	4	3	5.00	1.20	9	1.651	1.317	1.651	1.317	3.21	non-LIQ CLAY	1	0.80	NA	9.42	non-LIQ	non-LIQ	0.933	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
28.87	52.8	115.0	115.0	9.6	0.3	3.1	76	4	3	5.00	1.20	9	1.660	1.321	1.660	1.321	3.24	non-LIQ CLAY	1	0.80	NA	9.76	non-LIQ	non-LIQ	0.933	0.30	0.300	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
29.04	52.7	115.0	115.0	8.6	0.3	3.5	83	3	3	5.00	1.20	9	1.670	1.325	1.670	1.325	3.32	non-LIQ CLAY	1	0.80	NA	11.01	non-LIQ	non-LIQ	0.932	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
29.20	52.5	115.0	115.0	8.6	0.3	3.5	83	3	3	5.00	1.20	9	1.679	1.330	1.679	1.330	3.32	non-LIQ CLAY	1	0.80	NA	11.05	non-LIQ	non-LIQ	0.932	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
29.36	52.3	115.0	115.0	9.2	0.4	4.3	85	4	3	5.00	1.20	9	1.688	1.334	1.688	1.334	3.34	non-LIQ CLAY	1	0.79	NA	11.41	non-LIQ	non-LIQ	0.932	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
29.53	52.2	115.0	115.0	10.8	0.4	3.7	75	4	4	5.00	1.20	9	1.698	1.338	1.698	1.338	3.23	non-LIQ CLAY	1	0.79	NA	9.66	non-LIQ	non-LIQ	0.931	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
29.69	52.0	115.0	115.0	12.3	0.4	3.3	68	4	4	5.00	1.20	10	1.707	1.342	1.707	1.342	3.14	non-LIQ CLAY	1	0.79	NA	8.42	non-LIQ	non-LIQ	0.931	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
29.86	51.8	115.0	115.0	12.8	0.5	3.9	71	5	4	5.00	1.20	10	1.717	1.347	1.717	1.347	3.17	non-LIQ CLAY	1	0.79	NA	8.82	non-LIQ	non-LIQ	0.930	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
30.02	51.7	115.0	115.0	11.7	0.5	4.3	76	4	4	5.00	1.20	10	1.726	1.351	1.726	1.351	3.23	non-LIQ CLAY	1	0.78	NA	9.73	non-LIQ	non-LIQ	0.930	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
30.19	51.5	115.0	115.0	12.4	0.5	4.0	73	5	4	5.00	1.20	10	1.736	1.356	1.736	1.356	3.19	non-LIQ CLAY	1	0.78	NA	9.17	non-LIQ	non-LIQ	0.928	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
30.35	51.4	115.0	115.0	10.5	0.4	3.8	78	4	4	5.00	1.20	9	1.745	1.360	1.745	1.360	3.26	non-LIQ CLAY	1	0.78	NA	10.09	non-LIQ	non-LIQ	0.927	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
30.51	51.2	115.0	115.0	9.6	0.3	3.1	77	4	3	5.00	1.20	9	1.754	1.364	1.754	1.364	3.25	non-LIQ CLAY	1	0.78	NA	10.04	non-LIQ	non-LIQ	0.926	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
30.68	51.0	115.0	115.0	8.5	0.3	3.5	85	3	3	5.00	1.20	9	1.764	1.368	1.764	1.368	3.35	non-LIQ CLAY	1	0.77	NA	11.47	non-LIQ	non-LIQ	0.924	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
30.84	50.9	115.0	115.0	8.5	0.3	3.5	85	3	3	5.00	1.20	9	1.773	1.373	1.773	1.373	3.35	non-LIQ CLAY	1	0.77	NA	11.50	non-LIQ	non-LIQ	0.923	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
31.01	50.7	115.0	115.0	9.1	0.3	3.3	81	4	3	5.00	1.20	9	1.783	1.377	1.783	1.377	3.30	non-LIQ CLAY	1	0.77	NA	10.72	non-LIQ	non-LIQ	0.922	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
31.17	50.5	115.0	115.0	8.8	0.3	3.4	83	4	3	5.00	1.20	9	1.792	1.381	1.792	1.381	3.33	non-LIQ CLAY	1	0.77	NA	11.14	non-LIQ	non-LIQ	0.920	0.31	0.310	non-LIQ	NA	NA	NA	NA	NA	0.000	NA	NA	0.000
31.33	50.4	115.0	115.0	8.8	0.3	3.4	83.5	3.5	3.1	5.0	1.2	9.0	1.80	1.39	1.80	1.39	3.33	non-LIQ CLAY	1	0.76	NA	11.17	non-LIQ	non-LIQ	0.919	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
31.50	50.2	115.0	115.0	9.0	0.3	3.3	82.3	3.6	3.1	5.0	1.2	9.0	1.81	1.39	1.81	1.39	3.31	non-LIQ CLAY	1	0.76	NA	10.94	non-LIQ	non-LIQ	0.918	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
31.66	50.0	115.0	115.0	8.8	0.3	3.4	83.9	3.6	3.1	5.0	1.2	9.0	1.82	1.39	1.82	1.39	3.33	non-LIQ CLAY	1	0.76	NA	11.24	non-LIQ	non-LIQ	0.916	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
31.83	49.9	115.0	115.0	8.1	0.2	2.5	81.4	3.2	2.8	5.0	1.2	8.0	1.83	1.40	1.83	1.40	3.30	non-LIQ CLAY	1	0.76	NA	10.78	non-LIQ	non-LIQ	0.915	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
31.99	49.7	115.0	115.0	8.2	0.2	2.4	80.8	3.2	2.8	5.0	1.2	8.0	1.84	1.40	1.84	1.40	3.30	non-LIQ CLAY	1	0.75	NA	10.66	non-LIQ	non-LIQ	0.914	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
32.15	49.6	115.0	115.0	8.1	0.2	2.5	81.7	3.2	2.8	5.0	1.2	8.0	1.85	1.41	1.85	1.41	3.31	non-LIQ CLAY	1	0.75	NA	10.84	non-LIQ	non-LIQ	0.912	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
32.32	49.4	115.0	115.0	8.6	0.3	3.5	86.1	3.5	3.1	5.0	1.2	9.0	1.86	1.41	1.86	1.41	3.36	non-LIQ CLAY	1	0.75	NA	11.64	non-LIQ	non-LIQ	0.911	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
32.48	49.2	115.0	115.0	9.0	0.3	3.3	83.2	3.6	3.1	5.0	1.2	9.0	1.87	1.42	1.87	1.42	3.33	non-LIQ CLAY	1	0.75	NA	11.12	non-LIQ	non-LIQ	0.910	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
32.65	49.1	115.0	115.0	9.6	0.3	3.1	79.3	3.7	3.2	5.0	1.2	9.0	1.88	1.42	1.88	1.42	3.28	non-LIQ CLAY	1	0.74	NA	10.40	non-LIQ	non-LIQ	0.908	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
32.81	48.9	115.0	115.0	9.7	0.3	3.1	78.8	3.7	3.2	5.0	1.2	9.0	1.89	1.42	1.89	1.42	3.27	non-LIQ CLAY	1	0.74	NA	10.31	non-LIQ	non-LIQ	0.907	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
32.97	48.7	115.0	115.0	9.7	0.3	3.1	79.0	3.7	3.2	5.0	1.2	9.0	1.90	1.43	1.90	1.43	3.27	non-LIQ CLAY	1	0.74	NA	10.33	non-LIQ	non-LIQ	0.906	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
33.14	48.6	115.0	115.0	9.9	0.3	3.0	77.9	3.8	3.3	5.0	1.2	9.0	1.91	1.43	1.91	1.43	3.26	non-LIQ CLAY	1	0.74	NA	10.13	non-LIQ	non-LIQ	0.904	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
33.30	48.4	115.0	115.0	9.9	0.3	3.0	78.0	3.8	3.2	5.0	1.2	9.0	1.91	1.44	1.91	1.44	3.26	non-LIQ CLAY	1	0.74	NA	10.16	non-LIQ	non-LIQ	0.903	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
33.47	48.2	115.0	115.0	10.0	0.3	3.0	77.6	3.8	3.3	5.0	1.2	9.0	1.92	1.44	1.92	1.44	3.26	non-LIQ CLAY	1	0.73	NA	10.08	non-LIQ	non-LIQ	0.902	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
33.63	48.1	115.0	115.0	10.1	0.3	3.0	77.1	3.8	3.3	5.0	1.2	9.0	1.93	1.45	1.93	1.45	3.25	non-LIQ CLAY	1	0.73	NA	9.99	non-LIQ	non-LIQ	0.900	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
33.79	47.9	115.0	115.0	10.2	0.3	2.9	76.7	3.9	3.3	5.0	1.2	9.0	1.94	1.45	1.94	1.45	3.25	non-LIQ CLAY	1	0.73	NA	9.91	non-LIQ	non-LIQ	0.899	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
33.96	47.7	115.0	115.0	10.0	0.3	3.0	78.0	3.8	3.3	5.0	1.2	9.0	1.95	1.45	1.95	1.45	3.26	non-LIQ CLAY	1	0.73	NA	10.16	non-LIQ	non-LIQ	0.898	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
34.12	47.6	115.0	115.0	10.2	0.3	2.9	77.0	3.9	3.3	5.0	1.2	9.0	1.96	1.46	1.96	1.46	3.25	non-LIQ CLAY	1	0.73	NA	9.96	non-LIQ	non-LIQ	0.896	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
34.29	47.4	115.0	115.0	10.7	0.3	2.8	74.3	4.0	3.4	5.0	1.2	9.0	1.97	1.46	1.97	1.46	3.22	non-LIQ CLAY	1	0.72	NA	9.48	non-LIQ	non-LIQ	0.895	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
34.45	47.3	115.0	115.0	11.6	0.3	2.6	69.8	4.1	3.5	5.0	1.2	9.0	1.98	1.47	1.98	1.47	3.16	non-LIQ CLAY	1	0.72	NA	8.69	non-LIQ	non-LIQ	0.894	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
34.61	47.1	115.0	115.0	10.8	0.3	2.8	74.0	4.0	3.4	5.0	1.2	9.0	1.99	1.47	1.99	1.47	3.21	non-LIQ CLAY	1	0.72	NA	9.43	non-LIQ	non-LIQ	0.892	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
34.78	46.9	115.0	115.0	10.8	0.3	2.8	74.1	4.0	3.4	5.0	1.2	9.0	2.00	1.48	2.00	1.48	3.21	non-LIQ CLAY	1	0.72	NA	9.45	non-LIQ	non-LIQ	0.891	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
34.94	46.8	115.0	115.0	11.3	0.3	2.7	71.7	4.1	3.4	5.0	1.2	9.0	2.01	1.48	2.01	1.48	3.18	non-LIQ CLAY	1	0.71	NA	9.01	non-LIQ	non-LIQ	0.890	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
35.11	46.6	115.0	115.0	12.3	0.3	2.4	67.2	4.3	3.6	5.0	1.2	9.0	2.02	1.48	2.02	1.48	3.12	non-LIQ CLAY	1	0.71	NA	8.22	non-LIQ	non-LIQ	0.888	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
35.27	46.4	115.0	115.0	11.8	0.4	3.4	74.9	4.4	3.7	5.0	1.2	9.0	2.03	1.49	2.03	1.49	3.22	non-LIQ CLAY	1	0.71	NA	9.59	non-LIQ	non-LIQ	0.887	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
35.43	46.3	115.0	115.0	12.3	0.3	2.4	67.4	4.3	3.6	5.0	1.2	9.0	2.04	1.49	2.04	1.49	3.13	non-LIQ CLAY	1	0.71	NA	8.26	non-LIQ	non-LIQ	0.886	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
35.60	46.1	115.0	115.0	12.6	0.4	3.2	71.4	4.5	3.8	5.0	1.2	10.0	2.05	1.50	2.05	1.50	3.18	non-LIQ CLAY	1	0.71	NA	8.97	non-LIQ	non-LIQ	0.884	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
35.76	45.9	115.0	115.0	13.0	0.4	3.1	69.8	4.6	3.9	5.0	1.2	10.0	2.06	1.50	2.06	1.50	3.16	non-LIQ CLAY	1	0.70	NA	8.69	non-LIQ	non-LIQ	0.883	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
35.93	45.8	115.0	115.0	13.7	0.4	2.9	67.2	4.7	4.0	5.0	1.2	10.0	2.07	1.51	2.07	1.51	3.12	non-LIQ CLAY	1	0.70	NA	8.22	non-LIQ	non-LIQ	0.882	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
36.09	45.6	115.0	115.0	14.0	0.4	2.9	66.1	4.8	4.0	5.0	1.2	10.0	2.08	1.51	2.08	1.51	3.11	non-LIQ CLAY	1	0.70	NA	8.04	non-LIQ	non-LIQ	0.880	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
36.26	45.4	115.0	115.0	13.0	0.4	3.1	70.2	4.6	3.9	5.0	1.2	10.0	2.08	1.52	2.08	1.52	3.16	non-LIQ CLAY	1	0.70	NA	8.75	non-LIQ	non-LIQ	0.879	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
36.42	45.3	115.0	115.0	14.6	0.4	2.7	64.2	4.9	4.1	5.0	1.2	10.0	2.09	1.52	2.09	1.52	3.08	non-LIQ CLAY	1	0.70	NA	7.71	non-LIQ	non-LIQ	0.878	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
36.58	45.1	115.0	115.0	16.3	0.4	2.5	59.0	5.2	4.4	5.0	1.2	10.0	2.10	1.52	2.10	1.52	3.01	non-LIQ CLAY	1	0.69	NA	6.62	non-LIQ	non-LIQ	0.876	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
36.75	45.0	115.0	115.0	15.8	0.5	3.2	64.4	5.3	4.4	5.0	1.2	10.0	2.11	1.53	2.11	1.53	3.09	non-LIQ CLAY	1	0.69	NA	7.74	non-LIQ	non-LIQ	0.875	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
36.91	44.8	115.0	115.0	16.8	0.5	3.0	61.5	5.5	4.6	5.0	1.2	11.0	2.12	1.53	2.12	1.53	3.04	non-LIQ CLAY	1	0.69	NA	7.24	non-LIQ	non-LIQ	0.874	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
37.08	44.6	115.0	115.0	16.6	0.4	2.4	57.6	5.3	4.4	5.0	1.2	10.0	2.13	1.54	2.13	1.54	2.99	non-LIQ CLAY	1	0.69	NA	6.64	non-LIQ	non-LIQ	0.872	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
37.24	44.5	115.0	115.0	15.4	0.9	5.8	77.9	5.9	4.9	5.0	1.2	11.0	2.14	1.54	2.14	1.54	3.26	non-LIQ CLAY	1	0.69	NA	10.13	non-LIQ	non-LIQ	0.871	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
37.40	44.3	115.0	115.0	16.0	0.7	4.4	70.6	5.7	4.7	5.0	1.2	11.0	2.15	1.55	2.15	1.55	3.17	non-LIQ CLAY	1	0.68	NA	8.82	non-LIQ	non-LIQ	0.870	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00

Liquefaction Analysis with Cone Penetration Test (CPT) Data

Depth (ft)	Elev. (ft, MSL)	Unit Weight (pcf) γ'_{MOIST}	Unit Weight (pcf) γ'_{SAT}	q_c (tsf)	f_s (tsf)	Frict. Ratio (%)	% Fines	Equiv. N_{60}	Equiv. $(N_1)_{60}$	α	β	Equiv. $(N_1)_{60CS}$	Stresses at Exploration Water Level σ_v (tsf)	Stresses at Exploration Water Level σ_v' (tsf)	Stresses at Design Water Level σ_v (tsf)	Stresses at Design Water Level σ_v' (tsf)	I_c	Soil Type Character (SAND, SILT or non-LIQ CLAY)	Normalization of Tip Resistance n	C_Q	q_{c1N}	Fines Correction Kc	$(q_{c1n})_{cs}$	$CRR_{7.5}$	r_d	CSR_M	$CSR_{7.5}$	FS	a	b	Max Shear Modulus G_{max} (tsf)	Cyclic Shear Strain γ (%)	Norm. Vol. Strain ε_{Nc} (%)	Dry Settle. ΔS (in)	Post-Liq. $(N_1)_{60CS}$	Post-Liq. Vol. Strain ε (%)	Layer Post-Liq. Settle. ΔS (in)
37.57	44.1	115.0	115.0	16.9	0.7	4.1	67.8	5.9	4.9	5.0	1.2	11.0	2.16	1.55	2.16	1.55	3.13	non-LIQ CLAY	1	0.68	NA	8.33	non-LIQ	non-LIQ	0.868	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
37.73	44.0	115.0	115.0	16.1	0.4	2.5	60.2	5.2	4.3	5.0	1.2	10.0	2.17	1.55	2.17	1.55	3.03	non-LIQ CLAY	1	0.68	NA	7.03	non-LIQ	non-LIQ	0.867	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
37.90	43.8	115.0	115.0	14.8	0.4	2.7	64.5	5.0	4.1	5.0	1.2	10.0	2.18	1.56	2.18	1.56	3.09	non-LIQ CLAY	1	0.68	NA	7.75	non-LIQ	non-LIQ	0.866	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
38.06	43.6	115.0	115.0	15.2	0.4	2.6	63.2	5.1	4.2	5.0	1.2	10.0	2.19	1.56	2.19	1.56	3.07	non-LIQ CLAY	1	0.68	NA	7.54	non-LIQ	non-LIQ	0.864	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
38.22	43.5	115.0	115.0	15.4	0.4	2.6	62.7	5.1	4.2	5.0	1.2	10.0	2.20	1.57	2.20	1.57	3.06	non-LIQ CLAY	1	0.68	NA	7.45	non-LIQ	non-LIQ	0.863	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
38.39	43.3	115.0	115.0	15.5	0.4	2.6	62.5	5.1	4.2	5.0	1.2	10.0	2.21	1.57	2.21	1.57	3.06	non-LIQ CLAY	1	0.67	NA	7.41	non-LIQ	non-LIQ	0.862	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
38.55	43.2	115.0	115.0	14.9	0.4	2.7	64.5	5.0	4.1	5.0	1.2	10.0	2.22	1.58	2.22	1.58	3.09	non-LIQ CLAY	1	0.67	NA	7.76	non-LIQ	non-LIQ	0.860	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
38.72	43.0	115.0	115.0	15.1	0.5	3.3	68.0	5.3	4.3	5.0	1.2	10.0	2.23	1.58	2.23	1.58	3.13	non-LIQ CLAY	1	0.67	NA	8.36	non-LIQ	non-LIQ	0.859	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
38.88	42.8	115.0	115.0	17.1	0.6	3.5	65.0	5.8	4.7	5.0	1.2	11.0	2.24	1.58	2.24	1.58	3.09	non-LIQ CLAY	1	0.67	NA	7.85	non-LIQ	non-LIQ	0.858	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
39.04	42.7	115.0	115.0	29.6	0.6	2.0	41.8	8.1	6.6	5.0	1.2	13.0	2.24	1.59	2.24	1.59	2.73	non-LIQ CLAY	1	0.67	NA	4.18	non-LIQ	non-LIQ	0.856	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
39.21	42.5	115.0	115.0	30.9	0.9	2.9	46.2	8.8	7.2	5.0	1.2	14.0	2.25	1.59	2.25	1.59	2.80	non-LIQ CLAY	1	0.66	NA	4.81	non-LIQ	non-LIQ	0.855	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
39.37	42.3	115.0	115.0	23.1	0.7	3.0	54.0	7.1	5.8	5.0	1.2	12.0	2.26	1.60	2.26	1.60	2.93	non-LIQ CLAY	1	0.66	NA	6.01	non-LIQ	non-LIQ	0.854	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
39.54	42.2	115.0	115.0	18.0	0.4	2.2	56.1	5.6	4.6	5.0	1.2	10.0	2.27	1.60	2.27	1.60	2.96	non-LIQ CLAY	1	0.66	NA	6.35	non-LIQ	non-LIQ	0.852	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
39.70	42.0	115.0	115.0	13.3	0.3	2.3	66.2	4.6	3.7	5.0	1.2	9.0	2.28	1.61	2.28	1.61	3.11	non-LIQ CLAY	1	0.66	NA	8.06	non-LIQ	non-LIQ	0.851	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
39.86	41.8	115.0	115.0	12.7	0.4	3.1	74.1	4.7	3.8	5.0	1.2	10.0	2.29	1.61	2.29	1.61	3.21	non-LIQ CLAY	1	0.66	NA	9.45	non-LIQ	non-LIQ	0.850	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
40.03	41.7	115.0	115.0	12.3	0.4	3.3	76.1	4.6	3.7	5.0	1.2	9.0	2.30	1.61	2.30	1.61	3.24	non-LIQ CLAY	1	0.66	NA	9.81	non-LIQ	non-LIQ	0.848	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
40.19	41.5	115.0	115.0	14.7	0.3	2.0	61.4	4.8	3.9	5.0	1.2	10.0	2.31	1.62	2.31	1.62	3.04	non-LIQ CLAY	1	0.65	NA	7.24	non-LIQ	non-LIQ	0.847	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
40.36	41.3	115.0	115.0	12.6	0.4	3.2	74.9	4.7	3.8	5.0	1.2	10.0	2.32	1.62	2.32	1.62	3.22	non-LIQ CLAY	1	0.65	NA	9.59	non-LIQ	non-LIQ	0.846	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
40.52	41.2	115.0	115.0	15.2	0.6	3.9	72.3	5.5	4.4	5.0	1.2	10.0	2.33	1.63	2.33	1.63	3.19	non-LIQ CLAY	1	0.65	NA	9.12	non-LIQ	non-LIQ	0.844	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
40.68	41.0	115.0	115.0	22.3	0.6	2.7	53.6	6.8	5.5	5.0	1.2	12.0	2.34	1.63	2.34	1.63	2.93	non-LIQ CLAY	1	0.65	NA	5.95	non-LIQ	non-LIQ	0.843	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
40.85	40.9	115.0	115.0	20.6	0.7	3.4	59.9	6.7	5.4	5.0	1.2	11.0	2.35	1.64	2.35	1.64	3.02	non-LIQ CLAY	1	0.65	NA	6.97	non-LIQ	non-LIQ	0.842	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
41.01	40.7	115.0	115.0	18.9	0.6	3.2	61.3	6.2	5.0	5.0	1.2	11.0	2.36	1.64	2.36	1.64	3.04	non-LIQ CLAY	1	0.65	NA	7.22	non-LIQ	non-LIQ	0.840	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
41.18	40.5	115.0	115.0	15.0	0.4	2.7	65.8	5.1	4.1	5.0	1.2	10.0	2.37	1.64	2.37	1.64	3.10	non-LIQ CLAY	1	0.64	NA	7.99	non-LIQ	non-LIQ	0.839	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
41.34	40.4	115.0	115.0	14.4	0.3	2.1	63.2	4.8	3.9	5.0	1.2	10.0	2.38	1.65	2.38	1.65	3.07	non-LIQ CLAY	1	0.64	NA	7.53	non-LIQ	non-LIQ	0.838	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
41.50	40.2	115.0	115.0	14.1	0.3	2.1	64.4	4.8	3.8	5.0	1.2	10.0	2.39	1.65	2.39	1.65	3.08	non-LIQ CLAY	1	0.64	NA	7.73	non-LIQ	non-LIQ	0.836	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
41.67	40.0	115.0	115.0	12.6	0.3	2.4	70.5	4.5	3.6	5.0	1.2	9.0	2.40	1.66	2.40	1.66	3.17	non-LIQ CLAY	1	0.64	NA	8.81	non-LIQ	non-LIQ	0.835	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
41.83	39.9	115.0	115.0	11.9	0.2	1.7	67.0	4.1	3.3	5.0	1.2	9.0	2.41	1.66	2.41	1.66	3.12	non-LIQ CLAY	1	0.64	NA	8.20	non-LIQ	non-LIQ	0.834	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
42.00	39.7	115.0	115.0	12.3	0.4	3.3	77.6	4.7	3.7	5.0	1.2	9.0	2.42	1.67	2.42	1.67	3.26	non-LIQ CLAY	1	0.64	NA	10.07	non-LIQ	non-LIQ	0.832	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
42.16	39.5	115.0	115.0	15.6	0.5	3.2	68.4	5.5	4.3	5.0	1.2	10.0	2.42	1.67	2.42	1.67	3.14	non-LIQ CLAY	1	0.63	NA	8.43	non-LIQ	non-LIQ	0.831	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
42.32	39.4	115.0	115.0	21.5	0.6	2.8	56.0	6.7	5.3	5.0	1.2	11.0	2.43	1.67	2.43	1.67	2.96	non-LIQ CLAY	1	0.63	NA	6.34	non-LIQ	non-LIQ	0.830	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
42.49	39.2	115.0	115.0	22.1	0.7	3.2	57.4	7.0	5.6	5.0	1.2	12.0	2.44	1.68	2.44	1.68	2.98	non-LIQ CLAY	1	0.63	NA	6.57	non-LIQ	non-LIQ	0.828	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
42.65	39.1	115.0	115.0	21.9	0.7	3.2	57.9	7.0	5.5	5.0	1.2	12.0	2.45	1.68	2.45	1.68	2.99	non-LIQ CLAY	1	0.63	NA	6.65	non-LIQ	non-LIQ	0.827	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
42.82	38.9	115.0	115.0	19.0	0.5	2.6	58.9	6.1	4.8	5.0	1.2	11.0	2.46	1.69	2.46	1.69	3.01	non-LIQ CLAY	1	0.63	NA	6.81	non-LIQ	non-LIQ	0.826	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
42.98	38.7	115.0	115.0	18.7	0.5	2.7	59.7	6.0	4.8	5.0	1.2	11.0	2.47	1.69	2.47	1.69	3.02	non-LIQ CLAY	1	0.63	NA	6.95	non-LIQ	non-LIQ	0.824	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
43.15	38.6	115.0	115.0	15.2	0.4	2.6	66.4	5.2	4.1	5.0	1.2	10.0	2.48	1.70	2.48	1.70	3.11	non-LIQ CLAY	1	0.62	NA	8.08	non-LIQ	non-LIQ	0.823	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
43.31	38.4	115.0	115.0	15.3	0.5	3.3	70.2	5.4	4.3	5.0	1.2	10.0	2.49	1.70	2.49	1.70	3.16	non-LIQ CLAY	1	0.62	NA	8.74	non-LIQ	non-LIQ	0.822	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
43.47	38.2	115.0	115.0	17.7	0.7	4.0	68.9	6.2	4.9	5.0	1.2	11.0	2.50	1.70	2.50	1.70	3.15	non-LIQ CLAY	1	0.62	NA	8.51	non-LIQ	non-LIQ	0.820	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
43.64	38.1	115.0	115.0	22.2	0.9	4.1	62.3	7.4	5.8	5.0	1.2	12.0	2.51	1.71	2.51	1.71	3.06	non-LIQ CLAY	1	0.62	NA	7.38	non-LIQ	non-LIQ	0.819	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
43.80	37.9	115.0	115.0	24.5	0.9	3.7	57.8	7.8	6.1	5.0	1.2	12.0	2.52	1.71	2.52	1.71	2.99	non-LIQ CLAY	1	0.62	NA	6.62	non-LIQ	non-LIQ	0.818	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
43.97	37.7	115.0	115.0	21.7	0.9	4.1	63.6	7.3	5.7	5.0	1.2	12.0	2.53	1.72	2.53	1.72	3.07	non-LIQ CLAY	1	0.62	NA	7.60	non-LIQ	non-LIQ	0.816	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
44.13	37.6	115.0	115.0	22.5	1.0	4.4	63.9	7.6	5.9	5.0	1.2	12.0	2.54	1.72	2.54	1.72	3.08	non-LIQ CLAY	1	0.61	NA	7.65	non-LIQ	non-LIQ	0.815	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
44.29	37.4	115.0	115.0	22.2	1.0	4.5	64.6	7.5	5.9	5.0	1.2	12.0	2.55	1.73	2.55	1.73	3.09	non-LIQ CLAY	1	0.61	NA	7.78	non-LIQ	non-LIQ	0.814	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
44.46	37.2	115.0	115.0	22.9	0.8	3.5	59.1	7.4	5.8	5.0	1.2	12.0	2.56	1.73	2.56	1.73	3.01	non-LIQ CLAY	1	0.61	NA	6.84	non-LIQ	non-LIQ	0.812	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
44.62	37.1	115.0	115.0	20.4	0.8	3.9	64.7	6.9	5.4	5.0	1.2	11.0	2.57	1.74	2.57	1.74	3.09	non-LIQ CLAY	1	0.61	NA	7.80	non-LIQ	non-LIQ	0.811	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
44.79	36.9	115.0	115.0	20.5	1.1	5.4	70.9	7.3	5.7	5.0	1.2	12.0	2.58	1.74	2.58	1.74	3.17	non-LIQ CLAY	1	0.61	NA	8.88	non-LIQ	non-LIQ	0.809	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
44.95	36.8	115.0	115.0	20.9	1.2	5.7	71.8	7.6	5.9	5.0	1.2	12.0	2.58	1.74	2.58	1.74	3.18	non-LIQ CLAY	1	0.61	NA	9.04	non-LIQ	non-LIQ	0.808	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
45.11	36.6	115.0	115.0	29.3	1.1	3.8	54.0	9.0	7.0	5.0	1.2	13.0	2.59	1.75	2.59	1.75	2.93	non-LIQ CLAY	1	0.61	NA	6.01	non-LIQ	non-LIQ	0.807	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
45.28	36.4	115.0	115.0	25.9	1.0	3.9	57.8	8.2	6.4	5.0	1.2	13.0	2.60	1.75	2.60	1.75	2.99	non-LIQ CLAY	1	0.60	NA	6.63	non-LIQ	non-LIQ	0.806	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
45.44	36.3	115.0	115.0	24.0	0.8	3.3	57.4	7.6	5.9	5.0	1.2	12.0	2.61	1.76	2.61	1.76	2.98	non-LIQ CLAY	1	0.60	NA	6.56	non-LIQ	non-LIQ	0.804	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
45.61	36.1	115.0	115.0	22.4	0.8	3.6	60.7	7.3	5.7	5.0	1.2	12.0	2.62	1.76	2.62	1.76	3.03	non-LIQ CLAY	1	0.60	NA	7.11	non-LIQ	non-LIQ	0.803	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
45.77	35.9	115.0	115.0	22.8	0.8	3.5	59.9	7.4	5.7	5.0	1.2	12.0	2.63	1.77	2.63	1.77	3.02	non-LIQ CLAY	1	0.60	NA	6.98	non-LIQ	non-LIQ	0.802	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
45.93	35.8	115.0	115.0	24.6	0.9	3.7	58.5	7.9	6.1	5.0	1.2	12.0	2.64	1.77	2.64	1.77	3.00	non-LIQ CLAY	1	0.60	NA	6.75	non-LIQ	non-LIQ	0.800	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
46.10	35.6	115.0	115.0	26.6	1.0	3.8	56.9	8.4	6.5	5.0	1.2	13.0	2.65	1.77	2.65	1.77	2.98	non-LIQ CLAY	1	0.60	NA	6.49	non-LIQ	non-LIQ	0.799	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
46.26	35.4	115.0	115.0	27.1	1.0	3.7	56.2	8.5	6.5	5.0	1.2	13.0	2.66	1.78	2.66	1.78	2.97	non-LIQ CLAY	1	0.60	NA	6.37	non-LIQ	non-LIQ	0.798	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
46.43	35.3	115.0	115.0	27.8	1.0	3.6	55.1	8.6	6.6	5.0	1.2	13.0	2.67	1.78	2.67	1.78	2.95	non-LIQ CLAY	1	0.59	NA	6.20	non-LIQ	non-LIQ	0.796	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
46.59	35.1	115.0	115.0	28.4	1.0	3.5	54.3	8.7	6.7	5.0	1.2	13.0	2.68	1.79	2.68	1.79	2.94	non-LIQ CLAY	1	0.59	NA	6.06	non-LIQ	non-LIQ	0.795	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
46.75	35.0	115.0	115.0	28.6	0.8	2.8	50.4	8.5	6.5	5.0	1.2	13.0	2.69	1.79	2.69	1.79	2.87	non-LIQ CLAY	1	0.59	NA	5.44	non-LIQ	non-LIQ	0.794	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
46.92	34.8	115.0	115.0	26.1	0.7	2.7	52.1	7.9	6.0	5.0	1.2	12.0	2.70	1.80	2.70	1.80	2.90	non-LIQ CLAY	1	0.59	NA	5.72	non-LIQ	non-LIQ	0.792	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
47.08	34.6	115.0	115.0	21.4	0.5	2.3	55.5	6.7	5.1	5.0	1.2	11.0	2.71	1.80	2.71	1.80	2.96	non-LIQ CLAY	1	0.59	NA	6.26	non-LIQ	non-LIQ	0.791	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
47.25	34.5	115.0	115.0	18.1	0.6	3.3	66.9	6.3	4.8	5.0	1.2	11.0	2.72	1.80	2.72	1.80	3.12	non-LIQ CLAY	1	0.59	NA	8.17	non-LIQ	non-LIQ	0.789	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
47.41	34.3	115.0	115.0	21.5	0.8	3.7	63.5	7.2	5.5	5.0	1.2	12.0	2.73	1.81	2.73	1.81	3.07	non-LIQ CLAY	1	0.59	NA	7.59	non-LIQ	non-LIQ	0.788	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
47.57	34.1	115.0	115.0	30.1	1.0	3.3	52.2	9.1	6.9	5.0	1.2	13.0	2.74	1.81	2.74	1.81	2.90	non-LIQ CLAY	1	0.58	NA	5.73	non-LIQ	non-LIQ	0.787	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
47.74	34.0	115.0	115.0	30.7	1.3	4.2	56.0	9.6	7.3	5.0	1.2	14.0	2.75	1.82	2.75	1.82	2.96	non-LIQ CLAY	1	0.58	NA	6.33	non-LIQ	non-LIQ	0.785	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
47.90	33.8	115.0	115.0	31.7	1.9	6.0	61.9	10.5	8.0	5.0	1.2	15.0	2.75	1.82	2.75	1.82	3.05	non-LIQ CLAY	1	0.58	NA	7.31	non-LIQ	non-LIQ	0.784	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
48.07	33.6	115.0	115.0	80.2	2.7	3.4	29.2	19.2	14.6	4.6	1.1	21.0	2.76	1.83	2.76	1.83	2.47	SAND	0.5	0.76	58	2.60	150	0.394	0.783	0.310	0.310	1.27	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
48.23	33.5	115.0	115.0	96.5	3.3	3.4	26.9	22.6	17.1	4.5	1.1	24.0	2.77	1.83	2.77	1.83	2.41	SAND	0.5	0.76	69	2.36	164	non-LIQ	0.781	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
48.39	33.3	115.0	115.0	54.4	2.0	3.7	41.1	14.7	11.2	5.0	1.2	18.0	2.78	1.83	2.78	1.83	2.71	non-LIQ CLAY	1	0.58	NA	4.08	non-LIQ	non-LIQ	0.780	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
48.56	33.1	115.0	115.0	28.6	1.4	4.9	60.9	9.4	7.1	5.0	1.2	14.0	2.79	1.84	2.79	1.84	3.04	non-LIQ CLAY	1	0.58	NA	7.15	non-LIQ	non-LIQ	0.779	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
48.72	33.0	115.0	115.0	28.3	1.6	5.7	64.1	9.5	7.2	5.0	1.2	14.0	2.80	1.84	2.80	1.84	3.08	non-LIQ CLAY	1	0.57	NA	7.70	non-LIQ	non-LIQ	0.778	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
48.89	32.8	115.0	115.0	58.9	2.1	3.6	39.2	15.7	11.9	5.0	1.2	19.0	2.81	1.85	2.81	1.85	2.68	non-LIQ CLAY	1	0.57	NA	3.83	non-LIQ	non-LIQ	0.776	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
49.05	32.7	115.0	115.0	123.4	2.4	1.9	17.7	25.9	19.5	3.2	1.1	24.0	2.82	1.85	2.82	1.85	2.16	SAND	0.5	0.76	88	1.57	139	0.328	0.775	0.310	0.310	1.06	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
49.22	32.5	115.0	115.0	133.7	3.2	2.4	19.0	28.5	21.5	3.4	1.1	26.0	2.83	1.86	2.83	1.86	2.20	SAND	0.5	0.76	95	1.66	159	0.452	0.773	0.310	0.310	1.46	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
49.38	32.3	115.0	115.0	108.5	3.2	2.9	23.7	24.5	18.4	4.1	1.1	25.0	2.84	1.86	2.84	1.86	2.33	SAND	0.5	0.75	77	2.05	159	0.451	0.772	0.310	0.310	1.46	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
49.54	32.2	115.0	115.0	95.9	3.0	3.1	26.0	22.2	16.7	4.4	1.1	23.0	2.85	1.86	2.85	1.86	2.39	SAND	0.5	0.75	68	2.27	155	0.425	0.771	0.310	0.310	1.37	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
49.71	32.0	115.0	115.0	83.6	2.9	3.5	29.2	20.0	15.1	4.6	1.1	22.0	2.86	1.87	2.86	1.87	2.47	SAND	0.5	0.75	59	2.60	155	0.424	0.769	0.310	0.310	1.37	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
49.87	31.8	115.0	115.0	56.8	2.4	4.2	42.9	15.7	11.8	5.0	1.2	19.0	2.87	1.87	2.87	1.87	2.74	non-LIQ CLAY	1	0.56	NA	4.33	non-LIQ	non-LIQ	0.768	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
50.04	31.7	115.0	115.0	42.1	2.7	6.4	56.9	13.3	10.0	5.0	1.2	17.0	2.88	1.88	2.88	1.88	2.98	non-LIQ CLAY	1	0.56	NA	6.46	non-LIQ	non-LIQ	0.767	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
50.20	31.5	115.0	115.0	59.3	2.3	3.9	40.8	16.0	12.0	5.0	1.2	19.0	2.89	1.88	2.89	1.88	2.71	non-LIQ CLAY	1	0.56	NA	4.04	non-LIQ	non-LIQ	0.765	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
50.36	31.3	115.0	115.0	39.9	1.4	3.5	47.4	11.5	8.6	5.0	1.2	15.0	2.90	1.89	2.90	1.89	2.82	non-LIQ CLAY	1	0.56	NA	4.99	non-LIQ	non-LIQ	0.764	0.310	0.310	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
50.53	31.2	115.0	115.0	25.7	0.6	2.3	51.9	7.7	5.8	5.0	1.2	12.0	2.91	1.89	2.91	1.89	2.90	non-LIQ CLAY	1	0.56	NA	5.68	non-LIQ	non-LIQ	0.763	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
50.69	31.0	115.0	115.0	22.9	1.1	4.8	68.1	8.0	6.0	5.0	1.2	12.0	2.91	1.89	2.91	1.89	3.14	non-LIQ CLAY	1	0.56	NA	8.38	non-LIQ	non-LIQ	0.761	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
50.86	30.8	115.0	115.0	71.6	1.9	2.7	28.0	16.9	12.6	4.6	1.1	19.0	2.92	1.90	2.92	1.90	2.44	SAND	0.5	0.75	51	2.48	125	0.262	0.760	0.300	0.300	0.87	NA	NA	NA	NA	NA	0.00	15.00	1.91	0.04
51.02	30.7	115.0	115.0	87.8	2.7	3.1	27.0	20.6	15.3	4.5	1.1	22.0	2.93	1.90	2.93	1.90	2.42	SAND	0.5	0.75	62	2.38	147	0.376	0.759	0.300	0.300	1.25	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
51.18	30.5	115.0	115.0	92.4	3.1	3.4	27.5	21.7	16.2	4.5	1.1	23.0	2.94	1.91	2.94	1.91	2.43	SAND	0.5	0.74	65	2.42	158	0.445	0.757	0.300	0.300	1.48	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
51.35	30.4	115.0	115.0	84.8	3.2	3.8	30.3	20.6	15.3	4.7	1.2	22.0	2.95	1.91	2.95	1.91	2.49	SAND	0.5	0.74	60	2.73	163	non-LIQ	0.756	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
51.51	30.2	115.0	115.0	74.0	3.0	4.1	37.8	19.4	14.4	5.0	1.2	22.0	2.96	1.92	2.96	1.92	2.65	non-LIQ CLAY	1	0.55	NA	3.64	non-LIQ	non-LIQ	0.755	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
51.68	30.0	115.0	115.0	59.7	2.7	4.5	43.5	16.6	12.3	5.0	1.2	20.0	2.97	1.92	2.97	1.92	2.76	non-LIQ CLAY	1	0.55	NA	4.43	non-LIQ	non-LIQ	0.753	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
51.84	29.9	115.0	115.0	35.6	2.0	5.6	59.1	11.4	8.5	5.0	1.2	15.0	2.98	1.92	2.98	1.92	3.01	non-LIQ CLAY	1	0.55	NA	6.84	non-LIQ	non-LIQ	0.752	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
52.00	29.7	115.0	115.0	35.8	1.5	4.2	53.5	10.9	8.1	5.0	1.2	15.0	2.99	1.93	2.99	1.93	2.92	non-LIQ CLAY	1	0.55	NA	5.94	non-LIQ	non-LIQ	0.751	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00

Liquefaction Analysis with Cone Penetration Test (CPT) Data

Depth (ft)	Elev. (ft, MSL)	Unit Weight (pcf) γ'_{MOIST}	Unit Weight (pcf) γ'_{SAT}	q_c (tsf)	f_s (tsf)	Frict. Ratio (%)	% Fines	Equiv. N_{60}	Equiv. $(N_1)_{60}$	α	β	Equiv. $(N_1)_{60cs}$	Stresses at Exploration Water Level σ_v (tsf)	Stresses at Exploration Water Level σ'_v (tsf)	Stresses at Design Water Level σ_v (tsf)	Stresses at Design Water Level σ'_v (tsf)	I_c	Soil Type Character (SAND, SILT or non-LIQ CLAY)	Normalization of Tip Resistance n	C_Q	q_{c1N}	Fines Correction Kc	$(q_{c1N})_{cs}$	$CRR_{7.5}$	r_d	CSR_M	$CSR_{7.5}$	FS	a	b	Max Shear Modulus G_{max} (tsf)	Cyclic Shear Strain γ (%)	Norm. Vol. Strain ε_{Nc} (%)	Dry Settle. ΔS (in)	Post-Liq. $(N_1)_{60cs}$	Post-Liq. Vol. Strain ε (%)	Layer Post-Liq. Settle. ΔS (in)
52.17	29.5	115.0	115.0	37.8	1.9	5.0	55.5	11.8	6.7	5.0	1.2	15.0	3.00	1.93	3.00	1.93	2.96	non-LIQ CLAY	1	0.55	NA	6.26	non-LIQ	non-LIQ	0.749	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
52.33	29.4	115.0	115.0	58.6	2.0	3.4	39.6	15.6	11.6	5.0	1.2	19.0	3.01	1.94	3.01	1.94	2.68	non-LIQ CLAY	1	0.55	NA	3.88	non-LIQ	non-LIQ	0.748	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
52.50	29.2	115.0	115.0	58.8	2.2	3.7	41.0	15.9	11.7	5.0	1.2	19.0	3.02	1.94	3.02	1.94	2.71	non-LIQ CLAY	1	0.54	NA	4.07	non-LIQ	non-LIQ	0.747	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
52.66	29.0	115.0	115.0	69.0	1.8	2.6	26.6	16.4	12.1	4.6	1.1	18.0	3.03	1.95	3.03	1.95	2.45	SAND	0.5	0.74	48	2.53	122	0.248	0.745	0.300	0.300	0.83	NA	NA	NA	NA	NA	0.00	14.00	2.00	0.04
52.82	28.9	115.0	115.0	47.4	1.9	4.0	46.6	13.5	10.0	5.0	1.2	17.0	3.04	1.95	3.04	1.95	2.81	non-LIQ CLAY	1	0.54	NA	4.87	non-LIQ	non-LIQ	0.744	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
52.99	28.7	115.0	115.0	52.3	2.5	4.8	47.5	15.1	11.1	5.0	1.2	18.0	3.05	1.96	3.05	1.96	2.83	non-LIQ CLAY	1	0.54	NA	5.01	non-LIQ	non-LIQ	0.743	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
53.15	28.6	115.0	115.0	39.5	2.6	6.6	60.1	12.8	9.4	5.0	1.2	16.0	3.06	1.96	3.06	1.96	3.02	non-LIQ CLAY	1	0.54	NA	7.01	non-LIQ	non-LIQ	0.741	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
53.32	28.4	115.0	115.0	58.8	1.9	3.2	39.0	15.6	11.4	5.0	1.2	19.0	3.07	1.96	3.07	1.96	2.67	non-LIQ CLAY	1	0.54	NA	3.80	non-LIQ	non-LIQ	0.740	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
53.48	28.2	115.0	115.0	61.5	2.0	3.3	38.3	16.2	11.9	5.0	1.2	19.0	3.08	1.97	3.08	1.97	2.66	non-LIQ CLAY	1	0.54	NA	3.70	non-LIQ	non-LIQ	0.739	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
53.64	28.1	115.0	115.0	36.9	1.5	4.1	52.8	11.2	8.2	5.0	1.2	15.0	3.08	1.97	3.08	1.97	2.91	non-LIQ CLAY	1	0.54	NA	5.83	non-LIQ	non-LIQ	0.737	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
53.81	27.9	115.0	115.0	28.5	1.2	4.2	60.3	9.3	6.8	5.0	1.2	13.0	3.09	1.98	3.09	1.98	3.03	non-LIQ CLAY	1	0.54	NA	7.05	non-LIQ	non-LIQ	0.736	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
53.97	27.7	115.0	115.0	28.0	1.3	4.6	62.8	9.3	6.8	5.0	1.2	13.0	3.10	1.98	3.10	1.98	3.06	non-LIQ CLAY	1	0.53	NA	7.46	non-LIQ	non-LIQ	0.735	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
54.14	27.6	115.0	115.0	54.0	2.0	3.7	43.0	14.9	10.9	5.0	1.2	18.0	3.11	1.99	3.11	1.99	2.75	non-LIQ CLAY	1	0.53	NA	4.34	non-LIQ	non-LIQ	0.733	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
54.30	27.4	115.0	115.0	54.7	2.1	3.8	43.3	15.1	11.0	5.0	1.2	18.0	3.12	1.99	3.12	1.99	2.75	non-LIQ CLAY	1	0.53	NA	4.39	non-LIQ	non-LIQ	0.732	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
54.46	27.2	115.0	115.0	41.4	1.9	4.6	52.5	12.5	9.1	5.0	1.2	16.0	3.13	1.99	3.13	1.99	2.91	non-LIQ CLAY	1	0.53	NA	5.77	non-LIQ	non-LIQ	0.731	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
54.63	27.1	115.0	115.0	40.0	1.4	3.5	48.7	11.7	8.5	5.0	1.2	15.0	3.14	2.00	3.14	2.00	2.85	non-LIQ CLAY	1	0.53	NA	5.18	non-LIQ	non-LIQ	0.729	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
54.79	26.9	115.0	115.0	34.3	1.8	5.2	59.8	11.1	8.1	5.0	1.2	15.0	3.15	2.00	3.15	2.00	3.02	non-LIQ CLAY	1	0.53	NA	6.96	non-LIQ	non-LIQ	0.728	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
54.96	26.7	115.0	115.0	61.2	1.9	3.1	38.1	16.1	11.7	5.0	1.2	19.0	3.16	2.01	3.16	2.01	2.65	non-LIQ CLAY	1	0.53	NA	3.68	non-LIQ	non-LIQ	0.727	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
55.12	26.6	115.0	115.0	56.3	1.7	3.0	39.3	15.0	10.9	5.0	1.2	18.0	3.17	2.01	3.17	2.01	2.68	non-LIQ CLAY	1	0.53	NA	3.84	non-LIQ	non-LIQ	0.725	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
55.28	26.4	115.0	115.0	32.5	1.5	4.6	59.0	10.4	7.6	5.0	1.2	14.0	3.18	2.02	3.18	2.02	3.01	non-LIQ CLAY	1	0.52	NA	6.83	non-LIQ	non-LIQ	0.724	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
55.45	26.3	115.0	115.0	26.5	1.1	4.2	62.9	8.8	6.4	5.0	1.2	13.0	3.19	2.02	3.19	2.02	3.06	non-LIQ CLAY	1	0.52	NA	7.48	non-LIQ	non-LIQ	0.723	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
55.61	26.1	115.0	115.0	31.2	1.0	3.2	53.7	9.5	6.9	5.0	1.2	13.0	3.20	2.02	3.20	2.02	2.93	non-LIQ CLAY	1	0.52	NA	5.97	non-LIQ	non-LIQ	0.721	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
55.78	25.9	115.0	115.0	36.1	0.9	2.5	46.1	10.3	7.4	5.0	1.2	14.0	3.21	2.03	3.21	2.03	2.80	non-LIQ CLAY	1	0.52	NA	4.81	non-LIQ	non-LIQ	0.720	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
55.94	25.8	115.0	115.0	31.4	1.0	3.2	53.5	9.6	6.9	5.0	1.2	13.0	3.22	2.03	3.22	2.03	2.92	non-LIQ CLAY	1	0.52	NA	5.94	non-LIQ	non-LIQ	0.719	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
56.11	25.6	115.0	115.0	59.0	1.5	2.5	36.2	15.2	11.0	5.0	1.2	18.0	3.23	2.04	3.23	2.04	2.62	non-LIQ CLAY	1	0.52	NA	3.44	non-LIQ	non-LIQ	0.717	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
56.27	25.4	115.0	115.0	47.3	1.5	3.2	43.9	13.2	9.5	5.0	1.2	16.0	3.24	2.04	3.24	2.04	2.76	non-LIQ CLAY	1	0.52	NA	4.47	non-LIQ	non-LIQ	0.716	0.300	0.300	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
56.43	25.3	115.0	115.0	31.9	1.1	3.4	54.7	9.8	7.1	5.0	1.2	13.0	3.24	2.05	3.24	2.05	2.94	non-LIQ CLAY	1	0.52	NA	6.12	non-LIQ	non-LIQ	0.715	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
56.60	25.1	115.0	115.0	27.9	0.8	2.9	55.3	8.7	6.2	5.0	1.2	12.0	3.25	2.05	3.25	2.05	2.95	non-LIQ CLAY	1	0.52	NA	6.22	non-LIQ	non-LIQ	0.713	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
56.76	24.9	115.0	115.0	27.1	1.1	4.1	62.3	9.0	6.4	5.0	1.2	13.0	3.26	2.05	3.26	2.05	3.06	non-LIQ CLAY	1	0.52	NA	7.38	non-LIQ	non-LIQ	0.712	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
56.93	24.8	115.0	115.0	38.4	1.3	3.4	49.8	11.3	8.1	5.0	1.2	15.0	3.27	2.06	3.27	2.06	2.86	non-LIQ CLAY	1	0.51	NA	5.36	non-LIQ	non-LIQ	0.711	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
57.09	24.6	115.0	115.0	46.5	1.6	3.4	45.7	13.2	9.4	5.0	1.2	16.0	3.28	2.06	3.28	2.06	2.80	non-LIQ CLAY	1	0.51	NA	4.75	non-LIQ	non-LIQ	0.709	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
57.25	24.5	115.0	115.0	33.1	1.3	3.9	56.2	10.4	7.4	5.0	1.2	14.0	3.29	2.07	3.29	2.07	2.97	non-LIQ CLAY	1	0.51	NA	6.38	non-LIQ	non-LIQ	0.708	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
57.42	24.3	115.0	115.0	30.3	0.9	3.0	53.9	9.3	6.6	5.0	1.2	13.0	3.30	2.07	3.30	2.07	2.93	non-LIQ CLAY	1	0.51	NA	6.00	non-LIQ	non-LIQ	0.707	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
57.58	24.1	115.0	115.0	25.8	0.9	3.5	61.3	8.5	6.0	5.0	1.2	12.0	3.31	2.08	3.31	2.08	3.04	non-LIQ CLAY	1	0.51	NA	7.22	non-LIQ	non-LIQ	0.705	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
57.75	24.0	115.0	115.0	25.2	0.8	3.2	60.4	8.2	5.8	5.0	1.2	12.0	3.32	2.08	3.32	2.08	3.03	non-LIQ CLAY	1	0.51	NA	7.07	non-LIQ	non-LIQ	0.704	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
57.91	23.8	115.0	115.0	25.9	0.9	3.5	61.3	8.5	6.1	5.0	1.2	12.0	3.33	2.08	3.33	2.08	3.04	non-LIQ CLAY	1	0.51	NA	7.21	non-LIQ	non-LIQ	0.703	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
58.07	23.6	115.0	115.0	25.3	0.9	3.6	62.5	8.4	6.0	5.0	1.2	12.0	3.34	2.09	3.34	2.09	3.06	non-LIQ CLAY	1	0.51	NA	7.41	non-LIQ	non-LIQ	0.701	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
58.24	23.5	115.0	115.0	25.9	0.9	3.5	61.4	8.5	6.0	5.0	1.2	12.0	3.35	2.09	3.35	2.09	3.04	non-LIQ CLAY	1	0.51	NA	7.23	non-LIQ	non-LIQ	0.700	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
58.40	23.3	115.0	115.0	27.8	0.9	3.2	58.1	8.9	6.3	5.0	1.2	13.0	3.36	2.10	3.36	2.10	2.99	non-LIQ CLAY	1	0.50	NA	6.68	non-LIQ	non-LIQ	0.699	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
58.57	23.1	115.0	115.0	28.8	0.9	3.1	56.6	9.0	6.4	5.0	1.2	13.0	3.37	2.10	3.37	2.10	2.97	non-LIQ CLAY	1	0.50	NA	6.43	non-LIQ	non-LIQ	0.697	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
58.73	23.0	115.0	115.0	28.5	0.9	3.2	57.1	9.0	6.4	5.0	1.2	13.0	3.38	2.11	3.38	2.11	2.98	non-LIQ CLAY	1	0.50	NA	6.52	non-LIQ	non-LIQ	0.696	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
58.89	22.8	115.0	115.0	28.7	0.9	3.1	56.8	9.0	6.4	5.0	1.2	13.0	3.39	2.11	3.39	2.11	2.98	non-LIQ CLAY	1	0.50	NA	6.47	non-LIQ	non-LIQ	0.695	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
59.06	22.6	115.0	115.0	37.7	1.2	3.2	50.0	11.1	7.9	5.0	1.2	14.0	3.40	2.11	3.40	2.11	2.87	non-LIQ CLAY	1	0.50	NA	5.38	non-LIQ	non-LIQ	0.693	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
59.22	22.5	115.0	115.0	40.6	1.4	3.4	49.3	12.0	8.5	5.0	1.2	15.0	3.41	2.12	3.41	2.12	2.86	non-LIQ CLAY	1	0.50	NA	5.28	non-LIQ	non-LIQ	0.692	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
59.39	22.3	115.0	115.0	35.9	1.1	3.1	50.7	10.7	7.5	5.0	1.2	14.0	3.41	2.12	3.41	2.12	2.88	non-LIQ CLAY	1	0.50	NA	5.49	non-LIQ	non-LIQ	0.691	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
59.55	22.2	115.0	115.0	32.5	0.9	2.8	51.6	9.7	6.9	5.0	1.2	13.0	3.42	2.13	3.42	2.13	2.89	non-LIQ CLAY	1	0.50	NA	5.64	non-LIQ	non-LIQ	0.689	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
59.71	22.0	115.0	115.0	28.8	0.9	3.1	57.0	9.1	6.4	5.0	1.2	13.0	3.43	2.13	3.43	2.13	2.98	non-LIQ CLAY	1	0.50	NA	6.50	non-LIQ	non-LIQ	0.688	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
59.88	21.8	115.0	115.0	28.9	1.1	3.8	60.4	9.4	6.6	5.0	1.2	13.0	3.44	2.14	3.44	2.14	3.03	non-LIQ CLAY	1	0.50	NA	7.07	non-LIQ	non-LIQ	0.687	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
60.04	21.7	115.0	115.0	30.1	1.2	4.0	60.2	9.8	6.9	5.0	1.2	13.0	3.45	2.14	3.45	2.14	3.02	non-LIQ CLAY	1	0.49	NA	7.03	non-LIQ	non-LIQ	0.685	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
60.21	21.5	115.0	115.0	34.9	1.3	3.7	54.9	10.8	7.6	5.0	1.2	14.0	3.46	2.15	3.46	2.15	2.95	non-LIQ CLAY	1	0.49	NA	6.17	non-LIQ	non-LIQ	0.684	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
60.37	21.3	115.0	115.0	34.0	1.2	3.5	54.8	10.5	7.4	5.0	1.2	14.0	3.47	2.15	3.47	2.15	2.94	non-LIQ CLAY	1	0.49	NA	6.14	non-LIQ	non-LIQ	0.683	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
60.53	21.2	115.0	115.0	33.6	1.2	3.6	55.3	10.4	7.3	5.0	1.2	14.0	3.48	2.15	3.48	2.15	2.95	non-LIQ CLAY	1	0.49	NA	6.23	non-LIQ	non-LIQ	0.681	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
60.70	21.0	115.0	115.0	32.3	1.1	3.4	55.6	10.1	7.0	5.0	1.2	13.0	3.49	2.16	3.49	2.16	2.96	non-LIQ CLAY	1	0.49	NA	6.28	non-LIQ	non-LIQ	0.680	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
60.86	20.6	115.0	115.0	33.1	1.1	3.3	54.6	10.2	7.1	5.0	1.2	14.0	3.50	2.16	3.50	2.16	2.94	non-LIQ CLAY	1	0.49	NA	6.11	non-LIQ	non-LIQ	0.679	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
61.03	20.7	115.0	115.0	30.7	1.0	3.3	56.4	9.6	6.7	5.0	1.2	13.0	3.51	2.17	3.51	2.17	2.97	non-LIQ CLAY	1	0.49	NA	6.40	non-LIQ	non-LIQ	0.677	0.290	0.290	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
61.19	20.5	115.0	115.0	29.6	1.0	3.4	58.1	9.4	6.6	5.0	1.2	13.0	3.52	2.17	3.52	2.17	2.99	non-LIQ CLAY	1	0.49	NA	6.68	non-LIQ	non-LIQ	0.676	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
61.35	20.4	115.0	115.0	30.0	1.0	3.3	57.6	9.5	6.6	5.0	1.2	13.0	3.53	2.18	3.53	2.18	2.99	non-LIQ CLAY	1	0.49	NA	6.59	non-LIQ	non-LIQ	0.675	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
61.52	20.2	115.0	115.0	31.1	1.1	3.5	57.6	9.9	6.9	5.0	1.2	13.0	3.54	2.18	3.54	2.18	2.99	non-LIQ CLAY	1	0.49	NA	6.60	non-LIQ	non-LIQ	0.673	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
61.68	20.0	115.0	115.0	31.2	1.1	3.5	57.5	9.9	6.9	5.0	1.2	13.0	3.55	2.18	3.55	2.18	2.99	non-LIQ CLAY	1	0.48	NA	6.59	non-LIQ	non-LIQ	0.672	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
61.85	19.9	115.0	115.0	32.0	1.0	3.1	54.8	9.9	6.9	5.0	1.2	13.0	3.56	2.19	3.56	2.19	2.94	non-LIQ CLAY	1	0.48	NA	6.15	non-LIQ	non-LIQ	0.671	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
62.01	19.7	115.0	115.0	31.5	0.8	2.5	51.9	9.5	6.6	5.0	1.2	13.0	3.57	2.19	3.57	2.19	2.90	non-LIQ CLAY	1	0.48	NA	5.69	non-LIQ	non-LIQ	0.669	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
62.17	19.5	115.0	115.0	27.3	0.7	2.6	56.2	8.5	5.9	5.0	1.2	12.0	3.57	2.20	3.57	2.20	2.97	non-LIQ CLAY	1	0.48	NA	6.37	non-LIQ	non-LIQ	0.668	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
62.34	19.4	115.0	115.0	24.8	0.6	2.4	58.2	7.9	5.5	5.0	1.2	12.0	3.58	2.20	3.58	2.20	3.00	non-LIQ CLAY	1	0.48	NA	6.70	non-LIQ	non-LIQ	0.667	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
62.50	19.2	115.0	115.0	24.9	0.7	2.8	60.6	8.1	5.6	5.0	1.2	12.0	3.59	2.21	3.59	2.21	3.03	non-LIQ CLAY	1	0.48	NA	7.10	non-LIQ	non-LIQ	0.665	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
62.67	19.0	115.0	115.0	26.2	0.7	2.7	58.3	8.4	5.8	5.0	1.2	12.0	3.60	2.21	3.60	2.21	3.00	non-LIQ CLAY	1	0.48	NA	6.71	non-LIQ	non-LIQ	0.664	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
62.83	18.9	115.0	115.0	27.0	0.8	3.0	59.2	8.7	6.0	5.0	1.2	12.0	3.61	2.21	3.61	2.21	3.01	non-LIQ CLAY	1	0.48	NA	6.86	non-LIQ	non-LIQ	0.663	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
63.00	18.7	115.0	115.0	27.5	0.8	2.9	58.4	8.8	6.1	5.0	1.2	12.0	3.62	2.22	3.62	2.22	3.00	non-LIQ CLAY	1	0.48	NA	6.72	non-LIQ	non-LIQ	0.661	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
63.16	18.5	115.0	115.0	28.3	0.8	2.8	57.1	8.9	6.2	5.0	1.2	12.0	3.63	2.22	3.63	2.22	2.98	non-LIQ CLAY	1	0.48	NA	6.52	non-LIQ	non-LIQ	0.660	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
63.32	18.4	115.0	115.0	29.5	0.8	2.7	55.3	9.2	6.3	5.0	1.2	13.0	3.64	2.23	3.64	2.23	2.95	non-LIQ CLAY	1	0.48	NA	6.22	non-LIQ	non-LIQ	0.659	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
63.49	18.2	115.0	115.0	29.6	1.1	3.7	60.7	9.7	6.6	5.0	1.2	13.0	3.65	2.23	3.65	2.23	3.03	non-LIQ CLAY	1	0.47	NA	7.11	non-LIQ	non-LIQ	0.657	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
63.65	18.1	115.0	115.0	31.7	1.3	4.1	60.5	10.3	7.1	5.0	1.2	14.0	3.66	2.24	3.66	2.24	3.03	non-LIQ CLAY	1	0.47	NA	7.09	non-LIQ	non-LIQ	0.656	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
63.82	17.9	115.0	115.0	47.9	2.1	4.4	51.1	14.3	9.8	5.0	1.2	17.0	3.67	2.24	3.67	2.24	2.89	non-LIQ CLAY	1	0.47	NA	5.56	non-LIQ	non-LIQ	0.655	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
63.98	17.7	115.0	115.0	57.4	3.0	5.2	50.2	17.0	11.7	5.0	1.2	19.0	3.68	2.24	3.68	2.24	2.87	non-LIQ CLAY	1	0.47	NA	5.42	non-LIQ	non-LIQ	0.653	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
64.14	17.6	115.0	115.0	73.5	3.5	4.8	43.5	20.4	14.0	5.0	1.2	22.0	3.69	2.25	3.69	2.25	2.76	non-LIQ CLAY	1	0.47	NA	4.43	non-LIQ	non-LIQ	0.652	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
64.31	17.4	115.0	115.0	74.5	3.5	4.7	43.1	20.6	14.1	5.0	1.2	22.0	3.70	2.25	3.70	2.25	2.75	non-LIQ CLAY	1	0.47	NA	4.36	non-LIQ	non-LIQ	0.651	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
64.47	17.2	115.0	115.0	65.8	2.6	4.0	42.7	18.1	12.4	5.0	1.2	20.0	3.71	2.26	3.71	2.26	2.74	non-LIQ CLAY	1	0.47	NA	4.31	non-LIQ	non-LIQ	0.649	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
64.64	17.1	115.0	115.0	44.6	1.8	4.0	51.4	13.4	9.2	5.0	1.2	16.0	3.72	2.26	3.72	2.26	2.89	non-LIQ CLAY	1	0.47	NA	5.60	non-LIQ	non-LIQ	0.648	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
64.80	16.9	115.0	115.0	38.1	1.7	4.5	57.4	12.1	8.2	5.0	1.2	15.0	3.73	2.27	3.73	2.27	2.98	non-LIQ CLAY	1	0.47	NA	6.57	non-LIQ	non-LIQ	0.647	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
64.96	16.7	115.0	115.0	39.2	2.0	5.1	59.2	12.6	8.6	5.0	1.2	15.0	3.74	2.27	3.74	2.27	3.01	non-LIQ CLAY	1	0.47	NA	6.87	non-LIQ	non-LIQ	0.645	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
65.13	16.6	115.0	115.0	60.5	1.8	3.0	40.2	16.2	11.1	5.0	1.2	18.0	3.74	2.27	3.74	2.27	2.69	non-LIQ CLAY	1	0.47	NA	3.96	non-LIQ	non-LIQ	0.644	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
65.29	16.4	115.0	115.0	48.7	1.7	3.5	47.3	14.0	9.5	5.0	1.2	16.0	3.75	2.28	3.75	2.28	2.82	non-LIQ CLAY	1	0.46	NA	4.97	non-LIQ	non-LIQ	0.643	0.280	0.280	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
65.46	16.2	115.0	115.0	46.0	1.5	3.3	47.5	13.3	9.0	5.0	1.2	16.0	3.76	2.28	3.76	2.28	2.83	non-LIQ CLAY	1	0.46	NA	5.01	non-LIQ	non-LIQ	0.641	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
65.62	16.1	115.0	115.0	46.0	1.3	2.8	45.3	13.0	8.8	5.0	1.2	16.0	3.77	2.29	3.77	2.29	2.79	non-LIQ CLAY	1	0.46	NA	4.69	non-LIQ	non-LIQ	0.640	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
65.78	15.9	115.0	115.0	41.0	1.1	2.7	47.3	11.8	8.0	5.0	1.2	15.0	3.78	2.29	3.78	2.29	2.82	non-LIQ CLAY	1	0.46	NA	4.97	non-LIQ	non-LIQ	0.639	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
65.95	15.8	115.0	115.0	38.9	1.2	3.1	50.8	11.6	7.9	5.0	1.2	14.0	3.79	2.30	3.79	2.30	2.88	non-LIQ CLAY	1	0.46	NA	5.51	non-LIQ	non-LIQ	0.637	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
66.11	15.6	115.0	115.0	37.0	1.2	3.2	53.0	11.2	7.6	5.0	1.2	14.0	3.80	2.30	3.80	2.30	2.92	non-LIQ CLAY	1	0.46	NA	5.85	non-LIQ	non-LIQ	0.636	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
66.28	15.4	115.0	115.0	45.9	1.3	2.8	45.6	13.0	8.8	5.0	1.2	16.0	3.81	2.30	3.81	2.30	2.79	non-LIQ CLAY	1	0.46	NA	4.72	non-LIQ	non-LIQ	0.635	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
66.44	15.3	115.0	115.0	45.3	1.5	3.3	48.4	13.2	8.9	5.0	1.2	16.0	3.82	2.31	3.82	2.31	2.84	non-LIQ CLAY	1	0.46	NA	5.14	non-LIQ	non-LIQ	0.633	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
66.60	15.1	115.0	115.0	40.8	1.3	3.2	50.3	12.1	8.2	5.0	1.2	15.0	3.83	2.31	3.83	2.31	2.87	non-LIQ CLAY	1	0.46	NA	5.44	non-LIQ	non-LIQ	0.632	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00

Liquefaction Analysis with Cone Penetration Test (CPT) Data

Depth (ft)	Elev. (ft, MSL)	Unit Weight (pcf) γ'_{MOIST}	Unit Weight (pcf) γ'_{SAT}	q_c (tsf)	f_s (tsf)	Frict. Ratio (%)	% Fines	Equiv. N_{60}	Equiv. $(N_1)_{60}$	α	β	Equiv. $(N_1)_{60cs}$	Stresses at Exploration Water Level σ_v (tsf)	Stresses at Exploration Water Level σ_v' (tsf)	Stresses at Design Water Level σ_v (tsf)	Stresses at Design Water Level σ_v' (tsf)	I_c	Soil Type Character (SAND, SILT or non-LIQ CLAY)	Normalization of Tip Resistance n	C_Q	q_{c1N}	Fines Correction Kc	$(q_{c1N})_{cs}$	$CRR_{7.5}$	r_d	CSR_M	$CSR_{7.5}$	FS	a	b	Max Shear Modulus G_{max} (tsf)	Cyclic Shear Strain γ (%)	Norm. Vol. Strain ε_{Nc} (%)	Dry Settle. ΔS (in)	Post-Liq. $(N_1)_{60cs}$	Post-Liq. Vol. Strain ε (%)	Layer Post-Liq. Settle. ΔS (in)
66.77	14.9	115.0	115.0	34.6	1.1	3.2	54.6	10.7	7.2	5.0	1.2	14.0	3.84	2.32	3.84	2.32	2.94	non-LIQ CLAY	1	0.46	NA	6.12	non-LIQ	non-LIQ	0.631	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
66.93	14.8	115.0	115.0	33.1	1.0	3.0	55.1	10.2	6.9	5.0	1.2	13.0	3.85	2.32	3.85	2.32	2.95	non-LIQ CLAY	1	0.46	NA	6.18	non-LIQ	non-LIQ	0.629	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
67.10	14.6	115.0	115.0	32.6	1.1	3.4	57.4	10.3	7.0	5.0	1.2	13.0	3.86	2.33	3.86	2.33	2.98	non-LIQ CLAY	1	0.45	NA	6.57	non-LIQ	non-LIQ	0.628	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
67.26	14.4	115.0	115.0	33.0	1.1	3.3	56.9	10.4	7.0	5.0	1.2	13.0	3.87	2.33	3.87	2.33	2.98	non-LIQ CLAY	1	0.45	NA	6.49	non-LIQ	non-LIQ	0.627	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
67.42	14.3	115.0	115.0	34.4	1.2	3.5	56.6	10.8	7.3	5.0	1.2	14.0	3.88	2.33	3.88	2.33	2.97	non-LIQ CLAY	1	0.45	NA	6.44	non-LIQ	non-LIQ	0.625	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
67.59	14.1	115.0	115.0	34.3	1.2	3.5	56.8	10.8	7.3	5.0	1.2	14.0	3.89	2.34	3.89	2.34	2.97	non-LIQ CLAY	1	0.45	NA	6.47	non-LIQ	non-LIQ	0.624	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
67.75	14.0	115.0	115.0	34.9	1.0	2.9	53.0	10.6	7.1	5.0	1.2	14.0	3.90	2.34	3.90	2.34	2.92	non-LIQ CLAY	1	0.45	NA	5.86	non-LIQ	non-LIQ	0.623	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
67.92	13.8	115.0	115.0	35.2	1.0	2.8	52.7	10.7	7.2	5.0	1.2	14.0	3.91	2.35	3.91	2.35	2.91	non-LIQ CLAY	1	0.45	NA	5.81	non-LIQ	non-LIQ	0.621	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
68.08	13.6	115.0	115.0	33.3	1.0	3.0	55.2	10.3	6.9	5.0	1.2	13.0	3.91	2.35	3.91	2.35	2.95	non-LIQ CLAY	1	0.45	NA	6.20	non-LIQ	non-LIQ	0.620	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
68.24	13.5	115.0	115.0	34.6	1.1	3.2	55.1	10.7	7.2	5.0	1.2	14.0	3.92	2.36	3.92	2.36	2.95	non-LIQ CLAY	1	0.45	NA	6.20	non-LIQ	non-LIQ	0.619	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
68.41	13.3	115.0	115.0	33.4	1.1	3.3	56.8	10.5	7.0	5.0	1.2	13.0	3.93	2.36	3.93	2.36	2.97	non-LIQ CLAY	1	0.45	NA	6.46	non-LIQ	non-LIQ	0.617	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
68.57	13.1	115.0	115.0	32.6	1.1	3.4	57.9	10.4	6.9	5.0	1.2	13.0	3.94	2.36	3.94	2.36	2.99	non-LIQ CLAY	1	0.45	NA	6.65	non-LIQ	non-LIQ	0.616	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
68.74	13.0	115.0	115.0	32.6	1.0	3.1	56.3	10.2	6.8	5.0	1.2	13.0	3.95	2.37	3.95	2.37	2.97	non-LIQ CLAY	1	0.45	NA	6.39	non-LIQ	non-LIQ	0.615	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
68.90	12.8	115.0	115.0	32.2	1.0	3.1	57.0	10.1	6.8	5.0	1.2	13.0	3.96	2.37	3.96	2.37	2.98	non-LIQ CLAY	1	0.45	NA	6.49	non-LIQ	non-LIQ	0.613	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
69.07	12.6	115.0	115.0	31.3	1.0	3.2	58.3	10.0	6.7	5.0	1.2	13.0	3.97	2.38	3.97	2.38	3.00	non-LIQ CLAY	1	0.44	NA	6.72	non-LIQ	non-LIQ	0.612	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
69.23	12.5	115.0	115.0	32.3	1.1	3.4	58.6	10.3	6.9	5.0	1.2	13.0	3.98	2.38	3.98	2.38	3.00	non-LIQ CLAY	1	0.44	NA	6.76	non-LIQ	non-LIQ	0.611	0.270	0.270	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
69.39	12.3	115.0	115.0	33.7	1.1	3.3	56.7	10.6	7.1	5.0	1.2	13.0	3.99	2.39	3.99	2.39	2.97	non-LIQ CLAY	1	0.44	NA	6.45	non-LIQ	non-LIQ	0.609	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
69.56	12.1	115.0	115.0	33.3	1.0	3.0	55.7	10.4	6.9	5.0	1.2	13.0	4.00	2.39	4.00	2.39	2.96	non-LIQ CLAY	1	0.44	NA	6.28	non-LIQ	non-LIQ	0.608	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
69.72	12.0	115.0	115.0	33.4	1.0	3.0	55.6	10.4	6.9	5.0	1.2	13.0	4.01	2.40	4.01	2.40	2.96	non-LIQ CLAY	1	0.44	NA	6.27	non-LIQ	non-LIQ	0.607	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
69.89	11.8	115.0	115.0	33.7	1.2	3.6	58.4	10.8	7.1	5.0	1.2	14.0	4.02	2.40	4.02	2.40	3.00	non-LIQ CLAY	1	0.44	NA	6.73	non-LIQ	non-LIQ	0.605	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
70.05	11.7	115.0	115.0	32.1	1.1	3.4	59.2	10.3	6.9	5.0	1.2	13.0	4.03	2.40	4.03	2.40	3.01	non-LIQ CLAY	1	0.44	NA	6.86	non-LIQ	non-LIQ	0.604	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
70.21	11.5	115.0	115.0	31.2	1.0	3.2	58.9	10.0	6.6	5.0	1.2	13.0	4.04	2.41	4.04	2.41	3.01	non-LIQ CLAY	1	0.44	NA	6.81	non-LIQ	non-LIQ	0.603	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
70.38	11.3	115.0	115.0	30.0	0.9	3.0	59.0	9.6	6.4	5.0	1.2	13.0	4.05	2.41	4.05	2.41	3.01	non-LIQ CLAY	1	0.44	NA	6.82	non-LIQ	non-LIQ	0.601	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
70.54	11.2	115.0	115.0	29.6	1.0	3.4	61.5	9.7	6.4	5.0	1.2	13.0	4.06	2.42	4.06	2.42	3.04	non-LIQ CLAY	1	0.44	NA	7.25	non-LIQ	non-LIQ	0.600	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
70.71	11.0	115.0	115.0	30.9	1.0	3.2	59.5	10.0	6.6	5.0	1.2	13.0	4.07	2.42	4.07	2.42	3.02	non-LIQ CLAY	1	0.44	NA	6.91	non-LIQ	non-LIQ	0.599	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
70.87	10.8	115.0	115.0	30.0	0.9	3.0	59.1	9.6	6.4	5.0	1.2	13.0	4.08	2.43	4.08	2.43	3.01	non-LIQ CLAY	1	0.44	NA	6.85	non-LIQ	non-LIQ	0.597	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
71.03	10.7	115.0	115.0	26.7	0.8	2.8	59.3	9.2	6.1	5.0	1.2	12.0	4.08	2.43	4.08	2.43	3.01	non-LIQ CLAY	1	0.44	NA	6.88	non-LIQ	non-LIQ	0.596	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
71.20	10.5	115.0	115.0	26.6	0.8	2.8	59.5	9.2	6.1	5.0	1.2	12.0	4.09	2.43	4.09	2.43	3.02	non-LIQ CLAY	1	0.43	NA	6.92	non-LIQ	non-LIQ	0.595	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
71.36	10.3	115.0	115.0	28.0	0.9	3.2	62.7	9.3	6.1	5.0	1.2	12.0	4.10	2.44	4.10	2.44	3.06	non-LIQ CLAY	1	0.43	NA	7.45	non-LIQ	non-LIQ	0.593	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
71.53	10.2	115.0	115.0	26.8	0.9	3.1	61.4	9.5	6.2	5.0	1.2	12.0	4.11	2.44	4.11	2.44	3.04	non-LIQ CLAY	1	0.43	NA	7.22	non-LIQ	non-LIQ	0.592	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
71.69	10.0	115.0	115.0	29.1	1.0	3.4	62.8	9.7	6.4	5.0	1.2	13.0	4.12	2.45	4.12	2.45	3.06	non-LIQ CLAY	1	0.43	NA	7.47	non-LIQ	non-LIQ	0.591	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
71.85	9.9	115.0	115.0	29.2	1.0	3.4	62.7	9.7	6.4	5.0	1.2	13.0	4.13	2.45	4.13	2.45	3.06	non-LIQ CLAY	1	0.43	NA	7.45	non-LIQ	non-LIQ	0.589	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
72.02	9.7	115.0	115.0	29.0	1.0	3.4	63.1	9.7	6.3	5.0	1.2	13.0	4.14	2.46	4.14	2.46	3.07	non-LIQ CLAY	1	0.43	NA	7.52	non-LIQ	non-LIQ	0.588	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
72.18	9.5	115.0	115.0	29.6	1.0	3.4	62.1	9.8	6.4	5.0	1.2	13.0	4.15	2.46	4.15	2.46	3.05	non-LIQ CLAY	1	0.43	NA	7.35	non-LIQ	non-LIQ	0.587	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
72.35	9.4	115.0	115.0	30.0	0.9	3.0	59.7	9.7	6.4	5.0	1.2	13.0	4.16	2.46	4.16	2.46	3.02	non-LIQ CLAY	1	0.43	NA	6.94	non-LIQ	non-LIQ	0.585	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
72.51	9.2	115.0	115.0	29.6	0.9	3.0	60.4	9.6	6.3	5.0	1.2	13.0	4.17	2.47	4.17	2.47	3.03	non-LIQ CLAY	1	0.43	NA	7.06	non-LIQ	non-LIQ	0.584	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
72.67	9.0	115.0	115.0	28.7	0.9	3.1	61.9	9.5	6.2	5.0	1.2	12.0	4.18	2.47	4.18	2.47	3.05	non-LIQ CLAY	1	0.43	NA	7.32	non-LIQ	non-LIQ	0.583	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
72.84	8.9	115.0	115.0	28.1	0.9	3.2	63.1	9.4	6.1	5.0	1.2	12.0	4.19	2.48	4.19	2.48	3.07	non-LIQ CLAY	1	0.43	NA	7.51	non-LIQ	non-LIQ	0.581	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
73.00	8.7	115.0	115.0	28.3	0.9	3.2	62.8	9.4	6.1	5.0	1.2	12.0	4.20	2.48	4.20	2.48	3.06	non-LIQ CLAY	1	0.43	NA	7.46	non-LIQ	non-LIQ	0.580	0.260	0.260	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
73.17	8.5	115.0	115.0	28.5	0.9	3.2	62.5	9.5	6.2	5.0	1.2	12.0	4.21	2.49	4.21	2.49	3.06	non-LIQ CLAY	1	0.43	NA	7.41	non-LIQ	non-LIQ	0.579	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
73.33	8.4	115.0	115.0	28.4	0.9	3.2	62.7	9.4	6.2	5.0	1.2	12.0	4.22	2.49	4.22	2.49	3.06	non-LIQ CLAY	1	0.42	NA	7.45	non-LIQ	non-LIQ	0.577	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
73.49	8.2	115.0	115.0	29.0	1.0	3.4	63.6	9.7	6.3	5.0	1.2	13.0	4.23	2.49	4.23	2.49	3.07	non-LIQ CLAY	1	0.42	NA	7.61	non-LIQ	non-LIQ	0.576	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
73.66	8.0	115.0	115.0	29.8	0.8	2.7	58.4	9.5	6.2	5.0	1.2	12.0	4.24	2.50	4.24	2.50	3.00	non-LIQ CLAY	1	0.42	NA	6.73	non-LIQ	non-LIQ	0.575	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
73.82	7.9	115.0	115.0	30.2	1.0	3.3	61.7	9.9	6.5	5.0	1.2	13.0	4.24	2.50	4.24	2.50	3.05	non-LIQ CLAY	1	0.42	NA	7.28	non-LIQ	non-LIQ	0.573	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
73.99	7.7	115.0	115.0	23.2	1.0	4.3	76.1	8.7	5.7	5.0	1.2	12.0	4.25	2.51	4.25	2.51	3.24	non-LIQ CLAY	1	0.42	NA	9.80	non-LIQ	non-LIQ	0.572	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
74.15	7.6	115.0	115.0	29.6	1.0	3.4	62.8	9.8	6.4	5.0	1.2	13.0	4.26	2.51	4.26	2.51	3.06	non-LIQ CLAY	1	0.42	NA	7.47	non-LIQ	non-LIQ	0.571	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
74.31	7.4	115.0	115.0	29.6	1.0	3.4	62.9	9.9	6.4	5.0	1.2	13.0	4.27	2.52	4.27	2.52	3.06	non-LIQ CLAY	1	0.42	NA	7.48	non-LIQ	non-LIQ	0.569	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
74.48	7.2	115.0	115.0	30.2	1.2	4.0	65.3	10.3	6.7	5.0	1.2	13.0	4.28	2.52	4.28	2.52	3.10	non-LIQ CLAY	1	0.42	NA	7.90	non-LIQ	non-LIQ	0.568	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
74.64	7.1	115.0	115.0	35.4	1.5	4.2	61.7	11.7	7.5	5.0	1.2	14.0	4.29	2.52	4.29	2.52	3.05	non-LIQ CLAY	1	0.42	NA	7.28	non-LIQ	non-LIQ	0.567	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
74.81	6.9	115.0	115.0	48.2	1.3	2.7	46.0	13.7	8.9	5.0	1.2	16.0	4.30	2.53	4.30	2.53	2.80	non-LIQ CLAY	1	0.42	NA	4.78	non-LIQ	non-LIQ	0.565	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
74.97	6.7	115.0	115.0	39.2	1.2	3.1	53.2	11.9	7.7	5.0	1.2	14.0	4.31	2.53	4.31	2.53	2.92	non-LIQ CLAY	1	0.42	NA	5.88	non-LIQ	non-LIQ	0.564	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
75.13	6.6	115.0	115.0	29.7	1.0	3.4	63.0	9.9	6.4	5.0	1.2	13.0	4.32	2.54	4.32	2.54	3.07	non-LIQ CLAY	1	0.42	NA	7.50	non-LIQ	non-LIQ	0.563	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
75.30	6.4	115.0	115.0	26.9	0.8	3.0	64.1	9.1	5.8	5.0	1.2	12.0	4.33	2.54	4.33	2.54	3.08	non-LIQ CLAY	1	0.42	NA	7.69	non-LIQ	non-LIQ	0.561	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
75.46	6.2	115.0	115.0	27.4	0.7	2.6	60.9	9.0	5.8	5.0	1.2	12.0	4.34	2.55	4.34	2.55	3.04	non-LIQ CLAY	1	0.42	NA	7.15	non-LIQ	non-LIQ	0.560	0.250	0.250	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
75.63	6.1	115.0	115.0	25.7	0.7	2.7	64.2	8.7	5.6	5.0	1.2	12.0	4.35	2.55	4.35	2.55	3.08	non-LIQ CLAY	1	0.41	NA	7.71	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
75.79	5.9	115.0	115.0	25.2	0.8	3.2	67.7	8.8	5.6	5.0	1.2	12.0	4.36	2.55	4.36	2.55	3.13	non-LIQ CLAY	1	0.41	NA	8.32	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
75.96	5.7	115.0	115.0	25.9	0.8	3.1	66.3	8.9	5.7	5.0	1.2	12.0	4.37	2.56	4.37	2.56	3.11	non-LIQ CLAY	1	0.41	NA	8.07	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
76.12	5.6	115.0	115.0	26.8	0.8	3.0	64.6	9.1	5.8	5.0	1.2	12.0	4.38	2.56	4.38	2.56	3.09	non-LIQ CLAY	1	0.41	NA	7.77	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
76.28	5.4	115.0	115.0	27.0	0.9	3.3	66.4	9.3	6.0	5.0	1.2	12.0	4.39	2.57	4.39	2.57	3.11	non-LIQ CLAY	1	0.41	NA	8.09	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
76.45	5.3	115.0	115.0	29.1	0.8	2.7	60.5	9.5	6.1	5.0	1.2	12.0	4.40	2.57	4.40	2.57	3.03	non-LIQ CLAY	1	0.41	NA	7.09	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
76.61	5.1	115.0	115.0	28.4	1.0	3.5	65.8	9.7	6.2	5.0	1.2	12.0	4.41	2.58	4.41	2.58	3.10	non-LIQ CLAY	1	0.41	NA	7.99	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
76.78	4.9	115.0	115.0	27.9	1.0	3.6	66.8	9.6	6.2	5.0	1.2	12.0	4.41	2.58	4.41	2.58	3.12	non-LIQ CLAY	1	0.41	NA	8.16	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
76.94	4.8	115.0	115.0	41.0	1.4	3.4	54.4	12.6	8.1	5.0	1.2	15.0	4.42	2.59	4.42	2.59	2.94	non-LIQ CLAY	1	0.41	NA	6.08	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
77.10	4.6	115.0	115.0	42.8	1.4	3.3	52.6	12.9	8.3	5.0	1.2	15.0	4.43	2.59	4.43	2.59	2.91	non-LIQ CLAY	1	0.41	NA	5.79	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
77.27	4.4	115.0	115.0	36.5	1.5	4.1	61.1	11.9	7.6	5.0	1.2	14.0	4.44	2.59	4.44	2.59	3.04	non-LIQ CLAY	1	0.41	NA	7.17	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
77.43	4.3	115.0	115.0	34.3	1.2	3.5	60.0	11.1	7.1	5.0	1.2	14.0	4.45	2.60	4.45	2.60	3.02	non-LIQ CLAY	1	0.41	NA	7.00	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
77.60	4.1	115.0	115.0	30.8	1.0	3.2	62.0	10.2	6.5	5.0	1.2	13.0	4.46	2.60	4.46	2.60	3.05	non-LIQ CLAY	1	0.41	NA	7.34	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
77.76	3.9	115.0	115.0	28.3	0.9	3.2	64.5	9.6	6.1	5.0	1.2	12.0	4.47	2.61	4.47	2.61	3.09	non-LIQ CLAY	1	0.41	NA	7.76	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
77.92	3.8	115.0	115.0	29.7	0.8	2.7	60.0	9.6	6.1	5.0	1.2	12.0	4.48	2.61	4.48	2.61	3.02	non-LIQ CLAY	1	0.41	NA	7.00	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
78.09	3.6	115.0	115.0	26.4	0.8	3.0	66.1	9.1	5.8	5.0	1.2	12.0	4.49	2.62	4.49	2.62	3.11	non-LIQ CLAY	1	0.40	NA	8.04	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
78.25	3.5	115.0	115.0	25.8	0.7	2.7	65.0	8.8	5.6	5.0	1.2	12.0	4.50	2.62	4.50	2.62	3.09	non-LIQ CLAY	1	0.40	NA	7.84	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
78.42	3.3	115.0	115.0	26.5	0.7	2.6	63.7	8.9	5.6	5.0	1.2	12.0	4.51	2.62	4.51	2.62	3.07	non-LIQ CLAY	1	0.40	NA	7.61	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
78.58	3.1	115.0	115.0	26.5	0.8	3.0	66.1	9.1	5.8	5.0	1.2	12.0	4.52	2.63	4.52	2.63	3.11	non-LIQ CLAY	1	0.40	NA	8.03	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
78.74	3.0	115.0	115.0	27.0	0.8	3.0	65.2	9.2	5.8	5.0	1.2	12.0	4.53	2.63	4.53	2.63	3.10	non-LIQ CLAY	1	0.40	NA	7.87	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
78.91	2.8	115.0	115.0	27.5	0.8	2.9	64.3	9.3	5.9	5.0	1.2	12.0	4.54	2.64	4.54	2.64	3.08	non-LIQ CLAY	1	0.40	NA	7.72	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
79.07	2.6	115.0	115.0	26.9	0.8	3.0	65.5	9.2	5.8	5.0	1.2	12.0	4.55	2.64	4.55	2.64	3.10	non-LIQ CLAY	1	0.40	NA	7.93	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
79.24	2.5	115.0	115.0	27.6	0.8	2.9	64.2	9.3	5.9	5.0	1.2	12.0	4.56	2.65	4.56	2.65	3.08	non-LIQ CLAY	1	0.40	NA	7.71	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
79.40	2.3	115.0	115.0	26.9	0.8	3.0	65.6	9.2	5.8	5.0	1.2	12.0	4.57	2.65	4.57	2.65	3.10	non-LIQ CLAY	1	0.40	NA	7.95	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00
79.56	2.1	115.0	115.0	27.2	0.8	2.9	65.1	9.2	5.8	5.0	1.2	12.0	4.57	2.65	4.57	2.65	3.09	non-LIQ CLAY	1	0.40	NA	7.86	non-LIQ	non-LIQ	TOO DEEP	NA	NA	non-LIQ	NA	NA	NA	NA	NA	0.00	NA	NA	0.00

Camino Capistrano UC (55-0227) SP 11-137
LIQUEFACTION ANALYSIS; ACC. = 0.4 g 01-Mar-12

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-11-350

Emean (%) 75 Sur.= psf 113.1 =top of ground el. Borehole Diamete 8 71.7 =water table El. acc. max = 0.41 g Earthq. M= 7.5
C_E 1.25 C_B 1.15 Cm= 1.00

ELEVATION TOP OF LAYER (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-				-	-		-	-	-	-	-		-	-		-	-
108.1	5	0.29	0.29	5.00	1.91	0.75	1.20	1.00	115	1	1	6	0.99	0.26	15	51.0	23	1.00	0.26	0.26	0.98	AboveWT
103.1	5	0.58	0.58	10.00	1.35	0.75	1.00	0.50	115	2	2	27	0.98	0.26	20	51.0	29	1.00	0.41	0.41	1.58	AboveWT
98.1	5	0.86	0.86	15.00	1.10	0.85	1.20	1.00	115	1	1	9	0.97	0.26	15	51.0	23	1.00	0.26	0.26	1.00	AboveWT
93.1	5	1.15	1.15	20.00	0.95	0.85	1.00	0.50	115	2	2	18	0.95	0.25	11	51.0	19	0.98	0.20	0.20	0.78	AboveWT
88.1	5	1.44	1.44	25.00	0.85	0.95	1.20	1.00	115	1	1	5	0.94	0.25	7	51.0	14	0.94	0.15	0.14	0.56	AboveWT
83.1	5	1.73	1.73	30.00	0.78	0.95	1.00	0.50	115	2	2	23	0.93	0.25	13	51.0	21	0.90	0.23	0.21	0.83	AboveWT
78.1	5	2.01	2.01	35.00	0.72	1.00	1.20	1.00	115	1	1	7	0.89	0.24	9	51.0	16	0.88	0.17	0.15	0.63	AboveWT
73.1	5	2.30	2.30	40.00	0.67	1.00	1.00	0.50	115	2	2	32	0.85	0.23	16	51.0	25	0.86	0.29	0.25	1.10	AboveWT
68.1	5	2.59	2.43	45.00	0.66	1.00	1.20	1.00	115	1	1	6	0.81	0.23	7	51.0	14	0.85	0.15	0.13	0.55	fines
63.1	5	2.88	2.56	50.00	0.64	1.00	1.00	0.50	115	2	2	32	0.77	0.23	15	51.0	23	0.83	0.26	0.21	0.94	fines
58.1	5	3.16	2.69	55.00	0.62	1.00	1.20	1.00	115	1	1	6	0.73	0.23	7	51.0	14	0.82	0.15	0.12	0.54	fines
53.1	5	3.45	2.83	60.00	0.61	1.00	1.00	0.50	115	2	2	28	0.69	0.22	13	51.0	21	0.81	0.23	0.19	0.83	fines
48.1	5	3.74	2.96	65.00	0.59	1.00	1.20	1.00	115	1	1	11	0.64	0.22	12	51.0	20	0.80	0.22	0.17	0.80	fines
43.1	5	4.03	3.09	70.00	0.58	1.00	1.00	0.50	115	2	2	100	0.60	0.21	42	51.0	56	0.78	high N	high N	LARGE	high N/fines
38.1	5	4.31	3.22	75.00	0.57	1.00	1.20	1.00	115	1	1	29	0.56	0.20	29	51.0	40	0.77	high N	high N	LARGE	high N/fines
33.1	5	4.60	3.35	80.00	0.56	1.00	1.00	0.50	115	2	2	100	0.55	0.20	41	51.0	55	0.76	high N	high N	LARGE	high N/fines
28.1	5	4.89	3.48	85.00	0.55	1.00	1.20	1.00	115	1	1	50	0.54	0.20	48	51.0	63	0.75	high N	high N	LARGE	high N/fines

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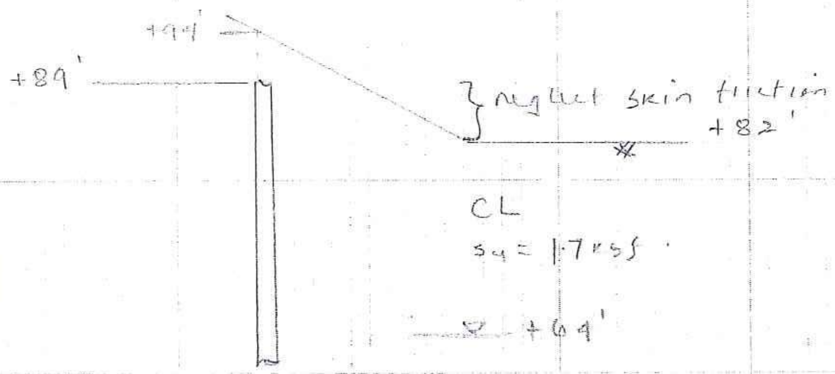
Project Camino Capistrano UC (55-0227) **Project No.** 11-157

By SP **Date** 4/4/12 **Checked By** LCC **Date** 4/4/12 **Sheet** ___ **of** ___

Abutment 1



14-inch square concrete piles

perimeter = 4 × 14/12 = 4.67 ft

Area = $(\frac{14}{12})^2$ = 1.36 ft²

$I = \frac{14^4}{12}$ = 3201 in⁴

maximum load per pile = 92 kips

Nominal resistance per pile = 92 × 2 = 184 kips

consider 190 kips

Total load per support = 803 kips

Nominal resistance per support = 803 × 2 = 1606 kips

consider 1610 kips.

average center to center spacing = 3.4d

group reduction factor = 0.86

from the analysis

at depth of 55 ft pile capacity = 190.5 kips (skin friction only)

pile tip elevation for compression = 89 − 55 = +34 ft

available group nominal resistance at tip elevation of +34 ft = 13 × 0.86 × 190.5 = 2130 kips

required group nominal resistance = 1610 kips < 2130 kips

available group nominal resistance exceeds the required group nominal resistance.

pile tip elevation for compression = +34 feet

Nominal resistance per pile = 190 kips

Driving resistance = 190 kips

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Camino Capistrano UC Abutment 1, 04/04/2012 SP
Caltrans Class 200 Alt X 14-inch PCC

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SOIL DATA

NUMBER OF SOIL UNITS = 2
DEPTH TO WATER TABLE = 25.00'
UNIT WEIGHT OF WATER = .0624 kcf

SOIL UNIT	DEPTH (ft)	(ft)	UNIT WT. (kcf)	CLAY: SAND:	c (ksf) PHI (deg)	Nc Nq	Cac Khc	Cat Kht	delta (deg)
1	.0 -	7.0	.120	CLAY	.00	0.	.50	.50	
2	7.0 -	75.0	.120	CLAY	1.70	0.	.50	.50	

PILE DATA		PILE TOP	PILE TIP
DEPTH	=	.00	100.00'
CIRCUMFERENCE	=	4.670	4.670'
CROSS-SECTIONAL AREA	=	1.3600	1.3600 ft2

PILE STIFFNESS AE/L = 99999. kips/ft
DISPLACEMENT TO MOBILIZE FULL SKIN FRICTION = 1.670E-02' (= 2.004E-01")
DISPLACEMENT TO MOBILIZE FULL END BEARING = 6.700E-02' (= 8.040E-01")
DEPTH INCREMENT FOR CAPACITY CALCULATIONS = 1.00'
FACTOR OF SAFETY FOR SKIN FRICTION = 1.00
FACTOR OF SAFETY FOR END-BEARING = 1.00

SOIL UNIT -	DEPTH (ft)	EFF. STRESS (ksf)	UNIT SKIN FRICT COMPR. (ksf)	UPLIFT (ksf)	UNIT END BEARING (ksf)	CUM.FR. COMPR. (kips)	END BEARING (kips)	CAPACITY COMPRESS (kips)	UPLIFT (kips)
1	.00	.00	.00	.00	.0	.0	.0	.0	.0
1	1.00	.12	.00	.00	.0	.0	.0	.0	.0
1	2.00	.24	.00	.00	.0	.0	.0	.0	.0
1	3.00	.36	.00	.00	.0	.0	.0	.0	.0
1	4.00	.48	.00	.00	.0	.0	.0	.0	.0
1	5.00	.60	.00	.00	.0	.0	.0	.0	.0
1	6.00	.72	.00	.00	.0	.0	.0	.0	.0
1	7.00	.84	.00	.00	.0	.0	.0	.0	.0
2	7.00	.84	.85	.85	.0	.0	.0	.0	.0
2	8.00	.96	.85	.85	.0	4.0	.0	4.0	4.0
2	9.00	1.08	.85	.85	.0	7.9	.0	7.9	7.9
2	10.00	1.20	.85	.85	.0	11.9	.0	11.9	11.9
2	11.00	1.32	.85	.85	.0	15.9	.0	15.9	15.9
2	12.00	1.44	.85	.85	.0	19.8	.0	19.8	19.8
2	13.00	1.56	.85	.85	.0	23.8	.0	23.8	23.8
2	14.00	1.68	.85	.85	.0	27.8	.0	27.8	27.8
2	15.00	1.80	.85	.85	.0	31.8	.0	31.8	31.8
2	16.00	1.92	.85	.85	.0	35.7	.0	35.7	35.7
2	17.00	2.04	.85	.85	.0	39.7	.0	39.7	39.7
2	18.00	2.16	.85	.85	.0	43.7	.0	43.7	43.7
2	19.00	2.28	.85	.85	.0	47.6	.0	47.6	47.6
2	20.00	2.40	.85	.85	.0	51.6	.0	51.6	51.6
2	21.00	2.52	.85	.85	.0	55.6	.0	55.6	55.6
2	22.00	2.64	.85	.85	.0	59.5	.0	59.5	59.5
2	23.00	2.76	.85	.85	.0	63.5	.0	63.5	63.5
2	24.00	2.88	.85	.85	.0	67.5	.0	67.5	67.5
2	25.00	3.00	.85	.85	.0	71.5	.0	71.5	71.5
2	26.00	3.06	.85	.85	.0	75.4	.0	75.4	75.4
2	27.00	3.12	.85	.85	.0	79.4	.0	79.4	79.4
2	28.00	3.17	.85	.85	.0	83.4	.0	83.4	83.4
2	29.00	3.23	.85	.85	.0	87.3	.0	87.3	87.3
2	30.00	3.29	.85	.85	.0	91.3	.0	91.3	91.3
2	31.00	3.35	.85	.85	.0	95.3	.0	95.3	95.3
2	32.00	3.40	.85	.85	.0	99.2	.0	99.2	99.2
2	33.00	3.46	.85	.85	.0	103.2	.0	103.2	103.2
2	34.00	3.52	.85	.85	.0	107.2	.0	107.2	107.2
2	35.00	3.58	.85	.85	.0	111.1	.0	111.1	111.1
2	36.00	3.63	.85	.85	.0	115.1	.0	115.1	115.1
2	37.00	3.69	.85	.85	.0	119.1	.0	119.1	119.1
2	38.00	3.75	.85	.85	.0	123.1	.0	123.1	123.1
2	39.00	3.81	.85	.85	.0	127.0	.0	127.0	127.0
2	40.00	3.86	.85	.85	.0	131.0	.0	131.0	131.0
2	41.00	3.92	.85	.85	.0	135.0	.0	135.0	135.0
2	42.00	3.98	.85	.85	.0	138.9	.0	138.9	138.9
2	43.00	4.04	.85	.85	.0	142.9	.0	142.9	142.9
2	44.00	4.09	.85	.85	.0	146.9	.0	146.9	146.9
2	45.00	4.15	.85	.85	.0	150.8	.0	150.8	150.8
2	46.00	4.21	.85	.85	.0	154.8	.0	154.8	154.8
2	47.00	4.27	.85	.85	.0	158.8	.0	158.8	158.8
2	48.00	4.32	.85	.85	.0	162.7	.0	162.7	162.7
2	49.00	4.38	.85	.85	.0	166.7	.0	166.7	166.7
2	50.00	4.44	.85	.85	.0	170.7	.0	170.7	170.7
2	51.00	4.50	.85	.85	.0	174.7	.0	174.7	174.7
2	52.00	4.56	.85	.85	.0	178.6	.0	178.6	178.6

2	53.00	4.61	.85	.85	.0	182.6	.0	182.6	182.6
2	54.00	4.67	.85	.85	.0	186.6	.0	186.6	186.6
2	55.00	4.73	.85	.85	.0	190.5	.0	190.5	190.5
2	56.00	4.79	.85	.85	.0	194.5	.0	194.5	194.5
2	57.00	4.84	.85	.85	.0	198.5	.0	198.5	198.5
2	58.00	4.90	.85	.85	.0	202.4	.0	202.4	202.4
2	59.00	4.96	.85	.85	.0	206.4	.0	206.4	206.4
2	60.00	5.02	.85	.85	.0	210.4	.0	210.4	210.4
2	61.00	5.07	.85	.85	.0	214.4	.0	214.4	214.4
2	62.00	5.13	.85	.85	.0	218.3	.0	218.3	218.3
2	63.00	5.19	.85	.85	.0	222.3	.0	222.3	222.3
2	64.00	5.25	.85	.85	.0	226.3	.0	226.3	226.3
2	65.00	5.30	.85	.85	.0	230.2	.0	230.2	230.2
2	66.00	5.36	.85	.85	.0	234.2	.0	234.2	234.2
2	67.00	5.42	.85	.85	.0	238.2	.0	238.2	238.2
2	68.00	5.48	.85	.85	.0	242.1	.0	242.1	242.1
2	69.00	5.53	.85	.85	.0	246.1	.0	246.1	246.1
2	70.00	5.59	.85	.85	.0	250.1	.0	250.1	250.1
2	71.00	5.65	.85	.85	.0	254.0	.0	254.0	254.0
2	72.00	5.71	.85	.85	.0	258.0	.0	258.0	258.0
2	73.00	5.76	.85	.85	.0	262.0	.0	262.0	262.0
2	74.00	5.82	.85	.85	.0	266.0	.0	266.0	266.0
2	75.00	5.88	.85	.85	.0	269.9	.0	269.9	269.9
0	75.00	5.88	.00	.00	.0	269.9	.0	269.9	269.9

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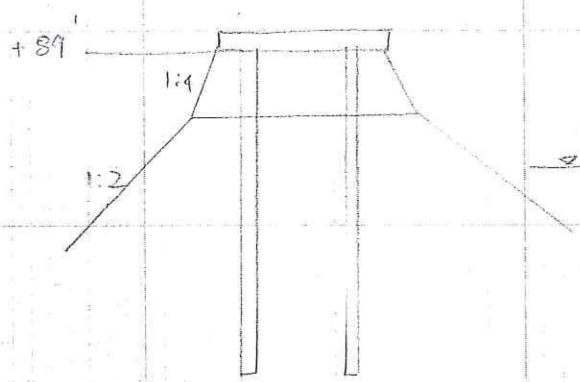
Project Camino Capistrano UC (55-0227) Project No. 11-137

By SP Date 4/4/12 Checked By LCC Date 4/4/12 Sheet ____ of ____

Abutment 1 settlement



Total load = 803 kips
permanent load = 735 kips
pile cap = 8' x 16'

considered pile length = 24'

$\frac{2D}{3} = 16'$

Equivalent footing = $(8 + \frac{16}{4} \times 2)(16 + \frac{16}{4} \times 2)$
= 16' x 24'

$q = \frac{803}{16 \times 24}$ = 2.1 ksf for immediate settlement

$= \frac{735}{16 \times 24}$ = 1.9 ksf for consolidation settlement

σ_{vo}	$\Delta\sigma$	settlement
20.5 x 120 = 2.46	$\frac{803}{(16+4.5)(24+4.5)} = 1.37$	$9 \times \frac{1}{40} \log\left(\frac{2.46+1.37}{2.46}\right) = 0.52$
25 x 120 + 10 x 57.6 = 3.6	$\frac{735}{(16+19)(24+19)} = 0.49$	$20 \times \frac{1}{40} \times \log\left(\frac{3.6+0.49}{3.6}\right) = 0.33$
25 x 120 + 25 x 57.6 = 4.4	$\frac{735}{(16+34)(24+34)} = 0.25$	$10 \times \frac{1}{40} \log\left(\frac{4.4+0.25}{4.4}\right) = 0.1$
		0.95"

pile tip elevation for settlement = 89 - 24
= +65 feet

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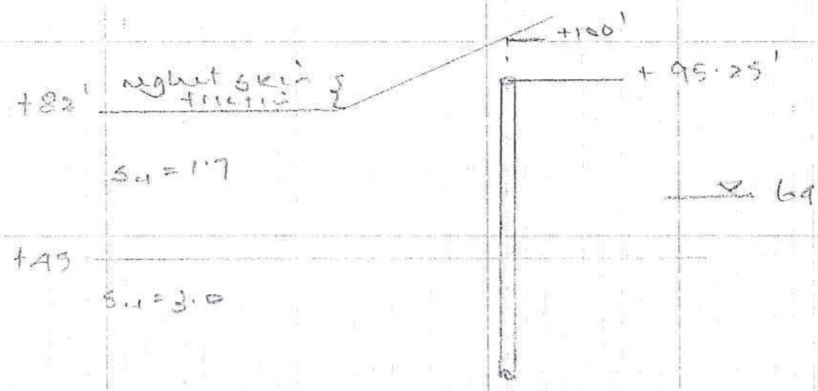
Project Camino Capistrano UC (55-0227) Project No. 11-137

By SP Date 4/5/12 Checked By LCC Date 4/5/12 Sheet ____ of ____

Abutment 5



Maximum load per pile = 68 kips
Nominal resistance per pile = 68×2 = 136 kips
consider 140 kips

Total load per support = 408 kips
Nominal resistance per support = 408×2 = 816 kips
consider 820 kips

average center to center spacing = 3.4d
group reduction factor = 0.86

from the analysis
at depth of 50 feet, pile capacity = 147 kips > 140 kips
(skin friction only)

pile tip elevation for compression = 95 - 50 = +45 feet

available group nominal resistance at tip
elevation at +45 ft = 13 × 0.86 × 147 = 1643 kips
required group nominal resistance = 820 kips < 1643 kips

available group nominal resistance exceeds the required group nominal resistance.

increase the pile length by 5 feet to embed the pile into bedrock.

pile tip elevation for compression = +40 feet
Nominal resistance per pile = 140 kips
Driving resistance = 140 kips

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Camino Capistrano UC Abutment 5, 04/04/2012 SP
Caltrans Class 200 Alt X 14-inch PCC

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SOIL DATA

NUMBER OF SOIL UNITS = 3
DEPTH TO WATER TABLE = 31.00'
UNIT WEIGHT OF WATER = .0624 kcf

SOIL UNIT	DEPTH (ft)	(ft)	UNIT WT. (kcf)	CLAY: SAND:	c (ksf) PHI (deg)	Nc Nq	Cac Khc	Cat Kht	delta (deg)
1	.0 -	13.0	.120	CLAY	.00	0.	.50	.50	
2	13.0 -	50.0	.120	CLAY	1.70	0.	.50	.50	
3	50.0 -	75.0	.120	CLAY	3.00	0.	.50	.50	

PILE DATA		PILE TOP	PILE TIP
DEPTH	=	.00	100.00'
CIRCUMFERENCE	=	4.670	4.670'
CROSS-SECTIONAL AREA	=	1.3600	1.3600 ft2

PILE STIFFNESS AE/L = 99999. kips/ft
DISPLACEMENT TO MOBILIZE FULL SKIN FRICTION = 1.670E-02' (= 2.004E-01")
DISPLACEMENT TO MOBILIZE FULL END BEARING = 6.700E-02' (= 8.040E-01")
DEPTH INCREMENT FOR CAPACITY CALCULATIONS = 1.00'
FACTOR OF SAFETY FOR SKIN FRICTION = 1.00
FACTOR OF SAFETY FOR END-BEARING = 1.00

SOIL UNIT -	DEPTH (ft)	EFF. STRESS (ksf)	UNIT SKIN FRICT COMPR. (ksf)	UNIT SKIN FRICT UPLIFT (ksf)	UNIT END BEARING (ksf)	CUM.FR. COMPR. (kips)	END BEARING (kips)	CAPACITY COMPRESS (kips)	CAPACITY UPLIFT (kips)
1	.00	.00	.00	.00	.0	.0	.0	.0	.0
1	1.00	.12	.00	.00	.0	.0	.0	.0	.0
1	2.00	.24	.00	.00	.0	.0	.0	.0	.0
1	3.00	.36	.00	.00	.0	.0	.0	.0	.0
1	4.00	.48	.00	.00	.0	.0	.0	.0	.0
1	5.00	.60	.00	.00	.0	.0	.0	.0	.0
1	6.00	.72	.00	.00	.0	.0	.0	.0	.0
1	7.00	.84	.00	.00	.0	.0	.0	.0	.0
1	8.00	.96	.00	.00	.0	.0	.0	.0	.0
1	9.00	1.08	.00	.00	.0	.0	.0	.0	.0
1	10.00	1.20	.00	.00	.0	.0	.0	.0	.0
1	11.00	1.32	.00	.00	.0	.0	.0	.0	.0
1	12.00	1.44	.00	.00	.0	.0	.0	.0	.0
1	13.00	1.56	.00	.00	.0	.0	.0	.0	.0
2	13.00	1.56	.85	.85	.0	.0	.0	.0	.0
2	14.00	1.68	.85	.85	.0	4.0	.0	4.0	4.0
2	15.00	1.80	.85	.85	.0	7.9	.0	7.9	7.9
2	16.00	1.92	.85	.85	.0	11.9	.0	11.9	11.9
2	17.00	2.04	.85	.85	.0	15.9	.0	15.9	15.9
2	18.00	2.16	.85	.85	.0	19.8	.0	19.8	19.8
2	19.00	2.28	.85	.85	.0	23.8	.0	23.8	23.8
2	20.00	2.40	.85	.85	.0	27.8	.0	27.8	27.8
2	21.00	2.52	.85	.85	.0	31.8	.0	31.8	31.8
2	22.00	2.64	.85	.85	.0	35.7	.0	35.7	35.7
2	23.00	2.76	.85	.85	.0	39.7	.0	39.7	39.7
2	24.00	2.88	.85	.85	.0	43.7	.0	43.7	43.7
2	25.00	3.00	.85	.85	.0	47.6	.0	47.6	47.6
2	26.00	3.12	.85	.85	.0	51.6	.0	51.6	51.6
2	27.00	3.24	.85	.85	.0	55.6	.0	55.6	55.6
2	28.00	3.36	.85	.85	.0	59.5	.0	59.5	59.5
2	29.00	3.48	.85	.85	.0	63.5	.0	63.5	63.5
2	30.00	3.60	.85	.85	.0	67.5	.0	67.5	67.5
2	31.00	3.72	.85	.85	.0	71.5	.0	71.5	71.5
2	32.00	3.78	.85	.85	.0	75.4	.0	75.4	75.4
2	33.00	3.84	.85	.85	.0	79.4	.0	79.4	79.4
2	34.00	3.89	.85	.85	.0	83.4	.0	83.4	83.4
2	35.00	3.95	.85	.85	.0	87.3	.0	87.3	87.3
2	36.00	4.01	.85	.85	.0	91.3	.0	91.3	91.3
2	37.00	4.07	.85	.85	.0	95.3	.0	95.3	95.3
2	38.00	4.12	.85	.85	.0	99.2	.0	99.2	99.2
2	39.00	4.18	.85	.85	.0	103.2	.0	103.2	103.2
2	40.00	4.24	.85	.85	.0	107.2	.0	107.2	107.2
2	41.00	4.30	.85	.85	.0	111.1	.0	111.1	111.1
2	42.00	4.35	.85	.85	.0	115.1	.0	115.1	115.1
2	43.00	4.41	.85	.85	.0	119.1	.0	119.1	119.1
2	44.00	4.47	.85	.85	.0	123.1	.0	123.1	123.1
2	45.00	4.53	.85	.85	.0	127.0	.0	127.0	127.0
2	46.00	4.58	.85	.85	.0	131.0	.0	131.0	131.0
2	47.00	4.64	.85	.85	.0	135.0	.0	135.0	135.0
2	48.00	4.70	.85	.85	.0	138.9	.0	138.9	138.9
2	49.00	4.76	.85	.85	.0	142.9	.0	142.9	142.9
2	50.00	4.81	.85	.85	.0	146.9	.0	146.9	146.9
3	50.00	4.81	1.50	1.50	.0	146.9	.0	146.9	146.9

3	51.00	4.87	1.50	1.50	.0	153.9	.0	153.9	153.9
3	52.00	4.93	1.50	1.50	.0	160.9	.0	160.9	160.9
3	53.00	4.99	1.50	1.50	.0	167.9	.0	167.9	167.9
3	54.00	5.04	1.50	1.50	.0	174.9	.0	174.9	174.9
3	55.00	5.10	1.50	1.50	.0	181.9	.0	181.9	181.9
3	56.00	5.16	1.50	1.50	.0	188.9	.0	188.9	188.9
3	57.00	5.22	1.50	1.50	.0	195.9	.0	195.9	195.9
3	58.00	5.28	1.50	1.50	.0	202.9	.0	202.9	202.9
3	59.00	5.33	1.50	1.50	.0	209.9	.0	209.9	209.9
3	60.00	5.39	1.50	1.50	.0	216.9	.0	216.9	216.9
3	61.00	5.45	1.50	1.50	.0	223.9	.0	223.9	223.9
3	62.00	5.51	1.50	1.50	.0	230.9	.0	230.9	230.9
3	63.00	5.56	1.50	1.50	.0	237.9	.0	237.9	237.9
3	64.00	5.62	1.50	1.50	.0	244.9	.0	244.9	244.9
3	65.00	5.68	1.50	1.50	.0	251.9	.0	251.9	251.9
3	66.00	5.74	1.50	1.50	.0	259.0	.0	259.0	259.0
3	67.00	5.79	1.50	1.50	.0	266.0	.0	266.0	266.0
3	68.00	5.85	1.50	1.50	.0	273.0	.0	273.0	273.0
3	69.00	5.91	1.50	1.50	.0	280.0	.0	280.0	280.0
3	70.00	5.97	1.50	1.50	.0	287.0	.0	287.0	287.0
3	71.00	6.02	1.50	1.50	.0	294.0	.0	294.0	294.0
3	72.00	6.08	1.50	1.50	.0	301.0	.0	301.0	301.0
3	73.00	6.14	1.50	1.50	.0	308.0	.0	308.0	308.0
3	74.00	6.20	1.50	1.50	.0	315.0	.0	315.0	315.0
3	75.00	6.25	1.50	1.50	.0	322.0	.0	322.0	322.0
0	75.00	6.25	.00	.00	.0	322.0	.0	322.0	322.0

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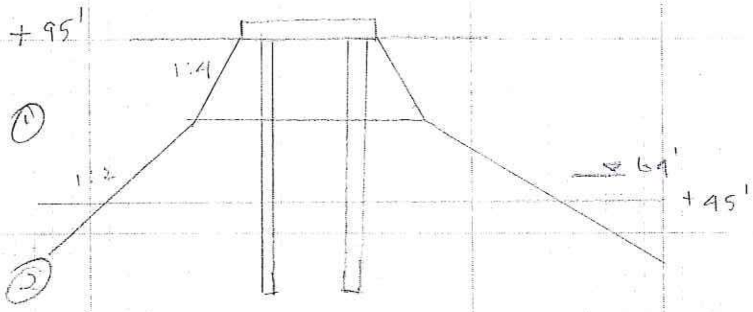
Project Camino Capistrano UC (55-0227) Project No. 11-137

By SP Date 4/5/12 Checked By HCC Date 4/5/12 Sheet ___ of ___

Abutment 5 settlement



Total load = 908 kips
permanent load = 341 kips
pile cap = 8' x 16'

consider pile length = 12 ft

$\frac{2D}{3} = 8$

Equivalent footing = $(8+\frac{8}{4}\times2)(16+\frac{8}{4}\times2)$
= 12 x 20

$q = \frac{908}{12\times20} = 1.7$ ksf for immediate settlement

$q = \frac{341}{12\times20} = 1.423$ ksf for consolidation settlement

σ_{vo}	$\Delta\sigma$	Settlement
① 13 x 120 = 1.56	$\frac{908}{(12+5)(20+5)} = 0.96$	$10 \times \frac{1}{40} \log\left(\frac{1.56+0.96}{1.56}\right) = 0.62$
24.5x120 = 2.94	$\frac{908}{(12+16.5)(20+16.5)} = 0.9$	$13 \times \frac{1}{40} \log\left(\frac{2.94+0.9}{2.94}\right) = 0.22$
31x120 + 9.5x57.6 = 4.3	$\frac{908}{(12+32.5)(20+32.5)} = 0.17$	$19 \times \frac{1}{40} \log\left(\frac{4.3+0.17}{4.3}\right) = 0.1$
② 31x120 + 24x57.6 = 5.1	$\frac{341}{(12+47)(20+47)} = 0.1$	$10 \times \frac{1}{40} \log\left(\frac{5.1+0.1}{5.1}\right) = 0.03$
		0.97"

pile tip elevation for settlement = 95-12
= +83 feet

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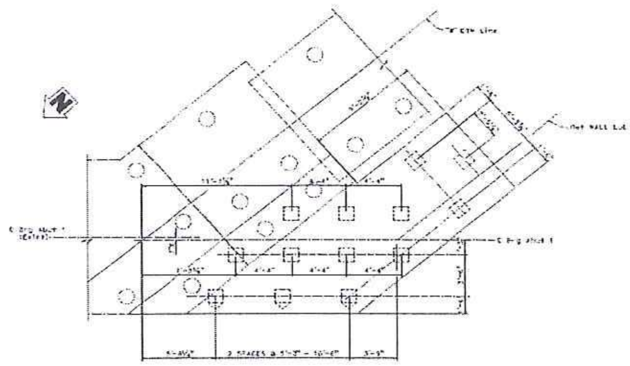
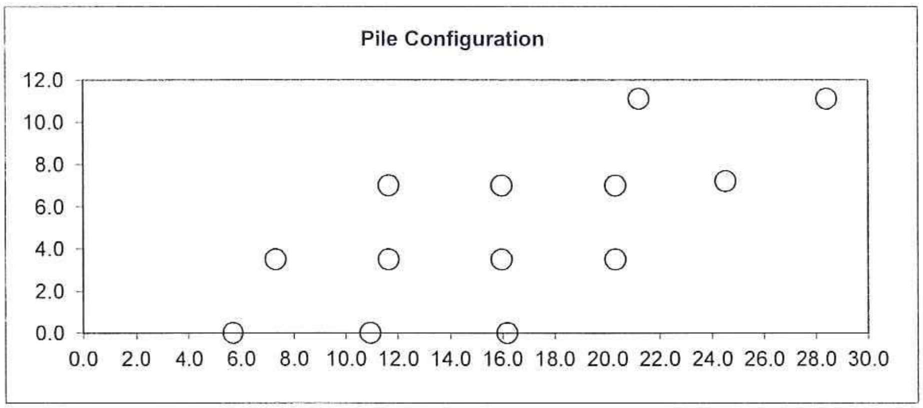
Project: Camino Capistrano UC   Project No. 11-137
By SP   Date 04/04/12   Check by   Date   Sheet ______

Proposed Abutment 1 Pile Layout



Calculation of Pile Group Efficiency for Lateral Load Capacity
(using formula in Group 7.0 Technical Manual)



Pile Dia. (feet): 1.1667
No. of Piles: 13

	X-Dir	Y-Dir
Group Efficiency	0.76	0.79

Coordinates

Pile No.	X	Y	Reduction Factors in X-dir	Reduction Factors in Y-dir
1	5.7	0.0	0.756	0.785
2	10.9	0.0	0.738	0.633
3	16.2	0.0	0.857	0.625
4	7.3	3.5	0.644	0.909
5	11.6	3.5	0.579	0.648
6	16.0	3.5	0.621	0.613
7	20.3	3.5	0.851	0.643
8	11.6	7.0	0.678	0.931
9	16.0	7.0	0.639	0.907
10	20.3	7.0	0.702	0.729
11	21.2	11.1	0.888	0.977
12	24.5	7.2	0.914	0.843
13	28.4	11.1	1.000	1.000

```
================================================================================

             LPile Plus for Windows, Version 6.0 (6.0.09)

             Analysis of Individual Piles and Drilled Shafts
             Subjected to Lateral Loading Using the p-y Method

                      (c) 1985-2010 by Ensoft, Inc.
                           All Rights Reserved

================================================================================

This program is licensed to:

Earth Mechanics, Inc.
Earth Mechanics, Inc.

--------------------------------------------------------------------------------
                         Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:      X:\Projects\2011\11-137 - TRC, I-5 HOV Widening - Segment 3\Reports\04 Camino Capistrano UC (55-0227)\Appendix C Analyses\Lateral Capacity\
Name of input data file:     Camino Capistrano 14-inch PCC (Abutments).lp6d
Name of output file:         Camino Capistrano 14-inch PCC (Abutments).lp6o
Name of plot output file:    Camino Capistrano 14-inch PCC (Abutments).lp6p
Name of runtime file:        Camino Capistrano 14-inch PCC (Abutments).lp6r

--------------------------------------------------------------------------------
                        Date and Time of Analysis
--------------------------------------------------------------------------------

              Date:  April 6, 2012     Time:  19:25:52

--------------------------------------------------------------------------------
                              Problem Title
--------------------------------------------------------------------------------

Project Name:

Job Number:

Client:

Engineer:

Description:



--------------------------------------------------------------------------------
                             Program Options
--------------------------------------------------------------------------------

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
  Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum
  bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments                          =        100
- Maximum number of iterations allowed               =        100
- Deflection tolerance for convergence               =   1.0000E-05  in
- Maximum allowable deflection                       =     100.0000  in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment,
  and maximum shear force are to be written to output report file.

--------------------------------------------------------------------------------
                   Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Total Number of Sections                             =          1
```

```
Total Pile Length                                   =      50.00 ft

Depth of ground surface below top of pile          =      -2.00 ft

Slope angle of ground surface                       =       0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point         Depth           Pile
                X           Diameter
                ft             in
-----       ---------     -----------
  1          0.00000       14.0000000
  2         50.000000      14.0000000

Input Structural Properties:
----------------------------

Section No. 1:

   Section Type                                    =     Elastic Pile
   Cross-sectional Shape                           =      Rectangular
   Section Length                                  =          50.000 ft
   Top Width                                       =          14.000 in
   Bottom Width                                    =          14.000 in
   Top Section Depth                               =          14.000 in
   Bottom Section Depth                            =          14.000 in
   Top Area                                        =      196.000000 Sq. in
   Bottom Area                                     =      196.000000 Sq. in
   Moment of Inertia at Top                        =       3.201E+03 in^4
   Moment of Inertia at Bottom                     =       3.201E+03 in^4
   Elastic Modulus                                 =     3200000.000 lbs/in


--------------------------------------------------------------------------------
                      Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------

Ground Slope Angle                                  =        0.000 degrees
                                                    =        0.000 radians

Pile Batter Angle                                   =        0.000 degrees
                                                    =        0.000 radians


--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 3 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer           =       -2.000 ft
Distance from top of pile to bottom of layer        =        7.000 ft

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer           =        7.000 ft
Distance from top of pile to bottom of layer        =       25.000 ft

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer           =       25.000 ft
Distance from top of pile to bottom of layer        =       60.000 ft

(Depth of lowest layer extends   10.00 ft below pile tip)

--------------------------------------------------------------------------------
                      Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using 6 points

Point       Depth X     Eff. Unit Weight
 No.          ft             pcf
-----     ----------   ----------------
  1          -2.00        60.00000
  2           7.00        60.00000
  3           7.00       120.00000
```

4	25.00	120.00000
5	25.00	57.60000
6	60.00	57.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	Soft Clay	-2.000	60.000	1700.000	--	--	--	0.00700	--	--	--	--	--	--
		7.000	60.000	1700.000	--	--	--	0.00700	--	--	--	--	--	--
2	Soft Clay	7.000	120.000	1700.000	--	--	--	0.00700	--	--	--	--	--	--
		25.000	120.000	1700.000	--	--	--	0.00700	--	--	--	--	--	--
3	Soft Clay	25.000	57.600	1700.000	--	--	--	0.00700	--	--	--	--	--	--
		60.000	57.600	1700.000	--	--	--	0.00700	--	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7600	1.0000
2	50.000	0.7600	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	4	y = 0.250 in	M = 0.000 in-lbs	92000.000
2	4	y = 0.500 in	M = 0.000 in-lbs	92000.000
3	4	y = 1.000 in	M = 0.000 in-lbs	92000.000
4	4	y = 2.000 in	M = 0.000 in-lbs	92000.000
5	4	y = 5.000 in	M = 0.000 in-lbs	92000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

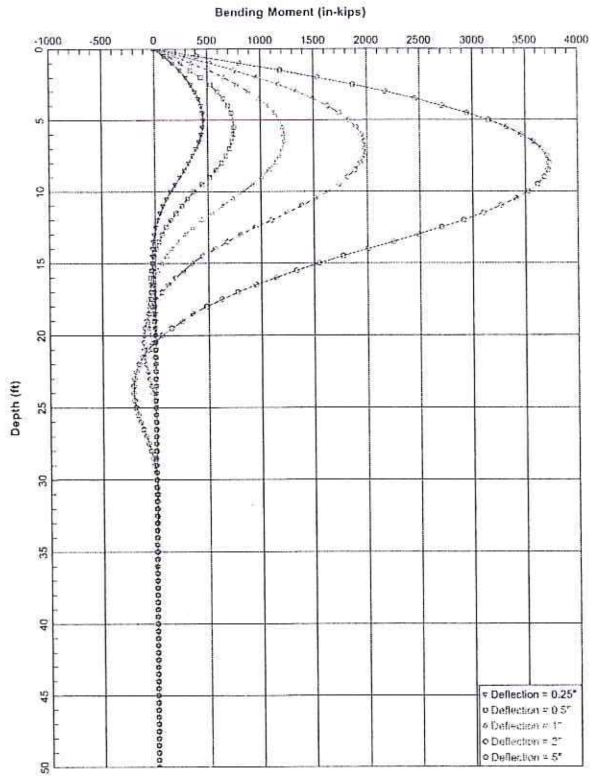
Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	92000.	0.25000000	465616.	15205.	0.00000000
2	4	y = 0.5000	M = 0.000	92000.	0.50000000	753916.	21798.	0.00000000
3	4	y = 1.0000	M = 0.000	92000.	1.00000000	1221239.	31258.	0.00000000
4	4	y = 2.0000	M = 0.000	92000.	2.00000000	1984987.	44816.	0.00000000
5	4	y = 5.0000	M = 0.000	92000.	5.00000000	3729498.	65942.	0.00000000

Summary of Warning Messages

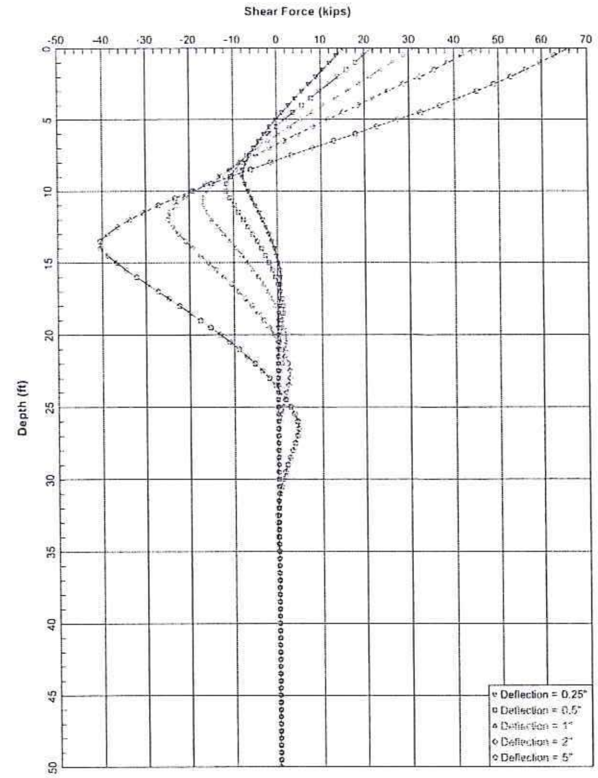
The following warning was reported 1881 times

**** Warning ****

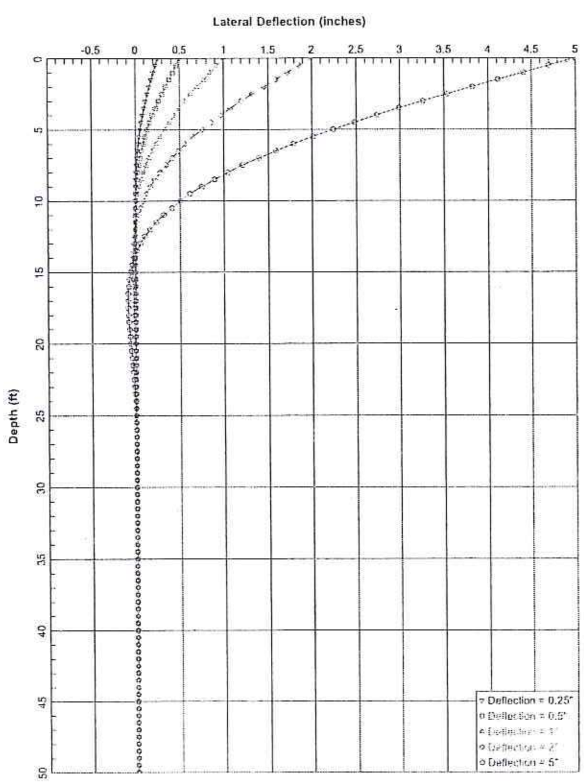
An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.



Camino Capistrano UC - Caltrans Class 200 Alt X 14-inch Square Concrete Piles at Abutments



Camino Capistrano UC - Caltrans Class 200 Alt X 14-inch Square Concrete Piles at Abutments



Camino Capistrano UC - Caltrans Class 200 Alt X 14-inch Square Concrete Piles at Abutments

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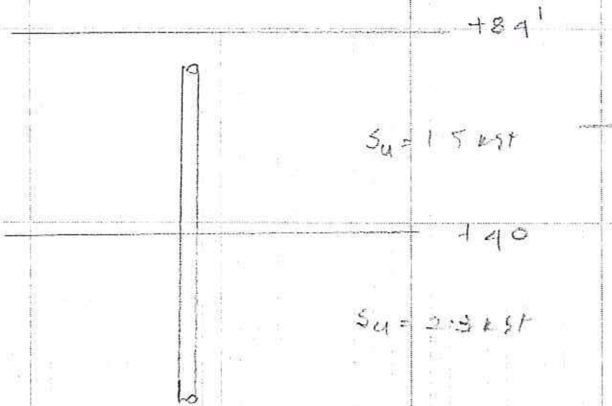
Project: Camino Capistrano UC (55-0227) Project No. 11-137

By SP Date 4/4/12 Checked By LCC Date 4/4/12 Sheet ____ of ____

Bents 2, 3 & 4



7-foot diameter shaft
perimeter = $\pi \times 7$ = 22 ft
area = $\frac{\pi}{4} 7^2$ = 38.5 ft²
$I = \frac{\pi}{64} 7^4$ = 117.9 ft⁴
= 2,443,920 in⁴
I_{crack} = 1,221,960 in⁴

cut off elevation = +83.5 ft for Bent 2
= +79.75 ft for Bent 3
= +82.84 ft for Bent 4

Nominal resistance per pile
Strength limit = 762/0.7 = 1089 kips
consider 1090 kips for Bent 2
= 847/0.7 = 1210 kips for Bent 3
= 722/0.7 = 1031 kips
consider 1040 kips for Bent 4

Extreme event limit = 398/1.0 = 398 kips
consider 400 kips for Bent 2
= 450/1.0 = 450 kips for Bent 3
= 359/1.0 = 359 kips
consider 360 kips for Bent 4

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Project Camino Capistrano UC (55-0227) **Project No.** 11-137

By SP **Date** 9/9/12 **Checked By** LCC **Date** 9/9/12 **Sheet** ____ **of** ____

from the analysis
strength limit state
at depth of 58 feet pile capacity = 1107 kips > 1090 kips for Bent 2
at depth of 62 feet pile capacity = 1218 kips > 1210 kips for Bent 3
at depth of 56 feet pile capacity = 1051 kips > 1040 kips for Bent 4
add 7 feet to the pile length
pile tip elevation for compression = 83 - 65 = +18 ft Bent 2
= 79 - 69 = +10 ft Bent 3
= 82 - 65 = +17 ft Bent 4

Extreme Event limit
at depth of 28 ft pile capacity = 417 kips > 400 kips for Bent 2
at depth of 30 ft pile capacity = 459 kips > 450 kips for Bent 3
at depth of 25 ft pile capacity = 363 kips > 360 kips for Bent 4
add 7 feet to pile length

pile length for compression (Extreme event)
= 83 - 35 = +48 ft for Bent 2
= 79 - 37 = +42 ft for Bent 3
= 82 - 35 = +47 ft for Bent 4

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

PROJECT: Camino Capistrano UC (55-0227)
ITEM: 7 feet Diameter Shaft
Bents 2, 3 and 4

PROJECT NO.: 11-137
DONE BY: SP DATE: 04/04/12
CHECKED BY: DATE:

D_s =>	7.00 ft	Hw =>	19.0 ft	Hg =>	0.0 ft		
p =	21.99 ft	Ho =>	0.0 ft	Hf =>	0.0 ft		
Soil Layer =>	from Top to Bottom =>		γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	43	120	57.6	1.50	0	CL
(2)	43	80	120	57.6	2.30	0	CL

Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = +83 ft

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	120.0	0									
1	0.0	0.0	0.0	120.0	0	1.5				0.0			0.0	0.0
2	1.0	0.5	0.5	120.0	60	1.5	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	120.0	180	1.5	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	120.0	300	1.5	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	120.0	420	1.5	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	120.0	540	1.5	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
7	6.0	5.5	5.5	120.0	660	1.5	1.18	0.00	0.0	0.0	0.83	18.1	18.1	18.1
8	7.0	6.5	6.5	120.0	780	1.5	1.16	0.00	0.0	0.0	0.83	18.1	36.3	36.3
9	8.0	7.5	7.5	120.0	900	1.5	1.13	0.00	0.0	0.0	0.83	18.1	54.4	54.4
10	9.0	8.5	8.5	120.0	1020	1.5	1.11	0.00	0.0	0.0	0.83	18.1	72.6	72.6
11	10.0	9.5	9.5	120.0	1140	1.5	1.08	0.00	0.0	0.0	0.83	18.1	90.7	90.7
12	11.0	10.5	10.5	120.0	1260	1.5	1.06	0.00	0.0	0.0	0.83	18.1	108.9	108.9
13	12.0	11.5	11.5	120.0	1380	1.5	1.04	0.00	0.0	0.0	0.83	18.1	127.0	127.0
14	13.0	12.5	12.5	120.0	1500	1.5	1.02	0.00	0.0	0.0	0.83	18.1	145.1	145.1
15	14.0	13.5	13.5	120.0	1620	1.5	1.00	0.00	0.0	0.0	0.83	18.1	163.3	163.3
16	15.0	14.5	14.5	120.0	1740	1.5	0.99	0.00	0.0	0.0	0.83	18.1	181.4	181.4
17	16.0	15.5	15.5	120.0	1860	1.5	0.97	0.00	0.0	0.0	0.83	18.1	199.6	199.6
18	17.0	16.5	16.5	120.0	1980	1.5	0.95	0.00	0.0	0.0	0.83	18.1	217.7	217.7
19	18.0	17.5	17.5	120.0	2100	1.5	0.94	0.00	0.0	0.0	0.83	18.1	235.9	235.9
20	19.0	18.5	18.5	120.0	2220	1.5	0.92	0.00	0.0	0.0	0.83	18.1	254.0	254.0
21	20.0	19.5	19.5	57.6	2278	1.5	0.90	0.00	0.0	0.0	0.83	18.1	272.1	272.1
22	21.0	20.5	20.5	57.6	2335	1.5	0.89	0.00	0.0	0.0	0.83	18.1	290.3	290.3
23	22.0	21.5	21.5	57.6	2393	1.5	0.87	0.00	0.0	0.0	0.83	18.1	308.4	308.4
24	23.0	22.5	22.5	57.6	2450	1.5	0.86	0.00	0.0	0.0	0.83	18.1	326.6	326.6
25	24.0	23.5	23.5	57.6	2508	1.5	0.85	0.00	0.0	0.0	0.83	18.1	344.7	344.7
26	25.0	24.5	24.5	57.6	2566	1.5	0.83	0.00	0.0	0.0	0.83	18.1	362.9	362.9
27	26.0	25.5	25.5	57.6	2623	1.5	0.82	0.00	0.0	0.0	0.83	18.1	381.0	381.0
28	27.0	26.5	26.5	57.6	2681	1.5	0.81	0.00	0.0	0.0	0.83	18.1	399.1	399.1
29	28.0	27.5	27.5	57.6	2738	1.5	0.79	0.00	0.0	0.0	0.83	18.1	417.3	417.3
30	29.0	28.5	28.5	57.6	2796	1.5	0.78	0.00	0.0	0.0	0.83	18.1	435.4	435.4
31	30.0	29.5	29.5	57.6	2854	1.5	0.77	0.00	0.0	0.0	0.83	18.1	453.6	453.6
32	31.0	30.5	30.5	57.6	2911	1.5	0.75	0.00	0.0	0.0	0.83	18.1	471.7	471.7
33	32.0	31.5	31.5	57.6	2969	1.5	0.74	0.00	0.0	0.0	0.83	18.1	489.9	489.9
34	33.0	32.5	32.5	57.6	3026	1.5	0.73	0.00	0.0	0.0	0.83	18.1	508.0	508.0
35	34.0	33.5	33.5	57.6	3084	1.5	0.72	0.00	0.0	0.0	0.83	18.1	526.1	526.1
36	35.0	34.5	34.5	57.6	3142	1.5	0.71	0.00	0.0	0.0	0.83	18.1	544.3	544.3
37	36.0	35.5	35.5	57.6	3199	1.5	0.70	0.00	0.0	0.0	0.83	18.1	562.4	562.4
38	37.0	36.5	36.5	57.6	3257	1.5	0.68	0.00	0.0	0.0	0.83	18.1	580.6	580.6
39	38.0	37.5	37.5	57.6	3314	1.5	0.67	0.00	0.0	0.0	0.83	18.1	598.7	598.7
40	39.0	38.5	38.5	57.6	3372	1.5	0.66	0.00	0.0	0.0	0.83	18.1	616.9	616.9
41	40.0	39.5	39.5	57.6	3430	1.5	0.65	0.00	0.0	0.0	0.83	18.1	635.0	635.0
42	41.0	40.5	40.5	57.6	3487	1.5	0.64	0.00	0.0	0.0	0.83	18.1	653.1	653.1
43	42.0	41.5	41.5	57.6	3545	1.5	0.63	0.00	0.0	0.0	0.83	18.1	671.3	671.3
44	43.0	42.5	42.5	57.6	3602	1.5	0.62	0.00	0.0	0.0	0.83	18.1	689.4	689.4
45	44.0	43.5	43.5	57.6	3660	2.3	0.61	0.00	0.0	0.0	1.27	27.8	717.2	717.2

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
46	45.0	44.5	44.5	57.6	3718	2.3	0.60	0.00	0.0	0.0	1.27	27.8	745.1	745.1
47	46.0	45.5	45.5	57.6	3775	2.3	0.59	0.00	0.0	0.0	1.27	27.8	772.9	772.9
48	47.0	46.5	46.5	57.6	3833	2.3	0.58	0.00	0.0	0.0	1.27	27.8	800.7	800.7
49	48.0	47.5	47.5	57.6	3890	2.3	0.57	0.00	0.0	0.0	1.27	27.8	828.5	828.5
50	49.0	48.5	48.5	57.6	3948	2.3	0.56	0.00	0.0	0.0	1.27	27.8	856.3	856.3
51	50.0	49.5	49.5	57.6	4006	2.3	0.55	0.00	0.0	0.0	1.27	27.8	884.2	884.2
52	51.0	50.5	50.5	57.6	4063	2.3	0.54	0.00	0.0	0.0	1.27	27.8	912.0	912.0
53	52.0	51.5	51.5	57.6	4121	2.3	0.53	0.00	0.0	0.0	1.27	27.8	939.8	939.8
54	53.0	52.5	52.5	57.6	4178	2.3	0.52	0.00	0.0	0.0	1.27	27.8	967.6	967.6
55	54.0	53.5	53.5	57.6	4236	2.3	0.51	0.00	0.0	0.0	1.27	27.8	995.4	995.4
56	55.0	54.5	54.5	57.6	4294	2.3	0.50	0.00	0.0	0.0	1.27	27.8	1023.2	1023.2
57	56.0	55.5	55.5	57.6	4351	2.3	0.49	0.00	0.0	0.0	1.27	27.8	1051.1	1051.1
58	57.0	56.5	56.5	57.6	4409	2.3	0.49	0.00	0.0	0.0	1.27	27.8	1078.9	1078.9
59	58.0	57.5	57.5	57.6	4466	2.3	0.48	0.00	0.0	0.0	1.27	27.8	1106.7	1106.7
60	59.0	58.5	58.5	57.6	4524	2.3	0.47	0.00	0.0	0.0	1.27	27.8	1134.5	1134.5
61	60.0	59.5	59.5	57.6	4582	2.3	0.46	0.00	0.0	0.0	1.27	27.8	1162.3	1162.3
62	61.0	60.5	60.5	57.6	4639	2.3	0.45	0.00	0.0	0.0	1.27	27.8	1190.2	1190.2
63	62.0	61.5	61.5	57.6	4697	2.3	0.44	0.00	0.0	0.0	1.27	27.8	1218.0	1218.0
64	63.0	62.5	62.5	57.6	4754	2.3	0.43	0.00	0.0	0.0	1.27	27.8	1245.8	1245.8
65	64.0	63.5	63.5	57.6	4812	2.3	0.42	0.00	0.0	0.0	1.27	27.8	1273.6	1273.6
66	65.0	64.5	64.5	57.6	4870	2.3	0.42	0.00	0.0	0.0	1.27	27.8	1301.4	1301.4
67	66.0	65.5	65.5	57.6	4927	2.3	0.41	0.00	0.0	0.0	1.27	27.8	1329.3	1329.3
68	67.0	66.5	66.5	57.6	4985	2.3	0.40	0.00	0.0	0.0	1.27	27.8	1357.1	1357.1
69	68.0	67.5	67.5	57.6	5042	2.3	0.39	0.00	0.0	0.0	1.27	27.8	1384.9	1384.9
70	69.0	68.5	68.5	57.6	5100	2.3	0.38	0.00	0.0	0.0	1.27	27.8	1412.7	1412.7
71	70.0	69.5	69.5	57.6	5158	2.3	0.37	0.00	0.0	0.0	1.27	27.8	1440.5	1440.5
72	71.0	70.5	70.5	57.6	5215	2.3	0.37	0.00	0.0	0.0	1.27	27.8	1468.3	1468.3
73	72.0	71.5	71.5	57.6	5273	2.3	0.36	0.00	0.0	0.0	1.27	27.8	1496.2	1496.2
74	73.0	72.5	72.5	57.6	5330	2.3	0.35	0.00	0.0	0.0	1.27	27.8	1524.0	1524.0
75	74.0	73.5	73.5	57.6	5388	2.3	0.34	0.00	0.0	0.0	1.27	27.8	1551.8	1551.8
76	75.0	74.5	74.5	57.6	5446	2.3	0.33	0.00	0.0	0.0	1.27	27.8	1579.6	1579.6
77	76.0	75.5	75.5	57.6	5503	2.3	0.33	0.00	0.0	0.0	1.27	27.8	1607.4	1607.4
78	77.0	76.5	76.5	57.6	5561	2.3	0.32	0.00	0.0	0.0	1.27	27.8	1635.3	1635.3
79	78.0	77.5	77.5	57.6	5618	2.3	0.31	0.00	0.0	0.0	1.27	27.8	1663.1	1663.1
80	79.0	78.5	78.5	57.6	5676	2.3	0.30	0.00	0.0	0.0	1.27	27.8	1690.9	1690.9
81	80.0	79.5	79.5	57.6	5734	2.3	0.30	0.00	0.0	0.0	1.27	27.8	1718.7	1718.7

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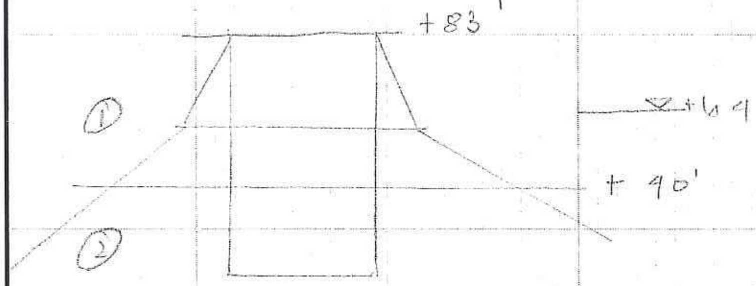
Project: Camino Capistrano UC (55-0227) Project No. 11-137

By SP Date 4/4/12 Checked By LCC Date 4/4/12 Sheet ___ of ___

Bents settlement



shaft dia = 7 ft

Total load = 583 kips
permanent load = 450 kips

consider pile length = 27 ft

$2D/3 = 18$

Equivalent footing $= (7 + \frac{18}{4} \times 2)$
$=$ 16 ft shaft

$q = \frac{583}{(\frac{\pi}{4} \times 16^2)} = 2.9$ ksf for immediate settlement

$= \frac{450}{(\frac{\pi}{4} \times 16^2)} = 2.2$ ksf for consolidation settlement

σ_{vo}	$\Delta\sigma$	settlement
① $18 \times 120 + 5 \times 57.6 = 2.45$	$\frac{450}{\pi/4 \times (16+5)^2} = 1.3$	$10 \times \frac{1}{40} \log\left(\frac{2.45 + 1.3}{2.45}\right) = 0.55$
$18 \times 120 + 17.5 \times 57.6 = 3.17$	$\frac{450}{\pi/4 \times (16+17.5)} = 0.51$	$15 \times \frac{1}{40} \log\left(\frac{3.17 + 0.51}{3.17}\right) = 0.29$
② $19 \times 120 + 34 \times 57.6 = 4.24$	$\frac{450}{\pi/4 \times (16+35)^2} = 0.22$	$20 \times \frac{1}{40} \log\left(\frac{4.24 + 0.22}{4.24}\right) = 0.13$
		0.97

pile tip elevation for settlement = 83 − 27 = +56 ft for Bent 2
= 79 − 27 = +52 ft for Bent 3
= 82 − 27 = +55 ft for Bent 1

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

This program is licensed to:

Earth Mechanics, Inc.
Earth Mechanics, Inc.

Files Used for Analysis

Path to file locations: X:\Projects\2011\11-137 - TRC, I-5 HOV Widening - Segment 3\Reports\04 Camino Capistrano UC (55-0227)\Appendix C Analyses\Lateral Capacity\
Name of input data file: Camino Capistrano 7-foot Shaft (Bents).lp6d
Name of output file: Camino Capistrano 7-foot Shaft (Bents).lp6o
Name of plot output file: Camino Capistrano 7-foot Shaft (Bents).lp6p
Name of runtime file: Camino Capistrano 7-foot Shaft (Bents).lp6r

Date and Time of Analysis

Date: April 6, 2012 Time: 19:23:05

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 90.00 ft

Depth of ground surface below top of pile = 0.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	84.0000000
2	90.000000	84.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	90.000 in
Top Width	=	84.000 in
Bottom Width	=	84.000 in
Top Area	=	5541.000000 sq. in
Bottom Area	=	5541.000000 sq. in
Moment of Inertia at Top	=	1.222E+06 in^4
Moment of Inertia at Bottom	=	1.222E+06 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 0.000 ft
Distance from top of pile to bottom of layer = 19.000 ft

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 19.000 ft
Distance from top of pile to bottom of layer = 24.000 ft

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 24.000 ft
Distance from top of pile to bottom of layer = 100.000 ft

(Depth of lowest layer extends 10.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 6 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	0.00	120.00000
2	19.00	120.00000
3	19.00	57.60000
4	24.00	57.60000
5	24.00	57.60000

6 100.00 57.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	Soft Clay	0.00	120.000	1500.000	--	--	--	0.00700	--	--	--	--	--	--
		19.000	120.000	1500.000	--	--	--	0.00700	--	--	--	--	--	--
2	Soft Clay	19.000	57.600	1500.000	--	--	--	0.00700	--	--	--	--	--	--
		24.000	57.600	1500.000	--	--	--	0.00700	--	--	--	--	--	--
3	Soft Clay	24.000	57.600	2300.000	--	--	--	0.00500	--	--	--	--	--	--
		100.000	57.600	2300.000	--	--	--	0.00500	--	--	--	--	--	--

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 250000.000 lbs	M = 82224000.000 in-lbs	1020000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

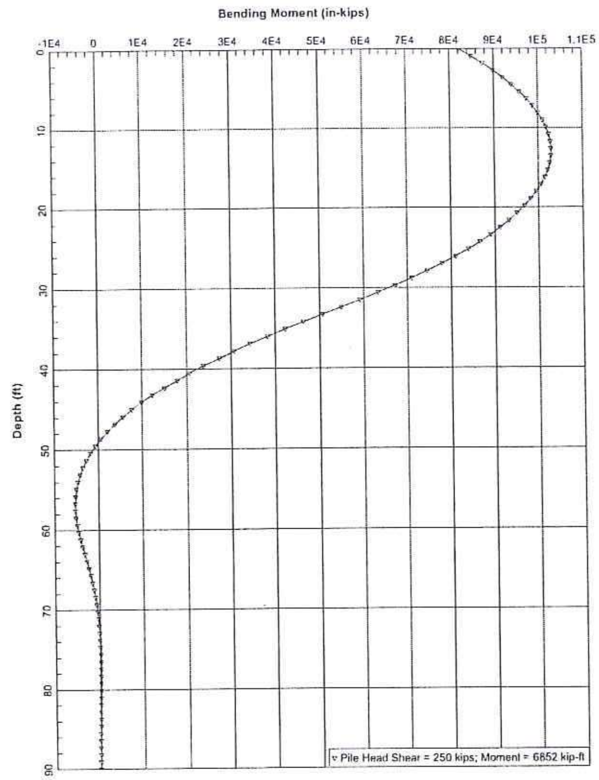
Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	1	V = 250000.	M = 82224000.	1020000.	2.04005947	102896024.	-397821.	0.00000000

Summary of Warning Messages

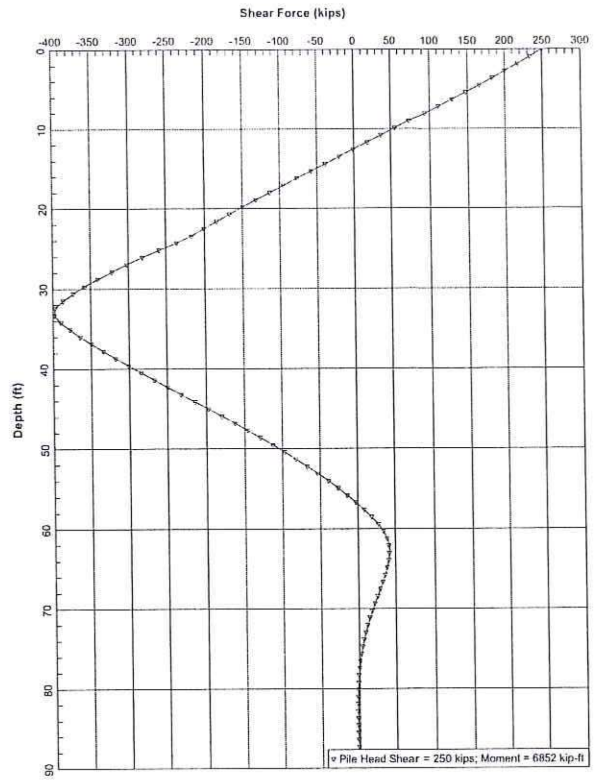
The following warning was reported 2525 times

**** Warning ****

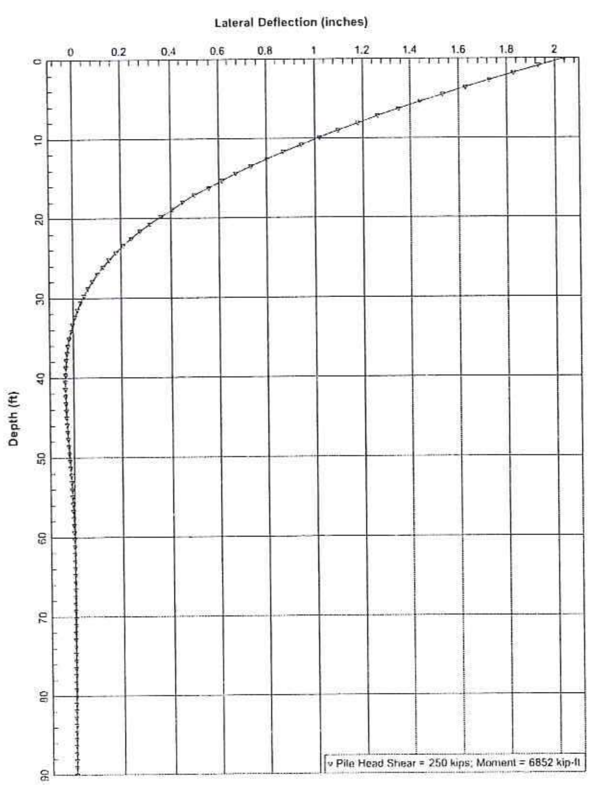
An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.



Camino Capistrano UC - 7-foot Diameter CIDH Piles at Bents



Camino Capistrano UC - 7-foot Diameter CIDH Piles at Bents



Camino Capistrano UC - 7-foot Diameter CIDH Piles at Bents

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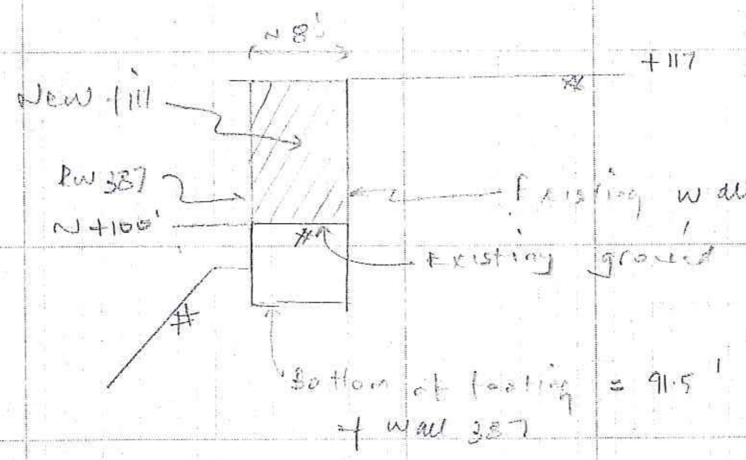
(714) 751-3826, Fax (714) 751-3928

Project Camino Capistrano UC (55-0227) Project No. 11-137

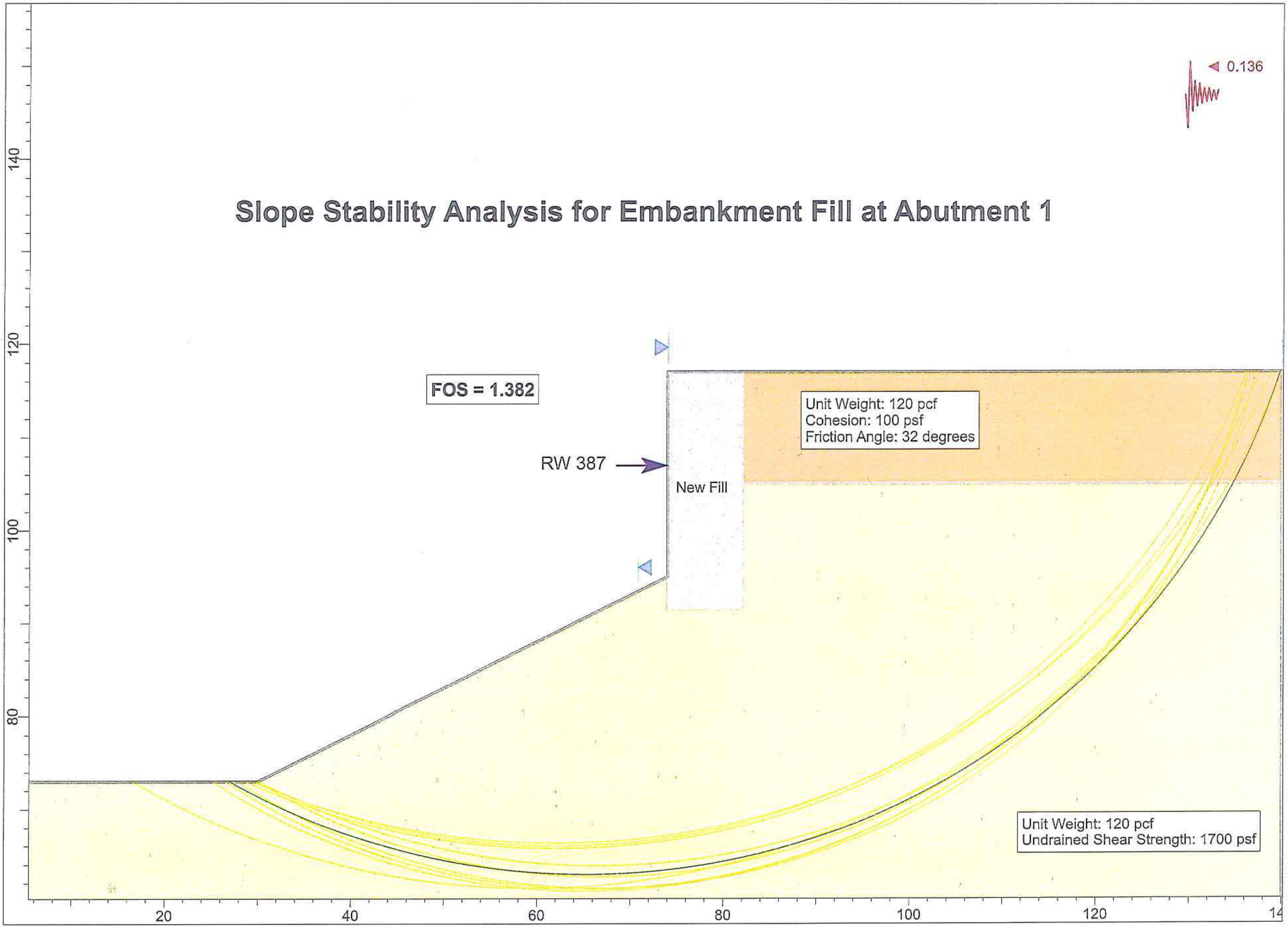
By SP Date 4/6/12 Checked By ______ Date ______ Sheet ____ of ____

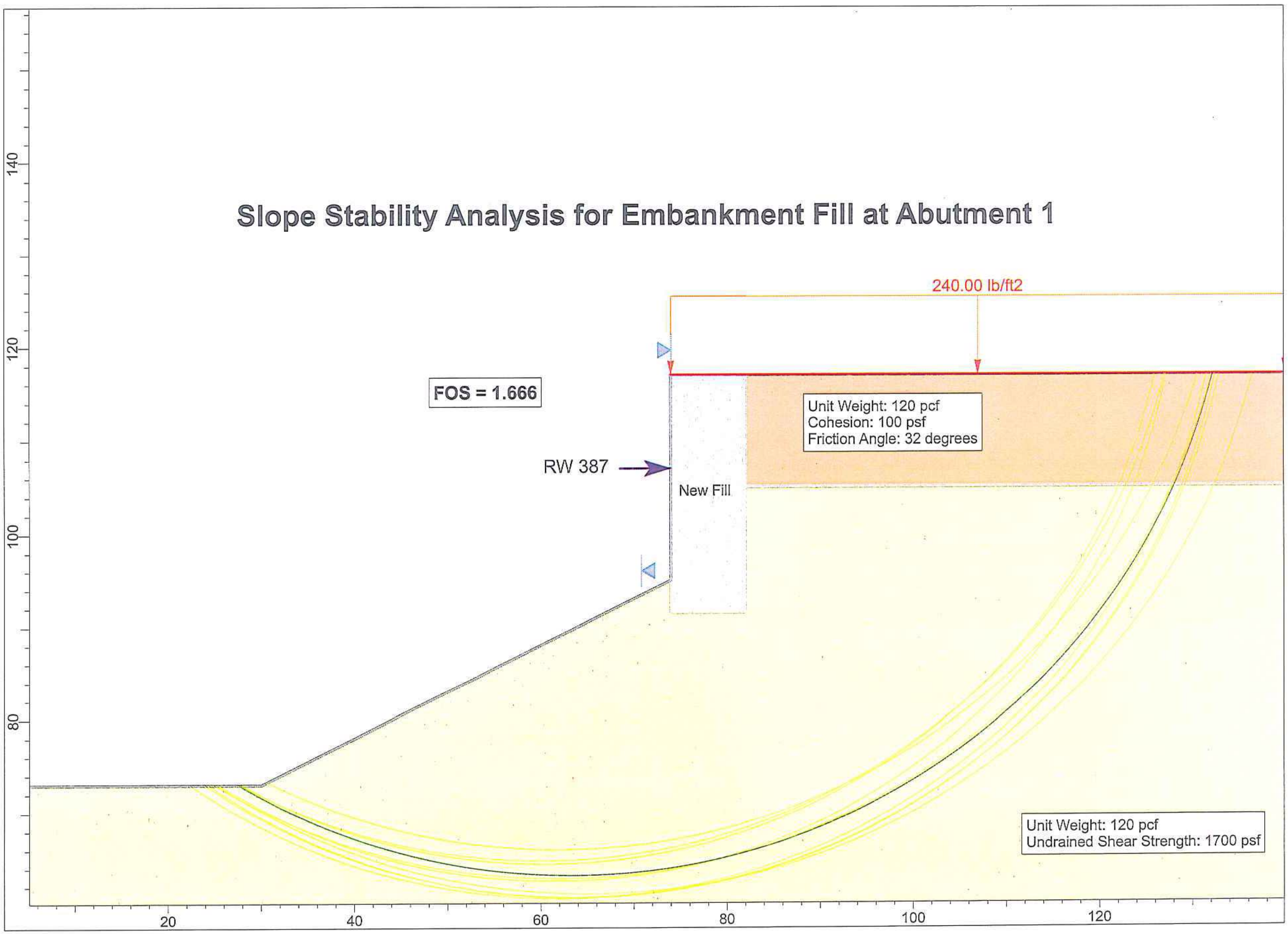
Embankment fill at Abutment 1



Due to new fill = 17 × 120 = 2 ksf

σvo	Δσ	settlement
15×120 = 1.8	2 × 0.7 = 1.4	$10 \times \frac{1}{40} \log\left(\frac{1.8+1.4}{1.8}\right) = 0.75$
27×120 = 3.2	2 × 0.25 = 0.5	$14 \times \frac{1}{40} \log\left(\frac{3.2+0.5}{3.2}\right) = 0.36$
		1.0"


0.136
Slope Stability Analysis for Embankment Fill at Abutment 1
FOS = 1.382
RW 387
New Fill
Unit Weight: 120 pcf
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 120 pcf
Undrained Shear Strength: 1700 psf
140
120
100
80
20
40
60
80
100
120
14


Slope Stability Analysis for Embankment Fill at Abutment 1
240.00 lb/ft2
FOS = 1.666
RW 387
New Fill
Unit Weight: 120 pcf
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 120 pcf
Undrained Shear Strength: 1700 psf
140
120
100
80
20
40
60
80
100
120

Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESPONSES

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JEFF DEFEVERE
Office of Special Funded Projects (OSFP)
Attention: Ms. LUQI YANG
Fax: (916) 227-8683

DATE: January 22, 2013

FILE: 12 ORA 05 7.4
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: Jan. 19, 2013

Camino Capistrano UC (Widen)
Structure Name

GENERAL PLAN DATED: Nov. 12, 2012 FDN PLAN DATED: Nov.12, 2012

12-0F96E4 55-0227L
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Revised Final Foundation Report for Camino Capistrano Undercrossing (Widen), Bridge No. 55-0227L, Orange County, California, 12-ORA-05, PM 7.4, Caltrans Project No. 1200020279, EA No 12-0F96E4", prepared by Earth Mechanics, Inc, dated January 19, 2013.

During our review we made reference to the following:

- OGDS-1 review comment memorandum dated January 4, 2013.
- Responses to OGDS-1 review comment memorandum, prepared by Earth Mechanics, Inc., dated January 11, 2013.

The consultants have adequately responded to our review comments and incorporated the revisions in the subject report. Include this memorandum in the report, where appropriate.

.

Please call Sharid Amiri at (949)724-2599, if you have any questions.

Approval:

Reviewed By: Sharid Amiri, PhD, P.E.
Geotechnical Design South-1

(C1) Approved
Office of Special Funded projects

Cc: OGDS (Sacramento) DES Office of Specifications and Estimates (All Reviews) OSC R.E Pending File

Raja Pirathiviraj

From: Sharid Amiri <sharid.amiri@dot.ca.gov>
Sent: Saturday, January 19, 2013 5:34 PM
To: Raja Pirathiviraj; Salama, Ayman
Cc: Ahmed Abou-Abdou; Salama, Ayman; Kamran Mazhar; Luqi Yang (luqi.yang@dot.ca.gov); Lino Cheang
Subject: RE: EFIS 1200020279, FR (Bridge Structures Foundation Report) "Over the shoulder" review: Review of January 11th, Consultant response memo
Attachments: EMI Response Calculations.pdf

Your response is adequate, please revise the subject reports and submit them (pdf) for our review.

Thank you

Sharid K. Amiri (PhD, PE)

Senior Transportation Engineer
D-12 Oversight
Geotechnical Design South-1
3347 Michelson Drive, Suite 100
Irvine, Ca. 92612
Tel. (949) 724-2599

Raja Pirathiviraj <raja@earthmech.com>

Raja Pirathiviraj <raja@earthmech.com>

01/19/2013 03:00 PM

To: Sharid Amiri <sharid.amiri@dot.ca.gov>

cc: Lino Cheang <L.Cheang@earthmech.com>, Kamran Mazhar <kamran.mazhar@dot.ca.gov>, Ahmed Abou-Abdou <ahmed.abou-abdou@dot.ca.gov>, "Luqi Yang (luqi.yang@dot.ca.gov)" <luqi.yang@dot.ca.gov>, "Salama, Ayman" <ASalama@trcsolutions.com>

Subject: RE: EFIS 1200020279, FR (Bridge Structures Foundation Report) "Over the shoulder" review: Review of January 11th, Consultant response memo

Sharid,

Thank you for reviewing our responses. Please see below our responses to your comments in your email for Bridge No. 55-0226, Bridge No. 55-0510 and Bridge No. 55-0227. Please let us know if you accept it.

For convenience, your email comments are provided in ***bold and italics*** followed by EMI responses in square parenthesis.

- ***The Foundation Reports were submitted to Caltrans on November 28th, 2012. Include the latter and revise the response memo accordingly.***

[EMI Response: We will revise our response memo as "Earth Mechanics, Inc. (EMI) submitted the Final Foundation Report, dated October 5, 2012, to Caltrans for Review and Caltrans Office of Geotechnical Design South 1 (OGDS-1) has received it on November 28, 2012" and will include in Appendix D of the report.]

- ***Expand on the response to comment No.16: "...Sufficient data does not exist to modify the Nk value for local conditions"..***

In retrospect, what engineering tasks should have been performed so that sufficient data exist to evaluate site specific Nk? explain.

[EMI Response: Based on the CPT interpretation files provided in Appendix A of the report, an Nk value of 15 was used in estimating the undrained shear strength values using CPT correlation, which is the mid value of typical Nk values that range between 10 and 20 indicated in the CPT guidelines by Robertson (2009). In addition, based on our laboratory test results, over consolidation ratio (OCR) is slightly higher than 1.0. The OCR of 1 or slightly higher indicates that the soil is normally consolidated or slightly over consolidated (calculation sheets are attached). Based on these data, we believe that using Nk value of 15 is appropriate for the design. Based on Nk value of 15 and cone tip resistances, the estimated undrained shear strength values are higher than the undrained shear strength values used in our design; therefore, the design is appropriately conservative.
In retrospect, the cone factor Nk, which varies mainly between 10 and 20 should preferably have been obtained from empirical correlation with the strength test used in that area (Robertson, 2009). As a minimum, we believe that one boring and two to five CPT soundings should be performed for a site, depending on the number of supports and width of the bridge. This boring used for sampling and testing should be performed next to one of the CPT soundings to check the local CPT correlations and soil behavior type. The boring should be extended to the same depth as he CPT sounding. Soil samples should be taken at least every 2.5 or 3 feet using SPT, Modified California Drive, or other appropriate samplers, or at changes in soil stratigraphy. Additional confirmation borings and CPT soundings should be necessary if the site is large or the subsurface conditions vary significantly within the site. The need for and the number of the additional borings should be determined by the project geotechnical consultant, subject to the review of the appropriate regulatory agencies.]

- ***Robertson (2009) is cited as a reference in the response to comment No.16. Include it in the list of references in the subject Foundation Reports and revise accordingly.***

[EMI Responses:
Robertson, P.K., 2009, Interpretation of Cone Penetration Tests – A Unified Approach, Canadian Geotechnical Journal Volume 46: 1337-1355. We will include this reference in the report.]

- ***Include all Caltrans geotechnical review comments and the over the shoulder review comments (i.e.email correspondence) in the appendix.***

[EMI Response: We will include all the email correspondences in the Appendix D of the report.]

Thanks
regards
Raja

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

"Raja" Sivasubramaniam Pirathiviraj, P.E., G.E.
Earth Mechanics Inc | Senior Staff Engineer | 17800 Newhope Street, Suite B, Fountain Valley CA 92708 | Office 714.751-3826 Ext. 123 | Fax 714.751-3928

From: Sharid Amiri [mailto:sharid.amiri@dot.ca.gov]
Sent: Friday, January 18, 2013 3:34 PM
To: Salama, Ayman; Luqi Yang
Cc: Lino Cheang; Raja Pirathiviraj; Kamran Mazhar; Ahmed Abou-Abdou
Subject: EFIS 1200020279, FR (Bridge Structures Foundation Report) "Over the shoulder" review: Review of January 11th, Consultant response memo

Bridge No.55-0226, Bridge No.55-0510, Bridge No.55-0227

- The Foundation Reports were submitted to Caltrans on November 28th, 2012. Include the latter and revise the response memo accordingly.
- Expand on the response to comment No.16: "...Sufficient data does not exist to modify the Nk value for local conditions"..

In retrospect, what engineering tasks should have been performed so that sufficient data exist to evaluate site specific Nk? explain.

- Robertson (2009) is cited as a reference in the response to comment No.16. Include it in the list of references in the subject Foundation Reports and revise accordingly.
- Include all Caltrans geotechnical review comments and the over the shoulder review comments (i.e.email correspondence) in the appendix.

Our office will review the revised foundation reports, once we receive them and submit the review memorandum accordingly.

Sharid K. Amiri (PhD, PE)

Senior Transportation Engineer
D-12 Oversight
Geotechnical Design South-1
3347 Michelson Drive, Suite 100
Irvine, Ca. 92612
Tel. (949) 724-2599

"Salama, Ayman" <ASalama@trcsolutions.com>

"Salama, Ayman" <ASalama@trcsolutions.com>	To	Sharid Amiri <sharid.amiri@dot.ca.gov>
	cc	"Ahmed Abou-Abdou (ahmed.abou-abdou@dot.ca.gov)" <ahmed.abou-abdou@dot.ca.gov>, Bob Bazargan <bob.bazargan@dot.ca.gov>, Kamran Mazhar <kamran.mazhar@dot.ca.gov>, Luqi Yang <luqi.yang@dot.ca.gov>, "L.Cheang@earthmech.com" <L.Cheang@earthmech.com>, "raja@earthmech.com" <raja@earthmech.com>
01/16/2013 01:42 PM	Subject	Re: EFIS 1200020279, FR (Bridge Structures Foundation Report) Review (2nd)

I understand Sharid.
Thank you for working with us to meet the tight schedule for HQ-OE.
Best regards,

Ayman Salama
TRC
T: 949 789 4413
C: 949 798 9385

On Jan 16, 2013, at 11:08 AM, "Sharid Amiri" <sharid.amiri@dot.ca.gov> wrote:

Hi Ayman

I am in receipt of your email. I will submit my review comments for the response for the three bridge structures by Friday. Keep in mind that some of these comments had to do with the quality of the calcs that have not been reviewed in its entirety.

We will review the revised reports once these comments are incorporated.

Sharid K. Amiri (PhD, PE)

Senior Transportation Engineer
D-12 Oversight
Geotechnical Design South-1
3347 Michelson Drive, Suite 100
Irvine, Ca. 92612
Tel. (949) 724-2599
<graycol.gif>"Salama, Ayman" <ASalama@trcsolutions.com>

"Salama, Ayman" <ASalama@trcsolutions.com>

01/16/2013 10:02 AM

<ecblank.gif><ecblank.gif>
To Sharid Amiri <sharid.amiri@dot.ca.gov>
<ecblank.gif><ecblank.gif>
cc Kamran Mazhar <kamran.mazhar@dot.ca.gov>, Luqi Yang <luqi.yang@dot.ca.gov>, "Ahmed Abou-Abdou (ahmed.abou-abdou@dot.ca.gov)" <ahmed.abou-abdou@dot.ca.gov>, Bob Bazargan <bob.bazargan@dot.ca.gov>, "L.Cheang@earthmech.com" <L.Cheang@earthmech.com>, "raja@earthmech.com" <raja@earthmech.com>
<ecblank.gif><ecblank.gif>
Subject RE: EFIS 1200020279, FR (Bridge Structures Foundation Report) Review (2nd)

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Hi Sharid,
It was nice talking with you today to follow up on the status on the Foundation Reports for Bridge Nos. 55-0510, 55-0226, and 55-0227L.
It is my understanding that EMI met with you last week and submitted a response to your comments on the three FRs on Saturday 01/12/13 and if you agreed with their responses they will revise the foundation reports for the three bridges and

submit the final foundation reports.

Due to the project schedule we need to submit the Final PSE package to HQ-OE on Tuesday next week (01/22) and I would really appreciate it if you can review and respond to EMI responses for to your comments on the reports and provide them with your comments for each report as soon as you complete your review and hopefully will get all the reviews complete by this Friday 01/18 as EMI will need 3 days to revise the three reports and submit them to us on Monday COB or Tuesday morning the latest.

I truly appreciate your continuous support and cooperation to prioritize the review of these three bridges and to provide EMI with your review comments bridge by bridge so they can work in parallel while you are reviewing the other reports.

Best Regards,
Ayman

From: Sharid Amiri [mailto:sharid.amiri@dot.ca.gov]
Sent: Sunday, January 06, 2013 7:28 PM
To: Luqi Yang
Cc: Bob Bazargan; Kamran Mazhar; L.Cheang@earthmech.com; Salama, Ayman
Subject: EFIS 1200020279, FR (Bridge Structures Foundation Report) Review (2nd)

Luqi

Please find attached

(See attached file: Route 5_1 Separation _widen__ Bridge No. 55-0510_FR Review_2__ 100512_ EMI.pdf)(See attached file: 5_N5-N1 Connector Separation _widen__ Bridge No. 55-0226_FR Review_2__ 100512_ EMI.pdf)(See attached file: Camino Capistrano UC_ Bridge No. 55-0227L_FR Review_2__ 100512_ EMI.pdf)

Sharid K. Amiri (PhD, PE)

Senior Transportation Engineer
D-12 Oversight
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3347 Michelson Drive, Suite 100
Irvine, Ca. 92612
Tel. (949) 724-2599

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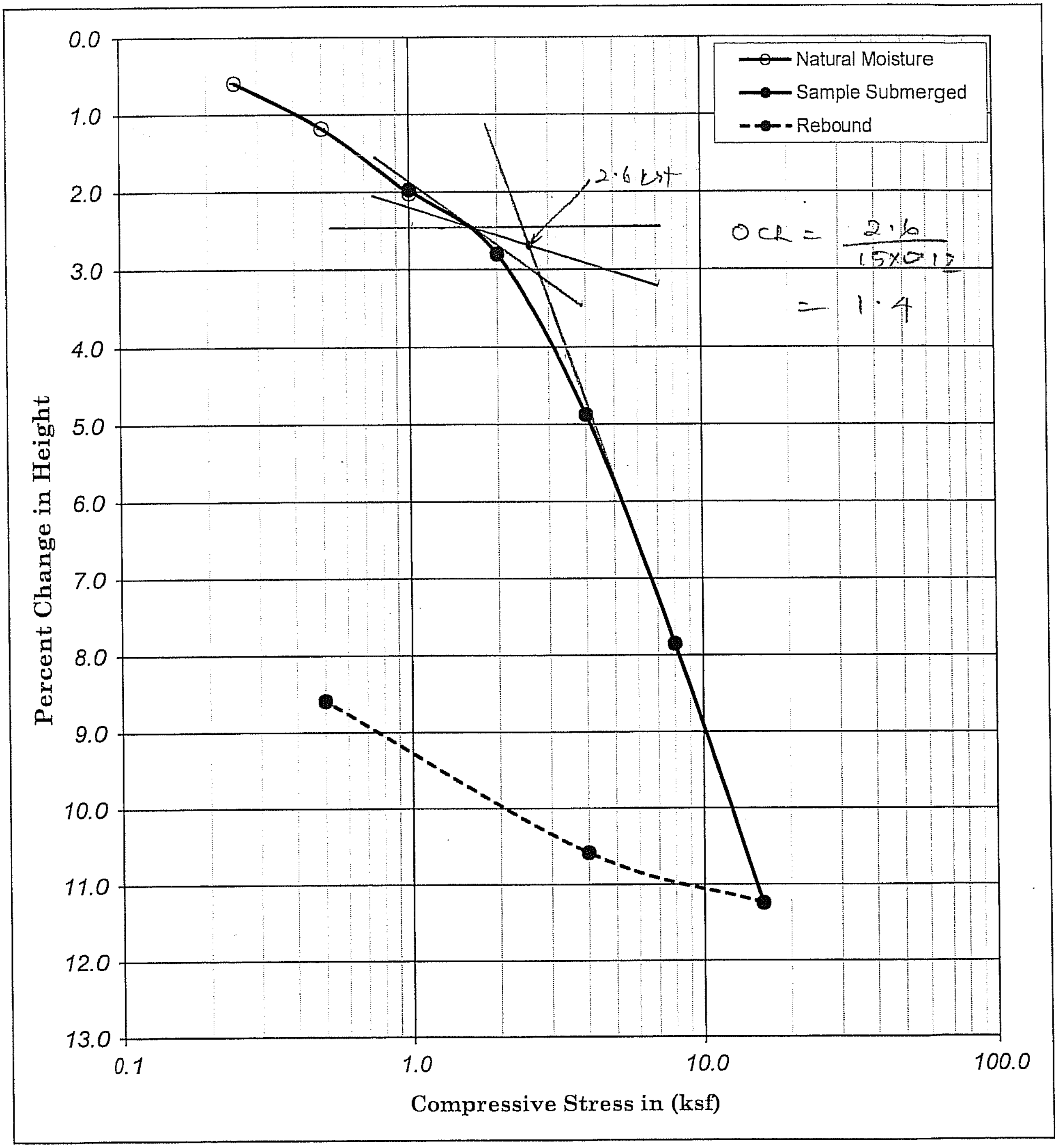


							Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Boring No.	: A-11-319		Liquid Limit :	-							
Sample No.	: D-3		Plastic Limit :	-							
Depth	(ft) : 15.0	16.5	Plastic Index :	-	Initial		24.03	98.00	15.43	90.11	0.72
	(m) : 4.58	5.03	Specific Gravity :	2.70	Final		21.19	107.25	16.88	100.10	0.57

Description : *Olive-gray with yellowish brown , Lean CLAY (CL)*

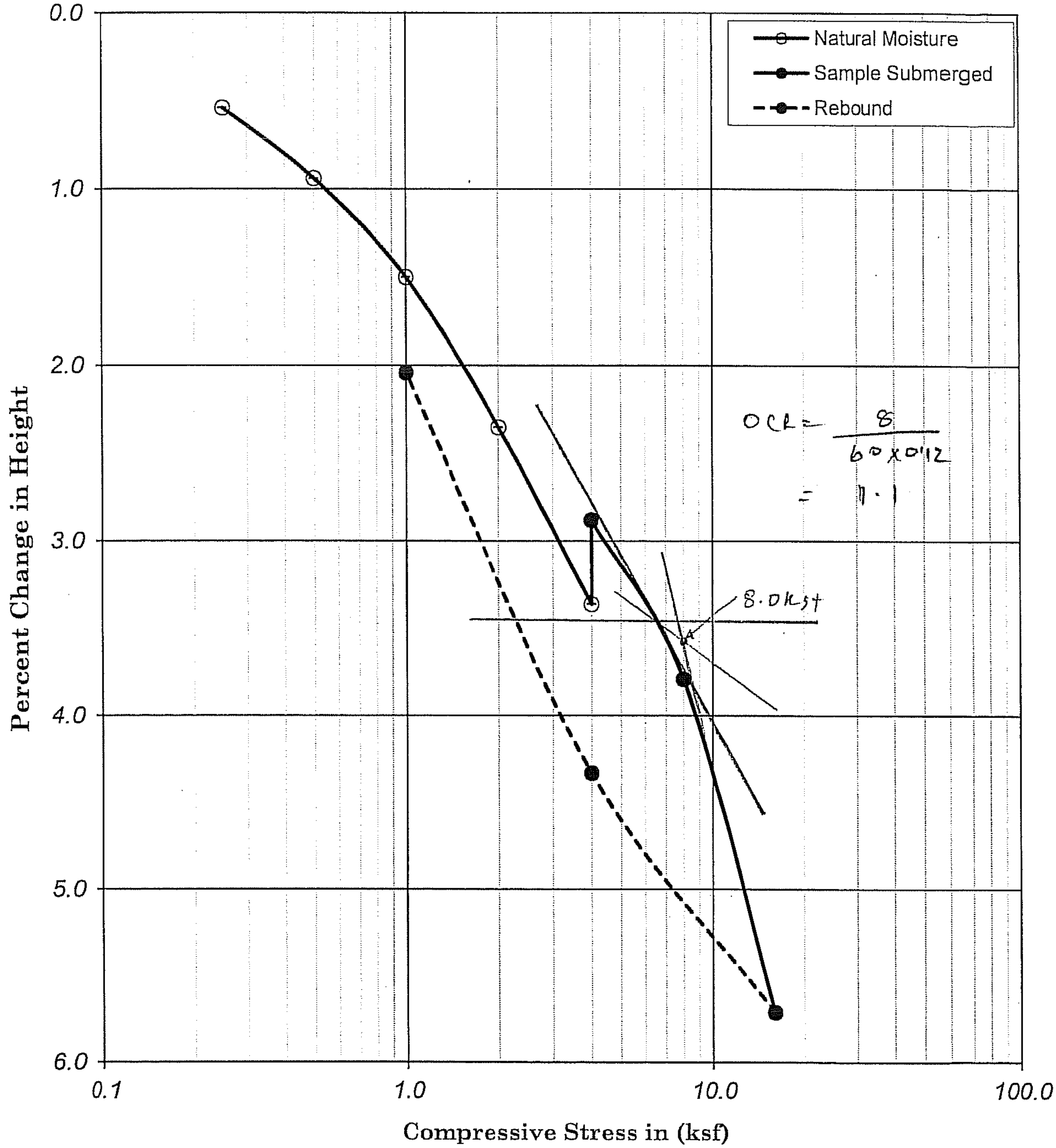
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

I-5 HOV Improvement Project
PCH to San Juan Creek Road

Project No.: 11-137 12/04/11

CONSOLIDATION TEST

(ASTM D-2435 / CT-219)



Boring No.	: A-11-319		Liquid Limit :	-		Moisture Content (%)	Dry Density		Percent Saturation	Void Ratio
Sample No.	: D-13		Plastic Limit :	-			(pcf)	(kN/m³)		
Depth (ft)	: 60.0	61.5	Plastic Index :	-	Initial	33.85	84.62	13.32	92.12	0.99
Depth (m)	: 18.30	18.76	Specific Gravity :	2.70	Final	36.30	86.39	13.60	103.05	0.95

Description : *Very dark gray, Elastic SILT (MH)*

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

I-5 HOV Improvement Project
PCH to San Juan Creek Road

Project No. : *11-137* *12/04/11*

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)

MEMORANDUM

EMI PROJECT NO: 11-137

DATE: January 19, 2013

PREPARED FOR: Dr. Ayman Salama / TRC Solutions, Inc. (TRC)

PREPARED BY: (Raja) S. Pirathiviraj and Lino Cheang / Earth Mechanics, Inc. (EMI)

SUBJECT: Responses to Caltrans 2nd Review Comments
Final Foundation Report for Camino Capistrano Undercrossing (Widen)
Bridge No. 55-0227L
Orange County, California
12-ORA-5, PM 7.4
Caltrans Project No. 1200020279 (EA 12-0F96E4)

Earth Mechanics, Inc. (EMI) submitted the Final Foundation Report, dated October 5, 2012, to Caltrans for review and Caltrans Office of Geotechnical Design South 1 (OGDS-1) has received the report on November 28, 2012. OGDS-1 has reviewed the report and provided their comments in a memorandum dated January 04, 2013. A copy of the memorandum is provided in Attachment 1.

This memorandum provides our responses to Caltrans OGDS-1 comments. For convenience, Caltrans comments are provided in italics followed by EMI responses.

1. Title Sheet addressed to TRC: Include the date of the meeting where over the shoulder meeting was conducted and the name of the oversight geo-professional.

The second paragraph of the title sheet (letter) will be revised as follows:

"Earlier versions of this report dated April 23, 2012 and October 5, 2012 were submitted to Caltrans for review. Office of Geotechnical Design South 1 (OGDS-1) provided their comments in memorandums dated August 31, 2012 and January 4, 2013. EMI prepared responses to the OGDS-1 review comments, which were reviewed by the Caltrans Oversight Geo-Professional Dr. Sharid Amiri at the over-the-shoulder review meeting conducted at the EMI office on September 20, 2012 and January 9, 2013. The EMI oversight engineers, Mr. Lino Cheang and Mr. Raja Pirathiviraj on September 20, 2012, and Mr. Andrew Korkos, Mr. Mike Kapuskar and Mr. Raja Pirathiviraj on January 9, 2013, were the attendees of the meeting. Responses to Caltrans comments have been incorporated into this Revised Final Foundation Report. Caltrans review comments and EMI responses are provided in Appendix D."

2. Existing geotechnical information was reviewed and collected to prepare the subject report. Revise Section 1.2 of the subject report accordingly.

This task is listed in Section 1.1 of the report as a first bullet item.

3. The site investigation must be site specific and stated as such in the report. Revise Section 1.2 of the subject report accordingly.

The second bullet item in Section 1.1 of the report will be revised as follows:.

“ • Site-specific field exploration consisting of drilling and logging exploratory borings and cone penetration test (CPT) sounding;”

4. Project description does not make any reference to the other bridge structures that are part of the subject project. Revise Section 1.3 accordingly.

The first paragraph in Section 1.2, Project Description, will include reference to the other bridge structures as follows:

“The proposed improvement project includes widening of three bridge structures; 5/N5-N1 Connector Separation (Bridge No. 55-0226), Route 5/1 Separation (Bridge No. 55-0510) and Camino Capistrano Undercrossing (Bridge No. 55-0227)”

5. Revise Section 1.0 to include a table for “As-Built Foundation Data” with the relevant information.

A “Section 1.3. As-Built Foundation Data” will be included in Section 1.0 of the report as follows.

“1.3 As-Built Foundation Data

This existing bridge was originally entitled “Serra On-Ramp Undercrossing” in the 1960 and 1969 as-built plans, and then changed to “Camino Capistrano On-Ramp Undercrossing” in the 1996 as-built plans. Currently, the bridge is known as “Camino Capistrano Undercrossing”. The structure was originally constructed in 1960 as separate left and right bridges. The left and right bridges were widened in 1969. The median was closed in 1996. The existing structure is a four-span structure with a variable length of about 250 feet and a variable width of about 164 feet. The existing UC is supported on shallow and pile foundations. Pertinent foundation data as shown on the as-built plans is summarized in Table 1-1.

Table 1-1. As-Built Foundation Data

Structures	Support Location	Foundation Type	Foundation Load	Bottom of Footing Elevations (feet)	Average As-Built Pile Tip Elevations (feet)
1960 Original	Abutment 1R	Concrete Piles	45 tons	+101.0	+38.6 to +41.3
	Bent 2R			+85.5 to +88.0	+34.7 to +49.7
	Bent 3R	Spread Footing	3 tsf	+75.0 to +80.5	Not Applicable
	Bent 4R			+80.5 to +85.0	
	Abutment 5R			+95.0 to +96.5	
	Abutment 1L	Concrete Piles	45 tons	+96.5 to +100.5	+34.7
	Bent 2L			+79.5 to +88.0	+34.7
	Bent 3L			+75.0 to +76.5	+34.7
	Bent 4L			+77.0 to +78.5	+39.7
	Abutment 5L			+90.0 to +96.5	+39.6
1969 Widening	Abutment 1R	16-inch CIDH Piles	45 tons	Match Existing	+55.0
	Bent 2R			+86.0	+54.3
	Bent 3R			+80.0	+54.3
	Bent 4R			+80.0	+59.0
	Abutment 5R			+93.0	+64.0
	Abutment 1L	Driven Class I Concrete Piles	45 tons	+89.75 to +96.5	+34.5
	Bent 2L			+80.0	+35.0
	Bent 3L			+74.0	+10.0
	Bent 4L			+76.0	+35.0
	Abutment 5L			+98.0	+34.0
1996 Median Closure	Abutment 1R	Driven PCC, 15-inch Octagonal Piles	70 tons	Match Existing	+28.20
	Abutment 1L			Match Existing	+28.20
	Bent 2			+78.5	+30.00
	Bent 3			+73.0	+40.00
	Bent 4			+75.0	+40.00
	Abutment 5R			Match Existing	+53.75
	Abutment 5L			Match Existing	+55.92

6. *Revise the notes in Table 2.1, to include the appropriate Survey Datum.*

We will include the survey datum in the notes in Table 2-1 as follows:

"Exploration locations were field surveyed using California Coordinate System (CCS) 83 (1991.35) Zone 6 and vertical datum NAVD 1988."

7. Revise Section 2 to include survey conducted for each boring and CPT.

We will revise the second paragraph in Section 2.1 of the report as follows:

"To supplement the existing subsurface information, three soil borings and one cone penetration test (CPT) sounding were performed between October 2 and 11, 2011. The exploration locations were field surveyed using California Coordinate System (CCS) 83 (1991.35) Zone 6 and vertical datum NAVD 1988 to obtain coordinates and elevations and establish stations and offsets. Boring information, including surveyed locations and elevations, are summarized in Table 2-1. Locations of the borings and CPTs are shown on the LOTB sheets provided in Appendix A."

8. Revise Section 2.0 of the subject report to include a narrative as to how the hammer efficiency is assessed per Caltrans Guidelines.

The fourth paragraph in Section 2.1 of the report will include a narrative as to how the hammer efficiency is assessed as follows:

"The SPT hammer energy measurements for this drill rig were performed by SPT CAL under subcontract with 2R Drilling on April 14, 2011. The SPT hammer energy report is provided in Appendix A."

9. Revise Section 2.2 to include a Table for the laboratory tests performed with type of test, applicable test method (i.e. ASTM, CT designation) and purpose of the test.

Section 2.2 of the foundation report will be revised to include the table below.

Table 2-2. Explanation of Laboratory Tests Performed

Type of Test	Applicable Test Method	Purpose
Unit Weight	ASTM D 4767	Estimate in-situ unit soil weight
Moisture Content	ASTM D 2216	Estimate in-situ soil moisture content
Percent Passing No. 200 Sieve	ASTM D 1140	Determine the percentage of fine grained particles of soil
Consolidation	ASTM D 2435	Determine compressibility of fine-grained soil
Direct Shear	ASTM D 3080	Determine strength parameters of coarse-grained soil
Unconsolidated Undrained Triaxial	ASTM D 2850	Estimate strength parameters of fine-grained soil
Soil pH	CT 532/643	Determine corrosion potential of soil
Minimum Resistivity	CT 532/643	Determine corrosion potential of soil
Sulfate Content	CT 417	Determine corrosion potential of soil
Chloride Content	CT 422	Determine corrosion potential of soil

Notes:
1. ASTM = American Society for Testing and Materials.
2. CT = California Test Method.

10. Revise Section 4.0 to include a separate subsection (i.e. 4.3) for Idealized Soil Profile along with the Table 2 and the corresponding narrative.

"Section 4.2 Idealized Soil Profile" will be added to the Foundation Report along with "Table 4-1 Idealized Soil Profile and Strength Parameters".

11. Insert the Idealized Soil Profile in the main report where appropriate.

"Figure 4-1 Idealized Soil Profile" will be added to the Section 4.2 of the report.

12. Revise the Idealized Soil Profile to include station line.

"Figure 4-1 Idealized Soil Profile" showing the idealized soil profile with the station line, will be added to Section 4.2 of the report.

13. Designate where the supports are located on the Idealized Soil Profile.

"Figure 4-1 Idealized Soil Profile", showing the support locations, will be added to Section 4.2 of the report.

14. Revise the Table of Contents accordingly.

The table of contents will be revised to reflect the format changes discussed herein.

15. Was the CPT calibrated against the borings performed at the site? Explain and provide justification.

CPT-11-349 was calibrated against the nearby boring A-11-349 performed at the site. Based on the boring, stratigraphy consists of lean clay and silt. The soil behavior type shown on the CPT sounding is consistent with the observations from the nearby boring A-11-349.

The CPT output data file with the estimated undrained shear strength using CPT correlations is provided in Appendix A of the report. Unconsolidated-undtained triaxial test results are presented in Appendix B of the report. The undrained shear strength values obtained from unconsolidated-undrained triaxial tests falls within the lower bound shear strength values that were estimated using CPT correlations. The design strength parameters were conservatively selected based on the average lower bound shear strength values.

In addition, the small-strain shear wave velocity (Vs30) measured by the seismic cone penetrometer used in Sounding CPT-11-349 was used to normalize the Vs30 values calculated using correlations with SPT blowcounts obtained from other borings.

16. How was the cone factor Nk as it relates to the subject CPT investigation evaluated? Explain and provide justification.

Based on the CPT interpretation files provided in Appendix A of the report, an Nk value of 15 was used in estimating the undrained shear strength values using CPT correlation, which is the mid value of typical Nk values that range between 10 and 20 indicated in the CPT guidelines by Robertson (2009). In addition, based on our laboratory test results, over consolidation ratio (OCR) is slightly higher than 1.0. The OCR of 1 or slightly higher indicates that the soil is normally consolidated or slightly over consolidated (calculation sheets are attached). Based on these data, we believe that using Nk value of 15 is appropriate for the design. Based on Nk value of 15 and cone tip resistances, the estimated undrained shear strength values are higher than the undrained shear strength values used in our design; therefore, the design is appropriately conservative.

In retrospect, the cone factor Nk, which varies mainly between 10 and 20 should preferably have been obtained from empirical correlation with the strength test used in that area (Robertson, 2009). As a minimum, we believe that one boring and two to five CPT soundings should be performed for a site, depending on the number of supports and width of the bridge. This boring used for sampling and testing should be performed next to one of the CPT soundings to check the local CPT correlations and soil behavior type. The boring should be extended to the same depth as he CPT sounding. Soil samples should be taken at least every 2.5 or 3 feet using SPT, Modified California Drive, or other appropriate samplers, or at changes in soil stratigraphy. Additional confirmation borings and CPT soundings should be necessary if the site is large or the subsurface conditions vary significantly within the site. The need for and the number of the additional borings should be determined by the project geotechnical consultant, subject to the review of the appropriate regulatory agencies.

17. Refer to the CPT data and calculate the bearing capacity and the consolidation settlement magnitude when spread footing is considered. Explain why spread footing cannot be considered based on the engineering calculation derived from the CPT.

The CPT data shows that the lower-bound undrained shear strength is similar to the strength obtained from laboratory tests, which was used in the analysis to determine bearing capacity. Since only 1 CPT was performed for this bridge, consolidation settlements were performed based on the soil boring data and the laboratory testing. The CPT data was not used to evaluate consolidation settlement. The primary purpose of the CPT sounding, conducted for the bridge, was to estimate shear wave velocity and assess liquefaction potential.

Spread footing is not recommended as a suitable foundation option for the widening of Camino Capistrano UC due to excessive settlement. Spread footing settlement is estimated using the AASHTO LRFD Equation 10.6.2.4.2-3. Using the footing pressures presented in the as-built plans for abutments and bents, the settlement of the spread footing is estimated to be about 4.2 inches and 5.2 inches at abutments and bents, respectively. A 5-foot deep overexcavation will only lower the settlement to about 2.3 inches and 3.5 inches at abutments and bents, respectively. The settlement calculations are included in Appendix C of the report.

18. Why CPT data was not used in part for evaluation of the design parameters?

CPT data was used in assessing the in-situ shear strength and subsurface conditions. Although the CPT data shows that there are layers with higher shear strengths, the CPT data also shows soil layers with lower strengths that are equivalent to the strengths selected for the idealized soil profile. Our rationale was to use lower-bound strengths from the CPT data as well as strength data from the UU triaxial and direct shear tests.

19. Compare the in-situ data interpreted by CPT with the laboratory tests values and come up with idealized strength parameters.

Please see response to Comment No. 18.

20. Why idealized soil profile soil strength characterization in Table 4.1 is based only on the SPT, when CPT was also conducted to characterize the subsurface soil?

Please see response to Comment No. 18.

21. Provide SAP input files corresponding to the seismic analysis of the bridge pile foundation.

EMI did not perform SAP analyses for the subject project and does not have the SAP files. JACOBS should be contacted regarding the SAP analysis.

22. Revise the subject report to include Section 3.0 for only "Geology".

Section 3.0 will be retitled as requested.

23. Take out Seismicity from Section 3.0.

Section 3.0 will be retitled as requested and the seismicity will be included in Section 5.0 as requested in Comment No. 24.

24. Revise the subject report to include Section 5 as "Seismicity and Geo-Seismic Hazards" to have subsections 5-1 for "Seismic Study", 5-2 for "Ground Rupture", 5-3 for "Caltrans ARS Curve", 5-3-1 for "Development of Vs30", 5-3-2 for "Development of Caltrans ARS Curve", 5-4 for "Liquefaction", 5-5 for "Lateral Spread", 5-6 for "Seismic Settlement".

Section 5.0 and its subsections will be formatted as requested.

25. Revise the subject report to include Section 6 for "Soil Corrosion".

Section 6.0 will be retitled as requested.

26. Revise the subject report to include Section 7 for "Scour".

Section 7.0 will be retitled as requested.

27. Revise the subject report to include Section 8.0 for "Foundation Recommendations".

Section 8.0 will be retitled as requested.

Attachments:

Attachment 1 – Second Review Comments by Caltrans Office of Geotechnical Design South 1 (OGDS-1), Dated January 4, 2013, on the Final Foundation Report for Camino Capistrano Undercrossing (Widen), Bridge No. 55-0227L, Orange County, California, 12-ORA-05, PM 7.4, Caltrans Project No. 1200020279, EA No. 12-0F96E4, Prepared by Earth Mechanics, Inc., Dated October 5, 2012.

Reference:

Earth Mechanics, Inc., 2012, Final Foundation Report for Camino Capistrano Undercrossing (Widen), Bridge No. 55-0227L, Orange County, California, 12-ORA-05, PM 7.4, Caltrans Project No. 1200020279, EA No. 12-0F96E4, October 5.

ATTACHMENT 1

Caltrans Review Comments, Dated January 4, 2013

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO:	MR. JEFF DEFEVERE Office of Special Funded Projects (OSFP) Attention: Ms. LUQI YANG Fax: (916) 227-8683	DATE:	January 04, 2013
		FILE:	12 ORA 05 7.4 District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: Oct. 05, 2012 Camino Capistrano UC (Widen)
Structure Name

GENERAL PLAN DATED: Nov. 12, 2012 FDN PLAN DATED: Nov.12, 2012 12-0F96E4 55-0227L
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [X] 2nd [ ] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Final Foundation Report for Camino Capistrano Undercrossing (Widen), Bridge No. 55-0227L, Orange County, California, 12-ORA-05, PM 7.4, Caltrans Project No. 1200020279, EA No 12-0F96E4", prepared by Earth Mechanics, Inc, dated October 05, 2012 and received by our office on November 28, 2012.

We have the following comments:

1. Title Sheet addressed to TRC: Include the date of the meeting where over the shoulder meeting was conducted and the name of the oversight geo-professional.
2. Existing geotechnical information was reviewed and collected to prepare the subject report. Revise Section 1.2 of the subject report accordingly.
3. The site investigation must be site specific and stated as such in the report. Revise Section 1.2 of the subject report accordingly.
4. Project description does not make any reference to the other bridge structures that are part of the subject project. Revise Section 1.3 accordingly.
5. Revise Section 1.0 to include a table for "As-Built Foundation Data" with the relevant information.
6. Revise the notes in Table 2.1, to include the appropriate Survey Datum.
7. Revise Section 2 to include survey conducted for each boring and CPT.
8. Revise Section 2.0 of the subject report to include a narrative as to how the hammer efficiency is assessed per Caltrans Guidelines.
9. Revise Section 2.2 to include a Table for the laboratory tests performed with type of test, applicable test method (i.e. ASTM, CT designation) and purpose of the test.
10. Revise Section 4.0 to include a separate subsection (i.e. 4.3) for Idealized Soil Profile along with the Table 2 and the corresponding narrative.
11. Insert the Idealized Soil Profile in the main report where appropriate.
12. Revise the Idealized Soil Profile to include station line.
13. Designate where the supports are located on the Idealized Soil Profile.
14. Revise the Table of Contents accordingly.
15. Was the CPT calibrated against the borings performed at the site? Explain and provide justification.

16. How was the cone factor Nk as it relates to the subject CPT investigation evaluated? Explain and provide justification.
17. Refer to the CPT data and calculate the bearing capacity and the consolidation settlement magnitude when spread footing is considered. Explain why spread footing cannot be considered based on the engineering calculation derived from the CPT.
18. Why CPT data was not used in part for evaluation of the design parameters?
19. Compare the in-situ data interpreted by CPT with the laboratory tests values and come up with idealized strength parameters.
20. Why idealized soil profile soil strength characterization in Table 4.1 is based only on the SPT, when CPT was also conducted to characterize the subsurface soil?
21. Provide SAP input files corresponding to the seismic analysis of the bridge pile foundation.
22. Revise the subject report to include Section 3.0 for only "Geology".
23. Take out Seismicity from Section 3.0.
24. Revise the subject report to include Section 5 as "Seismicity and Geo-Seismic Hazards" to have subsections 5-1 for "Seismic Study", 5-2 for "Ground Rupture", 5-3 for "Caltrans ARS Curve", 5-3-1 for "Development of Vs30", 5-3-2 for "Development of Caltrans ARS Curve", 5-4 for "Liquefaction", 5-5 for "Lateral Spread", 5-6 for "Seismic Settlement".
25. Revise the subject report to include Section 6 for "Soil Corrosion".
26. Revise the subject report to include Section 7 for "Scour".
27. Revise the subject report to include Section 8.0 for "Foundation Recommendations" .

Please call Sharid Amiri at (949)724-2599, if you have any questions.

Approval:

Reviewed By: Sharid Amiri, PhD, P.E.
Geotechnical Design South-1

(C3) Not Approved
Office of Special Funded projects

Cc: OGDS (Sacramento) DES Office of Specifications and Estimates (All Reviews) OSC R.E Pending File

MEMORANDUM

EMI PROJECT NO: 11-137

DATE: September 27, 2012

PREPARED FOR: Dr. Ayman Salama / TRC Solutions, Inc. (TRC)

PREPARED BY: (Raja) S. Pirathiviraj and Lino Cheang / Earth Mechanics, Inc. (EMI)

SUBJECT: Responses to Caltrans Review Comments
Foundation Report for Camino Capistrano Undercrossing (Widen)
Bridge No. 55-0227L
Orange County, California
12-ORA-5, PM 7.4
Caltrans Project No. 1200020279 (EA 12-0F96E4)

Earth Mechanics, Inc. (EMI) submitted the subject structure foundation report, dated April 23, 2012, to Caltrans for review. Caltrans Office of Geotechnical Design South 1 (OGDS-1) has reviewed the report and provided their comments in a memorandum dated August 31, 2012. A copy of this memorandum is provided in Attachment 1.

This memorandum provides our responses to Caltrans OGDS-1 comments. For convenience, Caltrans comments are provided in italics followed by EMI responses.

1. *Provide all input software files and actual spread sheets (not PDF) in a CD for our review.*

We comply. We provide a CD containing all input software files and actual spread sheets of our analyses.

2. *Provide backup information for the development of the Design ARS curve.*

We comply. All the backup information for the development of the design ARS curve is provided in Attachment 2.

3. *Provide CPT (Cone Penetrometer Test) data file in pdf format.*

We comply. We include the CPT data file in the CD.

4. *The project description refers to the existing structure supported on shallow and pile foundations. Table 5-4 does not show any shallow foundation. Revise table 5-4 to include spread footing and reconcile accordingly.*

We comply. We will revise the Table 5-4 to reflect the spread footing.

5. *It is not clear why spread footing is not suitable for the abutments and bents. Provide justification and engineering calculation.*

Spread footing is not recommended as a suitable foundation option for the widening of Camino Capistrano UC due to excessive settlement. Using the footing pressures presented in the as-built plans for abutments and bents, the settlement of the spread footing is estimated to be about 4.2 inches and 5.2 inches at abutments and bents, respectively. A 5-foot deep overexcavation will only lower the settlement to about 2.3 inches and 3.5 inches at abutments and bents, respectively. The settlement calculations are included in Appendix C of the Final Foundation Report.

6. *Provide Idealized soil profile that includes CPT/Boring information, stations, along with the water table elevation information (measured and design), liquefiable zone and other relevant information.*

We comply. A cross section, showing the idealized soil profile with CPT/Boring information, field and design groundwater table elevations, design soil strength parameters, and liquefiable zone is included in Appendix C of the Final Foundation Report. The cross section will also show the proposed foundation plan and the CPT/Boring locations.

7. *The project plans refer to the Bridge No. 55-0227. Reconcile accordingly.*

The correct bridge number is 55-0227L. The plans will be revised to reflect the correct bridge number.

Attachments

Attachment 1 – Caltrans Review Comments, Dated August 31, 2012.

Attachment 2 – Backup Information for Development of Design ARS Curve.

ATTACHMENT 1

Caltrans Review Comments, Dated August 31, 2012

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JEFF DEFEVERE
Office of Special Funded Projects (OSFP)
Attention: Ms. LUQI YANG
Fax: (916) 227-8683

DATE: August 31, 2012

FILE: 12 ORA 05 7.4
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: April 23, 2012

Camino Capistrano UC (Widen)
Structure Name

GENERAL PLAN DATED: April 23, 2012 FDN PLAN DATED: April 23, 2012

12-0F96E4 55-0227L
EA Number Bridge Number

Submittal (*Check One*): [x] 1st [ ] 2nd [ ] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Foundation Report for Camino Capistrano Undercrossing (Widen), Bridge No. 55-0227L, Orange County, California, 12-ORA-05, PM 7.4, Caltrans Project No. 1200020279, EA No 12-0F96E4", prepared by Earth Mechanics, Inc, dated April 23, 2012.

We have the following comments:

1. Provide all input software files and actual spread sheets (not PDF) in a CD for our review.
2. Provide backup information for the development of the design ARS curve.
3. Provide CPT (Cone Penetrometer Test) data file in pdf format.
4. The project description refers to the existing structure supported on shallow and pile foundations. Table 5-4 does not show any shallow foundation. Revise table 5-4 to include spread footing and reconcile accordingly.
5. It is not clear why spread footing is not suitable for the abutments and bents. Provide justification and engineering calculation.
6. Provide Idealized soil profile that includes CPT/Boring information, stations, along with the water table elevation information (measured and design), liquefiable zone and other relevant information.
7. The project plans refer to the Bridge No. 55-0227. Reconcile accordingly.

Please call Sharid Amiri at (949)724-2599, if you have any questions.

Approval:

Reviewed By: Sharid Amiri, PhD, P.E.

ATTACHMENT 2

Backup Information for Development of Design ARS Curve

Shear Wave Velocity V_s^{30} Calculations

Boring	A-11-348
Depth	100 feet
ER_i	75 %
V_{s30}	220 m/s

Depth	Soil Type	Blow count N	N_{60}	Vs (m/s)	Thickness of Layer d (feet)	d/Vs
5	Sand	14	18	230	7.5	0.03254
10	Sand	16	20	240	5	0.020869
15	Clay	6	8	170	5	0.029414
20	Clay	8	10	187	5	0.026727
25	Clay	15	19	231	5	0.021679
30	Clay	15	19	231	5	0.021679
35	Clay	11	14	208	5	0.024038
40	Clay	9	11	195	5	0.025699
45	Clay	12	15	214	5	0.023351
50	Clay	7	9	179	5	0.027942
55	Clay	11	14	208	5	0.024038
60	Clay	12	15	214	5	0.023351
65	Clay	16	20	236	5	0.021218
70	Clay	12	15	214	5	0.023351
75	Clay	13	16	220	5	0.022737
80	Clay	17	21	240	5	0.020794
85	Clay	23	29	266	5	0.018803
90	Clay	17	21	240	5	0.020794
95	Clay	29	36	287	5	0.017406
100	Clay	27	34	281	2.5	0.008913

Boring	A-11-349
Depth	81.5 feet
ER_i	75 %
V_{s30}	202 m/s

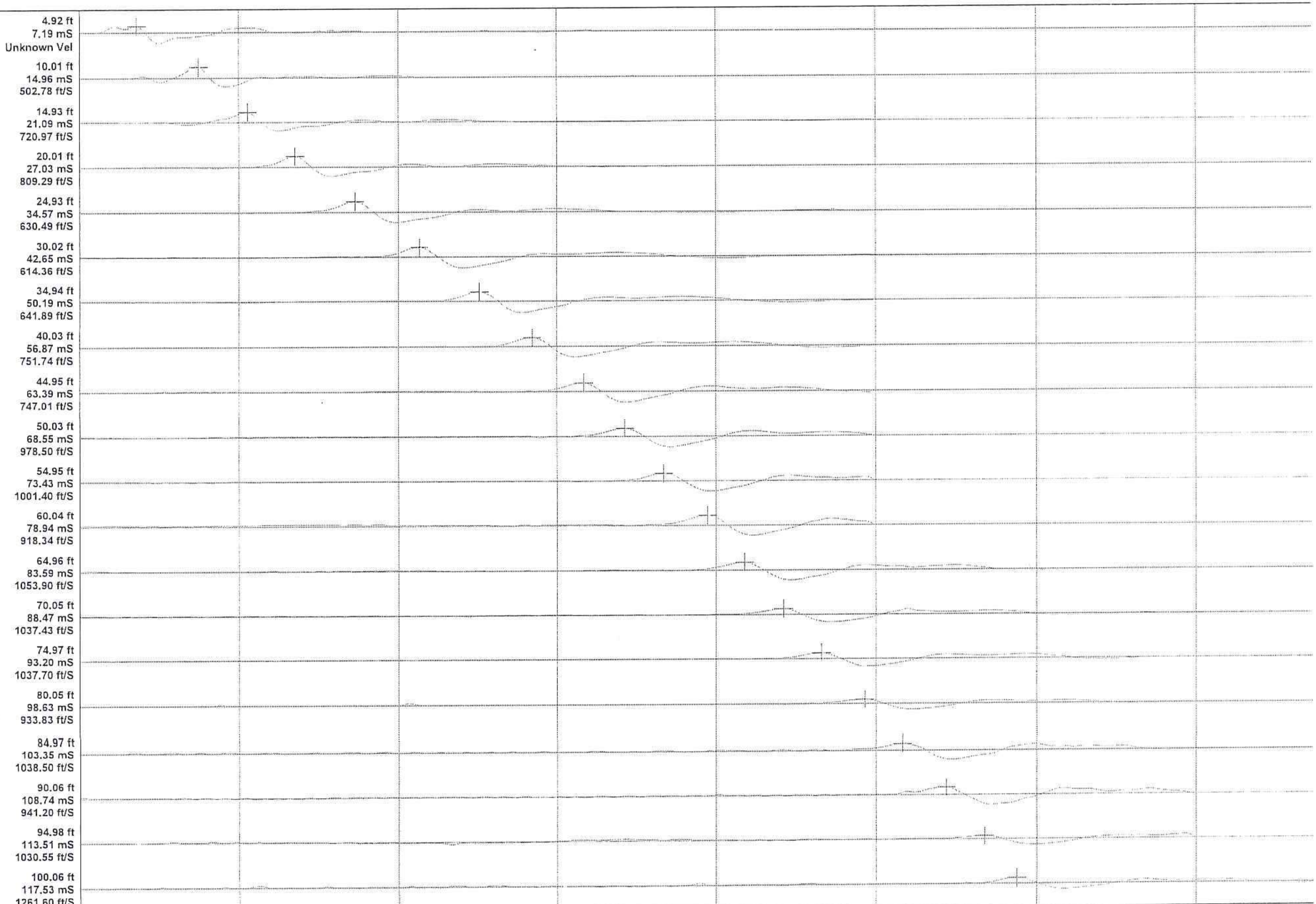
Depth	Soil Type	Blow count N	N_{60}	Vs (m/s)	Thickness of Layer d (feet)	d/Vs
5	Clay	6	8	170	7.5	0.044121
10	Clay	11	14	208	5	0.024038
15	Clay	12	15	214	5	0.023351
20	Clay	4	5	149	5	0.033666
25	Clay	4	5	149	5	0.033666
30	Clay	5	6	160	5	0.031255
35	Clay	8	10	187	5	0.026727
40	Clay	5	6	160	5	0.031255
45	Clay	13	16	220	5	0.022737
50	Clay	9	11	195	5	0.025699
55	Clay	13	16	220	5	0.022737
60	Clay	6	8	170	5	0.029414
65	Clay	18	23	245	5	0.020402
70	Clay	7	9	179	5	0.027942
75	Clay	16	20	236	5	0.021218
80	Clay	11	14	208	3.25	0.015625

Boring	CPT-11-349
Depth	100 feet
V_{s30}	245 m/s

Depth	Vs (ft/s)	Vs (m/s)	Thickness of Layer d (feet)	d/Vs
10.01	503	153	12.47	0.081372
14.93	721	220	5	0.022753
20.01	809	247	5	0.02027
24.93	630	192	5.005	0.026044
30.02	614	187	5.005	0.026728
34.94	752	229	5.005	0.021843
40.03	747	228	5.005	0.021982
44.95	979	298	5	0.016765
50.03	1001	305	5	0.016381
54.95	918	280	5.005	0.017881
60.04	1054	321	5.005	0.015581
64.96	1037	316	5.005	0.015828
70.05	1037	316	5.005	0.015828
74.97	1038	316	5.015	0.015856
80.08	934	285	5	0.017567
84.97	1039	317	4.99	0.015764
90.06	941	287	5.005	0.017446
94.98	1031	314	5	0.015918
100.06	1262	385	2.54	0.006605

Earth Mechanics

Location	I-5 HOV Widening Segment 3	Operator	BH-JC	GPS
Job Number	11-137	Cone Number	DSG1023	
Hole Number	CPT-11-349	Date and Time	10/11/2011 1:20:42 AM	



Boring	A-11-350
Depth	100 feet
ER_i	75 %
V_{s30}	236 m/s

Depth	Soil Type	Blow count N	N_{60}	Vs (m/s)	Thickness of Layer d (feet)	d/Vs
5	Clay	6	8	170	7.5	0.044121
10	Clay	14	18	225	5	0.022183
15	Clay	9	11	195	5	0.025699
20	Clay	9	11	195	5	0.025699
25	Clay	5	6	160	5	0.031255
30	Clay	12	15	214	5	0.023351
35	Clay	7	9	179	5	0.027942
40	Clay	16	20	236	5	0.021218
45	Clay	6	8	170	5	0.029414
50	Clay	16	20	236	5	0.021218
55	Clay	6	8	170	5	0.029414
60	Clay	14	18	225	5	0.022183
65	Clay	11	14	208	5	0.024038
70	Rock	100	125	509	5	0.009832
75	Rock	29	36	343	5	0.014592
80	Rock	100	125	509	5	0.009832
85	Rock	50	63	408	5	0.012265
90	Rock	100	125	509	5	0.009832
95	Rock	31	39	350	5	0.014285
100	Rock	100	125	509	2.5	0.004916

Camino Capistrano UC (55-0227)

ARS Curve

Fault & Site Data Input Sheet

Fault & Site Data Input Sheet

The input sheet is to help the user organize the site data for developing the design response spectrum. Beta-Testers: If you fill out the fault and site information for each location, please provide this document and the *checker* to facilitate the QC/QA procedures listed in the 2009 Deterministic Fault Information & Seismic Procedures QC/QA checklist.

Project Information

Dist – EA: 12 - 0F96E County: Orange Route: I-5 PM: 7.94

Bridge/Facility Name: Camino Capistrano UC Bridge/Facility No.: 55 - 0227

Latitude: 33° 28' 24.9" = 33.4736 Longitude: 117° 40' 29.70" = -117.6749

probabilistic Rmean = 7.2 km

Fault Information (#1)

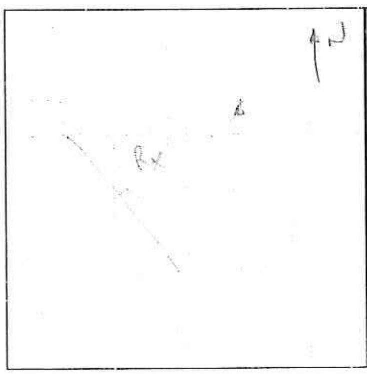
Fault Name: Newport Inglewood - Rose Canyon fault zone (offshore @ San Onofre section) Fault ID#: 222

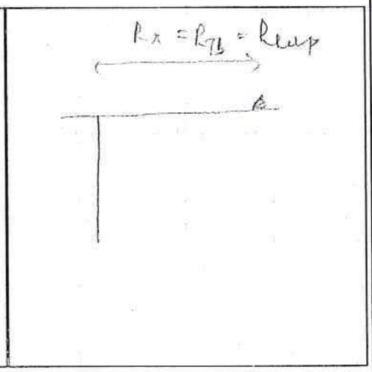
MMax: 7.5 Fault Type: RLSS

Fault Dip: 90 Dip Direction: V

Top of Rupture: 0 Bottom of Rupture: 13

Plan View **Elevation View**





Calculated or Measure Distances

R_{RUP}: 6.28 km

R_{JB}: 6.28 km

R_X: 6.28 km

Determination of V_{S30}

V_{S30} (m/s): 245

Determination of Z1.0 and Z2.5

$Z_{1.0}$ (m/s): 0

$Z_{2.5}$ (km/s): 0

Notes:

Similar calculations for other Vs30

Vs30 = 267, 286

Fault Information (#2)

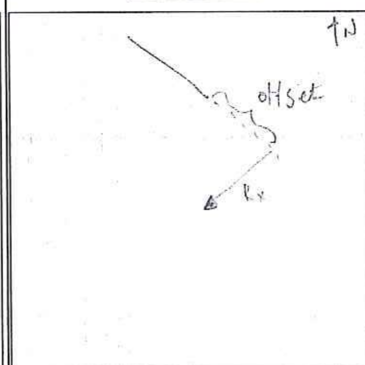
Fault Name: San Joaquin Hills blind thrust Fault ID#: 17

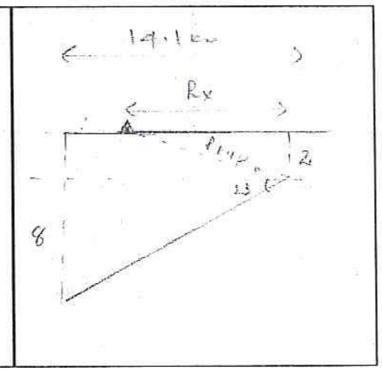
MMax: 6.6 Fault Type: R

Fault Dip: 23 Dip Direction: SW

Top of Rupture: 2 Bottom of Rupture: 8

Plan View **Elevation View**





Calculated or Measure Distances

R_{RUP}: $((9.4^2 + 2^2) + 9.7^2)^{1/2}$ = 13.6 km

R_{JB}: 9.7 km

R_X: 9.4 km

measured from map

offset = 10.6 km

Determination of V_{S30}

V_{S30} (m/s): 245

Determination of Z1.0 and Z2.5

$Z_{1.0}$ (m/s): 0

$Z_{2.5}$ (km/s): 0

Notes:

from Caltrans ARS online

Rrup = [illegible] km

RJB = [illegible] km

Rx = [illegible] km

ARS Online Output, Fault Map and Basin Map

SITE DATA

Shear Wave Velocity, V_{S30}:	245 m/s
Latitude:	33.473600
Longitude:	-117.674900
Depth to Vs = 1.0 km/s:	333 m
Depth to Vs = 2.5 km/s:	2.00 km

DETERMINISTIC

Newport Inglewood-Rose Canyon fault zone (Offshore or Dana Point section)

Fault ID:	222
Maximum Magnitude (MMax):	7.5
Fault Type:	RLSS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	13.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	6.27 km
Rjb:	6.27 km
Rx:	6.27 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor (Applied)	SA(Final Spectrum)
0.01	0.369	1.000	1.000	0.369
0.02	0.374	1.000	1.000	0.374
0.022	0.378	1.000	1.000	0.378
0.025	0.382	1.000	1.000	0.382
0.029	0.387	1.000	1.000	0.387
0.03	0.389	1.000	1.000	0.389
0.032	0.393	1.000	1.000	0.393
0.035	0.399	1.000	1.000	0.399
0.036	0.401	1.000	1.000	0.401
0.04	0.409	1.000	1.000	0.409
0.042	0.413	1.000	1.000	0.413
0.044	0.417	1.000	1.000	0.417
0.045	0.419	1.000	1.000	0.419
0.046	0.422	1.000	1.000	0.422
0.048	0.426	1.000	1.000	0.426

0.05	0.430	1.000	1.000	0.430
0.055	0.442	1.000	1.000	0.442
0.06	0.454	1.000	1.000	0.454
0.065	0.467	1.000	1.000	0.467
0.067	0.472	1.000	1.000	0.472
0.07	0.480	1.000	1.000	0.480
0.075	0.493	1.000	1.000	0.493
0.08	0.506	1.000	1.000	0.506
0.085	0.520	1.000	1.000	0.520
0.09	0.534	1.000	1.000	0.534
0.095	0.547	1.000	1.000	0.547
0.1	0.560	1.000	1.000	0.560
0.11	0.583	1.000	1.000	0.583
0.12	0.605	1.000	1.000	0.605
0.13	0.624	1.000	1.000	0.624
0.133	0.630	1.000	1.000	0.630
0.14	0.641	1.000	1.000	0.641
0.15	0.657	1.000	1.000	0.657
0.16	0.671	1.000	1.000	0.671
0.17	0.683	1.000	1.000	0.683
0.18	0.695	1.000	1.000	0.695
0.19	0.706	1.000	1.000	0.706
0.2	0.716	1.000	1.000	0.716
0.22	0.727	1.000	1.000	0.727
0.24	0.736	1.000	1.000	0.736
0.25	0.740	1.000	1.000	0.740
0.26	0.742	1.000	1.000	0.742
0.28	0.747	1.000	1.000	0.747
0.29	0.748	1.000	1.000	0.748
0.3	0.749	1.000	1.000	0.749
0.32	0.750	1.000	1.000	0.750
0.34	0.749	1.000	1.000	0.749
0.35	0.748	1.000	1.000	0.748
0.36	0.747	1.000	1.000	0.747
0.38	0.745	1.000	1.000	0.745
0.4	0.742	1.000	1.000	0.742
0.42	0.740	1.000	1.000	0.740
0.44	0.738	1.000	1.000	0.738
0.45	0.738	1.000	1.000	0.738
0.46	0.737	1.000	1.000	0.737
0.48	0.734	1.000	1.000	0.734
0.5	0.732	1.000	1.000	0.732
0.55	0.712	1.000	1.020	0.727
0.6	0.695	1.000	1.040	0.722
0.65	0.678	1.000	1.060	0.719
0.667	0.672	1.000	1.067	0.717
0.7	0.662	1.000	1.080	0.715
0.75	0.648	1.000	1.100	0.712
0.8	0.631	1.000	1.120	0.706
0.85	0.615	1.000	1.140	0.701

0.9	0.599	1.000	1.160	0.695
0.95	0.585	1.000	1.180	0.690
1	0.571	1.000	1.200	0.685
1.1	0.542	1.000	1.200	0.651
1.2	0.516	1.000	1.200	0.619
1.3	0.493	1.000	1.200	0.591
1.4	0.471	1.000	1.200	0.565
1.5	0.450	1.000	1.200	0.540
1.6	0.428	1.000	1.200	0.514
1.7	0.408	1.000	1.200	0.490
1.8	0.390	1.000	1.200	0.468
1.9	0.374	1.000	1.200	0.449
2	0.359	1.000	1.200	0.431
2.2	0.327	1.000	1.200	0.392
2.4	0.299	1.000	1.200	0.359
2.5	0.286	1.000	1.200	0.344
2.6	0.275	1.000	1.200	0.330
2.8	0.254	1.000	1.200	0.305
3	0.236	1.000	1.200	0.283
3.2	0.219	1.000	1.200	0.263
3.4	0.205	1.000	1.200	0.245
3.5	0.198	1.000	1.200	0.237
3.6	0.192	1.000	1.200	0.230
3.8	0.180	1.000	1.200	0.216
4	0.169	1.000	1.200	0.203
4.2	0.160	1.000	1.200	0.193
4.4	0.152	1.000	1.200	0.183
4.6	0.145	1.000	1.200	0.173
4.8	0.138	1.000	1.200	0.165
5	0.131	1.000	1.200	0.157

To use above data in Excel, copy/paste:

```
0.01    0.369    1.000    1.000    0.369
0.02    0.374    1.000    1.000    0.374
```

San Joaquin Hills Blind Thrust

Fault ID:	7
Maximum Magnitude (MMax):	6.6
Fault Type:	R
Fault Dip:	23 Deg
Dip Direction:	SW
Bottom of Rupture Plane:	8.00 km
Top of Rupture Plane(Ztor):	2.00 km
Rrup	9.05 km
Rjb:	7.22 km
Rx:	9.26 km
Fnorm:	0
Frev:	1

Period	**SA(Base Spectrum)**	**Basin Factor**	**Near Fault Factor (Applied)**	**SA(Final Spectrum)**
0.01	0.354	1.000	1.000	0.354

0.02	0.358	1.000	1.000	0.358
0.022	0.361	1.000	1.000	0.361
0.025	0.365	1.000	1.000	0.365
0.029	0.370	1.000	1.000	0.370
0.03	0.371	1.000	1.000	0.371
0.032	0.376	1.000	1.000	0.376
0.035	0.381	1.000	1.000	0.381
0.036	0.383	1.000	1.000	0.383
0.04	0.390	1.000	1.000	0.390
0.042	0.394	1.000	1.000	0.394
0.044	0.398	1.000	1.000	0.398
0.045	0.401	1.000	1.000	0.401
0.046	0.403	1.000	1.000	0.403
0.048	0.407	1.000	1.000	0.407
0.05	0.411	1.000	1.000	0.411
0.055	0.425	1.000	1.000	0.425
0.06	0.439	1.000	1.000	0.439
0.065	0.453	1.000	1.000	0.453
0.067	0.459	1.000	1.000	0.459
0.07	0.467	1.000	1.000	0.467
0.075	0.481	1.000	1.000	0.481
0.08	0.497	1.000	1.000	0.497
0.085	0.511	1.000	1.000	0.511
0.09	0.526	1.000	1.000	0.526
0.095	0.541	1.000	1.000	0.541
0.1	0.555	1.000	1.000	0.555
0.11	0.579	1.000	1.000	0.579
0.12	0.602	1.000	1.000	0.602
0.13	0.622	1.000	1.000	0.622
0.133	0.628	1.000	1.000	0.628
0.14	0.640	1.000	1.000	0.640
0.15	0.656	1.000	1.000	0.656
0.16	0.668	1.000	1.000	0.668
0.17	0.678	1.000	1.000	0.678
0.18	0.687	1.000	1.000	0.687
0.19	0.695	1.000	1.000	0.695
0.2	0.703	1.000	1.000	0.703
0.22	0.708	1.000	1.000	0.708
0.24	0.712	1.000	1.000	0.712
0.25	0.713	1.000	1.000	0.713
0.26	0.713	1.000	1.000	0.713
0.28	0.713	1.000	1.000	0.713
0.29	0.712	1.000	1.000	0.712
0.3	0.712	1.000	1.000	0.712
0.32	0.708	1.000	1.000	0.708
0.34	0.703	1.000	1.000	0.703
0.35	0.700	1.000	1.000	0.700
0.36	0.697	1.000	1.000	0.697
0.38	0.691	1.000	1.000	0.691
0.4	0.684	1.000	1.000	0.684

0.42	0.675	1.000	1.000	0.675
0.44	0.666	1.000	1.000	0.666
0.45	0.661	1.000	1.000	0.661
0.46	0.657	1.000	1.000	0.657
0.48	0.648	1.000	1.000	0.648
0.5	0.639	1.000	1.000	0.639
0.55	0.606	1.000	1.020	0.618
0.6	0.577	1.000	1.040	0.600
0.65	0.551	1.000	1.060	0.584
0.667	0.542	1.000	1.067	0.578
0.7	0.527	1.000	1.080	0.569
0.75	0.505	1.000	1.100	0.555
0.8	0.481	1.000	1.120	0.538
0.85	0.458	1.000	1.140	0.523
0.9	0.438	1.000	1.160	0.508
0.95	0.419	1.000	1.180	0.494
1	0.401	1.000	1.200	0.481
1.1	0.364	1.000	1.200	0.437
1.2	0.332	1.000	1.200	0.399
1.3	0.304	1.000	1.200	0.365
1.4	0.279	1.000	1.200	0.335
1.5	0.257	1.000	1.200	0.309
1.6	0.236	1.000	1.200	0.283
1.7	0.217	1.000	1.200	0.261
1.8	0.201	1.000	1.200	0.241
1.9	0.187	1.000	1.200	0.224
2	0.174	1.000	1.200	0.209
2.2	0.151	1.000	1.200	0.181
2.4	0.133	1.000	1.200	0.159
2.5	0.125	1.000	1.200	0.150
2.6	0.117	1.000	1.200	0.141
2.8	0.105	1.000	1.200	0.126
3	0.094	1.000	1.200	0.113
3.2	0.086	1.000	1.200	0.103
3.4	0.079	1.000	1.200	0.095
3.5	0.076	1.000	1.200	0.091
3.6	0.073	1.000	1.200	0.087
3.8	0.067	1.000	1.200	0.081
4	0.063	1.000	1.200	0.075
4.2	0.059	1.000	1.200	0.071
4.4	0.055	1.000	1.200	0.066
4.6	0.052	1.000	1.200	0.063
4.8	0.049	1.000	1.200	0.059
5	0.047	1.000	1.200	0.056

To use above data in Excel, copy/paste:

```
0.01    0.354    1.000    1.000    0.354
0.02    0.358    1.000    1.000    0.358
```

PROBABILISTIC

Probabilistic Model
USGS Seismic Hazard Map(2008) 975 Year Return Period

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor (Applied)	SA(Final Spectrum)
0.01	0.368	1.000	1.000	0.368
0.02	0.425	1.000	1.000	0.425
0.022	0.434	1.000	1.000	0.434
0.025	0.445	1.000	1.000	0.445
0.029	0.459	1.000	1.000	0.459
0.03	0.463	1.000	1.000	0.463
0.032	0.469	1.000	1.000	0.469
0.035	0.478	1.000	1.000	0.478
0.036	0.481	1.000	1.000	0.481
0.04	0.491	1.000	1.000	0.491
0.042	0.496	1.000	1.000	0.496
0.044	0.501	1.000	1.000	0.501
0.045	0.503	1.000	1.000	0.503
0.046	0.506	1.000	1.000	0.506
0.048	0.510	1.000	1.000	0.510
0.05	0.515	1.000	1.000	0.515
0.055	0.525	1.000	1.000	0.525
0.06	0.535	1.000	1.000	0.535
0.065	0.544	1.000	1.000	0.544
0.067	0.547	1.000	1.000	0.547
0.07	0.552	1.000	1.000	0.552
0.075	0.560	1.000	1.000	0.560
0.08	0.568	1.000	1.000	0.568
0.085	0.575	1.000	1.000	0.575
0.09	0.582	1.000	1.000	0.582
0.095	0.589	1.000	1.000	0.589
0.1	0.595	1.000	1.000	0.595
0.11	0.614	1.000	1.000	0.614
0.12	0.632	1.000	1.000	0.632
0.13	0.649	1.000	1.000	0.649
0.133	0.654	1.000	1.000	0.654
0.14	0.666	1.000	1.000	0.666
0.15	0.681	1.000	1.000	0.681
0.16	0.696	1.000	1.000	0.696
0.17	0.710	1.000	1.000	0.710
0.18	0.724	1.000	1.000	0.724
0.19	0.737	1.000	1.000	0.737
0.2	0.750	1.000	1.000	0.750
0.22	0.754	1.000	1.000	0.754
0.24	0.757	1.000	1.000	0.757
0.25	0.759	1.000	1.000	0.759
0.26	0.761	1.000	1.000	0.761
0.28	0.764	1.000	1.000	0.764
0.29	0.766	1.000	1.000	0.766
0.3	0.767	1.000	1.000	0.767

0.32	0.759	1.000	1.000	0.759
0.34	0.751	1.000	1.000	0.751
0.35	0.748	1.000	1.000	0.748
0.36	0.744	1.000	1.000	0.744
0.38	0.738	1.000	1.000	0.738
0.4	0.732	1.000	1.000	0.732
0.42	0.726	1.000	1.000	0.726
0.44	0.720	1.000	1.000	0.720
0.45	0.717	1.000	1.000	0.717
0.46	0.715	1.000	1.000	0.715
0.48	0.710	1.000	1.000	0.710
0.5	0.705	1.000	1.000	0.705
0.55	0.679	1.000	1.020	0.693
0.6	0.656	1.000	1.040	0.682
0.65	0.636	1.000	1.060	0.674
0.667	0.629	1.000	1.067	0.671
0.7	0.617	1.000	1.080	0.667
0.75	0.601	1.000	1.100	0.661
0.8	0.577	1.000	1.120	0.646
0.85	0.556	1.000	1.140	0.633
0.9	0.536	1.000	1.160	0.622
0.95	0.518	1.000	1.180	0.612
1	0.502	1.000	1.200	0.602
1.1	0.468	1.000	1.200	0.562
1.2	0.440	1.000	1.200	0.528
1.3	0.415	1.000	1.200	0.498
1.4	0.393	1.000	1.200	0.472
1.5	0.374	1.000	1.200	0.449
1.6	0.357	1.000	1.200	0.428
1.7	0.341	1.000	1.200	0.410
1.8	0.328	1.000	1.200	0.393
1.9	0.315	1.000	1.200	0.378
2	0.303	1.000	1.200	0.364
2.2	0.276	1.000	1.200	0.331
2.4	0.253	1.000	1.200	0.303
2.5	0.242	1.000	1.200	0.291
2.6	0.233	1.000	1.200	0.280
2.8	0.216	1.000	1.200	0.259
3	0.202	1.000	1.200	0.242
3.2	0.187	1.000	1.200	0.225
3.4	0.175	1.000	1.200	0.210
3.5	0.169	1.000	1.200	0.203
3.6	0.164	1.000	1.200	0.197
3.8	0.154	1.000	1.200	0.185
4	0.146	1.000	1.200	0.175
4.2	0.140	1.000	1.200	0.167
4.4	0.134	1.000	1.200	0.161
4.6	0.129	1.000	1.200	0.155
4.8	0.124	1.000	1.200	0.149
5	0.120	1.000	1.200	0.144

To use above data in Excel, copy/paste:

```
0.01    0.368    1.000    1.000    0.368
0.02    0.425    1.000    1.000    0.425
```

MINIMUM DETERMINISTIC SPECTRUM

Period	SA
0.01	0.225
0.02	0.228
0.022	0.230
0.025	0.233
0.029	0.236
0.03	0.238
0.032	0.241
0.035	0.245
0.036	0.247
0.04	0.253
0.042	0.256
0.044	0.260
0.045	0.261
0.046	0.263
0.048	0.267
0.05	0.270
0.055	0.282
0.06	0.294
0.065	0.305
0.067	0.310
0.07	0.317
0.075	0.329
0.08	0.342
0.085	0.354
0.09	0.366
0.095	0.378
0.1	0.389
0.11	0.409
0.12	0.426
0.13	0.442
0.133	0.446
0.14	0.456
0.15	0.469
0.16	0.476
0.17	0.482
0.18	0.487
0.19	0.491
0.2	0.495
0.22	0.495
0.24	0.493
0.25	0.492
0.26	0.490
0.28	0.487
0.29	0.485

0.3	0.482
0.32	0.476
0.34	0.469
0.35	0.465
0.36	0.462
0.38	0.454
0.4	0.447
0.42	0.438
0.44	0.429
0.45	0.425
0.46	0.421
0.48	0.412
0.5	0.405
0.55	0.379
0.6	0.357
0.65	0.337
0.667	0.331
0.7	0.320
0.75	0.304
0.8	0.289
0.85	0.275
0.9	0.262
0.95	0.251
1	0.240
1.1	0.220
1.2	0.202
1.3	0.187
1.4	0.174
1.5	0.162
1.6	0.150
1.7	0.140
1.8	0.131
1.9	0.123
2	0.116
2.2	0.103
2.4	0.092
2.5	0.088
2.6	0.083
2.8	0.076
3	0.069
3.2	0.063
3.4	0.059
3.5	0.056
3.6	0.054
3.8	0.050
4	0.047
4.2	0.044
4.4	0.042
4.6	0.039
4.8	0.037

5	0.035	
To use above data in Excel, copy/paste:	0.01 0.02	0.225 0.228

Envelope Data

Period	**SA**
0.01	0.369
0.02	0.425
0.022	0.434
0.025	0.445
0.029	0.459
0.03	0.463
0.032	0.469
0.035	0.478
0.036	0.481
0.04	0.491
0.042	0.496
0.044	0.501
0.045	0.503
0.046	0.506
0.048	0.510
0.05	0.515
0.055	0.525
0.06	0.535
0.065	0.544
0.067	0.547
0.07	0.552
0.075	0.560
0.08	0.568
0.085	0.575
0.09	0.582
0.095	0.589
0.1	0.595
0.11	0.614
0.12	0.632
0.13	0.649
0.133	0.654
0.14	0.666
0.15	0.681
0.16	0.696
0.17	0.710
0.18	0.724
0.19	0.737
0.2	0.750
0.22	0.754
0.24	0.757
0.25	0.759
0.26	0.761
0.28	0.764
0.29	0.766

0.3	0.767
0.32	0.759
0.34	0.751
0.35	0.748
0.36	0.747
0.38	0.745
0.4	0.742
0.42	0.740
0.44	0.738
0.45	0.738
0.46	0.737
0.48	0.734
0.5	0.732
0.55	0.727
0.6	0.722
0.65	0.719
0.667	0.717
0.7	0.715
0.75	0.712
0.8	0.706
0.85	0.701
0.9	0.695
0.95	0.690
1	0.685
1.1	0.651
1.2	0.619
1.3	0.591
1.4	0.565
1.5	0.540
1.6	0.514
1.7	0.490
1.8	0.468
1.9	0.449
2	0.431
2.2	0.392
2.4	0.359
2.5	0.344
2.6	0.330
2.8	0.305
3	0.283
3.2	0.263
3.4	0.245
3.5	0.237
3.6	0.230
3.8	0.216
4	0.203
4.2	0.193
4.4	0.183
4.6	0.173
4.8	0.165

5	0.157

To use above data in Excel, copy/paste:

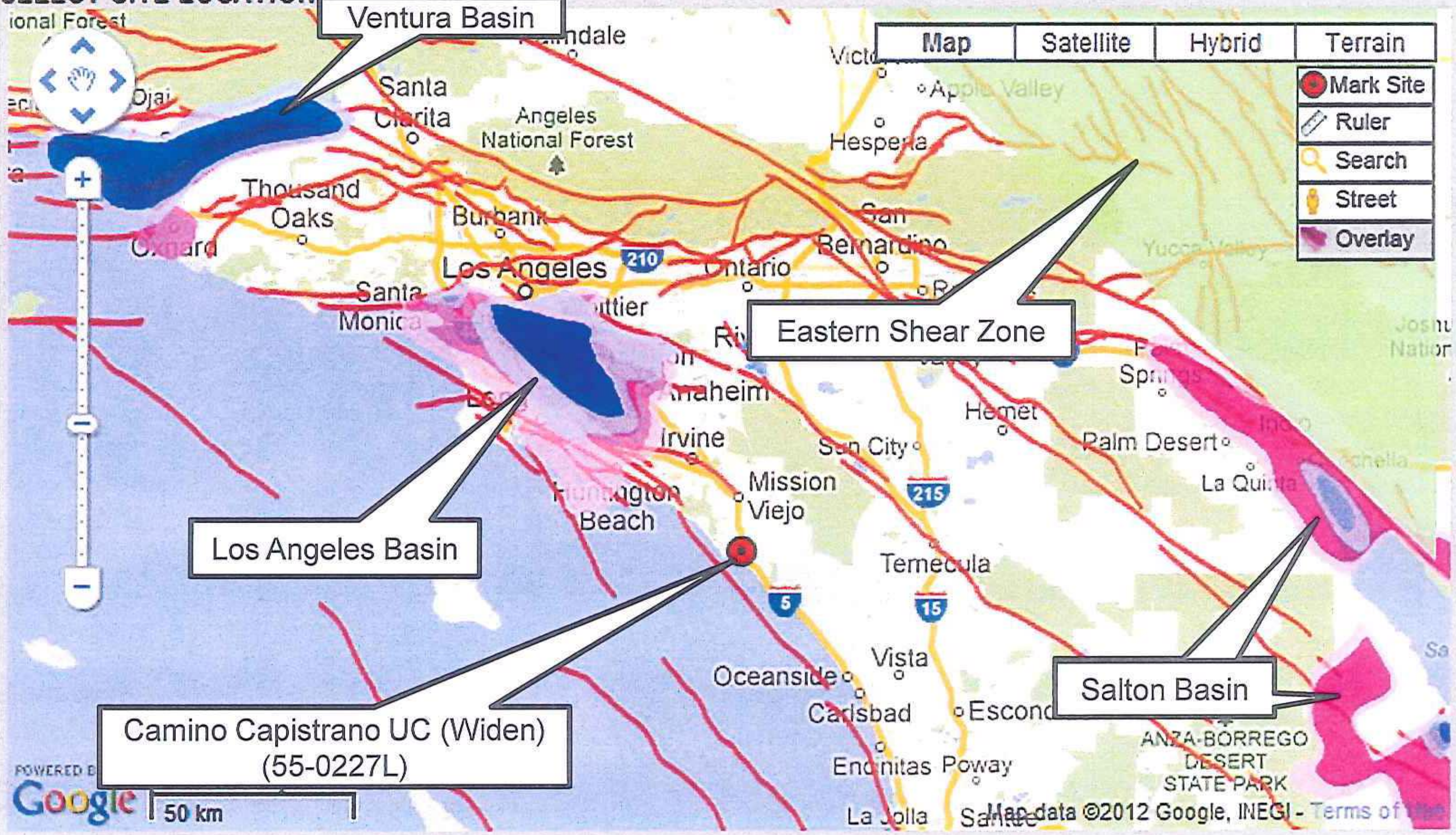
```
0.01        0.369
0.02        0.425
```

SELECT SITE LOCATION

Latitude: 33.4736 **Longitude:** -117.6749 **V_{S30}:** 245 m/s **Calculate**

Camino Capistrano UC (Widen) Bridge No. 55-0227L	ARS Online Fault Map	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Project No. 11-137	Date: 09-25-12

SELECT SITE LOCATION



Latitude: 33.4736 Longitude: -117.6749 V_{s30}: 245 m/s **Calculate**

BASIN LEGEND

Depth to Vs = 1.0 km/s		400 m		500 m		600 m		700 m		800 m		1000 m
Depth to Vs = 2.5 km/s		3.0 km		3.5 m		4.0 km		5.0 km		6.0 km		
Eastern Shear Zone												

Camino Capistrano UC (Widen) Bridge No. 55-0227L	ARS Online Basin Map
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Project No. 11-137 | Date: 09-25-12

Caltrans Deterministic ARS Spreadsheet

Newport Inglewood-Ross Canyon Fault (Fault ID# 222)

Comparison of ARS Curves
(unlock sheet with "shmi")

Model Inputs

Fault

Magnitude	7.5	(5 to 8.5)
F_{RV}	0	(input 1 = Rev)
F_{NM}	0	(input 1 = Normal)
Dip (degree)	90	(0 to 90)
Z_{TOR} *(km)*	0	

Distance

R_{RUP} *(km)*	6.3	
R_{JB} *(km)*	6.3	
R_x *(km)*	6.3	
Hanging Wall?	☐ Yes?	
Near-Field Factor?	☑ Yes?	

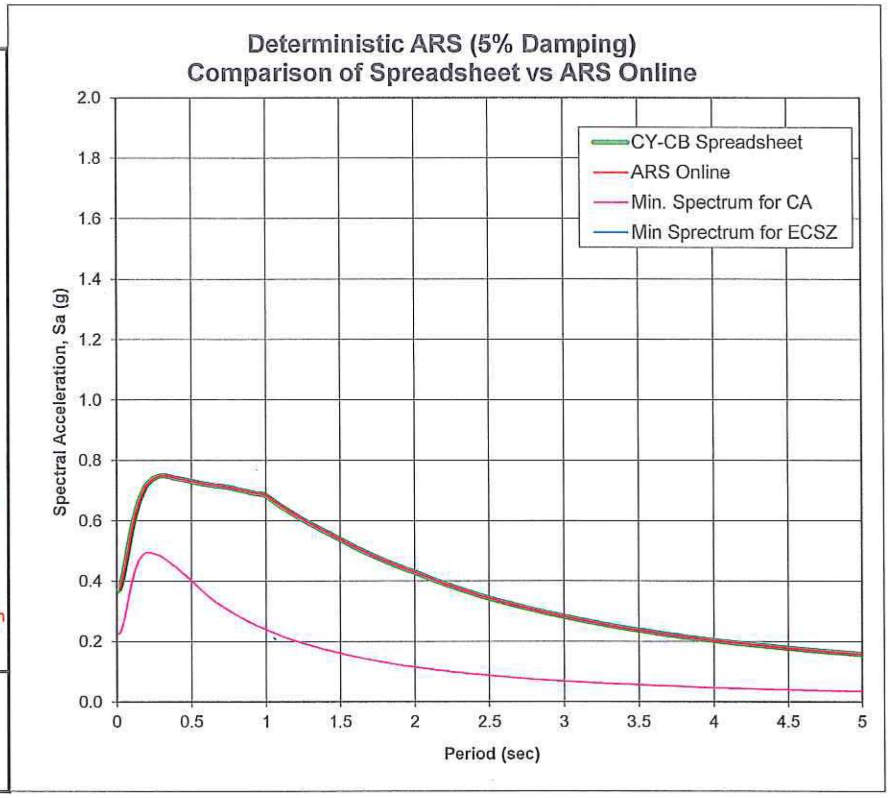
Site

V_{S30} *(m/sec)*	245	(270 to 1500 m/s)
$Z_{1.0}$ *(m)*	0	(0 - No Basin)
$Z_{2.5}$ *(km)*	0	(0 - No Basin)
No. Cal. Basin?	☐ Yes ?	(Check only for sites located within a Basin)
So. Cal. Basin?	☐ Yes ?	

Analysis

ARS Online vs CY-CB Spreadsheet Results

MAX. % Diff. = 0%



CY-CB Spreadsheet Results

T (sec)	CB-CY S(a)
0.010	0.36933
0.020	0.37413
0.022	0.37756
0.025	0.38198
0.029	0.38712
0.030	0.38878
0.032	0.39311
0.035	0.39923
0.036	0.40118
0.040	0.40862
0.042	0.41279
0.044	0.41698
0.045	0.41924
0.046	0.42146
0.048	0.42566
0.050	0.42981
0.055	0.44196
0.060	0.45436
0.065	0.46684
0.067	0.47207
0.070	0.47977
0.075	0.49261
0.080	0.50635
0.085	0.51995
0.090	0.53346
0.095	0.54685
0.100	0.55984
0.110	0.58310
0.120	0.60462
0.130	0.62421
0.133	0.62951
0.140	0.64122
0.150	0.65672
0.160	0.67085
0.170	0.68340

Place ARS Online Deterministic Data Here "Paste"

T (sec)	Base S(a)	Basin Factor	Near Fault Factor	Final Adj. S(a)	Diff. (%)
0.01	0.369	1	1	0.369	0%
0.02	0.374	1	1	0.374	0%
0.022	0.378	1	1	0.378	0%
0.025	0.382	1	1	0.382	0%
0.029	0.387	1	1	0.387	0%
0.03	0.389	1	1	0.389	0%
0.032	0.393	1	1	0.393	0%
0.035	0.399	1	1	0.399	0%
0.036	0.401	1	1	0.401	0%
0.04	0.409	1	1	0.409	0%
0.042	0.413	1	1	0.413	0%
0.044	0.417	1	1	0.417	0%
0.045	0.419	1	1	0.419	0%
0.046	0.422	1	1	0.422	0%
0.048	0.426	1	1	0.426	0%
0.05	0.43	1	1	0.43	0%
0.055	0.442	1	1	0.442	0%
0.06	0.454	1	1	0.454	0%
0.065	0.467	1	1	0.467	0%
0.067	0.472	1	1	0.472	0%
0.07	0.48	1	1	0.48	0%
0.075	0.493	1	1	0.493	0%
0.08	0.506	1	1	0.506	0%
0.085	0.52	1	1	0.52	0%
0.09	0.534	1	1	0.534	0%
0.095	0.547	1	1	0.547	0%
0.1	0.56	1	1	0.56	0%
0.11	0.583	1	1	0.583	0%
0.12	0.605	1	1	0.605	0%
0.13	0.624	1	1	0.624	0%
0.133	0.63	1	1	0.63	0%
0.14	0.641	1	1	0.641	0%
0.15	0.657	1	1	0.657	0%
0.16	0.671	1	1	0.671	0%
0.17	0.683	1	1	0.683	0%

For Comparsion Plots of Min. Sprectra, Paste Special into Cells

Min. Spectrum for CA		Min Sprectrum for ECSZ	
T (sec)	S (a)	T (sec)	S (a)
0.01	0.2251371		
0.02	0.227673		
0.022	0.2298483		
0.025	0.2327976		
0.029	0.2364344		
0.03	0.2375072		
0.032	0.240747		
0.035	0.245462		
0.036	0.2470442		
0.04	0.253143		
0.042	0.2564221		
0.044	0.259736		
0.045	0.2614518		
0.046	0.2631768		
0.048	0.2665085		
0.05	0.2698554		
0.055	0.2816564		
0.06	0.2935355		
0.065	0.3053768		
0.067	0.3101755		
0.07	0.3172979		
0.075	0.3291013		
0.08	0.3415315		
0.085	0.3538081		
0.09	0.365894		
0.095	0.377761		
0.1	0.3892979		
0.11	0.4085219		
0.12	0.4261732		
0.13	0.4421254		
0.133	0.4464402		
0.14	0.4560439		
0.15	0.4686581		
0.16	0.4758073		
0.17	0.4817415		

0.180	0.69509
0.190	0.70572
0.200	0.71541
0.220	0.72678
0.240	0.73609
0.250	0.73986
0.260	0.74215
0.280	0.74665
0.290	0.74784
0.300	0.74910
0.320	0.74958
0.340	0.74886
0.350	0.74804
0.360	0.74711
0.380	0.74445
0.400	0.74134
0.420	0.74007
0.440	0.73812
0.450	0.73736
0.460	0.73632
0.480	0.73410
0.500	0.73204
0.550	0.72648
0.600	0.72220
0.650	0.71829
0.660	0.71607
0.700	0.71487
0.750	0.71201
0.800	0.70590
0.850	0.70022
0.900	0.69455
0.950	0.68957
1.000	0.68444
1.100	0.64994
1.200	0.61875
1.300	0.59024
1.400	0.56405
1.500	0.53928
1.600	0.51323
1.700	0.48922
1.800	0.46746
1.900	0.44772
2.000	0.42963
2.200	0.39110
2.400	0.35797
2.500	0.34310
2.600	0.32924
2.800	0.30422
3.000	0.28239
3.200	0.26261
3.400	0.24509
3.500	0.23706
3.600	0.22948
3.800	0.21547
4.000	0.20292
4.200	0.19219
4.400	0.18224
4.600	0.17313
4.800	0.16477
5.000	0.15703

0.18	0.695	1	1	0.695	0%
0.19	0.706	1	1	0.706	0%
0.2	0.716	1	1	0.716	0%
0.22	0.727	1	1	0.727	0%
0.24	0.736	1	1	0.736	0%
0.25	0.74	1	1	0.74	0%
0.26	0.742	1	1	0.742	0%
0.28	0.747	1	1	0.747	0%
0.29	0.748	1	1	0.748	0%
0.3	0.749	1	1	0.749	0%
0.32	0.75	1	1	0.75	0%
0.34	0.749	1	1	0.749	0%
0.35	0.748	1	1	0.748	0%
0.36	0.747	1	1	0.747	0%
0.38	0.745	1	1	0.745	0%
0.4	0.742	1	1	0.742	0%
0.42	0.74	1	1	0.74	0%
0.44	0.738	1	1	0.738	0%
0.45	0.738	1	1	0.738	0%
0.46	0.737	1	1	0.737	0%
0.48	0.734	1	1	0.734	0%
0.5	0.732	1	1	0.732	0%
0.55	0.712	1	1.02	0.727	0%
0.6	0.695	1	1.04	0.722	0%
0.65	0.678	1	1.06	0.719	0%
0.667	0.672	1	1.067	0.717	0%
0.7	0.662	1	1.08	0.715	0%
0.75	0.648	1	1.1	0.712	0%
0.8	0.631	1	1.12	0.706	0%
0.85	0.615	1	1.14	0.701	0%
0.9	0.599	1	1.16	0.695	0%
0.95	0.585	1	1.18	0.69	0%
1	0.571	1	1.2	0.685	0%
1.1	0.542	1	1.2	0.651	0%
1.2	0.516	1	1.2	0.619	0%
1.3	0.493	1	1.2	0.591	0%
1.4	0.471	1	1.2	0.565	0%
1.5	0.45	1	1.2	0.54	0%
1.6	0.428	1	1.2	0.514	0%
1.7	0.408	1	1.2	0.49	0%
1.8	0.39	1	1.2	0.468	0%
1.9	0.374	1	1.2	0.449	0%
2	0.359	1	1.2	0.431	0%
2.2	0.327	1	1.2	0.392	0%
2.4	0.299	1	1.2	0.359	0%
2.5	0.286	1	1.2	0.344	0%
2.6	0.275	1	1.2	0.33	0%
2.8	0.254	1	1.2	0.305	0%
3	0.236	1	1.2	0.283	0%
3.2	0.219	1	1.2	0.263	0%
3.4	0.205	1	1.2	0.245	0%
3.5	0.198	1	1.2	0.237	0%
3.6	0.192	1	1.2	0.23	0%
3.8	0.18	1	1.2	0.216	0%
4	0.169	1	1.2	0.203	0%
4.2	0.16	1	1.2	0.193	0%
4.4	0.152	1	1.2	0.183	0%
4.6	0.145	1	1.2	0.173	0%
4.8	0.138	1	1.2	0.165	0%
5	0.131	1	1.2	0.157	0%

0.18	0.4869137		
0.19	0.4912439		
0.2	0.4949344		
0.22	0.4946523		
0.24	0.4931876		
0.25	0.4919963		
0.26	0.4902766		
0.28	0.4868487		
0.29	0.4846507		
0.3	0.482453		
0.32	0.4757242		
0.34	0.4687082		
0.35	0.4650939		
0.36	0.4615137		
0.38	0.4542204		
0.4	0.4470228		
0.42	0.4379394		
0.44	0.4290256		
0.45	0.4247943		
0.46	0.4205471		
0.48	0.4123544		
0.5	0.4045111		
0.55	0.3790764		
0.6	0.3569844		
0.65	0.3374034		
0.66	0.332641		
0.7	0.3199945		
0.75	0.3043788		
0.8	0.2889993		
0.85	0.2750255		
0.9	0.2622177		
0.95	0.2505523		
1	0.2397175		
1.1	0.2194223		
1.2	0.2020163		
1.3	0.1868575		
1.4	0.1734775		
1.5	0.1614872		
1.6	0.1501231		
1.7	0.1399747		
1.8	0.13094		
1.9	0.1228753		
2	0.1156788		
2.2	0.1027948		
2.4	0.0921085		
2.5	0.0874345		
2.6	0.0831422		
2.8	0.075522		
3	0.0689993		
3.2	0.0634076		
3.4	0.058519		
3.5	0.056305		
3.6	0.0542208		
3.8	0.0503956		
4	0.0469946		
4.2	0.0441046		
4.4	0.0414755		
4.6	0.0390858		
4.8	0.0368962		
5	0.0348888		

Caltrans Deterministic ARS Spreadsheet

San Joaquin Hills Blind Thrust (Fault ID# 7)

Comparison of ARS Curves
(unlock sheet with "shmi")

Model Inputs

Fault

Magnitude	6.6	(5 to 8.5)
F_{RV}	1	(input 1 = Rev)
F_{NM}	0	(input 1 = Normal)
Dip (degree)	23	(0 to 90)
Z_{TOR} *(km)*	2	

Distance

R_{RUP} *(km)*	13.6	
R_{JB} *(km)*	9.7	
R_x *(km)*	9.4	
Hanging Wall?	☑ Yes?	
Near-Field Factor?	☑ Yes?	

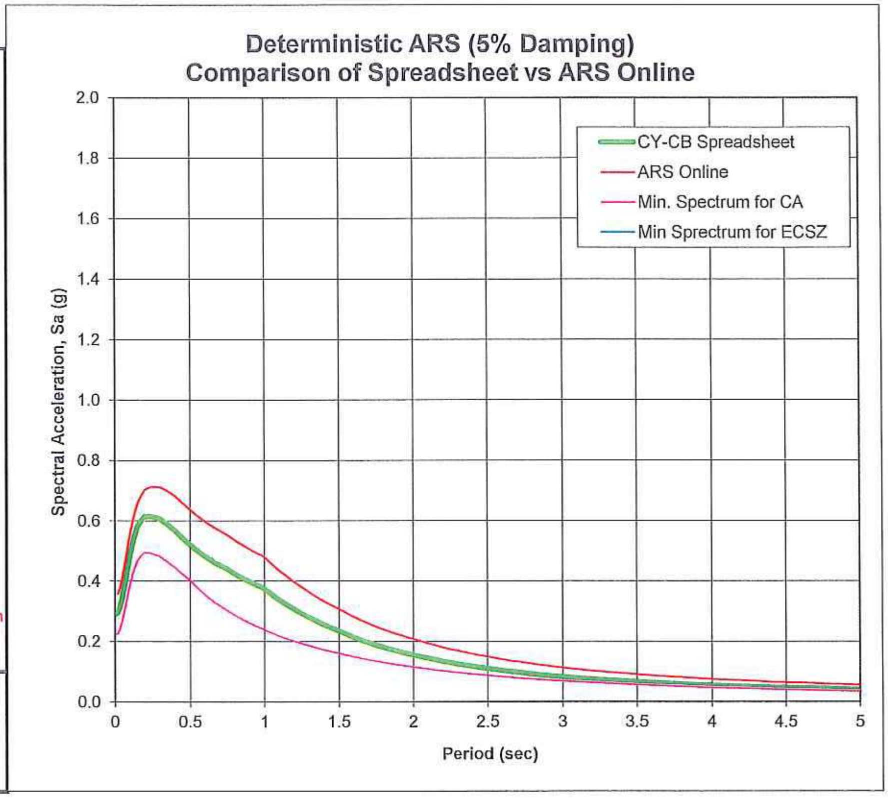
Site

V_{S30} *(m/sec)*	245	(270 to 1500 m/s)
$Z_{1.0}$ *(m)*	0	(0 - No Basin)
$Z_{2.5}$ *(km)*	0	(0 - No Basin)
No. Cal. Basin?	☐ Yes ?	(Check only for sites located within a Basin)
So. Cal. Basin?	☐ Yes ?	

Analysis

ARS Online vs CY-CB Spreadsheet Results

MAX. % Diff. = 41%



CY-CB Spreadsheet Results

T (sec)	CB-CY S(a)
0.010	0.29112
0.020	0.29498
0.022	0.29762
0.025	0.30113
0.029	0.30541
0.030	0.30671
0.032	0.31042
0.035	0.31570
0.036	0.31743
0.040	0.32412
0.042	0.32776
0.044	0.33146
0.045	0.33340
0.046	0.33532
0.048	0.33905
0.050	0.34273
0.055	0.35623
0.060	0.36978
0.065	0.38334
0.067	0.38885
0.070	0.39704
0.075	0.41060
0.080	0.42518
0.085	0.43953
0.090	0.45375
0.095	0.46773
0.100	0.48131
0.110	0.50458
0.120	0.52598
0.130	0.54536
0.133	0.55064
0.140	0.56229
0.150	0.57761
0.160	0.58685
0.170	0.59466

Place ARS Online Deterministic Data Here "Paste"

T (sec)	Base S(a)	Basin Factor	Near Fault Factor	Final Adj. S(a)	Diff. (%)
0.01	0.354	1	1	0.354	22%
0.02	0.358	1	1	0.358	21%
0.022	0.361	1	1	0.361	21%
0.025	0.365	1	1	0.365	21%
0.029	0.37	1	1	0.37	21%
0.03	0.371	1	1	0.371	21%
0.032	0.376	1	1	0.376	21%
0.035	0.381	1	1	0.381	21%
0.036	0.383	1	1	0.383	21%
0.04	0.39	1	1	0.39	20%
0.042	0.394	1	1	0.394	20%
0.044	0.398	1	1	0.398	20%
0.045	0.401	1	1	0.401	20%
0.046	0.403	1	1	0.403	20%
0.048	0.407	1	1	0.407	20%
0.05	0.411	1	1	0.411	20%
0.055	0.425	1	1	0.425	19%
0.06	0.439	1	1	0.439	19%
0.065	0.453	1	1	0.453	18%
0.067	0.459	1	1	0.459	18%
0.07	0.467	1	1	0.467	18%
0.075	0.481	1	1	0.481	17%
0.08	0.497	1	1	0.497	17%
0.085	0.511	1	1	0.511	16%
0.09	0.526	1	1	0.526	16%
0.095	0.541	1	1	0.541	16%
0.1	0.555	1	1	0.555	15%
0.11	0.579	1	1	0.579	15%
0.12	0.602	1	1	0.602	14%
0.13	0.622	1	1	0.622	14%
0.133	0.628	1	1	0.628	14%
0.14	0.64	1	1	0.64	14%
0.15	0.656	1	1	0.656	14%
0.16	0.668	1	1	0.668	14%
0.17	0.678	1	1	0.678	14%

For Comparsion Plots of Min. Sprectra, Paste Special into Cells

Min. Spectrum for CA		Min Sprectrum for ECSZ	
T (sec)	S (a)	T (sec)	S (a)
0.01	0.2251371		
0.02	0.227673		
0.022	0.2298483		
0.025	0.2327976		
0.029	0.2364344		
0.03	0.2375072		
0.032	0.240747		
0.035	0.245462		
0.036	0.2470442		
0.04	0.253143		
0.042	0.2564221		
0.044	0.259736		
0.045	0.2614518		
0.046	0.2631768		
0.048	0.2665085		
0.05	0.2698554		
0.055	0.2816564		
0.06	0.2935355		
0.065	0.3053768		
0.067	0.3101755		
0.07	0.3172979		
0.075	0.3291013		
0.08	0.3415315		
0.085	0.3538081		
0.09	0.365894		
0.095	0.377761		
0.1	0.3892979		
0.11	0.4085219		
0.12	0.4261732		
0.13	0.4421254		
0.133	0.4464402		
0.14	0.4560439		
0.15	0.4686581		
0.16	0.4758073		
0.17	0.4817415		

0.180	0.60151
0.190	0.60736
0.200	0.61237
0.220	0.61394
0.240	0.61393
0.250	0.61327
0.260	0.61221
0.280	0.60990
0.290	0.60813
0.300	0.60634
0.320	0.59958
0.340	0.59235
0.350	0.58854
0.360	0.58470
0.380	0.57688
0.400	0.56902
0.420	0.55912
0.440	0.54931
0.450	0.54465
0.460	0.53994
0.480	0.53079
0.500	0.52200
0.550	0.50165
0.600	0.48389
0.650	0.46803
0.660	0.46349
0.700	0.45378
0.750	0.44090
0.800	0.42581
0.850	0.41193
0.900	0.39892
0.950	0.38693
1.000	0.37552
1.100	0.33918
1.200	0.30786
1.300	0.28056
1.400	0.25654
1.500	0.23525
1.600	0.21474
1.700	0.19682
1.800	0.18116
1.900	0.16746
2.000	0.15542
2.200	0.13401
2.400	0.11688
2.500	0.10956
2.600	0.10293
2.800	0.09143
3.000	0.08189
3.200	0.07447
3.400	0.06814
3.500	0.06532
3.600	0.06270
3.800	0.05796
4.000	0.05380
4.200	0.05050
4.400	0.04751
4.600	0.04482
4.800	0.04236
5.000	0.04011

0.18	0.687	1	1	0.687	14%
0.19	0.695	1	1	0.695	14%
0.2	0.703	1	1	0.703	15%
0.22	0.708	1	1	0.708	15%
0.24	0.712	1	1	0.712	16%
0.25	0.713	1	1	0.713	16%
0.26	0.713	1	1	0.713	16%
0.28	0.713	1	1	0.713	17%
0.29	0.712	1	1	0.712	17%
0.3	0.712	1	1	0.712	17%
0.32	0.708	1	1	0.708	18%
0.34	0.703	1	1	0.703	19%
0.35	0.7	1	1	0.7	19%
0.36	0.697	1	1	0.697	19%
0.38	0.691	1	1	0.691	20%
0.4	0.684	1	1	0.684	20%
0.42	0.675	1	1	0.675	21%
0.44	0.666	1	1	0.666	21%
0.45	0.661	1	1	0.661	21%
0.46	0.657	1	1	0.657	22%
0.48	0.648	1	1	0.648	22%
0.5	0.639	1	1	0.639	22%
0.55	0.606	1	1.02	0.618	23%
0.6	0.577	1	1.04	0.6	24%
0.65	0.551	1	1.06	0.584	25%
0.667	0.542	1	1.067	0.578	25%
0.7	0.527	1	1.08	0.569	25%
0.75	0.505	1	1.1	0.555	26%
0.8	0.481	1	1.12	0.538	26%
0.85	0.458	1	1.14	0.523	27%
0.9	0.438	1	1.16	0.508	27%
0.95	0.419	1	1.18	0.494	28%
1	0.401	1	1.2	0.481	28%
1.1	0.364	1	1.2	0.437	29%
1.2	0.332	1	1.2	0.399	30%
1.3	0.304	1	1.2	0.365	30%
1.4	0.279	1	1.2	0.335	31%
1.5	0.257	1	1.2	0.309	31%
1.6	0.236	1	1.2	0.283	32%
1.7	0.217	1	1.2	0.261	33%
1.8	0.201	1	1.2	0.241	33%
1.9	0.187	1	1.2	0.224	34%
2	0.174	1	1.2	0.209	34%
2.2	0.151	1	1.2	0.181	35%
2.4	0.133	1	1.2	0.159	36%
2.5	0.125	1	1.2	0.15	37%
2.6	0.117	1	1.2	0.141	37%
2.8	0.105	1	1.2	0.126	38%
3	0.094	1	1.2	0.113	38%
3.2	0.086	1	1.2	0.103	38%
3.4	0.079	1	1.2	0.095	39%
3.5	0.076	1	1.2	0.091	39%
3.6	0.073	1	1.2	0.087	39%
3.8	0.067	1	1.2	0.081	40%
4	0.063	1	1.2	0.075	39%
4.2	0.059	1	1.2	0.071	41%
4.4	0.055	1	1.2	0.066	39%
4.6	0.052	1	1.2	0.063	41%
4.8	0.049	1	1.2	0.059	39%
5	0.047	1	1.2	0.056	40%

0.18	0.4869137		
0.19	0.4912439		
0.2	0.4949344		
0.22	0.4946523		
0.24	0.4931876		
0.25	0.4919963		
0.26	0.4902766		
0.28	0.4868487		
0.29	0.4846507		
0.3	0.482453		
0.32	0.4757242		
0.34	0.4687082		
0.35	0.4650939		
0.36	0.4615137		
0.38	0.4542204		
0.4	0.4470228		
0.42	0.4379394		
0.44	0.4290256		
0.45	0.4247943		
0.46	0.4205471		
0.48	0.4123544		
0.5	0.4045111		
0.55	0.3790764		
0.6	0.3569844		
0.65	0.3374034		
0.66	0.332641		
0.7	0.3199945		
0.75	0.3043788		
0.8	0.2889993		
0.85	0.2750255		
0.9	0.2622177		
0.95	0.2505523		
1	0.2397175		
1.1	0.2194223		
1.2	0.2020163		
1.3	0.1868575		
1.4	0.1734775		
1.5	0.1614872		
1.6	0.1501231		
1.7	0.1399747		
1.8	0.13094		
1.9	0.1228753		
2	0.1156788		
2.2	0.1027948		
2.4	0.0921085		
2.5	0.0874345		
2.6	0.0831422		
2.8	0.075522		
3	0.0689993		
3.2	0.0634076		
3.4	0.058519		
3.5	0.056305		
3.6	0.0542208		
3.8	0.0503956		
4	0.0469946		
4.2	0.0441046		
4.4	0.0414755		
4.6	0.0390858		
4.8	0.0368962		
5	0.0348888		

2009 Deterministic Fault Information & Seismic Procedure QC/QA Checklist

This document is to be filled out by *checker* to evaluate the fault parameters and design response spectrum used for seismic design recommendations for bridge structures. To facilitate the quality check, the designer shall provide the checker all pertinent project information, geologic information and approved exceptions (if applicable) needed to complete this form. The *checker* must be familiar with the Seismic Design Criteria (Appendix B), Deterministic PGA Map and ARS Online Report, and Geotechnical Services Design Manual in order to successfully perform a quality check. Tools available to checkers include the Deterministic Response Spectrum Spreadsheet, Probabilistic Response Spectrum Spreadsheet (after USGS), 2008 USGS National Seismic Hazard Map and the ARS Online web tool. The above documents and tools are available at http://dap3.dot.ca.gov/shake_stable/technical.php.

Project Information

Dist – EA: 12 - 0F96E County: ORA Route: 5 PM: 7.34

Bridge/Facility Name: Camino Capistrano UC Bridge/Facility No.: 55 - 0227

Latitude: 33.4736 Longitude: -117.6749

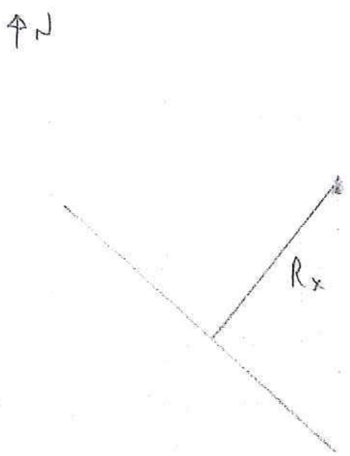
Deterministic Fault Information

Fault Name: Newport Inglewood Rose Canyon Fault ID#: 222 M_{MAX}: 7.5 Fault Type: RLSS

Fault Dip: 90 Dip Direction: V Top of Rupture: 0 Bottom of Rupture: 13

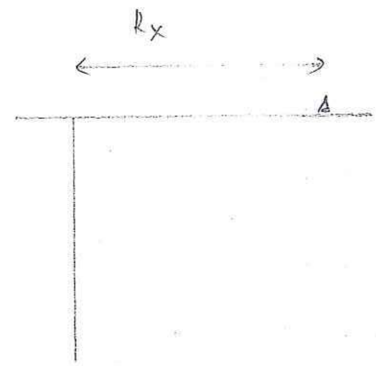
Plan View

(rough sketch; show dimensions)



Elevation View

(rough sketch; show dimensions)



Calculated or Measured Distances

R_{RUP}:	6.3 km	☒	Calculated / graphically	☒	Same as Rx (by definition)
R_{JB}:	6.3 km	☒	Calculated / graphically	☒	Same as Rx (by definition)
R_X:	6.3 km	☒	"Ruler" function on ARS Online	☐	Deterministic PGA Map

2009 Deterministic Fault Information & Seismic Procedure QC/QA Checklist

Determination of V_{S30}

V_{S30} (m/s): 245

Method of Determining V_{S30}: SPT & CPT (e.g. P-S logging, Geophysics, SPT correlations, etc)

Additional Explanation (if needed): Calibrated with CPT data

Determination of Z1.0 and Z2.5 (if site located in designated California deep basin)

$Z_{1.0}$ (m/s): 0 $Z_{2.5}$ (km/s): 0

Method of Determining $Z_{1.0}$ & $Z_{2.5}$: ARS online (e.g. ARS Online, SDC figure, other)

Additional Explanation (if needed): ______

Deterministic - Special Conditions

Yes	No	N/A	
☒	☐		Was the Errata Deterministic Fault Database Spreadsheet reviewed to ensure that the correct fault parameters used in the analysis.
☒	☐	☐	Were the Near-Fault Factors applied correctly? *Applies to sites with a R_{RUP} distance of 25 km or less, as defined in the SDC.*
☒	☐	☐	Were deep basin depths ($Z_{1.0}$ & $Z_{2.5}$) estimated correctly? *Applies to sites located in deep basins as shown in Figures B.5 - B.11 of the SDC or ARS Online.*
☐	☐	☒	If the site is located within the Eastern California Shear Zone (ECSZ), was the design ARS larger than the minimum spectrum for the ECSZ (as defined in the SDC, Appendix B, Figure B.2)?
☐	☐	☒	If the controlling fault is the Cascadia Subduction Zone, was the alternate seismic procedure applied correctly (as defined in the SDC, Appendix B)?
☐	☐	☒	If the deterministic ARS falls below the Minimum Deterministic Spectra (as defined in the SDC), did the Minimum Deterministic Spectra control the deterministic design spectrum?
☒	☐		Did the ARS Online deterministic spectrum correspond within 10% of the calculated deterministic spectrum? If not, note it in the comments section of this document and email a copy to the ARS Online development team, ARS_Online@dot.ca.gov, so that they may address the potential bug.

Probabilistic - Special Conditions

Yes	No	N/A	
☒	☐	☐	Were Near-Fault Factors applied correctly (as defined by SDC)? *Applies to sites with a deaggregation R distance of 25 km or less.*
☒	☐	☐	Were deep basin depths ($Z_{1.0}$ & $Z_{2.5}$) estimated correctly? *Applies to sites located in deep basins as shown in Figures B.5 - B.11 of the SDC or ARS Online.*
☒	☐	☐	If the site has a V_{S30} of less than 300 m/s, was the resulting ARS curve checked against spectral acceleration from USGS Interactive Deaggregation tool?
☒	☐	☐	If the USGS Interactive Deaggregation tool and spectral acceleration data were used, were the appropriate near-fault and basin correction factors applied?

2009 Deterministic Fault Information & Seismic Procedure QC/QA Checklist

Yes	No	N/A	
☐	☐	☒	If the probabilistic ARS falls below the Minimum Deterministic Spectra (as defined in the SDC), did the Minimum Deterministic Spectra control the design spectrum?
☒	☐		Did the ARS Online design spectrum correspond within 10% of the USGS spectral acceleration data from the verification spreadsheet? If not, note it in the comments section of this document and email a copy to the ARS Online development team, ARS_Online@dot.ca.gov, so that they may address the potential bug.

Comments / Observations Encountered during QC/QA process:

ARS curves were generated for other V_{s30} = 267 & 286.

Design ARS curve is average of all the curves

I certify that I have performed a quality check of the referenced fault information and design response spectrum provided by the geotechnical designer. The quality check is based on Seismic Design Criteria (Appendix B), Deterministic PGA Map and ARS Online Report, and the Geotechnical Services Design Manual.

LINO CHEANG — PRINCIPAL

Checker (Print) — Title

[signature] — 1/12/2012

Checker (Signature) — Date

I certify that the referenced project complies with Geotechnical Service's Quality Control/Quality Assurance procedures, as described in the memorandum, "Quality Control/Quality Assurance for the 2009 Seismic Design Procedures", dated August 12, 2009.

LINO CHEANG — PRINCIPAL

Functional Supervisor (Print) — Title

[signature] — 1/12/2012

Functional Supervisor (Signature) — Date

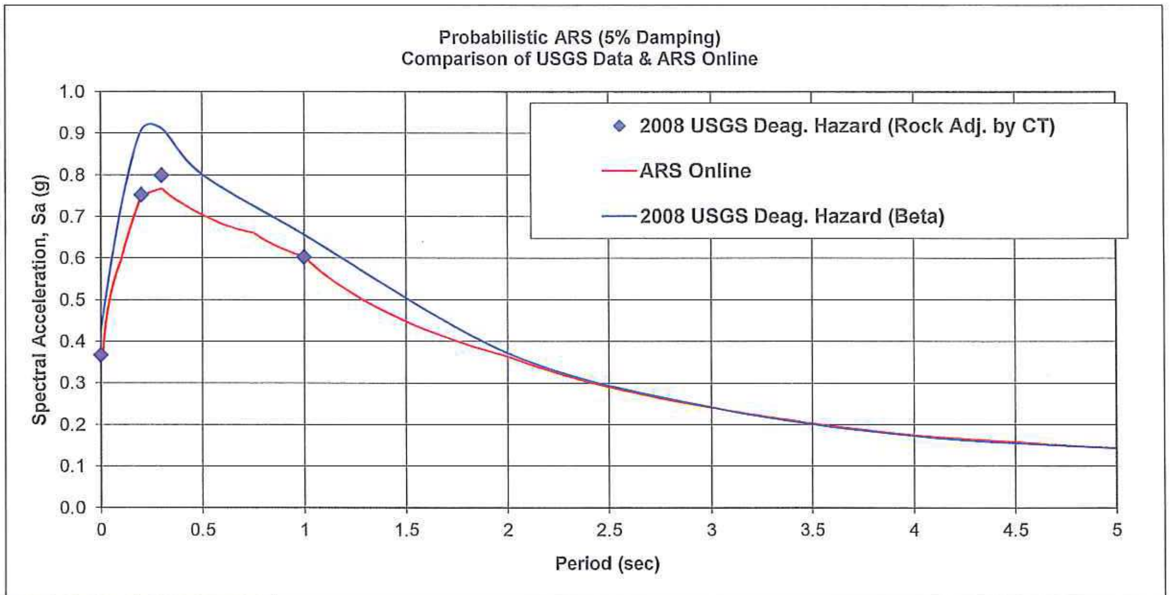
(This original checklist and signature sheet shall be placed in the geotechnical project file, and a copy sent to the Mark Willian of the Geotechnical Services Corporate Unit).

Caltrans Probabilistic Spreadsheet

Comparison spreadsheet of the 2008 USGS Probabilistic Seismic Hazard Data and ARS Online Probabilistic Data (unlock spreadsheet "shmi")
Spectral Accelerations Points from USGS Website at http://earthquake.usgs.gov/research/hazmaps/products_data/2008/data/

*** Note: This spreadsheet uses the given latitude and longitude data provided by the user to estimate spectral acceleration values with a probability of exceedence 5% in 50 yrs (or 975 yr return period). The four spectral acceleration data points plotted on the graph are from the USGS website and are based on a 0.05 degree grid. Basic interpolation is used to estimate intermediate values inside each grid. Raw Data points are provided in the tabs of this spreadsheet. Corner grid spectral acceleration data are shown in the "calculation" tab.**

Input Site Information	
Latitude	Longitude
33.4736	-117.6749
V_{S30} (m/s) =	245
Near Fault Factor, Derived from USGS Deagg. Dist (km) =	7.2
$Z_{1.0}$ (m) =	0
$Z_{2.5}$ (km) =	0



Place ARS Online Probabilistic Data Here "Paste"

T (sec)	Base Spectrum S(a)	Basin Factor	Near Fault Factor	Final Adj. Spectrum S(a)
0.01	0.368	1	1	0.368
0.02	0.425	1	1	0.425
0.022	0.434	1	1	0.434
0.025	0.445	1	1	0.445
0.029	0.459	1	1	0.459
0.03	0.463	1	1	0.463
0.032	0.469	1	1	0.469
0.035	0.478	1	1	0.478
0.036	0.481	1	1	0.481
0.04	0.491	1	1	0.491
0.042	0.496	1	1	0.496
0.044	0.501	1	1	0.501
0.045	0.503	1	1	0.503
0.046	0.506	1	1	0.506
0.048	0.51	1	1	0.51
0.05	0.515	1	1	0.515
0.055	0.525	1	1	0.525
0.06	0.535	1	1	0.535
0.065	0.544	1	1	0.544
0.067	0.547	1	1	0.547
0.07	0.552	1	1	0.552
0.075	0.56	1	1	0.56
0.08	0.568	1	1	0.568
0.085	0.575	1	1	0.575
0.09	0.582	1	1	0.582
0.095	0.589	1	1	0.589
0.1	0.595	1	1	0.595
0.11	0.614	1	1	0.614
0.12	0.632	1	1	0.632
0.13	0.649	1	1	0.649
0.133	0.654	1	1	0.654
0.14	0.666	1	1	0.666
0.15	0.681	1	1	0.681
0.16	0.696	1	1	0.696
0.17	0.71	1	1	0.71
0.18	0.724	1	1	0.724
0.19	0.737	1	1	0.737
0.2	0.75	1	1	0.75
0.22	0.754	1	1	0.754
0.24	0.757	1	1	0.757
0.25	0.759	1	1	0.759
0.26	0.761	1	1	0.761
0.28	0.764	1	1	0.764

Analysis of ARS Online Results vs USGS Deaggregation Hazard (Adj. By CT)

Period (sec)	USGS Interpolated Spectral Accel.	Adj. for Near Fault Effect	Adj. for Soil Amplification	Adj. For Basin Effect	Final Adj. USGS Spec Accel	ARS Online Final Adj. Spect. Accel.	% Difference (bet. USGS & ARS Online)
0	0.371	1.000	0.992	1.000	0.367	0.368	-0.1%
0.2	0.886	1.000	0.850	1.000	0.753	0.75	0.4%
0.3	0.730	1.000	1.095	1.000	0.799	0.767	4.0%
1	0.275	1.200	1.829	1.000	0.603	0.602	0.2%

Max % Difference = **4.0%**

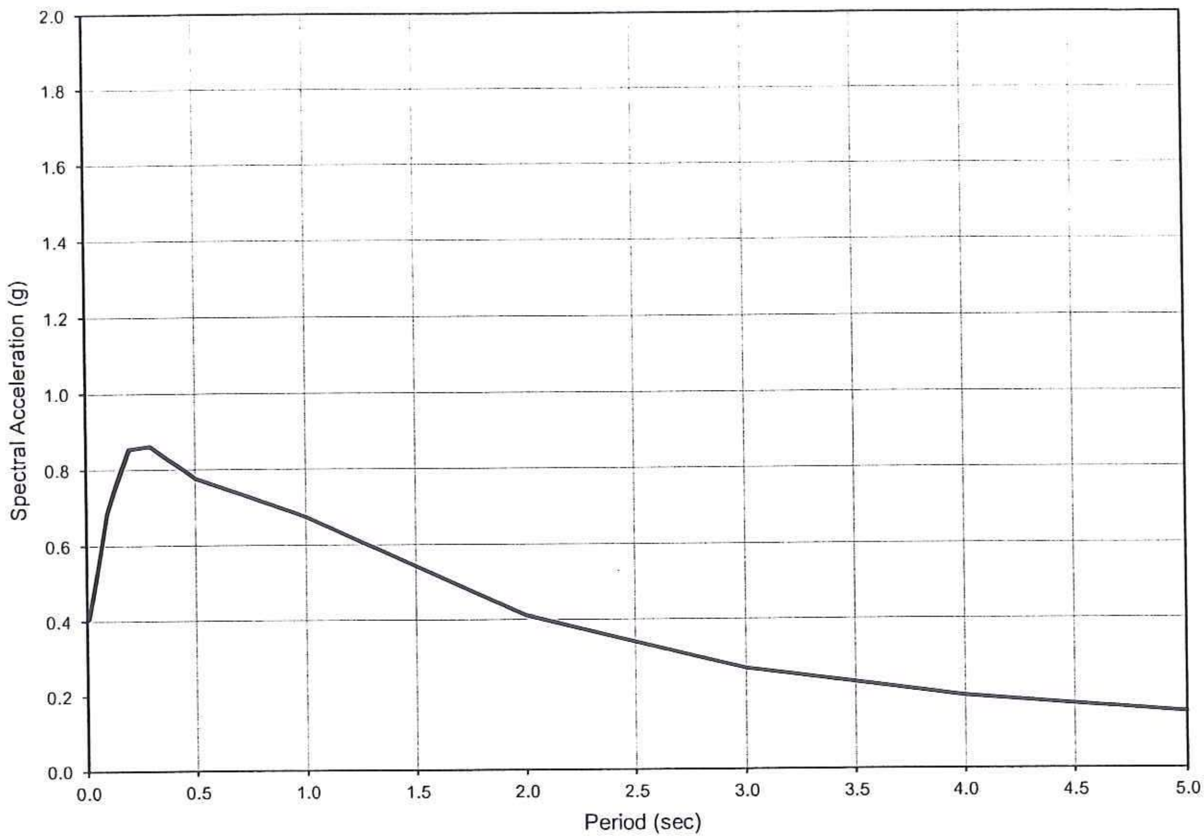
USGS Deaggregation Hazard (Beta) with Near Field and Basin Factors

Period (sec)	INPUT USGS Deagg. Spec Accel	Adj. for Near Fault Effect	Adj. For Basin Effect	Final Adj. USGS Deagg Spec Accel	ARS Online Final Adj. Spect. Accel.	% Difference (bet. USGS & ARS Online)
0	0.4246	1.000	1.000	0.425	0.368	13.3%
0.1	0.7202	1.000	1.000	0.720	0.595	17.4%
0.2	0.9067	1.000	1.000	0.907	0.75	17.3%
0.3	0.9125	1.000	1.000	0.913	0.767	15.9%
0.5	0.8022	1.000	1.000	0.802	0.705	12.1%
1	0.5479	1.200	1.000	0.657	0.602	8.4%
2	0.3107	1.200	1.000	0.373	0.364	2.4%
3	0.2019	1.200	1.000	0.242	0.242	0.1%
4	0.14426	1.200	1.000	0.173	0.175	1.0%
5	0.11937	1.200	1.001	0.143	0.144	0.5%

Max % Difference = **12.1%**

0.29	0.766	1	1	0.766
0.3	0.767	1	1	0.767
0.32	0.759	1	1	0.759
0.34	0.751	1	1	0.751
0.35	0.748	1	1	0.748
0.36	0.744	1	1	0.744
0.38	0.738	1	1	0.738
0.4	0.732	1	1	0.732
0.42	0.726	1	1	0.726
0.44	0.72	1	1	0.72
0.45	0.717	1	1	0.717
0.46	0.715	1	1	0.715
0.48	0.71	1	1	0.71
0.5	0.705	1	1	0.705
0.55	0.679	1	1.02	0.693
0.6	0.656	1	1.04	0.682
0.65	0.636	1	1.06	0.674
0.667	0.629	1	1.067	0.671
0.7	0.617	1	1.08	0.667
0.75	0.601	1	1.1	0.661
0.8	0.577	1	1.12	0.646
0.85	0.556	1	1.14	0.633
0.9	0.536	1	1.16	0.622
0.95	0.518	1	1.18	0.612
1	0.502	1	1.2	0.602
1.1	0.468	1	1.2	0.562
1.2	0.44	1	1.2	0.528
1.3	0.415	1	1.2	0.498
1.4	0.393	1	1.2	0.472
1.5	0.374	1	1.2	0.449
1.6	0.357	1	1.2	0.428
1.7	0.341	1	1.2	0.41
1.8	0.328	1	1.2	0.393
1.9	0.315	1	1.2	0.378
2	0.303	1	1.2	0.364
2.2	0.276	1	1.2	0.331
2.4	0.253	1	1.2	0.303
2.5	0.242	1	1.2	0.291
2.6	0.233	1	1.2	0.28
2.8	0.216	1	1.2	0.259
3	0.202	1	1.2	0.242
3.2	0.187	1	1.2	0.225
3.4	0.175	1	1.2	0.21
3.5	0.169	1	1.2	0.203
3.6	0.164	1	1.2	0.197
3.8	0.154	1	1.2	0.185
4	0.146	1	1.2	0.175
4.2	0.14	1	1.2	0.167
4.4	0.134	1	1.2	0.161
4.6	0.129	1	1.2	0.155
4.8	0.124	1	1.2	0.149
5	0.12	1	1.2	0.144

ARS Curve



Latitude = 33.4736 °
Longitude = -117.6749 °
Damping Ratio = 5%

Spectral Coordinates	
	Acc. (g)
Period (sec)	Design
0.010	0.408
0.100	0.684
0.200	0.855
0.300	0.862
0.500	0.777
1.000	0.675
2.000	0.412
3.000	0.269
4.000	0.193
5.000	0.150

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Camino Capistrano UC		Design ARS Curve
	Project: 11-137	Date: 01/12/12	Figure 2